EXHIBIT NO. _____

BEFORE
THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Application of	)	
Ohio Power Company for Approval	)	Case No. 16-0574-EL-POR
of Its Energy Efficiency/Peak Demand	)	
Reduction Portfolio Plan	)	

DIRECT TESTIMONY
OF
JON F. WILLIAMS
ON BEHALF OF
OHIO POWER COMPANY

INDEX TO DIRECT TESTIMONY OF
JON F. WILLIAMS
PUCO CASE NO. 16-0574-EL-POR

SUBJECT	PAGE
PERSONAL DATA	1
PURPOSE OF TESTIMONY	3
AEP OHIO'S 2017-2019 EE/PDR ACTION PLAN	5
EE/PDR PROGRAM EVALUATION AND MONITORING	14
PJM BIDDING OF EE/PDR CAPACITY	18
SHARED SAVINGS	19
NET LOST REVENUE RECOVERY MECHANISM	23
REQUEST FOR WAIVER	25
CONCLUSION	26

BEFORE
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DIRECT TESTIMONY OF
JON F. WILLIAMS
ON BEHALF OF
OHIO POWER COMPANY

PERSONAL DATA

Q. WHAT IS YOUR NAME AND BUSINESS ADDRESS?

A. My name is Jon F. Williams. My business address is 301 Cleveland Ave., S.W., Canton, OH 44702.

Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A. I am employed by Ohio Power Company (AEP Ohio or the Company), a subsidiary of American Electric Power Company, Inc. (AEP), as Manager of Energy Efficiency and Peak Demand Reduction Programs.

Q. WHAT IS YOUR EDUCATIONAL BACKGROUND AND PROFESSIONAL EXPERIENCE?

A. I graduated with a Bachelor of Science Degree in Mechanical Engineering from Clemson University in May 1981. I joined Appalachian Power Company (APCo), an AEP operating company, in June 1981 as Commercial Engineer. I was promoted to Energy Services Engineer in 1985, Marketing & Customer Services Supervisor – Logan/Williamson Division in 1986, Marketing & Customer Services Supervisor – Roanoke Division in 1988, Business Services Supervisor & Healthcare Segment Manager in 1996, and Business Services Manager in 1998. I transferred to AEP Ohio and was promoted to Customer Services & Marketing Supervisor in 2000 and Customer Services & Marketing Manager in 2003. I was promoted to my current position in 2008. I also

serve on the Executive Committee and on the Board of Directors of the Midwest Energy Efficiency Alliance.

Q. WHAT ARE YOUR RESPONSIBILITIES AS MANAGER OF ENERGY EFFICIENCY AND PEAK DEMAND REDUCTION (EE/PDR) PROGRAMS FOR AEP OHIO?

A. I am responsible for the design, development, and implementation of the portfolio of customer programs relating to energy efficiency (EE) and peak demand reduction (PDR) for AEP Ohio, including overseeing compliance with EE/PDR requirements under Senate Bill 221 (S.B. 221), Senate Bill 310 (S.B. 310), and applicable Commission regulations. My duties include working with a variety of stakeholders in the AEP Ohio EE/PDR Collaborative (Collaborative) to develop cost-effective programs that cover all customer classes. In addition, my responsibilities include overseeing the implementation of AEP Ohio's EE/PDR programs as well as measuring their success and evaluating their results.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE PUBLIC UTILITIES COMMISSION OF OHIO?

A. Yes. I provided testimony in the Commission proceedings for each of the Company's previous EE/PDR Program Portfolio Plans (EE/PDR Action Plan or Plan), including the proceeding for AEP Ohio's 2009-2011 Plan (Case Nos. 09-1089-EL-POR and 09-1090-EL-POR) and the proceeding for AEP Ohio's 2012-2014 Plan (Case Nos. 11-5568-EL-POR and 11-5569-EL-POR).

PURPOSE OF TESTIMONY

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is (1) to sponsor the Company's proposed 2017-2019 EE/PDR Program Portfolio Plan (EE/PDR Action Plan or Plan), which sets forth AEP Ohio's proposed EE/PDR programs (including some changes to existing programs and the addition of new programs) and the methodology used for evaluating, measuring, and verifying the programs; (2) to discuss AEP Ohio's plans to bid EE/PDR resources into the PJM auctions; (3) to support the importance of continuing the EE/PDR Rider, including maintaining the current recovery of program costs and shared savings incentives and continuing a net lost distribution revenue recovery mechanism; and (4) to outline the Company's request for a limited waiver of OAC 4901:1-39-05(C) to extend the deadline for annual status report filings to May 15 of each year through 2019.

Q. DO YOU SPONSOR ANY EXHIBITS IN YOUR TESTIMONY?

A. Yes. I will sponsor the following exhibits:

Exhibit JFW-1: AEP Ohio 2017-2019 EE/PDR Plan Volume 1 – Action Plan

Exhibit JFW-2: AEP Ohio 2017-2019 EE/PDR Plan Volume 2 – Appendices

Exhibit JFW-3: AEP Ohio Industry and Peer Group Awards

Q. WHAT OTHER AEP OHIO WITNESSES WILL BE SUBMITTING TESTIMONY?

A. David Gill, AEP Ohio Senior Regulatory Consultant, will support the EE/PDR Rider cost recovery rate design for the proposed Plan.

Q. WHY IS AEP OHIO FILING ITS PROPOSED PLAN ON JUNE 15, 2016?

A. On March 16, 2016, AEP Ohio filed an application in this docket seeking a limited waiver of O.A.C. 4901:l-39-04(A) to extend the April 15 filing requirement by sixty days, until June 15, 2016. In an April 7, 2016 Entry, the Commission granted AEP Ohio's request.

Q. FOR ITS 2017-2019 EE/PDR ACTION PLAN, HAS AEP OHIO COMPLIED WITH THE PLANNING REQUIREMENTS SET FORTH IN OAC 4901:1-39-03?

A. Yes. As discussed further below, in developing the programs to be included in its 2017-2019 EE/PDR Action Plan, AEP Ohio complied with OAC 4901:1-39-03 by assessing the potential energy savings and potential demand reduction; by considering each of the program design criteria set forth in the Commission's rules; by identifying promising measures not selected for inclusion in the Plan; and by collaborating with other interested parties.

Q. DOES THE PLAN BENEFIT CUSTOMERS AND THE PUBLIC INTEREST?

A. Yes. The Plan provides for equal and fair treatment on all issues for both the Company and its customers. It is in the public interest for AEP Ohio to continue current EE/PDR programs and to implement new or revised EE/PDR programs that will assist customers in becoming more energy efficient and could defer future capacity additions, thereby reducing costs for customers. All customers will benefit from the 2017-2019 Plan because the avoided generation costs saved by the Plan's EE and PDR programs are greater than the costs of providing the programs. Moreover, the 2017-2019 EE/PDR Plan will promote the public interest by reducing total generating plant emissions and, as a result, will provide significant environmental benefits to all customers. The energy

savings resulting from the Plan also will meet or exceed the requirements of S.B. 221 and S.B. 310. The proposed Plan will benefit all AEP Ohio customers.

AEP OHIO'S 2017-2019 EE/PDR ACTION PLAN

Q. WHAT ARE THE GOALS OF THE 2017-2019 ACTION PLAN?

A. The Plan is designed to meet or exceed the benchmark EE/PDR requirements in Ohio law and to fulfill the EE/PDR commitments contained in the Joint Stipulation and Recommendation (Stipulation) modified and approved by the Commission in Case Nos. 14-1693-EL-RDR et seq.[1] Once S.B. 310's "freeze" expires at the end of 2016, AEP Ohio's EE/PDR benchmarks will resume beginning in 2017. Those benchmarks require AEP Ohio to achieve 1 percent energy efficiency savings and 0.75 percent peak demand reduction in each of the three Plan years.

In addition to meeting AEP Ohio's EE/PDR benchmarks, the Plan is designed to achieve a number of other goals, a full list of which is laid out on page 1 of the Plan (Exhibit JFW-1). These goals include delivering a cost-effective and comprehensive suite of programs that provide participation opportunities for all classes of customers and every major customer segment in every region of the Company's service territory. In addition, the Plan seeks to reduce inefficient uses of electricity while improving customer productivity, enhancing customer comfort and safety, increasing customer satisfaction, and developing resources to support economic development and retention in Ohio. The Company's Plan seeks to accomplish these goals by overcoming barriers that prevent residential and business customers from adopting energy efficient technologies. AEP

[1] I am informed by counsel that the Commission's approval of the Stipulation in Case Nos. 14-1693-EL-RDR et seq. is currently subject to rehearing and that AEP Ohio retains a right to withdraw from the Stipulation, as described in AEP Ohio's filings on rehearing in that proceeding.

Ohio also intends to leverage load management capability to reduce peak demand on the system, which, all things being equal, should decrease the amount of investment required to meet peak demand.

Q. PLEASE DESCRIBE THE PROPOSED 2017-2019 EE/PDR ACTION PLAN.

A. The proposed Plan details a diverse portfolio of energy efficiency and peak demand reduction programs AEP Ohio intends to offer from 2017 through 2019. Programs are available for all customer classes, including low-income residential. To craft the Plan, AEP Ohio drew upon the success of the 2012-2014 EE/PDR Action Plan that AEP Ohio elected to continue through 2016. The Company also drew upon accepted best practices from other states (particularly in the Midwest area) along with its own substantial program design and implementation experience and the experience of other AEP operating companies.

Throughout the process of developing the 2017-2019 Plan, AEP Ohio met often with a diverse working group of stakeholders, referred to as the Collaborative, to provide input to the Plan. The Collaborative includes the following members shown in Figure 1:

Figure 1 – Collaborative Members

PUCO Staff	Ohio Farm Bureau
Ohio Consumers' Counsel	Environmental Defense Fund
Sierra Club	Mid-Ohio Regional Planning Commission
Natural Resources Defense Council	Ohio Poverty Law Center
Ohio Environmental Council	Corporation for Ohio Appalachian Development
Industrial Energy Users - Ohio	Building Industry Association of Central Ohio
Ohio Manufacturing Association	Ohio Legal Services
Ohio Development Services Agency, including the Office of Energy and Office of Community Assistance	Association of Independent Colleges and Universities of Ohio
Ohio Hospital Association	Ground Level Solutions
Ohio Partners for Affordable Energy	IMPACT Community Action
Ohio Air Quality Development Authority	CLEADS Community Action
Ohio Energy Group	Ohio Energy Project
Ohio Chamber of Commerce	Environmental Law and Policy Center
Ohio Board of Regents	

AEP Ohio held a series of regular meetings with the Collaborative to provide stakeholders opportunities to review and provide input on the existing Plan's performance, as well as to assist and advise AEP Ohio in the development of the 2017-2019 EE/PDR programs.

Q. HOW OFTEN DOES THE COMPANY MEET WITH THE COLLABORATIVE?

A. Normally, AEP Ohio meets with the Collaborative on a quarterly basis to report on EE/PDR program progress and gain input from stakeholders on the implementation of those programs. In addition to these quarterly meetings, AEP Ohio held planning meetings to develop the 2017-2019 Plan. AEP Ohio sought – and received – substantial input from stakeholders concerning the program modifications and additions proposed in the Plan, and AEP Ohio relied on that input in the developing the Plan.

Q. PLEASE ELABORATE ON AEP OHIO'S INTERACTION WITH THE COLLABORATIVE DURING THE DEVELOPMENT OF AEP OHIO'S 2017-2019 PLAN.

A. AEP Ohio established the Collaborative in October 2008 to provide key stakeholders the opportunity to provide input on program design, development, and implementation. As shown on Figure 1 above, Collaborative members include representatives from state government, business, industry, healthcare, and education, as well as consumer, low-income, and environmental advocates. AEP Ohio has held regular meetings to date, with continued, ongoing meetings planned. To date, AEP Ohio has shared key information with the Collaborative, including the Market Potential Study, the Baseline Survey, and the 2017-2019 EE/PDR Action Plan. AEP Ohio is committed to the Collaborative process and has gained valuable insight from its members. The Collaborative has been instrumental in shaping the 2017-2019 Plan, and AEP Ohio believes it has established and maintained effective and positive working relationships with Collaborative members.

Q. WHAT ARE THE CONTINUING AND NEW EE/PDR PROGRAMS FOR THE 2017-2019 ACTION PLAN?

A. Figure 2 below summarizes the ongoing and newly recommended EE/PDR programs proposed in the Plan, organized by program category.

Figure 2 – 2017-2019 EE/PDR Ongoing and New Portfolio Programs

Consumer Programs	Business Programs	Cross-Sector Programs
Ongoing Programs		
e3smart℠	Efficient Products for Business	gridSMART® Enabled EE/PDR Savings
Applicance Recycling	Process Efficiency	Education and Training
In-Home Audit	New Construction	T&D Loss Reduction Projects
Behavior Change	Self-Direct	Targeted Advertising
Community Assistance	Continuous Energy Improvement (CEI)	Research and Development
Efficient Products	Express	
New Home Program	Retro-Commissioning	
	Demand Response	
	Energy Efficiency Auction	
	Transmission and Distribution (T&D) Customer Efficiency Program	
	Data Center	
New Programs		
Intelligent Home Energy Assistance and Demand Response	Combined Heat and Power and Waste Energy Recovery - CHP/WER	Multifamily
New Energy Efficient Manufactured Home	Business Behavior Change	Customer EE Assessment Survey Program
	Microbusiness	Agricultural
	Business Outreach	Efficient Financing Program
		Community Energy Savers Program

Q. WERE ANY OF THE ONGOING PROGRAMS CHANGED FROM THEIR ORIGINAL DESIGN?

A. Yes. As a result of the Market Potential Study, the Baseline Survey, and AEP Ohio's experience implementing the programs, the 2017-19 Plan proposes slight modifications

to some of the existing programs to encourage broader participation. The Plan introduces new programs as well.

In determining whether to propose new programs or program changes, AEP Ohio examined its existing programs in detail. Although AEP Ohio's programs have been extremely successful to date, AEP Ohio has identified several challenges that will make achieving energy and demand savings goals more difficult in the future. For instance, increasingly stringent federal codes and standards for energy efficiency will require AEP Ohio to be more innovative in its program offerings. In addition, the high initial investment necessary for energy efficiency improvements continues to pose a significant obstacle for many customers, requiring AEP Ohio to calibrate the level of support it offers in its programs to encourage sufficient customer participation. There are also inherent challenges in reaching all customer segments (demographic and geographic). Accordingly, AEP Ohio designed many of the new programs proposed in the 2017-2019 Plan to focus specifically on underserved segments of AEP Ohio's customer base and to utilize new approaches to provide cost-effective energy and demand savings to these groups. In this way, the new programs provide an important supplement to the successful on-going programs in AEP Ohio's current Plan.

Detailed information about each of the EE/PDR programs proposed in the 2017-2019 Action Plan can be found in the Plan's Executive Summary (pages 34-39 of Exhibit JFW-1) and in Section 4 of the Plan (pages 70-169 of Exhibit JFW-1).

Q. WHAT IS THE ESTIMATED COST FOR THE PROPOSED PROGRAMS OVER THE PORTFOLIO PLAN PERIOD OF 2017-2019?

A. AEP Ohio is projecting to spend $292.5 million on EE/PDR programs from 2017 to 2019 in order to meet or exceed its EE/PDR goals. The proposed annual average expenditures in the 2017-2019 Plan are approximately the same as AEP Ohio's Commission-approved EE/PDR budget levels for 2014. This is a result of AEP Ohio's strong planning efforts and program management experience, as well as AEP Ohio's focused effort to retain program cost effectiveness while still providing participation opportunities for all customers. Figure 3 below shows the 2017-2019 projected spending by sector.

Figure 3 – Summary of Plan Expenditures

2017-2019 Action Plan	
Sector	**AEP Ohio Expenditure**
Consumer Sector	$114.9 million
Business Sector	$137.5 million
Cross-Sector	$40.1 million
Portfolio Total	**$292.5 million**

A more detailed breakdown of AEP Ohio's estimated expenditures is shown in Table 7 of the Plan (pages 15-16 of Exhibit JFW-1). In addition, Company witness Gill supports the corresponding EE/PDR Rider impacts.

The Company's proposed expenditure levels are necessary to achieve the goals of the proposed EE/PDR programs and are justified by many factors. As discussed above, AEP Ohio's continued focus on cost effectiveness has allowed it to keep costs in check and maintain its Commission-approved 2014 budget levels. Moreover, customer participation and interest in AEP Ohio's programs continues to grow, and

AEP Ohio is promoting the programs in a variety of ways, including through awareness campaigns on various media, AEP Ohio's website, community and business-to-business events, and customer and trade seminars. AEP Ohio customer service representatives are making direct contact with customers to educate them about program options and assist them with program participation. In addition, Collaborative members continue to be very supportive of AEP Ohio's customer education efforts. Collaborative members have distributed program information to their constituents and have hosted webinars and seminars for AEP Ohio to reach out to their members. AEP Ohio also has developed a strong network of trade allies in the energy efficiency industry that promote AEP Ohio's programs and help educate AEP Ohio's customers about energy efficiency opportunities.

Q. WHAT IS THE ESTIMATED INCREMENTAL ANNUAL SAVINGS GOAL FOR THESE PROGRAMS ACROSS ALL SECTORS OVER THE PLAN PERIOD OF 2017-2019?

A. The benchmark savings for annual sales across all sectors is 1 percent annually for energy and 0.75 percent annually for demand reduction, and the Company's Plan exceeds that goal, achieving an estimated 1.33 percent each year in energy savings and an average 1.3 percent annually in demand reduction. Tables 3, 4, and 5 of the Plan (pages 7-13 of Exhibit JFW-1) provide additional detail.

Q. DOES AEP OHIO'S PROPOSED PLAN MEET THE REQUIREMENTS OF O.A.C. 4901:1-39-04(C)?

A. Yes. In Figure 4 below, I list the requirements set forth in O.A.C. 4901:1-39-04(C) and explain how AEP Ohio addressed each requirement in its 2017-2019 Plan.

Figure 4 – EE/PDR Program Portfolio Plan Requirements

Program Requirements OAC 4901:1-39-04(C):	**Location Found in EE/PDR Action Plan (Volume 1) or Market Potential Study (Volume 2):**
(1) An executive summary and its assessment of potential pursuant to paragraph (A) of OAC 4901:1-39-03.	EE/PDR Action Plan - Executive Summary at Page 1
(2) A description of stakeholder participation in program planning efforts and program portfolio development.	EE/PDR Action Plan - Section 2.4 at Page 59 - Stakeholder Participation
(3) A description of attempts to align and coordinate programs with other public utilities' programs.	EE/PDR Action Plan - Section 2.5 at Page 60 - Inter-Utility Coordination
(4) A description of existing programs. The electric utility shall provide a summary of existing programs with a recommendation for whether the program should continue and, if so, a description of its relationship to any proposed programs. If a program has previously been approved and is unchanged, the electric utility may reference the program description currently in effect. If the electric utility is proposing to modify an existing program, the electric utility shall provide a description of the proposed modification and the basis for proposed changes.	EE/PDR Action Plan - Section 4 at Page 70 For existing programs, refer to the 2012-2014 EE/PDR Action Plan (Case Nos. 11-5568-EL-POR and 11-5569-EL-POR) and the 2015 Portfolio Status Report (Case No. 16-1099-EL-EEC). For proposed programs, refer to the EE/PDR Action Plans - Section 4 starting at Page 68.
(5) A description of proposed programs. An electric utility shall describe each program proposed to be included within its program portfolio plan with at least the following information:	[See Below]
(a) A narrative describing why the program is recommended pursuant to the program design criteria in this chapter.	EE/PDR Action Plan - Section 4 beginning at Page 70 - Program Description Section for each Program
(b) Program objectives, including projections and basis for calculating energy savings and/or peak-demand reduction resulting from the program.	EE/PDR Action Plan - Section 4 beginning at Page 70 - Objective Section for each Program
(c) The targeted customer sector.	EE/PDR Action Plan - Section 4 beginning at Page 70 - Target Market Section for each Program
(d) The proposed duration of the program.	EE/PDR Action Plan - Section 4 beginning at Page 70 - Program Duration Section for each Program
(e) An estimate of the level of program participation.	EE/PDR Action Plan - Section 4 beginning at Page 70 - Participation Section for each Program
(f) Program participation requirements, if any.	EE/PDR Action Plan - Section 4 beginning at Page 70 - Participation Section for each Program
(g) A description of the marketing approach to be employed, including rebates or incentives offered through each program, and how it is expected to influence consumer choice or behavior.	EE/PDR Action Plan - Section 4 beginning at Page 70 - Marketing Strategy Section for each Program
(h) A description of the program implementation approach to be employed.	EE/PDR Action Plan - Section 4 beginning at Page 70 - Implementation Strategy Section for each Program
(i) A program budget with projected expenditures, identifying program costs to be borne by the electric utility and collected from its customers, with customer class allocation, if appropriate.	EE/PDR Action Plan - Section 4 beginning at Page 70 - Budget Section for each Program
(j) Participant costs, if any.	EE/PDR Action Plan - Section 4 beginning at Page 70 - Participation Section for each Program

Program Requirements OAC 4901:1-39-04(C):	Location Found in EE/PDR Action Plan (Volume 1) or Market Potential Study (Volume 2):
(k) Proposed market transformation activities, if any, which have been identified and proposed to be included in the program portfolio plan.	EE/PDR Action Plan – Market Segmentation in Section 2.3 at Page 53; Cross Sector Programs - Education and Training Section 4.3.8 at Page 162; Targeted Advertising in Section 4.3.9 at Page 164; and Business Behavior Change in Section 4.2.9 at Page 126.
(l) A description of the electric utility's evaluation, measurement, and verification of the energy savings and/or peak-demand reduction resulting from each program and the process evaluations to be conducted by the electric utility.	EE/PDR Action Plan - Section 4 beginning at Page 70 – Evaluation, Measurement and Verification (EM&V) Strategy Section for each Program and Section E.11 beginning at Page 40.

EE/PDR PROGRAM EVALUATION AND MONITORING

Q. HOW DID AEP OHIO EVALUATE THE EE/PDR PROGRAMS PROPOSED IN THE PLAN?

A. The Plan includes a benefit-cost analysis for each proposed program and for the total portfolio annually for 2017 to 2019. As required by the Commission's rules, AEP Ohio applied the Commission-endorsed Total Resource Cost (TRC) test to evaluate the overall Plan. In addition, AEP Ohio also applied the TRC test to each program.

A ratio greater than or equal to 1.0 on the TRC test indicates that the programs are beneficial from a total resource perspective. Energy efficiency and peak demand reduction programs that pass the TRC test will meet customers' needs for electricity at lower costs than would meeting those needs through building or acquisition of supply-side resources.

Q. DOES AEP OHIO'S PROPOSED 2017-2019 PLAN PASS THE TRC TEST?

A. Yes. As shown in Table 9 of the Plan (pages 18-19 of Exhibit JFW-1), the overall proposed Plan passes the TRC test with a plan total TRC ratio of 1.6. In addition, as shown on Table 9, all individual programs pass the TRC test with the exception of the

Community Assistance Program, which provides weatherization assistance at no cost to qualifying lower income customers.

Q. HOW DOES AEP OHIO MEASURE PROGRAM SAVINGS?

A. AEP Ohio relies on program Evaluation, Measurement, and Verification (EM&V) methodologies and activities to verify program savings and monitor program performance. These EM&V methodologies allow AEP Ohio to determine the actual energy efficiency savings realized by each program and, as a result, help AEP Ohio maximize its energy efficiency investments. Effective EM&V ensures that expected results are measurable, that achieved results are robust and defensible, that program delivery is effective in maximizing participation, and that the overall portfolio is cost-effective.

Q. WHAT EM&V GUIDELINES DOES THE COMPANY FOLLOW?

A. At this time, AEP Ohio continues to pursue compliance with the principles established by the Commission in its rules. The Company will continue to follow the Commission's rules until further guidance is provided by the Commission.

Q. PLEASE DESCRIBE AEP OHIO'S EM&V APPROACH.

A. Section E.11 of the Plan (pages 40-44 of Exhibit JFW-1) describes AEP Ohio's EM&V approach. This approach was developed with input from the Collaborative, as well as from Navigant Consulting, Inc. (Navigant), an EM&V contractor that AEP Ohio retained to develop the Plan and that worked under my supervision.

AEP Ohio currently uses Navigant and will continue to use an experienced third-party evaluation consultant through the Plan period to further refine the EM&V

process and provide validated data for compliance reporting. Further, the Company works collaboratively with the EM&V consultant hired by the Commission.

Q. PLEASE DESCRIBE EXHIBIT JFW-2.

A. Exhibit JFW-2 contains four appendices for AEP Ohio's 2017-2019 EE/PDR Action Plan. The Volume 2 appendices are:

- Appendix A - EE/PDR Potential Study
- Appendix B - EE/PDR Benchmarking
- Appendix C - EE/PDR Measures
- Appendix D - ELRAM Model Methodology

Appendix A includes an overview and the results of the EE/PDR market potential analysis conducted over the 2017 to 2036 period. The EE/PDR market potential study provides results on the basis of three modeling scenarios: (1) technical potential; (2) economic potential; and (3) market potential. Technical potential measures the estimated total energy efficiency potential as limited by technological feasibility; economic potential measures the estimated total cost-effective potential; and market potential measures the estimated total potential that is reasonable and attainable given market limitations and program infrastructure.

A series of tables, histograms, and pie charts show the estimated EE/PDR potential for AEP Ohio across the three scenarios for the residential and commercial/industrial sectors, and all major consumer end uses, for both energy and demand savings over the 2017 to 2036 period. Appendix A additionally provides an overview discussion and data tables outlining the baseline market profile characteristics for the residential and commercial/industrial sectors used in the analysis model to

represent the characteristics of AEP Ohio's service territory and to estimate potential energy and summer peak demand savings and costs. Measure-level cost effectiveness tables are presented for all measures included in the Plan (beginning at page A-17 of Exhibit JFW-2). Measures considered for inclusion that did not meet the TRC test are also listed.

Appendix B includes the methodology and results of a benchmarking analysis that compares twelve major Midwestern Investor-Owned Utilities (IOUs) with AEP Ohio. Metrics and data presented include energy savings as a percentage of total energy sales, cost of first year energy savings per kWh, peak demand savings as a percent of peak demand, cost of first year demand savings per kW, as well as other sector-level metrics and summary market results. A key function of the benchmarking analysis is to ensure that EE/PDR potential estimates are reasonable and appropriate. In 2014 and 2015, AEP Ohio produced above-median energy savings as a percentage of sales at approximately median cost as compared with the twelve utility comparison group.

Appendix C describes a sample of the primary energy efficiency/peak demand reduction measures analyzed for the Plan and the methods used to estimate measure-level savings. The methodology and resources utilized to characterize EE/PDR measures are presented for the residential sector, non-residential sector, and cross sectors. Summary measure descriptions are provided for the residential and non-residential sectors across all major consumer end-uses. Finally, the full list of measures included in the Plan is detailed by sector and by program. Estimated measure-level data presented includes: efficiency measure name, existing baseline measure, customer decision type, unit basis,

energy impact (kWh/unit), coincident summer peak impact (W/unit), measure life, base measure incentive ($/unit), incremental cost ($/unit), and admin cost ($/unit).

AEP Ohio used the Electricity Resource Assessment Model (ELRAM), developed by Navigant, to produce a cost-effective Action Plan and to estimate energy efficiency market potential over the 2017 to 2036 period. Appendix D includes a detailed discussion of the model's key design elements, inputs, calculation steps, and outputs.

PJM BIDDING OF EE/PDR CAPACITY

Q. DOES AEP OHIO BID ELIGIBLE EE/PDR SAVINGS INTO PJM AUCTIONS?

A. Yes. AEP Ohio has been voluntarily bidding eligible demand resources from its EE/PDR programs into PJM auctions since 2012.

Q. HOW DOES AEP OHIO TREAT PJM EE/PDR REVENUES?

A. As a result of bidding resources from its EE/PDR programs into the PJM auctions, the Company receives EE/PDR capacity payments from PJM. The Company returns 80 percent of the PJM EE/PDR revenues to customers through the EE/PDR Rider and retains 20 percent of the PJM EE/PDR revenues.

Q. WHAT IS AEP OHIO REQUESTING IN ITS 2017-2019 PLAN RELATING TO BIDDING OF EE/PDR SAVINGS INTO THE PJM AUCTIONS?

A. AEP Ohio proposes to continue its efforts to bid EE/PDR savings into the PJM auctions through the next Plan period in order to monetize these demand resources to the greatest extent possible while also managing performance risk. AEP Ohio further proposes to continue the 80/20 PJM EE/PDR revenue splitting arrangement.

SHARED SAVINGS

Q. DOES AEP OHIO PROPOSE AN INCENTIVE IF THE COMPANY EXCEEDS ITS PLAN BENCHMARKS?

A. Yes. The Company proposes to maintain its current shared savings mechanism in the EE/PDR Rider as previously approved by the Commission in Case Nos. 11-5568-EL-POR and 11-5569-EL-POR. Under this Commission-approved sharing mechanism, the Company will receive, in each of the three Plan years, certain shared savings incentives if the Company exceeds its EE/PDR benchmarks. As shown in Figure 5 below, AEP Ohio's Commission-approved performance incentives are tiered, beginning at 5 percent and increasing to a maximum of 13 percent of net benefits, after taxes. These shared savings levels are also subject to an annual $20 million cap.

Figure 5 – Shared Savings Net Benefits Awarded to AEP Ohio

Achievement of Annual Target	Shared Savings %
Less than 100 %	0
100-105 %	5
Greater than 105% to 100%	7.5
Greater than 110% to 115%	10
Greater than 115%	13

Q. WHAT IS THE VALUE OF THE PROPOSED SHARED SAVINGS MECHANISM?

A. The proposed shared savings mechanism has provided – and will continue to provide – a critical incentive for the Company to exceed its EE/PDR benchmarks, which encourages more cost-effective EE/PDR activities and produces additional net savings both for

customers and the Company.[2] This incentive encourages the Company to make prudent and cost-effective decisions to maximize net benefits to customers while also exceeding the benchmark target to the greatest extent possible within the Plan budget. Many jurisdictions recognize the need to include a utility return component, such as a shared savings mechanism, in order to make EE/PDR programs attractive, from a utility financial perspective, when compared to supply-side alternatives.

AEP Ohio's Commission-approved shared savings mechanism shares the calculated net benefits for measurable EE/PDR programs between customers and the Company. The net benefits on which shared savings are based are calculated on a Utility Cost Test (UCT) basis. Specifically, net benefits are the difference between the costs avoided by implementing the EE/PDR programs (avoided capacity, energy, distribution, and transmission costs) and the costs incurred by AEP Ohio in implementing its EE/PDR programs. Generally, net benefits are calculated at the Plan level. However, the Self Direct Program and internal AEP Ohio transmission and distribution loss reduction efforts do not count toward the net benefits calculation. In addition, the Community Assistance Program does not count against the net benefits calculation.

Q. WHY IS THE COMPANY USING THE UTILITY COST TEST (UCT) TO CALCULATE NET BENEFITS?

A. The UCT properly motivates the utility to control EE/PDR program administration costs as well as participant incentive costs. In contrast, the Total Resource Cost (TRC) test

[2] As described above, AEP Ohio's EE/PDR benchmarks for the 2017-2019 period are 1 percent each year in energy savings and 0.75 percent each year in peak demand reduction.

excludes the cost of incentives provided to participants and could lead to higher total program costs for all customers.

The Ohio legislative mandate and potential penalties for failure to meet legislative targets can create a single-minded focus on meeting targets with less regard to cost. Without a return based upon the UCT effectiveness standard, a utility could meet and exceed its targets with programs that meet the TRC test effectiveness standard by offering excessive participant incentives. Program selection and Plan design based upon the TRC standard combined with a utility return based upon the UCT effectiveness standard motivates the utility to control both administrative and participant incentive costs and thus the overall costs for all customers.

Q. WHY IS IT NECESSARY FOR A UTILITY TO EARN AN INCENTIVE FOR SUCCESSFUL IMPLEMENTATION OF EE/PDR PROGRAMS?

A. Full utility cost recovery for EE/PDR programs consists of three components: program costs, net lost revenues (discussed below), and shared savings. Shared savings, in particular, are necessary to provide AEP Ohio with an opportunity to earn a return on its investment for effective EE/PDR program implementation.

EE/PDR programs are considered an alternative to supply-side investments, such as investing in generation or making potentially more expensive purchases from the market. AEP Ohio's shared savings incentive provides the opportunity for the Company to earn a reasonable return on its EE/PDR investment and properly incents the Company to control program costs and incentive levels. AEP Ohio has the expertise to administer the most effective EE/PDR programs for its customers and should continue to be permitted the opportunity to share in the savings that it helps to create for its customers

through this mechanism. Further, AEP Ohio has been extremely successful in providing innovative and highly desirable programs for its customers. See Exhibit JFW-3 for a listing of the many awards received by AEP Ohio from industry and peer groups for its programs. Also see the Company's most recent annual Portfolio Status Report (Case No. 16-1099-EL-EEC) for discussions of high customer satisfaction seen with its programs.

Q. IS THE COMPANY REQUESTING A NEW INCENTIVE APPLICABLE TO LONG-LIFE MEASURES?

A. Yes. Current shared savings incentives encourage AEP Ohio to focus its EE/PDR programs on measures that result in immediate EE/PDR impact, but there are many long-life EE/PDR measures (e.g., home insulation) whose impact is spread over a period of years. In order to encourage AEP Ohio to balance its efforts more and also focus on long-life measures that may not be as cost effective to support deeper retrofits and whole home or building energy efficiency improvements, the Company is requesting an incentive in addition to and separate from shared savings. Specifically, if the Company achieves its annual benchmark in energy efficiency of 1 percent, the Company proposes to receive an annual incentive of 10 percent of the customer incentives paid for measures installed in a given calendar year that have expected lives of 15 years or greater, up to an after-tax cap of $5 million.

Q. WHAT ARE THE BENEFITS OF THIS ADDITIONAL LONG-LIFE MEASURE COMPANY INCENTIVE?

A. With shared savings, the Company is highly focused on achieving greater savings than the legislative and regulatory requirements and delivering the most benefits possible for customers. The long-life measure incentive helps drive deeper savings and encourages

the Company to find innovative ways to exceed goals focusing on both high cost effectiveness and sustainable, long-life energy efficiency improvements, which at times can conflict with each other. Further, long-life measures can be less cost effective, but are very helpful and needed in the implementation of the Community Assistance program. This additional incentive would support efforts by the Company to assist those customers in the greatest need. Already, AEP Ohio provides high levels of funding to this program to support its lower income customers.

NET LOST REVENUE RECOVERY MECHANISM

Q. WHAT ARE NET LOST REVENUES?

A. Successful EE/PDR programs could decrease electricity consumption and, as a result, cause the utility to lose revenues. Net lost revenues are the revenues lost to EE/PDR savings minus the costs saved as a result of EE/PDR programs.

Q. WHY SHOULD AEP OHIO BE PERMITTED TO RECOVER NET LOST REVENUES?

A. No rational business would make an investment that would reduce its sales and, therefore, reduce its likelihood of recovering its fixed costs. Yet that is precisely what EE/PDR programs entail for utilities like AEP Ohio. By implementing EE/PDR programs, AEP Ohio brings about a reduction in customer energy and demand use. This will result in lower billed revenues for AEP Ohio until billing determinants can be recalculated in a subsequent base rate proceeding.

Therefore, a cost recovery policy which allows the utility to fully recover net lost revenues is essential to the continuation of a successful EE/PDR plan. This business model allows the utility to fully recover its fixed costs while at the same time offering

valuable energy efficiency products and services to its customers. As recognized in a December 2014 report from the Edison Foundation Institute for Electric Innovation, thirty-two states have recognized the importance of allowing utilities to recover net lost revenues and have implemented net lost revenue recovery mechanisms.[3]

Q. DOES AEP OHIO CURRENTLY HAVE A NET LOST REVENUE RECOVERY MECHANISM IN PLACE?

A. Only partially. AEP Ohio's Pilot Throughput Balancing Adjustment Rider (PTBAR), first approved in the Company's last distribution base case (Case No. 11-0351-EL-AIR) in connection with AEP Ohio's EE/PDR plan, and continued in the Company's third electric security plan (ESP III) (Case Nos. 13-2385-EL-SSO et seq.), allows the Company to recover lost distribution revenues.

Q. DOES THE PTBAR ALLOW AEP OHIO TO RECOVER ALL NET LOST REVENUES ATTRIBUTABLE TO ITS EE/PDR PROGRAMS?

A. No. The PTBAR applies only for residential and non-demand commercial (GS1) customers. Currently, there is no mechanism in place for AEP Ohio to recover net lost revenues for demand-metered commercial and industrial customers.

Q. WHAT DOES THE COMPANY RECOMMEND WITH RESPECT TO THE PTBAR?

A. First, the Company is requesting that the PTBAR be continued for residential and non-demand-metered commercial customers, as directed by the Commission in AEP Ohio's

[3] The Edison Foundation Institute for Electric Innovation, *State Electric Efficiency Regulatory Frameworks* at 1 (Dec. 2014), http://www.edisonfoundation.net/iei/Documents/IEI_stateEEpolicyupdate_1214.pdf

ESP III case. That proposal is reflected in AEP Ohio's recent ESP III extension filing in Case Nos. 13-2385-EL-SSO et seq.

Second, in addition to continuing the PTBAR for non-demand-metered commercial customers, AEP Ohio also requests that the Commission amend the PTBAR to allow AEP Ohio to recover net lost revenues for demand-metered commercial and industrial customers. On page 7 of the stipulation recently filed in AEP Ohio's gridSMART[4] Phase 2 proceeding (Case No. 13-1939-EL-RDR), the signatory parties (including the Commission's Staff) agreed that "another mechanism will be implemented for the Company to recover any lost distribution revenue associated with demand-metered commercial and industrial class customers." Consistent with that provision of the stipulation, AEP Ohio is requesting that the Commission affirm the Company's right to collect all net lost revenues resulting from the proposed Plan through a change to the PTBAR to include GS2, GS3, and GS4 commercial customers. In the event that the PTBAR or a similar cost recovery mechanism is not approved for continuation in the ESP III case, the Company reserves the right to request a mechanism to recover net lost revenues due to implementing the Plan's programs, for all customer classes.

REQUEST FOR WAIVER

Q. IS AEP OHIO REQUESTING A WAIVER OF THE MARCH 15 FILING REQUIREMENT IN OAC 4901:1-39-05(C)?

A. Yes. In Case No. 15-0010-EL-WVR, the Commission granted the request of the FirstEnergy companies to extend the filing deadline for the portfolio status report of all jurisdictional electric utilities to May 15 for the years 2014 through 2018. AEP Ohio

requests that this filing deadline be extended to include 2019, which would cover the period of the proposed Plan, and allow sufficient time to compile and analyze data relative to program impacts for the previous calendar year.

CONCLUSION

Q. PLEASE SUMMARIZE YOUR TESTIMONY.

A. AEP Ohio has been working closely with stakeholders through the Collaborative as well as experts in the energy efficiency industry to design, develop, and implement EE/PDR programs for all customer classes. In addition, the Company's Plan is cost effective based on the TRC and UCT tests and provides opportunities for participation for all classes of customers through a wide range of program offerings. AEP Ohio's Plan meets the requirements of the Commission's rules, S.B. 221, and S.B. 310. AEP Ohio requests that the EE/PDR Rider rates be placed in effect with the first billing cycle of 2017.

The Company requests that the Commission approve AEP Ohio's proposed 2017-2019 EE/PDR Action Plan; the proposed programs, expenditures, and cost recovery as set forth in the Plan; as well as the following:

- EE/PDR Rider Rates and Operation of the Rider – AEP Ohio requests that the Commission approve the EE/PDR Rider rates and operation as described by AEP Ohio witness Gill, including the request to adopt annual rider true-ups for actual program costs and shared savings and automatic approval of true-up filings in the absence of Commission action.

[4] "gridSMART" is a registered trademark of American Electric Power Company, Inc.

- Shared Savings – AEP Ohio requests that the Commission continue AEP Ohio's existing, Commission-approved shared savings mechanism as outlined in this testimony.
- Long-Life Measure Company Incentive – AEP Ohio requests that the Commission adopt the Long-Life Measure Company Incentive described in this testimony, so that if the Company achieves its benchmark in energy efficiency of 1 percent in a Plan year, the Company will receive an annual incentive of 10 percent of the customer incentives paid for measures installed in a given calendar year that have expected lives of 15 years or greater, up to an after-tax cap of $5 million.
- Rate Design and Cost Allocation Methodology – AEP Ohio requests that the Commission approve the rate design and cost allocation methodology supported by AEP Ohio witness Gill, in which EE/PDR Rider rates will be allocated based on the percentage of base distribution revenues by customer class.
- Net Lost Revenues – AEP Ohio requests that the Commission affirm the Company's right to collect all net lost revenues resulting from the proposed Plan through a change to the PTBAR to include GS2, GS3, and GS4 commercial customers.
- PJM EE/PDR Payments – AEP Ohio requests that the Commission approve the Company's plan to continue bidding EE/PDR resources into the PJM auctions and returning 80 percent of PJM EE/PDR revenues to customers through the EE/PDR Rider.

- Request for Waiver of OAC 4901:1-39-05(C) – AEP Ohio requests a waiver of the March 15 filing requirement extending the filing deadline for the portfolio status report to May 15 each year through the Plan period (2017-2019).

Further, this testimony has demonstrated that the Company's proposal, as a whole, will benefit customers and the public interest. AEP Ohio recommends that the Commission approve the Company's 2017-2019 Action Plan and associated cost recovery and issue its Opinion and Order in accordance with the recommendations made by the Company in this proceeding.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes.

AEP OHIO®
A unit of American Electric Power

VOLUME 1:

2017 TO 2019

ENERGY EFFICIENCY / PEAK DEMAND REDUCTION (EE / PDR) ACTION PLAN

June 15, 2016

Table of Contents

E Executive Summary 1

E.1 AEP Ohio's Commitment and Strategic Plan Goals 1
E.2 Summary of 2017-2019 EE/PDR Plan 2
E.3 Summary of EE/PDR Program Results 5
E.4 EE/PDR Plan Summary 5
E.5 Energy, Demand and Emissions Savings 10
E.6 EE/PDRs Investment and Potential Job Creation 15
E.7 Benefit-Cost Analysis, Net Benefits and Bill Impacts 17
E.8 2017 to 2036 EE/PDR Savings Potential Analysis 24
E.9 Overview of Program Plans 34
E.10 Plan Implementation 40
E.11 Evaluation, Measurement and Verification 40
E.12 Plan Risk 44
E.13 Conclusions and Recommendations 46

1 Introduction 47

1.1 AEP Ohio Overview 48
1.2 EE/PDR Study Goals and Approach 50
1.3 2017 to 2019 EE/PDR Action Plan Report Organization 50

2 Plan Development 51

2.1 Plan Tactical Objectives 51
2.2 Planning Process 51
2.3 Market Segmentation 53
2.4 Stakeholder Participation in the Planning Process 59
2.5 Attempts to Align and Coordinate with Other Public Utility Programs 60
2.6 AEP Ohio Plan Management 60

3 EE/PDR Plan Summary Results 63

3.1 Plan Framework and Summary 63
3.2 Benefit-Cost Analysis Background 63
3.3 Benefit-Cost Methodology 65
3.4 Program Development 68

4 EE/PDR Program Plans 70

4.1 Consumer Programs 70
4.1.1 Efficient Products (Ongoing Program) 70
4.1.2 Appliance Recycling (Ongoing Program) 74
4.1.3 In-Home Audit (Ongoing Program) 76
4.1.4 New Home Program (Ongoing Program) 81
4.1.5 Behavior Change (Ongoing Program) 84
4.1.6 e^{3}smart^{SM} (Ongoing Program) 86
4.1.7 Community Assistance (Ongoing Program) 88
4.1.8 Intelligent Home Energy Assistance and Demand Response (New Program) 92
4.1.9 New Energy Efficient Manufactured Home (New Program) 96
4.2 Business Programs 101
4.2.1 Efficient Products for Business (Ongoing Program, previously 'Prescriptive') 101
4.2.2 Process Efficiency (Ongoing Program, previously 'Custom') 107
4.2.3 New Construction (Ongoing Program) 110
4.2.4 Express (Ongoing Program) 114
4.2.5 Self-Direct (Ongoing Program) 118
4.2.6 Retro-Commissioning (Ongoing Program) 120
4.2.7 Continuous Energy Improvement (Ongoing Program) 122
4.2.8 Data Center (Ongoing Program) 124
4.2.9 Business Behavior Change (New Program) 126
4.2.10 Microbusiness (New Program) 129
4.2.11 Combined Heat and Power and Waste Energy Recovery – CHP/WER (New Program) 134
4.2.12 Energy Efficiency Auction (ongoing program) 137
4.2.13 Demand Response (Ongoing Program) 138
4.2.14 Transmission and Distribution (T&D) Customer Efficiency Projects (Ongoing Program) 138
4.2.15 Business Outreach (New Program) 140
4.3 Cross-Sector Programs and Other Activities 141
4.3.1 Agricultural (New Program) 141
4.3.2 Multifamily Program (New Program) 146
4.3.3 Customer Energy Efficiency Assessment Survey Program (New Program) 152
4.3.4 Efficient Financing Program (New Program) 155

4.3.5 Community Energy Savers Program (New Program).....157

4.3.6 gridSMART® Enabled EE/PDR Savings (Ongoing Program).....160

4.3.7 Transmission and Distribution (T&D) Loss Reduction Projects (Ongoing Program, previously 'T&D and Internal Efficiency Improvements').....161

4.3.8 Education and Training.....162

4.3.9 Targeted Advertising.....164

4.3.10 Research and Development 166

5 Glossary of Terms 170

Table of Tables

Table 1. SB 310 Savings Requirements (at Meter) – 2017 to 2019 4
Table 2. EE/PDR Plan Savings Results (at Meter) – 2011 to 2015 5
Table 3. Savings Goals and Efficiency Plan Investment – 2017 to 2019 7
Table 4. Incremental Annual Energy (GWh) Savings at Meter – 2017 to 2019 10
Table 5. Incremental Annual Summer Peak Demand (MW) Savings at Meter – 2017 to 2019...12
Table 6. Estimated Total Emissions Reductions – 2017 to 2019 (Metric Tons).....13
Table 7. Estimated Annual Total Investments by Program (millions) 15
Table 8. Number of Jobs Created – 2017 through 2019 17
Table 9. Cost-effectiveness Ratios – 2017 to 2019 18
Table 10. Benefit-Cost Test Formulas.....20
Table 11. Present Value Costs – 2017 to 2019 (2017$) 20
Table 12. Costs Tests – Net Present Value Benefits – 2017 to 2019 (million 2017$) 21
Table 13. Utility Cost Test (UCT) – Total Benefits (millions) 22
Table 14. 2014 EE/PDR Benchmarking Data 27
Table 15. Projected Cumulative Annual Savings at Meter and Costs – 2036.....31
Table 16. AEP Ohio Key Statistics – 2015 49
Table 17. Residential Customer Data – 2015 53
Table 18. Consumer Programs Participation – 2015.....54
Table 19. Nonresidential Customer Data – 2015 56
Table 20. Business Programs Participant Savings – 2015 57
Table 21. Comparative Benefit-Cost Tests 64

Table of Figures

Figure 1. EE/PDR vs. Supply-Side Investments (Average Unsubsidized Levelized Cost) 7
Figure 2. EE/PDR Action Plan Structure – 2017 to 2019 9
Figure 3. The Four Stages of Energy Efficiency Potential 24
Figure 4. Cumulative Annual GWh Energy Savings in 2036 32
Figure 5. Cumulative Annual Summer Peak MW Demand Savings in 2036 32
Figure 6. Market Potential Annual Energy Savings at Meter as Percent of Economic Potential in 2036 33
Figure 7. Peak Demand Savings at Meter as Percent of Economic Potential in 2036 33
Figure 8. Steps of the EM&V Process 42
Figure 9. Phases of Energy Efficiency Promotion 48
Figure 10. AEP Ohio's Service Territory 48
Figure 11. Four Stages of Energy Efficiency Potential 52
Figure 12. Residential Sector Energy Consumption – 2015 55
Figure 13. Consumer Programs Participant Savings – 2015 55
Figure 14. Nonresidential Energy Consumption – 2015 58
Figure 15. Business Programs Participant Savings – 2015 59

E EXECUTIVE SUMMARY

E.1 AEP Ohio's Commitment and Strategic Plan Goals

AEP Ohio is committed to helping customers use energy more efficiently and productively by delivering cost-effective programs that provide value to all stakeholders.

The strategic goals of this 2017-2019 Energy Efficiency and Peak Demand Reduction (EE/PDR) Action Plan (Plan) are to:

- Deliver a comprehensive and cost-effective Plan providing the opportunity for participation by all customer rate classes and every major customer segment in every region of AEP Ohio's service territory.
- Reduce inefficient uses of electricity while improving customer productivity, providing comfort and safety, and increasing customer satisfaction.
- Provide additional customer financial resources through energy savings for other important needs and to offset rising costs.
- Help delay the need for new electricity generation and future related rate impacts.
- Continue to provide the lowest cost alternative to new generation, including fossil fuels and renewable generation sources.
- Reduce the environmental impacts of fossil fuel generation facilities and the cost of compliance with environmental regulations.
- Help provide and increase sustainable jobs for Ohio.
- Increase and complement economic development in Ohio by reducing energy density per product or service provided and improving competitiveness.
- Identify and promote non-energy related financial benefits to support program delivery, providing customers total financial benefits of participation.
- Meet or exceed Ohio Senate Bill (SB) 310 energy efficiency and peak demand reduction requirements[1] and PPA Stipulation (case: 14-1693) agreement.
- Comply with Ohio Revised Code 4901:1-39 for Plan content.[2]

[1] See http://archives.legislature.state.oh.us/BillText130/130_SB_310_EN_N.pdf

[2] See http://codes.ohio.gov/oac/4901%3A1-39

E.2 Summary of 2017-2019 EE/PDR Plan

This is the third Plan developed and submitted for approval to the Public Utilities Commission of Ohio (PUCO) by AEP Ohio, and follows the approved 2012-2014 EE/PDR Action Plan.[3] The 2012-2014 EE/PDR Action Plan was extended for 2015 and 2016 as allowed under SB 310. The Plan is modeled based on the current market potential study, most recent baseline analyses, and actual results from programs delivered through the current Plan.

The Plan reflects the continuance of successful existing programs and modifications to improve program success. In addition, new programs have been added to the Plan to encourage greater participation by customers. AEP Ohio EE/PDR Collaborative (Collaborative) stakeholder input has been instrumental in identifying and adding new programs and modifications to existing ones. Segmentation continues to be enhanced, enabling targeted marketing to continue increasing customer participation. Ongoing Plan viability, customer acceptance, customer satisfaction and cost effectiveness are critically important; therefore, the Plan continues a rigorous research and development function, to ensure ongoing effective energy efficiency programs that deliver strong performance. The research and development function will also allow new program opportunities identified over the Plan life to be tested, measured and integrated into the program offerings after passing AEP Ohio's screening process.

Significant effort was made to design the Plan as cost effectively as possible. As AEP Ohio reviewed the measures available as well as current codes and standards, it has become apparent that a shift completely away from CFL lighting to light emitting diode lighting in the residential market is timely beginning in 2017. Light emitting diode lighting (LED) has significant benefits over CFLs and slightly higher savings. This shift has raised costs somewhat in the programs offered, as many of the residential programs rely on lighting to increase cost effectiveness. The Plan is designed to meet or exceed the benchmark energy efficiency and peak demand reduction requirements in Ohio law and the PPA stipulation agreement in Case #14-1693, as well as meeting AEP Ohio goals and objectives.

This Plan allows the flexibility to adjust and shift incentives within and between programs to maximize cost effectiveness and increase customer participation as conditions change over the three year period. The Plan also allows changes in the mix of measures in the programs such that new measures or changes in measures can be identified and incorporated to increase energy savings and adapt to market changes and customer preferences. Any shifting of incentives between residential and commercial/industrial customer classes would require separate PUCO approval and is not expected at this time. AEP Ohio proposes to develop separate residential and

[3] See PUCO dockets 11-5568-EL-POR and 11-5569-EL-POR for the 2012-2014 EE/PDR Action Plan.

business pools of incentive dollars, allocating those incentive dollars to the programs that are the most cost effective and have the highest customer participation each year. Further, AEP Ohio intends to utilize competitive bidding for business incentive dollars through its Auction program in the fall of each year to provide competitive intelligence that can be used to inform business program incentives in the following year, where applicable.

Cost management and overall improvement strategies for the 2017-2019 Plan include:

- Provide program opportunities to improve cost effectiveness while also increasing customer participation and satisfaction.
- Continue and enhance the successful programs currently being delivered; however, focus on adjusting incentives, as well as varying incentive strategies for all programs based on market conditions through competitive bidding and ongoing market analyses.
- Pool some incentive dollars into residential and business buckets to be delivered to customers through approved programs based on cost effectiveness and program participation. Identify methods of reducing the cost of managing and delivering incentives. Provide incentive value to customers through varying methods, considering mid-stream and upstream approaches as well as qualified contractors, co-op advertising and other approaches.
- Increase multifamily opportunities for new construction and home retrofit programs as well as delivery of multifamily program as a cross sector effort.
- Continue to investigate building code compliance educational opportunities and attribute appropriate savings.
- Focus on total electric residential customer opportunities to increase savings per home, including manufactured housing.
- Improve target marketing in all sectors. Identify likely participation by segment.
- Increase customer awareness of AEP Ohio programs with research and segmentation, to increase opportunities for all customers to participate.
- Add Combined Heat and Power and Waste Energy Recovery (CHP/WER) program and deliver performance based and highly cost effective customer projects to help offset cost effectiveness losses by other programs to codes and standards changes.
- Enhance the Continuous Energy Improvement (CEI) program to increase customer productivity and reduce energy density for large scale energy savings at lower cost. Deliver an ongoing CEI maintenance program for past and current participants.

- Provide AEP Ohio side-of-the-meter customer energy efficiency programs, such as Volt Var, and investigate LED street lighting and LED outdoor lighting programs.
- Incorporate other statewide, regional and local efforts to provide energy efficiency and demand response into AEP Ohio program offerings and partner to provide energy efficiency and demand response more cost effectively as opportunities arise through legislative, regulatory or community efforts.

Energy Efficiency and Peak Demand Reduction is an important resource for the state of Ohio, AEP Ohio and its customers, and continues to be important as future fuel and commodity prices remain volatile and environmental regulation becomes more stringent. EE/PDR may become an effective resource to help state compliance with potential future federal greenhouse gas regulations.

The market potential study that informs this Plan is the result of a current analysis of the EE/PDR market potential in AEP Ohio's service territory by Navigant Consulting, Inc. (Navigant), an experienced EE/PDR consultant, under the direct supervision and guidance of AEP Ohio. The market potential study included the results of a recent baseline study completed in AEP Ohio's service territory and the significant direct experience of AEP Ohio in its current program Plan implementation and performance, as well as benchmarking and best practices program analyses from other successful utility programs.

Ohio law in SB 310 requires investor-owned electric utilities beginning in 2009 to achieve incremental energy savings each year through EE/PDR programs, with a cumulative achievement in excess of 22 percent by the end of 2027. Utilities also must implement programs to achieve incremental peak energy demand reduction each year, with a total of 7.75 percent cumulatively through 2020. Table 1 presents SB 310 EE/PDR percentage requirements and associated energy and summer peak demand requirements for 2017 through 2019, which is the focus of this EE/PDR Action Plan.

Table 1. SB 310 Savings Requirements (at Meter) – 2017 to 2019

At Meter	Energy Savings (GWh)			
Year	Incremental		Cumulative (2009 Through)	
2017	1.0%	431.7	7.2%	3,155.3
2018	1.0%	436.3	8.2%	3,591.6
2019	1.0%	441.6	9.2%	4,033.2
At Meter	**Peak Demand Savings (MW)**			
Year	**Incremental**		**Cumulative (2009 through)**	
2017	0.75%	62.6	7.00%	584.5
2018	0.75%	64.4	7.75%	665.4
2019	0.75%	65.3	8.50%	739.8

AEP Ohio plans to meet or exceed the SB 310 savings requirements for 2017 through 2019, ensuring that all customer classes have energy saving opportunities. The Plan presents detailed information on the approach, energy efficiency and demand response measures and proposed incentive levels. AEP Ohio anticipates that portions of the Plan will need to be adjusted during implementation in response to better information or changing market conditions. AEP Ohio will update the PUCO in accordance with the rules, and advise the Collaborative regarding the need for any substantive revisions to this Plan.

E.3 Summary of EE/PDR Program Results

Table 2 presents the actual ex ante savings results submitted to the PUCO for 2011 to 2015 programs.

Table 2. EE/PDR Plan Savings Results (at Meter) – 2011 to 2015

At Meter	Energy Savings (GWh)					
Year	Incremental			Cumulative (2009 through)		
	SB 310 Requirement	GWh Achieved	Achievement as Percent of Sales	SB 310 Requirement	GWh Achieved	Achievement as Percent of Sales
2011	0.70%	445	0.92%	1.50%	1,062	2.25%
2012	0.80%	518	1.10%	2.30%	1,580	3.35%
2013	0.90%	531	1.19%	3.20%	2,111	4.53%
2014	1.00%	574	1.31%	4.20%	2,685	5.82%
2015	1.00%	540	1.24%	5.20%	3,224	7.05%
At Meter	**Peak Demand Savings (MW)**					
Year	**Incremental**			**Cumulative (2009 through)**		
	SB 310 Requirement	MW Achieved	Achievement as Percent of Sales	SB 310 Requirement	MW Achieved	Achievement as Percent of Sales
2011	0.75%	128	1.37%	2.50%	146	1.66%
2012	0.75%	75	0.85%	3.25%	221	2.51%
2013	0.75%	86	0.98%	4.00%	307	3.49%
2014	0.75%	71	0.89%	4.75%	377	4.36%
2015	0.75%	68	0.81%	5.50%	445	5.17%

Note: Does not include retired Demand Response contracts or one year measure life programs.

E.4 EE/PDR Plan Summary

AEP Ohio proposes to invest up to $292.5 million (inflation adjusted) over three years on energy efficiency and demand response programs and projects full year savings of 1,622 GWh and 343 MW cumulative annual savings at the meter over a three-year

period during calendar years 2017 through 2019. The total customer bill gross savings from this investment estimated over the life of the installed EE/PDR measures are projected at approximately $925 million, using Participant Cost Test (PCT) net benefit results less program administrative costs. Further, the total net benefits based on the Total Resource Cost (TRC) Test are projected to be about $400 million, including re-participation over the 20-year planning horizon, including Combined Heat and Power/Waste Energy Recovery (CHP/WER). Finally, every dollar of program investment results in over three dollars in net benefit, using the Utility Cost Test (UCT).

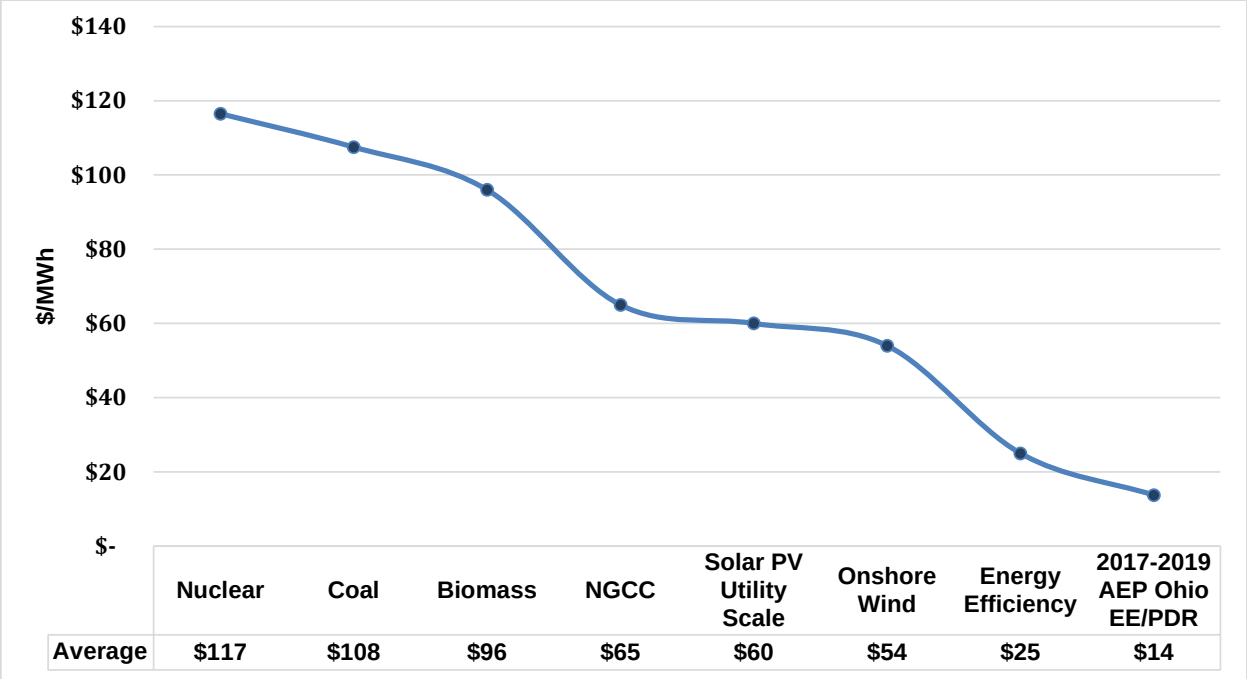
The overall Plan projected first year annual cost per kWh saved is $0.16/kWh (note this cost is not levelized, and thus is not comparable to a supply-side investment, and is only used to compare programs and Plans at a high level for reasonableness of cost.) This Plan continues the previous Plan's anticipation that the lower cost lighting opportunities are going to be less available over time; however, growing commercial and industrial measures are expected to make up for some of those losses. Large institutional or industrial combined heat and power projects can be highly cost-effective in the right applications and may provide significant opportunities to help offset the loss of low cost lighting applications. Another opportunity reflected in this Plan is the shift from CFL to LED lighting. While incremental annual savings will be lower, longer LED lighting measure life will help improve cost effectiveness.

This Plan reflects an ongoing reduction in lighting savings resulting from changes in baselines due to federal lighting standards impacts on CFL availability in AEP Ohio service territory over time affecting "as found" conditions and projected deeper savings from higher cost, but still cost effective, measures and measure combinations. AEP Ohio's actual program experience with costs has been factored into the 2017-2019 Plan cost projections.

In addition, the Plan did not assume any above primary voltage and self-assessor business customers would elect to take the streamlined opt out from the EE/PDR rider beginning in 2017 as allowed in SB 310. That information is not known and the impact of any opt outs to performance requirements is difficult to predict. Actual spending can be adjusted to reflect any future opt outs including those impacts on the Plan goals and requirements.

The lifetime cost of saved energy is estimated to be $0.014/kWh for the 2017 to 2019 EE/PDR Plan. The lifetime cost of saved energy is more comparable to a supply-side generation investment alternative. Currently, as compared with supply-side generation investment alternatives (including non-dispatchable technologies such as wind and solar), the EE/PDR Plan cost compares favorably and is the lowest cost alternative, as shown in Figure 1.

Figure 1. EE/PDR vs. Supply-Side Investments (Average Unsubsidized Levelized Cost)



Source: Lazard Levelized Cost of Energy Analysis, Version 9.0. November 2015.
Note: Properly comparing intermittent and dispatchable resource delivery cost requires consideration of other factors, including lifetime revenue.

The division of EE/PDR program investment between residential and business customers is commensurate with each sector's relative cost-effectiveness and savings contribution to the Plan. Table 3 provides the projected savings, associated funding for AEP Ohio's 2017 through 2019 program Plan, and projected net present value benefits. Annual and 2019 total dollars are inflation adjusted 2017 dollars without discounting. TRC benefits are net present value 2017 dollars.

Table 3. Savings Goals and Efficiency Plan Investment – 2017 to 2019

Consumer Sector (Incremental Annual Savings at Meter)	2017	2018	2019	2019 Cumulative Annual	TRC NPV Benefits (Million 2017$)
Energy Savings (GWh)	194.3	202.9	212.6	423.7	$118.7
% Savings of Sector Sales	1.4%	1.4%	1.5%	3.0%	
Note: Behavior Change program savings are not cumulative.					
Demand Savings (MW)	40.5	65.6	90.5	114.0	-
% Savings of Sector Sales	1.2%	1.9%	2.8%	3.5%	-
Note: Behavior Change program and Intelligent Home & DR program savings are not cumulative.					
Consumer Sector Total Cost (Million 2017$)	**$37.2**	**$38.0**	**$39.6**	**$114.9**	-

Business Sector (Incremental Annual Savings at Meter)	2017	2018	2019	2019 Cumulative Annual	TRC NPV Benefits (Million 2017$)
Energy Savings (GWh)	376.8	377.9	366.9	1,103.7	$297.4
% Savings of Sector Sales (includes Business & Cross Sectors)	1.3%	1.3%	1.3%	3.9%	
Note: Business Behavior Change program savings are not cumulative.					
Demand Savings (MW)	75.5	71.8	68.8	208.1	-
% Savings of Sector Sales (includes Business & Cross Sectors)	1.5%	1.4%	1.4%	4.1%	-
Note: Business Behavior Change program savings are not cumulative.					
Other Costs (million $)	$2.0	$2.0	$2.1	$6.1	-
Business Sector Total Cost (million 2017$)	**$46.1**	**$46.2**	**$45.2**	**$137.5**	**-**
Cross Sector (Incremental Annual Savings at Meter)	**2017**	**2018**	**2019**	**2019 Cumulative Annual**	**TRC NPV Benefits (Million 2017$)**
Energy Savings (GWh)	31.4	31.7	31.9	95.1	($22.3)
Demand Savings (MW)	1.9	2.0	2.1	6.1	
Other Costs (million $)	$10.6	$10.6	$10.6	$31.8	-
Total Costs (million 2017$)	**$13.3**	**$13.4**	**$13.4**	**$40.1**	-
Total All Sectors (Incremental Annual Savings at Meter)	**2017**	**2018**	**2019**	**2019 Cumulative Annual**	**TRC NPV Benefits (Million 2017$)**
Energy Savings (GWh)	602.5	612.5	611.5	1,622.5	$393.9
% Savings of Sector Sales	1.33%	1.36%	1.35%	3.6%	
Demand Savings (MW)	122.9	144.4	166.4	343.2	-
% Savings of Sector Sales	1.4%	1.6%	1.9%	3.9%	-
Other Costs (million $)	$12.6	$12.6	$12.7	$37.9	-
Plan Total Investment (million 2017$)	**$96.6**	**$97.6**	**$98.2**	**$292.5**	**-**

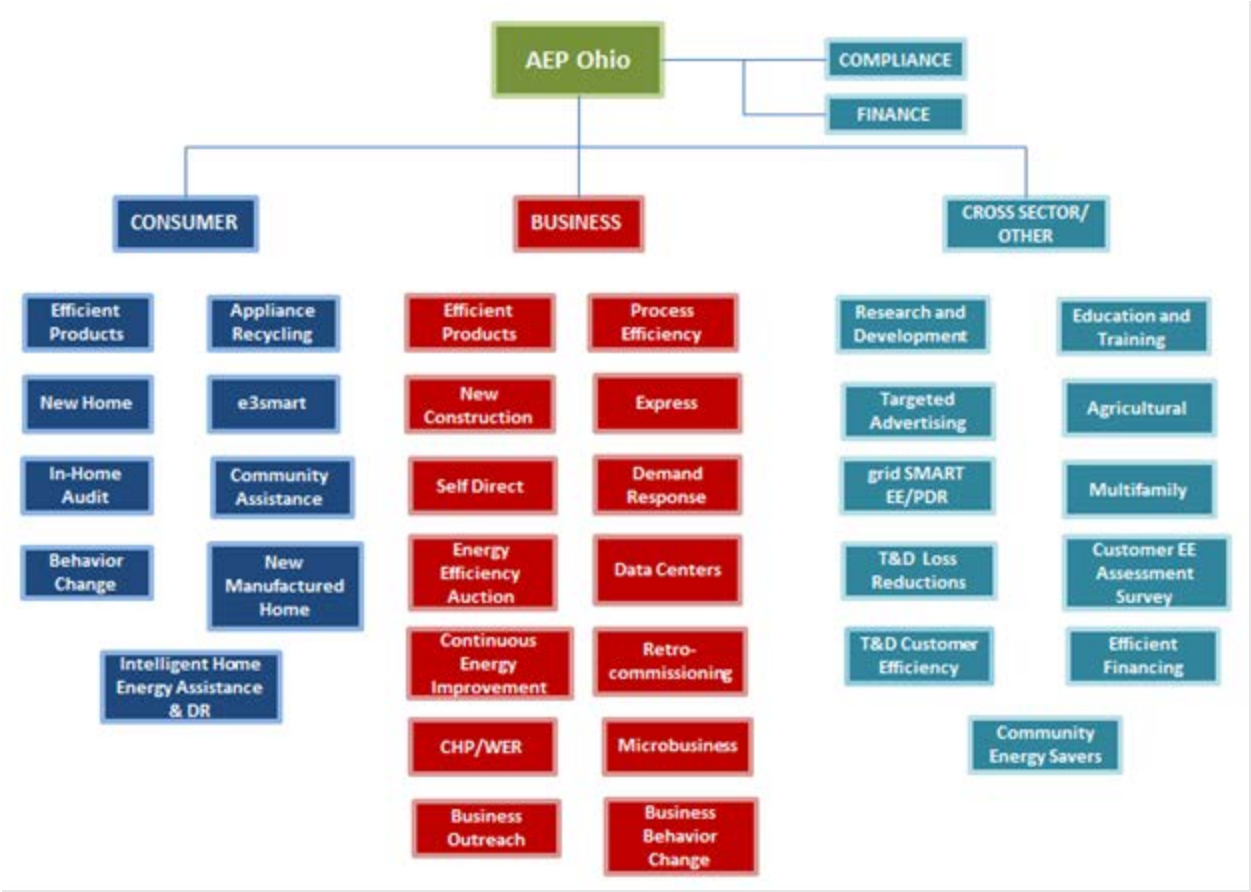
(1) Savings are not projected for Research and Development, Transmission and Distribution (T&D) Loss Reductions, T&D Customer Efficiency, Energy Efficiency Auction, gridSMART EE/PDR, Customer EE Assessment Survey, Community Energy Savers. AEP Ohio also will conduct program evaluation and other essential program support functions, such as compliance and reporting, database management, contracting and payables, and Plan cost-benefit analysis.
(2) Plan Total, Business Sector and Cross Sector TRC benefits include Other Costs.
(3) Other cross-sector costs include support and other services, general education and training, and targeted advertising, efficient financing, etc. and most of the activities listed in (1) above.
(4) The 2019 Cumulative Annual savings does not equal the sum of the 2017 to 2019 incremental annual values because of a variety of factors.
(5) Annual data is presented in inflation adjusted 2017$. Only total TRC NPV benefits are PV.
(6) TRC NPV benefits are based on benefits at generator. All other costs and savings presented at meter.
(7) Section or annual totals may not sum to Plan totals due to rounding.

Incentive levels and other program elements will be reviewed and adjusted to reflect changes in market conditions or implementation processes in order to maximize cost-effective savings.

Plan Structure

Figure 2 presents the proposed Plan structure, including nine consumer sector and fourteen business sector programs, as well as eleven cross-sector programs and other activities. AEP Ohio also will conduct program evaluation and other essential program support functions, such as compliance and reporting, financials, database management, contracting and payables and Plan benefit-cost analysis. The new programs are Agriculture, Multifamily, Manufactured Homes, Community Energy Savers, Combined Heat and Power/Waste Energy Recovery (CHP/WER), Efficient Financing, Customer EE Assessment Survey, Microbusiness, Business Behavior Change, Business Outreach, and Intelligent Home Energy Assistance and Demand Response.

Figure 2. EE/PDR Action Plan Structure – 2017 to 2019



E.5 Energy, Demand and Emissions Savings

Table 4 presents the projected incremental annual GWh energy savings for each year as well as cumulative annual through 2019, TRC test results, net present value benefits, lifetime energy saved in thousand MWh, and lifetime cost of saved energy in 2017 dollars per kWh over the three-year period from 2017 to 2019.

Table 4. Incremental Annual Energy (GWh) Savings at Meter – 2017 to 2019

Consumer Sector	2017	2018	2019	2019 Cumulative Annual	Percent of Plan Total	Total Resource Cost Test (TRC)	TRC NPV Benefits (million 2017$)	Lifetime Energy Saved (thousand MWh)	Lifetime Utility Cost of Saved Energy (2017$/ kWh)
Appliance Recycling	11.8	11.9	11.9	35.7	2.2%	1.3	$9.9	285	$0.033
Community Assistance	8.4	8.5	8.5	25.4	1.6%	0.8	($5.1)	385	$0.061
e3smart	6.8	6.8	6.9	20.5	1.3%	4.0	$10.5	262	$0.013
Efficient Products	64.5	61.1	57.0	182.6	11.3%	4.1	$96.8	2,615	$0.009
Behavior Change	75.0	75.0	75.0	75.0	4.6%	1.7	$2.9	225	$0.019
In-Home Energy	8.7	8.3	8.6	25.7	1.6%	1.5	$8.6	458	$0.032
New Home	4.7	4.8	6.1	15.6	1.0%	1.0	($0.5)	326	$0.022
Manufactured Home	2.2	2.5	2.5	7.2	0.4%	1.2	$0.7	145	$0.015
Intelligent Home & Demand Response	12.0	24.1	36.1	36.1	2.2%	1.2	$1.8	72	$0.148
Consumer Sector Total	**194.3**	**202.9**	**212.6**	**423.7**	**26.1%**	**2.0**	**$118.7**	**4,772**	**$0.023**
% Savings of Consumer Sector Sales	1.4%	1.4%	1.5%	3.0%	Note: Behavior Change and Intelligent Home & Demand Response savings are not cumulative.				

Business Sector	2017	2018	2019	2019 Cumulative Annual	Percent of Plan Total	Total Resource Cost Test (TRC)	TRC NPV Benefits (million 2017$)	Lifetime Energy Saved (thousand MWh)	Lifetime Utility CSE (2017$ / kWh)
Business Behavior Change	8.9	8.9	9.4	9.4	0.6%	1.3	$0.3	27	$0.031
Continuous Energy Improvement	19.8	23.2	23.1	66.0	4.1%	2.2	$9.3	330	$0.022
Data Center	16.6	17.1	14.3	48.0	3.0%	1.3	$3.5	240	$0.029
Efficient Products for Business	109.7	105.3	99.1	314.1	19.4%	1.9	$130.8	3,445	$0.011
New Construction and Major Renovation	27.6	28.2	28.8	84.6	5.2%	1.4	$17.0	994	$0.020
Express	14.4	14.8	14.7	43.9	2.7%	1.3	$9.8	397	$0.029
Microbusiness	9.9	9.7	10.1	29.7	1.8%	1.7	$9.2	330	$0.012
Process Efficiency	42.0	41.9	38.1	122.0	7.5%	2.4	$60.8	1,855	$0.008
Retro-Commissioning	8.6	9.4	10.2	28.2	1.7%	1.0	$0.2	141	$0.031
Self-Direct	13.2	13.3	13.4	39.9	2.5%	4.6	$18.7	390	$0.011
CHP	106.0	106.0	106.0	318.0	19.6%	1.2	$43.5	6,042	$0.0014
Business Sector Total	**376.8**	**377.9**	**366.9**	**1,103.7**	**68.0%**	**1.6**	**$297.4**	**14,191**	**$0.010**
% Savings of Sector Sales (includes Business & Cross Sectors)	1.3%	1.3%	1.3%	3.9%	Note: Behavior Change savings are not cumulative.				

Cross Sector	2017	2018	2019	2019 Cumulative Annual	Percent of Plan Total	Total Resource Cost Test (TRC)	TRC NPV Benefits (million 2017$)	Lifetime Energy Saved (thousand MWh)	Lifetime Utility CSE (2017$ / kWh)
Multifamily	5.8	6.0	6.2	18.0	1.1%	1.6	$5.4	274	$0.025
Agriculture	1.7	1.7	1.8	5.1	0.3%	2.0	$1.7	52	$0.015
T&D Loss Reductions	20.0	20.0	20.0	60.0	3.7%	NA	NA	NA	NA
Customer EE Assessment Survey	4.0	4.0	4.0	12.0	0.7%	1.7	NA	NA	NA
Cross Sector Total	**31.4**	**31.7**	**31.9**	**95.1**	**5.9%**	**0.5**	**($22.3)**	**326**	$0.11
Plan Total	**602.5**	**612.5**	**611.5**	**1,622.5**	**100%**	**1.6**	**$393.9**	**19,289**	**$0.014**
% Total Sales	1.33%	1.36%	1.35%	3.6%	Note: Business/Cross Sector and Plan Total NPV benefits include Other Costs.				

Note: The 2019 Cumulative Annual savings does not equal the sum of the 2017 to 2019 incremental annual values because of a variety of factors. Section totals may not sum to Plan totals due to rounding.

Table 5 presents the projected incremental annual summer peak demand MW savings levels as well as cumulative annual through 2019.

Table 5. Incremental Annual Summer Peak Demand (MW) Savings at Meter – 2017 to 2019

Consumer Sector	2017	2018	2019	2019 Cumulative Annual	Percent of Plan Total
Appliance Recycling	1.8	1.8	1.8	5.4	1.6%
Community Assistance	0.7	0.7	0.7	2.2	0.7%
e3smart	0.5	0.5	0.5	1.6	0.5%
Efficient Products	5.1	5.3	5.0	15.4	4.5%
Behavior Change	3.8	3.8	3.8	3.8	1.1%
In-Home Energy	2.5	2.3	2.3	7.1	2.1%
New Home	1.0	0.9	1.2	3.1	0.9%
Manufactured Home	0.1	0.1	0.1	0.3	0.1%
Intelligent Home & Demand Response	25.0	50.0	75.0	75.0	21.9%
Consumer Sector Total	**40.5**	**65.6**	**90.5**	**114.0**	**33.2%**
Percent Total of Sector Sales	**1.2%**	**1.9%**	**2.8%**	**3.5%**	**-**
Business Sector	**2017**	**2018**	**2019**	**2019 Cumulative Annual**	**Percent of Plan Total**
Business Behavior Change	4.0	4.0	4.2	4.2	1.2%
Continuous Energy Improvement	0.4	0.5	0.5	1.4	0.4%
Data Center	1.5	1.5	1.3	4.3	1.2%
Efficient Products for Business	31.5	27.9	25.6	85.0	24.8%
New Construction and Major Renovation	6.2	6.3	6.3	18.8	5.5%
Express	3.7	3.9	4.0	11.6	3.4%
Microbusiness	4.1	3.9	3.8	11.8	3.4%
Process Efficiency	7.0	6.8	6.1	20.0	5.8%
Retro-Commissioning	0.01	0.01	0.01	0.03	0.01%
Self-Direct	1.9	1.9	1.9	5.6	1.6%
CHP	15.1	15.1	15.1	45.4	13.2%
Business Sector Total	**75.5**	**71.8**	**68.8**	**208.1**	**60.7%**
Percent Total of Sector Sales	**1.5%**	**1.4%**	**1.4%**	**4.1%**	**-**

Cross Sector	2017	2018	2019	2019 Cumulative Annual	Percent of Plan Total
Multifamily	1.7	1.8	1.8	5.2	1.5%
Agriculture	0.3	0.3	0.3	0.8	0.2%
T&D Loss Reductions	5.0	5.0	5.0	15.0	4.4%
Customer EE Assessment Survey	0.0	0.0	0.0	0.0	0.0%
Cross Sector Total	**6.9**	**7.0**	**7.1**	**21.1**	6.1%
Plan Total	**122.9**	**144.3**	**166.3**	**343.0**	-
Percent of Total Sales	**1.4%**	**1.6%**	**1.9%**	**3.9%**	**-**

Note: Cumulative Annual savings in 2019 does not equal the sum of the 2017 to 2019 incremental annual values because of a variety of factors. Section totals may not sum to Plan totals due to rounding.

Table 6 presents the estimated total emissions reductions in metric tons based on the projected 2019 cumulative annual energy savings at meter.

Table 6. Estimated Total Emissions Reductions – 2017 to 2019 (Metric Tons)

Consumer Sector	CO_2	SO_2	NOx
Appliance Recycling	28,689	61	24
Community Assistance	20,445	43	17
e3smart	16,348	35	14
Efficient Products	146,874	312	124
Behavior Change	180,412	384	153
In-Home Energy	20,064	43	17
New Home	11,437	24	10
Manufactured Home	6,014	13	5
Intelligent Home & Demand Response	57,852	123	49
Consumer Sector Total	**488,135**	**1,038**	**413**

Business Sector	CO_2	SO_2	NOx
Business Behavior Change	21,469	46	18
Continuous Energy Improvement	55,705	118	47
Data Center	41,218	88	35
Efficient Products for Business	253,406	539	214
New Construction and Major Renovation	67,801	144	57
Express	35,512	76	30
Microbusiness	23,323	50	20
Process Efficiency	100,904	215	85
Retro-Commissioning	22,637	48	19
Self-Direct	32,004	68	27
CHP	254,982	542	216
Business Sector Total	**908,962**	**1,933**	**769**
Cross Sector	**CO_2**	**SO_2**	**NOx**
Multifamily	14,456	31	12
Agriculture	4,016	9	3
T&D Loss Reductions	48,110	102	41
Customer EE Assessment Survey	9,622	20	8
Cross Sector Total	**76,203**	**162**	**64**
Plan Total	**CO_2**	**SO_2**	**NOx**
	1,473,300	**3,132**	**1,246**

Source: 2017-2019 AEP Ohio EE/PDR planned efficiency investment and EPA AVERT Model. Based on 2007-2013 historical regional dispatch data. Section totals may not sum to Plan totals due to rounding.

E.6 EE/PDRs Investment and Potential Job Creation

The estimated investment for these programs is approximately $97.5 million in each year from 2017-2019, for a total $292.5 million (inflation adjusted 2017$, not present value), as shown in Table 7.

Table 7. Estimated Annual Total Investments by Program (millions)

Consumer Sector	2017	2018	2019	2017-2019 Total (cumulative)	Percent of Plan Total
Appliance Recycling	$3.2	$3.4	$3.5	$10.1	3.5%
Community Assistance	$8.5	$8.5	$8.5	$25.5	8.7%
e3smart	$1.2	$1.2	$1.2	$3.7	1.3%
Efficient Products	$9.1	$8.7	$8.0	$25.8	8.8%
Behavior Change	$1.5	$1.5	$1.5	$4.5	1.5%
In-Home Energy	$5.3	$5.1	$5.2	$15.6	5.3%
New Home	$2.4	$2.4	$3.1	$7.9	2.7%
Manufactured Home	$0.7	$0.8	$0.8	$2.3	0.8%
Intelligent Home & DR (expense)	$3.0	$4.2	$5.5	$12.7	4.3%
Intelligent Home & DR (capital)	$2.3	$2.3	$2.3	$6.8	2.3%
Consumer Sector Total	**$37.2**	**$38.0**	**$39.6**	**$114.9**	**39.3%**
Business Sector	**2017**	**2018**	**2019**	**17-19 Total (cumulative)**	**Percent of Plan Total**
Business Behavior Change	$0.3	$0.3	$0.3	$0.9	0.3%
Continuous Energy Improvement	$2.3	$2.8	$2.7	$7.8	2.7%
Data Center	$2.6	$2.7	$2.2	$7.5	2.6%
Efficient Products for Business	$14.3	$13.7	$13.3	$41.3	14.1%
New Construction/Major Renovation	$6.8	$7.1	$7.2	$21.1	7.2%
Express	$4.1	$4.2	$4.2	$12.6	4.3%
Microbusiness	$1.4	$1.4	$1.4	$4.3	1.5%
Process Efficiency	$5.7	$5.6	$4.9	$16.2	5.5%
Retro-Commissioning	$1.5	$1.6	$1.7	$4.8	1.6%
Self-Direct	$1.5	$1.5	$1.5	$4.5	1.6%
CHP	$3.4	$3.4	$3.4	$10.2	3.5%
Energy Efficiency Auction	$0.2	$0.2	$0.2	$0.6	0.2%
T&D Customer Efficiency Projects	$0.2	$0.2	$0.2	$0.6	0.2%
Business Outreach	$1.6	$1.6	$1.7	$4.9	1.7%
Business Sector Total	**$46.1**	**$46.2**	**$45.2**	**$137.5**	**47.0%**

Cross Sector	2017	2018	2019	2017-2019 Total (cumulative)	Percent of Plan Total
Multifamily	$2.4	$2.5	$2.5	$7.4	2.5%
Agriculture	$0.3	$0.3	$0.3	$0.9	0.3%
Customer EE Assessment Survey	$0.2	$0.2	$0.2	$0.6	0.2%
Efficient Financing	$1.0	$1.0	$1.0	$3.0	1.0%
Community Energy Savers	$0.5	$0.5	$0.5	$1.5	0.5%
Education and Training	$0.4	$0.4	$0.4	$1.2	0.4%
Targeted Advertising	$6.0	$6.0	$6.0	$18.0	6.2%
Research and Development	$2.5	$2.5	$2.5	$7.5	2.6%
Cross Sector Total	**$13.3**	**$13.4**	**$13.4**	**$40.1**	**13.7%**
Plan Total Investment	**$96.6**	**$97.6**	**$98.2**	**$292.5**	**100.0%**

(1) Savings are not projected for Research and Development, T&D Customer Efficiency, Energy Efficiency Auction, gridSMART EE/PDR, and Community Energy Savers. AEP Ohio also will conduct program evaluation and other essential program support functions, such as compliance and reporting, database management, contracting and payables, and Plan cost-benefit analysis.
(2) Cross-Sector Costs include support and other services, including general education and training, and targeted advertising, efficient financing, and most of the activities listed in (1) above.
(3) Section or annual totals may not sum to Plan totals due to rounding.

To firm up cost estimates and make any necessary budget and schedule changes, AEP Ohio may re-negotiate existing contracts for ongoing programs or issue Requests for Proposals (RFPs) for implementation contractors to bid on the work, and require them to submit detailed budgets along with estimated savings and implementation schedules. All new programs may be competitively bid through an RFP process. The cost for incremental internal management and third party evaluation, measurement and verification activities, and future plan development is included in the cost of the Plan. It is anticipated that these costs will not exceed ten percent of the total costs for the Plan.

Potential Job Creation

To capture the full economic impacts of the investments in energy efficiency, three separate effects (direct, indirect, and induced) must be examined for each change in expenditure. The sum of these three effects yields the total effect resulting from a single expenditure.

- The **direct effect** refers to the on-site or immediate effects produced by expenditures. In the case of installing energy efficiency upgrades in a home or business, the direct effect is the on-site expenditures and jobs of the construction or trade contractors hired to carry out the work.
- The **indirect effect** refers to the increase in economic activity that occurs when a contractor or vendor receives payment for goods or services delivered and is

able to pay others who support their businesses. This includes the equipment manufacturer or wholesaler who provided the new technology. It also includes the bank that provides financing to the contractor, the vendor's accountant, and the building owner where the contractor maintains its local offices.

- The **induced effect** derives from the change in spending that energy efficiency investments enable. Businesses and households are able to meet their energy, heating, cooling, and lighting needs at a lower total cost, due to efficiency investments. This lower cost of doing business and operating households makes greater wealth available for businesses and families to spend or invest in other goods and services such as food, clothing, entertainment, or marketing (in the case of businesses).

Table 8 shows the total number of potential jobs—direct, indirect, and induced—that are estimated would be created from investing $292.5 million in electric energy efficiency and peak demand reduction in AEP Ohio customer homes and businesses in 2017 through 2019. On average, based on this analysis, one job potentially will be created for approximately $100,000 in spending.

Table 8. Number of Jobs Created – 2017 through 2019

2017 to 2019	Direct	Indirect	Induced	Total
Jobs Created	1,300	975	650	2,925

E.7 Benefit-Cost Analysis, Net Benefits and Bill Impacts

Energy efficiency measures were evaluated with respect to each of the four standard benefit-cost tests:[4]

Participant Test (PCT): Measures are cost effective from this perspective if the reduced electric costs to the participating customer from the measure exceed the after-incentive cost of the measure to the customer.

Utility/Program Administrator (UCT or PAC) Cost Test: Measures are cost effective from this perspective if the costs avoided by the measures' energy and demand savings are greater than the utility's EE/PDR program costs to promote the measure, including customer incentives.

Ratepayer Impact Measure (RIM) Test: Measures are cost effective from this perspective if their avoided costs are greater than the sum of the EE/PDR program costs and the "lost revenues" caused by the measure.

[4] California Public Utilities Commission. California Standard Practice Manual Economic Analysis of Demand-Side Programs and Projects, October 2001, http://drrc.lbl.gov/pubs/CA-SPManual-7-02.pdf

Total Resource Cost (TRC) Test: Measures are cost effective from this perspective if their avoided costs are greater than the sum of the measure costs and the EE/PDR program administrative costs.

AEP Ohio used the TRC test to guide which EE/PDR programs to include in the Plan, noting that the Plan as a whole passes the TRC test as required by the PUCO. Most measures passed the TRC test. The Plan and the EE/PDR programs in the Plan are cost effective by industry standards.
Table 9 presents the overall benefit cost ratios for the consumer sector, the business sector, and the cross sector, and the overall Plan including all costs from other activities.

Table 9. Cost-effectiveness Ratios – 2017 to 2019

Consumer Sector	Total Resource Cost Test (TRC)	Utility Cost Test (UCT)	Participant Cost Test (PCT)	Rate Impact Measure Test (RIM)
Appliance Recycling	1.3	1.3	N/A	0.3
Community Assistance	0.8	0.8	N/A	0.3
e3smart	4.0	4.0	22.8	0.4
Efficient Products	4.1	5.5	15.1	0.4
Behavior Change	1.7	1.7	N/A	0.2
In-Home Energy	1.5	1.8	5.9	0.5
New Home	1.0	1.7	2.9	0.4
Manufactured Home	1.2	2.0	4.2	0.3
Intelligent Home & Demand Response	1.2	1.1	2.3	0.6
Consumer Sector Total	**2.1**	**2.2**	**9.3**	**0.4**

Business Sector	Total Resource Cost Test (TRC)	Utility Cost Test (UCT)	Participant Cost Test (PCT)	Rate Impact Measure Test (RIM)
Business Behavior Change	1.3	1.7	6.5	0.4
Continuous Energy Improvement	2.2	2.4	30.4	0.3
Data Center	1.3	2.4	4.1	0.4
Efficient Products for Business	1.9	7.4	3.0	0.7
New Construction and Major Renovation	1.4	2.9	2.9	0.5
Express	1.3	3.2	2.9	0.6
Microbusiness	1.7	5.6	2.8	0.7
Process Efficiency	2.4	6.9	3.9	0.7
Retro-Commissioning	1.0	1.7	4.5	0.3
Self-Direct	4.6	7.0	11.7	0.5
CHP	1.2	28.7	0.9	1.3
Business Sector Total (includes Other Costs)	**1.6**	**6.4**	**2.4**	**0.7**
Cross Sector	**Total Resource Cost Test (TRC)**	**Utility Cost Test (UCT)**	**Participant Cost Test (PCT)**	**Rate Impact Measure Test (RIM)**
Multifamily	1.6	2.1	4.5	0.5
Agriculture	2.0	4.4	4.0	0.6
Customer EE Assessment Survey	1.7	1.7	1.7	0.3
Cross Sector Total (includes Other Costs)	**0.4**	**0.5**	**4.4**	**0.3**
Plan Total (includes Other Costs)	**(TRC)**	**(UCT)**	**(PCT)**	**(RIM)**
	1.6	**4.0**	**2.8**	**0.7**

Projected Net Benefits

The formulas used to determine the net benefits for each benefit-cost test are provided in Table 10. All tests are evaluated by calculating the net present values over the lifetimes of the measures covered by the 20-year planning horizon. The total net benefits for each benefit-cost test for the 2017-2019 EE/PDR Plan are calculated by subtracting the value(s) in the denominator of each formula from the value(s) in the numerator. For example, subtracting both Administrative Costs (B) and Incentive Costs (C) from the Avoided Costs (A) results in the the UCT net benefits. Table 11 presents the present value costs for the 2017-2019 EE/PDR Plan in present value 2017 dollars (8.29% discount rate). The Avoided Costs (A) and Bill Reductions (E) result from energy

savings and are valued as benefits. The Administrative Costs (B), Incentive Costs (C), and Technology Costs (D) are valued as costs.

Table 10. Benefit-Cost Test Formulas

Cost Test	Formula	Key of Terms	
Utility Cost Test (UCT)	UCT = A / (B + C)	A = PV Avoided Costs	D = PV Technology Costs
Participant Cost Test (PCT)	PCT = (C + E) / D	B = PV Administrative Costs	E = PV Bill Reductions
Rate Impact Measure Cost Test (RIM)	RIM = A / (B + C + E)	C = PV Incentive Costs	PV = Present Value
Total Resource Cost Test (TRC)	TRC = A / (B + D)	Discount Rate = 8.29%	

Table 11. Present Value Costs – 2017 to 2019 (2017$)

PV Avoided Costs (A)	PV Administrative Costs (B)	PV Incentive Costs (C)	PV Technology Costs (D)	PV Bill Reductions (E)
$1,024,093,604	$146,885,813	$122,017,583.81	$516,620,637	$1,295,762,037

Utilty Cost Test (UCT) indicates how much utilty costs will decrease due to the projected EE/PDR programs. The UCT examines the EE/PDR costs and benefits from AEP Ohio's perspective. The UCT allows AEP Ohio to evaluate EE/PDR benefits and costs on a comparable basis with supply-side investments. A positive UCT indicates the total EE/PDR costs to save energy are less than AEP Ohio's costs to deliver the same amount of power though new supply side resources. The net benefits from the UCT is the reduction in supply costs to AEP Ohio due to reduced energy consumption.

Participant Cost Test (PCT) examines the costs and benefits from the perspective of the customer installing the EE/PDR measures. The PCT shows how much the EE/PDR program participants are projected to save over the life of the meaures installed.

Rate Impact Measure Test (RIM) indicates how much AEP Ohio's rates are projected to increase or decrease over the long term as a result of the EE/PDR measures installed. Unlike typical supply-side investments, EE/PDR programs reduce energy sales. It is also important to consider whether rates overall will increase more or less by installing EE/PDR measures than new supply side resources over the long term.

Total Resource Cost Test (TRC) shows how much more or less energy efficiency resources cost compared to new supply-side electricity resources in the AEP Ohio service area. Unlike other cost tests, the TRC does not take the view of a class of stakeholders. The TRC test is essentially the "all ratepayer" test. The TRC is similar to the UCT except that the TRC considers the full cost of the measure itself rather than only the portion covered by the incentive paid by AEP Ohio.

Table 12 presents the cost test results in terms of net present value benefits in present value 2017 dollars (8.29% discount rate) based on the projected 2017 to 2019 EE/PDR programs. A positive value indicates cost savings, while a negative value indicates increased costs.

Table 12. Costs Tests – Net Present Value Benefits – 2017 to 2019 (million 2017$)

Consumer Sector	Total Resource Cost Test (TRC)	Utility Cost Test (UCT)	Participant Cost Test (PCT)	Rate Impact Measure Test (RIM)
Appliance Recycling	$9.9	$2.7	$32.1	($22.2)
Community Assistance	($5.1)	($5.4)	$40.3	($45.4)
e3smart	$10.5	$10.5	$31.6	($21.1)
Efficient Products	$96.8	$104.5	$274.2	($177.4)
Behavior Change	$2.9	$2.9	$24.6	($21.7)
In-Home Energy	$8.6	$11.6	$39.9	($31.3)
New Home	($0.5)	$4.8	$15.2	($15.7)
Manufactured Home	$0.7	$2.1	$8.7	($8.1)
Intelligent Home & DR[1] (expense)	$1.8	$1.0	$9.0	($7.3)
Consumer Sector Total	**$125.5**	**$134.6**	**$475.8**	**($357.0)**
Business Sector	**TRC**	**UCT**	**PCT**	**RIM**
Business Behavior Change	$0.3	$0.6	$2.4	($2.0)
Continuous Energy Improvement	$9.3	$9.8	$42.6	($33.3)
Data Center	$3.5	$9.3	$27.9	($24.4)
Efficient Products for Business	$130.8	$240.2	$263.6	($132.9)
New Construction and Major Renovation	$17.0	$37.0	$66.7	($49.7)
Express	$9.8	$27.2	$36.4	($26.6)
Microbusiness	$9.2	$17.7	$20.7	($11.5)
Process Efficiency	$60.8	$89.0	$109.9	($49.1)
Retro-Commissioning	$0.2	$3.0	$15.1	($14.9)
Self-Direct	$18.7	$20.5	$38.3	($19.6)
CHP	$43.5	$227.7	($15.2)	$58.7
Energy Efficiency Auction	($0.6)	($0.6)	$0.0	($0.6)
T&D Customer Efficiency Projects	($0.6)	($0.6)	$0.0	($0.6)
Business Outreach	($4.5)	($4.5)	$0.0	($4.4)
Business Sector Total	**$297.4**	**$676.5**	**$608.4**	**($310.9)**

Cross Sector	Total Resource Cost Test (TRC)	Utility Cost Test (UCT)	Participant Cost Test (PCT)	Rate Impact Measure Test (RIM)
Multifamily	$5.4	$7.8	$21.4	($16.0)
Agriculture	$1.7	$2.6	$3.7	($2.0)
Customer EE Assessment Survey	$0.3	$0.3	$2.08	(1.47)
Other Activities	($29.4)	($29.4)	$0.0	($29.4)
Cross Sector Total	**($22.3)**	**($19.0)**	**$25.1**	**($47.4)**
Plan Total (Includes All Other Costs)	**TRC**	**UCT**	**PCT**	**RIM**
	$400.6	**$792.0**	**$1,109.3**	**($715.4)**

Note: [1] Intelligent Home & Demand Response capital costs are not included. Section totals may not sum to Plan totals due to rounding.

Table 13 shows the projected UCT results by program by year for 2017 to 2019. Annual data is presented in inflation adjusted 2017$ without discounting. 2017-2019 total is net present value 2017 dollars (8.29% discount rate).

Table 13. Utility Cost Test (UCT) – Total Benefits (millions)

Consumer Sector	2017	2018	2019	NPV 2017-2019 Total
Appliance Recycling	$0.8	$1.0	$1.2	$2.7
Community Assistance	($2.3)	($1.9)	($1.5)	($5.4)
e3smart	$3.5	$3.8	$4.1	$10.5
Efficient Products	$37.0	$37.9	$38.17	$104.5
Behavior Change	$0.9	$1.0	$1.3	$2.9
In-Home Energy	$3.7	$4.1	$4.8	$11.6
New Home	$1.5	$1.8	$2.0	$4.8
Manufactured Home	$0.6	$0.8	$0.9	$2.1
Intelligent Home & DR[2] (expense)	($1.6)	($0.4)	$2.5	$1.0
Consumer Sector Total	**$43.9**	**$48.0**	**$53.3**	**$134.6**

Business Sector	2017	2018	2019	NPV 2017-2019 Total
Business Behavior Change	$0.1	$0.2	$0.3	$0.6
Continuous Energy Improvement	$2.8	$3.7	$4.2	$9.8
Data Center	$2.9	$3.4	$3.9	$9.3
Efficient Products for Business	$85.1	$88.2	$86.3	$240.2
New Construction and Major Renovation	$11.8	$13.4	$15.1	$37.0
Express	$8.4	$9.9	$11.3	$27.2
Microbusiness	$5.9	$6.4	$7.0	$17.7
Process Efficiency	$29.7	$31.6	$35.2	$89.0
Retro-Commissioning	$0.8	$1.1	$1.4	$3.0
Self-Direct	$6.8	$7.4	$8.0	$20.5
CHP	$79.5	$75.3	$72.3	$227.7
Energy Efficiency Auction	($0.2)	($0.2)	($0.2)	($0.6)
T&D Customer Efficiency Projects	($0.2)	($0.2)	($0.2)	($0.6)
Business Outreach	($1.6)	($1.6)	($1.7)	($4.5)
Business Sector Total	**$231.9**	**$238.6**	**$243.0**	**$676.5**
Cross Sector	**2017**	**2018**	**2019**	**NPV 2017-2019 Total**
Multifamily	$2.3	$2.9	$3.3	$7.8
Agriculture	$0.9	$0.9	$1.0	$2.6
Customer EE Assessment Survey	$0.2	$0.1	($0.0)	$0.3
Other Activities	($10.4)	($10.5)	($10.6)	($29.1)
Cross Sector Total	**($7.1)**	**($6.6)**	**($6.1)**	**($18.5)**
Plan Total (includes Other Costs)	**2017**	**2018**	**2019**	**NPV 2017-2019 Total**
	$268.4	**$279.8**	**$290.1**	**$792.0**

(1) Intelligent Home & Demand Response capital costs are not included. Section totals may not sum to Plan totals due to rounding.

Projected Electric Bill Reductions

The projected gross reductions in electric bills for participants in each consumer and business sector program over the life of the measures installed during 2017 to 2019 is approximately $1.3 billion. The next section discusses the approach to estimating EE/PDR potential, along with an overview of EE/PDR Potential results for 2017 to 2036, and then program plans are presented, followed by conclusions and recommendations.

E.8 2017 to 2036 EE/PDR Savings Potential Analysis

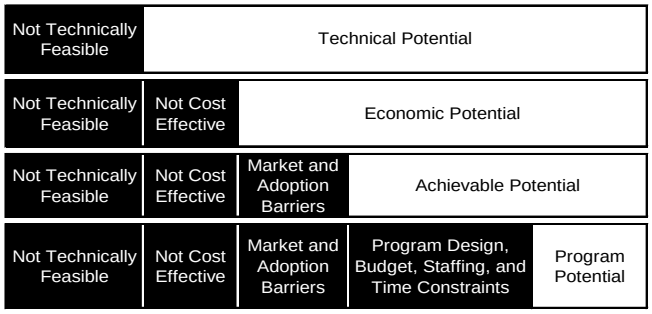
AEP Ohio's program Plan was developed by incorporating elements of the most successful energy efficiency and peak demand reduction programs across North America many of which are already being delivered by AEP Ohio, into program plans designed for the Ohio market and AEP Ohio customers in particular. AEP Ohio used a benchmarking process to review the selected programs, with a focus on successful AEP Ohio and other programs in the Midwest to help shape this Plan.

As detailed in Figure 1, there are four major types of EE/PDR potential:

1. *Technical* potential for all technologies.
2. *Economic* potential, the amount of EE/PDR available that is cost effective.
3. *Achievable (or Market)* potential, the amount of EE/PDR available under current market conditions and available investments.
4. *Program* potential, the amount of EE/PDR available given limited resources, available time and duration of the efficiency program planning period.

AEP Ohio's EE/PDR Action Plan is focused on capturing cost-effective *program potential* in its service territory while achieving SB 310 requirements for 2017 to 2019. Most energy efficiency measures that were known not to be cost-effective were pre-screened and eliminated from all potential scenarios. Some measures not cost-effective were included as part of an overall program delivery strategy for high customer satisfaction and participation.

Figure 3. The Four Stages of Energy Efficiency Potential



Source: Reproduced from "Guide to Resource Planning with Energy Efficiency November 2007", US EPA. Figure 2-1.

AEP Ohio undertook the EE/PDR potential study with the following key tasks:

- Characterize the EE/PDR measures.
- Conduct an EE/PDR benchmarking and best practices analysis.
- Conduct benefit-cost analysis (discussed in Section E.7).

- Estimate EE/PDR potentials.
- Develop EE/PDR program plans.
- Utilize the most recent baseline market profile study, which included conducting telephone surveys and on-site surveys with random samples of AEP Ohio's residential and non-residential customers. The telephone surveys collected information on customers' awareness of AEP Ohio programs and energy efficiency measures, as well as customers' energy efficient equipment decision making criteria. The on-site surveys conducted detailed inventories of customers' energy using equipment, as well as building shell characteristics.
- Utilize the most recently developed baseline consumption profiles and initial building simulation model specifications.

A summary of each of these tasks follows.

Baseline Market Assessments

AEP Ohio conducted a baseline study of the residential market segments in 2013 to characterize AEP Ohio's service territory in terms of customer numbers, age and size of household and housing stock, key building characteristics, saturation of efficient technologies, and customer awareness of and decision making about efficient options. Appendix A in Plan Volume 2 includes detailed baseline survey results.

Baseline Consumption Profiles and Simulation Model Specifications

Segment-level commercial and industrial sales data delivered by AEP Ohio provide a good starting point to determine customer energy use in broad end-use categories, such as lighting, heating, and cooling. These profiles were the calibration points in developing hourly computer models of energy consumption. With building characteristics from the baseline study, the models were used to estimate savings from EE/PDR measures.

The derivation of the residential electricity market profile relied on monthly consumption data and benchmark monthly profiles of end uses to derive annual electricity consumption for seasonal and non-seasonal uses. The starting point in this exercise was the AEP Ohio system-level residential electricity consumption by month for 2014-2015. The household total electricity consumption by month was calculated from this data. There are four seasonal end uses that were tabulated (heating, cooling, hot water, and lighting) in addition to the non-seasonal end uses (appliances, plug loads, and other). Results of the baseline study were used for technology saturation data.

Characterizing EE/PDR Measures

Characterization of EE/PDR measures requires:

- Estimating the baseline energy consumption for each end-use (heating, cooling, cooking, hot water, etc.) or unit energy consumption (UEC).
- Estimating the incremental savings from each measure – improving from the baseline to the new technology.
- Determining the incremental costs and lifetimes for each of the new technologies.

In addition, the baselines must consider that different classes of buildings have different penetrations of technologies, such as existing homes compared to new construction. A combination of approaches to characterize the EE/PDR measures was used for this study. For EE/PDR measures having impacts that do not vary with climate, data was used from several different sources, including: ongoing AEP Ohio programs, the 2013 residential and baseline study, the 2014 residential lighting socket study, the Ohio Statewide TRM, and engineering estimates, as well as publicly available and well-respected sources, such as the California Database on Energy-Efficiency Resources (DEER). The approach adjusted the DEER energy and demand impacts for AEP Ohio's customer operating parameters as necessary based on the local weather. In addition to using data from ongoing AEP Ohio programs, or the Ohio Statewide TRM for climate-dependent measures, the analysis used a combination of building simulation modeling and engineering estimates specifically developed for AEP Ohio to estimate EE/PDR measure per unit savings.

For EE/PDR measure costs, in addition to using data from ongoing AEP Ohio programs or the Ohio Statewide TRM for climate dependent data, AEP Ohio primarily used the California DEER database, adjusted by geographic multiplier factors from industry sources, such as RS Means Mechanical Cost Data.[5] A variety of sources were used to establish measure lifetimes, including, ongoing AEP Ohio programs, the Ohio Statewide TRM, manufacturer data, typical economic depreciation assumptions, and the California DEER database. Appendix C in Plan Volume 2 provides detailed measure descriptions and characterizations.

EE/PDR Benchmarking and Best Practices Assessment

To ensure that the demand side management (DSM) potential estimates developed are reasonable and appropriate, and to identify the best practices of DSM programs, AEP Ohio conducted a benchmarking assessment on other utilities' DSM programs, in Ohio

[5] http://rsmeans.reedconstructiondata.com/

and in neighboring states, that have similar DSM requirements and Plans and available data about them. To identify common best practices of top performers, the analysis compared detailed program results by customer sector of those utilities identified as achieving high levels of DSM savings for below-median costs.

Table 14 shows the 2014 and 2015 median EE/PDR benchmarking data for AEP Ohio and twelve other Midwest utilities, including overall spending, savings, costs, and energy costs. Appendix B in Plan Volume 2 provides more benchmarking results.

Table 14. 2014 EE/PDR Benchmarking Data

	Spending as Percent of Revenue	Energy Savings as Percent of Sales	Peak Demand Savings as Percent of Peak Demand	Retail Cost of Energy $/kWh	Cost of First Year Savings (1)	
					$/kWh	$/kW
All Region Median 2014	1.4%	1.1%	0.8%	$0.10	$0.12	$963
AEP Ohio 2014	1.7%	1.5%	1.0%	$0.10	$0.12	$946
AEP Ohio 2015 (2)	1.5%	1.2%	0.8%	$0.10	$0.12	$981

(1) Note: Cost of First Year Savings is not comparable to a supply-side investment and is only used to compare programs and Plans at a high level for reasonableness of cost.
(2) AEP Ohio 2015 results have not been evaluated.

In 2014, the utilities with the largest relative energy savings and below-median costs achieved energy savings at about 1.4 percent of annual sales. The utilities with the largest relative peak demand savings and below-median costs saved about 1.1 percent of peak demand. AEP Ohio saved more than the median amount of savings from the utilities' benchmarked in 2014 and 2015, and AEP Ohio's program costs were lower than the median program costs.

EE/PDR Program Potentials

AEP Ohio developed estimates of EE/PDR measure potentials in terms of technical, economic, and market potential (the program results that are realistic for AEP Ohio to achieve through cost-effective EE/PDR programs). Economic potential was estimated using the TRC test as described above as the economic "screen" to apply to technical potential estimates in order to determine whether the measures are "cost-effective" or not, and inform which measures were to be included or excluded.

EE/PDR market potential estimates the amount of EE/PDR potential that could be captured by realistic EE/PDR programs that include cost effective EE/PDR measures over the forecast period covered by this EE/PDR potential analysis. EE/PDR market potential can vary with EE/PDR program parameters, such as the magnitude of rebates or incentives offered to customers for installing EE/PDR measures and, thus, many different scenarios can be modeled.

To estimate market potential, a computer model was used to estimate conversion rates from inefficient products to more efficient products for retrofit and replacement measures, as well as installation rates in new buildings for new construction markets. These conversion, replacement, and new construction penetration rates are based on AEP Ohio's and other utilities' actual experiences with these types of programs.

The market potential estimates assume that adequate funding is available to achieve the EE/PDR potentials and that AEP Ohio is able to achieve "best practice" EE/PDR program performance over the short term, from 2017 to 2019.

EE/PDR Potential Results

The cumulative annual EE/PDR potential savings (Market Potential) in 2036, not including CHP/WER, is estimated to be approximately 6.8 thousand GWh at meter, about 14.0 percent of forecast baseline sales, and approximately 1,330 MW at meter, about 13.6 percent of baseline peak summer demand, as shown in

Table 15.

Table 15 also presents the projected savings in 2036 for the technical and economic potential scenarios.

These results assume a net-to-gross impact ratio of 1.0 whereby free ridership is assumed for this analysis to be offset by spillover impacts. The market potential meets the SB 310 savings targets over the short term, from 2017 to 2019. Unless already specified for a particular measure, the market potential includes incentives at 50 percent of incremental measure costs. Appendix A in Plan Volume 2 provides detailed EE/PDR potential study results.

Table 15. Projected Cumulative Annual Savings at Meter and Costs – 2036

Potential Scenario	Cumulative Annual Gross Energy Savings at Meter (2036) (1)		Cumulative Annual Gross Summer Peak Demand Savings at Meter (2036) (1)		Total Cost (Energy Efficiency Only) (2)
Sector	GWh	Percent of 2036 Forecast Sales	MW	Percent of 2036 Forecast Sales	20 Year Cost (2017 to 2036) (million 2017$)
Residential					
Technical	8,600	58.3%	2,492	69.9%	-
Economic	6,443	43.7%	1,624	45.5%	-
Market	1,946	13.2%	526	14.7%	$1,223
Commercial and Industrial (does not include CHP)					
Technical	24,223	72.8%	3,480	56.1%	-
Economic	22,226	66.8%	3,254	52.5%	-
Market	4,790	14.4%	803	12.9%	$889
Total					
Technical (3)	**32,823**	**68.3%**	**5,972**	**61.1%**	**-**
Economic	**28,669**	**59.7%**	**4,878**	**49.9%**	**-**
Market	**6,736**	**14.0%**	**1,329**	**13.6%**	**$2,113**

(1) Savings are not projected for Research and Development, Transmission and Distribution (T&D) Loss Reductions, T&D Customer Efficiency, Energy Efficiency Auction, gridSMART EE/PDR, Customer EE Assessment Survey, Community Energy Savers. For comparative purposes, savings are not included for Combined Heat and Power / Waste Energy Recovery. AEP Ohio also will conduct program evaluation and other essential program support functions, such as compliance and reporting, database management, contracting and payables, and Plan cost-benefit analysis.
(2) Total Technical Potential does not include savings from codes and standards.

show the cumulative annual energy and summer peak demand savings in 2036 for each of the three potential analysis scenarios. Figure 6 and Figure 7 show the cumulative Market Potential as a percent of the Economic Potential for EE/PDR.

Figure 4 and Figure 5 show the cumulative annual energy and summer peak demand savings in 2036 for each of the three potential analysis scenarios. Figure 6 and Figure 7 show the cumulative Market Potential[6] as a percent of the Economic Potential for EE/PDR.

[6] Defined here as the potential achievable in real-world market risk situations.

Figure 4. Cumulative Annual GWh Energy Savings in 2036

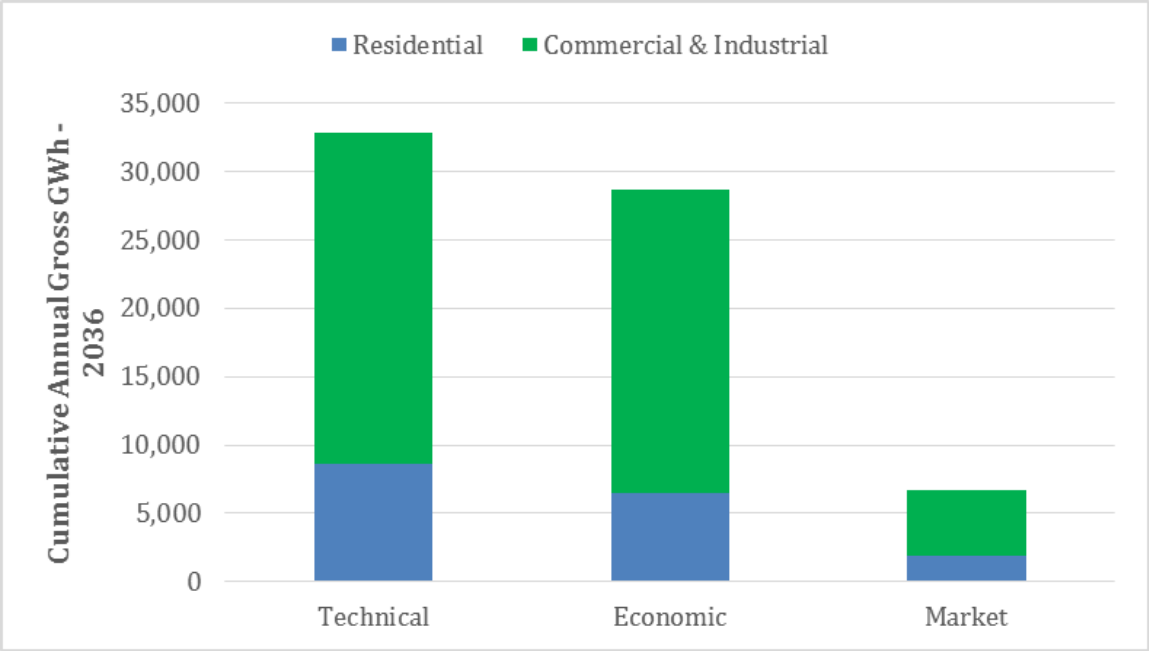
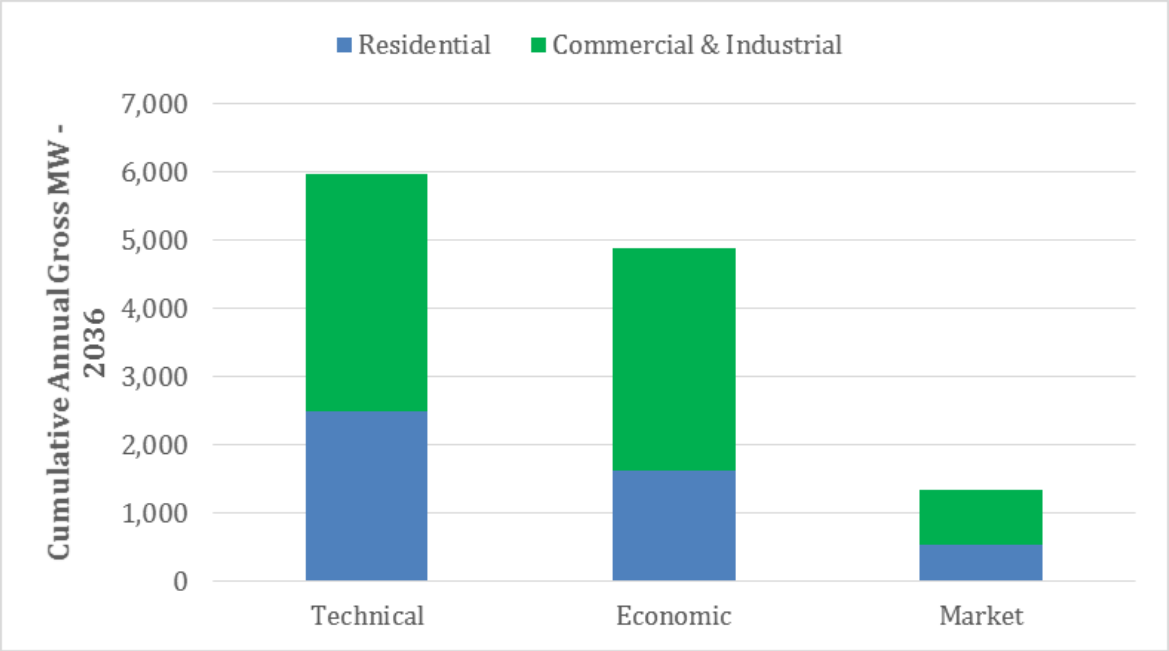


Figure 5. Cumulative Annual Summer Peak MW Demand Savings in 2036



Note for Figure 4 and Figure 5: Savings are not projected for Research and Development, Transmission and Distribution (T&D) Loss Reductions, T&D Customer Efficiency, Energy Efficiency Auction, gridSMART EE/PDR, Customer EE Assessment Survey, Community Energy Savers. For comparative purposes, savings are not included for Combined Heat and Power / Waste Energy Recovery. AEP Ohio also will conduct program evaluation and other essential program support functions, such as compliance and reporting, database management, contracting and payables, and Plan cost-benefit analysis. (2) Total Technical Potential does not include savings from codes and standards.

Figure 6. Market Potential Annual Energy Savings at Meter as Percent of Economic Potential in 2036

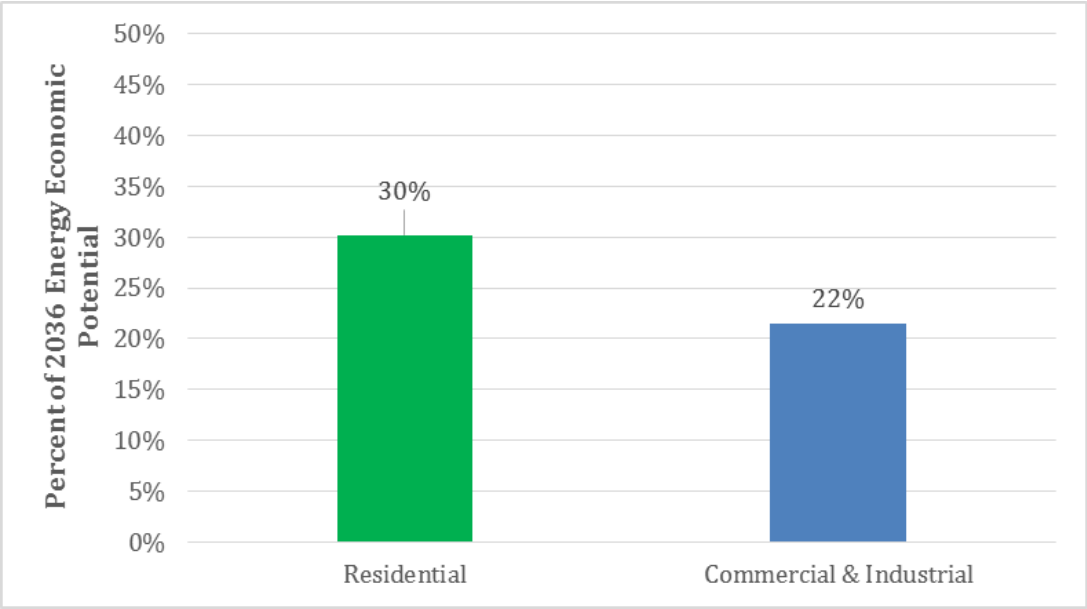
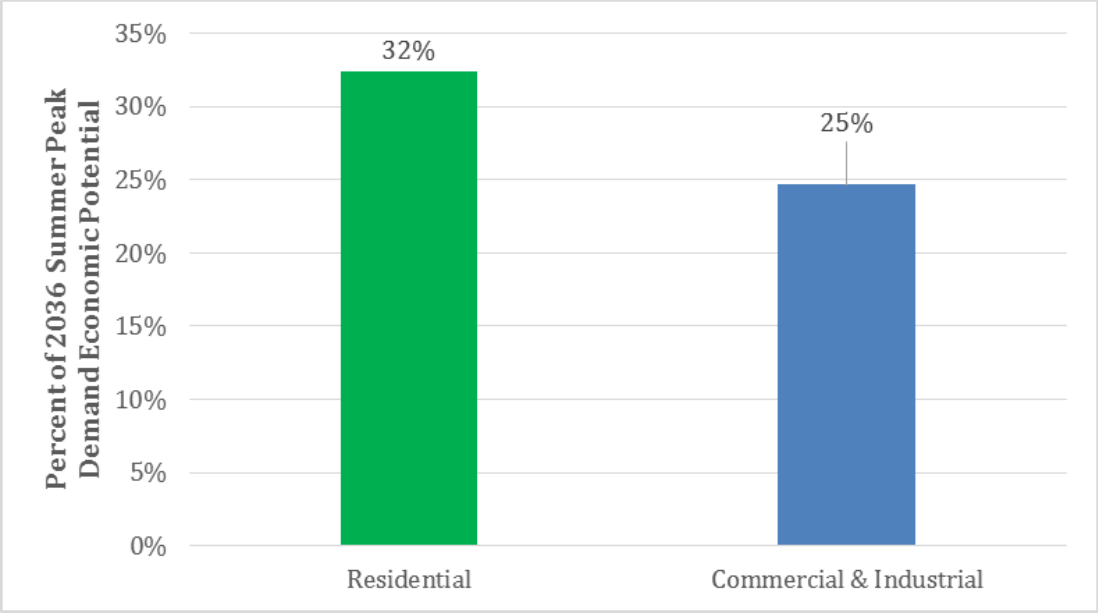


Figure 7. Peak Demand Savings at Meter as Percent of Economic Potential in 2036



Note for Figure 6 and Figure 7: Savings are not projected for Research and Development, Transmission and Distribution (T&D) Loss Reductions, T&D Customer Efficiency, Energy Efficiency Auction, gridSMART EE/PDR, Customer EE Assessment Survey, Community Energy Savers. For comparative purposes, savings are not included for Combined Heat and Power / Waste Energy Recovery. AEP Ohio also will conduct program evaluation and other essential program support functions, such as compliance and reporting, database management, contracting and payables, and Plan cost-benefit analysis. (2) Total Technical Potential does not include savings from codes and standards.

E.9 Overview of Program Plans

The overview of the Plan presented here is to provide a sense of scope and scale and to convey the general schedule and resources needed to increase participation in the various markets in which AEP Ohio will operate the programs. The plans developed for newly-proposed programs are based on a combination of best-practice program standards and the experience gained by AEP Ohio through its 2012-2014 Plan as well as with significant input by the Collaborative, with the strategic concepts outlined. These high-level program plans are proposed as guidelines for more detailed program planning. An update is presented for ongoing programs, along with proposed program modifications that were approved in the 2012-2014 EE/PDR Action Plan.

Overall, the Plan covers a broad range of demographic, business, facility and end-use markets. AEP Ohio's Plan can be divided into consumer (residential), business and cross-sector, with utility administrative functions providing support across all program areas. AEP Ohio will maintain as part of its functions the education and training, advertising, customer outreach, and research and development budgets.

Consumer Sector

AEP Ohio currently offers seven consumer (residential) sector programs. This Plan proposes a continuation of the existing programs, and includes two new programs.

- **Efficient Products** (ongoing) – This program produces long-term electric savings by increasing the market share of efficient lighting, HVAC and appliances through price markdowns, coupons and rebates. Direct to customer, midstream, upstream or combination approaches can be utilized to increase customer purchase of efficient products.
- **Appliance Recycling** (ongoing) – This program permanently removes and recycles in an environmentally safe manner operable second refrigerators and freezers.
- **In-Home Audit** (ongoing) – This program provides custom, prioritized recommendations on appropriate weatherization measures, high-efficiency lighting, appliances, HVAC and other equipment. The program provides an in-home audit (all electric only), in-home assessment, or online energy survey for a single family or multifamily home. Free energy saving items such as LED light bulbs and electric water heater measures (e.g., low-flow shower head, faucet aerators, pipe wrap), are installed or provided to participating customers, depending on the type of audit requested. In addition to the audit offerings, this program provides direct incentives for contractor installed energy efficiency measures such as HVAC equipment. Joint program delivery with local gas utilities has been successful and will be considered again in this Plan period.

- **Behavior Change** (ongoing) – This program provides tips that are relevant to a customer's home and provides an estimate on how much electricity and money they may save by implementing suggested energy efficiency measures and changing energy usage behaviors.
- **New Home** (ongoing) – This program produces long-term electric energy savings by improving the construction of efficient single family homes, duplexes and multifamily housing to meet select ENERGY STAR® efficiency standards on insulation, HVAC, water heating, appliances, lighting, windows, doors and other quality construction measures.
- **e^{3}smart^{SM} school** program (ongoing) – This energy efficiency education program is for students of schools served by AEP Ohio. The curriculum is designed to meet national and state science standards for grades 4-12. Students take home and install energy efficiency measures as part of the learning experience.
- **Community Assistance Program or CAP** (ongoing) – This program generates energy savings for residential low-income customers through the installation of a wide range of weatherization upgrades and base load electric measures. Qualified customers must be at or below 200 percent of the federal poverty level. Typically these customers also are eligible for an energy assistance program such as Home Energy Assistance Program (HEAP), Percentage of Income Payment Plan (PIPP) or Home Weatherization Assistance Program (HWAP).
- **Intelligent Home Energy Assistance and Demand Response** (new) – This program will provide customers with home energy management, providing the means to engage customers and provide energy use in near real time and support participation in demand response and energy efficiency through a smart phone application. Smart connected thermostats will be a measure offered in multiple programs and will be used in this program to offer demand response and energy savings from HVAC equipment. Disaggregation of load in the home will also be offered to help guide customers toward other opportunities to reduce energy and demand use. This program will be offered for AMI metered customers initially. In addition to the Plan expense funding, capital funding is requested to support adding approximately 75,000 customers to this program over three years.
- **New Manufactured Home** (new) – This program will collaborate with, educate, and incentivize manufactured home producers to integrate energy efficient measures, design, and building practices into new manufactured homes.

Business Sector

AEP Ohio currently offers ten business (nonresidential) sector programs. This Plan proposes a continuation of the existing programs and includes four additional programs.

- **Efficient Products for Business** (previously Prescriptive and ongoing) – This program is based on a menu of standardized incentives for high efficiency lighting, heating, ventilation, and air conditioning (HVAC), motors, drives, refrigeration and other measures. Direct to customer, midstream, upstream or combination approaches can be utilized to increase customer purchase of efficient products.
- **Process Efficiency** (previously Custom and ongoing) – This program provides incentives for qualifying efficiency improvements not included in the Efficient Products for Business Program or other AEP Ohio Programs. Engineering calculations and/or metering may be required to determine savings from these types of customer projects. Incentive levels for projects may vary based on cost effectiveness, project size and market indicators.
- **New Construction** and Major Renovation (ongoing) – This program provides incentives for new construction and major renovation to exceed current building energy code requirements.
- **Self-Direct** (ongoing) – This program is available to capture retrospective energy savings from large mercantile customers with the capability to administer internal energy management efforts of their own. It allows submittal of energy saving projects from the previous three years.
- **Demand Response** (ongoing) – This program primarily counts the IRP-D tariff demand response participation and is used to supplement the peak demand reductions achieved from energy efficiency programs. In addition, demand response may be offered to very small business customers in a similar manner as the Consumer Intelligent Energy Assistance program.
- **Express** (ongoing) – This program provides a streamlined, one-stop, turn-key assessment and installation of recommended energy efficiency measures for small to mid-size business customers. Measures installed are primarily indoor and outdoor lighting and refrigeration. Other measures can also be considered.
- **Retro-commissioning** (ongoing) – This program for medium and large customers provides assessments to identify and implement low-cost, operational adjustments that improve the efficiency of existing buildings' operating systems by optimizing the systems to meet the building's requirements, with a focus on building controls and HVAC systems.
- **Continuous Energy Improvement** (CEI) (previously Continuous Improvement, ongoing) – This program is for large customers that consume significant amounts of energy and focuses on low cost, no cost opportunities to

save energy and reduce energy intensity in the customers' production processes. It is designed to engage corporate management to create a sustainable culture and planned actions to reduce energy use long term. The program is primarily aimed at manufacturers as well as institutional and hospital customers. A maintenance program for existing CEI customers is an additional offering.

- **Energy Efficiency Auction** (ongoing) – This program is for business customers in the capital planning process considering large potential energy efficiency projects, or for Solution Providers that aggregate customer energy efficiency projects. The program also provides some input into future incentive level pricing for other business programs.
- **Data Center** (ongoing) – This program provides for energy savings opportunities for new and existing data centers of all sizes from data closets to enterprise class centers.
- **Business Behavior Change** (new) – This program provides tips that are relevant to small business and provides an estimate on how much electricity and money they may save by implementing suggested energy efficiency measures and changing energy usage behaviors. In addition, this program could also assist in identifying business customers with the highest propensity to participate in Business programs and support outreach efforts to increase participation.
- **Microbusiness** (new) – This program targets very small business customers, that are too small to take part in the Express program. These customers primarily have profiles and energy usage that are very similar to residential customers and this program can allow participation in Consumer programs as well as unique business outreach but with funding provided by this program to avoid cross subsidization.
- **Combined Heat and Power and Waste Energy Recovery (CHP/WER)** (new) – This program is primarily for larger cost effective CHP/WER projects, allowable to count as EE/PDR projects through the passage of SB 315.[7] The program provides performance based funding for CHP/WER projects that meet all PUCO and AEP Ohio requirements. Until PUCO regulations provide for a different approach, AEP Ohio will follow the qualifications and approach approved by the PUCO in case #14-2296 and file unique arrangements for individual approval of projects. The incentive levels will be established on a project specific basis; however, the incentive floor is the lower of 10% of CHP/WER direct project cost or 0.5 cents per kWh annually for five years. The incentive payment will typically be paid per annual kWh produced for net generation, and payable over five years. Depending on available AEP Ohio budget, CHP/WER projects in progress, the economic feasibility studies of specific projects and customer need to justify projects, the incentives could be increased, but no more than 2 times

[7] See http://archives.legislature.state.oh.us/BillText129/129_SB_315_EN_N.pdf.

the incentive floor. Also, incentive payments can be timed in different ways depending on customer needs, so long as a performance basis is included. Each project will require screening for feasibility and cost effectiveness.

- **Transmission and Distribution (T&D) Customer Efficiency Program** (ongoing) – This program provides the ability to count energy and demand savings through the implementation of high efficiency technologies that reduce customer demand and energy use. Two potential projects described in this Plan are Volt Var and LED Street and Outdoor Lighting. Additionally, the program provides customers with specific technology measures that can be implemented to improve power quality and to produce energy and demand savings within a customers' facilities.
- **Business Outreach** (new) – This program provides a team of dedicated outreach professionals geographically located throughout AEP Ohio's service territory to represent, promote and sell all Business programs to Business customers and contractors. This group works with customers and contractors to determine their specific needs and provides the right program to fit those needs.

Cross-Sector Activities and Other Programs

AEP Ohio proposes eleven cross-sector programs and other activities. Five activities are new for the 2017-2019 Plan, the remainder are proposed to continue from the previous period.

- **Agricultural** (new) – This program will provide long-term electric energy savings in both the Consumer and Business sectors for Agriculture. The Agriculture program is considered cross sector as farms in Ohio may be residentially or non-residentially metered, and energy savings can have a significant impact on agricultural operations in AEP Ohio service territory. An agriculture pilot was conducted and determined that farm operations are both unique and diverse. Energy and demand savings opportunities are significant and the outreach to this segment is specialized and this program provides the opportunity to more actively target farms, large and small, for energy efficiency program participation. With the assistance of the Ohio Farm Bureau and other key stakeholders, this program is expected to significantly assist this customer segment.
- **Multi-Family (New Construction and Existing)** (new) – This program provides both consumer (tenant) and business (common areas) customers with energy saving opportunities and implementation of cost effective measures to existing and new construction buildings.
- **Customer EE Assessment Survey** (new) – The Customer EE Assessment Survey identifies long-term electric energy savings in both Consumer and Business sectors implemented by customers not accounted for in existing

programs. The program will capture savings and peak demand reductions achieved outside of EE/PDR programs for counting toward EE/PDR benchmark requirements according to SB 310.

- **Efficient Financing** (new) – This program will provide Consumer and Business sectors with financing options to overcome first cost barriers of implementing energy efficiency improvements. The program may serve both retrofits and new construction projects.
- **Community Energy Savers –** (new) – This program will leverage local community leaders and forums to increase community member participation in programs that produce long-term electric energy savings in both Consumer and Business sectors. The program will promote increased participation in many of our programs through a significant and targeted community based outreach effort. After multiple highly successful pilots, AEP Ohio has an effective model to deliver this program to multiple communities in this Plan period.
- **gridSMART Enabled EE/PDR Savings** (ongoing) – This activity provides energy and demand savings achieved from this project that are not otherwise accounted for and delivered through in this Plan.
- **T&D Loss Reduction Projects** (ongoing) (formerly T&D and Internal System Efficiency Improvements) – This activity provides energy savings from AEP Ohio T&D projects that reduce losses on its system, thereby saving energy and demand.
- **Education and Training** (ongoing) – This program will coordinate AEP Ohio's efforts to create customer, employee, marketer, contractor and supplier awareness for the programs and the proper installation of measures, enhance demand and educate customers on energy efficiency.
- **Targeted Advertising** (ongoing) – This program is designed to build customer awareness of energy efficiency and opportunities to participate in support of AEP Ohio EE/PDR programs and also to encourage market transformation in support of AEP Ohio's commitment and key goals in this Plan.
- **Research and Development** (ongoing**)** – The program objective is to identify and develop new and innovative energy efficient technologies, programs and marketing approaches to capture cost effective energy and demand savings.

E.10 Plan Implementation

AEP Ohio plans to continue implementing the proposed Plan through a combination of in-house utility staff and competitively selected third-party implementation contractors. For newly-proposed programs, AEP Ohio may issue request for proposals (RFP) to qualified firms for the program delivery. Implementation contractors are eligible to respond to any or all of the RFPs. From start to finish and subject to PUCO approval of the Plan, AEP Ohio anticipates the process of issuing RFPs, evaluating responses and negotiating contracts along with associated program start-up time will result in January 2017 launch dates for most newly-proposed programs. Some programs could need longer preparation times and those will begin on an extended schedule. For existing programs, AEP Ohio may issue RFPs or re-negotiate contracts with existing implementation contractors, depending on performance and cost effectiveness. AEP Ohio plans to issue RFPs for all contractors that have not gone through the RFP process for two previous approved Plan periods.

E.11 Evaluation, Measurement and Verification

Program evaluation, measurement, and verification (EM&V) activities are central to the success of AEP Ohio's Plan and will be used to verify program savings impacts and monitor program performance. These activities serve as a way to determine the actual program level savings being delivered and to maximize the impacts of energy efficiency and peak demand reduction investments.

Effective EM&V ensures that expected results are measurable, achieved results are robust and defensible, program delivery is effective in maximizing participation, and the overall Plan is cost-effective.

Framework for Evaluation

Appropriate EM&V requires that a framework be established that encompasses both planned EM&V efforts and data collected as part of program implementation. This section provides an overview of the monitoring, verification, and evaluation efforts recommended. The basic requirements and approaches for planning program-specific evaluations, including the allocation of funds across evaluation efforts, also are discussed in this section. Importantly, EM&V efforts evolve over time and change as programs move from initial roll-out with few participants to full-scale implementation.

All significant evaluation activities will be conducted by third-party evaluation consultants. Impact evaluations are most often performed by organizations independent of those responsible for designing and implementing programs to ensure objectivity. Process evaluations and market effects studies typically also are prepared by independent evaluators, but process evaluations in particular are used less to verify

performance than to help improve performance and, as such, require active participation by the program administrator/implementer.

Approach to Evaluation

The overall evaluation approach is based on an integrated cross-disciplinary model that includes evaluators as members of “project teams” involved in the various stages of program planning, design, monitoring and evaluation. This is a very cost-effective method that has been very successful for AEP Ohio over the last seven years.

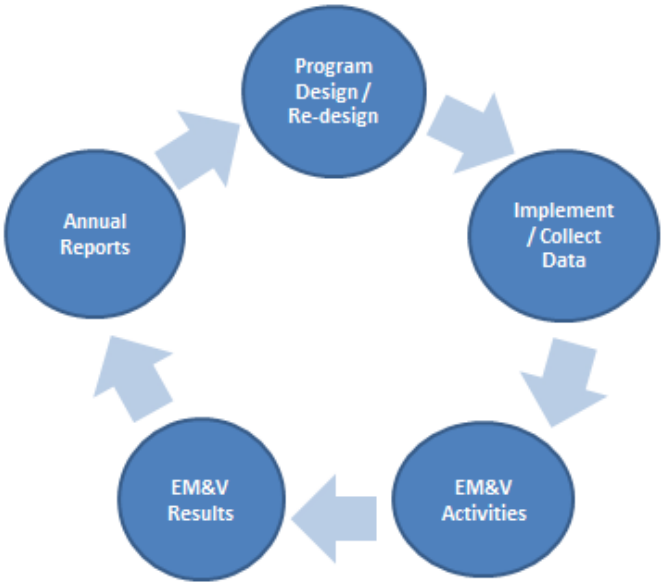
The timing of EM&V activities and reporting can have a significant effect on the accuracy and usefulness of findings. Data collection done months or years after a program intervention can be weakened by fading memories, lost data, and confounding events that have happened in the intervening time. EM&V reports that come well after program intervention can arrive too late to provide input at key program implementation stages.

EM&V plans are designed to mitigate these problems. The process by which this is done is to integrate select data collection within the program implementation process and to provide near real-time feedback on key indicators of program progress. EM&V processes that take an “integrated data collection” (IDC) approach to planning seek out opportunities in the program implementation process where evaluation data can be collected efficiently, cost-effectively, accurately, and produce timely results. One example is program application forms, where programs can collect comparable data in standard formats across programs. Of course, this approach will be highly dependent on the program design and the points where the program interacts with the customer or trade ally.

The IDC approach requires the EM&V and implementation staffs to work closely together to develop a protocol for collecting data as part of the standard program implementation practices and customer correspondence associated with the program. It also is important for the program implementation staff to see successful M&V as part of their responsibility; i.e., the program will get credit for the savings that can be verified and program implementers can have a dramatic influence on how accurately this in-field verification can be accomplished.

The IDC protocol garners participant feedback in near real-time to support process, market, and impact analyses. Examples include exit surveys with training participants designed by evaluation staff, but administered by program implementation staff; evaluation inputs on program application forms so key baseline data is collected before existing equipment is replaced; and regular transfer of program data to evaluators so follow-up surveys can be implemented soon after program participation. Figure 8 shows the program evaluation cycle.

Figure 8. Steps of the EM&V Process



Approximately three percent of overall Plan program costs will be allocated to the following activities, further described in the following sections:

- EM&V-related activities.
- Project savings verification and due diligence.
- Independent program evaluations.
- Independent assessment of annual program impacts.
- Internal quality assurance and control.
- Coordination of evaluation activities with other players, such as the PUCO statewide evaluator.

Independent Program Evaluations

Descriptions of proposed evaluations for each program are included in the program plans. The key components of the process and impact evaluations include:

- Evaluations conducted by an independent, EE/PDR evaluation consultant.
- Verification, by an appropriate sample, that efficiency measures are installed as expected.
- In-field measure performance measurement and data collection.

- Energy and demand savings analysis to compute the results that are being achieved.
- Cost-effectiveness analysis by program and overall EE/PDR Plan.
- Process evaluation to indicate how well programs are working to achieve objectives.
- Identification of important opportunities for improvement.

Assessment of Annual Impacts

AEP Ohio's EM&V contractor will prepare an annual report of EE/PDR program results, which will incorporate findings from evaluation activities completed that year, changes to programs, and new programs implemented, as well as energy savings, costs and cost-effectiveness results by program and Plan. It is anticipated that the EM&V contractor's work, as well as participation in the process by the implementation contractor, will identify numerous areas where improvements and refinements to the AEP Ohio deemed measure database would be useful. As required, AEP Ohio will submit program evaluations to the PUCO statewide evaluator for its review.

In addition to the procedures outlined above for verifying savings from AEP Ohio's proposed Plan, AEP Ohio will implement appropriate internal controls to assure the quality of program design and implementation and establish a consistent and integrated tracking and reporting system for all programs in the Plan. AEP Ohio tracks customer interactions, including customers recruited, incentive applications, incentives processed and installations verified, and will establish procedures for ongoing verification.

AEP Ohio will require implementation contractors or staff to routinely contact or visit a sample of participating customers to assess the quality of program delivery and the installation of measures for which incentives were claimed. AEP Ohio intends to also track on an on-going basis incentive fulfillment time, technical services delivery times (how long between customer request and audit completion for example), incentive documentation, and customer complaints among other metrics of program performance.

PJM Evaluation Requirements

AEP Ohio's EM&V plans will be developed to ensure that the evaluations to be conducted are done in a manner that enables AEP Ohio the ability to nominate achieved and verified energy efficiency and peak demand reduction values with a level of

statistical confidence and precision that complies with PJM's Manual 18B Energy Efficiency Measurement & Verification.[8]

E.12 Plan Risk

In the current economic environment, AEP Ohio's ability to convince customers to voluntarily take on additional debt for the installation of cost-effective measures, even with very short pay-back periods, may continue to be challenging. AEP Ohio recognizes this challenge and has striven to develop a balanced Plan that provides opportunities for participation at multiple levels. By proposing a multi-faceted and broad Plan of programs, AEP Ohio will be able to capitalize on those sectors of the market willing to invest in energy efficiency, regardless of the challenging economic landscape. This Plan is designed to allow AEP Ohio to meet overall legislative efficiency goals.

AEP Ohio plans to use the following strategies to minimize the risks associated with its portfolio of EE/PDR programs in this Plan:

- Utilize AEP Ohio's significant experience in successful program implementation and maintain Plan flexibility to adjust programs to meet changing market conditions and other externalities, such as the opt-out opportunity for large Business customers.
- Implementing both traditional programs that have been successful at AEP Ohio and in other Midwest utilities and across the country as well as a more "future focused" effort to incorporate big data opportunities, high degrees of segmentation, intelligent energy assistance and innovative incentive and participation strategies.
- Hiring program implementation contractors with success in implementing EE/PDR programs in the Midwest and other regions.
- Initiating program evaluation activities at the start of program implementation to get real-time feedback on program progress, and to allow any needed fine-tuning to occur as soon as possible.
- Setting up post installation inspection procedures and data to collect before inspections begin.
- Anticipating and preparing for stronger than expected market response.
- Conducting adequate market checks on standard practices and energy efficient product availability.

[8] See http://pjm.com/~/media/documents/manuals/m18b.ashx. PJM Interconnection is a regional transmission organization (RTO) that coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

- Developing incentive structures that are simple to understand.
- Creating simple participation rules.
- Monitoring and responding to rapidly dropping equipment prices quickly.
- Setting appropriate qualifying efficiency levels.
- Setting appropriate incentive levels.
- Rolling out targeted marketing to contractors focusing on what is in it for them and how they participate.
- Training internal employees and external contractors on program rules.
- Establishing documentation, analysis methods and reporting requirements for technical studies.
- Managing the pipeline of projects and establishing decision deadlines so the response time to those waiting for decisions is reasonable.
- Expanding research and development to assist in mid-stream adjustments to current programs as needed and developing new programs for future implementation.

The performance targets of the program plans are based on normal economic conditions and the ability to overcome a variety of market barriers and perceived risks customers have regarding EE/PDR improvements and load management. Problems commonly encountered that affect delivery may occur and dampen program performance. Other barriers include a variety of real and perceived risks in undertaking efficiency improvements or participating in load management programs:

- Reliability of the efficiency improvement, whether real or perceived.
- Fit with existing facilities and processes.
- Return on investment and cash flow effects compared to other financial and operating priorities.
- Unfamiliarity with the technology leading to non-participation.
- Availability of funds or credit to purchase the improvement.
- Concern about occupant comfort and other aesthetics.

E.13 Conclusions and Recommendations

The EE/PDR market potential identified in this study represents cumulative annual energy reductions over 20 years of approximately 13.2 percent for AEP Ohio residential customers and 14.4 percent for commercial and industrial customers below forecasted levels and known enacted energy codes and standards by 2036, or approximately 0.7 percent per year (excluding CHP/WER). This magnitude of savings has been achieved by best practice program portfolios in the Midwest, Northeast and Western U.S. Summer peak demand and annual energy reductions of the magnitudes found for the market potential case are being achieved by a variety of utilities.

AEP Ohio plans to achieve the 2% energy efficiency requirement beginning in 2021 and required each year through 2027, by using its banked energy efficiency achievements above the requirements to cover approximately 1% in each year from 2021 through 2027. New energy efficiency savings will then be required to cover a level 1% per year each year from 2021 through 2027.

The EE/PDR benchmarking analysis results presented in this report give AEP Ohio management confidence that a variety of utilities in the region and throughout the country are achieving similar large-scale results from their EE/PDR programs.

Utilities that choose to invest significantly in EE/PDR programs often make significant periodic investments to develop and update secondary best-practice and primary market research data to aid their EE/PDR program planning. AEP Ohio conducted a market assessment baseline study of the residential customer sector in 2013 that included significant on-site customer data collection. Both AEP Ohio's 2017 to 2019 EE/PDR Action Plan and the 2017 to 2036 potential study include significant customer data from the residential baseline study. In addition, AEP Ohio's significant direct experience with all customer classes in the implementation of its current Plan has aided the development of the 2017-2019 Plan.

Recommendations to consider include the following:

- Move results into operational planning with a focus on integrating newly proposed programs seamlessly and making ongoing adjustments.
- Consider both insourcing and outsourcing strategies to selectively jump-start key additions to the ongoing Plan and more cost effectively manage existing programs.
- Update baseline analyses in the 2018 period to prepare for planning in 2020 and beyond.

1 INTRODUCTION

AEP Ohio or Ohio Power Company, is based in Gahanna, and is Ohio's second largest provider of electric service with a mix of approximately 1.5 million residential, commercial and industrial customers. Pursuant to the requirements in Senate Bill (SB) 310[9] and Ohio Revised Code 4901:1-39[10], AEP Ohio submits this Plan for calendar years 2017 to 2019 for approval by the Public Utility Commission of Ohio (PUCO).

The following Plan presents a detailed overview of the proposed electric efficiency programs targeted at the consumer and business sectors, and associated implementation costs, savings, and benefit-cost results. This Plan presents detailed information on the approach, EE/PDR measures, and initial proposed incentive levels, though AEP Ohio anticipates that, upon implementation, portions of this Plan will need to be adjusted to reflect better information or changing market conditions. AEP Ohio will update the PUCO and Collaborative accordingly regarding any substantive revisions to the Plan.

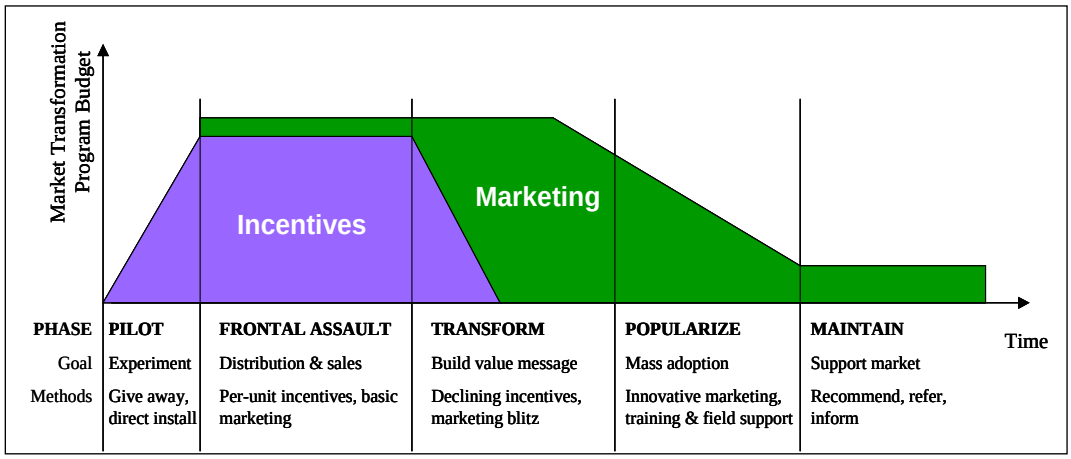
Together with stakeholders and the assistance of industry expert Navigant Consulting, Inc. (Navigant), AEP Ohio has designed a comprehensive EE/PDR Plan to deliver significant cost-effective electric efficiency savings. These programs include incentive and buy down approaches for energy efficient products and services, educational, marketing, and outreach approaches to raise awareness and enhance demand, and partnerships with trade allies to apply as much leverage as possible to augment the ratepayer dollars invested. Proper coordination between the programs is essential to maximizing this leverage.

As detailed in Figure 9, AEP Ohio anticipates that over time investment in energy efficiency measures will follow a predictable path of market transformation that has been experienced in other jurisdictions. With sustained levels of investment, promotion of efficient measures will in the early years focus on immediate up-front incentives to stimulate the marketplace. Over time, funds will be transitioned to marketing, training, education, and awareness to sustain program participation. Furthermore, as certain markets become transformed, and the baseline conditions become the efficient options, program resources will be transferred to new program areas and new technologies, and the process will repeat. Each series of the market transformation process will result in greater and more efficient opportunities for residential and business customers.

[9] See http://archives.legislature.state.oh.us/BillText130/130_SB_310_EN_N.pdf

[10] See http://codes.ohio.gov/oac/4901%3A1-39

Figure 9. Phases of Energy Efficiency Promotion



Source: ENERGY STAR® YEAR 3 AND BEYOND, Presentation by Anne Wilkins, NRCAN, 2005

Demand Side Management (DSM) is the planning and implementation of programs and services that help and encourage customers to use electricity as efficiently as possible. DSM represents an important resource for AEP Ohio, growing increasingly important as fuel and commodity prices become more volatile and greenhouse gas regulation becomes more likely. Estimates of DSM or (EE/PDR) potential are a key input to the integrated resource planning process, which considers the load forecast and both supply and demand-side resources. This study presents the results of an analysis of the EE/PDR potential in AEP Ohio's service territory from 2017 to 2036.

1.1 AEP Ohio Overview

As described on AEP Ohio's web site, the Company is a significant distribution utility in the Midwest. With approximately 1.5 million customers, AEP Ohio has a strong market presence. Figure 10 presents AEP Ohio's service territory, which spans a large geographic area in Ohio. AEP Ohio provides power to 1,126 communities located in 61 of Ohio's 88 counties.

Figure 10. AEP Ohio's Service Territory

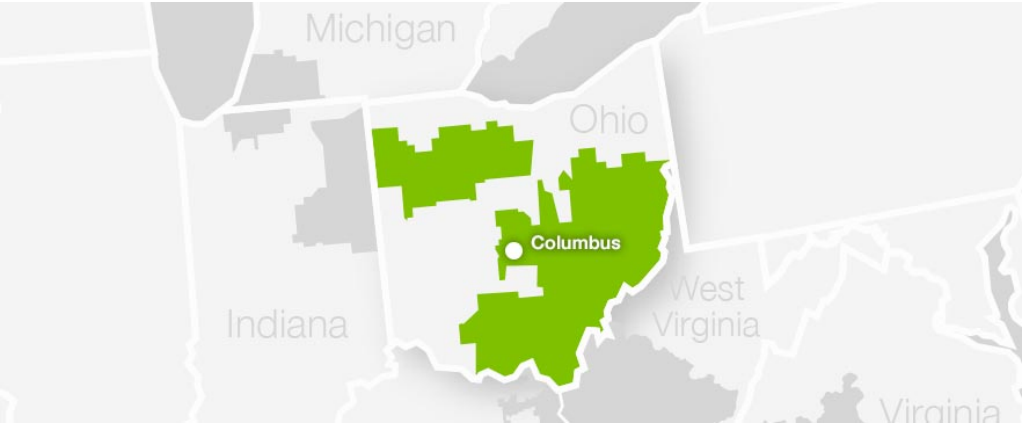


Table 16 outlines key statistics for AEP Ohio.

Table 16. AEP Ohio Key Statistics – 2015[11]

Operating Information	
Residential	1,276,363
Commercial	175,013
Industrial	9,959
Other	2,737
Total Customers (distribution and transmission)	**1,464,072**
2015 electrical sales in megawatt-hours	43,415,882
Size of service area (asset)	10,354 square miles
Communities served	nearly 1,000
Net plant in service	$4.6 billion
Size of distribution system	45,718 miles
Size of transmission system	8,195 circuit miles
Total number of AEP Ohio employees (distribution and transmission)	1,551
Financial Information	
2015 Operating Revenue	$3.1 billion
2015 Net Income	$232.7 million
2015 Ohio Taxes Paid	$160.9 million
2015 Local Taxes Paid	$190.2 million
Top 5 Customers (by 2015 kWh used)	
The Timken Co.	Globe Metallurgical Inc.
Lima Refining Co.	The Ohio State University
Republic Steel	

[11] AEP Ohio Fact Sheet, April 2016.

1.2 EE/PDR Study Goals and Approach

The overall goals of the EE/PDR potential study are to:

- Assess the technical, economic, and achievable potential for the residential, commercial and industrial sectors.
- Develop high-level EE/PDR program plans.

AEP Ohio undertook the EE/PDR potential study with the following key tasks:

- Conduct a customer market baseline study using telephone and on-site customer surveys to profile AEP Ohio's residential and non-residential customers.
- Develop baseline consumption profiles, and develop initial building simulation model specifications.
- Characterize the EE/PDR measures.
- Conduct an EE/PDR benchmarking and best practices analysis.
- Conduct benefit-cost analysis.
- Estimate EE/PDR potentials.
- Develop program plans.

These steps are discussed in more detail in Volumes 1 and 2 of the Plan.

1.3 2017 to 2019 EE/PDR Action Plan Report Organization

The remainder of AEP Ohio's EE/PDR Action Plan is divided into the following sections:

Section 2: Plan Development provides an overview of the process used and considerations in developing this Plan.

Section 3: EE/PDR Plan Summary Results details the summary results of Plan electric savings, investment allocations and benefit-cost results.

Section 4: EE/PDR Program Plans presents detailed program plans for AEP Ohio's proposed programs, with full descriptions for new programs.

Section 5: Glossary defines key terms used in the report.

Volume 2 Appendices include: EE/PDR Potential Study results (Appendix A); overall EE/PDR Benchmarking results (Appendix B); EE/PDR Measure Descriptions and Characterizations Results (Appendix C); and EE/PDR Methodology (Appendix D).

2 PLAN DEVELOPMENT

Based on a national review of leading EE/PDR programs, AEP Ohio is proposing a balanced Plan including EE/PDR programs that will achieve significant energy savings, while establishing trade ally and retailer partnerships resulting in lasting market transformation. AEP Ohio's programs will target all major sectors and customer classes, including low-income and small business customers.

AEP Ohio plans to continue offering a diverse Plan of "tried and true" major programs (some of which include sub-program components) across the residential, commercial and industrial sectors. Additionally, in this Plan, AEP Ohio proposes new programs, research and development activities targeting experimental opportunities, as well as broad-based education and training and targeted advertising.

2.1 Plan Tactical Objectives

In addition to AEP Ohio's strategic goals provided in the Plan Executive Summary, AEP Ohio has the following tactical objectives for the 2017-2019 Plan:

- Meet or exceed SB 310 resource acquisition goals for 2017-2019 and achieve PPA stipulation agreement commitments in Case 14-1693, while laying the groundwork for long-term market transformation.
- Design and implement a diverse group of programs that provide opportunities for participation by all customers.
- When feasible, maximize opportunities for program coordination with other efficiency programs to yield maximum benefits.
- Maximize program savings at a minimum cost by striving to achieve comprehensive cost-effective savings opportunities.
- Expand the energy efficiency infrastructure in the state - for example, increasing the number of available qualified contractors.
- Transform the market for efficient technologies and highly qualified efficiency-oriented trade allies (such as electricians, air sealing and insulation contractors, HVAC contractors, home energy raters, builders, architects and engineers).
- Inform and educate customers and students to enable them to use energy more efficiently.

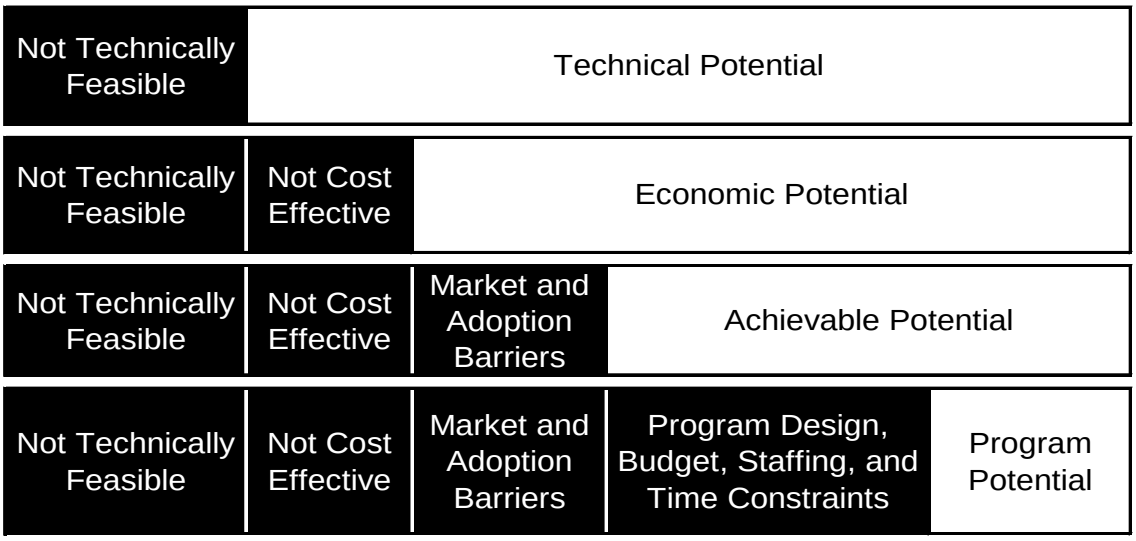
2.2 Planning Process

AEP Ohio's Plan of programs continues its successful programs while incorporating additional elements of the most successful EE/PDR programs across North America into

program plans designed for the Ohio market and AEP Ohio customers in particular. A substantial amount of information including current program performance and evaluation studies was used to develop specific programs for AEP Ohio. AEP Ohio also used a benchmarking process to review the most successful EE/PDR programs from across the country, with a focus on successful Midwest programs to help shape the Plan.

As detailed in Figure 11, there are four major types of energy efficiency potential: (1) *technical* potential for all technologies, (2) *economic* potential, the amount of energy efficiency available that is cost effective, (3) *achievable* potential, the amount of energy efficiency available under current market conditions and available investments, and (4) *program* potential, the amount of energy efficiency available given limited resources, available time and duration of the efficiency program planning period. AEP Ohio's EE/PDR Action Plan is focused on capturing cost-effective *program potential* in its service territory while achieving SB 310 requirements for 2017 to 2019.

Figure 11. Four Stages of Energy Efficiency Potential



Reproduced from "Guide to Resource Planning with Energy Efficiency November 2007", U.S. EPA, Figure 2-1.

2.3 Market Segmentation

Segmentation of the market in AEP Ohio is under way to have ongoing and effective outreach and participation across segments and classes of customers. In addition, AEP Ohio plans to continue measuring geographical participation for geo-targeting opportunities going forward.

Consumer Segmentation

Table 17 presents 2015 data for single-family and multifamily residential customers, including low income. Overall, 66.8 percent of the total residential sector customers are in the base residential segment that excludes all single-family and multifamily low income customer segments. 89 percent of the base residential customers live in single-family homes while the remainder lives in multifamily housing.

Overall, 33.2 percent of total residential sector customers are in the low income segment. Most of these customers (92.4%) live in single-family homes, while the remainder lives in multifamily housing.

Table 17. Residential Customer Data – 2015

Customer Segment - 2015	Number of Accounts	Percent of Accounts	Percent of Electricity Consumption
Single-Family	735,040	90.6%	94.0%
Multifamily	76,587	9.4%	6.0%
Residential (Excluding Low Income)	**811,627**	**66.8%**	**67.9%**
Single-Family	338,721	83.9%	89.0%
Multifamily	65,234	16.1%	11.0%
Residential (Low Income Only)	**403,955**	**33.2%**	**32.1%**
Single-Family	1,073,761	88.3%	92.4%
Multifamily	141,821	11.7%	7.6%
Total – All Residential	**1,215,582**	**100.0%**	**100.0%**

Table 18 presents 2015 participant data for single-family and multifamily residential customers. There is not a significant difference in the EE/PDR program 2015 participant savings as a percent of customer segment consumption (1.9% for low income segment vs. 1.8% for the base residential segment). Average 2015 participant savings vs. participant consumption was higher for multifamily than single-family homes, with low income customers savings more on average than for single-family homes.

Table 18. Consumer Programs Participation – 2015

Customer Segment - 2015	Program Participant Average Consumption (kWh)	Participants vs. Segment Consumption (percent)	Participant Savings vs. Customer Segment Consumption (percent)	Participant Savings vs. Participant Segment Consumption (percent)	2009-2015 Participant vs. All 2015 Consumption (percent)
Single-Family	12,342	61.4%	1.1%	1.8%	23.6%
Multifamily	8,003	34.1%	0.8%	2.4%	19.2%
Residential (Excluding Low Income)	**12,102**	**60.3%**	**1.1%**	**1.8%**	**23.4%**
Single-Family	12,030	54.3%	1.0%	1.8%	21.6%
Multifamily	8,092	35.2%	0.9%	2.5%	26.7%
Residential (Low Income Only)	**11,501**	**52.2%**	**0.1%**	**1.9%**	**21.6%**
Single-Family	11,128	59.3%	1.1%	1.8%	23.0%
Multifamily	6,906	34.6%	0.8%	2.4%	20.2%
Total – All Residential	**10,635**	**57.4%**	**1.1%**	**1.8%**	**22.8%**

(1)Efficient Lighting calculated at a fully saturated 46 lamps per household. 50% of these households are assumed to be new participants

(2) 46 lamps per household source: http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2010-lmc-final-jan-2012.pdf Page 26

(3) Excludes 44,119 accounts (3.5% of total) that do not have income or dwelling type data available

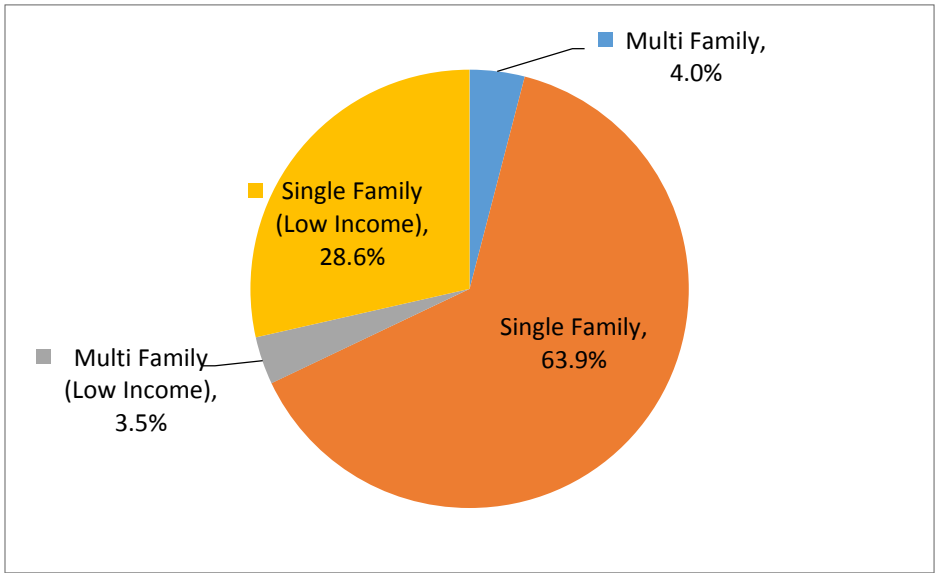
(4) Low income residential customers are defined as those having incomes less than 200% of the federal income poverty guidelines

(5) Penetration Consumption adjusted for past energy savings

(6) This analysis excludes energy savings from Behavioral Programs

Figure 12 shows 2015 single-family and multifamily residential energy consumption by segment. Single-family homes comprised the large majority of residential sector usage.

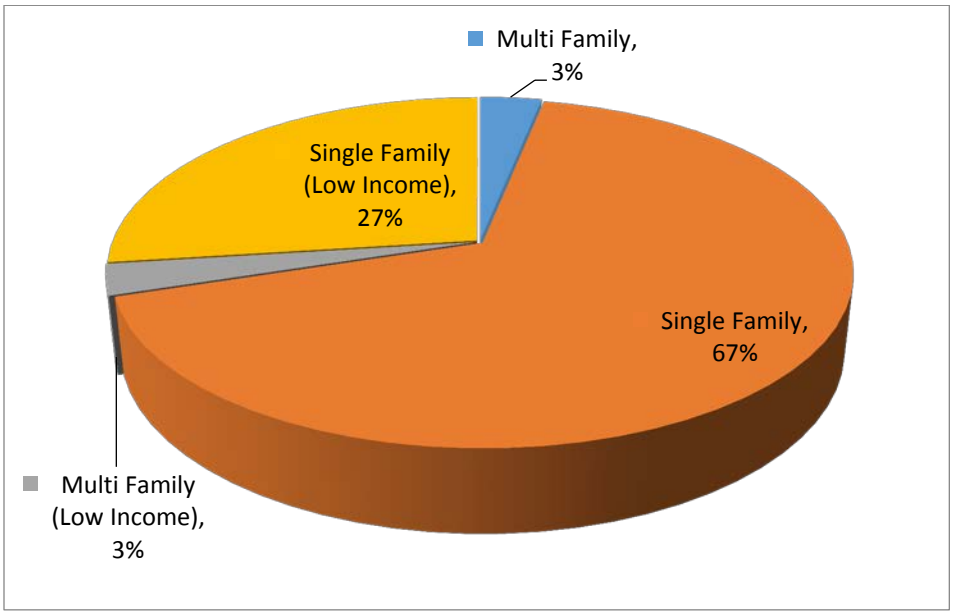
Figure 12. Residential Sector Energy Consumption – 2015



(1) Excludes accounts with a dwelling type of 'other' or 'unknown'.

Figure 13 presents 2015 participant savings by segment. Single-family homes comprised the large majority of participants.

Figure 13. Consumer Programs Participant Savings – 2015



(1) Includes Efficient Products program participation or savings.
(2) Excludes accounts that do not have income or dwelling type data available.
(3) Low income residential customers are defined as those having incomes less than 200 percent of the federal income poverty level.

Business Segmentation

Current programs as well as proposed programs are designed to target all segments of the business sector. There are specific target segments that recognize key activities with significant available EE/PDR opportunities. Table presents 2015 nonresidential customer data by customer type, including the number of EE/PDR participants. Small Office, Manufacturing, Small Retail, and Schools comprised over half the participants.

Table 19. Nonresidential Customer Data – 2015

Customer Segment - 2015	Number of Accounts	Percent of Accounts	Number of Participants	Penetration 2009-2015
Agriculture, Mine, Construction	13,210	6.7%	46	2%
Assembly	13,916	7.1%	184	5%
Flat Load Commercial	11,860	6.1%	21	1%
Grocery	2,099	1.1%	153	25%
Health Service	5,227	2.7%	45	6%
Hospitals	367	0.2%	19	18%
Light Industrial	182	0.1%	5	16%
Manufacturing	5,447	2.8%	257	21%
Office Large	1,892	1.0%	163	34%
Office Small	68,276	34.8%	460	4%
Other	521	0.3%	2	4%
Restaurant Large	388	0.2%	28	22%
Restaurant Small	6,355	3.2%	172	9%
Retail Large	1,457	0.7%	140	38%
Retail Small	54,974	28.1%	493	5%
Schools	4,700	2.4%	193	22%
Warehouse	5,085	2.6%	85	10%
Total	**195,956**	**100%**	**2,466**	**6%**

Table 20 presents 2015 nonresidential participant data. The average Small Office building type participant saved over 34 percent of annual electricity usage, followed by Small Retail at 22 percent. All other participants saved less than 20 percent.

Table 20. Business Programs Participant Savings – 2015

Customer Segment - 2015	Total Participants Consumption (kWh)	Participants vs. Segment Consumption (percent)	Participant Savings vs. Customer Segment Consumption (percent)	Participant Savings vs. Participant Segment Consumption (percent)	2009-2015 Participant vs. All 2015 Consumption (percent)
Agriculture, Mine, Construction	10,243,902	0.9%	0.2%	19%	1%
Assembly	131,680,000	13.6%	8.5%	9%	5%
Flat Load Commercial	29,704,544	7.5%	1.8%	2%	1%
Grocery	111,070,000	17.5%	7.7%	8%	8%
Health Service	31,840,266	5.6%	12.4%	12%	3%
Hospitals	216,970,000	28.1%	1.7%	2%	4%
Light Industrial	2,918,524	4.8%	12.1%	12%	7%
Manufacturing	6,421,100,000	48.1%	1.7%	2%	5%
Office Large	697,960,000	19.3%	4.0%	4%	5%
Office Small	27,343,811	1.8%	33.8%	34%	5%
Other	511,788	2.4%	0.3%	13%	8%
Restaurant Large	14,260,360	6.4%	3.6%	4%	2%
Restaurant Small	44,657,056	6.9%	6.9%	7%	2%
Retail Large	281,460,000	17.0%	8.3%	8%	8%
Retail Small	64,113,835	4.8%	21.7%	22%	6%
Schools	764,890,000	38.1%	3.4%	3%	9%
Warehouse	127,470,000	19.6%	5.8%	6%	12%
Total	**8,978,194,086**	**-**	**-**	**-**	**-**

Figure 14 shows 2015 nonresidential energy consumption by segment. Manufacturing facilities consume over 70 percent nonresidential customer usage.

Figure 14. Nonresidential Energy Consumption – 2015

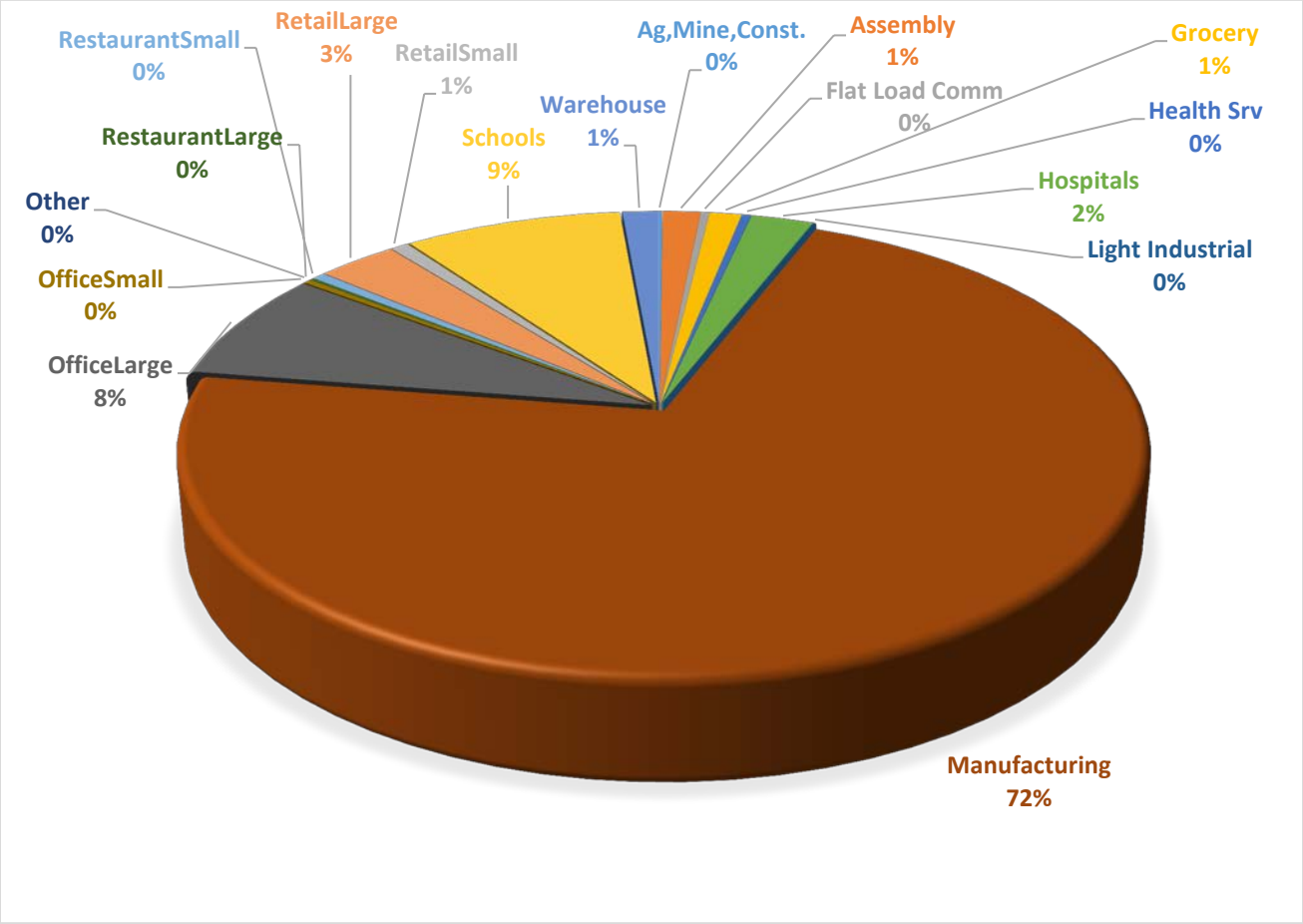
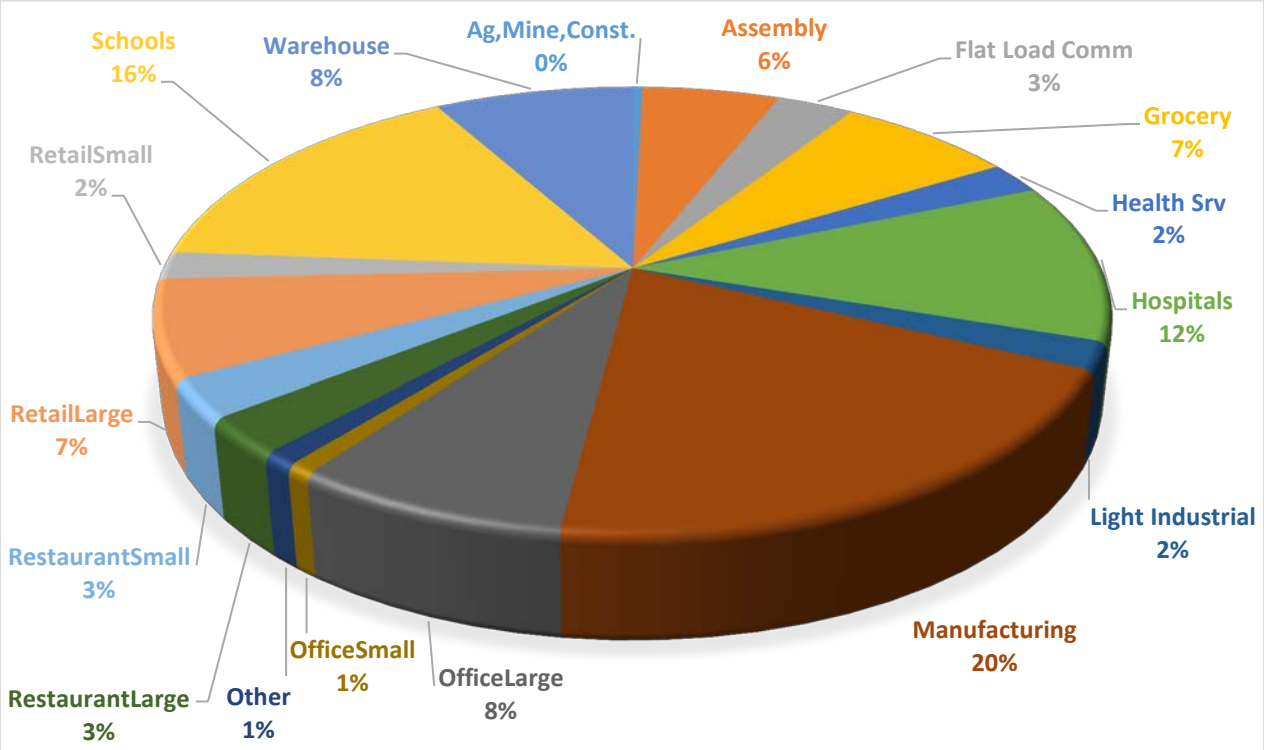


Figure 15 shows 2015 participant savings by segment. Health Services, Light Industrial, Small Office and Small Retail participated in greater numbers than their share of the AEP Ohio customer base.

Figure 15. Business Programs Participant Savings – 2015



2.4 Stakeholder Participation in the Planning Process

AEP Ohio established the AEP Ohio EE/PDR Collaborative in October 2008, and has met regularly since that time to gain input from its approximately twenty-five members representing all classes of customers on program planning and to provide feedback on the current Plan and its performance.

For this Plan's development, the Collaborative met three times in 2016 to review AEP Ohio's proposed Plan approaches and Collaborative members had the opportunity as a group and individually to provide feedback throughout the entire process. Not included in the count were individual meetings held with interested Collaborative members to provide additional time for input. In some cases, Collaborative members brought in third party EE/PDR consultants to assist AEP Ohio.

The Collaborative members include: PUCO Staff, Ohio Consumers' Counsel, Sierra Club, Natural Resources Defense Council, Ohio Environmental Council, Industrial Energy Users-Ohio, Ohio Manufacturing Association, Ohio Energy Group, Ohio Hospital Association, Ohio Partners for Affordable Energy, Ohio Air Quality Development Authority, Ohio Development Services Agency (includes the Office of Energy and Office of Community Assistance), Ohio Chamber of Commerce, Ohio Board of Regents, Ohio Farm Bureau, Mid-Ohio Regional Planning Commission, Ohio Poverty Law Center, Corporation for Ohio Appalachian Development, Building Industry Association of Central Ohio, Association of Independent Colleges and Universities of Ohio, IMPACT Community Action, Ohio Energy Project, Environmental Law and Policy Center, Environmental Defense Fund and Ohio Legal Services.

2.5 Attempts to Align and Coordinate with Other Public Utility Programs

AEP Ohio has regular communication with other utilities in the state regarding EE/PDR activities and is open to opportunities to work together and share information. AEP Ohio has met with the other utilities, electric and gas, over the last five years to share knowledge on program design and implementation. For example, AEP Ohio and Columbia Gas are currently working together to deliver New Homes, In-Home Audit, e^{3}smart^{SM} and pilot programs such as Energy Code Support and Community Energy Savers. As opportunities arise to improve program delivery, partnerships may continue or new ones may develop.

2.6 AEP Ohio Plan Management

AEP Ohio serves as the overall program administrator for delivery of the Plan. AEP Ohio plans to engage third-party implementation contractors when it is more cost effective than running the programs in house. Utilization of third party contractors will continue to be subject to cost effectiveness throughout the Plan period. Competitive bidding for third party work is planned where opportunities to improve cost effectiveness are available and for contractors that have been working for AEP Ohio through two previous Plan cycles.

AEP Ohio is responsible for high-level administrative, contract and program management, program design and marketing oversight of the selected implementation contractors. A Plan of this proposed size and scope requires careful management oversight. The experience gained from implementation of the 2009-2011 and 2012-2014 Plans and continuation of programs during 2015-2016 provides the best guidance as to the structure and size required to administer these programs. AEP Ohio will continue to have a small and dedicated group of EE/PDR program staff overseeing both AEP Ohio and third-party implemented programs including compliance and financial management activities, as well as research, development, education, training, planning and promotion of programs to increase customer awareness and participation.

AEP Ohio's Manager EE/PDR is responsible for the overall Plan and reports to the Director of Customer Services and Marketing, who reports to the President of AEP Ohio. Six functional areas report to the Manager EE/PDR and include Research & Development, Education & Training, Compliance, Finance, Consumer Programs and Business Programs. A staffing complement of twenty five is approved to manage these activities, and it is not projected that additional full-time employees (FTEs) will be needed to manage this Plan While this staffing level contemplates a continuing reliance on external third-party contractors, it is possible that in house staff may be more cost effective after third-party bidding is analyzed for the various programs. In any case, any increase in the level of in house staffing beyond the FTEs indicated above would be constrained within the overall budget proposed in this Plan, and only if it were determined that in house staffing additions were cost effective and improved program performance and delivery.

AEP Ohio has developed a comprehensive tracking database to ensure accurate and comprehensive reporting of all program participation that is planned to be launched by the end of 2016. Additionally, the database will allow AEP Ohio to more effectively research and track participation by customer class, segment and geographic area, to identify trends and untapped opportunities to advance program goals and increase first time program participation. Also, AEP Ohio staff has primary responsibility for general energy efficiency education and awareness strategies and activities, including the content of the EE/PDR web site[12], online energy audit software, mass-market media, general education, and efficiency awareness promotions. Research and Development will support Plan adjustments and future planning intelligence for the achievement of goals.

In summary, AEP Ohio will provide comprehensive program contract oversight, including management, financial planning and budgeting, regulatory and legal support, as well as:

- High-level guidance and direction to any implementation contractors, including review and revision of proposed annual implementation plans and proposed milestones, and additionally, daily engagement with the contractor team when working through strategy and policy issues.

- Review and approval of implementation contractor invoices and ensuring program activities are within budget and on schedule.
- Assurance that implementation contractor operational databases are accurate, and data is incorporated into AEP Ohio's comprehensive Plan tracking database to be used for overall tracking, management and regulatory reporting.

[12] See http://www.aepohio.com/save

- Review of measure saving estimates maintained by AEP Ohio and the implementation contractors.
- Oversight and coordination of evaluation, measurement, and verification contractors.
- Public education and outreach to customers, community groups, trade allies and trade associations.
- Guidance and direction on new initiatives or strategies.
- Communication and direction to implementation contractors regarding other AEP Ohio initiatives that may provide opportunities for cross-program promotion.
- Development, review and approval of printed materials and advertising plans.
- Evaluation of Plan and program cost effectiveness and recommendations for modifications to programs and approach as needed.
- Periodic review of program metrics, investment analyses, and evolving program designs.
- Research and development, both internal and oversight of third party providers.

3 EE/PDR PLAN SUMMARY RESULTS

3.1 Plan Framework and Summary

For the 2017-2019 Plan, AEP Ohio is proposing average annual Plan spending at levels similar to the 2014 approved level of $97.5 million in the current 2012-2014 EE/PDR Action Plan, which was supported by a broad coalition of stakeholders and approved by the PUCO. Over the three years of the Plan, total spending is proposed at $292.5 million (inflation adjusted) on EE/PDR programs during calendar years 2017 to 2019. The division of EE/PDR program investment between residential and business customers is commensurate with each sector's relative contribution to the Plan overall and to the Plan's cost effectiveness.

The Plan maximizes the amount of program funds that go directly to customers through rebates and incentives, training and technical assistance, and customer and trade ally education. This Plan also takes into account the realities of program start-up costs for newly proposed programs, and the funds needed to adequately plan, develop, deliver, and evaluate quality programs. The balance of the expenditures will be applied to program administration, including staffing.

Incentive levels and other program elements will be reviewed and modified to reflect changes in market conditions or implementation processes in order to maximize cost-effective savings. Modifications will be reported in the annual reports submitted to the PUCO. As previously detailed in Table 3, AEP Ohio has developed this Plan with the intent to meet or exceed statutory energy savings goals as percent of sales and demand savings as a percent of peak load.

3.2 Benefit-Cost Analysis Background

AEP Ohio has estimated the energy savings, costs and benefits associated with each of the programs included in the proposed Plan. The following section presents the benefit-cost results.

Types of Benefit-Cost Tests

As detailed in Table 21 there are four major benefit-cost tests commonly utilized in the energy efficiency industry, each of which addresses different perspectives. The PUCO established that the Total Resource Cost (TRC) Test be the key test to determine if EE/PDR programs should be offered to customers. Regardless of which perspective is used, benefit-cost ratios greater than or equal to 1.0 are considered beneficial. While various perspectives are often referred to as tests, the following list of criteria demonstrates that decisions on program development go beyond a pass/fail test.

Table 21. Comparative Benefit-Cost Tests

	PARTICIPANT COST TEST (PCT)	RATE IMPACT MEASURE TEST (RIM)	TOTAL RESOURCE COST TEST (TRC)	UTILITY COST TEST (UCT)
Reduction in Customer's Utility Bill	X	X		
Incentive Paid by Utility	X	X		X
Any Tax Credit Received	X		X	
Avoided Supply Costs		X	X	X
Avoided Participant Costs			X	
Participant Payment to Utility (if any)	X	X		X
Utility Admin Costs		X	X	X
Participant Costs	X		X	
Lost Revenues		X		

AEP Ohio evaluated the cost-effectiveness of the measures, programs and overall Plan based on the following standard tests:

The Participant Cost Test (PCT) illustrates the relative magnitude of net benefits that go to participants compared to net benefits achieved from other perspectives. While called a “participant” perspective, it is not necessarily a perspective indicating whether customers participate. The implied discount rate can vary substantially between customers. More importantly, many customers neither understand nor make decisions based on present-value benefit-cost analysis. Consequently, a simple payback (years) net of incentive has been shown to provide further guidance on customer participation. The benefits derived from this test reflect reductions in a customer’s bill and energy costs plus any incentives received from the utility or third parties, and any tax credit. Savings are based on gross revenues. Costs are based on out-of-pocket expenses from participating in a program, plus any increases in the customer’s utility bill(s).

The Rate Impact Measure (RIM) Test measures the change in utility energy rates resulting from changes in revenues and operating costs. The higher the RIM test, the less impact is on increasing energy rates. While the RIM results provide a guide as to which technology has more impact on rates, generally it is not considered a pass/fail test. Instead, the amount of rate impact usually is considered at a policy level. The policy level decision is whether the entire Plan's impact on rates is so detrimental that some net benefits have to be forgone.

The Total Resource Cost Test (TRC) is a test that measures the total net resource expenditures of an EE/PDR program from the point of view of the utility and its ratepayers. Resource costs include changes in supply and participant costs. An EE/PDR program, which passes the TRC test (i.e., a ratio greater than 1.0) is viewed as beneficial to the utility and its customers because the savings in electric costs outweigh the EE/PDR costs incurred by the utility and its customers.

The Utility Cost Test (UCT, also referred to as the Program Administrator Test) measures the net benefits of a EE/PDR program as a resource option based on the costs and benefits incurred by the utility (including incentive costs) and excluding any net costs incurred by the customer participating in the efficiency program. The benefits are the avoided supply costs of energy and demand, the reduction in transmission, distribution, generation and capacity valued at marginal costs for the periods when there is a load reduction. The costs are the program costs incurred by the utility, the incentives paid to the customers, and the increased supply costs for the periods in which load is increased.

3.3 Benefit-Cost Methodology

The Energy Efficiency Resource Assessment Model (EERAM) is a model based on the integration of EE/PDR measure impacts and costs, utility customer characteristics, utility load forecasts, and utility avoided costs and rate schedules. The model utilizes a "bottom-up" approach in that the starting points are the study area building stocks and equipment saturation estimates, forecasts of building stock decay and new construction, EE/PDR technology data, past EE/PDR program accomplishments, and decision maker variables that help drive the market potential scenarios.

The baseline estimates of building stocks and equipment saturations came from the results of the on-site assessments conducted by AEP Ohio for the 2013 residential and nonresidential baseline studies and 2014 Residential Lighting Socket Study. EERAM also used the electricity forecast, avoided cost forecast, and electricity prices as described below.

EERAM estimates technical, economic, and achievable EE/PDR resource potential as defined below:

- **Technical EE/PDR potential** describes the amount of EE/PDR savings that could be achieved, not considering economic and market barriers, by customers installing EE/PDR measures. Technical potential is calculated as the product of the EE/PDR measures' savings per unit, the quantity of applicable equipment in each facility, the number of facilities in a utility's service area, and 100 percent current market saturation of the measure. Technical potential estimates include EE/PDR measures that may not be cost effective, and technical potential does not consider market barriers, such as customer's lack of awareness of EE/PDR measures. Therefore, technical EE/PDR potential estimates do not provide a realistic basis for setting EE/PDR program goals.
- **Economic EE/PDR potential** describes the amount of technical EE/PDR potential that is "cost-effective," as defined by the results of the TRC test (or other preferred cost effectiveness test). The program benefits for the TRC test include the avoided costs of generation, transmission, and distribution investments and avoided fuel costs due to the energy conserved by the EE/PDR programs. The costs for the TRC test are the EE/PDR measure costs, plus the EE/PDR program administration costs. The TRC test does not consider economic or market barriers to customers installing EE/PDR measures.
- **Achievable EE/PDR market potential** estimates the amount of EE/PDR potential that could be captured by realistic EE/PDR programs that include cost effective EE/PDR measures over the forecast period covered by this EE/PDR potential analysis. Achievable EE/PDR potential can vary with EE/PDR program parameters, such as the magnitude of rebates or incentives offered to customers for installing EE/PDR measures and, thus, many different scenarios can be modeled.

Within the achievable EE/PDR potential assessment, the individual measures are modeled by expected type of EE/PDR program design. Three different program design options are included in EERAM.

- **Replace on Burnout (ROB)** means that an EE/PDR measure is not implemented until the existing technology it is replacing fails. An example would be an energy efficient clothes washer being purchased after the failure of the existing clothes washer.
- **Retrofit (RET)** means that the EE/PDR measure could be implemented immediately. For instance, installing a low flow shower head is usually implemented before an existing shower head fails. Replacing incandescent lamps may be a ROB, but can be treated as a RET, because of the relatively short lifetime for incandescent bulbs.
- **New Construction (New)** means measures that are installed at the time of new construction. Baseline technologies may be different in the new construction

market, and implementation costs are often different due to the different technologies, either the energy efficient or base technology.

Cost Effectiveness Tests

EERAM employs several financial tests, including the cost effectiveness tests described above: the TRC, UCT, PCT, and RIM tests.

Simple Customer Payback

The decision model of EERAM includes simple customer payback as part of its analysis. The calculation takes measure cost less the incentive received and divides it by first year energy bill savings.

EE/PDR Measure Levelized Cost/kWh

EE/PDR supply curves are based on the EE/PDR measure cost per kWh, levelized over the lifetime of the measure. It is calculated by multiplying EE/PDR measure costs by the Capital Recovery Factor (CRF), then dividing by the first year kWh savings.

Discount Rate

There is a time value of money because money spent in the future does not have the same value as money spent today. This time value is represented by a discount rate (analogous to an interest rate). Economic equations use the discount rate to convert all costs and benefits to a “present value” for comparing alternative costs and benefits. AEP Ohio used a uniform discount rate of 8.29 percent for planning purposes only.

Avoided Costs and Energy Costs

EE/PDR avoided cost benefits fall into two categories, avoided capacity benefits, and avoided energy costs. Avoided capacity benefits are the benefits derived from deferring the need to build new generating plants in the future. Avoided capacity values were based on AEP Ohio projections of future power plant costs considering expected level of capacity available over future years, and the costs of that capacity.

Administration, Implementation and Direct Costs

Each program’s administration, implementation, and direct costs were allocated to the technologies delivered by the program based on the annual kWh savings per measure. The result is that individual technology benefit/cost ratios can appear low simply because administration or implementation costs have been allocated to the technology beyond the specific technology costs. On the one hand, this allocation helps ensure the overall cost-effectiveness of a program by guiding selection of technologies with sufficient benefits to

support program delivery costs. This still allows technologies with a benefit-cost ratio less than 1.0 to be included as needed to meet other goals in addition to Plan cost-effectiveness requirements. AEP Ohio support services that are not specific to individual programs are added as costs at the Plan level for all programs.

3.4 Program Development

Program development involves the selection of technologies to include in a program, estimates of participation levels and estimates of program costs. It is obviously necessary for a Plan to be cost-effective. However, there are multiple and often contradictory perspectives on cost effectiveness. Alternative perspectives are described below. The primary cost-effectiveness perspective in AEP Ohio is the total resource cost test. Fortunately, it is possible to achieve required cost-effectiveness at a Plan level while also considering other important criteria. The following list of criteria was considered in developing programs:

- Achieving more benefits net of cost is a higher priority than a high benefit-cost ratio.
- The Plan must provide opportunities for all customer sectors to participate.
- Long-term contribution of a technology is important to program success and to future cost reductions.
- Consideration of different benefit-cost perspectives is necessary.

While almost all customer sectors will pay a contribution in their utility bill towards the cost of efficiency programs, some customer sectors will not be able to participate unless a program is specifically targeted to overcome their barriers. The Residential Community Assistance Program is an example of a program where improving the ability of a specific sector to participate was a primary program design goal. Similarly the Business Express program is targeted to small businesses and without a focused effort those customers would not participate at a reasonable level.

The next section provides details on the adjustments and enhancements, projected participation, savings, budgets and benefit-cost test results for ongoing programs. Further details are provided for new programs, including:

- Objectives
- Target Markets
- Duration
- Description
- Incentive Strategy
- Eligible Measures

- Implementation Strategy
- Marketing Strategy
- Milestones
- EM&V Strategy
- AEP Ohio Administrative Requirements
- Budget
- Savings Targets
- Benefit-Cost Test Results

4 EE/PDR PROGRAM PLANS

The programs developed to achieve EE/PDR goals in this Plan are based on lessons learned from the implementation of EE/PDR Action Plans since 2009, as well as other best-practice programs from around the country, with the concepts outlined in a strategic manner. Existing program plans are not repeated from the 2012-2014 EE/PDR Action Plan; however, modifications are included. The plans are proposed guidelines for more detailed program planning, and the intent of the 2017-2019 Plans presented here is to provide a sense of scope and scale, and convey the general schedule and resources needed to increase customer participation from previous program efforts in the various markets in which the programs will operate.

Overall, a Plan is presented that covers a broad range of demographic, business, facility, and end-use markets. AEP Ohio's Plan can be divided into consumer, business and cross-sectors with utility administrative functions providing support across all program areas. AEP Ohio will maintain as part of its functionality the advertising, education, training and research and development budgets. The following sections present a summary of the services offered in each program.

4.1 Consumer Programs

For the complete program plan for each ongoing consumer EE/PDR program, please reference the Consumer Program Plans section (pages 57-80) of *Volume 1: AEP Ohio 2012 to 2014 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan*, dated November 29, 2011 (PUCO Docket 11-5568-EL-POR and 11-5569-EL-POR.) Included in each program description below are material program changes shown as adjustments and enhancements, projected participation levels, budgets, savings targets and benefit-cost test results. For the new programs, complete program descriptions are included.

4.1.1 Efficient Products (Ongoing Program)

To build market share and usage of efficient lighting, appliances, and HVAC equipment, this program provides incentives (primarily mark down and rebate approaches) and marketing support through retailers, trade allies, and an online rebate store. Customer incentives at the point of sale encourage increased purchases of high-efficiency products while in-store signage, sales associate training, and support simplify provider participation.

Lighting: As the market shifts away from CFL to newer LED technology, AEP Ohio will rely on LED sales through the over 600 retailers in place throughout its service territory and the AEP Ohio online lighting store (http://www.energyfederation.org/aepohio/). CFL's are not included in the 2017-2019 Plan.

Appliances: The program uses a retail channel-based strategy to influence the purchase of a variety of cost effective appliances, including refrigerators, freezers, clothes washers, clothes dryers, dishwashers, televisions, dehumidifiers, computer monitors, smart power strips, room air conditioners, and pool pumps. AEP Ohio plans for retailer based appliance programs with mid and downstream incentive strategies, depending on the overall cost effectiveness and savings potential for each appliance. As appliance standards and the market share of high-efficiency appliances gradually increase, the program will be specific in its list of qualifying models and marketing emphasis.

HVAC and Domestic Hot Water: The program affects the purchase and installation of HVAC equipment including air source heat pumps, air conditioners, mini-split heat pumps, electric hot water heaters, heat pump hot water heaters, intelligent thermostats, circulating pumps and drain water heat recovery systems. The program is implemented through a combination of market push and pull strategies that stimulate demand while simultaneously increasing trade ally investment in stocking and promoting high efficiency products. HVAC and Domestic Hot Water will be implemented through two distinct market channels – plumbing contractor trade allies and retail do-it-yourself stores.

Adjustments and Enhancements

AEP Ohio plans to make the following adjustments to the Efficient Products program in 2017-2019:
• CFL rebates will be discontinued across the portfolio, combined with aggressive promotion and rebate for qualifying LED products.
• The following measures may be added to the program:
  o Lighting controls
  ▪ Hardwired dimmer switches
  ▪ Outdoor and indoor fixture and wall-mounted motion sensors
  o HVAC
  ▪ Drain water heat recovery
  ▪ ECM fan motor for central air conditioners and heat pumps
  ▪ Intelligent *('smart')* thermostats
  ▪ Low flow shower heads with automatic start/stop control
  ▪ Revised electric water heater rebate through trained plumbing contractors and distributors rather than through typical DIY retailers

- Appliances
  - Air purifiers
  - Convection oven
  - ENERGY STAR® dishwasher
  - ENERGY STAR® clothes dryers (including heat pump clothes dryers) (CEF >= 5.0, replacing electric dryers)
  - ENERGY STAR® computer monitor
  - ENERGY STAR® television set top boxes
  - Smart power strips
  - Waterbed insulating pad
- Pool pumps:
  - Premium efficiency pool pumps
  - Variable speed drive pumps
  - Heavy duty outdoor pool pump timers

- Incentives not included in the measure mix from previous plan(s) have been determined either to not be cost effective or had low participation.
- Customer incentives may be adjusted to increase cost effectiveness and/or program participation.
- Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.

Participation

The following participation levels have been used for planning purposes. AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
LED Lighting 8W - Indoor	Lamp	686,091	613,011	559,048	1,858,150
LED Lighting 8W - Outdoor	Lamp	60,840	54,410	49,668	164,918
LED Lighting 15W - Indoor	Lamp	86,274	77,088	70,305	233,667
LED Lighting 15W - Outdoor	Lamp	12,852	11,494	10,492	34,838
LED Lighting 8W - Indoor (CFL Base)	Lamp	90	0	0	90
LED Lighting 8W - Outdoor (CFL Base)	Lamp	7	0	0	7

LED Lighting 12W - Indoor (CFL Base)	Lamp	12	0	0	12
LED Lighting 12W - Outdoor (CFL Base)	Lamp	1	0	0	1
5W Chandelier LED bulb	Lamp	9,165	8,129	7,314	24,608
DHW Pipe Insulation R-4 10 feet	10 Linear Feet	6,692	7,746	7,605	22,042
Low Flow Faucet Aerator, 1.5 GPM - EDHW	Faucet	14,515	17,089	16,858	48,462
Low Flow (1.25 GPM) showerhead	Shower	12,580	15,094	14,990	42,664
VSD Pool Pump	Pump	4	27	28	59
Premium Efficiency Pool Pumps	Pump	18	134	146	298
Heavy Duty Outdoor Timer for Pool Pump	Pump	184	1,335	1,309	2,828
Efficient Refrigerator (ENERGY STAR® or Better)	Refrigerator	20	16	13	50
Efficient Refrigerator (ENERGY STAR® or Better) (DUB)	Refrigerator	914	736	586	2,236
ENERGY STAR® Freezer	Freezer	69	56	44	170
ENERGY STAR® Freezer (DUB)	Freezer	814	656	522	1,992
ENERGY STAR® Dehumidifier	Dehumidifier	74	59	47	180
5-plug Smart Strip Power Bar	Power Strip	7,386	5,952	4,735	18,074
7-plug Smart Strip Power Bar	Power Strip	7,386	5,952	4,735	18,074
ENERGY STAR® v. 5.3 Television	TV	216	174	139	529
ENERGY STAR® Most Efficient Television	TV	218	176	140	534
ENERGY STAR® Set Top Boxes	Box	190	1,401	1,506	3,097
ENERGY STAR® Dishwasher - Elec DHW (DUB)	Dishwasher	372	2,723	2,846	5,942
ENERGY STAR® Dishwasher - Non-EL DHW (DUB)	Dishwasher	746	5,445	5,645	11,836
Convection Oven	Oven	101	737	779	1,616
Clothes Washer - Tier 3 >= 2.2 MEF-w/gas or no dry	Unit	5	32	32	69
Clothes Washer - Tier 3 >= 2.2 MEF-w/gas or no dry (DUB)	Unit	230	185	147	562
Clothes Washer - Tier 3 >= 2.2 MEF-w/elec dry	Unit	29	23	18	70
Clothes Washer - Tier 3 >= 2.2 MEF-w/elec dry (DUB)	Unit	650	524	417	1,591
ENERGY STAR® Air Purifier/Cleaner	Purifier	47	38	30	114
High Performance Circulating Pump (DHW)	Pump	143	161	161	465

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Incentive	$4.7	$4.5	$4.2	$13.5
Administrative	$4.4	$4.1	$3.9	$12.3
Total	**$9.1**	**$8.7**	**$8.0**	**$25.8**
Incremental Annual Participant Costs (Millions)				
	2017	2018	2019	Total 2017-2019
Participant Costs	$7.9	$7.6	$6.9	$22.4

Savings Targets

Incremental Annual Savings - at Meter				
	2017	2018	2019	2019 Cumulative Annual
Energy (MWh)	64,492	61,058	57,034	182,584
Summer Peak Demand (kW)	5,109	5,315	5,002	15,426

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	4.1
Utility System Resource Cost (UCT)	5.5
Participant Cost (PCT)	15.1
Rate Impact Measure (RIM)	0.4

4.1.2 Appliance Recycling (Ongoing Program)

Many of the refrigerators and freezers being replaced by AEP Ohio customers are still functioning, and, often end up as very inefficient secondary appliances in basements and garages. The Appliance Recycling Program targets these “second” refrigerators and freezers, cutting energy consumption. It also intervenes to keep the older, less efficient appliances out of the used appliance market. The program provides incentives to remove working appliances from service and fully recycle their materials. The program offers an environmentally responsible turnkey pick-up and recycling service.

Adjustments and Enhancements

AEP Ohio plans to make the following adjustments to the Appliance Recycling program for 2017-2019:

- Expand program to serve business customers with pick-up and recycling of their residential-grade refrigerators/freezers to broaden participation.
- Customer incentives may be adjusted to fine tune program cost effectiveness and/or participation. Strategies may include:
  - Correlating rebate amount to appliance characteristics such as age and efficiency of retired appliance, or operating status.
  - Providing customer rebates in the form of pre-paid credit cards for efficient lighting products, encouraging purchase of efficient lighting.
- Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
Refrigerator Retirement	Refrigerator	12,237	13,059	13,838	39,133
Freezer Retirement	Freezer	6,635	7,080	7,503	21,218

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Incentive	$2.7	$2.9	$3.1	$8.7
Administrative	$0.5	$0.5	$0.5	$1.5
Total	**$3.2**	**$3.4**	**$3.5**	**$10.1**
Incremental Annual Participant Costs (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Participant Costs	N/A	N/A	N/A	**N/A**

Savings Targets

Incremental Annual Savings - at Meter				
	2017	2018	2019	2019 Cumulative Annual
Energy (MWh)	11,833	11,927	11,895	35,654
Summer Peak Demand (kW)	1,806	1,820	1,815	5,441

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.3
Utility System Resource Cost (UCT)	1.3
Participant Cost (PCT)	N/A
Rate Impact Measure (RIM)	0.3

4.1.3 In-Home Audit (Ongoing Program)

This program produces long-term electric energy savings in the consumer sector by helping customers analyze and reduce their energy use from a comprehensive whole house perspective.

Option 1: On-Line Energy Analysis – This program is free to all AEP Ohio customers. Customers who complete the online analysis will receive a kit of energy efficiency measures by mail. Savings could include customer changes in behavior informed from the completion of the energy analysis.

Option 2: In-Home Energy Assessment – This program provides a walk-through audit by pre-certified contractors, direct installation of energy efficiency measures, and a prioritized list of energy savings recommendations. This option is available to customers that are not eligible for Option 3.

Option 3: In-Home Energy Audit (all electric only) – This program provides the customer a comprehensive energy efficiency audit. The audit is performed by a pre-qualified and certified energy auditor, either directly contracted or sub-contracted to AEP Ohio to deliver the services required. The auditors perform blower-door testing, infrared camera testing, combustion air tests, and utilize approved software to provide customers with a detailed report of energy usage and potential savings associated with improvements. Customers will also receive directly installed energy efficiency measures and a prioritized list of energy savings recommendations.

AEP Ohio also plans to collaborate with Columbia Gas to provide comprehensive services to customers who heat their homes with natural gas. Participating customers

will be eligible for incentives and can choose from a list of pre-qualified contractors to have energy-saving improvements installed.

Adjustments and Enhancements

AEP Ohio plans to make the following adjustments to the In-Home Audit program for 2017-2019:

- CFL rebates will be discontinued across the portfolio; direct installation projects will include qualifying LED lighting products.
- The following measures may be added to the program:
  - Lighting controls
    - Hardwired dimmer switches
    - Outdoor and indoor fixture and wall-mounted motion sensors
  - HVAC
    - ECM fan motor for central air conditioners and heat pumps
    - Intelligent *('smart')* thermostats
    - Low flow shower heads with automatic start/stop control
  - Appliances
    - Convection oven
    - ENERGY STAR® clothes dryers (including heat pump clothes dryers) (CEF >= 5.0, replacing electric dryers)
    - ENERGY STAR® computer monitor
    - ENERGY STAR® television set top boxes
    - Smart power strips
    - Waterbed insulating pad
  - Pool pumps:
    - Premium efficiency pool pumps
    - Variable speed drive pumps
    - Heavy duty outdoor pool pump timers
- AEP Ohio will continue to look for opportunities to partner with other utilities to lower program administration costs and increase participation.
- AEP Ohio may offer only the all-electric customer audit and replace the dual fuel home assessment with a free online audit, measures kit, and rebates.

- Consider continuation of the multi-family individual unit direct install program.
- Measure mix and rebate schedules will be reviewed and periodically adjusted to improve cost effectiveness and program participation.
- Measures and incentives removed from the program have been determined to be either not cost effective or had low participation.
- Customer incentives may be adjusted to increase cost effectiveness and/or program participation.
- Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.

Retrofit Manufactured Housing:

AEP Ohio will expand the In-Home Audit Program to improve the efficiency and comfort of existing occupied manufactured housing and serve a hard-to-reach customer segment. The Retrofit Manufactured Housing measures will achieve energy savings through the identification and implementation of cost-effective measures targeted at residential customers with all-electric manufactured housing on permanent foundations in urban and rural communities.

- AEP Ohio will offer assessment services to identify retrofit opportunities and will offer financial incentives to residents and/or to contractors to assist with installation of measures including:
    - A/C inspection and tune-up
    - High efficiency heat pump replacements of resistance heating
    - Ductless mini-splits
    - Duct sealing and repair
    - Mobile home belly patch
    - Mobile home roof coat
    - Mobile home roof patch
    - Attic radiant barrier
    - Mobile home insulation
    - Mobile home underneath vapor retarder
- The implementation strategy is designed to lower the cost of delivery and increase participation by:
    - Combining multiple measures in one treatment package per home.

- Identifying and engaging other program administrators and collaborators to share costs.
- Encouraging third party financing for energy efficiency loans.
- The marketing strategies will vary from community outreach and direct mail to reach the majority of manufactured housing that is sited in rural settings of low population density to door-to-door canvassing of more densely clustered mobile home parks and communities.

- The Manufactured Housing Retrofit implementation contractor will:
  - Market the retrofit program to customers.
  - Implement a screening process to qualify cost-effective candidates for retrofit.
  - Administer, provide quality control, and verify retrofit installations.
  - Identify and collaborate with other manufactured housing efficiency program administrators.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
Tier 1 GSHP, Closed Loop, water to air (DUB)	Ton	169	159	157	486
Tier 2 GSHP, Closed Loop, water to air	Ton	9	9	9	27
Tier 2 GSHP, Closed Loop, water to air (DUB)	Ton	31	29	29	90
Tier 3 GSHP, Closed Loop, water to air (DUB)	Ton	33	31	31	94
Tier 1 GSHP, Open Loop, water to air (DUB)	Ton	32	30	29	91
Tier 2 GSHP, Open Loop, water to air (DUB)	Ton	35	33	32	100
Tier 3 GSHP, Open Loop, water to air (DUB)	Ton	39	36	36	111
Air Source Heat Pump SEER 15, COP 2.49 (DUB)	Ton	482	452	447	1,381
SEER 15 CAC - Non-EL Heat (DUB)	Ton	8,701	8,165	8,078	24,944
SEER 15 CAC - EL Heat (DUB)	Ton	216	203	201	620
Ductless Mini Split HP SEER 15	Ton	6	6	6	17
Ductless Mini Split HP SEER 18	Ton	2	2	2	7
ENERGY STAR® Window / Room AC	Unit	19	18	17	54
ENERGY STAR® Window / Room AC (DUB)	Unit	150	141	140	431

ECM Fan Motor - Heat Pump	Home	174	164	162	500
ECM Fan Motor - Central A/C - Non-EL Heat	Home	1,878	1,763	1,744	5,385
ECM Fan Motor - Central A/C - EL Heat	Home	47	44	43	134
Duct Sealing and Insulation - Heat Pump	Home	0	43	46	89
Duct Sealing and Insulation - CAC - EL Heat	Home	2	2	2	7
Reduced ACHnat 0.3 - Heat Pump	Home	10	10	9	29
Reduced ACHnat 0.3 - Central A/C - EL Heat	Home	3	3	3	8
ENERGY STAR® 50 CFM Bathroom Ventilating Fan	Fan	156	147	145	448
Wall Insul. R-11 - Central A/C - EL Heat	1000 sqft wall area	15	14	14	44
ENERGY STAR® Double Pane Windows - Heat Pump (DUB)	100 sqft window area	284	266	264	814
ENERGY STAR® Double Pane Windows - Central A/C - Non-EL Heat (DUB)	100 sqft window area	3,086	2,896	2,865	8,847
ENERGY STAR® Double Pane Windows - Central A/C - EL Heat (DUB)	100 sqft window area	76	72	71	219
Triple Pane Windows - Heat Pump (DUB)	100 sqft window area	197	185	183	565
Triple Pane Windows - Central A/C - Non-EL Heat (DUB)	100 sqft window area	2,107	1,977	1,957	6,041
Triple Pane Windows - Central A/C - EL Heat (DUB)	100 sqft window area	53	49	49	151
1W LED Night Light	Lamp	8,273	7,958	8,055	24,286
LED Holiday Lights (300 bulb string)	300 bulb string	95,046	92,559	94,898	282,503
High Eff. Elec. Water Heat - Tank - .95 EF (DUB)	Unit	520	488	483	1,492
Heat Pump Water Heater - 2.0 EF	Unit	0	0	28	28
Heat Pump Water Heater - 2.0 EF (DUB)	Unit	116	109	107	331
Instantaneous Electric Water Heater - .99 EF (DUB)	Unit	289	271	268	829
Shower Start/Stop	Unit	965	905	896	2,766
Waterbed Insulating Pad	Pad	0	0	479	479

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Electricity and measure cost savings resulting from installing CFLs in lieu of incandescent bulbs result in negative participant costs (savings.)

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Incentive	$2.0	$1.9	$1.9	$5.7
Administrative	$3.4	$3.2	$3.3	$9.9
Total	**$5.3**	**$5.1**	**$5.2**	**$15.6**
Incremental Annual Participant Costs (Millions)				
	2017	2018	2019	Total 2017-2019
Participant Costs	$3.1	$3.0	$3.0	$9.0

Savings Targets

Incremental Annual Savings - at Meter				
	2017	2018	2019	2019 Cumulative Annual
Energy (MWh)	8,727	8,341	8,640	25,707
Summer Peak Demand (kW)	2,482	2,330	2,313	7,125

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.5
Utility System Resource Cost (UCT)	1.8
Participant Cost (PCT)	5.9
Rate Impact Measure (RIM)	0.5

4.1.4 New Home Program (Ongoing Program)

The New Home Program increases energy efficiency in the residential new construction sector. The program is designed to recruit and educate builders and their trades on the benefits associated with energy efficient homes and best practices in building efficient homes.

Homes become certified at different efficiency levels through the Home Energy Rating System (HERS), and incentivized based on the new home's final HERS score. Higher

incentives may be paid if the new home receives ENERGY STAR® Certification or meets other prescriptive criteria. Going forward, the program will continue to provide builder incentives, and also focus on creating a market demand for energy efficient homes through increasing customer awareness and encouraging customers to select efficient new homes.

Adjustments and Enhancements

AEP Ohio plans to make the following adjustments to the New Homes program in 2017-2019:

- CFL rebates will be discontinued across the portfolio, combined with aggressive promotion and rebate for qualifying LED products.
- The following measures may be added to the program:
  - Lighting controls
    - Hardwired dimmer switches
    - Outdoor and indoor fixture and wall-mounted motion sensors
  - HVAC
    - Drain water heat recovery (42% efficient or higher)
    - ECM fan motor for central air conditioners and heat pumps
    - Intelligent *('smart')* thermostats
    - Low flow shower heads with automatic start/stop control
  - Appliances
    - Convection oven
    - ENERGY STAR® clothes dryers (including heat pump clothes dryers) (CEF >= 5.0, replacing electric dryers)
    - ENERGY STAR® dishwasher
- Include code and standards education and awareness for builders and trade allies.
- Explore energy savings opportunities that may exist from energy code support activities designed to transform the market. AEP Ohio will attribute any quantifiable energy savings based on the difference between building to the energy code and actual market practices to the New Homes program.
- Incentives not included in the measure mix from previous plan(s) have been determined to be either not cost effective or had low participation.
- Customer/builder incentives may be adjusted to increase cost effectiveness

and/or program participation.

- Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.
- Provide builder, contractor or HERS rater training(s) as needed.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
Reduced ACHnat 0.3 - Heat Pump	Home	62	61	79	203h
Reduced ACHnat 0.3 - Central A/C - EL Heat	Home	15	15	19	49
ENERGY STAR® 50 CFM Bathroom Ventilating Fan	Fan	4,241	4,201	5,417	13,859
ENERGY STAR® Double Pane Windows - Heat Pump	100 sqft window area	401	397	512	1,310
ENERGY STAR® Double Pane Windows - Central A/C - Non-EL Heat	100 sqft window area	3,173	2,881	3,379	9,434
ENERGY STAR® Double Pane Windows - Central A/C - EL Heat	100 sqft window area	91	90	117	298
Triple Pane Windows - Heat Pump	100 sqft window area	281	279	361	921
Triple Pane Windows - Central A/C - Non-EL Heat	100 sqft window area	2,132	1,936	2,270	6,338
Triple Pane Windows - Central A/C - EL Heat	100 sqft window area	71	71	91	233
ENERGY STAR® 2.0/2.5 Qualified Home - Heat Pump	Home	911	940	1,216	3,066

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Incentive	$1.0	$1.0	$1.2	$3.1
Administrative	$1.5	$1.5	$1.9	$4.8
Total	**$2.4**	**$2.4**	**$3.1**	**$7.9**
Incremental Annual Participant Costs (Millions)				
	2017	2018	2019	Total 2017-2019
Participant Costs	$3.0	$2.9	$3.7	$9.6

Savings Targets

Incremental Annual Savings - at Meter				
	2017	2018	2019	2019 Cumulative Annual
Energy (MWh)	4,735	4,755	6,063	15,552
Summer Peak Demand (kW)	963	943	1,178	3,085

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.0
Utility System Resource Cost (UCT)	1.7
Participant Cost (PCT)	2.9
Rate Impact Measure (RIM)	0.4

4.1.5 Behavior Change (Ongoing Program)

This program helps pre-selected and new customers on an opt-in or opt-out basis to reduce energy use by encouraging them to alter their electricity usage habits by providing positive reinforcement. The report is shared with the customer via email or other electronic media (e.g. smartphone apps, web, or social media) to provide participants with their home's respective usage and other relevant information in a manner to motivate the customer to take action to save energy and maintain those savings through positive reinforcement. For example, the participant is provided a list of simple actions to follow to reduce electricity usage and promote other energy efficiency

programs in which they can participate. The Behavior Change Program will focus on delivering persistent savings as AEP Ohio switches to a digital based home energy savings and education report on an ongoing basis.

Adjustments and Enhancements

AEP Ohio plans modifications to the Home Energy Report Program as shown below:

- AEP Ohio will make reports available via email, online or other digital media.
- AEP Ohio customers may opt in to participate in the digital based communications (such as email, web, or app) whether they have received printed reports in the past or are new to the Behavior Change program.
- AEP Ohio may consider providing reports with internal resources if it is more cost effective.
- AEP Ohio will model savings from current participants to determine the persistence of savings over time and will count associated savings as long as persistence can be validated.
- Behavior programs nation-wide are undergoing significant change in the marketplace. AEP Ohio acknowledges the rapid pace of the industry and plans to continuously monitor and implement innovations. AEP is currently monitoring the following potential opportunities to revise or expand the program:
    - Behavioral demand response
    - Mid-period consumer high–bill alerts
    - Points and reward systems to encourage consumer energy conservation
    - Customized season change outreach

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Participation levels are not assumed to have a one year measure life; however, to be conservative the program design continued that assumption for Plan purposes. Therefore, the total participation over the three year period from 2017 to 2019 is based on the number of participants in the third year, 2019.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
Home Energy Report	Home	375,000	375,000	375,000	375,000

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Incentive	$0.0	$0.0	$0.0	$0.0
Administrative	$1.5	$1.5	$1.5	$4.5
Total	**$1.5**	**$1.5**	**$1.5**	**$4.5**

Incremental Annual Participant Costs (Millions)				
	2017	2018	2019	Total 2017-2019
Participant Costs	N/A	N/A	N/A	**N/A**

Savings Targets

Savings for this program are not cumulative due to a one year measure life.

Incremental Annual Savings - at Meter				
	2017	2018	2019	2019 Cumulative Annual
Energy (MWh)	75,000	75,000	75,000	75,000
Summer Peak Demand (kW)	3,750	3,750	3,750	3,750

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.7
Utility System Resource Cost (UCT)	1.7
Participant Cost (PCT)	N/A
Rate Impact Measure (RIM)	0.2

4.1.6 e^{3}smart^{SM} (Ongoing Program)

This energy efficiency education program provides curriculum, teacher training, and supplies for in-class instruction about energy sources, transformation, and uses. Students learn how to use energy efficiently at home. With the permission of their parents or caregiver(s), students take home and install energy efficiency measures as part of the learning experience. The curriculum is designed to meet national and state science standards for grades 4-12.

Adjustments and Enhancements

AEP Ohio plans to make the following adjustments to the e3SMART program in 2017-2019:

- Adjust the number of student participants to approximately 25,000 per year.
- Remove the outlet gasket measure as a preventative student safety action.
- Expand curriculum from grades 5-12 to grades 4-12.
- Update educational brochures in measure kits to improve compatibility with curriculum.
- Explore curriculum development for high school students to identify and analyze energy efficiency projects within their school or a local business.
- Distribution of CFL's will be discontinued across the portfolio, and will be replaced with qualifying LED lighting products in the e3SMART program.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
Weather-stripping and Door Sweep	Home	9,675	9,445	9,010	28,131
1W LED Night Light	Lamp	7,406	7,177	6,890	21,472
LED Lighting 8W - Indoor for Kit	Lamp	26,114	26,770	27,305	80,188
LED Lighting 8W - Outdoor for Kit	Lamp	24,049	23,615	23,178	70,842
LED Lighting 15W - Indoor for Kit	Lamp	24,205	23,406	23,664	71,274
LED Lighting 15W - Outdoor for Kit	Lamp	480	492	502	1,473
Low Flow (1.25 GPM) showerhead	Shower	4,904	5,027	5,128	15,060
Hot Water Temp Gauge (Tank Temperature Turn Down)	Unit	1,807	1,788	1,776	5,372
Low Flow Faucet Aerator, 1.5 GPM - EDHW -Kitchen	Faucet	7,967	7,433	8,009	23,408
Low Flow Faucet Aerator, 1.5 GPM - EDHW –Bathroom	Faucet	2,729	2,634	2,740	8,103

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Incentive	$0.5	$0.5	$0.5	$1.6
Administrative	$0.7	$0.7	$0.7	$2.1
Total	**$1.2**	**$1.2**	**$1.2**	**$3.7**
Incremental Annual Participant Costs (Millions)				
	2017	2018	2019	Total 2017-2019
Participant Costs	$0.5	$0.5	$0.5	$1.6

Savings Targets

Incremental Annual Savings - at Meter				
	2017	2018	2019	2019 Cumulative Annual
Energy (MWh)	6,773	6,796	6,897	20,466
Summer Peak Demand (kW)	525	527	535	1,587

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	4.0
Utility System Resource Cost (UCT)	4.0
Participant Cost (PCT)	22.8
Rate Impact Measure (RIM)	0.4

4.1.7 Community Assistance (Ongoing Program)

The program provides energy efficiency services to AEP Ohio customers with limited income to assist them in reducing their electric energy use and managing their utility costs. AEP Ohio low income residential customer households eligible to participate have an income less than 200 percent of the Federal Poverty Level (FPL). These customers are also typically approved for an energy assistance program such as PIPP (Percentage of Income Payment Plan) HEAP (Home Energy Assistance Program) or HWAP (Home Weatherization Assistance Program.)

The program generates energy savings for residential low-income customers through an in-home energy audit and the installation of a wide range of base load measures such as efficient lighting, efficient refrigerators as well as weatherization upgrades. The program can be delivered through community based action agencies or private contractors. While the program is not cost-effective on all cost effectiveness tests, it has significant non-energy benefits, including assisting customers with limited incomes to reduce their energy costs, improve their standard of living, and maintain their utility services.

Adjustments and Enhancements

AEP Ohio plans to make the following adjustments to the Community Assistance program in 2017-2019:

- Retrofit Manufactured Housing: AEP Ohio will expand the Community Assistance Program to obtain energy savings through the identification and implementation of cost-effective measures that improve the efficiency and comfort of existing occupied manufactured housing and to serve a hard-to-reach customer segment. The Retrofit Manufactured Housing measures are targeted for income-eligible residential customers with all-electric mobile homes on permanent foundations in urban and rural communities.
- Proposed adjustments to program measures include:
    - Distribution of CFL's will be discontinued across the portfolio, and will be replaced with qualifying LED lighting products.
    - Adding Exterior motion sensors
    - Adding Smart strip power bars
    - Adding Intelligent 'smart' thermostats
    - Adding Automatic start/stop shower heads
- Incentives not included in the measure mix from previous plan(s) have been determined to be either not cost effective or had low participation.
- Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on measure life, cost effectiveness and customer participation. Consideration will be given for measures that may not be cost effective if they have long term energy and demand savings. One example is ductless mini-split heat pumps.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
Air Source Heat Pump SEER 14.5, COP 2.49	Ton	88	93	92	274
ENERGY STAR® Window / Room AC (DUB)	Unit	306	320	318	944
Reduced ACHnat 0.3 - Heat Pump	Home	27	29	29	85
Reduced ACHnat 0.3 - Central A/C - Non-EL Heat	Home	87	91	90	268
Reduced ACHnat 0.3 - Central A/C - EL Heat	Home	7	7	7	21
Ceiling Ins. R-30 - Heat Pump	1000 sqft footprint	141	149	148	439
Ceiling Ins. R-30 - Central A/C - Non-EL Heat	1000 sqft footprint	280	294	292	866
Ceiling Ins. R-30 - Central A/C - EL Heat	1000 sqft footprint	35	36	36	107
Ceiling Insul R-45 - Heat Pump	1000 sqft footprint	141	149	148	438
Ceiling Insul R-45 - Central A/C - Non-EL Heat	1000 sqft footprint	280	293	292	865
Ceiling Insul R-45 - Central A/C - EL Heat	1000 sqft footprint	35	36	36	107
Wall Insul. R-11 - Heat Pump	1000 sqft wall area	47	49	49	144
Wall Insul. R-11 - Central A/C - Non-EL Heat	1000 sqft wall area	92	97	96	285
Wall Insul. R-11 - Central A/C - EL Heat	1000 sqft wall area	14	15	15	44
Underbelly Insulation R-19 - Heat Pump	100 sqft floor area	1,766	1,859	1,843	5,467
Underbelly Insulation R-19 - Central A/C - EL Heat	100 sqft floor area	434	454	451	1,339
1W LED Night Light	Lamp	1,298	1,248	1,239	3,785
LED Lighting 8W - Indoor	Lamp	84,042	80,857	81,006	245,906
LED Lighting 8W - Outdoor	Lamp	7,444	7,162	7,176	21,782
LED Lighting 15W - Indoor	Lamp	10,568	10,167	10,186	30,921
LED Lighting 15W - Outdoor	Lamp	1,572	1,513	1,515	4,600
High Eff. Elec. Water Heat - Tank - .95 EF (DUB)	Unit	208	172	146	525
Heat Pump Water Heater - 2.0 EF	Unit	4	3	2	9
Heat Pump Water Heater - 2.0 EF (DUB)	Unit	71	58	50	179
Instantaneous Electric Water Heater - .99 EF	Unit	10	9	7	26

Instantaneous Electric Water Heater - .99 EF (DUB)	Unit	208	172	146	525
DHW Pipe Insulation R-4 10 feet	10 Linear Feet	306	253	215	774
Low Flow Faucet Aerator, 1.5 GPM - EDHW	Faucet	663	548	465	1,676
Low Flow (1.25 GPM) showerhead	Shower	635	525	445	1,605
Efficient Refrigerator (ENERGY STAR® or Better) (DUB)	Refrigerator	1,645	1,656	1,670	4,970
Refrigerator Retirement	Refrigerator	829	854	878	2,561
ECM Fan Motor - Heat Pump	Home	141	162	166	468
ECM Fan Motor - Central A/C - Non-EL Heat	Home	1,087	1,250	1,283	3,620
ECM Fan Motor - Central A/C - EL Heat	Home	34	39	40	112
Shower Start/Stop	Unit	261	216	183	661

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Participant electricity cost savings result in negative participant costs.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Incentive	$3.9	$3.9	$3.9	$11.7
Administrative	$4.6	$4.6	$4.6	$13.9
Total	**$8.5**	**$8.5**	**$8.5**	**$25.5**
Incremental Annual Participant Costs (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Participant Costs	N/A	N/A	N/A	N/A

Savings Targets

Incremental Annual Savings - at Meter				
	2017	**2018**	**2019**	**2019 Cumulative Annual**
Energy (MWh)	8,436	8,499	8,499	25,435
Summer Peak Demand (kW)	760	774	774	2,308

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	0.8
Utility System Resource Cost (UCT)	0.8
Participant Cost (PCT)	N/A
Rate Impact Measure (RIM)	0.3

4.1.8 Intelligent Home Energy Assistance and Demand Response (New Program)

Objective

The objective of this program is to enhance customer energy management through providing residential customers with the ability to manage their energy use through a learning thermostat, while delivering demand reductions in the PJM market. AEP Ohio may utilize the home energy management platform to deliver the near real-time energy awareness, energy management and behavioral change solutions to its customers (e.g. through engagement on a daily basis). The home energy management platform may engage customers through smart phone applications.

Target Market

Single-family households, individually metered rental properties and small businesses with residential sector usage patterns including central air conditioning, electric space heating and electric water heating. According to Acxiom research data, 78% of customer households have broadband access with 65% having WIFI connectivity, and 88.6% have at least one cell phone user.

Program Duration

The Intelligent Home Energy Assistance Program will be an ongoing component of the AEP Ohio EE/PDR Plan.

Program Description

Beginning with AMI metered customers, AEP Ohio plans to offer a mobile smartphone app that customers may download for information to illustrate electricity consumption patterns, how their decisions and actions influence their usage, how that usage affects their energy bill, and actions they may take to manage and reduce their usage. App features may include a weather overlay, estimated billing based on usage, energy project tracking, and self-selected peer and community comparisons. AEP Ohio may offer an in-home energy management device that can communicate with the AMI meter and with the app to give customers near real-time, highly granular usage information, and through which customers may control various smart devices.

AEP Ohio plans to offer customers control of electric space cooling and heating load using a “learning” thermostat that has advanced analytics features in addition to two-way communication capabilities. These “learning” thermostats come with a number of capabilities that offer additional energy savings benefits to customers along with demand savings. Load control is achieved through temperature set point adjustments on individual thermostats for both cooling and heating loads and/or through cycling of compressors. The app will enable customers to change heating and cooling settings remotely. AEP Ohio may also offer incentives to encourage and support participation by customers with other approved learning thermostats or in-home devices. This program offering will be further informed through pilot performance.

Incentive Strategy

Customers may be eligible for direct install measures, incentives for next level implementation measures and/or may have energy-saving improvements installed through a list of pre-qualified contractors. Incentives may be adjusted to increase cost effectiveness and/or program participation.

Participants are offered incentives for participating in various ways, e.g., by controlling their end use equipment via a smartphone app, by allowing their end use equipment to be controlled in a "set it and forget it" mode and other control alternatives as developed.

Participants could be provided an incentive for participating and allowing their end use equipment to be controlled. Participants could receive these incentives seasonally for controlling heating or cooling control equipment, or throughout the year for water heater control. In addition, participants are either provided a rebate for thermostat purchase or are provided a free thermostat, depending on the implementation strategy described below.

Eligible Measures

- Download of app
- In-home energy management device
- Communicating thermostats
- Smart sensors
- Smart switches
- Behavioral measures
- End uses include, but not limited to:
    - Central Air Conditioning and Space Heating
    - Major Appliances
    - Electric Water Heating

Implementation Strategy

An implementation contractor may oversee the development, expansion and delivery of the Intelligent Home Energy Assistance program. The main focus of the implementation strategy is designed to lower the cost of delivery and increase the numbers of customers eligible to benefit.

This program will allow participation in the HVAC portion of the program via one or both of the following avenues, depending on pilot program outcomes:

- **Bring Your Own Thermostat (BYOT)** option, where customers are provided a rebate for purchasing their own thermostats from an approved list of technologies. Customers will be responsible for installing their thermostat. A customer would also qualify for a rebate if the customer already has a qualified thermostat installed prior to program enrollment. In this option, AEP contracts with a software only provider to provide the demand response service and customers receive free access to the software.
- **Direct Install** option, where the vendor is responsible for providing both the hardware and the software components to the customers. One possibility would be for customers to receive a free thermostat for enrollment in the program. Other options could be for customers to lease a thermostat at a fixed monthly charge, or earn a fixed rebate on the purchase price of the thermostat. AEP Ohio, through its contract with the outside vendor could ensure that the thermostat is installed and operating correctly. Customers receive free access to the software.

Marketing Strategy

The marketing strategy will be similar to the channels used for mass market energy efficiency programs, including bill inserts, direct mail, and social media. Since this program is likely to be contracted to a third-party, the vendor will be responsible for coordinating marketing and customer recruitment activities with AEP Ohio.

Milestones

Tasks	Timeframe
Program Implementation Contractor selected	3 months
Program materials developed	5 months
Program launch – marketing begins	6 months

EM&V Strategy

All evaluation activities will be conducted by AEP Ohio's evaluation contractor. An integrated evaluation approach will be taken that includes the following components:

- Addressing evaluation needs at the onset of program design and collecting evaluation data as part of program administration.
- Assessing and documenting baseline conditions.
- Establishing tracking metrics.
- Conducting primary and secondary research as part of the impact and process evaluations.

The overall goal of the impact evaluation will be to validate/calibrate savings values and determine program cost-effectiveness. The participant and nonparticipant surveys will also address program awareness, barriers to participation, user engagement, participant satisfaction, and process efficiency. These surveys will be enhanced by collecting market data and assessing trends as well as interviews with program staff, the implementation contractor, collaborating program administrators, and participating manufacturers.
The process evaluation will be conducted during the first program year and then coordinated with follow-up impact evaluation work to be performed once program-approved measures have been installed and operating for a sufficient time to enable a robust impact evaluation.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience. Participation levels are not assumed to have a one year measure life; however, to be conservative the program design continued that assumption for Plan purposes. Therefore, the total participation over the three year period from 2017 to 2019 is based on the number of participants in the third year, 2019.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
Cooling, Space or Water Heat Control	Per Home	25,000	50,000	75,000	75,000

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Incentive	$2.3	$3.0	$3.8	$9.0
Administrative	$0.7	$1.2	$1.7	$3.7
Total	**$3.0**	**$4.2**	**$5.5**	**$12.7**
Incremental Annual Participant Costs (Millions)				
	2017	2018	2019	Total 2017-2019
Participant Costs	$2.6	$2.6	$2.6	$7.7

Savings Targets

Savings for this program are not cumulative due to a one year measure life.

Incremental Annual Savings - at Meter				
	2017	2018	2019	2019 Cumulative Annual
Energy (MWh)	12,025	24,050	36,075	36,075
Summer Peak Demand (kW)	25,000	50,000	75,000	75,000

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.2
Utility System Resource Cost (UCT)	1.1
Participant Cost (PCT)	2.3
Rate Impact Measure (RIM)	0.6

4.1.9 New Energy Efficient Manufactured Home (New Program)

A high percentage of Ohio's housing is defined as pre-manufactured, or mobile homes. Mobile homes are not required to meet modern energy codes, and many do not.

This new Manufactured Home Program will improve the energy performance of new manufactured housing units. AEP Ohio will leverage the existing residential New Construction program to launch this program to reduce energy costs while improving home comfort and quality for customers purchasing new manufactured housing.

Objective

The New Manufactured Home Program will improve the energy performance of manufactured homes through a combination of improved home design and construction practices, and increased demand for improved performance through homebuyer outreach.

Target Market

The program's target market includes three distinct sets of stakeholders:

1. Manufacturers: Manufacturers of housing for sale and shipment to Ohio will be recruited for New Energy Efficient Manufactured Housing program participation.
2. Prospective new home purchasers: The program will provide education, technical, and financial assistance to new home purchasers and home distributors to encourage investment in energy efficient housing.
3. Mobile Home residents: For homeowners living in homes that have exceeded their useful life, the program will provide education, technical, and financial assistance to increase awareness of the benefits of new, energy efficient housing.

Program Duration

The New Energy Efficient Manufactured Home program will be an ongoing component of the AEP Ohio EE/PDR Plan.

Program Description

AEP Ohio will offer incentives to manufacturers to outfit new manufactured homes at the plant with high efficiency equipment, appliances, lighting and electronics for homes to be sited in AEP Ohio service territory.

AEP Ohio will provide participating manufacturers' with initial support to assist and overcome the barriers inherent with designing and implementing new equipment and processes. Additionally, AEP Ohio will engage stakeholders including distributors, sales people, realtors, and consumers to promote the benefits of energy efficient manufactured housing and build market demand. The program may collaborate with financial institutions to identify and overcome barriers to financing energy efficient manufactured housing.

Incentive Strategy

Incentives to the manufacturer based on installed measures and energy efficiency ratings.

Additionally, AEP Ohio will collaborate with financial institutions to provide financing options for these energy efficient homes. The initial goal will be to set incentives to promote home purchase while keeping the increased customer monthly payment less than the corresponding monthly energy savings for the home.

Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.

Eligible Measures

AEP Ohio will offer incentives to manufacturers to outfit new manufactured homes at the plant with high efficiency equipment, appliances, lighting and electronics for homes to be sited in AEP Ohio service territory. Measures may include:

- Heat pump water heaters
- Ductless mini-splits
- Intelligent 'Smart' thermostats
- ENERGY STAR® qualifying appliances (refrigerators, dishwashers, clothes washers and dryers)
- Whole-house air sealing
- Duct sealing
- LED lighting and controls

Implementation Strategy

- AEP Ohio will implement the program utilizing an energy efficient manufactured housing implementation contractor. The implementation contractor will be responsible for The Energy Efficient Manufactured Housing implementation contractor will be responsible for:
    - Recruiting manufacturers of housing for sale and shipment to Ohio to the program
    - Facilitating a collaborative design process to identify measures and costs that meet the needs of stakeholders (including AEP Ohio, manufacturers, and customers.)
    - Market the value of energy efficient manufactured housing to homebuyers.
    - Engage manufacturers to install high-efficiency equipment and lighting to be sited for customers served by AEP Ohio (including education, technical, and financial assistance to design, construct, and promote energy efficient

manufactured housing).

- Market the value of energy efficient manufactured housing to homebuyers.
- Identify and collaborate with other manufactured housing efficiency program administrators.

Marketing Strategy

The Energy Efficient Manufactured Housing implementation contractor will oversee the marketing and outreach directly to manufacturers, distributors and dealers of manufactured homes.

Milestones

Tasks	Timeframe
Program Implementation Contractor selected	3 months
Program materials developed	5 months
Program launch – marketing begins	6 months

EM&V Strategy

All evaluation activities will be conducted by AEP Ohio's evaluation contractor. An integrated evaluation approach will be taken that includes the following components:

- Addressing evaluation needs at the onset of program design and collecting evaluation data as part of program administration.
- Assessing and documenting baseline conditions.
- Establishing tracking metrics.
- Conducting primary and secondary research as part of the impact and process evaluations.

The overall goal of the impact evaluation will be to validate/calibrate savings values and determine program cost-effectiveness. The participant and nonparticipant surveys will also address program awareness, barriers to participation, participant satisfaction, and process efficiency. These surveys will be enhanced by collecting market data and assessing trends as well as interviews with program staff, the implementation contractor, collaborating program administrators, and participating manufacturers.

The process evaluation will be conducted during the first program year and then coordinated with follow-up impact evaluation work to be performed once program-approved measures have been installed and operating for a sufficient time to enable a robust impact evaluation.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
ENERGY STAR® Manufactured Homes - EL Heat	Home	188	209	209	606

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Incentive	$0.5	$0.5	$0.5	$1.6
Administrative	$0.2	$0.3	$0.3	$0.7
Total	**$0.7**	**$0.8**	**$0.8**	**$2.3**
Incremental Annual Participant Costs (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Participant Costs	$1.0	$1.1	$1.1	**$3.1**

Savings Targets

Incremental Annual Savings - at Meter				
	2017	**2018**	**2019**	**2019 Cumulative Annual**
Energy (MWh)	2,245	2,500	2,495	7,240
Summer Peak Demand (kW)	95	106	105	306

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.0
Utility System Resource Cost (UCT)	1.7
Participant Cost (PCT)	2.9
Rate Impact Measure (RIM)	0.4

4.2 Business Programs

For the complete program plan for each ongoing business program, please reference the Business Program Plans section (pages 81-126) of *Volume 1: AEP Ohio 2012 to 2014 Energy Efficiency/Peak Demand Reduction (EE/PDR) Action Plan*, dated November 29, 2011 (PUCO Docket 11-5568-EL-POR and 11-5569-EL-POR.) Included in each program description below are material program changes shown as adjustments and enhancements; projected participation levels, budgets, savings targets and benefit-cost test results. For the new programs, complete program descriptions are included.

4.2.1 Efficient Products for Business (Ongoing Program, previously 'Prescriptive')

All business (non-residential) customers in AEP Ohio's service territory are eligible to participate in this program. The program provides a simple and easy way to help support common energy efficiency projects in existing facilities. A standard menu of incentives, updated annually based on customer participation levels, competitive incentive pricing and market conditions, includes lighting, heating, ventilation, and air conditioning (HVAC), motor drives, refrigeration, and food preparation and storage equipment. The program also includes measures targeted at the industrial and agricultural sectors. Three primary program objectives in the 2017-2019 period include increasing market share and installation rates of efficient equipment, and overall facility operating efficiency. To reduce the upfront cost barrier of efficient equipment, incentives typically ranging from twenty to fifty percent of the efficiency equipment's incremental cost will be offered to business customers.

To increase program participation and simplify the customer experience, AEP Ohio plans to develop a series of tools with distributors and suppliers such as performance agreements, lead generation, distributor budgets, and planned promotion schedules.

AEP Ohio will investigate a midstream component for specific lighting and equipment measures to make efficiency available for small projects where the incentive application is a barrier to participation. Mid-stream incentives will also encourage energy efficient choices at the point of sale, directly through lighting and equipment distributors.

Adjustments and Enhancements
AEP Ohio plans to make the following modifications to the Efficient Products for Business Program as shown below: • Distribution of CFL's will be discontinued across the portfolio, and will be replaced with qualifying LED lighting products. • Add an Advanced Lighting Controls (ALC) incentive component for qualifying projects to keep pace with a rapidly evolving technology and encourage deeper

market penetration to achieve greater energy savings

- An ENERGY STAR TV initiative may be considered to target nursing homes, hospitals, and schools.
- Motor rewind initiative to enlist motor rewind shops for training and certification in efficient motor rewind; enrolled in the AEP Ohio EMotor Rewind approach
- Incentives not included in the measure mix from previous plan(s) have been determined to be either not cost effective or had low participation.
- Customer incentives may be adjusted to increase cost effectiveness and/or program participation.
- Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
1L4'T5 NLO	Lamp	11,188	13,036	13,664	37,889
1L4'T8 HP	Lamp	32,313	36,042	40,544	108,899
4L4'T5 HLO	Fixture	231	212	201	643
6L4'T8HP	Fixture	4,949	5,522	6,357	16,828
Advanced Pre-Rinse Spray Nozzle, <=1.6 GPM (Elec. HW)	Per Sprayer	134	127	123	384
Air Cooled Chiller <150 Tons, 0.864 kW/ton (IPLV)	Rated Tons Cooling	896	822	780	2,498
Air Cooled Chiller <150 Tons, 0.864 kW/ton (IPLV) (DUB)	Rated Tons Cooling	31,190	28,633	26,709	86,532
Air Cooled Chiller >150 Tons, 0.847 kW/ton (IPLV)	Rated Tons Cooling	867	796	755	2,418
Air Cooled Chiller >150 Tons, 0.847 kW/ton (IPLV) (DUB)	Rated Tons Cooling	31,762	29,158	27,204	88,123
Anti-Sweat Heat (ASH) Controls - freezer and cooler glass reach in or freezer door only are eligible	Linear foot door width	204	201	203	608
Centrifugal Water Cooled Chiller <300 tons (0.536 kW/ton-IPLV)	Rated Tons Cooling	13	16	16	45
Centrifugal Water Cooled Chiller <300 tons (0.536 kW/ton-IPLV) (DUB)	Rated Tons Cooling	1,504	1,368	1,072	3,944

Centrifugal Water Cooled Chiller >300 tons <600 tons (0.494 kW/ton-IPLV)	Rated Tons Cooling	93	85	81	259
Centrifugal Water Cooled Chiller >300 tons <600 tons (0.494 kW/ton-IPLV) (DUB)	Rated Tons Cooling	1,859	-	-	1,859
Centrifugal Water Cooled Chiller >600 tons, (0.485 kW/ton-IPLV)	Rated Tons Cooling	55	50	48	153
Centrifugal Water Cooled Chiller >600 tons, (0.485 kW/ton-IPLV) (DUB)	Rated Tons Cooling	760	697	662	2,119
Cogged (V) belts on fans 5 HP to 100 HP	Fan	542	498	472	1,513
Cogged V-belts on fans 5 HP to 100 HP	Fan	2,533	2,557	2,642	7,733
Compressed Air - Air Entraining Air Nozzle, 100 psi, 0.25 kW/scfm	Nozzle	1,289	1,533	1,238	4,060
Compressed Air - Air Receiver for Load/No-Load Compressors (>=5 gal/CFM storage), <=300 HP	Gallon Increased Storage	27,521	27,753	28,907	84,181
Compressed Air - Cycling Air Dryer, <=600scfm, thermal mass	sCFM	1,008	1,044	1,143	3,195
Compressed Air - Low Pressure Drop Filter for Compressed Air Systems, 25HP to 300HP, <500CFM, mist eliminator, <1 psi new	sCFM	1,304	1,344	1,452	4,100
Compressed air - no-loss condensate drains	per drain	2,713	2,619	2,602	7,934
Compressed Air - Variable Speed Drive Air Compressor, new, less than 150 HP	Compressor HP	701	682	682	2,065
Daylighting Control + Occ Sensor	Watts Controlled, 1 DC, 1 OC	355,268	302,621	218,324	876,213
Daylighting Controls	Watts Controlled, 1 DC	759,449	605,573	377,120	1,742,143
EC Motor for HVAC - Cooling Only	Motor	252	280	321	854
EC Motor for HVAC - Heating and Cooling	Motor	811	882	994	2,687
EC Motor for HVAC - Heating Only	Motor	34	37	40	111
EC Motor: Reach-In Enclosure; blended average of coolers and freezers; no controls	Motor	633	626	636	1,896
EC Motor: Walk-In Enclosure; blended average of coolers and freezers; no controls	Motor	581	569	573	1,723

ENERGY STAR Combination Oven	Unit	37	38	41	116
ENERGY STAR Glass Door Commercial Freezer	Freezer	33	34	36	103
ENERGY STAR Glass Door Commercial Refrigerator	Refrigerator	129	134	142	405
ENERGY STAR Hot Food Holding Cabinet, Full Size, 16 cu.ft. average	Unit	20	20	22	62
ENERGY STAR Hot Food Holding Cabinet, Half Size, 8 cuft average	Unit	10	11	11	32
Energy Star Ice Makers (>1000 lbs/day)	unit	285	279	288	851
Energy Star Ice Makers (101-400 lbs/day)	unit	303	316	341	960
Energy Star Ice Makers (401-1000 lbs/day)	unit	271	252	247	770
Energy Star Ice Making Head (401-1000 lbs/day)	100lbs ice	186	230	308	724
ENERGY STAR Refrigerated Beverage Vending Machine with Control Software, average	Average Standard Vending	15	15	16	46
ENERGY STAR Refrigerated Beverage Vending Machine without Control Software, average	Average Standard Vending	11	12	13	36
ENERGY STAR Solid Door Commercial Freezer	Freezer	18	18	20	56
ENERGY STAR Solid Door Commercial Refrigerator	Refrigerator	20	21	22	63
ENERGY STAR Steam Cooker - 4 Pan - 100lbs/day	Unit	2	2	2	6
ENERGY STAR, CEE Tier 2 or CEE Tier 3 Commercial Clothes Washer	Unit	279	301	339	920
ENERGY STAR® Heat Pump Water Heater (EF>2.0)	unit	1,282	1,348	1,464	4,094
Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - ECM	Fan	172	166	164	502
Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - Shaded Pole	Fan	260	250	245	755
Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - ECM	Fan	76	74	74	224
Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - Shaded Pole	Fan	151	145	144	439
High-Efficiency Electric Water Heater (EF>0.93)	unit	1,252	1,295	1,381	3,928
Hotel Guest Room Energy Management System (GREM), Electric Cooling, Electric Heating	Hotel Room Controller	2,825	2,939	2,452	8,216

Hotel Guest Room Energy Management System (GREM), Electric Cooling, NON-Electric Heating	Hotel Room Controller	648	499	309	1,457
LED Exit Sign	Sign	52	48	45	145
LED Exit Sign (DUB)	Sign	7,445	6,002	3,737	17,185
LED Lighting <10W - Indoor	Lamp	1,386	1,517	1,711	4,615
LED Lighting >=10W - Indoor	Lamp	10,822	12,064	13,830	36,716
LED T8 Tube (4' T8 Replacement)	Lamp	23,776	27,359	28,088	79,223
LED Troffer	Fixture	10,419	11,905	12,184	34,507
Multiplex system with oversized condenser: 85 Btu/hr of heat rejection per watt of fan, air; 195 Btu/h/Watt evap	Tons of Refrigeration	33	33	33	100
Occupancy Sensor	Watts Controlled, 1 OC	42,401	36,421	26,423	105,245
Outdoor LED Flood Light (30W), TC Control	Fixture	2,819	3,351	3,464	9,634
Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	Fixture	2,139	2,477	2,550	7,166
Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	Fixture	1,329	1,591	1,766	4,686
Outside Air Economizer for Coolers	Cooler	679	671	681	2,031
Package system A/C (>=63.3 tons, minimum 10.2 EER, 11.4 IEER) - Direct Exp / All Heating Types	Rated Tons Cooling	7,303	7,457	7,299	22,059
Package system A/C (>=63.3 tons, minimum 10.2 EER, 11.4 IEER) - Direct Exp / All Heating Types (DUB)	Rated Tons Cooling	10,306	10,549	10,612	31,467
Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER)	Rated Tons Cooling	733	673	558	1,964
Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER) (DUB)	Rated Tons Cooling	677	621	513	1,811
Permanent T12 Removal During T8 Retrofit	Lamp	23,009	18,622	12,955	54,586
Photocell (Outdoor Lighting)	Watts Controlled, 1 PC	8,952	7,736	5,574	22,262
Photocell + Timeclock (Outdoor Lighting)	Watts Controlled, 1 TC, 1 PC	15,093	13,099	9,654	37,846
Plug Load Occ Sensors	Per Sensor	35,544	39,417	46,283	121,244
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, >=300 tons, 0.486 kW/Ton (IPLV)	Rated Tons Cooling	1,468	1,348	1,162	3,978

Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, >=300 tons, 0.486 kW/Ton (IPLV) (DUB)	Rated Tons Cooling	1,005	922	798	2,725
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 150 tons to below 300 tons, 0.522 kW/Ton (IPLV)	Rated Tons Cooling	1,133	1,040	865	3,039
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 150 tons to below 300 tons, 0.522 kW/Ton (IPLV) (DUB)	Rated Tons Cooling	998	916	762	2,676
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 75 tons to below 150 tons, 0.554 kW/Ton (IPLV)	Rated Tons Cooling	1,212	1,112	970	3,294
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 75 tons to below 150 tons, 0.554 kW/Ton (IPLV) (DUB)	Rated Tons Cooling	862	792	683	2,336
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, below 75 tons, 0.567 kW/ton-IPLV	Rated Tons Cooling	1,112	1,021	839	2,971
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, below 75 tons, 0.567 kW/ton-IPLV (DUB)	Rated Tons Cooling	1,019	936	766	2,721
Refrigerated Display LED Lighting Strips	Linear foot case door	2,698	2,701	2,790	8,189
Split/Package system A/C (<65 kBtu/h, 15 SEER) - Direct Exp /All Heating Types	Rated Tons Cooling	823	906	1,035	2,763
Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types	Rated Tons Cooling	642	589	559	1,791
Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types (DUB)	Rated Tons Cooling	9,632	-	-	9,632
Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types	Rated Tons Cooling	273	290	317	881
Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types (DUB)	Rated Tons Cooling	1,245	1,143	1,084	3,472
Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump	Rated Tons Cooling	103	95	90	288
Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump (DUB)	Rated Tons Cooling	1,550	1,423	1,350	4,322
Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump	Rated Tons Cooling	199	215	239	653
Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump (DUB)	Rated Tons Cooling	668	614	582	1,864
Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump	Rated Tons Cooling	198	215	240	653

Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump (DUB)	Rated Tons Cooling	691	634	602	1,926
Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump	Rated Tons Cooling	506	549	616	1,672

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Incentive	$8.7	$8.3	$8.2	$25.2
Administrative	$5.6	$5.4	$5.1	$16.1
Total	$14.3	$13.7	$13.3	$41.3
Incremental Annual Participant Costs (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Participant Costs	$53.8	$47.5	$43.0	$144.3

Savings Targets

Incremental Annual Savings - at Meter				
	2017	**2018**	**2019**	**2019 Cumulative Annual**
Energy (MWh)	109,699	105,345	99,053	314,097
Summer Peak Demand (kW)	31,550	27,889	25,551	84,990

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.9
Utility System Resource Cost (UCT)	7.4
Participant Cost (PCT)	3.0
Rate Impact Measure (RIM)	0.7

4.2.2 Process Efficiency (Ongoing Program, previously 'Custom')

The program targets larger commercial and industrial customers to analyze and promote installation of high-efficiency equipment or processes not covered under the Efficient Products program or other program offerings. All business (non-residential)

customers in AEP Ohio's service territory are eligible to participate. The Process Efficiency program encourages cost-effective energy efficiency improvements not already covered by other AEP Ohio programs that reduce energy consumption and peak demand. This program approach identifies more complex energy savings projects, provides economic analysis and aids in the completion of incentive applications. All technologies are subject to engineering analysis to verify eligibility and energy savings. Customer incentives will be customized based on analysis of the specific energy efficiency measures implemented and calculated on a per kWh basis.

Within the Process Efficiency Program, during the 2017-2019 period AEP Ohio plans on continuing and/or expanding outreach efforts to targeted market sub-sectors. Initiatives will be designed to identify similar technical efficiency opportunities and overcome participation barriers specific to individual industries or technologies such as:

- Industrial/manufacturing
- Injection molding industry
- Compressed air users
- Hospitality (including hotels, restaurants, etc.)
- Grocery stores
- Large water users (concentrating on pumps and controls for water pumping, cooling towers, etc.)

Adjustments and Enhancements
AEP Ohio plans to make modifications to the Process Efficiency Program as follows: • Incentive levels will be reviewed and adjusted annually as appropriate with consideration of Energy Efficiency Auction results. • Incentives not included in the measure mix from previous plan(s) have been determined to be either not cost effective or had low participation. • Customer incentives may be adjusted to increase cost effectiveness and/or program participation. • Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation. • Eliminate the set 8 cents per kWh and ancillary $100/kW demand savings incentive at this time, although incentives based on kW may become more important in the future. Incentives will be adjusted on an annual basis depending on market conditions and customer participation.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
Code minimum R-20ci or R-38 batt - Chiller / Elec Resist	1000 sqft roof	1,144	583	415	2,142
Code minimum R-20ci or R-38 batt - Direct Exp / Elec Resist	1000 sqft roof	538	274	195	1,007
Compressed Air - Air Entraining Air Nozzle, 100 psi, 0.25 kW/scfm	Nozzle	1,584	1,826	2,427	5,838
Compressed Air - Controls	Compressor HP	14,486	15,750	13,825	44,061
Compressed Air - Cycling Air Dryer, >600scfm, all types	sCFM	9,715	9,664	9,097	28,477
Compressed Air - Variable Speed Drive Air Compressor, new, greater than 150 HP	Compressor HP	13,865	13,742	11,365	38,972
Daylighting Controls	Watts Controlled, 1 DC	591,949	303,428	219,194	1,114,571
High Performance Glazing - Chiller / Elec Resist	10 sqft glazed	5,355	-	-	5,355
High Performance Glazing - Direct Exp / Elec Resist	10 sqft glazed	9,650	4,974	3,664	18,288
NEMA Premium Efficiency Motor	per horsepower	16,306	18,295	23,700	58,301

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Incentive	$3.6	$3.4	$3.0	$10.0
Administrative	$2.2	$2.1	$1.9	$6.2
Total	**$5.7**	**$5.6**	**$4.9**	**$16.2**

Incremental Annual Participant Costs (Millions)				
	2017	2018	2019	Total 2017-2019
Participant Costs	$14.6	$13.6	$11.8	$40.0

Savings Targets

Incremental Annual Savings - at Meter				
	2017	2018	2019	2019 Cumulative Annual
Energy (MWh)	42,004	41,947	38,072	122,024
Summer Peak Demand (kW)	7,020	6,813	6,127	19,960

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	2.4
Utility System Resource Cost (UCT)	6.9
Participant Cost (PCT)	3.9
Rate Impact Measure (RIM)	0.7

4.2.3 New Construction (Ongoing Program)

All business (non-residential) customers in AEP Ohio's service territory are eligible to participate in this program. This program is for new construction and major renovation projects and designed to encourage building owners, designers, and architects to exceed standard building practices to achieve efficiency above current building energy code requirements. The program provides interactive design assistance to the architects and engineers responsible for designing new buildings. The key design assistance tool is building simulation modeling of more efficient building designs. The program provides incentives to new facility owners for the installation of high-efficiency lighting, HVAC,

building envelope, refrigeration and other equipment and controls. The program provides a marketing mechanism for architects and engineers to promote energy efficient new buildings and equipment to end users. This whole building approach requires fully-executable energy models for evaluation and therefore has incentives for the design team as well as the owner. Efficient Business Products and Process Efficiency incentives are available for individual energy efficiency measures that exceed then current code requirements.

Adjustments and Enhancements

AEP Ohio plans to make modifications to the New Construction Program as shown:

- Master metered apartment buildings metered for non-residential tariffs are eligible for this program.
- Eligible customers can receive incentives for conducting an early design meeting. The incentive is to support bringing the customer, AEP Ohio, architects, engineers, contractors and commissioning agents together for an energy focused meeting in the early design stage of a project.
- My Solutions program incentives are available for eligible office, retail, and other non-residential customer building types, for new construction projects less than 70,000 square feet. Eligible customers earn increasing incentives by selecting and installing more efficient measure combinations from a menu of items that were previously modeled for their building type.
- Incentives not included in the measure mix from previous plan(s) have been determined to be either not cost effective or had low participation.
- Incentives may be adjusted to increase cost effectiveness and/or program participation.
- Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
1L4'T8 HP	Lamp	8,654	9,151	9,783	27,588
6L4'T8HP	Fixture	4,796	5,100	5,356	15,252

Air Cooled Chiller <150 Tons, 0.864 kW/ton (IPLV)	Rated Tons Cooling	13,991	14,271	14,265	42,528
Air Cooled Chiller >150 Tons, 0.847 kW/ton (IPLV)	Rated Tons Cooling	13,991	14,271	14,265	42,528
Centrifugal Water Cooled Chiller <300 tons (0.536 kW/ton-IPLV)	Rated Tons Cooling	1,059	1,081	1,080	3,220
Centrifugal Water Cooled Chiller >300 tons <600 tons (0.494 kW/ton-IPLV)	Rated Tons Cooling	530	540	540	1,610
Centrifugal Water Cooled Chiller >600 tons, (0.485 kW/ton-IPLV)	Rated Tons Cooling	530	540	540	1,610
Cogged (V) belts on fans 5 HP to 100 HP	Fan	535	438	395	1,368
Cogged V-belts on fans 5 HP to 100 HP	Fan	1,277	1,345	1,393	4,015
Compressed Air - Controls	Compressor HP	500	502	509	1,511
Compressed Air - Cycling Air Dryer, <=600scfm, thermal mass	sCFM	145	148	149	442
Compressed Air - Variable Speed Drive Air Compressor, new, less than 150 HP	Compressor HP	109	116	121	347
Daylighting Controls	Watts Controlled, 1 DC	377,374	384,631	384,359	1,146,364
DCV - Office	1000sf	12,382	13,042	13,509	38,933
Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - ECM	Fan	587	618	640	1,844
Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - ECM	Fan	587	618	640	1,844
Hotel Guest Room Energy Management System (GREM), Electric Cooling, Electric Heating	Hotel Room Controller	1,408	1,436	1,435	4,278
Hotel Guest Room Energy Management System (GREM), Electric Cooling, NON-Electric Heating	Hotel Room Controller	541	552	552	1,645
Improved Ceiling Insulation R45 batt - Direct Exp / Elec Resist	1000 sqft roof	2,372	2,420	2,419	7,210
LED Lighting <10W - Indoor	Lamp	2,363	2,488	2,576	7,427
LED Lighting >=10W - Indoor	Lamp	20,725	21,826	22,598	65,149
LED T8 Tube (4' T8 Replacement)	Lamp	93,507	98,415	101,769	293,692

LED Troffer	Fixture	-	531	1,185	1,715
Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	Fixture	2,555	2,691	2,788	8,034
Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER)	Rated Tons Cooling	401	409	409	1,220
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, >=300 tons, 0.486 kW/Ton (IPLV)	Rated Tons Cooling	128	108	101	338
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 150 tons to below 300 tons, 0.522 kW/Ton (IPLV)	Rated Tons Cooling	122	105	97	324
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 75 tons to below 150 tons, 0.554 kW/Ton (IPLV)	Rated Tons Cooling	100	87	80	268
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, below 75 tons, 0.567 kW/ton-IPLV	Rated Tons Cooling	98	84	76	258
Split/Package system A/C (<65 kBtu/h, 15 SEER) - Direct Exp /All Heating Types	Rated Tons Cooling	3,009	3,069	3,068	9,145
Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types	Rated Tons Cooling	3,223	3,287	3,286	9,796
Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types	Rated Tons Cooling	1,426	1,500	1,550	4,476
Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump	Rated Tons Cooling	519	529	529	1,577
Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump	Rated Tons Cooling	951	1,001	1,035	2,987
Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump	Rated Tons Cooling	951	1,001	1,035	2,987
Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump	Rated Tons Cooling	2,432	2,560	2,647	7,638
Variable Refrigerant Flow A/C (135 - 240 kBtu/h, 12 EER, 13 IEER)	Rated Tons Cooling	1,569	774	774	3,116
Variable Refrigerant Flow A/C (240 - 760 kBtu/h, 10.8 EER, 12.1 IEER)	Rated Tons Cooling	66	81	84	231
Variable Refrigerant Flow A/C (65 - 135 kBtu/h, 12 EER, 13 IEER)	Rated Tons Cooling	1,569	1,600	1,599	4,768
Water Source (water to air) Heat Pump (< 17 kBtu/h) EER 13.4 - Heat Pump	Rated Tons Cooling	-	19	40	59
Water Source (water to water) Heat Pump (< 135 kBtu/h) EER 11.7 - Heat Pump	Rated Tons Cooling	373	148	64	585
Zero Energy Door	Refrigeration HP	149	157	162	467

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Incentive	$5.2	$5.4	$5.5	$16.1
Administrative	$1.6	$1.7	$1.7	$5.0
Total	**$6.8**	**$7.1**	**$7.2**	**$21.1**

Incremental Annual Participant Costs (Millions)				
	2017	2018	2019	Total 2017-2019
Participant Costs	$12.3	$12.5	$12.7	$37.5

Savings Targets

Incremental Annual Savings - at Meter				
	2017	2018	2019	2019 Cumulative Annual
Energy (MWh)	27,626	28,186	28,773	84,585
Summer Peak Demand (kW)	6,243	6,259	6,314	18,816

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.4
Utility System Resource Cost (UCT)	2.9
Participant Cost (PCT)	2.9
Rate Impact Measure (RIM)	0.5

4.2.4 Express (Ongoing Program)

The Express Program provides small businesses with a streamlined, one-stop, turn-key energy efficiency direct installation service delivered through a program implementer. The program generates energy savings through program services and incentives to help qualifying customers reduce energy usage and lower energy costs. Incentives for Express Program projects are generally higher than the Efficient Products for Business and Process Efficiency Programs, with an initial cap of eighty percent of project costs.

The Express Program targets small business customers, generally indicated as customers with demands of less than 100 kW or with annual energy consumption of 200,000 kWh or less, based on the last 12 months of billing history. Over 90% of AEP Ohio's commercial customers are under 100kW, representing a significant opportunity to reduce energy costs and impact customer satisfaction through a single program aimed at this group. Either the demand or energy consumption limits could be adjusted during implementation to ensure customer sectors are served equitably during the Plan period, and to address the needs of underserved sectors. Additionally:

- Corporate-owned national accounts are excluded from participation.
- Funding for large franchisee-owned national accounts customers are eligible but may be limited to ensure local small business participation.
- Consistent with the residential low income customer sector, small non-profit customers may require additional incentives to afford energy efficiency improvements; these opportunities will be considered to remove barriers to this sector's participation.

Adjustments and Enhancements
AEP Ohio plans to make modifications to the Express Program as shown below: • The Express Program is designed to operate with marketing and efficient product installations provided by a single Implementation Contractor. AEP Ohio will monitor customer participation and satisfaction and, as appropriate, may select multiple trade allies to provide marketing and installation services or, a hybrid of the two models. • Implementation contractors or other partners may offer financing to reduce barriers to small business installation of measures. • In the Plan, customers with an initial demand limit of 100 kW will be eligible to participate. Results of a study of customers with demands of 100 kW or less, even when energy usage is greater than 200,000 kWh, indicated that most of these customers shared characteristics of other small business Express participants, and would benefit by participation in the program. • Incentives not included in the measure mix from previous plan(s) have been determined to be either not cost effective or had low participation. • Incentives may be adjusted to increase cost effectiveness and/or program participation. • Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
Hotel Guest Room Energy Management System (GREM), Electric Cooling, Electric Heating	Hotel Room Controller	1,927	2,029	2,107	6,063
Hotel Guest Room Energy Management System (GREM), Electric Cooling, NON-Electric Heating	Hotel Room Controller	1,106	1,128	1,140	3,374
1L4'T5 NLO	Lamp	1,502	1,614	1,702	4,818
1L4'T8 HP	Lamp	3,687	3,808	3,858	11,352
6L4'T8HP	Fixture	821	852	870	2,543
LED Exit Sign	Sign	1,340	1,325	1,278	3,943
LED Lighting <10W - Indoor	Lamp	134	138	140	411
LED Lighting >=10W - Indoor	Lamp	1,245	1,284	1,302	3,831
Occupancy Sensor	Watts Controlled, 1 OC	13,742	14,017	14,154	41,913
Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	Fixture	183	186	185	554
Permanent T12 Removal During T8 Retrofit	Lamp	0	2,108	3,522	5,630
Photocell (Outdoor Lighting)	Watts Controlled, 1 PC	3,756	3,831	3,868	11,455
Photocell + Timeclock (Outdoor Lighting)	Watts Controlled, 1 TC, 1 PC	5,898	6,016	6,075	17,990
Time clock (Outdoor Lighting)	Watts Controlled, 1 TC	5,898	6,016	6,075	17,990
Advanced Pre-Rinse Spray Nozzle, <=1.6 GPM (Elec. HW)	Per Sprayer	153	84	0	237
Anti-Sweat Heat (ASH) Controls - freezer and cooler glass reach in or freezer door only are eligible	Linear foot door width	147	147	144	438
EC Motor: Reach-In Enclosure; blended average of coolers and freezers; no controls	Motor	483	488	481	1,453
EC Motor: Walk-In Enclosure; blended average of coolers and freezers; no controls	Motor	387	387	377	1,150
Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - ECM	Fan	76	74	71	221
Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - Shaded Pole	Fan	86	84	79	249

Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - ECM	Fan	51	51	49	151
Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - Shaded Pole	Fan	71	70	67	208
LED Refrigeration Case Lighting Open Display Case	Linear foot	3,176	3,109	2,556	8,841
Lighting Controls for Freezer and Cooler w/ Doors	Linear foot door width	1,638	1,596	1,512	4,746
Lighting Controls for Open Freezer and Cooler Display case	Linear foot	1,638	1,596	1,512	4,746
LED T8 Tube (4' T8 Replacement)	Lamp	3,461	3,810	4,162	11,433
LED Troffer	Fixture	2,813	3,131	3,472	9,416

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Incentive	$0.4	$0.5	$0.5	$1.4
Administrative	$3.7	$3.8	$3.8	$11.2
Total	**$4.1**	**$4.2**	**$4.2**	**$12.6**

Incremental Annual Participant Costs (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Participant Costs	$6.7	$6.8	$6.9	**$20.4**

Savings Targets

Incremental Annual Savings - at Meter				
	2017	**2018**	**2019**	**2019 Cumulative Annual**
Energy (MWh)	14,416	14,763	14,691	43,870
Summer Peak Demand (kW)	3,678	3,889	4,034	11,601

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.3
Utility System Resource Cost (UCT)	3.2
Participant Cost (PCT)	2.9
Rate Impact Measure (RIM)	0.6

4.2.5 Self-Direct (Ongoing Program)

The Self-Direct program is designed to capture energy savings and demand reduction from large customers with the capability to administer internal energy management efforts of their own. AEP Ohio commercial and industrial mercantile customers that consume more than 700,000 kWh/year, or customers that are part of a national account, may participate. Any energy efficiency measure reducing energy consumption or demand within a project verified as cost – effective is eligible for the Self-Direct program.

To participate, customers submit an application, calculation spreadsheets and supporting documentation. The application is reviewed and if approved by AEP Ohio and by the PUCO, a one-time payment is made or an EE/PDR rider exemption is applied. Customers accepting an exemption from the rider for a specified number of months are not allowed to participate in any other AEP Ohio EE/PDR programs during the period of exemption. The program allows customers to submit energy efficiency projects that were completed within the prior three years. Seventy-five percent of the calculated incentive under the Efficient Products for Business, Process Efficiency Program, or Data Center Program for customers applies.

Adjustments and Enhancements

AEP Ohio plans to make modifications to the Self- Direct Program as shown below:

- Incentives may be adjusted to increase cost effectiveness and/or program participation.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results, and program implementation experience. These measures are a proxy for the broad variety of measures that will generate the savings expected.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
Self-Direct Program	Project	77	77	78	232
Daylighting Controls	Watts Controlled, 1 DC	470	431	418	1,319
LED Exit Sign	Sign	13	12	12	37
Occupancy Sensor	Watts Controlled, 1 OC	257	236	228	720
Photocell (Outdoor Lighting)	Watts Controlled, 1 PC	19	17	17	52
Photocell + Timeclock (Outdoor Lighting)	Watts Controlled, 1 TC, 1 PC	1,463	1,458	1,460	4,381

Time clock (Outdoor Lighting)	Watts Controlled, 1 TC	286	263	255	804
4L4'T5 HLO	Fixture	59	54	53	166
6L4'T8HP	Fixture	46	42	41	130
LED Lighting <10W - Indoor	Lamp	3	3	3	8
LED Lighting >=10W - Indoor	Lamp	1	1	1	3
LED Outdoor Wall Pack (30W) TC Control	Fixture	3	3	3	9
Outdoor LED Flood Light (30W), TC Control	Fixture	0	88	98	186
Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	Fixture	6	6	5	17

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Incentive	$0.9	$0.9	$0.9	$2.7
Administrative	$0.6	$0.6	$0.6	$1.8
Total	**$1.5**	**$1.5**	**$1.5**	**$4.5**
Incremental Annual Participant Costs (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Participant Costs	$1.8	$1.8	$1.8	**$5.3**

Savings Targets

Incremental Annual Savings - at Meter				
	2017	**2018**	**2019**	**2019 Cumulative Annual**
Energy (MWh)	13,227	13,305	13,418	39,949
Summer Peak Demand (kW)	1,858	1,872	1,890	5,620

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	4.6
Utility System Resource Cost (UCT)	7.0
Participant Cost (PCT)	11.7
Rate Impact Measure (RIM)	0.5

4.2.6 Retro-Commissioning (Ongoing Program)

The Retro-Commissioning program obtains energy savings through the identification and implementation of low-cost, operational adjustments that improve the efficiency of existing buildings' operating controls and HVAC systems by optimizing the systems to meet the building's requirements.

The Retro-commissioning (RCx) Program will continue the current program design that provides a fully funded comprehensive study for two types of customers:

1) **RCx Standard** serves large buildings over 150,000 square feet, providing studies for customers with a minimum $15,000 commitment towards energy efficiency improvements,
2) **RCx Lite** program serves buildings between 50,000 and 150,000 square feet, providing studies for customers with a minimum $5,000 commitment toward energy efficiency improvements.

Eligible measures will vary depending on the business sector served; as applicable measures may include:

- **HVAC systems and controls**: Economizers, demand control ventilation, heat/energy recovery ventilators, fan and pump controls, head-pressure controls, setback controls, night venting controls.
- **Lighting controls**: Occupancy/vacancy controls, photo-sensors, timer controls.
- **Motor controls**: Variable frequency/speed drives, timer controls.
- **Process controls**: Where applicable.
- **Distribution transformers**: Harmonic filtering and harmonic mitigating.

Adjustments and Enhancements

AEP Ohio modifications to the Retro-commissioning Program as shown below:

- Incentives not included in the measure mix from previous plan(s) have been determined to be either not cost effective or had low participation.
- Customer incentives may be adjusted to increase cost effectiveness and/or

program participation.

- Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
RCx Program	Program	2	2	3	7

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Incentive	$0.5	$0.6	$0.6	$1.8
Administrative	$0.9	$1.0	$1.1	$3.0
Total	**$1.5**	**$1.6**	**$1.7**	**$4.8**
Incremental Annual Participant Costs (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Participant Costs	$1.5	$1.7	$1.8	**$5.1**

Savings Targets

Incremental Annual Savings - at Meter				
	2017	**2018**	**2019**	**2019 Cumulative Annual**
Energy (MWh)	8,622	9,410	10,175	28,207
Summer Peak Demand (kW)	9	9	10	28

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.0
Utility System Resource Cost (UCT)	1.7
Participant Cost (PCT)	4.5
Rate Impact Measure (RIM)	0.3

4.2.7 Continuous Energy Improvement (Ongoing Program)

The Continuous Energy Improvement (CEI) program facilitates a comprehensive and ongoing strategic approach to energy reduction at key customer facilities through providing tools, coaching, organizational structure and resources. The CEI program utilizes low cost/no cost measures to deliver productivity improvements that reduce the energy intensity of large customers. The program targets low cost and no cost operational savings opportunities.

The target participants include:

- Transmission, sub-transmission and self-assessor customers.
- Large, account managed business customers with site electric energy expenditures exceeding $500,000 per annum or with annual consumption greater than 10 GWh.
- Mid-range industrial accounts with energy expenditures ranging from $100,000 to $500,000 per annum or with annual consumption greater than 3 GWh.
- Institutional facilities.

Adjustments and Enhancements

AEP Ohio plans to make modifications to the Continuous Energy Improvement Program include:

- A streamlined option to baseline and model productivity improvements and energy density reductions through the program for transmission, sub-transmission and self-assessor customers.
- Measurement of facility productivity, energy density per product/service, reductions and streamlined processes. Focused efforts are enhanced for this program to increase economic development, retain and enhance manufacturing and increase customer competitiveness.
- An initiative targeted at compressed air opportunities with similar low cost/no cost objectives may be considered.

- An ongoing maintenance approach for customers having already finished cohort activities may be considered with the purpose of increasing energy savings or extending persistence of past energy saving initiatives.
- Incentives not included in the measure mix from previous plan(s) have been determined to be either not cost effective or had low participation.
- Customer incentives may be adjusted to increase cost effectiveness and/or program participation.
- Cost effective measures developed during Plan implementation may be added and measures currently included may be changed or removed depending on both cost effectiveness and customer participation.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results and program implementation experience. These measures are a proxy for the types of low cost, no cost activities that will generate the savings expected.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
Energy Management System	1000sf Conditioned Space	0	2,079	2,248	4,327
T8 Delamping	Lamp	5,613	6,608	6,615	18,836
Compressed air - Leak Repair 24-Hour Operation	sCFM	942	1,111	753	2,806
Compressed air - Leak Repair non-24-Hour Operation	sCFM	547	773	387	1,707
Multiplex system with oversized condenser: 85 Btu/hr of heat rejection per watt of fan, air; 195 Btu/h/Watt evap	Tons of Refrigeration	27	32	33	91
T8 Delamping	Lamp	9,530	11,200	11,845	32,575

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Incentive	$0.3	$0.4	$0.4	$1.1
Administrative	$2.0	$2.4	$2.4	$6.8
Total	**$2.3**	**$2.8**	**$2.7**	**$7.8**
Incremental Annual Participant Costs (Millions)				
	2017	2018	2019	Total 2017-2019
Participant Costs	$0.5	$0.6	$0.6	**$1.7**

Savings Targets

Incremental Annual Savings - at Meter				
	2017	2018	2019	2019 Cumulative Annual
Energy (MWh)	19,770	23,157	23,052	65,980
Summer Peak Demand (kW)	402	474	484	1,360

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	2.2
Utility System Resource Cost (UCT)	2.4
Participant Cost (PCT)	30.4
Rate Impact Measure (RIM)	0.3

4.2.8 Data Center (Ongoing Program)

The Data Center program supports projects that improve the energy efficiency of new and existing data centers. Incentives are provided to offset the cost of preliminary studies to identify opportunities, and support implementation of qualifying measures.

The Data Center Program is designed for customers seeking to improve the efficiency of their data center facilities. Special attention is given to meet the specific needs of each of the three sizes of data centers as defined by the Environmental Protection Agency, which include:

- Localized Data Centers (500-1,000 sq. ft.)
- Mid-tier Data Centers (1,000-5,000 sq. ft.)
- Enterprise-class Data Centers (5,000+ sq. ft.)

The following measures are eligible for the Data Center Program:

- Server virtualization
- ENERGY STAR® servers
- High efficiency UPS – power distribution optimization
- Distribution power transformer optimization
- Storage optimization – row-oriented cooling systems
- Efficient floor layout/properly located vented floor tiles
- Optimize temperature and humidity set points – economizers
- PC power management
- Desktop virtualization & VoIP
- Airflow optimization
- Variable flow devices
- Integrated controls
- Energy recovery devices and strategies
- Emerging technologies (power management)
- Optimize data center cooling technology
- Co-location facilities

Adjustments and Enhancements

AEP Ohio plans to make modifications to the Data Center program as shown below:

- Incentives not included in the measure mix from previous plan(s) have been determined to be either not cost effective or had low participation.
- Customer incentives may be adjusted to increase cost effectiveness and/or program participation.
- Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results and

program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
OH Data Center Post Retrofit	Sqft (DC Floor Area)	432,329	446,835	371,645	1,250,809

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Incentive	$1.2	$1.3	$1.1	$3.6
Administrative	$1.4	$1.4	$1.2	$3.9
Total	**$2.6**	**$2.7**	**$2.2**	**$7.5**

Incremental Annual Participant Costs (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Participant Costs	$3.5	$3.6	$3.0	**$10.2**

Savings Targets

Incremental Annual Savings - at Meter				
	2017	**2018**	**2019**	**2019 Cumulative Annual**
Energy (MWh)	16,579	17,135	14,252	47,965
Summer Peak Demand (kW)	1,480	1,530	1,272	4,283

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.3
Utility System Resource Cost (UCT)	2.4
Participant Cost (PCT)	4.1
Rate Impact Measure (RIM)	0.4

4.2.9 Business Behavior Change (New Program)

Program Objective

To provide electric energy savings for business customers with or without energy

management systems (EMS), changing their operations through behavioral opportunities.

Target Market

The Business Behavior Change program is designed to incentivize larger commercial buildings, offices, retail locations and schools with or without energy management systems to analyze and reduce their energy usage. Proactive outreach efforts will utilize a targeted strategy to influence specific market participants.

Program Duration

The Business Behavior Change Program will be an ongoing component of the AEP Ohio EE/PDR Plan.

Program Description

Behavioral programs utilize various techniques to educate and influence individual and business attitudes and behaviors that effect energy usage. AEP Ohio's program structure is intended to build awareness of energy use in normal operating processes and encourage a reduction in usage without replacing installed building technologies, such as HVAC and lighting. End results include influencing business customers to formalize ongoing energy management best practices.

Incentive Strategy

Business Behavioral Change relies on low to no cost behavioral adaptations; it is anticipated that no incentives or modest direct financial incentives will be required. Estimated savings and incentive levels will be established based on the type of project implemented, cost of implementation and participation levels. Positive business publicity and employee enthusiasm will enhance participation.

Participation in the retro-commissioning program and BOC Building Operator training may be offered to entice program participation.

Eligible Measures

The program measures are the comparative operating characteristics of the building before and after engagement.

Implementation Strategy

An implementation contractor will oversee the development and delivery of the Business Behavior Change program.

Marketing Strategy

Marketing of the program will be through Outreach and customer service and may include providing customers with comparative energy use reports.

Milestones

Tasks	Timeframe
Program Implementation Contractor selected	3 months
Program materials developed	6-9 months
Program launch – marketing begins	9-12 months

EM&V Strategy

All evaluation activities will be conducted by AEP Ohio's evaluation contractor. An integrated evaluation approach will be taken that includes the following components:

- Addressing evaluation needs at the onset of program design and collecting evaluation data as part of program administration.
- Assessing and documenting baseline conditions.
- Establishing tracking metrics.
- Conducting primary and secondary research as part of the impact and process evaluations.

The overall goal of the impact evaluation will be to validate/calibrate savings values and determine program cost-effectiveness. The participant and nonparticipant surveys will also address program awareness, barriers to participation, participant satisfaction, and process efficiency. These surveys will be enhanced by collecting market data and assessing trends as well as interviews with program staff, the implementation contractor, collaborating program administrators, and participating manufacturers.

The process evaluation will be conducted during the first program year and then coordinated with follow-up impact evaluation work to be performed once program-approved measures have been installed and operating for a sufficient time to enable a robust impact evaluation.

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results and program implementation experience. Participation levels are not assumed to have a one year measure life; however, to be conservative the program design continued that assumption for Plan purposes. Therefore, the total participation over the three year period from 2017 to 2019 is based on the number of participants in the third year, 2019.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
Business Behavior Change	Statewide	0.01	0.01	0.01	0.04

Intra-company behavioral change re plug loads	Building	2,328	2,328	2,444	7,100

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Incentive	$0.1	$0.1	$0.1	$0.2
Administrative	$0.2	$0.2	$0.2	$0.7
Total	**$0.3**	**$0.3**	**$0.3**	**$0.9**
Incremental Annual Participant Costs (Millions)				
	2017	2018	2019	Total 2017-2019
Participant Costs	$0.2	$0.2	$0.2	$0.5

Savings Targets

Savings for this program are not cumulative due to a one year measure life.

Incremental Annual Savings - at Meter				
	2017	2018	2019	2019 Cumulative Annual
Energy (MWh)	8,925	8,925	9,371	9,371
Summer Peak Demand (kW)	3,987	3,987	4,187	4,187

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.3
Utility System Resource Cost (UCT)	1.7
Participant Cost (PCT)	6.5
Rate Impact Measure (RIM)	0.4

4.2.10 Microbusiness (New Program)

The new Microbusiness Program is designed to target very small businesses. There are approximately 25,000 commercial customers in AEP Ohio territory using less than 12,500 kWh per year. Many of these small electricity users are located in old homes with commercial zoning or within small strip shopping centers with an estimated

average size of 1,400-1,600 square feet. Additionally, there are approximately 14,200 customers using less than 6,250 kWh per year.

Program Objective
The Program targets very small business customers with annual energy consumption of 13,000 kWh or less. These businesses have energy consumption levels similar to a residential account, which typically is too small to effectively be served through the comprehensive Express program for small business.
Target Market
The target market consists of small commercial businesses, typically with limited hours of operation and annual energy consumption of 13,000 kWh or less based on the last 12 months of billing history. These business types may include: apartment, condo or strip mall rental offices, and small offices for real estate, insurance, etc. Energy consumption limits may be adjusted during implementation to focus more on slightly larger customers during the Plan period.
Program Duration
The Microbusiness Program will be an ongoing component of the AEP Ohio EE/PDR Plan.
Program Description
The program will have an outreach and implementation strategy commensurate to the small level of energy savings available for these small business customers. There may be an initial outreach approach which solicits interaction based on replacing inefficient lighting, which is estimated to be the largest accessible efficiency opportunity of the business. This lighting component may be addressed by supplying lighting kits for customer installation or direct installation techniques. Also, HVAC and other measures may be employed.
Incentive Strategy
For customers where lighting kits can be supplied, several no-cost LEDs may be supplied with information to order additional lamps, if required. For direct install, the incentive may range from several no-cost LED's to a direct install of equipment not to exceed 80% of the project cost. HVAC and other measures may also be included with enhanced incentives. Incentives may be higher than the existing Express Program as the customer's practical energy measures may be limited. Once a microbusiness participates, future participation is unlikely.
Eligible Measures
Lighting and HVAC measures will be the primary focus of this program.
Implementation Strategy
An implementation contractor will oversee the development and delivery of the Microbusiness program. The Microbusiness program may be integrated into the Community Energy Savers Program strategy as a way to identify and serve these small

business customers.

Marketing Strategy

The marketing strategy may include direct mail and marketing as part of the Community Energy Savers Program.

Milestones

Tasks	Timeframe
Program Implementation Contractor selected	3 months
Program materials developed	5 months
Program launch – marketing begins	6 months

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	Units	2017	2018	2019	Total 2017-2019
Ductless Mini Split HP SEER 15	Ton	10	11	12	33
ENERGY STAR® Air Source Heat Pump (Elec Res Base)	Ton	44	45	39	128
SEER 15 CAC - EL Heat (DUB)	Ton	492	482	461	1,434
SEER 15 CAC - Non-EL Heat (DUB)	Ton	15,966	15,735	14,806	46,507
Efficient Refrigerator (ENERGY STAR® or Better) (DUB)	Refrigerator	949	871	856	2,676
DHW Pipe Insulation R-4 10 feet	10 Linear Feet	833	761	748	2,342
ENERGY STAR® Dishwasher (EFO 0.68) - Elec DHW (DUB)	Dishwasher	305	280	274	859
ENERGY STAR® Dishwasher (EFO 0.68) - Non-EL DHW (DUB)	Dishwasher	606	553	543	1,701
Heat Pump Water Heater - 2.0 EF	Unit	0	0	263	263
Low Flow (1.25 GPM) showerhead	Shower	1,254	1,510	1,538	4,302
Low Flow Faucet Aerator, 1.5 GPM - EDHW	Faucet	1,462	1,711	1,726	4,899
1L4'T5 NLO	Lamp	1,674	1,600	1,632	4,906
1L4'T8 HP	Lamp	4,801	4,597	4,674	14,071
Daylighting Control + Occ Sensor	Watts Controlled, 1 DC, 1 OC	102,361	91,791	91,980	286,131

Daylighting Controls	Watts Controlled, 1 DC	164,878	149,279	148,246	462,403
LED Exit Sign (DUB)	Sign	1,680	1,531	1,518	4,729
LED Lighting <10W - Indoor	Lamp	488	469	478	1,436
LED Lighting >=10W - Indoor	Lamp	4,260	4,083	4,160	12,503
Occupancy Sensor	Watts Controlled, 1 OC	13,616	12,254	12,227	38,097
Outdoor LED Flood Light (30W), TC Control	Fixture	323	302	311	936
Permanent T12 Removal During T8 Retrofit	Lamp	1,256	1,147	1,141	3,544
Photocell + Timeclock (Outdoor Lighting)	Watts Controlled, 1 TC, 1 PC	2,255	2,425	2,433	7,112
T8 Delamping	Lamp	1,999	1,824	1,805	5,628

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Incentive	$1.1	$1.0	$1.0	$3.1
Administrative	$0.4	$0.4	$0.4	$1.1
Total	**$1.4**	**$1.4**	**$1.4**	**$4.3**
Incremental Annual Participant Costs (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Participant Costs	$4.1	$3.9	$4.1	**$12.1**

Savings

Incremental Annual Savings - at Meter				
	2017	**2018**	**2019**	**2019 Cumulative Annual**
Energy (MWh)	9,908	9,696	10,090	29,694
Summer Peak Demand (kW)	4,084	3,900	3,799	11,783

Benefit Cost

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.7
Utility System Resource Cost (UCT)	5.6
Participant Cost (PCT)	2.8
Rate Impact Measure (RIM)	0.7

EM&V Strategy

All evaluation activities will be conducted by AEP Ohio's evaluation contractor. An integrated evaluation approach will be taken that includes the following components:

- Addressing evaluation needs at the onset of program design and collecting evaluation data as part of program administration.
- Assessing and documenting baseline conditions.
- Establishing tracking metrics.
- Conducting primary and secondary research as part of the impact and process evaluations.

The overall goal of the impact evaluation will be to validate/calibrate savings values and determine program cost-effectiveness. The participant and nonparticipant surveys will also address program awareness, barriers to participation, participant satisfaction, and process efficiency. These surveys will be enhanced by collecting market data and assessing trends as well as interviews with program staff, the implementation contractor, collaborating program administrators, and participating manufacturers.

The process evaluation will be conducted during the first program year and then coordinated with follow-up impact evaluation work to be performed once program-approved measures have been installed and operating for a sufficient time to enable a robust impact evaluation.

AEP Ohio Administrative Requirements

Initial program administration will be conducted by AEP Ohio EE/PDR personnel. To develop and manage the third-party implementation, it is estimated that 0.25 FTE staff will be required for program oversight. Key oversight functions include:

- Recruitment, selection, and management of the implementation contractor(s)
- Customer, Property Owner/Managers recruitment
- Coordination of marketing strategy/public relations among programs and market sectors
- Coordination of all education and training
- Data warehousing
- Management of the evaluation contractor

- Goal achievement within budget

AEP Ohio and its implementation contractor will follow industry best practices during final program design and start-up to ensure success, including:

- Following an integrated evaluation approach as described above
- Account manager and customer service training
- Establishing requirements for supporting documentation, analysis methods, and reporting requirements on technical studies
- Completing all program procedures from marketing through verification and payment and conducting a dry-run prior to launch
- Preparing for stronger or weaker than expected participant response

4.2.11 Combined Heat and Power and Waste Energy Recovery – CHP/WER (New Program)

Objective

Support the installation of high efficiency, sustainable and cost effective CHP/WER projects in AEP Ohio's service territory as allowed by SB 315 and supported by the PUCO and state of Ohio.

Target Market

Large users of steam for ongoing processes and could include industrial, institutional and healthcare facilities. Other types of CHP/WER projects can be considered if they meet minimum efficiency requirements.

Program Duration

The program will operate while funds are available through the Plan period. Filed and approved arrangements may have their own individual terms.

Program Description

Combined Heat and Power is a cogeneration strategy which involves the generation of both electricity and useful heating (and/or cooling). CHP is a thermodynamically efficient method of generating electricity because it utilizes waste heat for local heating and/or cooling.

The CHP Program is focused on incentivizing and enabling development of efficient CHP systems for large customers typically in the industrial, institutional, and healthcare sectors.

Incentive Strategy

All incentive payments are subject to AEP Ohio approval and are based on measured production kWh generated by the CHP/WER project.

The program provides performance based funding for CHP/WER projects that meet all PUCO and AEP Ohio requirements. Until PUCO regulations provide for a different

approach, AEP Ohio will follow the qualifications and approach approved by the PUCO in case #14-2296 and file unique arrangements for individual approval of projects. The incentive levels will be established on a project specific basis; however, the incentive floor is the lower of 10% of CHP/WER direct project cost or 0.5 cents per kWh annually for five years. The incentive payment will typically be paid per annual kWh produced for net generation, and payable over five years. Depending on available AEP Ohio budget, CHP/WER projects in progress, the economic feasibility studies of specific projects and customer need to justify projects, the incentives could be increased, but no more than 2 times the incentive floor. Also, incentive payments can be timed in different ways depending on customer needs, so long as a performance basis is included. Each project will require screening for feasibility and cost effectiveness. Any projects that have payments that extend past December 31, 2019 are required to be jointly filed with AEP Ohio for PUCO approval. In addition to incentives, AEP Ohio will work with customers to ensure they are aware of Ohio and Federal incentives and educational opportunities.

Eligible Measures

The minimum total CHP/WER system efficiency required is 60% with a minimum 20% useful thermal energy.

Implementation Strategy

AEP Ohio is working with a number of customers to develop joint applications for projects. Upon filing and approval of this Plan, it is expected that project activity will increase significantly with a likely backlog of projects available for limited funding. AEP Ohio intends to reach out to large customer groups for potential opportunities as well as work with CHP/WER developers who may be interested, if customer interest is insufficient.

Marketing Strategy

Develop promotional material, utilizing readily available information from the state of Ohio, Department of Energy, the Environmental Protection Agency and the Midwest CHP Application Center, among others.

Milestones

Tasks	Timeframe
Develop promotional material	3-6 months
Conduct outreach to large customers and segments	Ongoing
Hold periodic education/training on CHP/WER in conjunction with state, regional and federal efforts	Minimum 1 per year

EM&V Strategy

- Measure and validate production kWh and total system efficiency measurements for verification of payments on an annual basis.
- Develop effective measurement strategy for average total system efficiencies over the annual period to determine payment eligibility.
-

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	**Units**	**2017**	**2018**	**2019**	**Total 2017-2019**
Large CHP/WER	7.1 MW	1	1	1	**3**
Medium CHP/WER	3.6 MW	2	2	2	**6**
Small CHP/WER	0.3 MW	3	3	3	**9**

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Incentive	$0.23	$0.23	$0.23	$0.65
Administrative	$3.18	$3.18	$3.18	$8.83
Total	**$3.41**	**$3.41**	**$3.41**	**$9.48**

Incremental Annual Participant Costs (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Participant Costs	**$107.4**	**$104.1**	**$100.7**	**$318.0**

Savings Targets

Incremental Annual Savings - at Meter				
	2017	**2018**	**2019**	**2019 Cumulative Annual**
Energy (MWh)	106,000	106,000	106,000	318,000
Summer Peak Demand (kW)	15,143	15,143	15,143	45,429

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.2
Utility System Resource Cost (UCT)	28.7
Participant Cost (PCT)	0.9
Rate Impact Measure (RIM)	1.3

4.2.12 Energy Efficiency Auction (ongoing program)

The Energy Efficiency Auction Program produces long-term electric energy savings in the business sector by introducing a competitive bidding approach to EE/PDR. In addition, EE/PDR programs may not match up effectively with customers' capital planning schedules. This program provides an opportunity for large customers to competitively bid for EE/PDR projects and reserve funds won in a timeframe that fits an individual customer's capital planning needs. The target market consists primarily of larger customers and customer groups that may include industrial and manufacturing facilities, healthcare, government, education, and solution providers that implement projects for these customer types. Auction timeframes are planned for the fall of each year for future year(s) projects. The auction timing is designed to inform AEP Ohio during the process of setting incentives for other major Business programs in the following year.

The Energy Efficiency Auction Program concept involves the following steps:

1) Customers or solution providers develop projects with significant savings potential and prepare their projects for pre-qualification.
2) Bidders submit their projects for pre-qualification
3) Qualified bidders are approved to bid their projected energy savings in cost per annual energy saved ($/kWh).
4) Once the bidding process is complete, AEP Ohio selects winning applicants based on specified criteria set prior to the scheduled auction event.

Note: While there is a specific budget for this program, any related savings will be counted under other business programs, e.g. Efficient Products, Process, etc.

Adjustments and Enhancements
AEP Ohio plans to make modifications to the Energy Efficiency Auction Program as shown below: • Minimum project useful life of 10 years (including LED lighting). • The program will inform and support development of business incentives for subsequent years across multiple programs. Annual auction events, ideally in the fall, will identify large projects for the following year at cost competitive incentive rates. Results will inform AEP Ohio during program planning and determining incentives on all major programs in the following year, where appropriate. • Projects receive incentive payment based on verified energy savings following project completion and final project application approval. • The number of available auctions may be increased, decreased or eliminated

based on customer participation levels.

- Projects and measures eligible for incentive bidding may be added or removed to increase cost effectiveness and/or program participation.

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Administrative	$0.2	$0.2	$0.2	**$0.6**

4.2.13 Demand Response (Ongoing Program)

The Demand Response Program is available to non-residential customers only and may be used to supplement the peak demand reductions achieved from EE/PDR programs in order to ensure the peak demand reduction benchmark requirements of SB 310 are met.

The program includes monitoring, participation, and compliance with any Commercial and Industrial Interruptible Rates offered and in effect in the AEP Ohio service territory. In addition, PJM Demand Response Program participation may be utilized, provided mercantile customers commit that resource to AEP Ohio. Program funding is primarily limited to securing customer commitments for supplemental peak demand reduction that could include interruptible tariffs, special arrangements, and/or a standard offer or a bid process. No savings for the program are estimated since the program may not be needed during the three-year period.

Adjustments and Enhancements

AEP Ohio plans to make modifications to the Demand Response program as shown below:

- Incentives may be adjusted to increase cost effectiveness and/or program participation.

4.2.14 Transmission and Distribution (T&D) Customer Efficiency Projects (Ongoing Program)

Program Objective

AEP Ohio has opportunities to improve efficiency for customers on its distribution facilities through the installation of measures that can provide long-term savings. Utility distribution side energy efficiency programs are elective programs, not loss

reductions as covered in the T&D loss reduction projects. Capital and O&M cost recovery for T&D Customer Efficiency Projects can be managed in the EE/PDR rider just as other EE/PDR programs. The objective of this program is to describe those opportunities for implementation in a similar manner as other customer efficiency programs and/or complete further investigation. One difference from other programs, due to the capital investment required, may be to treat any earnings from T&D Customer Efficiency Projects using an enhanced return on investment instead of shared savings. Three of these potential programs are described below: Volt Var Optimization (VVO), LED Street/Outdoor Lighting, and Customer Power Factor Correction.

Program Description

Volt Var Optimization (VVO). End-of-line monitoring allows the utility to determine where AEP can maintain the voltage on the circuit through automating regulators and capacitors to reduce energy consumption and peak demand. In addition, it helps maintain unity power factor.

The VVO system that AEP Ohio piloted in its gridSMART phase 1 allows a reduction in voltage while remaining within acceptable ranges. This reduction in voltage yields a reduction in energy and demand that is measurable and consistent as long as the system is operational. In the initial pilot, the average savings in demand and energy was 3%. While this level of savings will vary by circuit, a key advantage of this program is that every customer on the circuits implemented will receive the savings. The non-participants in AEP Ohio's other EE/PDR programs that reside or have businesses on these circuits will automatically become participants in AEP Ohio's EE/PDR programs.

LED Street/Outdoor Lighting. AEP Ohio has been considering LED Street/Outdoor lighting for a period of time; however, pricing and utility grade LED technology concerns have not been conducive to moving forward. Even with the electricity and O&M savings, the capital costs offset those savings requiring a significant increase in the SL and OL rates. As pricing and quality both continue to improve, it is expected that during this Plan period, LED Street/Outdoor lighting conversions may be justified. This program would investigate the opportunity further, and if successful, would develop an implementation plan to move forward. Ideally, the energy and O&M savings would offset the capital costs. At that point, AEP Ohio would file for Commission approval, start the conversion process and complete it over a number of years. It is anticipated that Capital and O&M costs for this program would be requested through a different rate mechanism than the EE/PDR rider. Any energy savings would be counted toward goals under this Plan.

Customer Power Factor Correction. Power Factor Correction provides customers with specific technology measures that can be implemented to improve power quality and to produce demand savings within the customers' facilities and energy savings on the AEP Ohio Distribution System. Certain production intensive

manufacturing industries (large industrial customers >700,000 kWh/12 month average) have production equipment and facilities that contribute to low power factors that affect their equipment and reflect losses back to the distribution system limiting the ability to use this energy for useful purposes. Power Factor Correction reduces KVA, which is equivalent to KW at unity power factor. This is a program under development and any required funding will come from the Process Efficiency program.

Eligible Measures

Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.

Implementation Strategy

An implementation contractor will oversee the development and delivery of the Transmission and Distribution (T&D) Customer Efficiency Projects program.

Marketing Strategy

The marketing of this program is by direct communication by the account managers to the customers and through their industry associations.

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Administrative	$0.2	$0.2	$0.2	**$0.6**

4.2.15 Business Outreach (New Program)

The Consolidated Outreach Program is designed to create a hub of communication and information around trained regional energy advisors to increase customer knowledge and enroll customers in the most appropriate program for their needs. AEP Ohio endeavors to use the best program designs and most experienced Implementation contractors for EE programs. This usually requires multiple implementation contractors which require varying degrees of outreach to customers and solution providers (trade allies). This situation requires a single point of contact for customers, trade allies and customer services for information and enrollment into the most beneficial business program for the customer. Consolidated outreach covers all Business programs and the energy advisors can also provide information to consumer customers working as employees at AEP Ohio businesses.

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Administrative	$1.6	$1.6	$1.7	**$4.9**

4.3 Cross-Sector Programs and Other Activities

AEP Ohio plans to implement five new cross-sector programs and activities that provide measurable savings:

- Agricultural
- Multifamily
- Customer EE Assessment Survey
- Efficient Financing
- Community Energy Savers – government-based pilot

AEP Ohio plans to continue the following six cross-sector activities for 2017 to 2019:

- gridSMART Enabled EE/PDR Savings
- T&D Loss Reduction Projects (formerly T&D and Internal System Efficiency Improvements)
- Education and Training
- Targeted Advertising
- Research and Development

4.3.1 Agricultural (New Program)

The cross-sector Agricultural program will encourage program participation regardless of whether the facility has a residential or commercial electric rate tariff.

Objective

To provide long-term electric energy savings in both Consumer and Business sectors for the Agriculture sector. The Agriculture program is cross sector as farms in Ohio may be on a residential or non-residential tariff.

Target Market

The target market consists of industrial and family farms established for various agricultural activities including, but not limited to: dairy, egg, poultry, swine, grain, and wine production.

Program Duration

The Agriculture Program will be an ongoing component of the AEP Ohio EE/PDR Plan.

Program Description

The Agriculture Program combines measures from the AEP Ohio Business Programs such as Prescriptive, Custom and New Construction with Consumer Programs such as In-Home Audit and Efficient Products.

Incentive Strategy

Incentives are consistent with other standard programs. Additional incentives may be developed if necessary to accommodate new agricultural measures not already existing in other programs.

Eligible Measures

Eligible measures are consistent with other standard Business and Consumer Programs. Additionally, the program may include measures specific to the agricultural sector such as:

- Agriculture heat pads
- Dairy scroll compressors
- Fan thermostat controller
- Heat reclaimer units
- High volume low speed fans 16' -24' diameter
- High-speed fan - 24" to 71" diameter
- Livestock waterers
- Low pressure sprinkler nozzle
- Milk pre-cooler heat exchanger (chiller savings)
- Switch from sprinkler to drip irrigation
- Tractor engine block heater timer
- Variable speed drive for milk vacuum pump
- VFD on dairy transfer pumps up to 250 HP
- Water pre-heat heat exchanger (water heating savings)

Implementation Strategy

An implementation contractor will oversee the development and delivery of the Agricultural program. The main focus of the implementation strategy is targeted

outreach to the agricultural community. The agricultural community is hard to reach, particularly residential farms, which may not be identified as such in AEP Ohio customer information. The agricultural market sector has not had strong historical participation with the EE/DR program, and will be approached through an outreach strategy that demonstrates understanding of the agricultural business and concerns.

Marketing Strategy

An Implementation contractor will oversee the marketing and outreach to customers. Agricultural organizations such as OSU Extension, Farm Science and Ohio Farm Bureau Federation will be used to facilitate marketing through local organizations and events.

Milestones

Tasks	Timeframe
Program Implementation Contractor selected	3 months
Program materials developed	5 months
Program launch – marketing begins	6 months

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	Units	2017	2018	2019	Total 2017-2019
Agriculture Heat Pads	Unit/swine and hatchery farm	0	0	4	4
Dairy Scroll Compressors (Agriculture)	Unit/1000 dairy cows	1	1	1	2
Heat Reclaimer Units (Agriculture)	Unit/1000 dairy cows	1	1	1	4
High Volume Low Speed Fans 16' diameter (Agriculture)	Fan/livestock farm	11	11	11	32
High Volume Low Speed Fans 18' diameter(Agriculture)	Fan/livestock farm	11	11	11	32
High Volume Low Speed Fans 20' diameter (Agriculture)	Fan/livestock farm	11	11	11	32
High Volume Low Speed Fans 22' diameter (Agriculture)	Fan/livestock farm	11	11	11	32
High Volume Low Speed Fans 24' diameter (Agriculture)	Fan/livestock farm	11	11	11	32
Milk Pre-Cooler Heat Exchanger (Chiller Savings) (Agriculture)	lb. Milk/ Day	1	1	1	4
Water Pre-Heat Heat Exchanger (Water Heating Savings)	lb. Milk/ Day	0	0	0	1
Tractor Engine Block Heater Timer (Agriculture)	Unit/farm	119	120	123	361

Variable Speed Drive for Milk Vacuum Pump	HP/1000 dairy cows	1	1	1	2
VFD on Dairy Transfer pumps up to 250 HP	100 gallons	1	1	1	4
Low Pressure Sprinkler Nozzle,	nozzle	331	334	344	1,009
Fan thermostat controller (Agriculture)	HP/1000 dairy cows	17	17	18	53
HE High-Speed Fan - 24" to 35" diameter	Fan/livestock farm	18	18	19	55
HE High-Speed Fan - 36" to 47" diameter	Fan/livestock farm	18	18	19	55
HE High-Speed Fan - 48" to 71" diameter	Fan/livestock farm	17	17	18	52

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Incentive	$0.1	$0.1	$0.1	$0.3
Administrative	$0.2	$0.2	$0.2	$0.5
Total	**$0.3**	**$0.3**	**$0.3**	**$0.9**
Incremental Annual Participant Costs (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Participant Costs	$0.5	$0.5	$0.5	**$1.4**

Savings Targets

Incremental Annual Savings - at Meter				
	2017	**2018**	**2019**	**2019 Cumulative Annual**
Energy (MWh)	1,656	1,669	1,764	5,089
Summer Peak Demand (kW)	276	278	286	840

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	2.0
Utility System Resource Cost (UCT)	4.4
Participant Cost (PCT)	4.0
Rate Impact Measure (RIM)	0.6

EM&V Strategy

All evaluation activities will be conducted by AEP Ohio's evaluation contractor. An integrated evaluation approach will be taken that includes the following components:

- Addressing evaluation needs at the onset of program design and collecting evaluation data as part of program administration.
- Assessing and documenting baseline conditions.
- Establishing tracking metrics.
- Conducting primary and secondary research as part of the impact and process evaluations.

The overall goal of the impact evaluation will be to validate/calibrate savings values and determine program cost-effectiveness. The participant and nonparticipant surveys will also address program awareness, barriers to participation, participant satisfaction, and process efficiency. These surveys will be enhanced by collecting market data and assessing trends as well as interviews with program staff, the implementation contractor, collaborating program administrators, and participating manufacturers.

The process evaluation will be conducted during the first program year and then coordinated with follow-up impact evaluation work to be performed once program-approved measures have been installed and operating for a sufficient time to enable a robust impact evaluation.

AEP Ohio Administrative Requirements

Initial program administration will be conducted by AEP Ohio EE/PDR personnel. To develop and manage the third-party implementation, it is estimated that 0.25 FTE equivalent will be required for program oversight. Key oversight functions include:

- Recruitment, selection, and management of the implementation contractor(s)
- Customer, Property Owner/Managers recruitment
- Coordination of marketing strategy/public relations among programs and market sectors
- Coordination of all education and training
- Data warehousing
- Management of the evaluation contractor
- Goal achievement within budget

AEP Ohio and its implementation contractor will follow industry best practices during final program design and start-up to ensure success, including:

- Following an integrated evaluation approach as described above
- Account manager and customer service training
- Establishing requirements for supporting documentation, analysis methods, and

reporting requirements on technical studies

- Completing all program procedures from marketing through verification and payment and conducting a dry-run prior to launch
- Preparing for stronger or weaker than expected participant response

4.3.2 Multifamily Program (New Program)

Objective

To produce long-term electric energy savings for multifamily buildings that include both the Consumer and Business sectors. This cross-sector program will overcome historical challenges of serving the Consumer and Business components through separate programs and maximize savings for multifamily tenants. The program may include new construction, retrofit complexes, walk-through audits, direct install measures, and recommendations for next level energy efficiency measures.

Target Market

The target market consists of multifamily structures, typically three floors or higher, containing three or more dwelling units.

Program Duration

The Multifamily Program will be an ongoing component of the AEP Ohio EE/PDR Plan.

Program Description

This cross-sector program will work with property owners and managers to create an all-in-one program to support energy efficient new construction projects and retrofits of existing buildings. The new construction component will promote building above current code and the installation of efficient measures in the individual units. Retrofit of existing buildings will rely on audits of both individual units and common areas. Consumers may receive direct install measures, recommendations for additional measures and opportunities to apply for additional incentives through other programs such as the (Consumer) Efficient Products, and Efficient Products for Business Programs. The savings and cost associated with the Consumer measures will be allocated to the Consumer program and budget. Business sector measures will explore common areas such as HVAC systems, hallway lighting, exterior lighting, exit sign lighting and new construction measures. Business sector (typically common area) measures will be funded and energy savings attributed to the C&I sector.

AEP Ohio will consider an additional targeted pilot program where a team would work with the utility, building owner/manager, and tenants (commercial and/or multifamily) to devise incentive programs and value propositions allowing all parties to benefit from energy efficiency and conservation measures.

Incentive Strategy

Customers may be eligible for direct install measures, incentives for next level implementation measures and may choose from a list of pre-qualified contractors to have energy-saving improvements installed or constructed. Incentives may be adjusted to increase cost effectiveness and/or program participation.

Eligible Measures

Eligible measures will vary depending on whether the project is retrofit or new housing and the opportunities presented. Broadly, the portfolio of standard residential and commercial measures will be available to multifamily sector.

Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.

Implementation Strategy

An implementation contractor will oversee the development and delivery of the Multifamily program. The main focus of the implementation strategy is designed to lower the cost of delivery with combining both consumer and business portions of the multi-family facility into one visit. Property Managers and Owners will be engaged prior to the on-site visit and possibly incentivized to participate for common areas and engage the majority of tenants (if not all tenants) in program participation. Additionally, recommendations for home and common areas will promote the use of the Efficient Products program rebates for consumer and business sectors.

Marketing Strategy

Engage property managers and owners at the onset and encourage and secure full capacity participation from tenants.

Milestones

Tasks	Timeframe
Program Implementation Contractor selected	3 months
Program materials developed	5 months
Program launch – marketing begins	6 months

Participation

The following participation levels have been used for planning purposes. However, AEP Ohio may adjust qualifying energy efficiency measures and anticipated participation levels as necessary in accordance with current market conditions, EM&V results and program implementation experience.

Incremental Annual Participants (Units Installed)					
Measure Name	Units	2017	2018	2019	Total 2017-2019
1L4'T5 NLO	Lamp	439	475	502	1,416

1L4'T8 HP	Lamp	2,596	2,823	3,012	8,432
1W LED Night Light	Lamp	59	53	51	163
6L4'T8HP	Fixture	188	203	216	607
Air Source Heat Pump SEER 15, COP 2.49 (DUB)	Ton	193	203	210	606
Clothes Washer - Tier 3 >= 2.2 MEF-w/elec dry (DUB)	Unit	55	50	48	153
Clothes Washer - Tier 3 >= 2.2 MEF-w/gas or no dry (DUB)	Unit	31	28	26	85
Daylighting Controls	Watts Controlled, 1 DC	76,459	79,076	81,275	236,810
DHW Pipe Insulation R-4 10 feet	10 Linear Feet	608	672	677	1,957
Efficient Refrigerator (ENERGY STAR® or Better) (DUB)	Refrigerator	119	108	103	330
ENERGY STAR® 50 CFM Bathroom Ventilating Fan	Fan	44	51	54	149
ENERGY STAR® Dishwasher - Elec DHW (DUB)	Dishwasher	64	58	55	177
ENERGY STAR® Dishwasher - Non-EL DHW (DUB)	Dishwasher	93	84	80	257
ENERGY STAR® Set Top Boxes	Box	24	21	20	65
ENERGY STAR® Window / Room AC (DUB)	Unit	141	162	167	470
Freezer Retirement	Freezer	65	59	56	181
Heat Pump Water Heater - 2.0 EF (DUB)	Unit	70	78	79	228
High Eff. Elec. Water Heat - Tank - .95 EF (DUB)	Unit	310	345	347	1,001
High Performance Circulating Pump (DHW)	Pump	9	8	8	25
Instantaneous Electric Water Heater - .99 EF (DUB)	Unit	207	231	234	672
LED Exit Sign	Sign	572	595	610	1,777
LED Lighting <10W - Indoor	Lamp	68	75	80	222
LED Lighting >=10W - Indoor	Lamp	590	650	697	1,937
LED Lighting 12W - Indoor (CFL Base)	Lamp	249	226	215	691
LED Lighting 15W - Indoor	Lamp	1,989	1,805	1,712	5,506
LED Lighting 8W - Indoor	Lamp	15,814	14,356	13,618	43,788

LED Lighting 8W - Indoor (CFL Base)	Lamp	1,949	1,770	1,679	5,398
LED T8 Tube (4' T8 Replacement)	Lamp	1,325	1,442	1,556	4,322
LED Troffer	Fixture	311	333	354	997
Low Flow (1.25 GPM) showerhead	Shower	1,126	1,245	1,256	3,626
Low Flow Faucet Aerator, 1.5 GPM - EDHW	Faucet	1,313	1,451	1,461	4,225
Occupancy Sensor	Watts Controlled, 1 OC	3,951	4,088	4,202	12,241
Outdoor LED Flood Light (30W), TC Control	Fixture	91	98	104	293
Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	Fixture	69	74	79	221
Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	Fixture	71	77	83	231
Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER)	Rated Tons Cooling	33	43	46	122
Permanent T12 Removal During T8 Retrofit	Lamp	717	751	773	2,242
Photocell + Timeclock (Outdoor Lighting)	Watts Controlled, 1 TC, 1 PC	744	773	792	2,309
Reduced ACHnat 0.3 - Central A/C - EL Heat	Home	3	4	4	11
Reduced ACHnat 0.3 - Heat Pump	Home	13	15	16	44
Refrigerator Retirement	Refrigerator	76	69	65	210
SEER 15 CAC - EL Heat (DUB)	Ton	87	92	94	273
SEER 15 CAC - Non-EL Heat (DUB)	Ton	2,747	2,893	2,979	8,619
Split/Package system A/C (<65 kBtu/h, 15 SEER) - Direct Exp /All Heating Types	Rated Tons Cooling	35	47	50	133
Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types	Rated Tons Cooling	16	21	13	50
Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types	Rated Tons Cooling	24	32	34	90
Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types (DUB)	Rated Tons Cooling	153	201	212	567
Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump	Rated Tons Cooling	11	14	15	39
Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump	Rated Tons Cooling	21	29	31	81
Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump (DUB)	Rated Tons Cooling	93	121	127	342

Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump	Rated Tons Cooling	8	11	12	31
Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump (DUB)	Rated Tons Cooling	38	49	52	139
Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump	Rated Tons Cooling	6	7	7	20
Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump (DUB).	Rated Tons Cooling	23	30	32	85
T8 Delamping	Lamp	1,113	1,157	1,184	3,455
Time clock (Outdoor Lighting)	Watts Controlled, 1 TC	762	790	817	2,369
Triple Pane Windows - Central A/C - EL Heat (DUB)	100 sqft window area	46	48	50	143
Triple Pane Windows - Central A/C - Non-EL Heat (DUB)	100 sqft window area	1,383	1,458	1,509	4,350
Triple Pane Windows - Heat Pump (DUB)	100 sqft window area	187	197	205	589
Water Source (water to air) Heat Pump (< 17 kBtu/h) EER 13.4 - Heat Pump	Rated Tons Cooling	29	29	30	88
Water Source (water to air) Heat Pump (< 17 kBtu/h) EER 13.4 - Heat Pump (DUB)	Rated Tons Cooling	29	29	30	88
Water Source (water to air) Heat Pump (>= 17 kBtu/h) EER 14.3 - Heat Pump	Rated Tons Cooling	28	29	30	87
Water Source (water to air) Heat Pump (>= 17 kBtu/h) EER 14.3 - Heat Pump (DUB)	Rated Tons Cooling	28	29	30	87

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Incentive	$1.3	$1.4	$1.4	$4.1
Administrative	$1.1	$1.1	$1.1	$3.4
Total	**$2.4**	**$2.5**	**$2.5**	**$7.4**
Incremental Annual Participant Costs (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Participant Costs	$2.1	$2.2	$2.3	**$6.7**

Savings Targets

Incremental Annual Savings - at Meter				
	2017	2018	2019	2019 Cumulative Annual
Energy (MWh)	5,787	6,009	6,173	17,969
Summer Peak Demand (kW)	1,666	1,751	1,812	5,229

Benefit-Cost Test Results

Benefit-Cost Test	2017-2019 Test Ratio
Total Resource Cost (TRC)	1.6
Utility System Resource Cost (UCT)	2.1
Participant Cost (PCT)	4.5
Rate Impact Measure (RIM)	0.5

EM&V Strategy

All evaluation activities will be conducted by AEP Ohio's evaluation contractor. An integrated evaluation approach will be taken that includes the following components:

- Addressing evaluation needs at the onset of program design and collecting evaluation data as part of program administration.
- Assessing and documenting baseline conditions.
- Establishing tracking metrics.
- Conducting primary and secondary research as part of the impact and process evaluations.

The overall goal of the impact evaluation will be to validate/calibrate savings values and determine program cost-effectiveness. The participant and nonparticipant surveys will also address program awareness, barriers to participation, participant satisfaction, and process efficiency. These surveys will be enhanced by collecting market data and assessing trends as well as interviews with program staff, the implementation contractor, collaborating program administrators, and participating manufacturers.

The process evaluation will be conducted during the first program year and then coordinated with follow-up impact evaluation work to be performed once program-approved measures have been installed and operating for a sufficient time to enable a robust impact evaluation.

AEP Ohio Administrative Requirements

Initial program administration will be conducted by AEP Ohio EE/PDR personnel. To develop and manage the third-party implementation, it is estimated that 0.5 FTE equivalent will be required for program oversight. Key oversight functions include:

- Recruitment, selection, and management of the implementation contractor(s)

- Customer, Property Owner/Managers recruitment
- Coordination of marketing strategy/public relations among programs and market sectors
- Coordination of all education and training
- Data warehousing
- Management of the evaluation contractor
- Goal achievement within budget

AEP Ohio and its implementation contractor will follow industry best practices during final program design and start-up to ensure success, including:

- Following an integrated evaluation approach as described above
- Account manager and customer service training
- Establishing requirements for supporting documentation, analysis methods, and reporting requirements on technical studies
- Completing all program procedures from marketing through verification and payment and conducting a dry-run prior to launch
- Preparing for stronger or weaker than expected participant response

4.3.3 Customer Energy Efficiency Assessment Survey Program (New Program)

Objective
The Customer Energy Efficiency Assessment Survey identifies long-term electric energy savings in both Consumer and Business sectors implemented by customers not accounted for in existing programs. The program will capture savings and peak demand reductions achieved outside of EE/PDR programs.
Target Market
The target market consists of all residential and business customers within AEP Ohio service territory.
Program Duration
The Customer Energy Efficiency Assessment Survey Program will be an ongoing component of the AEP Ohio EE/PDR Plan.
Program Description
This program captures energy savings implemented by Consumer and Business sector customers outside of our programs. Through recent legislation, these savings are eligible for inclusion in this Plan. A number of approaches may be used to identify savings associated with this program. They include but are not limited to surveys, market research, trade allies and a variety of other approaches.
Incentive Strategy

Incentives in other programs would not be eligible in this program. Other incentives may be developed if necessary to accommodate for survey completion or other methods identified to obtain program data.

Eligible Measures

The Customer Energy Efficiency Assessment Survey program may research any of the residential and commercial measures in the 2017-2019 Plan which have been implemented outside of the program. Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.

Implementation Strategy

An Implementation contractor may be used to develop and manage survey tools, research studies and other components identified during the program.

Marketing Strategy

The marketing strategy may include but not limited to direct mail and online surveys.

Tasks	Timeframe
Program Implementation Contractor selected	3 months
Program materials developed	5 months
Program launch	6 months

Savings Targets

Incremental Annual Savings - at Meter				
	2017	2018	2019	2019 Cumulative Annual
Energy (MWh)	4,000	4,000	4,000	12,000
Summer Peak Demand (kW)	0	0	0	0

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Administrative	$0.2	$0.2	$0.2	$0.6

EM&V Strategy

All evaluation activities will be conducted by AEP Ohio's evaluation contractor. An integrated evaluation approach will be taken that includes the following components:

- Addressing evaluation needs at the onset of program design and collecting evaluation data as part of program administration.
- Assessing and documenting baseline conditions.
- Establishing tracking metrics.

- Conducting primary and secondary research as part of the impact and process evaluations.

The overall goal of the impact evaluation will be to validate/calibrate savings values and determine program cost-effectiveness. The participant and nonparticipant surveys will also address program awareness, barriers to participation, participant satisfaction, and process efficiency. These surveys will be enhanced by collecting market data and assessing trends as well as interviews with program staff, the implementation contractor, collaborating program administrators, and participating manufacturers.

The process evaluation will be conducted during the first program year and then coordinated with follow-up impact evaluation work to be performed once program-approved measures have been installed and operating for a sufficient time to enable a robust impact evaluation.

Initial program administration will be conducted by AEP Ohio EE/PDR personnel. To develop and manage the third-party implementation, it is estimated that 0.25 FTE equivalent will be required for program oversight. Key oversight functions include:

- Recruitment, selection, and management of the implementation contractor(s)
- Data acquisition activities
- Coordination of marketing strategy/public relations among programs and market sectors
- Coordination of all education and training
- Data warehousing
- Management of the evaluation contractor
- Goal achievement within budget

AEP Ohio and its implementation contractor will follow industry best practices during final program design and start-up to ensure success, including:

- Following an integrated evaluation approach as described above
- Training
- Establishing requirements for supporting documentation, analysis methods, and reporting requirements on technical studies
- Completing all program procedures from marketing through verification and payment and conducting a dry-run prior to launch

Preparing for stronger or weaker than expected participant response

4.3.4 Efficient Financing Program (New Program)

Objective
To assist customers overcome the first cost barrier of energy efficiency projects with financing options, available to both Consumer and Business sectors. Reducing first cost barriers will expand the quantity of customers participating in EE/PDR program, and also expand the average project size. The program may include retrofits and/or new construction projects.
Target Market
The target market consists of all eligible Consumer and Business sector customers participating in our Energy Efficiency and Peak Demand Response programs.
Program Duration
The Efficient Financing Program will be an ongoing component of the AEP Ohio EE/PDR Plan.
Program Description
In order to remove the first-cost barrier for implementation of energy efficiency projects, AEP Ohio will provide financing options to eligible Consumer and Business sector customers.
Incentive Strategy
Customers may be eligible for financing options including but not limited to interest rate buy downs or longer loan terms for energy-saving improvements installed, or other incentive methods. Incentives may be adjusted to increase cost effectiveness and/or program participation.
Eligible Measures
Financing may be used for any residential or commercial project exceeding a pre-determined minimum customer investment amount. Cost effective measures developed during Plan implementation may be added and measures currently on the list may be changed or removed depending on both cost effectiveness and customer participation.
Implementation Strategy
An implementation contractor will oversee the development and delivery of the Efficient Financing program. The main focus of the implementation strategy is to design a streamlined method for the financing process to serve customers that otherwise may not have participated, and expand the scope of individual projects.
Marketing Strategy
An implementation contractor will oversee the marketing and outreach to customers. Specific program Implementation Contractors, Trade Allies and Solution Providers may also be engaged in marketing the program.

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Administrative	$1.0	$1.0	$1.0	$3.0

Milestones

Tasks	Timeframe
Program Implementation Contractor selected	3 months
Program materials developed	5 months
Program launch – marketing begins	6 months

EM&V Strategy

All evaluation activities will be conducted by AEP Ohio's evaluation contractor. An integrated evaluation approach will be developed commensurate with program structure and may include the following components:

- Addressing evaluation needs at the onset of program design and collecting evaluation data as part of program administration.
- Assessing and documenting baseline conditions.
- Establishing tracking metrics.
- Conducting primary and secondary research as part of the impact and process evaluations.

The overall goal of the impact evaluation will be to validate/calibrate savings values and determine program cost-effectiveness. The participant and nonparticipant surveys will also address program awareness, barriers to participation, participant satisfaction, and process efficiency. These surveys will be enhanced by collecting market data and assessing trends as well as interviews with program staff, the implementation contractor, collaborating program administrators, and participating manufacturers.

The process evaluation will be conducted during the first program year and then coordinated with follow-up impact evaluation work to be performed once program-approved measures have been installed and operating for a sufficient time to enable a robust impact evaluation.

AEP Ohio Administrative Requirements

Initial program administration will be conducted by AEP Ohio EE/PDR personnel. To develop and manage the third-party implementation, it is estimated that 0.75 FTE equivalent will be required for program oversight. Key oversight functions include:

- Recruitment, selection, and management of the implementation contractor(s)
- Coordination of marketing strategy/public relations among programs and market sectors
- Coordination of all education and training
- Management of the evaluation contractor

AEP Ohio and its implementation contractor will follow industry best practices during final program design and start-up to ensure success, including:

- Following an integrated evaluation approach as described above
- Account manager and customer service training
- Establishing requirements for supporting documentation, analysis methods, and reporting requirements on technical studies
- Completing all program procedures from marketing through verification and payment and conducting a dry-run prior to launch
- Preparing for stronger or weaker than expected participant response

4.3.5 Community Energy Savers Program (New Program)

Objective
The program will collaborate with local community leaders to leverage increased EE/PDR program participation of stakeholders within a given community. Both Consumer and Business sectors will benefit from projects that produce long-term electric energy savings. The program may promote increased participation in Appliance Recycling, Community Assistance, Efficient Products, In-Home Retrofit, Intelligent Home Energy Assistance, Efficient Products for Business, Microbusiness, Express and Process Efficiency programs and measures.
Target Market
The target market consists of local governments including but not limited to cities, counties, townships, and villages.
Program Duration
The Community Energy Savers Program will be an ongoing component of the AEP Ohio EE/PDR Plan.
Program Description
Working with government officials such as city managers, mayors, council members, council presidents, commissioners and trustees, AEP Ohio and the community will identify and collaborate with local stakeholders, representatives and influencers to promote existing energy efficiency and peak demand reduction (EE/PDR) programs. The community goal will be to expand participation in these programs for the benefit of residents and businesses that may not otherwise be aware of their eligibility. AEP

Ohio and the community work together to define the community jurisdiction, determine the historical baseline for program participation, establish participation goals, identify meaningful community projects, develop outreach strategies, engage community members, promote programs, measure progress, recognize and celebrate achievement.

Incentive Strategy

Communities may be eligible to receive cash or services as awards upon reaching mutually agreed upon levels of achievement, e.g. 50%, 100%, etc. The Community Energy Saver Program will not affect customer eligibility for measure incentives as specified in other existing EE/PDR programs.

Eligible Measures

The program will collaborate with communities to choose measures from the existing portfolio of EE/PDR for historical baselines, promotion and participation counts. Eligible measures may also include behavioral savings measures attributable to community engagement and influence.

Implementation Strategy

An implementation contractor will oversee the development and delivery of the Community Energy Savers program. The main focus of the implementation strategy is designed to support the partnership between AEP Ohio and the participating communities through organizing and facilitating meetings, documenting implementation plans and action items, analyzing and tracking community baseline and progress towards goal, providing marketing and website services and other technical support.

Marketing Strategy

The marketing strategy is to increase awareness and encourage participation by consumers and businesses through the existing communication channels afforded by the local community. Examples include promotion through a local government's social media (Facebook, Twitter); inserts and messages on local water bills; letters, emails and personal outreach from government officials; access to speak and promote programs at local community events; introductions to multi-family property managers and owners and more.

Milestones

Tasks	Timeframe
Program Implementation Contractor selected	3 months
Program materials developed	4 months
Program launch – marketing begins	5 months

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Administrative	$0.5	$0.5	$0.5	$1.5

EM&V Strategy

All evaluation activities will be conducted by AEP Ohio's evaluation contractor. An integrated evaluation approach will be taken that includes the following components:

- Addressing evaluation needs at the onset of program design and collecting evaluation data as part of program administration.
- Assessing and documenting baseline conditions.
- Establishing tracking metrics.
- Conducting primary and secondary research as part of the impact and process evaluations.

The overall goal of the impact evaluation will be to validate/calibrate savings values and determine program cost-effectiveness. The participant and nonparticipant surveys will also address program awareness, barriers to participation, participant satisfaction, and process efficiency. These surveys will be enhanced by collecting market data and assessing trends as well as interviews with program staff, the implementation contractor, collaborating program administrators, and participating manufacturers.

The process evaluation will be conducted during the first program year and then coordinated with follow-up impact evaluation work to be performed once program-approved measures have been installed and operating for a sufficient time to enable a robust impact evaluation.

AEP Ohio Administrative Requirements

Initial program administration will be conducted by AEP Ohio EE/PDR personnel. To develop and manage the third-party implementation, it is estimated that 0.5 FTE equivalent will be required for program oversight. Key oversight functions include:

- Recruitment, selection, and management of the implementation contractor(s)
- Community recruitment and engagement
- Coordination of community implementation plans and their respective marketing strategy/public relations and education/training activities
- Coordination with EE/PDR program coordinators and implementers

- Data warehousing
- Management of the evaluation contractor
- Goal achievement within budget

AEP Ohio and its implementation contractor will follow industry best practices during final program design and start-up to ensure success, including:

- Following an integrated evaluation approach as described above
- Community member training and education
- Coordinated public relations/media creation and approvals
- Establishing requirements for supporting documentation, analysis methods, and reporting requirements on technical studies
- Completing all program procedures from marketing through verification and payment and conducting a dry-run prior to launch
- Preparing for stronger or weaker than expected participant response

4.3.6 gridSMART® Enabled EE/PDR Savings (Ongoing Program)

Objective

The gridSMART project is funded under a separate rider and no cost recovery is proposed under the EE/PDR rider. The project is listed here to note that peak demand reduction and energy efficiency savings results from this effort will be reported toward AEP Ohio's EE/PDR achievements.

Program Description

The current programs that could produce reportable savings include programs designed to reduce the growing demand for electricity, especially at times when demand is high:

- **Energy Portal.** Programs designed to produce energy and demand savings through greater access to energy information
- **Home Energy Report.** An option was filed for Phase 2 AMI-Smart Meter Deployment.

Enhancements/Adjustments

AEP Ohio has filed a plan to broaden the company's gridSMART program with Advanced Metering Infrastructure (AMI) and Distribution Automation Circuit Reconfiguration (DACR) expansion. gridSMART Phase 2 installations are planned to begin shortly after approval of the Plan by the Public Utilities Commission of Ohio.

- AMI deployment in more than 31 communities
- Volt Var Optimization on 160 circuits
- DACR on approximately 250 distribution circuits serving more than 300,000

customers.

- Home Energy Reports
  - Savings from gridSMART Phase 1 web portal and reports
  - Savings from gridSMART Phase 2 web portal
- Demand Response Consumer Programs may be introduced

4.3.7 Transmission and Distribution (T&D) Loss Reduction Projects (Ongoing Program, previously 'T&D and Internal Efficiency Improvements')

Objective

AEP Ohio T&D Loss Reduction Projects are funded through FERC and PUCO approved rates and no cost recovery is proposed under the EE/PDR rider in this Plan. This program captures loss reductions from projects AEP Ohio undertakes to improve the efficiency of its transmission and distribution facilities. These loss reductions will be reported in the annual Plan Status Report.

Program Description

The operation of a T&D power system includes a loss of the portion of the power being transmitted due to the electrical resistance of the power system elements (conductors, transformers and regulators). The transmission of power at different voltage levels throughout the power system yields different losses during the delivery of Power. The farther the delivery through the system from the generation point, the greater the loss component associated with the transfer through the voltage transformations.

There are various system improvements that, if made, will reduce the T&D losses, including:

- Re-conductoring of lines, substation improvements and the replacement of regulators.
- Re-conductoring projects involve the replacement of existing wires with larger wires and wires designed for lower losses at transmission and distribution voltages. Re-conductoring projects reduce line losses by lowering the resistance of the system through which energy is provided, such that the power lost during transmission is lowered.

Substation projects typically include connecting previously unconnected T&D lines, and/or the addition or upgrade of transformers and circuits in new or existing locations. These projects can improve efficiency and reduce line losses by providing additional transformation points closer to customers' loads. As a result, a greater portion of the energy is transmitted in the lower resistance transmission lines instead of the higher resistance distribution lines.

Savings Targets				
Incremental Annual Savings - at Meter				
	2017	**2018**	**2019**	**2019 Cumulative Annual**
Energy (MWh)	20,000	20,000	20,000	60,000
Summer Peak Demand (kW)	5,000	5,000	5,000	15,000

4.3.8 Education and Training

Objective

To raise awareness about the benefits of energy efficiency, to promote adoption of energy efficient behaviors and technologies, and to continue to build demand for AEP Ohio EE/PDR programs.

Target Market

The Education and Training Program is targeted to customers, customer groups, contractors, trade associations, civic associations and AEP Ohio employees.

Program Description

This program will continue to coordinate AEP Ohio's efforts to provide education, training and direct outreach for customers, customer groups, contractors, trade associations, civic associations and employees. Activities and materials will be tailored to specific audiences: facilities managers, building operators, financial decision makers, builders, contractors, trade associations, civic organizations, workforce development practitioners and students, and AEP Ohio employees whose work brings them in contact with customers.

Education and training participants will be surveyed for feedback on relevance, quality and satisfaction with activities. Pre- and post-learning will be evaluated. Customer Services employees will be surveyed annually in order to help direct training and development focus. Third-party implementers may be selected via competitive bids to assist with education and training activities. Audiences for training and education activities include:

- **Commercial & Industrial (C&I) Customers:** Customer education events will continue to be offered via webinar and face-to-face seminars at multiple sites throughout the service area as needed to permit customers to participate while minimizing travel. Seminars will continue to feature subject-matter experts, trade allies, and hands-on demonstrations of high efficiency technologies eligible for C&I programs.

  Content and outreach will be designed to increase participation by key decision makers, plant managers, finance managers, treasurers, energy managers and sustainability coordinators. Technical, in-depth training will be offered for building operators, facilities managers, designers, engineers and others whose day-to-day practices influence energy use. Ongoing customer education

programs will be marketed to appropriate customer segments across the 61 counties served by AEP Ohio. Marketing may include contact by customer service account representatives, direct mail, E-mail, and/or telephone. Overall objectives will be to develop knowledgeable and informed customers and EE/PDR providers to identify energy saving opportunities and take action to achieve long-term efficiency gains.

- **AEP Ohio Customer Service Employees:** AEP Ohio C&I customers have account representatives who assist them with new service, service changes, power quality issues, billing inquiries and more. Whether power engineers or representatives with more business than engineering training; all customer service employees are expected to assist customers with EE/PDR. Accordingly, they have participated in training on every one of AEP Ohio's programs as they have launched. Customer service employee training will continue through webinars, face-to-face meetings, and E-mail to continue to build staff knowledge about EE/PDR programs, to help them identify customers' energy efficiency opportunities, and to assist customers in applying for, monitoring and re-investing incentives in ongoing energy efficiency practices and equipment. Training will cover programs, technologies, decision-making support, financing and the benefits of energy efficiency to customers, their communities and AEP Ohio. The 2017-2019 Plan will focus on more efficient delivery through the development of more on-line, on-demand education and training resources. Objectives for training will be to raise awareness of the benefits of energy efficiency and to increase customer participation in AEP Ohio programs.
- **AEP Ohio Customer-Facing Employees:** Meter readers, line crews, field technicians, and community affairs representatives are among the many AEP Ohio employees who interact with customers daily - though they are not identified strictly as "customer service" employees. To date, many of these customer-facing employees, or their supervisors, have participated in briefings about AEP Ohio's EE/PDR programs. All have received printed materials for them to share with customers when opportunity and safety permit. Education activities will continue to help customer-facing employees understand the benefits energy efficiency can bring to communities, customers and AEP Ohio, to increase their awareness and understanding of programs to help business and residential customers save energy and money, and to encourage them to share information about these programs with the customers they encounter and with others in their communities.

Trade Associations, Civic and Other External organizations: AEP Ohio will expand outreach activities tailored for trade associations, civic and other external organizations whose members may be customers, and/or may provide services to customers. These activities will be coordinated with, and marketed through customer service employees, third-party implementers, direct mail, E-mail, and/or telephone.

This outreach effort will develop targeted presentations, recruit and train presenters, and deliver presentations to help trade associations' members understand the benefits energy efficiency brings to customers and to their members, to raise awareness of AEP Ohio programs, to help them participate in these programs as contractors and/or as customers, and to help them provide feedback to AEP Ohio.

Implementation Strategy

Education and training participants will be surveyed for feedback on relevance, quality and satisfaction with activities. Pre and post-learning will be evaluated. Customer Services employees will be surveyed annually with results compared to survey baseline. Third-party implementers may be selected via competitive bids to assist with education and training activities.

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Administrative	$0.4	$0.4	$0.4	$1.2

4.3.9 Targeted Advertising

Objective

The Targeted Advertising program builds customer awareness and program participation in energy efficiency in support of AEP Ohio EE/PDR programs and also encourages market transformation in support of AEP Ohio's commitment and key goals of this Plan.

Target Market

This program will target the mass market, both residential and commercial stakeholders.

Program Duration

The Targeted Advertising Program will be an ongoing component of the AEP Ohio EE/PDR Plan.

Program Description

Media outreach and advertising primarily is for the mass market, but outreach will also target small commercial and industrial customers. The program is designed to increase customer awareness and adoption of EE/PDR programs; as well as bringing AEP Ohio's commitment to energy efficiency to its customers.

There are several barriers to the adoption of energy efficiency. In some cases, it is simple lack of customer awareness or customers' misperception. In other cases, it is a lack of contractor awareness or support to make efficiency a realistic decision choice for customers. For other cases, many technology choices are made spur of the moment or in a fail-and-replace scenario, where the person or contractor contacted may or may not be aware of the available programs to influence the efficient decision. In all cases, these programs should further AEP Ohio's commitment to efficiency and bridge the Plan program goals and the consumer lack of adoption.

The Targeted Advertising program will focus on improving customer awareness and adoption of EE/PDR programs specifically, as well as encourage market transformation and adoption of energy efficiency in general through the following activities:

- Market research and market segmentation for target marketing
- Emphasis on customer satisfaction
- Advertising development
- Advertising campaigns
- Co-Op Advertising with Solution Providers and Program Implementation vendors
- Program promotional materials and displays
- Event marketing and outreach campaigns
- Increased social and mobile device media efforts
- Customer testimonials
- More emphasis on customer touch points and cross selling and promotion
- Customer surveys to identify market transformation opportunities and impacts

Adjustments and Enhancements

AEP Ohio modifications to Targeted Advertising will increase customer awareness and participation in AEP Ohio programs and increase cost effective energy savings. Outreach will be customized to strengthen relevance and increase program participation in some targeted hard to reach customer groups.

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	2018	2019	Total 2017-2019
Administrative	$6.0	$6.0	$6.0	$18.0

4.3.10 Research and Development

Objective

Identify and test new and innovative technologies, program concepts, and implementation methods that deliver contemporary solutions meeting customer needs and overcoming implementation barriers.

- Provide support to the implementation team for testing and making mid-stream adjustments to the current Plan as needed.
- Prepare for the new and modified cost effective programs needed to achieve EE/PDR targets in future plans.
- Support market transformation.

Description

AEP Ohio believes that a systematic research and development (R&D) process to test new and innovative technologies, program concepts, implementation methods and marketing techniques is critical to finding opportunities to drive down EE/PDR Plan costs, increase customer opportunities for participation and satisfaction with the programs. AEP Ohio will manage that R&D capacity and function with the flexibility and analytical rigor to assess changes in the market and alternative approaches to energy efficiency delivery for inclusion in the Plan.

AEP Ohio proposes that any kWh savings realized from R&D pilot activities count towards the annual kWh goal. AEP Ohio also intends to work with the Collaborative on the new concepts for consideration.

Given the ongoing rapid pace of change, AEP Ohio does not attempt to identify every project that could potentially be funded over the course of the Plan. Instead, AEP Ohio intends to continually monitor the energy efficiency space and identify opportunities when they arrive in partnership with the Collaborative.

Implementation Strategy

For this Plan, AEP Ohio intends to continue the screening process that identifies opportunities, ranks them, pilots the most promising, evaluates them for kWh savings and cost-effectiveness, and recommends appropriateness for Plan inclusion and

application to the annual kWh goal.

- **Scan & Screen Options:** This initial screen involves reviewing other utility programs, contacting various associations and communicating with key stakeholders to determine suitability, and expected savings. Next, the remaining technologies/programs are assessed for market opportunity, estimated costs, risks and barriers, proposed pilot strategies, targeted customers, and non-energy benefits (e.g., improved performance, water efficiency) to identify the most promising options for further development.
- **Define Pilots:** In this step, AEP Ohio completes a work plan including target market identification, measurement and verification plan, budget, timeline and launches a pilot implementation strategy.
- **Evaluate Results:** AEP Ohio evaluates the pilot results to determine the kWh savings, cost-effectiveness and whether the emerging technology or program strategy tested is suitable for inclusion in AEP Ohio's Plan.
- **Transfer to Programs:** AEP Ohio determines whether or not the technology or strategy should be incorporated into the Plan, whether as a new measure within an existing program or as an entirely new program, the determination of incentive levels and articulation of the value proposition.

Planned R&D Programs

AEP Ohio is considering R&D and pilot programs for the following technologies and/or programs:

Energy Benchmarking for Capturing Savings. AEP Ohio will provide the technical platform and the customer services support to help customers establish a monthly automatic upload of their electricity usage data to ENERGY STAR® Portfolio Manager to help them make informed electrical energy decisions and implement strategies to capture energy savings. Portfolio Manager is an interactive, online energy management tool developed by the U.S. Environmental Protection Agency that allows building owners and managers to track and assess energy and water consumption within individual buildings as well as across an entire portfolio of buildings in a secure online environment. Portfolio Manager can help set investment priorities, identify under-performing buildings, verify efficiency improvements and receive EPA recognition for superior energy performance.

Benchmarking will help non-residential customers set priorities for the facilities where energy audits will further identify economically viable improvements to yield annual energy savings by participating in the AEP Ohio Business incentives program.

The following planned programs require additional R&D prior to full scale launch:

- **Commercial and Residential New Construction Code Support.** AEP Ohio will research opportunities for attributing savings as well as various

program approaches to overcome the barriers to the effective implementation of improved commercial and residential building energy codes to capture all the energy savings available. AEP Ohio will consider approaches including but not limited to measuring energy code compliance, providing training and technical support to improve compliance and capture the energy savings available from the code, providing funding and/or other resources to better equip local code agencies to enforce and improve energy code compliance over time, and promoting market awareness of the value of compliant construction.

- **Energy and Sustainability**. AEP Ohio will research interest in collaboration with local governments and associations, such as the Mid-Ohio Regional Planning Commission, to examine ways to increase participation in energy efficiency programs such as Community Energy Savers through the combining of various stakeholder efforts, including benchmarking, transportation, financing or other areas.
- **Remodeling.** Energy codes for residential and non-residential construction apply when certain thresholds such as change in use, percentage of affected area are exceeded. Code compliance practitioners generally agree that substantial energy savings may be gained by improving remodelers' understanding of the energy code, when it applies, and how to comply. This pilot will assess the potential for savings, identify the activities with greatest likelihood for improving compliance, and test those with the estimated greatest cost-effectiveness. Benefits will include increased awareness by remodelers and the opportunity to promote installation of energy efficient lighting, appliances, and HVAC equipment and controls at the time that residential and commercial property owners are making investment decisions.
- **Water/Energy Nexus.** AEP Ohio will research the direct energy savings and combined financial savings of including water savings in overall program efforts. Any measurement of the energy and demand savings from water savings will be included if the research supports it and programs will be adjusted to include the marketing of water savings opportunities for customers.

Additional Research Under Consideration

New technologies enter the market every year. As a result, energy efficiency options are likely to be different from those being promoted today. AEP Ohio believes continuing to screen and research new technologies and program concepts will aid in developing future program plans.

Budget

The following budget has been used for planning purposes. However, AEP Ohio may adjust program budgets as necessary in accordance with current market conditions, EM&V results, and program implementation experience.

Incremental Annual Budget (Millions)				
	2017	**2018**	**2019**	**Total 2017-2019**
Administrative	$2.5	$2.5	$2.5	$7.5

5 GLOSSARY OF TERMS

Achievable Potential: the amount of energy use that efficiency can realistically be expected to displace assuming the most aggressive program scenario possible (such as providing end-users with payments for the entire incremental cost of more efficient equipment). This is often referred to as maximum achievable potential. Achievable potential takes into account real-world barriers to convincing end-users to adopt efficiency measures, the non-measure costs of delivering programs (for administration, marketing, tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time.

Applicability Factor: the fraction of the applicable dwelling units that are technically feasible for conversion to the efficient technology from an **engineering** perspective (e.g., it may not be possible to install CFL bulbs in all light sockets in a home because the CFL bulbs may not fit in every socket in a home).

Base Case Equipment End Use Intensity: the electricity used per customer per year by each base-case technology in each market segment. This is the consumption of the electric energy using equipment that the efficient technology replaces or affects. For example purposes only, if the efficient measure were a high efficiency lamp (CFL), the base end use intensity would be the annual kWh use per bulb per household associated with an incandescent light bulb that provides equivalent lumens to the CFL.

Base Case Factor: the fraction of the end use electric energy that is applicable for the efficient technology in a given market segment. For example, for residential lighting, this would be the fraction of all residential electric customers that have electric lighting in their household.

Coincidence Factor: the fraction of connected load expected to be “on” and using electricity coincident with the system peak period.

Cost-Effectiveness: a measure of the relevant economic effects resulting from the implementation of an energy efficiency measure. If the benefits outweigh the cost, the measure is said to be cost-effective.

Cumulative Annual: refers to the overall savings occurring in a given year from both new participants and savings continuing to result from past participation with measures that are still in place. Cumulative annual does not always equal the sum of all prior year incremental values as some measures have relatively short measure lives and, as a result, their savings drop off over time.

Demand Response: the ability to provide peak load capacity through demand management (load control) programs. This methodology focuses on curtailment of loads during peak demand times thus avoiding the requirement to find new sources of generation capacity.

Dispatchable: refers to generation technologies such as coal, natural gas, nuclear, geothermal and biomass whose output can be varied to follow demand. For non-dispatchable technologies such as wind, solar and hydro, operation is tied to the availability of an intermittent resource.

Early Replacement: refers to an efficiency measure or efficiency program that seeks to encourage the replacement of functional equipment before the end of its operating life with higher-efficiency units

Economic Potential: the subset of the technical potential screen that is economically cost-effective as compared to conventional supply-side energy resources. Both technical and economic potential screens are theoretical numbers that assume immediate implementation of efficiency measures, with no regard for the gradual "ramping up" process of real-life programs. In addition, they ignore market barriers to ensuring actual implementation of efficiency. Finally, they only consider the costs of efficiency measures themselves, ignoring any programmatic costs (such as marketing, analysis, administration) that would be necessary to capture them.

Effective Useful Life (EUL): the number of years (or hours) that the new energy efficient equipment is expected to function. Useful life is also commonly referred to as "measure life."

End-Use: a category of equipment or service that consumes energy (e.g., lighting, refrigeration, cooling, mechanical ventilation, heating, process heat, pumping, conveyance, compressed air).

Energy Efficiency: the practice of using less energy to provide the same or an improved level of output or service to the energy user. Sometimes "conservation" is used as a synonym, but that term is usually taken to mean using less of a resource even if this results in a lower service level (e.g., setting a thermostat lower or reducing lighting levels). This definition recognizes that energy efficiency includes using less energy at any time, including at times of peak demand through demand response and peak shaving efforts.

***Ex Ante*:** refers to the "claimed" savings values reported by an implementer or administrator *and often referred to in "deemed savings" or engineering calculations to estimate savings*.

***Ex Post*:** refers to the "evaluated" or "verified" savings values reported by an independent, third-party evaluator after the subject energy efficiency activities have been implemented and an impact evaluation has been completed.

Free Drivers: the individuals or businesses that adopt an energy efficient product or service because of an EE/PDR program, but are difficult to identify either because they do not receive an incentive or are not aware of exposure to the program.

Free Riders: the participants in an EE/PDR program who would have adopted an EE/PDR technology or improvement in the absence of a program or financial incentive.

Incremental: refers to savings or costs in a given year associated only with new installations happening in that year.

Impact Evaluation: the estimation of effects from the implementation of one or more EE/PDR programs. Most program impact projections contain ex-ante estimates of energy savings and demand reductions expected from program implementation efforts often used for program planning and contracting purposes and for setting program funding priorities. In contrast, the impact evaluation focuses on identifying and estimating the amount of energy and demand the program actually provides.

Integrated Data Collection (IDC): an approach in which surveys of key market actors and end-use customers (EUCs) are conducted in "real time" as close to the key intervention points as possible; usually integrated as part of the standard program implementation or other program paperwork process.

Lost-opportunity: refers to an efficiency measure or efficiency program that seeks to encourage the selection of higher-efficiency equipment or building practices than would typically be chosen at the time of a purchase or design decision.

Market Characterization: refers to evaluations focused on the evaluation of program-induced market effects when the program being evaluated has a goal of making longer-term lasting changes in the way a market operates. These evaluations examine changes within a market that are caused, at least in part, by the EE/PDR programs attempting to change that market.

Market Transformation: an approach in which a program attempts to influence "upstream" service and equipment provider market channels and what they offer end customers, along with educating and informing end customers directly. The emphasis is on influencing market channels and key market actors other than end customers.

Measure: any action taken to increase efficiency, whether through changes in construction, equipment, control strategies, or behavior. Examples are above-code buildings, higher-efficiency central air conditioners, occupancy sensor control of lighting,

and retro-commissioning. In some cases, bundles of technologies or practices may be modeled as single measures. For example, an ENERGY STAR™ home package may be treated as a single measure.

Megawatt (MW): a unit of electrical output, equal to one million watts or one thousand kilowatts. It is typically used to refer to the output of a power plant.

Megawatt-hour (MWh): one thousand kilowatt-hours, or one million watt-hours. One MWh is equal to the use of 1,000,000 watts of power in one hour.

Net-to-Gross (NTG) Ratio: a factor representing net program savings divided by gross program savings that is applied to gross program impacts to convert them into net program load impacts

Plan: either a collection of similar programs addressing the same market, technology, or mechanisms; or the set of all programs conducted by one organization.

Process Evaluation: a systematic assessment of an EE/PDR program for the purposes of documenting program operations at the time of the examination and identifying improvements that can be made to increase the program's efficiency or effectiveness for acquiring energy resources.

Program: a mechanism for encouraging EE/PDR. May be funded by a variety of sources and pursued by a wide range of approaches. Typically includes multiple measures.

Program Potential: the efficiency potential possible given specific program funding levels and designs. Often, program potential studies are referred to as "achievable" in contrast to "maximum achievable."

Remaining Factor: the fraction of applicable units that have not yet been converted to the electric EE/PDR measure; that is, one minus the fraction of units that already have the EE/PDR measure installed.

Replace on Burnout (ROB): an EE/PDR measure that is not implemented until the existing technology it is replacing fails. An example would be an energy efficient water heater being purchased after the failure of the existing water heater.

Resource Acquisition: an approach in which end customers are the primary target of program offerings (e.g., using rebates to influence customers' purchases of end use equipment).

Retrofit: refers to an efficiency measure or efficiency program that seeks to encourage the replacement of functional equipment before the end of its operating life with

higher-efficiency units (also called “early retirement”) or the installation of additional controls, equipment, or materials in existing facilities for purposes of reducing energy consumption (e.g., increased insulation, low flow devices, lighting occupancy controls, economizer ventilation systems).

Savings Factor: the percentage reduction in electricity consumption resulting from application of the efficient technology used in the formulas for technical potential screens.

Technical Potential: the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency measures. It is often estimated as a “snapshot” in time assuming immediate implementation of all technologically feasible energy saving measures, with additional efficiency opportunities assumed as they arise from activities such as new construction.

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VOLUME 2: APPENDICES

2017 TO 2019

ENERGY EFFICIENCY / PEAK DEMAND REDUCTION (EE / PDR) ACTION PLAN

APPENDIX A: EE / PDR POTENTIAL STUDY

APPENDIX B: EE / PDR BENCHMARKING

APPENDIX C: EE / PDR MEASURES

APPENDIX D: ELRAM MODEL METHODOLOGY

June 15, 2016

Table of Contents

A. INTRODUCTION A-1
A.1 EE/PDR Measure Characterizations A-2
A.1.1 EE/PDR Measure List A-2
A.1.2 Energy Savings Estimates A-4
A.2 Baseline Market Profiles A-4
A.3 EE/PDR MEASURE Cost-Effectiveness Analysis A-14
A.3.1 Model Inputs A-14
A.3.2 Cost-Effectiveness Results A-17
A.4 EE/PDR Potential Results A-46
A.4.1 Overall EE/PDR Potential Results A-46
A.4.2 Commercial and Industrial EE/PDR Potential Results A-61

B. Benchmarking EE/PDR Programs B-71
B.1 EE/PDR Benchmarking Results B-71
B.2 Benchmarking Presentation B-72

C. EE/PDR Measure Descriptions and Characterizations C-88
C.1 Overview C-88
C.2 Residential Measure Characterizations C-89
C.2.1 Residential Water Heating Measures C-90
C.2.2 Residential HVAC & Shell Measures C-91
C.2.3 Residential Appliance and Additional Measures C-93
C.3 Residential Measure Characteristics by Program C-97
C.4 Non-Residential DSM Measure Characterizations C-106
C.4.1 Sources Used for the Analysis C-106
C.4.2 Measure Characterization Overview C-107
C.4.3 Lighting Measures – Non-Residential C-107
C.4.4 Non-Residential Motors and Other C-110
C.4.5 Non-Residential Food Service Measures C-110
C.4.6 Non-Residential HVAC Measures C-111

C.4.7 Refrigeration and Custom Non-Residential Measures C-114
C.4.8 Non-Residential Agriculture Sector Measures C-117
C.5 Commercial and Industrial Measure Characteristics by Program C-119
C.6 Cross-Sector Measure Characteristics C-147

D. ELRAM Model Methodology D-D-154

Table of Tables

Table 1. AEP-Ohio Market Profile – Electricity (2015) A-6
Table 2. Domestic Water Heater Fuel Type A-7
Table 3. Domestic Water Heater Size Distribution A-7
Table 4. Residential Lighting Lamp Distribution A-9
Table 5. Non-Seasonal End Use Estimates A-9
Table 6. Residential Appliance Estimates A-9
Table 7. Primary Cooling Type Distribution A-10
Table 8 Primary Heating Type Distribution A-11
Table 9. Residential Technology Shares A-12
Table 10. 2014 EE/PDR Benchmarking Data A-14
Table 11. Summary of Program Benefit-Cost Test Results – 2017 to 2019 ..... A-15
Table 12. Cost-Effectiveness Tests A-18
Table 13. Residential Measures Not Included – 2017 to 2019 ..... A-19
Table 14. Residential Cost-Effectiveness Ratios – 2017 to 2019, Lighting A-20
Table 15. Residential Cost-Effectiveness Ratios – 2017 to 2019, Appliances A-21
Table 16. Residential Cost-Effectiveness Ratios – 2017 to 2019, Hot Water A-22
Table 17. Residential Cost-Effectiveness Ratios – 2017 to 2019, HVAC & Shell A-23
Table 18 Residential Cost-Effectiveness Ratios – 2017 to 2019, Package A-25
Table 19. Commercial Cost-Effectiveness Ratios – 2017 to 2019, Lighting A-26
Table 20. Commercial Cost-Effectiveness Results – 2017 to 2019, Other A-28
Table 21. Commercial Cost-Effectiveness Results – 2017 to 2019, HVAC & Shell A-29
Table 22. Commercial Cost-Effectiveness Results – 2017 to 2019, Refrigeration A-33
Table 23. Commercial Cost-Effectiveness Results – 2017 to 2019, Process A-35
Table 24. Commercial Cost-Effectiveness Results – 2017 to 2019, Motors A-36
Table 25. Industrial Measures Included and Cost-Effectiveness Results – 2017-2019 A-36
Table 26. Commercial Prescriptive Measures Not Included A-39
Table 27. Industrial Measures Not Included A-42
Table 28. Multifamily Measures Included and Cost Test Results, 2017-2019 ..... A-42
Table 29. Agriculture Measures Included and Cost Test Results, 2017-2019 ..... A-44

Table 30. Cross-Sector Measures Not Included A-45

Table 31. Projected Cumulative Annual Savings at Meter and Costs – 2036 .....A-49

Table 32. Residential Market Potential Scenario: 2017 – 2036 Cumulative Annual Savings at Meter A-53

Table 33. Residential Market Potential Scenario: 2017 – 2036 Incremental Annual Savings at Meter A-53

Table 34. Residential Market Potential Scenario: 2017 – 2036 Incremental Costs A-54

Table 35. Residential Technical Potential Scenario: 2017 – 2036 Savings at Meter ...A-55

Table 36. Residential Economic Potential Scenario: 2017 – 2036 Savings at Meter ...A-55

Table 37. Market Potential Scenario: 2017 – 2036 Commercial and Industrial Cumulative Annual Savings at Meter A-62

Table 38. Market Potential Scenario: 2017 – 2036 Commercial and Industrial Incremental Annual Savings at Meter A-63

Table 39. Market Potential Scenario: 2017 – 2036 Commercial and Industrial Incremental Costs A-64

Table 40. Commercial & Industrial Technical Potential Scenario: 2017 – 2036 Savings at Meter A-65

Table 41. Commercial & Industrial Economic Potential Scenario: 2017 – 2036 Savings at Meter A-65

Table 42. 2012 EE/PDR Benchmarking Data B-71

Table 43. Residential Measure Characteristics (at meter savings) C-97

Table 44. Commercial and Industrial Measure Characteristics (at meter savings) ...C-119

Table 45. Cross-Sector Measure Characteristics C-147

Table of Figures

Figure 1. AEP-Ohio Market Profile – Electricity (2015)..... A-6

Figure 2. Nonresidential Energy Consumption – 2013.....A-13

Figure 3. Cumulative Annual GWh Energy Savings in 2036 .....A-50

Figure 4. Cumulative Annual Summer Peak MW Demand Savings in 2036 .....A-50

Figure 5. Market Potential Annual Energy Savings at Meter as Percent of Economic Potential in 2036.....A-51

Figure 6. Peak Demand Savings at Meter as Percent of Economic Potential in 2036 .A-51

Figure 7. Residential Cumulative Annual Market Potential Energy Savings at Meter – 2017 by End Use (GWh).....A-56

Figure 8. Residential Market Potential Cumulative Annual Summer Peak Demand Savings at Meter – 2017 by End Use (MW).....A-56

Figure 9. Residential Market Potential Cumulative Annual Energy Savings at Meter – 2036 by End Use (GWh).....A-57

Figure 10. Residential Market Potential Cumulative Annual Summer Peak Demand Savings at Meter – 2036 by End Use (MW).....A-57

Figure 11. Residential Cumulative Annual Market and Economic Potential Energy Savings at Meter – 2036 by End Use A-58

Figure 12. Residential Cumulative Annual Market and Economic Potential Summer Peak Demand Savings at Meter – 2036 by End Use.....A-58

Figure 13. Residential Technical and Economic Potential Energy Savings at Meter – 2036 by End Use.....A-59

Figure 14. Residential Technical and Economic Potential Summer Peak Demand Savings at Meter – 2036 by End Use A-59

Figure 15. Residential Economic Potential Energy Savings at Meter – 2036 by End Use (GWh).....A-60

Figure 16. Residential Economic Potential Summer Peak Demand Savings at Meter – 2036 by End Use (MW) A-60

Figure 17. Commercial and Industrial Cumulative Annual Market Potential Energy Savings by End Use 2017 (GWh).....A-66

Figure 18. Commercial and Industrial Cumulative Annual Market Potential Summer Peak Demand Savings by End Use 2019 (MW).....A-66

Figure 19. Commercial and Industrial Cumulative Annual Market Potential Energy Savings at Meter by End Use 2036 (GWh) A-67

Figure 20. Commercial and Industrial Cumulative Annual Market Potential Summer Peak Demand Savings at Meter by End Use 2036 (MW).....A-67

Figure 21. Commercial and Industrial Cumulative Annual Market and Economic Potential Energy Savings at Meter – 2036 by End Use.....A-68

Figure 22. Commercial and Industrial Cumulative Annual Market and Economic Potential Summer Peak Demand Savings at Meter – 2036 by End Use A-68

Figure 23. Commercial and Industrial Technical and Economic Potential Energy Savings at Meter – 2036 by End Use A-69

Figure 24. Commercial and Industrial Technical and Economic Potential Summer Peak Demand Savings at Meter – 2036 by End Use.....A-69

Figure 25. Commercial and Industrial Economic Potential Annual Energy Savings at Meter by End Use 2036 (GWh) A-70

Figure 26. Commercial and Industrial Economic Potential Annual Summer Peak Demand Savings at Meter by End Use 2036 (MW).....A-70

A. INTRODUCTION

Pursuant to the requirements in 2008 Senate Bill (SB) 310, AEP Ohio developed an EE/PDR Action Plan for calendar years 2017 to 2019. This appendix describes the inputs and tasks involved in developing the potential estimates for the Plan.

Study Goals and Approach

The overall goals of the EE/PDR potential study are the following:

- Assess the technical, economic, and achievable potential for the residential, commercial, and industrial sectors.
- Develop high-level EE/PDR program plans.

AEP Ohio undertook the EE/PDR potential study in the following key tasks:

- Develop baseline consumption profiles.
- Characterize the EE/PDR measures.
- Conduct an EE benchmarking analysis.
- Conduct benefit-cost analysis.
- Estimate EE/PDR potentials.
- This EE/PDR potential study and the supporting tasks are discussed in detail in this appendix.

Appendix A 2017 to 2036 EE/PDR Potential Study Report Organization

The remainder of AEP Ohio's Appendix A 2017 to 2036 EE/PDR Potential Study is divided into the following sections:

Section 1: EE/PDR Measure Characterizations provides details on the EE/PDR measures and sources for measure statistics.

Section 2: Baseline Consumptions Profiles discusses baseline consumption profiles and initial building simulation model specifications for AEP Ohio.

Section 3: EE/PDR Measure Cost-Effectiveness Analysis presents the cost effectiveness analyses.

Section 4: EE/PDR Potential Methodology and Results presents the approach used to conduct the EE/PDR potential analysis and the results of different scenarios.

Appendices: other appendices are provided, including detailed Benchmarking results for 2014 programs (Appendix B), EE/PDR Measure Descriptions and Characterizations (Appendix C), and the ELRAM tool methodology (Appendix D).

A.1 EE/PDR Measure Characterizations

After estimating baseline consumption, characterization of EE/PDR measures requires:

- Determining the list of measures to evaluate;
- Estimating the incremental savings from each measure – improving from baseline technology to the efficient measure technology, and;
- Determining the incremental costs and lifetime for each of the new technologies.

A.1.1 EE/PDR Measure List

The first step in the EE/PDR measure characterization process is to develop appropriate sets of measures for inclusion in this study. The measures selected for analysis are based on the experience of Navigant (consultant to AEP Ohio) with a goal of balancing thoroughness in examining the broad range of available measures and timely completion of the analysis. The analyzed measures frequently pass various benefit-cost (B/C) tests in other areas, are widespread in their potential application, and garner a large portion of the overall pool of EE/PDR potential. Most energy efficiency measures that were known not to be cost-effective were pre-screened and eliminated from all potential scenarios.

Based on the measures characterized, Navigant developed estimates of energy and demand savings, costs, and expected lifetimes in the residential and non-residential sectors. Measures analyzed and high-level descriptions of the technologies are provided in Appendix C. The following four program design options are included; these design options affect savings estimates and measure costs:

- **Replacement on Burnout (ROB):** An energy efficiency measure is implemented after the existing equipment fails.

- **Retrofit:** An energy efficiency measure that can be implemented immediately. The lifetime of the base technology is not a factor as retrofit measures generally do not replace existing technologies, but rather improves the efficiency of existing technologies. The energy impact is therefore the amount of that improvement.

- **Dual Baseline (DUB):** The dual baseline measure type is an early replacement that replaces an existing technology before the end of useful life.

- **New Construction:** A measure or package of measures is installed at the time of construction.

Replace on Burnout (ROB)

The energy savings of ROB measures are measured as the incremental difference in energy use between the efficient measure and the standard or code-compliant baseline.[1] The incremental measure cost is likewise the difference between a standard code-compliant unit and the efficient measure. ROB does not typically include incremental labor cost for the delivery and installation of the replace on burnout unit since the customer would have borne those costs regardless when replacing the failed unit, unless the efficient replacement requires further modification over baseline.

Retrofit

For retrofit measures, the characterization can claim full savings between the existing inefficient equipment and the measure since the customer could have continued to use the baseline equipment as-is indefinitely. A typical example of this is adding insulation to existing homes. Similarly, the incremental measure cost is the full measure material cost plus the full labor cost of installation.

Dual Baseline (DUB)

For DUB measures, the savings is calculated using a less efficient "as found condition" baseline for the first part of the remaining useful life (RUL), and a "code condition" for the second portion of the RUL. These results in higher initial energy savings under the first baseline, and lower savings under the second baseline once the measure would have reached the end of its effective useful life (EUL). Measure costs are also adjusted to reflect the change in baselines.[2]

New Construction

New construction measures share many of the same characteristics with ROB measures because the baseline is code-compliant. If R-30 ceiling insulation is the current code, then the R-38 measure savings is only the difference between insulating with R-30 versus insulating with R-38 insulation. Using ceiling insulation as an example, the incremental cost in the efficient case is mostly material cost for thicker blankets (or

[1] For example, while an old refrigerator (1500 kWh/year) uses considerably more energy than current code-compliant refrigerators (500 kWh), a measure that replaces an old refrigerator on burn-out with an ENERGY STAR® refrigerator (425 kWh/year) will result in attributable energy savings of 75 kWh/year.

[2] See the Dual Baseline section 2.6 for more detail.

blown cellulose, etc.) and the incremental labor cost can be as low as $0, since the labor to roll out two R-19 batts is roughly the same as rolling out R-11 on top of R-19.

A.1.2 Energy Savings Estimates

A.1.2.1 Climate Dependent & Independent Measures

For both climate-dependent and climate-independent EE/PDR measures, Navigant evaluated the energy and demand savings and incremental costs using engineering calculations based on the 2015 AEP Ohio Prescriptive Measures Savings Workpapers, the 2010 Ohio Technical Reference Manual (TRM), and other secondary research. For climate dependent measures, the 2015 AEP Ohio Prescriptive Measures Savings Workpapers contain detailed savings estimates based on comprehensive, representative whole building eQuest energy models.

A.1.2.2 EE/PDR Measure Costs and Lifetimes

For EE/PDR measure costs, Navigant primarily used the 2015 AEP Ohio Prescriptive Measures Savings Workpapers which frequently reference the CA DEER database and other TRMs. Lighting measures used typical retail costs for the baseline and efficient case unit costs for most measures, and also utilized a 2012 Navigant measure cost study. Labor costs for lighting measures were determined by a combination of Navigant's 2012 measure cost study, RS Means data for standard union labor in Columbus, OH, and the 2015 AEP Ohio Prescriptive Measures Savings Workpapers. Incremental costs for non-lighting measures also utilized 2015 AEP Ohio Prescriptive Measures Savings Workpapers, and Navigant engineering estimates.

For EE/PDR measure lifetimes a combination of resources were consulted, with emphasis on the 2015 AEP Ohio Prescriptive Measures Savings Workpapers, manufacturer data, the DEER database, and other studies reviewed for this Plan. Results of the EE/PDR measure characterizations are presented in Appendix C along with measure descriptions.

A.2 Baseline Market Profiles

This section presents a brief profile of the AEP Ohio service territory, including an overview of the residential market using data from Navigant's 2013 residential baseline study and a general profile of the AEP C&I market using AEP and EIA data.

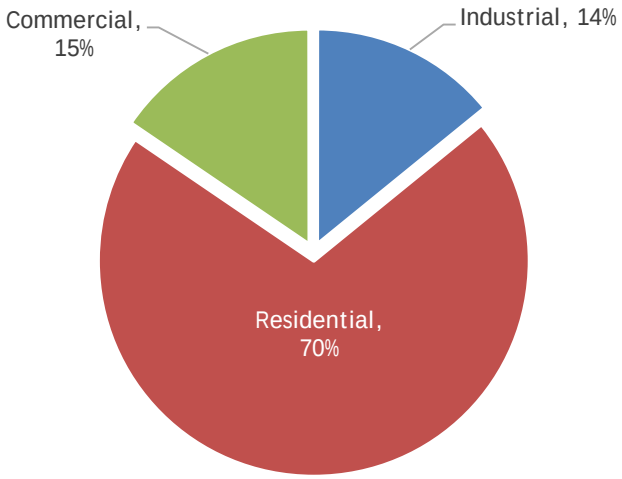
Table *1* and Figure 1 present 2015 data for AEP Ohio.

Table 1. AEP-Ohio Market Profile – Electricity (2015)

Market Sector	Sales (MWh)	Customers	Average Annual kWh per Customer
Industrial	1,916,578	9,959	192,447
Residential	9,551,582	1,276,363	7,483
Commercial	2,101,598	175,013	12,008
Total Billed	**13,569,758**	**1,464,072**	**-**

Source: U.S. Energy Information Administration, Form EIA-861, AEP 2015 fact sheet. Total customers includes 'other' customers.

Figure 1. AEP-Ohio Market Profile – Electricity (2015)



Source: U.S. Energy Information Administration, Form EIA-861, AEP 2015 fact sheet.

A.2.1.1 Residential Sector Market Profile

To estimate the potential for energy savings, it is desirable to have a snapshot of the appliance and equipment inventory in the area of study, including type of equipment and efficiency level. For the residential sector, Navigant conducted and used the results of a baseline survey study of AEP Ohio in 2012 for equipment age, saturation data, and building characteristics. Other sources, including publicly-available utility studies, statewide studies, and research papers, also have some limited information about efficiency levels where data were not available by inspection. Navigant used a variety of sources, together with our experience and judgment, to develop technology profiles for the key end uses presented below.

A.2.1.2 Residential Electricity Market Profile

The derivation of the residential electricity market profile relied on monthly consumption data and benchmark monthly profiles of end-uses to derive annual electricity

consumption for seasonal and non-seasonal uses. There are four seasonal end uses that were tabulated (heating, cooling, hot water, and lighting) in addition to the non-seasonal end uses (includes appliances, plug loads, and other).

Hot Water. As shown in Table 2**,** the residential baseline study determined that 66 percent of domestic water heating units were natural gas type, while 33 percent were electric, and 1 percent were classified as Propane or Bottled Gas.

Table 2. Domestic Water Heater Fuel Type

Primary Water Heating Fuel Type	Market Share
Natural Gas	66%
Electric	33%
Propane or Bottled gas	1%

As shown in Table 3, approximately 85 percent of water heaters are classified as either 40 or 50 gallon. Six percent of water heaters are 30 gallon units, and 9 percent of units are between 75 and 120 gallons.

Table 3. Domestic Water Heater Size Distribution

Primary Water Heating Size (Gallons)	Market Share (%)
30	6%
40	48%
50	37%
75	3%
80	3%
120	3%

Lighting. As shown in

Table 4, the average household has 62.24 lamps. Sixty percent of lamps are incandescent, 20 percent are CFL, and 8 percent are linear fluorescent. The remainder of lamps comprise of Halogen (6%), LED (2%), and Other (4%).

Table 4. Residential Lighting Lamp Distribution

Lamp Type	Market Share
Incandescent	60%
CFL	20%
Linear Fluorescent	8%
Halogen	6%
LED	2%
Other	4%
Average Bulbs per Home	62.24

Non-Seasonal End uses (Appliances, Plug Loads, Other). A summary of the non-seasonal end uses is presented in Table 5. Homes have on average 3.06 televisions. Forty percent of televisions are cathode ray tube (CRT) type. Fifty-one percent of televisions are Liquid Crystal Display (LCD) or Light Emitting Diode (LED) type. The remaining televisions are comprised of plasma type (7%) or "other" (2%). Homes have on average 1.29 DVR, DVD, or VCRs. There is an average of 1.59 computers per home. Six percent of computer monitors are CRT, while 81 percent are LCD.

Table 5. Non-Seasonal End Use Estimates

Plug Load Devices	Single Family Estimates
Televisions Per Home	3.06
% of TVs that are CRT	40%
% of TVs that are LCD/LED	51%
% of TVs that are Plasma	7%
% of TVs that are Other	2%
DVR/DVD/VCR Per Home	1.29
Computers/Laptops Per Home	1.59
% of Monitors that are CRT	6%
% of Monitors that are LCD	81%

A summary of residential appliance estimates is presented in Table 6. There is an average of 1.31 refrigerators per home. Forty-one percent of refrigerators are ENERGY STAR®. There is an average of 0.57 freezers per home. Twenty-eight percent of freezers are ENERGY STAR®.

Table 6. Residential Appliance Estimates

Plug Load Devices	Single Family

	Estimates
Number of Refrigerators Per Home	1.31
ENERGY STAR ® Refrigerators	41%
Number of Freezers Per Home	0.57
ENERGY STAR ® Freezers	28%

Heating and Cooling. A summary of primary cooling types is presented in Table 7. Seventy-four percent homes have central air conditioners as their primary cooling system. Central Heat Pumps are present in 17 percent of homes. Seven percent of homes have a primary cooling systems classified as room air conditioners. Three percent of homes do not have a cooling system.

Table 7. Primary Cooling Type Distribution

Primary Cooling Type	Market Share
Central Air Conditioners	74%
Central Heat Pump	17%
Room Air Conditioning	7%
No Cooling	3%

A summary of primary heating type distributions is shown .

Table 8. Eighty-five percent of homes have a central furnace as the primary heating system. Central heat pumps are the primary heating system in 11 percent of homes. Two percent of homes use a boiler, steam, or hot water system as their primary heating system. The remainder of primary heating systems are distributed among "other" (e.g. water heater as space heat), built-in electric room units (e.g. baseboard heating), and wall or floor furnaces.

Table 8 Primary Heating Type Distribution

Primary Heating Type	Market Share
Central Furnace	85%
Central Heat Pump	11%
Boiler/Steam/Hot Water	2%
Other - Water Heater as Space Heat	1%
Built-in Electric Room Units (e.g. baseboard)	1%
Wall or Floor Furnace	1%

Residential Technology Shares is shown in Table 9.

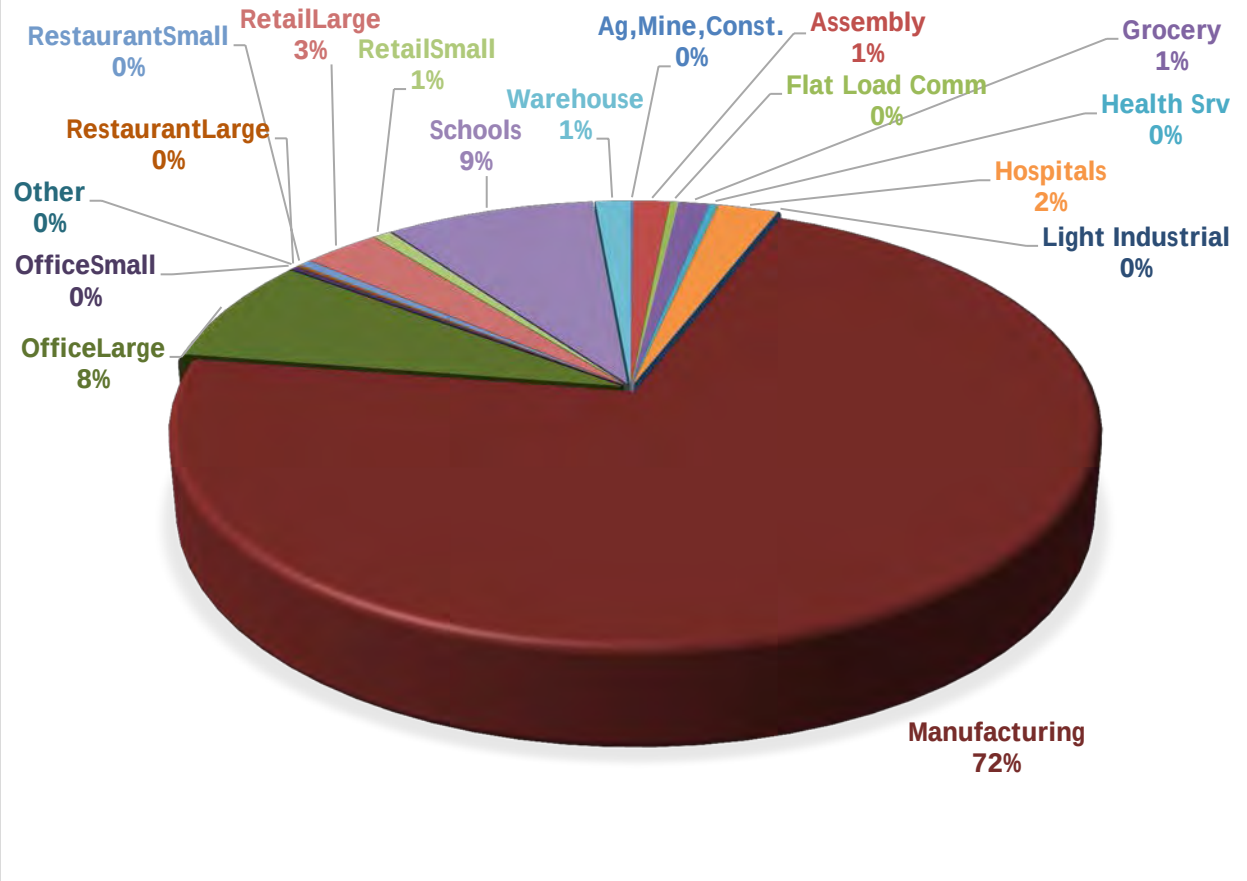
Table 9. Residential Technology Shares

End use	Technology	Electric Customer Technology Share	Fraction Not Efficient
Cooling	Heat pump	17%	11%
	Central AC	74%	38%
	Room AC	7%	66%
	None	3%	0%
Space heat	Heat Pump	11%	97%
	Central Furnace	85%	38%
	Natural Gas furnace/Boiler	2%	26%
	Other Fuel	2%	22%
Lighting*	Incandescent	60%	100%
	Compact Fluorescent Light (CFL)	20%	0%
	Halogen	6%	100%
	Fluorescent	8%	NA
Water Heater	Electric	33%	NA
	Gas/Propane/LPG	67%	NA
Appliances	Primary Refrigerator	100%	55%
	Primary Freezer	54%	66%

A.2.1.3 Commercial and Industrial Sector Market Profiles

Figure 2 shows 2013 nonresidential energy consumption by segment. Manufacturing facilities consume two-thirds of nonresidential customer usage.

Figure 2. Nonresidential Energy Consumption – 2015



A.2.1.4 AEP Ohio 2012 and 2013 EE/PDR Results

Table 10 shows the 2014 and 2015 median EE/PDR benchmarking data for AEP Ohio and eleven other Midwest utilities, including overall spending, savings, costs, and energy costs. Appendix B provides more benchmarking results.

Table 10. 2014 EE/PDR Benchmarking Data

	Spending as Percent of Revenue	Energy Savings as Percent of Sales	Peak Demand Savings as Percent of Peak Demand	Retail Cost of Energy $/kWh	Cost of First Year Savings (1)	
					$/kWh	$/kW
All Region Median 2014	1.4%	1.1%	0.8%	$0.10	$0.12	$963
AEP Ohio 2014	1.7%	1.5%	1.0%	$0.10	$0.12	$946
AEP Ohio 2015 (2)	1.5%	1.2%	0.8%	$0.10	$0.12	$981

1. Note: Cost of First Year Savings is not comparable to a supply-side investment and is only used to compare programs and Plans at a high level for reasonableness of cost.
2. AEP Ohio 2015 results have not been evaluated.

In 2014, the utilities with the largest relative energy savings and below-median costs achieved energy savings at about 1.4 percent of annual sales. The utilities with the largest relative peak demand savings and below-median costs saved about 1.1 percent of peak demand. AEP Ohio saved more than the median amount of savings from the utilities' benchmarked in 2014 and 2015, and AEP Ohio's program costs were lower than the median program costs.

A.3 EE/PDR MEASURE Cost-Effectiveness Analysis

The cost-effectiveness analysis of the modeled demand response and energy conservation measures seeks to determine the cost-effectiveness of each measure over a series of metrics given the modeled input parameters. This section of the report summarizes this procedure and presents the results of the cost-effectiveness analysis, and the discussion begins with a brief overview of the inputs into the model.

A.3.1 Model Inputs

Model inputs include general inputs, measure inputs, and program inputs.

A.3.1.1 General Inputs

Key general inputs are as follows:

Avoided energy costs: These reflect costs for new energy avoided or deferred by EE/PDR measures.

Avoided capacity cost: These reflect the capital costs of new capacity avoided or deferred by EE/PDR measures and were provided by AEP Ohio.

Electricity prices: These reflect the average retail price paid by AEP Ohio customers. Navigant used an average value of $0.1585/kWh for residential, $0.1371/kWh for commercial, and $0.1069/kWh for industrial, and an average value of $9.97/kW for demand where applicable per AEP Ohio's projections over the 2017-2036 period.

In line with standard industry practice, Navigant used the Total Resource Cost (TRC) test and Utility Cost Test (UCT), among other industry benefit/cost tests, to determine which EE/PDR measure and programs to include in AEP Ohio's portfolio of EE/PDR programs. As shown in Table 11 below the proposed AEP Ohio EE/PDR 2017 to 2019 portfolio of programs passes the TRC test with a ratio of 1.6.

Table 11. Summary of Program Benefit-Cost Test Results – 2017 to 2019

Consumer Sector	Total Resource Cost Test (TRC)	Utility Cost Test (UCT)	Participant Cost Test (PCT)	Rate Impact Measure Test (RIM)
Appliance Recycling	1.3	1.3	N/A	0.3
Community Assistance	0.8	0.8	N/A	0.3
e3smart	4.0	4.0	22.8	0.4
Efficient Products	4.1	5.5	15.1	0.4
Behavior Change	1.7	1.7	N/A	0.2
In-Home Energy	1.5	1.8	5.9	0.5
New Home	1.0	1.7	2.9	0.4
Manufactured Home	1.2	2.0	4.2	0.3
Intelligent Home & Demand Response	1.2	1.1	2.3	0.6
Consumer Sector Total	**2.1**	**2.2**	**9.3**	**0.4**

Business Sector	Total Resource Cost Test (TRC)	Utility Cost Test (UCT)	Participant Cost Test (PCT)	Rate Impact Measure Test (RIM)
Business Behavior Change	1.3	1.7	6.5	0.4
Continuous Energy Improvement	2.2	2.4	30.4	0.3
Data Center	1.3	2.4	4.1	0.4
Efficient Products for Business	1.9	7.4	3.0	0.7
New Construction and Major Renovation	1.4	2.9	2.9	0.5
Express	1.3	3.2	2.9	0.6
Microbusiness	1.7	5.6	2.8	0.7
Process Efficiency	2.4	6.9	3.9	0.7
Retro-Commissioning	1.0	1.7	4.5	0.3
Self-Direct	4.6	7.0	11.7	0.5
CHP	1.2	28.7	0.9	1.3
Business Sector Total (includes Other Costs)	**1.6**	**6.4**	**2.4**	**0.7**
Cross Sector	**Total Resource Cost Test (TRC)**	**Utility Cost Test (UCT)**	**Participant Cost Test (PCT)**	**Rate Impact Measure Test (RIM)**
Multifamily	1.6	2.1	4.5	0.5
Agriculture	2.0	4.4	4.0	0.6
Customer EE Assessment Survey	1.7	1.7	1.7	0.3
Cross Sector Total (includes Other Costs)	**0.4**	**0.5**	**4.4**	**0.3**
Plan Total (includes Other Costs)	**(TRC)**	**(UCT)**	**(PCT)**	**(RIM)**
	1.6	**4.0**	**2.8**	**0.7**

A.3.1.2 Measure-Specific Inputs

The key inputs into the cost-effectiveness analysis that are measure-specific are the measure's energy and demand savings, incremental cost, and lifetime. These inputs are described in the EE/PDR measure characterization appendix.

A.3.1.3 Program Cost Inputs

The final input into the cost-effectiveness analysis is the program cost. Unless already specified for a particular measure, the market potential includes incentives up to 50 percent of incremental measure costs. Program-specific administrative costs are

based on costs from AEP Ohio's 2014 and 2015 programs as well as the program benchmarking results. For each program, administrative cost changes as market potential approaches economic potential.

Technology costs per unit are outlined in section C.1. Using all of the above information, Navigant generated the cost-effectiveness numbers for each measure.

A.3.2 Cost-Effectiveness Results

This section summarizes the results of the cost-effectiveness analysis at the measure level. AEP Ohio evaluated cost-effectiveness of the measures on the following standard tests:[3]

1) **Total Resource Cost (TRC) test:** This test includes all quantifiable costs and benefits of an energy efficiency measure that may accrue to participants or the utility. For example, a measure passing the TRC test is cost effective from this perspective if the sum of its avoided costs and other benefits accruing to participants or the utility are greater than the sum of the measure costs and the utility's administrative costs.
2) **Utility/Program Administrator Cost Test (UCT):** This test measures the costs of an energy efficiency program based on the costs incurred by the utility (including incentive costs) and excluding any net costs incurred by the participant. For example, a measure passing the PAC test is cost effective from this perspective if the sum of the avoided costs (costs avoided by the measure's energy and demand savings) and other utility benefits are greater than the utility's costs to promote the measure, including incentives provided to customers.
3) **Participant Cost Test (PCT):** This test measures the quantifiable benefits and costs to the customer due to participation in the program. For example, a measure passing the PCT test is cost effective from this perspective if the reduced electric costs to the participating customer from the measure exceed the after-incentive cost of the measure to the customer.
4) **Ratepayer Impact Measure (RIM) Test:** This test measures what happens to a dwelling or business' electric bills or rates due to changes in utility revenue and operating costs caused by the program. For example, a measure passing the RIM test is cost effective from this perspective if its

[3] See, e.g.: California Public Utilities Commission. California Standard Practice Manual Economic Analysis of Demand-Side Programs and Projects, October 2001.

avoided costs are greater than the sum of the utility's costs and the "lost revenues" caused by the measure.

Table 12 shows benefit-cost tests commonly utilized in the energy efficiency industry, each of which addresses different perspectives and aspects. The PUCO has established that the TRC test be used as the key perspective for judging the cost-effectiveness of the EE/PDR programs. Across all tests benefit- cost ratios greater than or equal to 1.0 are considered beneficial. While various perspectives are often referred to as tests, the following list of criteria demonstrates that decisions on program development go beyond a simple pass/fail test.

Table 12. Cost-Effectiveness Tests

	PARTICIPANT TEST (PCT)	RATE IMPACT MEASURE TEST (RIM)	TOTAL RESOURCE COST TEST (TRC)	UTILITY COST TEST (UCT)
Reduction in Customer's Utility Bill	X	X		
Incentive Paid by Utility	X	X		X
Any Tax Credit Received	X		X	
Avoided Supply Costs		X	X	X
Avoided Participant Costs			X	
Participant Payment to Utility (if any)	X	X		X
Utility Admin Costs		X	X	X
Participant Costs	X		X	
Lost Revenues		X		

A.3.2.1 Residential Measures

The cost-effectiveness of each of the measures was analyzed for each residential program and end use. Unless already specified for a particular measure, in select instances, the market potential includes incentives up to 50 percent of incremental measure costs. Program-specific administrative costs are based on costs from AEP Ohio's 2015 programs and the program benchmarking results.

Navigant applied an initial screening to all residential measures, requiring a TRC greater than or equal to 0.75; about 57 percent of measures passed the initial screening and were included in the potential analysis. In some instances a measure with a TRC less than 0.75 was included where deemed appropriate to do so, particularly when a measure may be bundled with other measures. Table 13 shows the residential measures that were not included in the analysis, likely due to failing the TRC test at a threshold of 0.75. Table 14 to Table 18 show the residential measures that did pass this initial TRC screen.

Table 13. Residential Measures Not Included – 2017 to 2019

Program	End-Use	Measure	Measure TRC
In-Home Energy	Res-HVAC/Shell	Wall Insul. R-11 - Heat Pump	0.7
Efficient Products	Res-Lighting	Outdoor Motion Sensor	0.7
In-Home Energy	Res-HVAC/Shell	ENERGY STAR® Air Source Heat Pump (Elec Res Base)	0.7
Efficient Products	Res-Lighting	Hardwired Dimmer Switch	0.7
In-Home Energy	Res-HVAC/Shell	SEER 15 CAC - Non-EL Heat	0.7
In-Home Energy	Res-HVAC/Shell	SEER 15 CAC - EL Heat	0.7
New Home	RES-Package	ENERGY STAR® 2.0/2.5 Qualified Home - Central A/C - Non-EL Heat	0.6
In-Home Energy	Res-HVAC/Shell	Window Film (west facing windows)	0.6
Efficient Products	Res-Lighting	Indoor Wall-mounted Motion Sensor	0.6
Efficient Products	Res-Water Heat	Solar Water Heat (DUB)	0.5
In-Home Energy	Res-HVAC/Shell	Tier 3 GSHP, Open Loop, water to air	0.5
New Home	Res-Water Heat	Heat Pump Water Heater - 2.0 EF	0.5
In-Home Energy	Res-HVAC/Shell	NEST Consumer Controls - Heat Pump - (DUB)	0.5
In-Home Energy	Res-HVAC/Shell	ENERGY STAR® Door - EL Heat	0.5
Efficient Products	Res-Appliance	ENERGY STAR® Dishwasher - Elec DHW	0.5
New Home	RES-Package	ENERGY STAR® 3.0 Qualified Home - Central A/C - Non-EL Heat	0.5
In-Home Energy	Res-HVAC/Shell	Tier 2 GSHP, Open Loop, water to air	0.5
Efficient Products	Res-Appliance	ENERGY STAR® Monitor	0.4
In-Home Energy	Res-HVAC/Shell	Air Source Heat Pump SEER 15, COP 2.49	0.4
In-Home Energy	Res-HVAC/Shell	Tier 3 GSHP, Closed Loop, water to air	0.4
In-Home Energy	Res-HVAC/Shell	Tier 1 GSHP, Open Loop, water to air	0.4
In-Home Energy	Res-HVAC/Shell	Ceiling Insul R-45 - Central A/C - EL Heat	0.3
Efficient Products	Res-Appliance	Heat Pump Clothes Dryer (CEF >= 5.0) (Elec Dry)	0.3
New Home	Res-Water Heat	Drain Water Heat Recovery (42% efficient or higher)	0.3
In-Home Energy	Res-HVAC/Shell	Ground Source Heat Pump (Elec Res Base)	0.3

Program	End-Use	Measure	Measure TRC
Efficient Products	Res-Lighting	Indoor Fixture-mounted Motion Sensor	0.3
In-Home Energy	Res-Water Heat	Drain Water Heat Recovery (42% efficient or higher)	0.3
In-Home Energy	Res-HVAC/Shell	Tier 1 GSHP, Closed Loop, water to air	0.3
In-Home Energy	Res-HVAC/Shell	ENERGY STAR® Door - Heat Pump	0.3
Efficient Products	Res-Appliance	ENERGY STAR® Dishwasher - Non-EL DHW	0.2
In-Home Energy	Res-HVAC/Shell	Ceiling Insul R-45 - Heat Pump	0.2
In-Home Energy	Res-HVAC/Shell	Ceiling Ins. R-30 - Central A/C - EL Heat	0.2
In-Home Energy	RES-Package	Residential Solar PV	0.2
In-Home Energy	Res-HVAC/Shell	Wall Insul. R-11 - Central A/C - Non-EL Heat	0.2
In-Home Energy	Res-Water Heat	Instantaneous Electric Water Heater - .99 EF	0.2
In-Home Energy	Res-HVAC/Shell	NEST Consumer Controls - Non-EL Heat - (DUB)	0.1
In-Home Energy	Res-HVAC/Shell	Duct Sealing and Insulation - CAC - Non-EL Heat	0.1
In-Home Energy	Res-HVAC/Shell	Ceiling Ins. R-30 - Heat Pump	0.1
In-Home Energy	Res-HVAC/Shell	CAC Tune-Up	0.1
In-Home Energy	Res-HVAC/Shell	Reduced ACHnat 0.3 - Central A/C - Non-EL Heat	0.1
New Home	Res-HVAC/Shell	Reduced ACHnat 0.3 - Central A/C - Non-EL Heat	0.1
In-Home Energy	Res-HVAC/Shell	Solar Attic Ventilation Fans	0.0
In-Home Energy	Res-HVAC/Shell	ENERGY STAR® Door - Non-EL Heat	0.0
In-Home Energy	Res-HVAC/Shell	Ceiling Insul R-45 - Central A/C - Non-EL Heat	0.0
In-Home Energy	Res-HVAC/Shell	Ceiling Ins. R-30 - Central A/C - Non-EL Heat	0.0

As discussed, some measures that failed the initial TRC screen are included in the analysis because of their value when bundled with other measures into a program. Table 15 to Table 18 show results for the four main cost-effectiveness tests for those residential measures determined to be included in the portfolio, organized by end-use type. In these four tables, measures with a theoretical TRC value of infinity are indicated by 0.0; these values are not used to calculate the program-level or portfolio-level TRC.

Table 14. Residential Cost-Effectiveness Ratios – 2017 to 2019, Lighting

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Efficient Products	Res-Lighting	LED Lighting 12W - Indoor (CFL Base)	5.5	1.3	25.8	0.3
Efficient Products	Res-Lighting	LED Lighting 12W - Outdoor (CFL Base)	5.4	1.4	31.7	0.3
Efficient Products	Res-Lighting	LED Lighting 15W - Indoor	4.7	6.0	17.0	0.4
Efficient Products	Res-Lighting	LED Lighting 8W - Indoor	4.6	5.7	16.6	0.4

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Efficient Products	Res-Lighting	LED Lighting 15W - Outdoor	3.8	4.8	15.8	0.4
Efficient Products	Res-Lighting	LED Lighting 8W - Outdoor	3.7	4.7	15.4	0.4
e3smart	Res-Lighting	LED Lighting 8W - Indoor for Kit	3.6	3.8	18.0	0.4
e3smart	Res-Lighting	LED Lighting 15W - Indoor for Kit	3.6	3.8	17.5	0.4
e3smart	Res-Lighting	LED Lighting 15W - Outdoor for Kit	2.9	3.1	16.2	0.3
e3smart	Res-Lighting	LED Lighting 8W - Outdoor for Kit	2.9	3.0	15.8	0.3
Efficient Products	Res-Lighting	LED Lighting 8W - Outdoor (CFL Base)	2.4	0.8	10.8	0.3
Efficient Products	Res-Lighting	LED Lighting 8W - Indoor (CFL Base)	2.3	0.8	9.1	0.3
e3smart	Res-Lighting	1W LED Night Light	2.3	2.4	15.6	0.3
Efficient Products	Res-Lighting	5W Chandelier LED bulb	2.0	3.4	5.9	0.4
Community Assistance	Res-Lighting	LED Lighting 15W - Indoor	1.1	1.2	17.5	0.3
Community Assistance	Res-Lighting	LED Lighting 8W - Indoor	1.1	1.2	17.1	0.3
Community Assistance	Res-Lighting	LED Lighting 8W - Outdoor	0.9	1.0	15.8	0.3
Community Assistance	Res-Lighting	LED Lighting 15W - Outdoor	0.9	1.0	16.2	0.3
In-Home Energy	Res-Lighting	1W LED Night Light	0.9	1.0	15.1	0.3
In-Home Energy	Res-Lighting	LED Holiday Lights (300 bulb string)	0.9	1.2	5.4	0.3
Community Assistance	Res-Lighting	1W LED Night Light	0.7	0.7	15.6	0.2

Table 15. Residential Cost-Effectiveness Ratios – 2017 to 2019, Appliances

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Efficient Products	Res-Appliance	Premium Efficiency Pool Pumps	12.3	22.4	12.8	1.5
Efficient Products	Res-Appliance	ENERGY STAR® Most Efficient Television	8.0	8.6	331.5	0.4
Efficient Products	Res-Appliance	ENERGY STAR® v. 5.3 Television	8.0	8.5	286.6	0.4
Efficient Products	Res-Appliance	Clothes Washer - Tier 3 >= 2.2 MEF-w/elec dry (DUB)	4.4	4.8	23.4	0.4
Efficient Products	Res-Appliance	ENERGY STAR® Air Purifier/Cleaner	3.4	4.5	12.0	0.4
Efficient Products	Res-Appliance	VSD Pool Pump	3.2	11.4	2.6	1.4
Efficient Products	Res-Appliance	Efficient Refrigerator (ENERGY STAR® or Better) (DUB)	2.7	2.9	9.3	0.4
Efficient Products	Res-Appliance	ENERGY STAR® Dehumidifier	2.5	5.2	6.0	0.5
Efficient Products	Res-Appliance	Clothes Washer - Tier 3 >= 2.2 MEF-w/elec dry	2.3	4.0	6.1	0.4
Efficient Products	Res-Appliance	Clothes Washer - Tier 3 >= 2.2 MEF-w/gas or no dry (DUB)	2.3	2.4	8.3	0.4
Efficient Products	Res-Appliance	Heavy Duty Outdoor Timer for Pool Pump	2.1	15.1	1.1	2.1

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Efficient Products	Res-Appliance	Convection Oven	1.6	1.7	3.2	0.6
Efficient Products	Res-Appliance	ENERGY STAR® Dishwasher - Elec DHW (DUB)	1.5	1.7	6.4	0.3
Appliance Recycling	Res-Appliance	Refrigerator Retirement	1.3	1.4	N/A	0.3
Appliance Recycling	Res-Appliance	Freezer Retirement	1.2	1.2	N/A	0.3
Efficient Products	Res-Appliance	Efficient Refrigerator (ENERGY STAR® or Better)	1.0	1.9	2.7	0.4
Efficient Products	Res-Appliance	7-plug Smart Strip Power Bar	1.0	2.1	3.6	0.3
Efficient Products	Res-Appliance	ENERGY STAR® Set Top Boxes	0.9	1.0	4.0	0.3
Efficient Products	Res-Appliance	ENERGY STAR® Dishwasher - Non-EL DHW (DUB)	0.9	1.0	4.2	0.3
Efficient Products	Res-Appliance	5-plug Smart Strip Power Bar	0.9	1.4	3.5	0.3
Efficient Products	Res-Appliance	Clothes Washer - Tier 3 >= 2.2 MEF-w/gas or no dry	0.9	1.6	2.3	0.4
In-Home Energy	Res-Appliance	Waterbed Insulating Pad	0.7	0.9	15.4	0.3
Efficient Products	Res-Appliance	ENERGY STAR® Freezer	0.7	2.3	1.9	0.4
Efficient Products	Res-Appliance	ENERGY STAR® Freezer (DUB)	0.7	2.7	2.3	0.4
Community Assistance	Res-Appliance	Refrigerator Retirement	0.4	0.4	N/A	0.2
Community Assistance	Res-Appliance	Efficient Refrigerator (ENERGY STAR® or Better) (DUB)	0.1	0.2	1.4	0.1

Table 16. Residential Cost-Effectiveness Ratios – 2017 to 2019, Hot Water

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Efficient Products	Res-Water Heat	Low Flow (1.25 GPM) showerhead	7.1	6.4	46.2	0.4
e3smart	Res-Water Heat	Low Flow Faucet Aerator, 1.5 GPM - EDHW -Bathroom	6.2	9.2	137.8	0.5
e3smart	Res-Water Heat	Low Flow Faucet Aerator, 1.5 GPM - EDHW -Kitchen	5.7	8.4	80.8	0.5
e3smart	Res-Water Heat	Low Flow (1.25 GPM) showerhead	5.1	5.5	122.4	0.4
Efficient Products	Res-Water Heat	Low Flow Faucet Aerator, 1.5 GPM - EDHW	4.4	4.3	15.4	0.4
Efficient Products	Res-Water Heat	DHW Pipe Insulation R-4 10 feet	3.4	5.0	10.2	0.4
e3smart	Res-Water Heat	Hot Water Temp Gauge (Tank Temperature Turn Down)	2.3	2.5	113.2	0.3
Community Assistance	Res-Water Heat	DHW Pipe Insulation R-4 10 feet	1.1	1.4	10.6	0.4
Community Assistance	Res-Water Heat	Low Flow Faucet Aerator, 1.5 GPM - EDHW	1.1	1.4	15.3	0.4
Community Assistance	Res-Water Heat	Low Flow (1.25 GPM) showerhead	1.0	1.3	31.3	0.3
Efficient Products	Res-Water Heat	High Performance Circulating Pump (DHW)	0.9	4.0	2.3	0.4
In-Home Energy	Res-Water Heat	Heat Pump Water Heater - 2.0 EF (DUB)	0.8	0.9	12.1	0.3

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
In-Home Energy	Res-Water Heat	Heat Pump Water Heater - 2.0 EF	0.8	1.1	4.1	0.3
In-Home Energy	Res-Water Heat	Shower Start/Stop	0.7	0.9	10.2	0.3
Community Assistance	Res-Water Heat	Heat Pump Water Heater - 2.0 EF	0.6	0.8	4.4	0.3
Community Assistance	Res-Water Heat	Heat Pump Water Heater - 2.0 EF (DUB)	0.5	0.7	6.4	0.2
Community Assistance	Res-Water Heat	Shower Start/Stop	0.5	0.6	10.7	0.2
In-Home Energy	Res-Water Heat	Instantaneous Electric Water Heater - .99 EF (DUB)	0.4	0.4	2.5	0.2
Community Assistance	Res-Water Heat	Instantaneous Electric Water Heater - .99 EF (DUB)	0.2	0.2	1.7	0.1
In-Home Energy	Res-Water Heat	High Eff. Elec. Water Heat - Tank - .95 EF (DUB)	0.2	0.6	0.8	0.2
Community Assistance	Res-Water Heat	High Eff. Elec. Water Heat - Tank - .95 EF (DUB)	0.2	0.2	1.6	0.1
Community Assistance	Res-Water Heat	Instantaneous Electric Water Heater - .99 EF	0.2	0.2	1.4	0.1

Table 17. Residential Cost-Effectiveness Ratios – 2017 to 2019, HVAC & Shell

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
e3smart	Res-HVAC/Shell	Weatherstripping and Door Sweep	5.8	6.1	125.9	0.4
In-Home Energy	Res-HVAC/Shell	Ductless Mini Split HP SEER 15	2.4	3.9	3.2	1.1
In-Home Energy	Res-HVAC/Shell	ECM Fan Motor - Heat Pump	1.8	2.2	14.3	0.4
In-Home Energy	Res-HVAC/Shell	ECM Fan Motor - Central A/C - Non-EL Heat	1.8	3.0	14.3	0.5
In-Home Energy	Res-HVAC/Shell	ECM Fan Motor - Central A/C - EL Heat	1.8	2.2	14.3	0.4
In-Home Energy	Res-HVAC/Shell	ENERGY STAR® Double Pane Windows - Central A/C - Non-EL Heat (DUB)	1.8	2.4	7.0	0.6
In-Home Energy	Res-HVAC/Shell	Triple Pane Windows - Central A/C - Non-EL Heat (DUB)	1.7	2.8	6.4	0.6
In-Home Energy	Res-HVAC/Shell	ENERGY STAR® Window / Room AC	1.6	1.7	2.7	0.8
In-Home Energy	Res-HVAC/Shell	ENERGY STAR® Double Pane Windows - Heat Pump (DUB)	1.6	1.7	18.4	0.4
In-Home Energy	Res-HVAC/Shell	ENERGY STAR® Double Pane Windows - Central A/C - EL Heat (DUB)	1.6	1.7	21.5	0.4
In-Home Energy	Res-HVAC/Shell	Triple Pane Windows - Heat Pump (DUB)	1.6	1.7	18.7	0.4
In-Home Energy	Res-HVAC/Shell	Triple Pane Windows - Central A/C - EL Heat (DUB)	1.5	1.6	30.8	0.3
In-Home Energy	Res-HVAC/Shell	SEER 15 CAC - Non-EL Heat (DUB)	1.5	2.5	3.9	0.7
In-Home Energy	Res-HVAC/Shell	SEER 15 CAC - EL Heat (DUB)	1.5	1.6	4.2	0.6
Community Assistance	Res-HVAC/Shell	ECM Fan Motor - Heat Pump	1.4	1.4	14.7	0.4
Community Assistance	Res-HVAC/Shell	ECM Fan Motor - Central A/C - Non-EL Heat	1.4	1.9	14.7	0.4
Community Assistance	Res-HVAC/Shell	ECM Fan Motor - Central A/C - EL Heat	1.4	1.5	14.7	0.4

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
New Home	Res-HVAC/Shell	Triple Pane Windows - Central A/C - EL Heat	1.3	2.2	7.5	0.4
New Home	Res-HVAC/Shell	ENERGY STAR® Double Pane Windows - Central A/C - EL Heat	1.2	2.2	5.2	0.4
In-Home Energy	Res-HVAC/Shell	Reduced ACHnat 0.3 - Central A/C - EL Heat	1.2	1.6	11.9	0.3
New Home	Res-HVAC/Shell	ENERGY STAR® Double Pane Windows - Heat Pump	1.2	2.2	4.5	0.4
New Home	Res-HVAC/Shell	Triple Pane Windows - Heat Pump	1.2	1.6	5.0	0.4
In-Home Energy	Res-HVAC/Shell	Duct Sealing and Insulation - CAC - EL Heat	1.1	2.0	8.4	0.3
In-Home Energy	Res-HVAC/Shell	ENERGY STAR® Window / Room AC (DUB)	1.1	1.4	2.7	0.7
In-Home Energy	Res-HVAC/Shell	Tier 3 GSHP, Open Loop, water to air (DUB)	1.1	1.2	5.2	0.4
In-Home Energy	Res-HVAC/Shell	Tier 2 GSHP, Open Loop, water to air (DUB)	1.0	1.0	4.7	0.3
Community Assistance	Res-HVAC/Shell	ENERGY STAR® Window / Room AC (DUB)	1.0	1.2	2.9	0.6
In-Home Energy	Res-HVAC/Shell	Wall Insul. R-11 - Central A/C - EL Heat	1.0	1.6	5.9	0.3
In-Home Energy	Res-HVAC/Shell	Reduced ACHnat 0.3 - Heat Pump	1.0	1.4	6.2	0.3
In-Home Energy	Res-HVAC/Shell	ENERGY STAR® 50 CFM Bathroom Ventilating Fan	1.0	1.4	4.2	0.4
New Home	Res-HVAC/Shell	Reduced ACHnat 0.3 - Central A/C - EL Heat	0.9	1.4	8.7	0.3
In-Home Energy	Res-HVAC/Shell	Ductless Mini Split HP SEER 18	0.9	1.6	1.3	0.8
In-Home Energy	Res-HVAC/Shell	Tier 3 GSHP, Closed Loop, water to air (DUB)	0.9	1.0	4.3	0.3
Community Assistance	Res-HVAC/Shell	Reduced ACHnat 0.3 - Central A/C - EL Heat	0.9	1.1	12.6	0.3
In-Home Energy	Res-HVAC/Shell	Tier 1 GSHP, Open Loop, water to air (DUB)	0.9	1.0	4.2	0.3
New Home	Res-HVAC/Shell	ENERGY STAR® Double Pane Windows - Central A/C - Non-EL Heat	0.9	2.0	1.8	0.6
In-Home Energy	Res-HVAC/Shell	Tier 2 GSHP, Closed Loop, water to air (DUB)	0.9	0.9	4.1	0.3
New Home	Res-HVAC/Shell	ENERGY STAR® 50 CFM Bathroom Ventilating Fan	0.8	1.4	3.5	0.4
Community Assistance	Res-HVAC/Shell	Underbelly Insulation R-19 - Central A/C - EL Heat	0.8	0.9	7.6	0.3
New Home	Res-HVAC/Shell	Triple Pane Windows - Central A/C - Non-EL Heat	0.8	2.0	1.7	0.6
In-Home Energy	Res-HVAC/Shell	Duct Sealing and Insulation - Heat Pump	0.8	2.0	3.8	0.3
In-Home Energy	Res-HVAC/Shell	Air Source Heat Pump SEER 15, COP 2.49 (DUB)	0.8	0.9	6.2	0.3
Community Assistance	Res-HVAC/Shell	Wall Insul. R-11 - Central A/C - EL Heat	0.8	0.9	6.7	0.3
Community Assistance	Res-HVAC/Shell	Reduced ACHnat 0.3 - Heat Pump	0.8	0.9	6.8	0.3
Community Assistance	Res-HVAC/Shell	Air Source Heat Pump SEER 14.5, COP 2.49	0.7	0.8	6.0	0.3

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
In-Home Energy	Res-HVAC/Shell	Tier 1 GSHP, Closed Loop, water to air (DUB)	0.7	0.8	3.5	0.3
New Home	Res-HVAC/Shell	Reduced ACHnat 0.3 - Heat Pump	0.7	1.2	4.6	0.3
Community Assistance	Res-HVAC/Shell	Underbelly Insulation R-19 - Heat Pump	0.6	0.7	4.3	0.3
Community Assistance	Res-HVAC/Shell	Wall Insul. R-11 - Heat Pump	0.6	0.7	3.9	0.3
Air Conditioning Control - Res	Res-HVAC	A/C Cycling	0.4	1.1	2.3	0.6
In-Home Energy	Res-HVAC/Shell	Tier 2 GSHP, Closed Loop, water to air	0.4	0.7	1.4	0.3
Community Assistance	Res-HVAC/Shell	Ceiling Insul R-45 - Central A/C - EL Heat	0.3	0.3	2.1	0.2
Community Assistance	Res-HVAC/Shell	Ceiling Insul R-45 - Heat Pump	0.2	0.2	1.5	0.1
Community Assistance	Res-HVAC/Shell	Ceiling Ins. R-30 - Central A/C - EL Heat	0.2	0.2	1.5	0.1
Community Assistance	Res-HVAC/Shell	Wall Insul. R-11 - Central A/C - Non-EL Heat	0.1	0.1	1.1	0.1
Community Assistance	Res-HVAC/Shell	Ceiling Ins. R-30 - Heat Pump	0.1	0.1	1.3	0.1
Community Assistance	Res-HVAC/Shell	Reduced ACHnat 0.3 - Central A/C - Non-EL Heat	0.1	0.1	1.1	0.1
Community Assistance	Res-HVAC/Shell	Ceiling Insul R-45 - Central A/C - Non-EL Heat	0.0	0.0	1.0	0.0
Community Assistance	Res-HVAC/Shell	Ceiling Ins. R-30 - Central A/C - Non-EL Heat	0.0	0.0	1.0	0.0

Table 18 Residential Cost-Effectiveness Ratios – 2017 to 2019, Package

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
HER	RES-Package	Home Energy Report	1.6	1.7	0.0	0.2
Manufactured Home	RES-Package	ENERGY STAR® Manufactured Homes - EL Heat	1.1	2.0	4.2	0.3
New Home	RES-Package	ENERGY STAR® 2.0/2.5 Qualified Home - Heat Pump	0.9	1.6	3.4	0.4
New Home	RES-Package	ENERGY STAR® 3.0 Qualified Home - Heat Pump	0.7	1.3	2.7	0.4

The results for all residential segments combined show that the majority of the measures are cost-effective from the perspective of the PCT and UCT tests. About half of the measures passed the TRC test while only six passed the RIM test[4].

Half of the measures for water heating failed the TRC test in the initial screening or in the analysis across all segments, mostly due to high incremental costs and/or low energy and peak demand savings. Almost half of the HVAC and shell measures failed

[4] Results ratios less than one for the RIM test are typical for energy efficiency measures.

the TRC test due mostly to the high cost, labor-intensive retrofitting of cooling and heating measures in existing construction. AEP Ohio's relatively low estimated avoided energy costs also play a significant role in the benefit-cost test results. The low avoided costs tend to lower the portion of measures passing.

A.3.2.2 Non-Residential Measures

The non-residential sector includes measures for commercial and industrial end-uses. 372 non-residential measures were initially screened and 270 passed with a TRC greater than or equal to 0.75. Some measures that failed the initial TRC screen are included in the analysis because of their value when bundled with other measures into a program. For those measures determined to be included in the portfolio, Navigant performed four cost-effectiveness tests. Table 19 to Table 25 show the cost-effectiveness results for these measures by program for each end-use.

Table 19. Commercial Cost-Effectiveness Ratios – 2017 to 2019, Lighting

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Microbusiness	COM-Lighting	LED Lighting <10W - Indoor	6.6	10.0	20.7	0.6
Microbusiness	COM-Lighting	LED Lighting >=10W - Indoor	6.5	10.2	16.9	0.6
Efficient Products for Business	COM-Lighting	LED Lighting <10W - Indoor	5.8	8.3	20.7	0.6
Efficient Products for Business	COM-Lighting	LED Lighting >=10W - Indoor	5.8	8.6	17.0	0.6
Microbusiness	COM-Lighting	1L4'T8 HP	5.1	5.5	14.4	0.5
Efficient Products for Business	COM-Lighting	1L4'T8 HP	4.6	5.0	14.4	0.5
New Construction and Major Renovation	COM-Lighting	LED Lighting >=10W - Indoor	3.1	4.6	10.9	0.6
New Construction and Major Renovation	COM-Lighting	LED Lighting <10W - Indoor	3.0	4.4	13.3	0.5
Efficient Products for Business	COM-Lighting	6L4'T8HP	2.9	4.3	7.4	0.5
Efficient Products for Business	COM-Lighting	LED T8 Tube (4' T8 Replacement)	2.7	4.8	6.0	0.6
Microbusiness	COM-Lighting	1L4'T5 NLO	2.4	2.6	7.5	0.4
Efficient Products for Business	COM-Lighting	Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	2.3	3.3	9.6	0.4
Efficient Products for Business	COM-Lighting	1L4'T5 NLO	2.2	2.4	7.5	0.4
Express	COM-Lighting	LED Lighting >=10W - Indoor	2.1	2.3	17.4	0.5
Microbusiness	COM-Lighting	LED Exit Sign (DUB)	2.1	4.5	6.0	0.4
Efficient Products for Business	COM-Lighting	LED Exit Sign (DUB)	2.0	4.0	6.0	0.4
Express	COM-Lighting	LED Lighting <10W - Indoor	2.0	2.1	21.2	0.5
New Construction and Major Renovation	COM-Lighting	Daylighting Controls	1.9	5.4	2.4	1.0

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
New Construction and Major Renovation	COM-Lighting	1L4'T8 HP	1.9	2.8	10.1	0.4
Express	COM-Lighting	1L4'T8 HP	1.8	2.2	13.9	0.5
New Construction and Major Renovation	COM-Lighting	LED T8 Tube (4' T8 Replacement)	1.8	3.1	4.4	0.5
New Construction and Major Renovation	COM-Lighting	6L4'T8HP	1.8	2.6	5.2	0.4
Express	COM-Lighting	LED T8 Tube (4' T8 Replacement)	1.7	2.4	6.0	0.5
Express	COM-Lighting	6L4'T8HP	1.6	1.9	7.4	0.4
Microbusiness	COM-Lighting	Daylighting Controls	1.5	7.3	2.2	0.8
Efficient Products for Business	COM-Lighting	Daylighting Controls	1.5	6.5	2.2	0.8
Microbusiness	COM-Lighting	Permanent T12 Removal During T8 Retrofit	1.5	6.9	3.6	0.5
Process Efficiency	COM-Lighting	Daylighting Controls	1.4	6.2	2.2	0.7
Efficient Products for Business	COM-Lighting	Permanent T12 Removal During T8 Retrofit	1.4	5.6	3.6	0.5
Microbusiness	COM-Lighting	Occupancy Sensor	1.3	25.4	1.6	0.9
Microbusiness	COM-Lighting	T8 Delamping	1.3	3.0	3.2	0.5
Efficient Products for Business	COM-Lighting	Occupancy Sensor	1.3	18.7	1.6	0.9
Efficient Products for Business	COM-Lighting	LED Troffer	1.3	2.4	2.9	0.5
Efficient Products for Business	COM-Lighting	T8 Delamping	1.2	2.7	3.2	0.5
New Construction and Major Renovation	COM-Lighting	Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	1.1	1.9	5.2	0.3
Express	COM-Lighting	LED Exit Sign	1.1	1.7	5.5	0.4
Continuous Energy Improvement	COM-Lighting	T8 Delamping	1.1	1.8	3.4	0.4
Express	COM-Lighting	Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	1.0	1.3	7.9	0.3
Efficient Products for Business	COM-Lighting	Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	1.0	3.3	3.5	0.4
Express	COM-Lighting	1L4'T5 NLO	1.0	1.3	8.3	0.4
Express	COM-Lighting	Occupancy Sensor	1.0	3.8	1.6	0.7
Express	COM-Lighting	LED Troffer	1.0	1.6	2.9	0.5
Microbusiness	COM-Lighting	Daylighting Control + Occ Sensor	1.0	7.7	1.3	0.8
Microbusiness	COM-Lighting	Photocell + Timeclock (Outdoor Lighting)	1.0	11.5	2.9	0.4
Efficient Products for Business	COM-Lighting	Daylighting Control + Occ Sensor	1.0	7.0	1.3	0.8
Efficient Products for Business	COM-Lighting	Photocell + Timeclock (Outdoor Lighting)	0.9	8.5	2.9	0.4
Microbusiness	COM-Lighting	Outdoor LED Flood Light (30W), TC Control	0.9	3.6	3.0	0.4
Efficient Products for	COM-Lighting	Outdoor LED Flood Light (30W), TC	0.9	3.3	3.0	0.4

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Business		Control				
New Construction and Major Renovation	COM-Lighting	LED Troffer	0.8	1.7	2.3	0.5
Express	COM-Lighting	Permanent T12 Removal During T8 Retrofit	0.8	1.2	4.4	0.4
Express	COM-Lighting	Photocell + Timeclock (Outdoor Lighting)	0.6	1.7	2.4	0.3
Efficient Products for Business	COM-Lighting	Time clock (Outdoor Lighting)	0.6	8.8	1.6	0.4
Efficient Products for Business	COM-Lighting	Photocell (Outdoor Lighting)	0.5	8.4	1.3	0.4
Express	COM-Lighting	Time clock (Outdoor Lighting)	0.5	1.7	1.6	0.3
Express	COM-Lighting	Photocell (Outdoor Lighting)	0.3	1.7	1.1	0.3

Table 20. Commercial Cost-Effectiveness Results – 2017 to 2019, Other

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Microbusiness	COM-Other	Low Flow (1.25 GPM) showerhead	8.1	11.1	37.3	0.5
Self-Direct	COM-Other	Self-Direct Program	4.8	7.6	13.4	0.5
Microbusiness	COM-Other	Low Flow Faucet Aerator, 1.5 GPM - EDHW	4.3	4.5	12.2	0.5
Efficient Products for Business	COM-Other	ENERGY STAR Steam Cooker - 4 Pan - 100lbs/day	4.0	10.3	11.3	0.5
Efficient Products for Business	COM-Other	Advanced Pre-Rinse Spray Nozzle, <=1.6 GPM (Elec. HW)	3.5	5.7	29.7	0.4
Efficient Products for Business	COM-Other	ENERGY STAR Refrigerated Beverage Vending Machine with Control Software, average	3.4	7.7	11.1	0.4
Microbusiness	COM-Other	DHW Pipe Insulation R-4 10 feet	3.1	5.3	8.0	0.5
Microbusiness	COM-Other	Efficient Refrigerator (ENERGY STAR® or Better) (DUB)	2.6	2.8	8.1	0.4
Efficient Products for Business	COM-Other	ENERGY STAR Refrigerated Beverage Vending Machine without Control Software, average	2.6	6.7	8.0	0.4
Continuous Energy Improvement	COM-Other	Business Behavior Change	2.4	2.5	104.8	0.3
Efficient Products for Business	COM-Other	ENERGY STAR Hot Food Holding Cabinet, Full Size, 16 cu.ft. average	2.1	6.1	5.0	0.5
Efficient Products for Business	COM-Other	ENERGY STAR Combination Oven	1.9	4.0	5.6	0.4
Efficient Products for Business	COM-Other	ENERGY STAR® Heat Pump Water Heater (EF>2.0)	1.7	7.0	4.4	0.5
Microbusiness	COM-Other	ENERGY STAR® Dishwasher (EFO 0.68) - Elec DHW (DUB)	1.5	1.6	5.6	0.3
Efficient Products for Business	COM-Other	Vending Machine PIR Occupancy Sensor - Cold Drink	1.5	2.4	6.4	0.3
Business Behavior Change	COM-Other	Intra-company behavioral change re plugloads	1.2	2.5	3.9	0.6
Data Center	COM-Other	2013 OH Data Center Post Retrofit	1.2	2.4	4.1	0.4

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Efficient Products for Business	COM-Other	ENERGY STAR Hot Food Holding Cabinet, Half Size, 8 cuft average	1.1	3.4	2.5	0.5
Efficient Products for Business	COM-Other	High-Efficiency Electric Water Heater (EF>0.93)	1.1	2.3	3.0	0.4
Express	COM-Other	Advanced Pre-Rinse Spray Nozzle, <=1.6 GPM (Elec. HW)	0.9	1.2	29.7	0.3
Business Behavior Change	COM-Other	Business Behavior Change	0.9	1.0	15.3	0.2
Microbusiness	COM-Other	ENERGY STAR® Dishwasher (EFO 0.68) - Non-EL DHW (DUB)	0.9	1.0	3.7	0.3
Efficient Products for Business	COM-Other	Plug Load Occ Sensors	0.9	3.0	2.8	0.4
Efficient Products for Business	COM-Other	Vending Machine PIR Occupancy Sensor - Snacks	0.9	1.9	3.5	0.3
Microbusiness	COM-Other	Heat Pump Water Heater - 2.0 EF	0.8	4.0	2.2	0.4
Process Efficiency	COM-Other	Network PC Management Software	0.7	1.5	3.0	0.3

Table 21. Commercial Cost-Effectiveness Results – 2017 to 2019, HVAC & Shell

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
New Construction and Major Renovation	COM-HVAC	Water Source (water to water) Heat Pump (< 135 kBtu/h) EER 11.7 - Heat Pump	5.2	8.2	29.9	0.6
Efficient Products for Business	COM-HVAC	Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump	5.2	12.2	9.9	0.7
Efficient Products for Business	COM-HVAC	Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types	4.9	7.4	3.7	1.5
Efficient Products for Business	COM-HVAC	EC Motor for HVAC - Heating and Cooling	3.8	9.9	4.4	1.0
Efficient Products for Business	COM-HVAC	Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump	3.6	8.9	6.7	0.7
Microbusiness	COM-HVAC	Ductless Mini Split HP SEER 15	3.6	7.2	2.9	1.4
New Construction and Major Renovation	COM-HVAC	Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER)	3.5	8.7	3.2	1.4
Efficient Products for Business	COM-HVAC	EC Motor for HVAC - Heating Only	3.4	8.5	3.2	1.2
Express	COM-HVAC	Hotel Guest Room Energy Management System (GREM), Electric Cooling, NON-Electric Heating	3.3	13.7	1.8	2.5
Efficient Products for Business	COM-HVAC	Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump	3.2	8.4	5.3	0.7
New Construction and Major Renovation	COM-HVAC	Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump	3.1	7.0	7.5	0.6
Efficient Products for Business	COM-HVAC	Split/Package system A/C (<65 kBtu/h, 15 SEER) - Direct Exp /All Heating Types	2.9	10.2	2.5	1.3
Efficient Products for Business	COM-HVAC	Hotel Guest Room Energy Management System (GREM), Electric	2.7	15.3	5.5	0.6

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
		Cooling, Electric Heating				
New Construction and Major Renovation	COM-HVAC	Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types	2.7	4.0	2.8	1.1
Express	COM-HVAC	Hotel Guest Room Energy Management System (GREM), Electric Cooling, Electric Heating	2.6	6.2	6.0	1.0
Efficient Products for Business	COM-HVAC	Package system A/C (>=63.3 tons, minimum 10.2 EER, 11.4 IEER) - Direct Exp / All Heating Types (DUB)	2.5	7.7	3.1	1.0
Efficient Products for Business	COM-HVAC	Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, >=300 tons, 0.486 kW/Ton (IPLV)	2.5	21.9	0.9	2.9
Efficient Products for Business	COM-HVAC	Air Cooled Chiller <150 Tons, 0.864 kW/ton (IPLV) (DUB)	2.4	16.8	1.6	1.6
Efficient Products for Business	COM-HVAC	Air Cooled Chiller >150 Tons, 0.847 kW/ton (IPLV) (DUB)	2.3	15.4	1.8	1.5
Microbusiness	COM-HVAC	SEER 15 CAC - EL Heat (DUB)	2.3	2.5	3.9	0.7
Microbusiness	COM-HVAC	SEER 15 CAC - Non-EL Heat (DUB)	2.3	3.3	3.6	0.8
New Construction and Major Renovation	COM-HVAC	Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump	2.1	5.2	4.9	0.6
Efficient Products for Business	COM-HVAC	Centrifugal Water Cooled Chiller >600 tons, (0.485 kW/ton-IPLV)	2.1	20.7	0.3	7.5
Efficient Products for Business	COM-HVAC	Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types (DUB)	2.0	8.8	1.8	1.3
Efficient Products for Business	COM-HVAC	Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 75 tons to below 150 tons, 0.554 kW/Ton (IPLV)	2.0	28.4	0.5	4.7
New Construction and Major Renovation	COM-HVAC	Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, >=300 tons, 0.486 kW/Ton (IPLV)	2.0	17.0	1.0	2.0
New Construction and Major Renovation	COM-HVAC	Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump	2.0	4.9	4.2	0.6
New Construction and Major Renovation	COM-HVAC	Hotel Guest Room Energy Management System (GREM), Electric Cooling, Electric Heating	1.9	9.8	4.9	0.5
Efficient Products for Business	COM-HVAC	Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 150 tons to below 300 tons, 0.522 kW/Ton (IPLV)	1.9	21.6	0.7	2.9
New Construction and Major Renovation	COM-HVAC	Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 150 tons to below 300 tons, 0.522 kW/Ton (IPLV)	1.9	20.8	0.7	2.8
Efficient Products for Business	COM-HVAC	Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, below 75 tons, 0.567 kW/ton-IPLV	1.8	26.5	0.7	2.9
Efficient Products	COM-HVAC	EC Motor for HVAC - Cooling Only	1.8	4.9	1.6	1.2

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
for Business						
Efficient Products for Business	COM-HVAC	Package system A/C (>=63.3 tons, minimum 10.2 EER, 11.4 IEER) - Direct Exp / All Heating Types	1.8	5.4	3.1	0.7
New Construction and Major Renovation	COM-HVAC	Centrifugal Water Cooled Chiller >600 tons, (0.485 kW/ton-IPLV)	1.7	17.0	0.3	6.9
Efficient Products for Business	COM-HVAC	Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, >=300 tons, 0.486 kW/Ton (IPLV) (DUB)	1.7	15.0	0.9	2.0
Efficient Products for Business	COM-HVAC	Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, below 75 tons, 0.567 kW/ton-IPLV (DUB)	1.7	24.3	0.7	2.7
Process Efficiency	COM-HVAC	Code minimum R-20ci or R-38 batt - Chiller / Elec Resist	1.7	8.8	3.2	0.6
Efficient Products for Business	COM-HVAC	Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 150 tons to below 300 tons, 0.522 kW/Ton (IPLV) (DUB)	1.7	19.0	0.7	2.6
New Construction and Major Renovation	COM-HVAC	Split/Package system A/C (<65 kBtu/h, 15 SEER) - Direct Exp /All Heating Types	1.6	5.6	1.9	1.0
New Construction and Major Renovation	COM-HVAC	Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 75 tons to below 150 tons, 0.554 kW/Ton (IPLV)	1.6	21.1	0.5	3.0
Efficient Products for Business	COM-HVAC	Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump (DUB)	1.6	11.2	3.0	0.6
Efficient Products for Business	COM-HVAC	Hotel Guest Room Energy Management System (GREM), Electric Cooling, NON-Electric Heating	1.5	12.3	1.7	1.0
New Construction and Major Renovation	COM-HVAC	Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, below 75 tons, 0.567 kW/ton-IPLV	1.5	21.5	0.7	2.2
Efficient Products for Business	COM-HVAC	Centrifugal Water Cooled Chiller >600 tons, (0.485 kW/ton-IPLV) (DUB)	1.5	16.5	0.5	3.1
Efficient Products for Business	COM-HVAC	Cogged V-belts on fans 5 HP to 100 HP	1.5	2.6	4.3	0.4
Efficient Products for Business	COM-HVAC	Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types	1.5	5.6	0.9	1.7
Efficient Products for Business	COM-HVAC	Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 75 tons to below 150 tons, 0.554 kW/Ton (IPLV) (DUB)	1.4	20.1	0.5	3.3
Efficient Products for Business	COM-HVAC	Air Cooled Chiller <150 Tons, 0.864 kW/ton (IPLV)	1.4	10.1	1.0	1.4
Efficient Products for Business	COM-HVAC	Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump	1.3	8.1	2.4	0.6
Efficient Products for Business	COM-HVAC	Variable Refrigerant Flow A/C (240 - 760 kBtu/h, 10.8 EER, 12.1 IEER)	1.3	8.8	1.0	1.4

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Efficient Products for Business	COM-HVAC	Cogged V-belts on fans 5 HP to 100 HP	1.3	2.6	3.6	0.4
Process Efficiency	COM-HVAC	High Performance Glazing - Chiller / Elec Resist	1.3	3.5	3.8	0.4
Efficient Products for Business	COM-HVAC	Air Cooled Chiller >150 Tons, 0.847 kW/ton (IPLV)	1.3	9.3	1.0	1.3
Efficient Products for Business	COM-HVAC	Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump (DUB)	1.1	8.4	2.4	0.5
New Construction and Major Renovation	COM-HVAC	Hotel Guest Room Energy Management System (GREM), Electric Cooling, NON-Electric Heating	1.1	8.2	1.5	0.8
New Construction and Major Renovation	COM-HVAC	Air Cooled Chiller <150 Tons, 0.864 kW/ton (IPLV)	1.1	8.1	0.9	1.3
Efficient Products for Business	COM-HVAC	Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER)	1.1	13.3	0.8	1.4
Efficient Products for Business	COM-HVAC	Variable Refrigerant Flow A/C (135 - 240 kBtu/h, 12 EER, 13 IEER)	1.1	6.9	0.7	1.6
Efficient Products for Business	COM-HVAC	Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump (DUB)	1.0	8.4	2.0	0.6
New Construction and Major Renovation	COM-HVAC	Improved Ceiling Insulation R45 batt - Direct Exp / Elec Resist	1.0	3.2	3.0	0.4
New Construction and Major Renovation	COM-HVAC	Air Cooled Chiller >150 Tons, 0.847 kW/ton (IPLV)	1.0	7.5	0.9	1.2
New Construction and Major Renovation	COM-HVAC	DCV - Office	1.0	1.1	4.0	0.3
Efficient Products for Business	COM-HVAC	Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER) (DUB)	1.0	12.1	0.8	1.3
Retro-Commissioning	COM-HVAC	RCx Program	1.0	1.7	4.8	0.3
Process Efficiency	COM-HVAC	High Performance Glazing - Direct Exp / Elec Resist	0.9	4.0	2.3	0.5
Efficient Products for Business	COM-HVAC	Centrifugal Water Cooled Chiller <300 tons (0.536 kW/ton-IPLV) (DUB)	0.9	9.9	0.8	1.2
Microbusiness	COM-HVAC	ENERGY STAR® Air Source Heat Pump (Elec Res Base)	0.9	3.0	2.5	0.4
Efficient Products for Business	COM-HVAC	Window Films on Double Pane - Non-North Facing Windows	0.9	14.4	1.3	0.7
New Construction and Major Renovation	COM-HVAC	Variable Refrigerant Flow A/C (240 - 760 kBtu/h, 10.8 EER, 12.1 IEER)	0.9	5.9	0.7	1.3
Efficient Products for Business	COM-HVAC	Centrifugal Water Cooled Chiller <300 tons (0.536 kW/ton-IPLV)	0.9	12.4	0.2	4.7
Efficient Products for Business	COM-HVAC	Variable Refrigerant Flow A/C (65 - 135 kBtu/h, 12 EER, 13 IEER)	0.9	5.6	0.5	1.7
Efficient Products for Business	COM-HVAC	Water Source (water to air) Heat Pump (>= 17 kBtu/h) EER 14.3 - Heat Pump (DUB)	0.9	5.4	1.9	0.5
Efficient Products for Business	COM-HVAC	Water Source (water to air) Heat Pump (>= 17 kBtu/h) EER 14.3 - Heat Pump	0.9	5.4	1.9	0.5

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Efficient Products for Business	COM-HVAC	Water Source (water to air) Heat Pump (< 17 kBtu/h) EER 13.4 - Heat Pump	0.9	6.0	1.9	0.5
Process Efficiency	COM-HVAC	Energy Management System	0.9	0.9	3.1	0.3
Efficient Products for Business	COM-HVAC	Water Source (water to air) Heat Pump (< 17 kBtu/h) EER 13.4 - Heat Pump (DUB)	0.8	6.0	1.9	0.5
New Construction and Major Renovation	COM-HVAC	Water Source (water to air) Heat Pump (< 17 kBtu/h) EER 13.4 - Heat Pump	0.8	5.9	1.9	0.5
Continuous Energy Improvement	COM-HVAC	Energy Management System	0.8	0.9	3.2	0.3
Efficient Products for Business	COM-HVAC	Centrifugal Water Cooled Chiller >300 tons <600 tons (0.494 kW/ton-IPLV)	0.8	7.1	0.2	4.1
Process Efficiency	COM-HVAC	High Performance Glazing - Heat Pump	0.8	4.5	1.7	0.5
New Construction and Major Renovation	COM-HVAC	Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump	0.8	4.8	1.7	0.5
New Construction and Major Renovation	COM-HVAC	Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types	0.8	3.0	0.7	1.2
Efficient Products for Business	COM-HVAC	Centrifugal Water Cooled Chiller >300 tons <600 tons (0.494 kW/ton-IPLV) (DUB)	0.7	7.0	0.4	1.7
New Construction and Major Renovation	COM-HVAC	Variable Refrigerant Flow A/C (135 - 240 kBtu/h, 12 EER, 13 IEER)	0.7	4.7	0.5	1.4
New Construction and Major Renovation	COM-HVAC	Cogged V-belts on fans 5 HP to 100 HP	0.7	1.4	2.9	0.3
New Construction and Major Renovation	COM-HVAC	Centrifugal Water Cooled Chiller <300 tons (0.536 kW/ton-IPLV)	0.7	10.1	0.2	4.3
Efficient Products for Business	COM-HVAC	Variable Refrigerant Flow A/C (< 5.4 tons, 14 SEER)	0.7	5.0	0.7	1.0
New Construction and Major Renovation	COM-HVAC	Centrifugal Water Cooled Chiller >300 tons <600 tons (0.494 kW/ton-IPLV)	0.7	5.8	0.2	3.7
Efficient Products for Business	COM-HVAC	Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump (DUB)	0.6	9.6	1.0	0.6
New Construction and Major Renovation	COM-HVAC	Variable Refrigerant Flow A/C (65 - 135 kBtu/h, 12 EER, 13 IEER)	0.6	3.9	0.4	1.5
Process Efficiency	COM-HVAC	Code minimum R-20ci or R-38 batt - Direct Exp / Elec Resist	0.4	3.6	0.7	0.6

Table 22. Commercial Cost-Effectiveness Results – 2017 to 2019, Refrigeration

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Efficient Products for Business	COM-Refrigeration	Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in -	9.5	14.7	53.6	0.5

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
		Shaded Pole				
Efficient Products for Business	COM-Refrigeration	Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - ECM	6.4	11.7	22.0	0.5
Efficient Products for Business	COM-Refrigeration	Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - Shaded Pole	5.6	10.8	18.1	0.5
New Construction and Major Renovation	COM-Refrigeration	Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - ECM	4.4	7.8	17.2	0.5
Continuous Energy Improvement	COM-Refrigeration	Multiplex system with oversized condenser: 85 Btu/hr of heat rejection per watt of fan, air; 195 Btu/h/Watt evap	4.3	12.5	4.4	1.3
Efficient Products for Business	COM-Refrigeration	Multiplex system with oversized condenser: 85 Btu/hr of heat rejection per watt of fan, air; 195 Btu/h/Watt evap	4.0	13.9	4.4	1.1
Efficient Products for Business	COM-Refrigeration	Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - ECM	2.8	6.6	7.2	0.5
Efficient Products for Business	COM-Refrigeration	EC Motor: Walk-In Enclosure; blended average of coolers and freezers; no controls	2.8	9.3	7.1	0.5
Express	COM-Refrigeration	Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - Shaded Pole	2.7	3.4	53.6	0.5
Efficient Products for Business	COM-Refrigeration	ENERGY STAR Solid Door Commercial Freezer	2.4	4.4	6.6	0.5
Express	COM-Refrigeration	Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - ECM	2.4	3.3	22.0	0.5
Express	COM-Refrigeration	Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - Shaded Pole	2.2	3.2	18.1	0.5
Efficient Products for Business	COM-Refrigeration	ENERGY STAR Glass Door Commercial Refrigerator	2.2	4.2	5.9	0.5
Efficient Products for Business	COM-Refrigeration	Outside Air Economizer for Coolers	2.2	8.3	4.0	0.6
New Construction and Major Renovation	COM-Refrigeration	Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - ECM	2.1	4.6	5.7	0.5
Efficient Products for Business	COM-Refrigeration	ENERGY STAR Glass Door Commercial Freezer	2.0	3.7	5.4	0.4
Efficient Products for Business0	COM-Refrigeration	Anti-Sweat Heat (ASH) Controls - freezer and cooler glass reach in or freezer door only are eligible	2.0	7.6	5.1	0.5
Efficient Products for Business	COM-Refrigeration	EC Motor: Reach-In Enclosure; blended average of coolers and freezers; no controls	1.9	7.9	4.7	0.5
Efficient Products for Business	COM-Refrigeration	ENERGY STAR Solid Door Commercial Refrigerator	1.8	3.5	5.0	0.4
New Construction and Major	COM-Refrigeration	Zero Energy Door	1.8	3.2	6.0	0.4

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Renovation						
Express	COM-Refrigeration	Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - ECM	1.6	2.7	7.2	0.4
Express	COM-Refrigeration	Lighting Controls for Freezer and Cooler w/ Doors	1.6	1.7	16.1	0.3
Express	COM-Refrigeration	Lighting Controls for Open Freezer and Cooler Display case	1.6	1.7	16.1	0.3
Express	COM-Refrigeration	EC Motor: Walk-In Enclosure; blended average of coolers and freezers; no controls	1.6	3.0	7.1	0.4
Express	COM-Refrigeration	LED Refrigeration Case Lighting Open Display Case	1.6	2.1	15.0	0.4
Efficient Products for Business	COM-Refrigeration	Zero Energy Door	1.4	7.1	3.1	0.5
Efficient Products for Business	COM-Refrigeration	Zero Energy Door	1.4	7.1	3.1	0.5
Express	COM-Refrigeration	EC Motor: Reach-In Enclosure; blended average of coolers and freezers; no controls	1.3	2.8	4.7	0.4
Express	COM-Refrigeration	Anti-Sweat Heat (ASH) Controls - freezer and cooler glass reach in or freezer door only are eligible	1.2	2.5	5.1	0.4
Efficient Products for Business	COM-Refrigeration	Refrigerated Display LED Lighting Strips	1.1	5.6	2.5	0.5
Express	COM-Refrigeration	LED Refrigeration Case Lighting in Freezer & Cooler w/ Doors	0.7	2.1	2.5	0.4

Table 23. Commercial Cost-Effectiveness Results – 2017 to 2019, Process

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Process Efficiency	COM-Process	Compressed Air - Air Entraining Air Nozzle, 100 psi, 0.25 kW/scfm	9.2	14.3	33.7	0.6
Efficient Products for Business	COM-Process	Compressed Air - Air Entraining Air Nozzle, 100 psi, 0.25 kW/scfm	8.9	13.3	40.2	0.5
Process Efficiency	COM-Process	Compressed Air - Cycling Air Dryer, >600scfm, all types	4.9	7.2	12.1	0.6
Efficient Products for Business	COM-Process	Compressed Air - Air Receiver for Load/No-Load Compressors (>=5 gal/CFM storage), <=300 HP	4.7	8.5	15.3	0.5
Process Efficiency	COM-Process	Compressed Air - Cycling Air Dryer, >600scfm, all types	4.3	6.8	9.8	0.6
Process Efficiency	COM-Process	Compressed Air - Variable Speed Drive Air Compressor, new, greater than 150 HP	2.4	7.3	4.9	0.6
Process Efficiency	COM-Process	Compressed Air - Variable Speed Drive Air Compressor, new, greater than 150 HP	2.4	7.7	5.0	0.6
Efficient Products for Business	COM-Process	Energy Star Ice Making Head (401-1000 lbs/day)	2.4	9.3	6.0	0.5
Efficient Products for Business	COM-Process	Compressed Air - Low Pressure Drop Filter for Compressed Air Systems, 25HP to 300HP, <500CFM, mist eliminator, <1 psi new	2.3	3.8	6.8	0.5

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Efficient Products for Business	COM-Process	Compressed Air - Variable Speed Drive Air Compressor, new, less than 150 HP	2.2	7.0	5.0	0.5
Efficient Products for Business	COM-Process	Compressed Air - Variable Speed Drive Air Compressor, new, less than 150 HP	2.2	7.0	5.0	0.5
Efficient Products for Business	COM-Process	Compressed Air - Cycling Air Dryer, <=600scfm, thermal mass	2.2	3.9	5.2	0.5
Efficient Products for Business	COM-Process	ENERGY STAR, CEE Tier 2 or CEE Tier 3 Commercial Clothes Washer	1.9	7.4	3.4	0.7
Efficient Products for Business	COM-Process	Compressed Air - Cycling Air Dryer, <=600scfm, thermal mass	1.8	3.7	4.4	0.5
Efficient Products for Business	COM-Process	Compressed Air - Low Pressure Drop Filter for Compressed Air Systems, 25HP to 300HP, <500CFM, mist eliminator, <1 psi new	1.7	3.8	4.5	0.5
New Construction and Major Renovation	COM-Process	Compressed Air - Variable Speed Drive Air Compressor, new, less than 150 HP	1.5	4.5	3.7	0.5
Process Efficiency	COM-Process	Compressed Air - Controls	1.4	4.7	2.3	0.7
New Construction and Major Renovation	COM-Process	Compressed Air - Controls	1.4	3.2	2.6	0.6
New Construction and Major Renovation	COM-Process	Compressed Air - Cycling Air Dryer, <=600scfm, thermal mass	1.2	2.3	3.3	0.4
Efficient Products for Business	COM-Process	Compressed air - no-loss condensate drains	1.2	3.6	2.8	0.5
Efficient Products for Business	COM-Process	Energy Star Ice Makers (>1000 lbs/day)	1.1	2.9	2.9	0.4
Efficient Products for Business	COM-Process	Energy Star Ice Makers (401-1000 lbs/day)	0.8	1.7	2.1	0.4
Continuous Energy Improvement	COM-Process	Compressed air - Leak Repair non-24-Hour Operation	0.7	1.2	2.5	0.4
Continuous Energy Improvement	COM-Process	Compressed air - Leak Repair 24-Hour Operation	0.7	1.1	2.8	0.3
Efficient Products for Business	COM-Process	Energy Star Ice Makers (101-400 lbs/day)	0.6	1.3	1.8	0.4

Table 24. Commercial Cost-Effectiveness Results – 2017 to 2019, Motors

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Efficient Products for Business	COM-Motors	VFD on centrif load - Process or HVAC fans or pumps up to 250 HP	3.1	5.9	6.7	0.6
Process Efficiency	COM-Motors	NEMA Premium Efficiency Motor	1.3	5.4	2.9	0.5

Table 25. Industrial Measures Included and Cost-Effectiveness Results – 2017-2019

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Efficient Products for Business	IND	Compressed Air - Air Entraining Air Nozzle, 100 psi, 0.25 kW/scfm	9.8	13.9	35.7	0.7

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Process Efficiency	IND	Compressed Air - Air Entraining Air Nozzle, 100 psi, 0.25 kW/scfm	9.8	14.0	35.8	0.7
Efficient Products for Business	IND	1L4'T8 HP	6.0	6.4	23.9	0.6
Process Efficiency	IND	Compressed Air - Cycling Air Dryer, >600scfm, all types	5.7	9.7	12.6	0.7
Efficient Products for Business	IND	Compressed Air - Air Receiver for Load/No-Load Compressors (>=5 gal/CFM storage), <=300 HP	5.4	9.3	14.2	0.7
Efficient Products for Business	IND	6L4'T8HP	5.3	6.9	15.3	0.6
Self-Direct	IND	6L4'T8HP	5.1	7.9	12.7	0.6
Process Efficiency	IND	Compressed Air - Cycling Air Dryer, >600scfm, all types	5.0	9.7	10.5	0.7
Self-Direct	IND	Self-Direct Program	4.5	6.9	12.6	0.6
Efficient Products for Business	IND	LED T8 Tube (4' T8 Replacement)	4.4	9.0	9.7	0.7
Efficient Products for Business	IND	LED Lighting >=10W - Indoor	3.6	4.9	16.9	0.6
Efficient Products for Business	IND	LED Lighting <10W - Indoor	3.5	4.8	15.7	0.6
Efficient Products for Business	IND	Photocell (Outdoor Lighting)	3.5	7.9	13.3	0.5
Self-Direct	IND	Photocell (Outdoor Lighting)	3.4	5.2	11.7	0.5
Efficient Products for Business	IND	1L4'T5 NLO	3.4	3.6	12.8	0.5
Process Efficiency	IND	Compressed Air - Variable Speed Drive Air Compressor, new, greater than 150 HP	3.3	8.5	6.4	0.7
Efficient Products for Business	IND	VFD on centrif load - Process or HVAC fans or pumps up to 200 HP	3.1	6.0	4.8	0.8
Self-Direct	IND	Daylighting Controls	3.1	5.6	4.8	0.8
Efficient Products for Business	IND	Daylighting Controls	3.0	9.3	4.5	0.9
Efficient Products for Business	IND	Compressed Air - Variable Speed Drive Air Compressor, new, less than 150 HP	3.0	8.0	5.3	0.7
Efficient Products for Business	IND	Compressed Air - Variable Speed Drive Air Compressor, new, less than 150 HP	3.0	8.0	5.3	0.7
Process Efficiency	IND	Compressed Air - Variable Speed Drive Air Compressor, new, greater than 150 HP	3.0	8.0	5.3	0.7
Self-Direct	IND	LED Lighting <10W - Indoor	2.6	4.5	5.2	0.6
Efficient Products for Business	IND	Compressed Air - Low Pressure Drop Filter for Compressed Air Systems, 25HP to 300HP, <500CFM, mist eliminator, <1 psi new	2.6	4.2	6.3	0.6
New Construction and Major Renovation	IND	Daylighting Controls	2.5	4.1	5.4	0.7
Efficient Products for Business	IND	Compressed Air - Cycling Air Dryer, <=600scfm, thermal mass	2.5	4.5	4.6	0.6
Self-Direct	IND	LED Lighting >=10W - Indoor	2.4	4.3	4.8	0.6

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Efficient Products for Business	IND	LED Troffer	2.3	10.2	4.1	0.7
Efficient Products for Business	IND	Compressed Air - Cycling Air Dryer, <=600scfm, thermal mass	2.2	4.5	3.9	0.6
Self-Direct	IND	Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	2.2	3.7	6.3	0.5
Efficient Products for Business	IND	Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	2.1	3.1	6.4	0.4
Efficient Products for Business	IND	4L4'T5 HLO	2.0	4.9	5.6	0.6
Self-Direct	IND	4L4'T5 HLO	1.9	3.3	5.0	0.5
Efficient Products for Business	IND	Compressed Air - Low Pressure Drop Filter for Compressed Air Systems, 25HP to 300HP, <500CFM, mist eliminator, <1 psi new	1.9	4.2	4.2	0.6
Self-Direct	IND	Occupancy Sensor	1.9	3.5	3.6	0.6
Efficient Products for Business	IND	Occupancy Sensor	1.9	6.8	3.3	0.7
New Construction and Major Renovation	IND	Compressed Air - Controls	1.9	3.3	3.6	0.6
Process Efficiency	IND	Compressed Air - Controls	1.6	5.1	2.5	0.7
Efficient Products for Business	IND	Cogged (V) belts on fans 5 HP to 100 HP	1.6	3.1	3.7	0.6
Efficient Products for Business	IND	Compressed air - no-loss condensate drains	1.6	4.2	3.1	0.6
Efficient Products for Business	IND	Cogged (V) belts on fans 5 HP to 100 HP	1.5	2.6	4.4	0.5
Efficient Products for Business	IND	1L4'T8 HP	1.5	4.8	3.0	0.6
Efficient Products for Business	IND	T8 Delamping	1.4	2.4	4.4	0.5
Efficient Products for Business	IND	Permanent T12 Removal During T8 Retrofit	1.4	3.7	4.4	0.5
Self-Direct	IND	LED Exit Sign	1.3	2.5	3.2	0.4
Efficient Products for Business	IND	LED Exit Sign	1.3	2.0	3.4	0.4
Continuous Energy Improvement	IND	T8 Delamping	1.2	1.7	5.1	0.4
Efficient Products for Business	IND	Daylighting Control + Occ Sensor	1.0	5.8	1.6	0.7
Efficient Products for Business	IND	Photocell + Timeclock (Outdoor Lighting)	1.0	4.7	2.4	0.5
Retro-Commissioning	IND	RCx Program	1.0	1.7	3.8	0.4
New Construction and Major Renovation	IND	Cogged (V) belts on fans 5 HP to 100 HP	0.9	1.7	3.0	0.4
Self-Direct	IND	Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	0.9	1.8	2.6	0.4
Efficient Products for Business	IND	Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	0.9	3.0	2.3	0.4
Self-Direct	IND	Photocell + Timeclock (Outdoor Lighting)	0.9	1.7	2.4	0.4

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Self-Direct	IND	Outdoor LED Flood Light (30W), TC Control	0.8	1.6	2.3	0.4
Efficient Products for Business	IND	Outdoor LED Flood Light (30W), TC Control	0.8	3.1	2.0	0.4
Efficient Products for Business	IND	Time clock (Outdoor Lighting)	0.8	4.7	2.0	0.5
Self-Direct	IND	Time clock (Outdoor Lighting)	0.6	1.1	1.7	0.4
Self-Direct	IND	LED Outdoor Wall Pack (30W) TC Control	0.6	1.1	1.7	0.4

Of the C&I measures screened, a majority passed the TRC test. These results indicate that most common commercial EE/PDR measures are cost effective in AEP Ohio's service area. Table 26 and Table 27 show the measures that were not included in the potential analysis because they failed the initial screen.

Table 26. Commercial Prescriptive Measures Not Included

Program	End-Use	Measure	Measure TRC
New Construction and Major Renovation	COM-HVAC	Water Source (water to air) Heat Pump (>= 17 kBtu/h) EER 14.3 - Heat Pump	0.8[5]
Efficient Products for Business	COM-HVAC	Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types (DUB)	0.8[6]
Efficient Products for Business	COM-HVAC	Split/Packaged Air Conditioner (65 - 135 kBtu/h) 12.5 EER, 14 IEER - Direct Exp /All Heating Types	0.7
Microbusiness	COM-Lighting	Outdoor Motion Sensor	0.7
Express	COM-Lighting	T8 Delamping	0.7
Express	COM-Other	Vending Machine PIR Occupancy Sensor - Cold Drink	0.7
Express	COM-Lighting	Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	0.6
Process Efficiency	COM-HVAC	High Performance Glazing - Direct Exp / Gas Heat	0.6
Microbusiness	COM-Lighting	Time clock (Outdoor Lighting)	0.6
Microbusiness	COM-HVAC	ENERGY STAR® Window / Room AC (DUB)	0.6
Express	COM-Lighting	Outdoor LED Flood Light (30W), TC Control	0.6
Efficient Products for Business	COM-HVAC	Split/Packaged Air Conditioner (65 - 135 kBtu/h) 12.5 EER, 14 IEER - Direct Exp /All Heating Types (DUB)	0.6
Retro-Commissioning	COM-Refrigeration	Floating Head Pressure Controls; 70F or lower, 1 HP or greater	0.6
Efficient Products for Business	COM-Lighting	LED Outdoor Wall Pack (30W) TC Control	0.6
Microbusiness	COM-Lighting	1L4'T8 HP	0.6
Efficient Products for Business	COM-Lighting	1L4'T8 HP	0.5

[5] This measure was not included despite a TRC >0.75 because it was less cost effective than an identical measure with a slightly lower efficiency level.

[6] Id.

Program	End-Use	Measure	Measure TRC
Efficient Products for Business	COM-Lighting	4L4'T5 HLO	0.5
Microbusiness	COM-Lighting	Hardwired Dimmer Switch	0.5
Process Efficiency	COM-HVAC	High Performance Glazing - Chiller / Gas Heat	0.5
New Construction and Major Renovation	COM-Lighting	4L4'T5 HLO	0.5
Efficient Products for Business	COM-Refrigeration	Glass Doors on Low and Med. Temperature Displays with glass doors	0.5
New Construction and Major Renovation	COM-Lighting	Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	0.5
Microbusiness	COM-HVAC	Air Source Heat Pump SEER 15, COP 2.49 (DUB)	0.5
Express	COM-Other	Vending Machine PIR Occupancy Sensor - Snacks	0.5
Microbusiness	COM-Lighting	Indoor Fixture-mounted Motion Sensor	0.5
New Construction and Major Renovation	COM-HVAC	Variable Refrigerant Flow A/C (< 5.4 tons, 14 SEER)	0.5
Process Efficiency	COM-HVAC	Cool Roof - Direct Exp / Gas Heat	0.5
Microbusiness	COM-Lighting	Photocell (Outdoor Lighting)	0.5
Express	COM-Lighting	4L4'T5 HLO	0.5
New Construction and Major Renovation	COM-HVAC	High Performance Glazing R-5, U 0.20 - Direct Exp / Elec Resist	0.5
New Construction and Major Renovation	COM-Lighting	Outdoor LED Flood Light (30W), TC Control	0.5
Efficient Products for Business	COM-HVAC	Economizer - Heat Pump	0.4
Express	COM-Refrigeration	Glass Doors on Low and Med. Temperature Displays with glass doors	0.4
New Construction and Major Renovation	COM-HVAC	Package system A/C (>=63.3 tons, minimum 10.2 EER, 11.4 IEER) - Direct Exp / All Heating Types	0.4
Express	COM-HVAC	Economizer - Heat Pump	0.4
Express	COM-Lighting	1L4'T8 HP	0.4
Express	COM-Lighting	LED Outdoor Wall Pack (30W) TC Control	0.4
New Construction and Major Renovation	COM-HVAC	Airside Economizer - below 33,000 Btu/h	0.4
Process Efficiency	COM-HVAC	Code minimum R-20ci or R-38 batt - Heat Pump	0.4
Efficient Products for Business	COM-HVAC	Economizer - Direct Exp / Gas Heat	0.4
New Construction and Major Renovation	COM-HVAC	Split/Packaged Air Conditioner (65 - 135 kBtu/h) 12.5 EER, 14 IEER - Direct Exp /All Heating Types	0.4
Microbusiness	COM-Other	ENERGY STAR® Monitor	0.4
Express	COM-HVAC	Economizer - Direct Exp / Gas Heat	0.4
Data Center	COM-Other	Data Center PUE <=1.22	0.4
Data Center	COM-Other	Network PC Management Software	0.3
Microbusiness	COM-HVAC	Ground Source Heat Pump (Elec Res Base)	0.3
New Construction and Major Renovation	COM-HVAC	Improved Ceiling Insulation R45 batt - Heat Pump	0.3
Process Efficiency	COM-HVAC	Cool Roof - Heat Pump	0.3
Efficient Products for Business	COM-HVAC	Split/Package system A/C (<65 kBtu/h, 15 SEER) - Direct Exp /All Heating Types (DUB)	0.3

Program	End-Use	Measure	Measure TRC
New Construction and Major Renovation	COM-Lighting	LED Outdoor Wall Pack (30W) TC Control	0.3
New Construction and Major Renovation	COM-HVAC	Groundwater to Water Heat Pump (>17 kBtu/h and < 135 kBtu/h) EER 18.0 - Heat Pump	0.3
Process Efficiency	COM-HVAC	Cool Roof - Direct Exp / Elec Resist	0.3
Efficient Products for Business	COM-Lighting	LED Outdoor Wall Pack (15W) TC Control	0.3
Express	COM-Lighting	LED Outdoor Wall Pack (15W) TC Control	0.3
Microbusiness	COM-Lighting	Indoor Wall-mounted Motion Sensor	0.2
Microbusiness	COM-Other	Instantaneous Electric Water Heater - .99 EF (DUB)	0.2
Process Efficiency	COM-HVAC	Cool Roof - Chiller / Gas Heat	0.2
Process Efficiency	COM-HVAC	Code minimum R-20ci or R-38 batt - Chiller / Gas Heat	0.2
Process Efficiency	COM-HVAC	Improved Ceiling Insulation R24ci or R44 batt - Direct Exp / Elec Resist (DUB)	0.2
Efficient Products for Business	COM-HVAC	Economizer - Chiller / Elec Resist	0.2
Express	COM-HVAC	Economizer - Chiller / Elec Resist	0.2
Microbusiness	COM-Other	High Eff. Elec. Water Heat - Tank - .95 EF (DUB)	0.2
New Construction and Major Renovation	COM-HVAC	High Performance Glazing R-5, U 0.20 - Heat Pump	0.2
New Construction and Major Renovation	COM-Lighting	LED Outdoor Wall Pack (15W) TC Control	0.2
Efficient Products for Business	COM-HVAC	Economizer - Direct Exp / Elec Resist	0.1
Express	COM-HVAC	Economizer - Direct Exp / Elec Resist	0.1
Process Efficiency	COM-HVAC	Code minimum R-20ci or R-38 batt - Direct Exp / Gas Heat	0.1
Process Efficiency	COM-HVAC	Improved Ceiling Insulation R24ci or R44 batt - Chiller / Elec Resist (DUB)	0.1
Microbusiness	COM-HVAC	CAC Tune-Up	0.1
Efficient Products for Business	COM-Other	Neon sign replacement with LED	0.1
New Construction and Major Renovation	COM-HVAC	Cool Roof, max abs. = 0.3, non-electric heat	0.1
New Construction and Major Renovation	COM-HVAC	Improved Ceiling Insulation R45 batt - Direct Exp / Gas Heat	0.0
Efficient Products for Business	COM-Other	Efficient Open Display Cases	0.0
New Construction and Major Renovation	COM-HVAC	High Performance Glazing R-5, U 0.20 - Direct Exp / Gas Heat	0.0
Process Efficiency	COM-HVAC	Improved Ceiling Insulation R24ci or R44 batt - Heat Pump (DUB)	0.0
Process Efficiency	COM-HVAC	Cool Roof - Chiller / Elec Resist	0.0
Process Efficiency	COM-HVAC	Improved Ceiling Insulation R24ci or R44 batt - Chiller / Gas Heat (DUB)	0.0
Process Efficiency	COM-HVAC	Improved Ceiling Insulation R24ci or R44 batt - Direct Exp / Gas Heat (DUB)	0.0

Table 27. Industrial Measures Not Included

Program	End-Use	Measure	Measure TRC
Process Efficiency	IND	Energy Management System	0.7
Continuous Energy Improvement	IND	Energy Management System	0.6
Efficient Products for Business	IND	LED Outdoor Wall Pack (30W) TC Control	0.6
Self-Direct	IND	LED Outdoor Wall Pack (15W) TC Control	0.3
Efficient Products for Business	IND	LED Outdoor Wall Pack (15W) TC Control	0.3

A.3.2.3 Cross-Sector Measures

The cost-effectiveness of each measure in the cross-sector programs—which include Residential Multifamily, Commercial Multifamily, and Agriculture—was analyzed. About 71% of the measures passed the initial TRC screening and are included in the potential analysis. In some instances a measure with a TRC less than 0.75 was included where deemed appropriate to do so, particularly when a measure may be bundled with other measures. Table 28 and Table 29 show the cross-sector measures that were included in the potential analysis.

Table 28. Multifamily Measures Included and Cost Test Results, 2017-2019

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Multifamily-Com	COM-Lighting	LED Lighting <10W - Indoor	8.5	14.2	20.7	0.6
Multifamily-Com	COM-Lighting	LED Lighting >=10W - Indoor	7.9	13.8	17.0	0.6
Multifamily-Com	COM-HVAC	Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump	5.4	14.3	9.9	0.6
Multifamily-Com	COM-HVAC	Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types	4.2	6.3	3.7	1.3
Multifamily-Com	COM-Lighting	1L4'T8 HP	3.7	7.1	8.1	0.6
Multifamily-Com	COM-HVAC	Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump	3.7	10.0	6.7	0.6
Multifamily-Com	COM-Lighting	6L4'T8HP	3.4	5.3	7.4	0.5
Multifamily-Com	COM-HVAC	Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump	3.1	4.7	5.6	0.6
Multifamily-Com	COM-Lighting	LED T8 Tube (4' T8 Replacement)	2.9	5.6	6.0	0.6
Multifamily-Com	COM-Lighting	1L4'T5 NLO	2.7	5.1	7.0	0.5
Multifamily-Com	COM-Lighting	Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	2.6	4.9	7.9	0.4
Multifamily-Com	COM-Lighting	LED Exit Sign	2.5	6.0	6.0	0.5
Multifamily-Com	COM-HVAC	Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER)	2.5	9.5	2.5	1.1
Multifamily-Com	COM-HVAC	Split/Package system A/C (<65 kBtu/h, 15 SEER) - Direct Exp /All Heating	2.5	5.5	2.8	1.0

		Types				
Multifamily	Res-HVAC/Shell	Triple Pane Windows - Central A/C - Non-EL Heat (DUB)	1.9	2.5	6.4	0.6
Multifamily	Res-Lighting	LED Lighting 12W - Indoor (CFL Base)	1.9	1.0	28.1	0.3
Multifamily	Res-HVAC/Shell	Triple Pane Windows - Heat Pump (DUB)	1.9	2.0	18.8	0.4
Multifamily	Res-HVAC/Shell	Triple Pane Windows - Central A/C - EL Heat (DUB)	1.8	1.9	30.8	0.4
Multifamily	Res-Lighting	LED Lighting 15W - Indoor	1.8	1.9	17.4	0.4
Multifamily	Res-Lighting	LED Lighting 8W - Indoor	1.8	1.9	17.0	0.4
Multifamily-Com	COM-HVAC	Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types (DUB)	1.8	8.5	1.8	1.1
Multifamily	Res-Water Heat	Low Flow Faucet Aerator, 1.5 GPM - EDHW	1.7	2.3	15.4	0.4
Multifamily-Com	COM-Lighting	Permanent T12 Removal During T8 Retrofit	1.7	3.4	4.3	0.5
Multifamily	Res-HVAC/Shell	SEER 15 CAC - Non-EL Heat (DUB)	1.7	2.3	3.9	0.7
Multifamily	Res-HVAC/Shell	SEER 15 CAC - EL Heat (DUB)	1.7	1.8	4.2	0.7
Multifamily	Res-Water Heat	Low Flow (1.25 GPM) showerhead	1.7	2.7	31.0	0.4
Multifamily	Res-Water Heat	DHW Pipe Insulation R-4 10 feet	1.6	2.1	10.6	0.4
Multifamily-Com	COM-HVAC	Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump (DUB)	1.5	16.0	3.0	0.6
Multifamily-Com	COM-Lighting	Daylighting Controls	1.4	3.0	2.0	0.8
Multifamily	Res-HVAC/Shell	Reduced ACHnat 0.3 - Central A/C - EL Heat	1.4	1.9	12.0	0.3
Multifamily-Com	COM-Lighting	Occupancy Sensor	1.3	2.8	2.1	0.7
Multifamily-Com	COM-Lighting	LED Troffer	1.3	2.6	2.9	0.5
Multifamily-Com	COM-HVAC	Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump	1.3	5.5	2.5	0.6
Multifamily	Res-Appliance	Clothes Washer - Tier 3 >= 2.2 MEF-w/elec dry (DUB)	1.3	1.4	23.4	0.3
Multifamily	Res-Lighting	LED Lighting 8W - Indoor (CFL Base)	1.3	0.7	9.6	0.3
Multifamily	Res-HVAC/Shell	ENERGY STAR® Window / Room AC (DUB)	1.2	1.5	2.7	0.7
Multifamily	Res-Appliance	Efficient Refrigerator (ENERGY STAR® or Better) (DUB)	1.2	1.3	9.4	0.3
Multifamily-Com	COM-HVAC	Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types	1.2	4.5	0.9	1.4
Multifamily-Com	COM-Lighting	T8 Delamping	1.2	2.4	2.8	0.5
Multifamily-Com	COM-HVAC	Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump (DUB)	1.1	11.9	2.4	0.5
Multifamily	Res-Lighting	1W LED Night Light	1.1	1.3	15.1	0.3
Multifamily	Res-HVAC/Shell	Reduced ACHnat 0.3 - Heat Pump	1.1	1.6	6.2	0.3
Multifamily	Res-HVAC/Shell	ENERGY STAR® 50 CFM Bathroom Ventilating Fan	1.1	1.6	4.2	0.4

Multifamily	Res-Appliance	Clothes Washer - Tier 3 >= 2.2 MEF-w/gas or no dry (DUB)	1.0	1.1	8.4	0.3
Multifamily-Com	COM-Lighting	Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	1.0	2.1	3.2	0.4
Multifamily-Com	COM-HVAC	Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump (DUB).	1.0	6.2	2.1	0.5
Multifamily-Com	COM-Lighting	Time clock (Outdoor Lighting)	1.0	1.9	3.0	0.3
Multifamily-Com	COM-HVAC	Water Source (water to air) Heat Pump (< 17 kBtu/h) EER 13.4 - Heat Pump (DUB)	0.9	8.5	1.9	0.5
Multifamily-Com	COM-HVAC	Water Source (water to air) Heat Pump (< 17 kBtu/h) EER 13.4 - Heat Pump	0.9	8.5	1.9	0.5
Multifamily-Com	COM-Lighting	Photocell + Timeclock (Outdoor Lighting)	0.9	1.9	2.9	0.3
Multifamily-Com	COM-HVAC	Water Source (water to air) Heat Pump (>= 17 kBtu/h) EER 14.3 - Heat Pump (DUB)	0.9	7.3	1.9	0.5
Multifamily-Com	COM-HVAC	Water Source (water to air) Heat Pump (>= 17 kBtu/h) EER 14.3 - Heat Pump	0.9	7.3	1.9	0.5
Multifamily	Res-HVAC/Shell	Air Source Heat Pump SEER 15, COP 2.49 (DUB)	0.9	1.0	6.2	0.3
Multifamily-Com	COM-Lighting	Outdoor LED Flood Light (30W), TC Control	0.9	1.8	2.8	0.3
Multifamily	Res-Water Heat	Heat Pump Water Heater - 2.0 EF (DUB)	0.8	1.1	6.5	0.3
Multifamily	Res-Appliance	ENERGY STAR® Dishwasher - Elec DHW (DUB)	0.7	0.9	6.4	0.3
Multifamily	Res-Water Heat	High Performance Circulating Pump (DHW)	0.7	1.9	2.3	0.4
Multifamily	Res-Appliance	Refrigerator Retirement	0.6	0.7	N/A	0.3
Multifamily	Res-Appliance	Freezer Retirement	0.6	0.6	N/A	0.3
Multifamily	Res-Appliance	ENERGY STAR® Set Top Boxes	0.5	0.6	4.0	0.2
Multifamily	Res-Appliance	ENERGY STAR® Dishwasher - Non-EL DHW (DUB)	0.5	0.5	4.2	0.2
Multifamily	Res-Water Heat	Instantaneous Electric Water Heater - .99 EF (DUB)	0.2	0.3	1.7	0.2
Multifamily	Res-Water Heat	High Eff. Elec. Water Heat - Tank - .95 EF (DUB)	0.2	0.2	1.6	0.1

Table 29. Agriculture Measures Included and Cost Test Results, 2017-2019

Program Type	End Use	Measure	TRC	UCT	PCT	RIM
Agriculture	AG	Fan thermostat controller (Agriculture)	4.7	5.0	37.7	0.5
Agriculture	AG	Low Pressure Sprinkler Nozzle,	3.7	7.2	6.6	0.9
Agriculture	AG	Dairy Scroll Compressors (Agriculture)	3.6	3.8	19.6	0.5
Agriculture	AG	HE High-Speed Fan - 48" to 71" diameter	3.1	4.8	6.3	0.8
Agriculture	AG	Variable Speed Drive for Milk Vacuum Pump	2.6	4.7	6.3	0.6
Agriculture	AG	HE High-Speed Fan - 36" to 47" diameter	2.3	5.0	4.0	0.8

Agriculture	AG	High Volume Low Speed Fans 24' diameter (Agriculture)	2.2	4.8	4.6	0.7
Agriculture	AG	Tractor Engine Block Heater Timer (Agriculture)	2.2	3.6	7.8	0.5
Agriculture	AG	High Volume Low Speed Fans 22' diameter (Agriculture)	2.1	4.9	4.4	0.7
Agriculture	AG	High Volume Low Speed Fans 20' diameter (Agriculture)	2.1	5.0	4.2	0.7
Agriculture	AG	VFD on Dairy Transfer pumps up to 250 HP	2.1	4.1	5.3	0.5
Agriculture	AG	High Volume Low Speed Fans 18' diameter(Agriculture)	2.0	5.1	3.9	0.7
Agriculture	AG	High Volume Low Speed Fans 16' diameter (Agriculture)	1.9	5.3	3.6	0.7
Agriculture	AG	HE High-Speed Fan - 24" to 35" diameter	1.7	5.0	2.8	0.8
Agriculture	AG	Water Pre-Heat Heat Exchanger (Water Heating Savings)	1.5	4.1	3.4	0.6
Agriculture	AG	Heat Reclaimer Units (Agriculture)	1.3	2.6	3.4	0.5
Agriculture	AG	Milk Pre-Cooler Heat Exchanger (Chiller Savings) (Agriculture)	1.1	3.4	2.2	0.6
Agriculture	AG	Agriculture Heat Pads	0.7	1.6	2.7	0.4

Of the cross-sector measures screened, a majority passed the TRC test. These results indicate that most common cross-sector EE/PDR measures are cost effective in AEP Ohio's service area. Table 30 shows the measures that were not included in the potential analysis because they failed the initial screen.

Table 30. Cross-Sector Measures Not Included

Program	End-Use	Measure	Measure TRC
Agriculture	AG	Livestock Waterers (Agriculture)	0.7
Multifamily-Com	COM-HVAC	Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types (DUB)	0.7
Multifamily-Com	COM-HVAC	Split/Packaged Air Conditioner (65 - 135 kBtu/h) 12.5 EER, 14 IEER - Direct Exp /All Heating Types	0.6
Agriculture	AG	Switch from sprinkler to Drip Irrigation	0.6
Multifamily	Res-HVAC/Shell	NEST Consumer Controls - EL Heat - (DUB)	0.6
Multifamily-Com	COM-Lighting	LED Outdoor Wall Pack (30W) TC Control	0.6
Multifamily-Com	COM-Lighting	4L4'T5 HLO	0.6
Multifamily-Com	COM-HVAC	Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump (DUB)	0.6
Multifamily-Com	COM-Lighting	1L4'T8 HP	0.6
Multifamily	Res-HVAC/Shell	NEST Consumer Controls - Heat Pump - (DUB)	0.5
Multifamily	Res-HVAC/Shell	NEST Consumer Controls - Non-EL Heat - (DUB)	0.5
Multifamily-Com	COM-HVAC	Split/Packaged Air Conditioner (65 - 135 kBtu/h) 12.5 EER, 14 IEER - Direct Exp /All Heating Types (DUB)	0.5
Multifamily-Com	COM-Lighting	Photocell (Outdoor Lighting)	0.4

Program	End-Use	Measure	Measure TRC
Multifamily	Res-Appliance	ENERGY STAR® Dishwasher - Elec DHW	0.4
Multifamily-Com	COM-Lighting	LED Outdoor Wall Pack (15W) TC Control	0.3
Multifamily-Com	COM-HVAC	Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER) (DUB)	0.3
Multifamily-Com	COM-HVAC	Split/Package system A/C (<65 kBtu/h, 15 SEER) - Direct Exp /All Heating Types (DUB)	0.3
Multifamily	Res-Appliance	ENERGY STAR® Dishwasher - Non-EL DHW	0.2
Multifamily	Res-HVAC/Shell	CAC Tune-Up	0.1
Multifamily	Res-HVAC/Shell	Reduced ACHnat 0.3 - Central A/C - Non-EL Heat	0.1

A.4 EE/PDR Potential Results

This section presents a summary of the methodology and results for the EE/PDR potential aspect of the project. All results reported in this chapter are based on a summer peak analysis.

A.4.1 Overall EE/PDR Potential Results

The cumulative annual EE/PDR potential savings (Market Potential) in 2036, not including CHP/WER, is estimated to be approximately 6.8 thousand GWh at meter, about 14.0 percent of forecast baseline sales, and approximately 1,330 MW at meter, about 13.6 percent of baseline peak summer demand as shown in

Table 31.

Table 31 also presents the projected savings in 2036 for the technical, economic, and high market potential scenarios.

These results assume a net-to-gross impact ratio of 1.0 whereby free ridership is assumed for this analysis to be offset by spillover impacts. The market potential meets the SB 310 savings targets over the short term, from 2017 to 2019. Unless already specified for a particular measure, the market potential includes incentives up to 50 percent of incremental measure costs.

Table 31. Projected Cumulative Annual Savings at Meter and Costs – 2036

Potential Scenario	Cumulative Annual Gross Energy Savings at Meter (2036) (1)		Cumulative Annual Gross Summer Peak Demand Savings at Meter (2036) (1)		Total Cost (Energy Efficiency Only)
Sector	GWh	Percent of 2036 Forecast Sales	MW	Percent of 2036 Forecast Sales	20 Year Cost (2017 to 2036) (million 2017$)
Residential					
Technical	8,600	58.3%	2,492	69.9%	-
Economic	6,443	43.7%	1,624	45.5%	-
Market	1,946	13.2%	526	14.7%	$1,223
Commercial, Industrial, and Agriculture (does not include CHP/WER)					
Technical	24,223	72.8%	3,480	56.1%	-
Economic	22,226	66.8%	3,254	52.5%	-
Market	4,790	14.4%	803	12.9%	$889
Total					
Technical (2)	**32,823**	**68.3%**	**5,972**	**61.1%**	**-**
Economic	**28,669**	**59.7%**	**4,878**	**49.9%**	**-**
Market	**6,736**	**14.0%**	**1,329**	**13.6%**	**$2,113**

(1) Savings are not projected for Research and Development, Transmission and Distribution (T&D) Loss Reductions, T&D Customer Efficiency, Energy Efficiency Auction, gridSMART EE/PDR, Customer EE Assessment Survey, Community Energy Savers. For comparative purposes, savings are not included for Combined Heat and Power / Waste Energy Recovery. AEP Ohio also will conduct program evaluation and other essential program support functions, such as compliance and reporting, database management, contracting and payables, and Plan cost-benefit analysis. (2) Total Technical Potential does not include savings from codes and standards.

Figure 3 and Figure 4 show the cumulative annual energy and summer peak demand savings in 2031 for each of the four potential analysis scenarios.

Figure 3. Cumulative Annual GWh Energy Savings in 2036

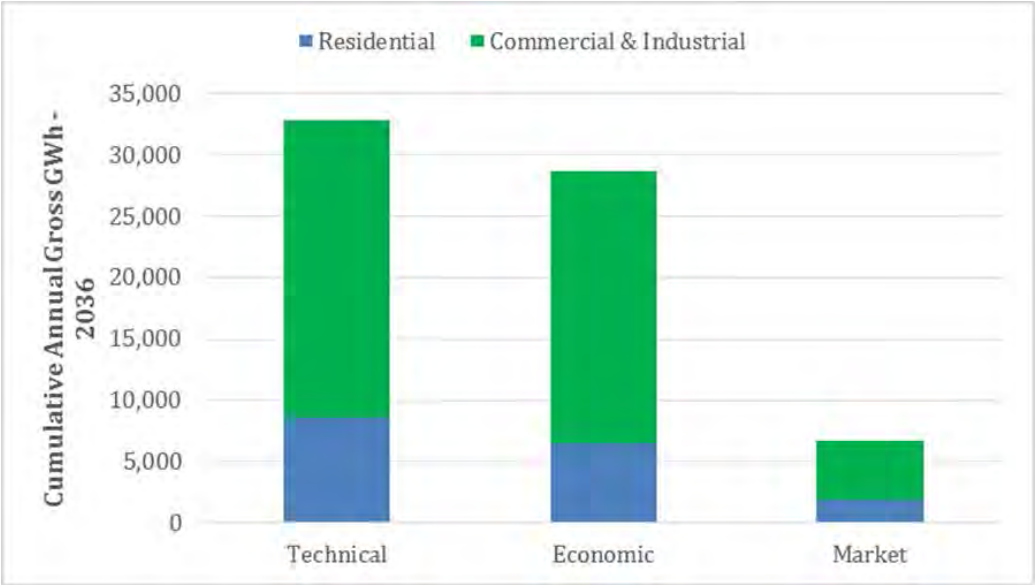
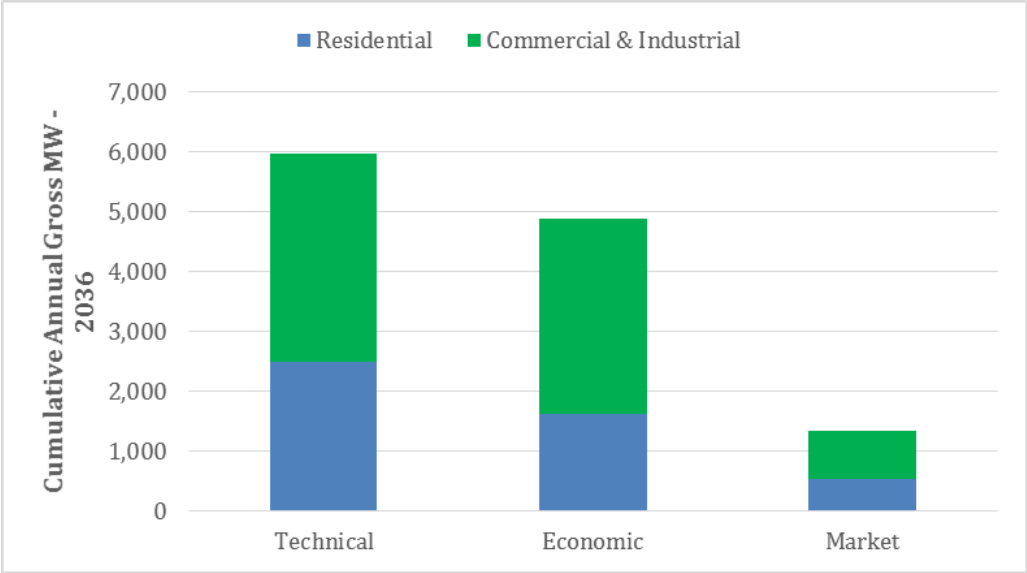


Figure 4. Cumulative Annual Summer Peak MW Demand Savings in 2036



Note for Figure 4 and Figure 5: Savings are not projected for Research and Development, Transmission and Distribution (T&D) Loss Reductions, T&D Customer Efficiency, Energy Efficiency Auction, gridSMART EE/PDR, Customer EE Assessment Survey, Community Energy Savers. For comparative purposes, savings are not included for Combined Heat and Power / Waste Energy Recovery. AEP Ohio also will conduct program evaluation and other essential program support functions, such as compliance and reporting, database management, contracting and payables, and Plan cost-benefit analysis. (2) Total Technical Potential does not include savings from codes and standards.

Figure 5 and Figure 6 show the cumulative Market Potential[7] as a percent of the Economic Potential for EE/PDR.

Figure 5. Market Potential Annual Energy Savings at Meter as Percent of Economic Potential in 2036

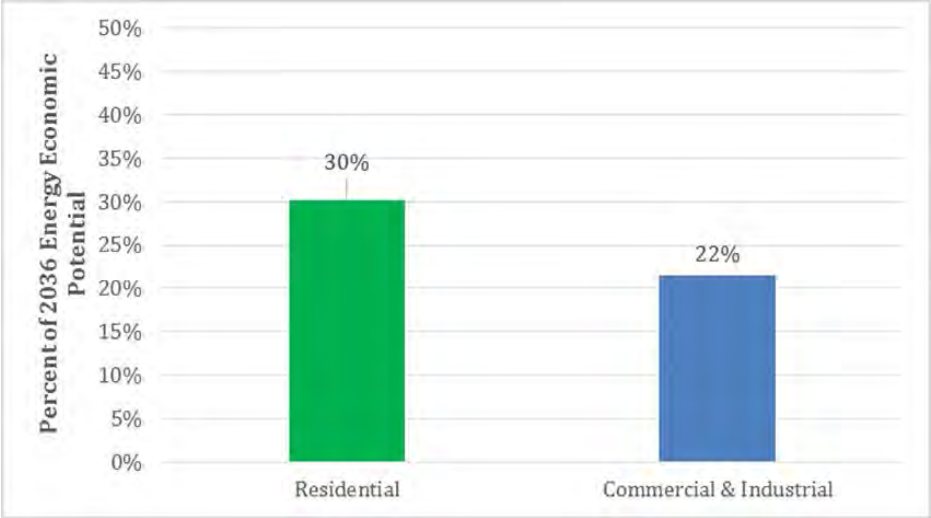
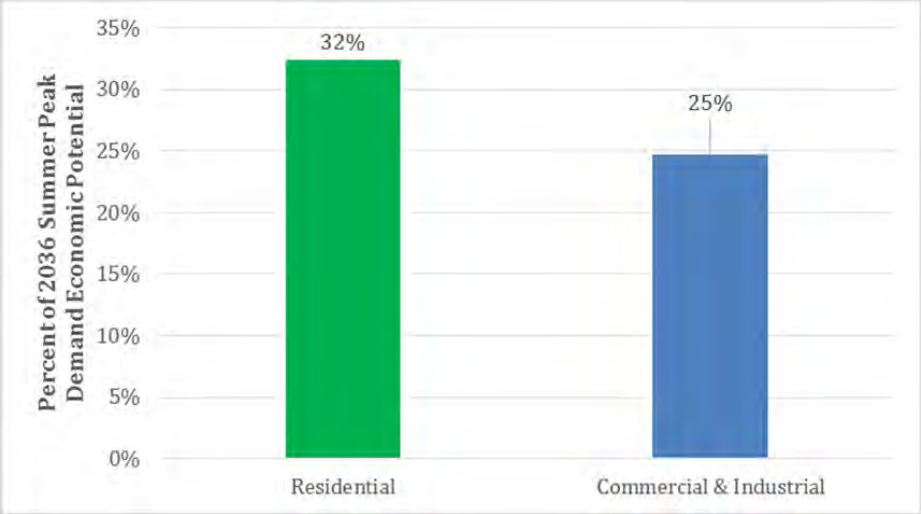


Figure 6. Peak Demand Savings at Meter as Percent of Economic Potential in 2036



Note for Figure 6 and Figure 7: Savings are not projected for Research and Development, Transmission and Distribution (T&D) Loss Reductions, T&D Customer Efficiency, Energy Efficiency Auction, gridSMART EE/PDR, Customer EE Assessment Survey, Community Energy Savers. For comparative purposes, savings are not included for Combined Heat and Power / Waste Energy Recovery. AEP Ohio also will conduct program evaluation and other essential program support functions, such as compliance and reporting, database management, contracting and

[7] Defined here as the potential achievable in real-world market risk situations.

payables, and Plan cost-benefit analysis. (2) Total Technical Potential does not include savings from codes and standards.

A.4.1.1 Residential EE/PDR Potential Results

This section provides the EE/PDR potential results for the residential sector. The total and annual incremental residential achievable EE/PDR potential results for twenty years (2017-2036) are shown in Table 32 and Table 33, the energy values shown below are for the measures' first-year savings at meter, the incremental demand savings are the summer peak coincident demand savings, and the program costs are the total estimated EE/PDR program budgets for a given year, including rebate or other customer incentive costs as well as administrative and implementation costs.

The total twenty-year estimated residential market potential in 2036 is about 1,946 GWh in cumulative annual savings at meter and about 526 MW of cumulative annual summer peak demand. The annual incremental energy savings at meter starts at 1.4 percent, and peaks out in 2025 at about 2.2 percent of AEP Ohio's forecast annual residential energy sales; annual impacts begin to decline slowly thereafter as markets become saturated. Savings are predominantly from lighting and HVAC/shell measures, followed by appliances, hot water, and whole building measures. These results assume a net-to-gross impact ratio of 1.0, whereby freeridership is assumed for this analysis to be offset by spillover impacts.

Table 34 to Table 36 show projected residential incremental costs, Technical Potential, and Economic Potential over the twenty-year time period.

Table 32. Residential Market Potential Scenario: 2017 – 2036 Cumulative Annual Savings at Meter

Residential Cumulative Market Potential																				
Energy Potential (GWh)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Appliances	15.3	31.1	46.7	64.0	82.6	101.6	121.7	144.3	168.9	181.7	194.9	209.7	224.6	239.9	255.7	269.3	280.5	289.5	297.7	305.3
HVAC	12.0	24.1	36.1	48.1	60.1	72.2	84.2	96.2	108.2	120.3	120.3	120.3	120.3	120.3	120.3	120.3	120.3	120.3	120.3	120.3
HVAC/Shell	11.3	22.4	34.0	46.2	60.2	76.3	93.5	113.6	134.1	155.6	177.2	196.9	216.3	235.1	254.6	271.6	287.2	301.9	315.5	328.9
Lighting	68.6	132.1	192.2	240.5	270.0	307.6	353.7	403.5	454.8	504.8	556.3	605.4	651.3	694.5	734.6	771.3	758.6	747.9	738.2	741.3
Package	80.3	86.0	92.6	97.6	102.3	107.1	112.6	119.3	126.3	133.4	140.4	147.8	155.6	163.6	172.1	180.1	187.9	196.0	204.2	212.5
Water Heat	9.8	20.8	31.7	44.8	58.6	72.9	88.3	104.0	117.3	130.0	142.8	154.8	167.1	178.2	190.1	200.7	210.3	218.6	228.8	238.0
Total	**197.5**	**316.5**	**433.3**	**541.2**	**633.8**	**737.6**	**853.9**	**980.8**	**1,109.6**	**1,225.8**	**1,331.9**	**1,434.8**	**1,535.2**	**1,631.7**	**1,727.4**	**1,813.4**	**1,844.7**	**1,874.1**	**1,904.6**	**1,946.2**
% of Sector Forecast	**1.4%**	**2.2%**	**3.1%**	**3.8%**	**4.5%**	**5.2%**	**6.1%**	**7.0%**	**7.9%**	**8.7%**	**9.4%**	**10.0%**	**10.7%**	**11.3%**	**11.9%**	**12.5%**	**12.7%**	**12.8%**	**13.0%**	**13.2%**
Demand Potential (MW)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Appliances	2.3	5.1	7.8	10.9	14.2	17.7	21.4	25.6	30.2	32.9	35.8	38.9	42.1	45.3	48.6	51.5	54.0	56.1	58.1	60.0
HVAC	25.0	50.0	75.0	100.0	125.0	150.0	175.0	200.0	225.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
HVAC/Shell	4.1	8.2	12.3	16.6	21.8	27.8	34.4	42.2	49.0	56.2	63.4	69.9	76.1	81.9	87.8	93.2	97.9	102.3	106.5	110.7
Lighting	4.7	9.0	13.1	16.4	18.1	20.1	23.2	26.6	30.1	33.7	37.7	41.7	45.4	49.1	52.6	55.9	55.7	55.5	55.2	55.7
Package	4.3	4.9	5.7	6.2	6.7	7.1	7.8	8.7	9.7	10.7	11.8	12.9	14.0	15.2	16.5	17.8	18.8	20.0	21.2	22.4
Water Heat	1.1	2.3	3.5	4.9	6.4	8.0	9.7	11.4	12.9	14.3	15.8	17.2	18.6	19.9	21.3	22.5	23.7	24.6	25.8	26.8
Total	**41.6**	**79.5**	**117.4**	**155.1**	**192.3**	**230.8**	**271.5**	**314.5**	**356.9**	**397.8**	**414.5**	**430.5**	**446.3**	**461.4**	**476.9**	**490.9**	**500.0**	**508.5**	**516.8**	**525.7**
% of Sector Forecast	**1.2%**	**2.3%**	**3.6%**	**4.8%**	**5.9%**	**7.1%**	**7.8%**	**9.6%**	**10.8%**	**12.0%**	**12.4%**	**12.8%**	**12.4%**	**13.5%**	**13.8%**	**14.1%**	**14.3%**	**13.6%**	**13.8%**	**14.7%**

Table 33. Residential Market Potential Scenario: 2017 – 2036 Incremental Annual Savings at Meter

Residential Incremental Market Potential																				
Energy Potential (GWh)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Appliances	15.3	15.8	15.6	17.3	18.5	19.6	20.8	23.4	25.7	26.5	27.0	28.6	30.2	31.7	33.2	31.8	31.8	31.8	31.7	31.7
HVAC	12.0	24.1	36.1	48.1	60.1	72.2	84.2	96.2	108.2	120.3	120.3	120.3	120.3	120.3	120.3	120.3	120.3	120.3	120.3	120.3
HVAC/Shell	11.3	11.2	11.5	12.3	14.0	16.0	17.3	20.0	22.9	23.8	23.8	24.1	24.5	24.5	25.6	25.2	24.8	24.6	24.0	24.1
Lighting	68.6	63.5	60.1	48.3	29.5	37.6	46.1	49.8	51.3	50.1	51.5	49.1	46.0	43.7	42.6	39.6	37.3	37.2	36.4	37.2
Package	80.3	80.7	81.6	79.9	79.8	79.8	80.5	81.7	82.0	82.1	82.1	82.4	82.7	83.0	83.5	83.1	82.8	83.0	83.2	83.3
Water Heat	9.8	11.0	10.9	13.1	13.8	14.5	15.8	16.0	13.7	13.3	14.7	14.2	14.6	13.9	14.8	13.7	13.9	12.9	13.2	12.6
Total	**197.5**	**206.1**	**215.8**	**219.0**	**215.7**	**239.6**	**264.7**	**287.2**	**303.9**	**316.0**	**319.3**	**318.7**	**318.2**	**317.1**	**319.9**	**313.6**	**310.7**	**309.7**	**308.8**	**309.1**
% of Sector Forecast	**1.4%**	**1.4%**	**1.5%**	**1.5%**	**1.5%**	**1.7%**	**1.9%**	**2.0%**	**2.2%**	**2.2%**	**2.2%**	**2.2%**	**2.2%**	**2.2%**	**2.2%**	**2.2%**	**2.1%**	**2.1%**	**2.1%**	**2.1%**
Demand Potential (MW)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Appliances	2.3	2.8	2.7	3.1	3.3	3.5	3.8	4.3	4.7	4.8	4.9	5.2	5.5	5.7	5.9	5.7	5.6	5.6	5.6	5.6
HVAC	25.0	50.0	75.0	100.0	125.0	150.0	175.0	200.0	225.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
HVAC/Shell	4.1	4.0	4.1	4.3	5.1	6.1	6.6	7.8	8.6	8.9	8.9	9.1	9.2	9.2	9.7	9.7	9.6	9.7	9.6	9.7
Lighting	4.7	4.3	4.1	3.2	1.8	2.0	3.1	3.4	3.6	3.6	4.1	4.0	3.8	3.6	3.6	3.3	3.2	3.2	3.1	3.2
Package	4.3	4.4	4.5	4.2	4.2	4.2	4.4	4.7	4.7	4.8	4.8	4.9	4.9	5.0	5.0	5.0	4.8	4.9	5.0	5.0
Water Heat	1.1	1.2	1.2	1.4	1.5	1.6	1.7	1.7	1.5	1.5	1.7	1.6	1.7	1.6	1.7	1.6	1.6	1.5	1.5	1.4
Total	**41.6**	**66.7**	**91.6**	**116.4**	**141.0**	**167.4**	**194.7**	**221.9**	**248.1**	**273.5**	**274.4**	**274.7**	**275.0**	**275.1**	**276.0**	**275.2**	**274.8**	**274.8**	**274.8**	**274.8**
% of Sector Forecast	**1.2%**	**1.9%**	**2.8%**	**3.6%**	**4.3%**	**5.1%**	**5.6%**	**6.8%**	**7.5%**	**8.2%**	**8.2%**	**8.1%**	**7.6%**	**8.0%**	**8.0%**	**7.9%**	**7.8%**	**7.4%**	**7.3%**	**7.7%**

Table 34. Residential Market Potential Scenario: 2017 – 2036 Incremental Costs

Residential - Administrative ($M) by End-Use																				
Administrative ($M)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Appliances	$1.2	$1.2	$1.2	$1.4	$1.5	$1.5	$1.6	$1.7	$1.7	$1.8	$1.8	$1.8	$1.9	$2.0	$2.0	$1.9	$1.9	$1.9	$1.9	$1.9
HVAC	$1.2	$2.4	$3.5	$4.7	$5.9	$7.1	$8.2	$9.4	$10.6	$11.8	$11.8	$11.8	$11.8	$11.8	$11.8	$11.8	$11.8	$11.8	$11.8	$11.8
HVAC/Shell	$4.1	$4.1	$4.3	$4.6	$5.2	$6.0	$6.5	$7.5	$8.5	$8.9	$8.9	$9.1	$9.2	$9.2	$9.6	$9.5	$9.4	$9.3	$9.1	$9.1
Lighting	$8.4	$8.0	$7.8	$6.5	$4.5	$5.4	$6.0	$6.3	$6.4	$6.1	$6.0	$5.6	$5.2	$4.9	$4.7	$4.4	$4.1	$3.9	$3.9	$3.9
Package	$2.7	$2.7	$3.0	$2.5	$2.5	$2.5	$2.7	$3.0	$3.1	$3.1	$3.1	$3.2	$3.3	$3.4	$3.5	$3.4	$3.3	$3.4	$3.5	$3.5
Water Heat	$1.3	$1.4	$1.3	$1.5	$1.7	$1.8	$2.0	$2.1	$1.8	$1.9	$2.0	$2.0	$2.1	$2.0	$2.1	$2.0	$2.1	$2.0	$2.0	$2.0
Total	**$18.9**	**$19.8**	**$21.2**	**$21.2**	**$21.2**	**$24.2**	**$26.9**	**$29.9**	**$32.1**	**$33.5**	**$33.6**	**$33.5**	**$33.5**	**$33.3**	**$33.8**	**$33.1**	**$32.6**	**$32.3**	**$32.1**	**$32.2**
Residential - Incentive ($M) by End-Use																				
Incentive ($M)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Appliances	$4.5	$4.9	$5.0	$5.9	$6.6	$7.3	$8.2	$9.6	$11.2	$11.4	$11.5	$12.1	$12.7	$13.3	$13.8	$13.2	$13.1	$13.1	$13.0	$12.9
HVAC	$0.8	$1.5	$2.3	$3.1	$3.8	$4.6	$5.4	$6.1	$6.9	$7.7	$7.7	$7.7	$7.7	$7.7	$7.7	$7.7	$7.7	$7.7	$7.7	$7.7
HVAC/Shell	$3.7	$3.7	$3.8	$4.2	$4.6	$5.0	$5.3	$6.9	$7.5	$7.6	$7.5	$7.5	$7.6	$7.5	$7.8	$7.7	$7.5	$7.4	$7.3	$7.3
Lighting	$5.7	$5.3	$4.9	$5.5	$5.9	$8.5	$10.7	$11.2	$11.3	$11.3	$13.2	$13.0	$12.4	$11.9	$11.8	$11.0	$10.4	$10.3	$10.0	$10.1
Package	$0.9	$1.0	$1.2	$0.9	$0.9	$0.9	$1.1	$1.4	$1.5	$1.5	$1.5	$1.6	$1.6	$1.7	$1.8	$1.7	$1.5	$1.7	$1.9	$1.9
Water Heat	$1.1	$1.2	$1.1	$1.3	$1.4	$1.5	$1.6	$1.6	$1.7	$2.0	$3.8	$3.9	$4.0	$3.9	$4.0	$3.7	$3.6	$3.2	$3.1	$3.0
Total	**$16.8**	**$17.5**	**$18.4**	**$21.0**	**$23.2**	**$27.8**	**$32.2**	**$37.0**	**$40.1**	**$41.4**	**$45.2**	**$45.8**	**$46.0**	**$46.0**	**$46.9**	**$44.9**	**$43.9**	**$43.4**	**$43.0**	**$42.9**
Residential - Administrative ($M) + Incentive ($M) by End-Use																				
Administrative ($M) + Incentive ($M)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Appliances	$5.7	$6.1	$6.3	$7.4	$8.1	$8.8	$9.7	$11.3	$12.9	$13.2	$13.3	$14.0	$14.6	$15.2	$15.8	$15.1	$15.0	$15.0	$14.9	$14.8
HVAC	$1.9	$3.9	$5.8	$7.8	$9.7	$11.7	$13.6	$15.6	$17.5	$19.5	$19.5	$19.5	$19.5	$19.5	$19.5	$19.5	$19.5	$19.5	$19.5	$19.5
HVAC/Shell	$7.9	$7.8	$8.1	$8.8	$9.8	$11.0	$11.8	$14.4	$16.0	$16.5	$16.4	$16.6	$16.8	$16.8	$17.5	$17.2	$16.9	$16.7	$16.4	$16.4
Lighting	$14.2	$13.2	$12.8	$12.0	$10.4	$13.9	$16.6	$17.5	$17.7	$17.4	$19.2	$18.6	$17.7	$16.8	$16.5	$15.4	$14.5	$14.2	$13.9	$14.0
Package	$3.6	$3.8	$4.2	$3.4	$3.4	$3.4	$3.8	$4.4	$4.6	$4.6	$4.6	$4.8	$5.0	$5.1	$5.3	$5.1	$4.9	$5.2	$5.4	$5.4
Water Heat	$2.4	$2.5	$2.5	$2.8	$3.0	$3.3	$3.5	$3.7	$3.5	$3.8	$5.8	$5.9	$6.0	$5.9	$6.1	$5.7	$5.7	$5.2	$5.2	$5.0
Total	**$35.7**	**$37.3**	**$39.6**	**$42.2**	**$44.4**	**$52.0**	**$59.0**	**$66.8**	**$72.2**	**$74.9**	**$78.8**	**$79.3**	**$79.5**	**$79.3**	**$80.7**	**$78.0**	**$76.5**	**$75.7**	**$75.1**	**$75.1**

Table 35. Residential Technical Potential Scenario: 2017 – 2036 Savings at Meter

Residential Technical Potential																				
Energy Potential (GWh)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Appliances	1,103.0	1,183.8	1,265.1	1,334.1	1,357.8	1,381.9	1,405.8	1,417.6	1,421.7	1,435.4	1,439.9	1,444.8	1,443.7	1,442.6	1,441.5	1,440.2	1,438.6	1,437.3	1,436.0	1,434.4
HVAC	298.8	298.5	298.2	297.9	297.6	297.3	297.0	296.7	296.4	296.1	295.8	295.5	295.3	295.0	294.7	294.4	294.1	293.8	293.5	293.2
HVAC/Shell	1,100.0	1,114.2	1,128.1	1,142.9	1,158.8	1,171.3	1,183.4	1,195.6	1,207.7	1,220.1	1,232.2	1,244.7	1,257.1	1,269.0	1,281.5	1,293.7	1,305.0	1,313.8	1,322.6	1,331.2
Lighting	4,058.2	4,119.8	4,180.9	3,118.7	2,018.1	2,040.8	2,062.8	2,085.1	2,107.6	2,105.4	2,103.2	2,101.1	2,099.1	2,096.6	2,094.6	2,092.4	2,090.2	2,088.2	2,085.8	2,083.8
Package	1,100.9	1,158.4	1,215.7	1,272.8	1,329.8	1,386.8	1,443.7	1,500.6	1,557.7	1,615.0	1,672.5	1,730.2	1,788.2	1,846.4	1,904.9	1,963.6	2,022.5	2,081.7	2,141.1	2,200.8
Water Heat	945.6	964.3	983.3	1,001.5	1,020.1	1,038.7	1,056.6	1,074.8	1,092.9	1,111.0	1,129.8	1,147.8	1,166.1	1,179.8	1,193.3	1,206.8	1,220.5	1,234.2	1,245.3	1,256.3
Total	**8,606.5**	**8,838.9**	**9,071.3**	**8,167.9**	**7,182.3**	**7,316.7**	**7,449.3**	**7,570.5**	**7,684.0**	**7,783.0**	**7,873.5**	**7,964.1**	**8,049.5**	**8,129.3**	**8,210.4**	**8,291.2**	**8,371.0**	**8,449.1**	**8,524.2**	**8,599.7**
% of Sector Forecast	**60.0%**	**62.0%**	**63.9%**	**57.7%**	**50.9%**	**51.9%**	**52.9%**	**53.7%**	**54.4%**	**54.9%**	**55.3%**	**55.8%**	**56.1%**	**56.5%**	**56.8%**	**57.1%**	**57.4%**	**57.8%**	**58.0%**	**58.3%**
Demand Potential (MW)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Appliances	214.1	237.1	260.2	282.3	297.4	312.6	327.7	341.5	343.8	347.6	348.4	349.1	348.8	348.5	348.3	347.9	347.6	347.2	346.9	346.5
HVAC	621.2	620.6	620.0	619.4	618.8	618.1	617.5	616.9	616.3	615.7	615.1	614.4	613.8	613.2	612.6	612.0	611.4	610.8	610.2	609.5
HVAC/Shell	293.9	299.0	303.9	309.6	316.3	319.8	323.3	326.8	330.2	333.7	337.2	340.6	344.1	347.3	350.7	353.9	356.8	359.5	362.1	364.6
Lighting	311.2	315.7	320.1	242.6	162.3	163.9	165.5	167.1	168.7	168.6	168.4	168.2	168.0	167.9	167.7	167.5	167.3	167.2	167.0	166.8
Package	544.3	562.1	579.9	597.6	615.2	632.9	650.5	668.1	685.8	703.5	721.3	739.2	757.2	775.2	793.3	811.5	829.7	848.0	866.4	884.9
Water Heat	97.2	98.6	100.0	101.4	102.8	104.1	105.5	106.8	108.2	109.5	111.0	112.3	113.7	114.7	115.6	116.5	117.5	118.4	119.2	119.9
Total	**2,082.0**	**2,133.1**	**2,184.1**	**2,152.8**	**2,112.7**	**2,151.5**	**2,190.1**	**2,227.3**	**2,253.1**	**2,278.7**	**2,301.3**	**2,323.9**	**2,345.6**	**2,366.7**	**2,388.1**	**2,409.3**	**2,430.3**	**2,451.1**	**2,471.8**	**2,492.3**
% of Sector Forecast	**60.2%**	**61.8%**	**67.0%**	**66.1%**	**64.7%**	**65.8%**	**63.2%**	**67.8%**	**68.1%**	**68.5%**	**68.6%**	**68.9%**	**65.2%**	**69.1%**	**69.2%**	**69.3%**	**69.3%**	**65.7%**	**65.8%**	**69.9%**

Table 36. Residential Economic Potential Scenario: 2017 – 2036 Savings at Meter

Residential Economic Potential																				
Energy Potential (GWh)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Appliances	572.7	913.9	1,166.1	1,229.9	1,248.5	1,293.8	1,312.8	1,319.5	1,320.3	1,328.5	1,332.7	1,344.6	1,343.6	1,342.6	1,340.8	1,344.2	1,343.2	1,342.0	1,340.7	1,339.3
HVAC	0.0	0.0	0.0	0.0	0.0	297.3	297.0	296.7	296.4	296.1	295.8	295.5	295.3	295.0	294.7	294.4	294.1	293.8	293.5	293.2
HVAC/Shell	757.1	765.9	812.0	826.1	832.8	855.1	868.0	882.1	909.5	921.2	956.9	968.5	977.4	988.8	1,143.1	1,164.3	1,177.8	1,186.6	1,226.6	1,235.4
Lighting	3,400.4	3,461.9	3,554.1	2,492.7	1,444.0	1,466.8	1,492.4	1,522.5	1,545.4	1,543.7	1,745.9	1,744.0	1,742.2	1,740.4	1,871.9	1,870.0	1,868.0	1,866.1	2,108.2	2,106.0
Package	83.6	83.5	83.3	97.2	111.1	125.0	138.9	152.8	166.8	180.8	206.0	231.3	256.7	282.2	307.7	333.4	359.2	403.6	448.2	492.9
Water Heat	467.1	498.3	573.9	585.0	615.9	804.6	841.6	848.9	828.0	834.4	840.5	846.9	872.9	874.7	888.5	891.2	931.4	916.1	968.3	976.4
Total	**5,280.9**	**5,723.5**	**6,189.4**	**5,230.9**	**4,252.4**	**4,842.6**	**4,950.8**	**5,022.6**	**5,066.4**	**5,104.8**	**5,377.8**	**5,430.8**	**5,488.0**	**5,523.6**	**5,846.7**	**5,897.5**	**5,973.7**	**6,008.1**	**6,385.5**	**6,443.2**
% of Sector Forecast	**36.8%**	**40.2%**	**43.6%**	**36.9%**	**30.1%**	**34.3%**	**35.1%**	**35.6%**	**35.9%**	**36.0%**	**37.8%**	**38.0%**	**38.3%**	**38.4%**	**40.4%**	**40.6%**	**41.0%**	**41.1%**	**43.5%**	**43.7%**
Demand Potential (MW)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Appliances	154.3	207.6	247.8	268.9	283.2	298.7	313.0	325.8	327.5	330.3	330.9	332.6	332.3	332.0	331.7	331.7	331.4	331.1	330.8	330.5
HVAC	0.0	0.0	0.0	0.0	0.0	618.1	617.5	616.9	616.3	615.7	615.1	614.4	613.8	613.2	612.6	612.0	611.4	610.8	610.2	609.5
HVAC/Shell	250.9	252.9	257.5	260.4	262.1	264.7	266.7	269.9	273.3	276.5	280.8	284.0	286.6	289.4	294.9	298.1	301.0	303.6	323.4	326.1
Lighting	249.6	254.1	258.6	181.1	100.9	102.5	104.2	105.9	107.6	107.5	107.3	107.2	107.1	107.0	135.5	135.4	135.2	135.1	167.0	166.8
Package	4.1	4.1	4.1	6.3	8.5	10.7	12.9	15.1	17.3	19.5	23.4	27.2	31.1	35.0	38.9	42.8	46.8	59.4	72.1	84.9
Water Heat	51.8	55.3	62.1	63.1	65.9	86.7	90.1	90.7	88.8	89.4	89.9	90.5	92.8	93.0	94.2	94.4	98.8	97.4	105.1	105.8
Total	**710.6**	**773.9**	**830.1**	**779.9**	**720.5**	**1,381.6**	**1,404.3**	**1,424.3**	**1,430.7**	**1,438.8**	**1,447.4**	**1,455.9**	**1,463.7**	**1,469.6**	**1,507.9**	**1,514.4**	**1,524.6**	**1,537.5**	**1,608.6**	**1,623.6**
% of Sector Forecast	**20.6%**	**22.4%**	**25.5%**	**23.9%**	**22.1%**	**42.2%**	**40.5%**	**43.4%**	**43.3%**	**43.2%**	**43.2%**	**43.2%**	**40.7%**	**42.9%**	**43.7%**	**43.6%**	**43.5%**	**41.2%**	**42.9%**	**45.5%**

A.4.1.2 Residential Energy Efficiency Results by End Use

Figure 7 to Figure 10 show residential sector Market Potential energy and peak demand savings for the first year (2017) and in year twenty (2036). Residential lighting and package measures account for most of the total estimated residential energy savings potential. HVAC, comprised of the A/C cycling measure, accounts for the majority of the total estimated residential peak demand savings potential.

Figure 7. Residential Cumulative Annual Market Potential Energy Savings at Meter – 2017 by End Use (GWh)

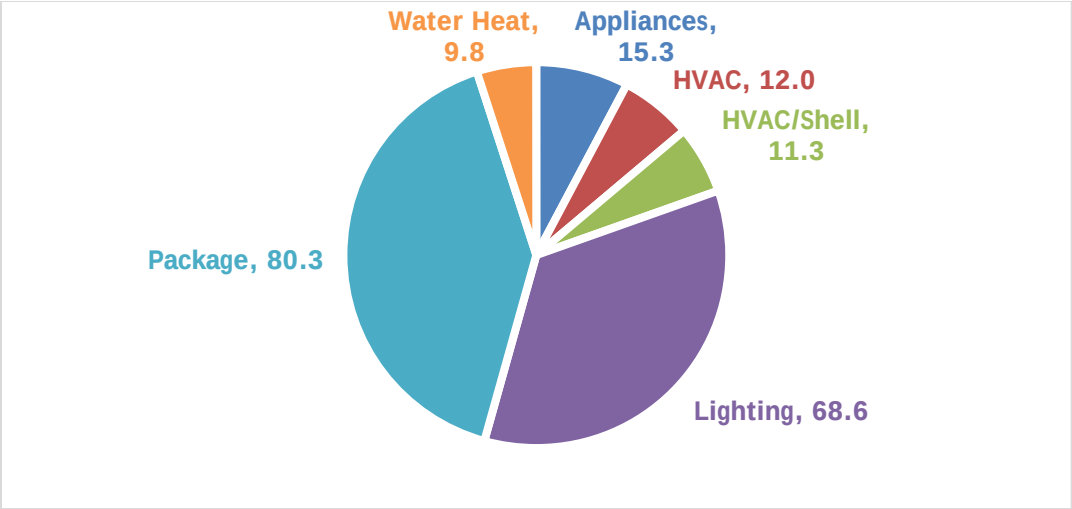


Figure 8. Residential Market Potential Cumulative Annual Summer Peak Demand Savings at Meter – 2017 by End Use (MW)

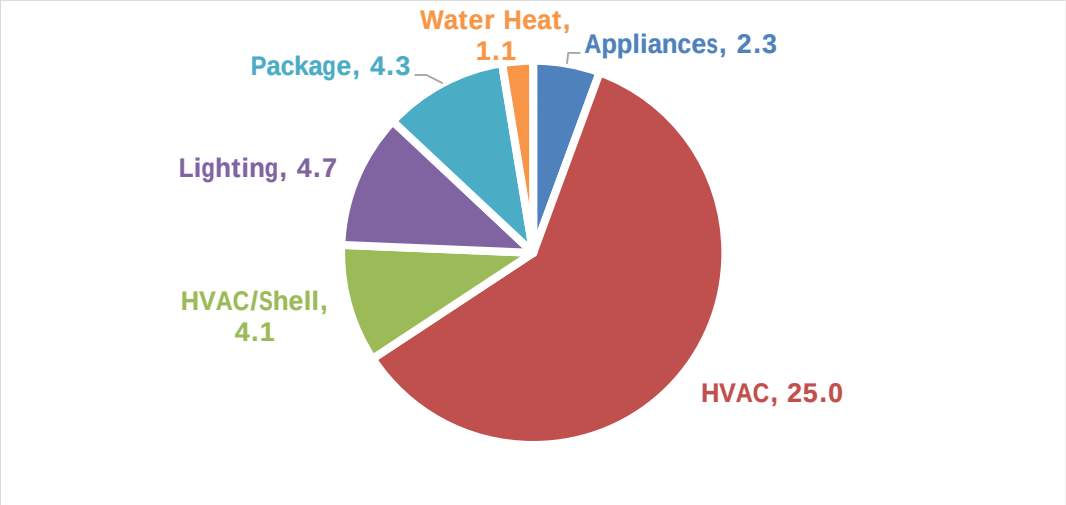


Figure 9. Residential Market Potential Cumulative Annual Energy Savings at Meter – 2036 by End Use (GWh)

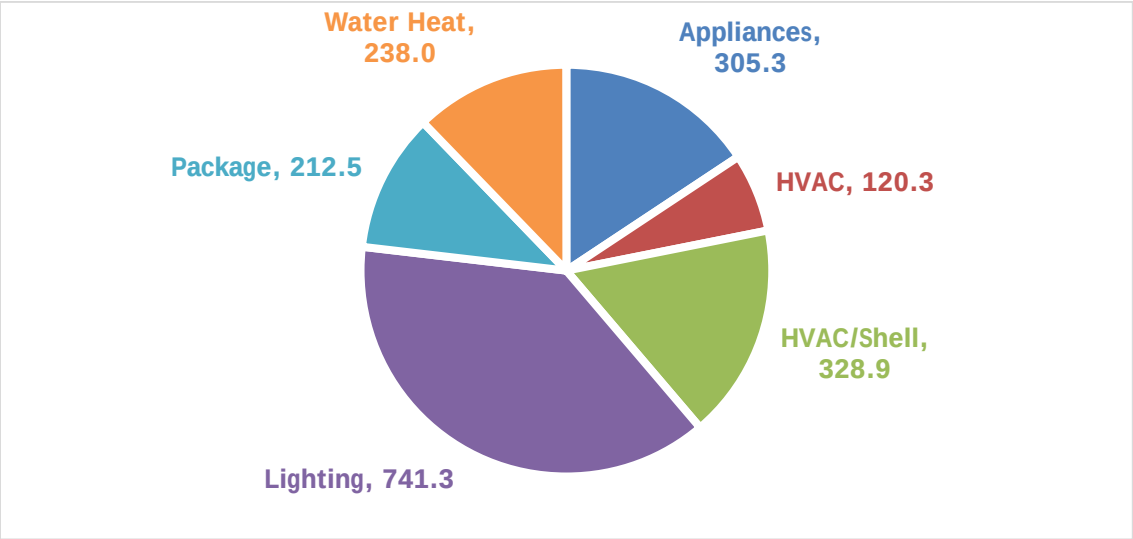


Figure 10. Residential Market Potential Cumulative Annual Summer Peak Demand Savings at Meter – 2036 by End Use (MW)

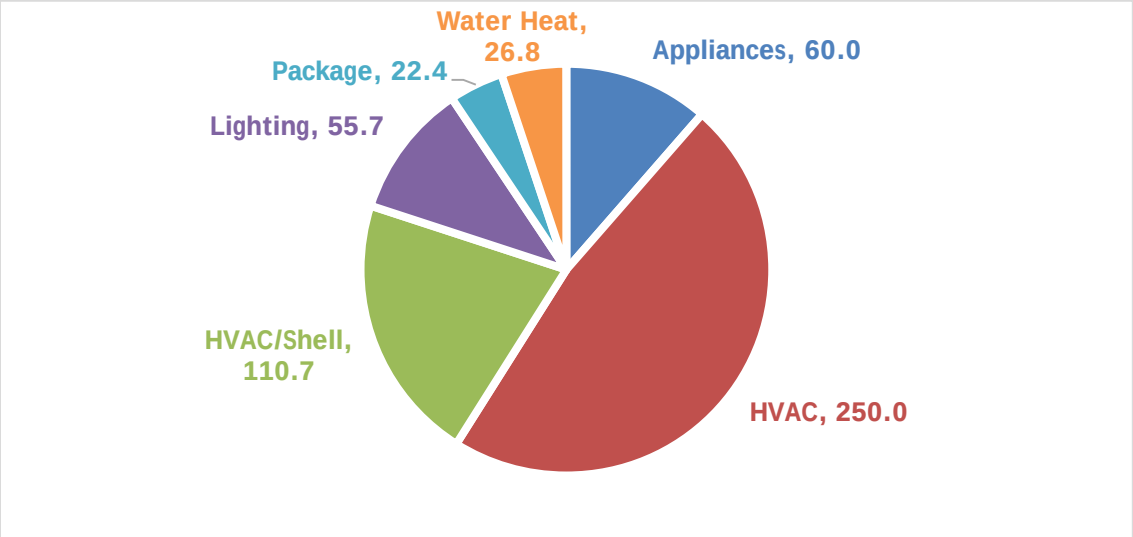


Figure 11 to Figure 16 present residential sector results for the Market, Economic, and Technical Potentials for the twenty year period (2017 to 2036) and in year twenty (2036). In 2036, lighting, appliance, and HVAC and shell energy savings account for most of the economic and market potential. The HVAC measure accounts for most of the projected demand savings for economic and market potential.

Total residential technical and economic potential energy savings through 2036 are projected primarily from appliance, lighting, and HVAC and shell measures with the other end uses providing less savings. Total residential technical and economic potential demand savings through 2036 are projected primarily from the HVAC measure with the other end uses providing less savings.

Figure 11. Residential Cumulative Annual Market and Economic Potential Energy Savings at Meter – 2036 by End Use

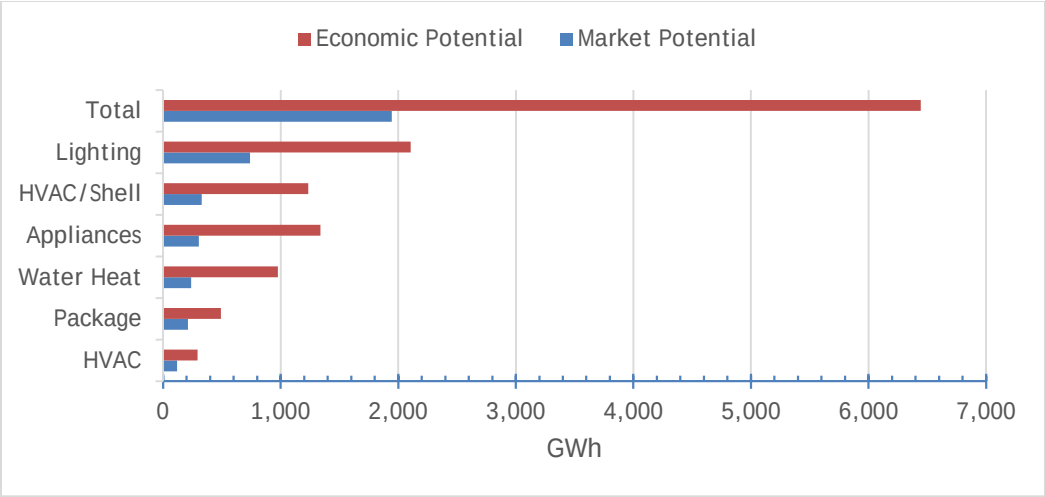


Figure 12. Residential Cumulative Annual Market and Economic Potential Summer Peak Demand Savings at Meter – 2036 by End Use

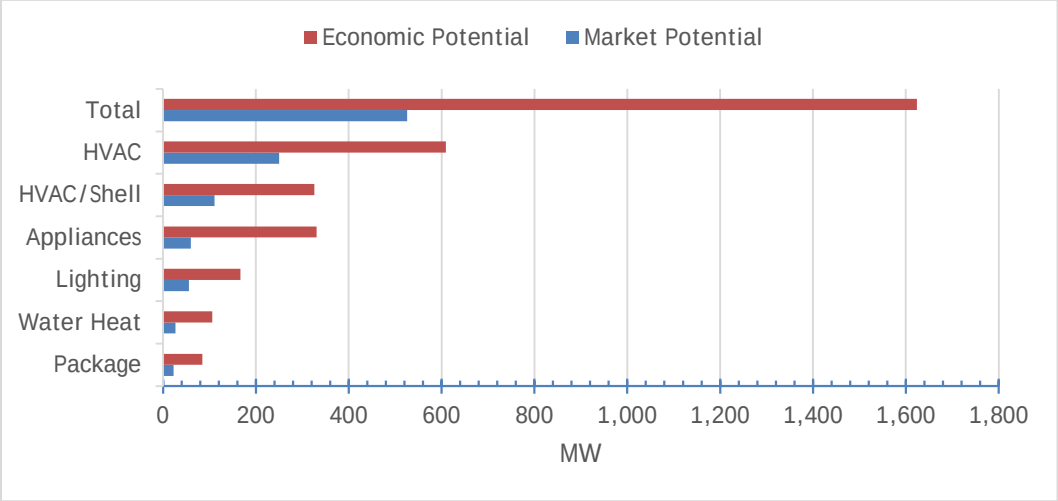


Figure 13. Residential Technical and Economic Potential Energy Savings at Meter – 2036 by End Use

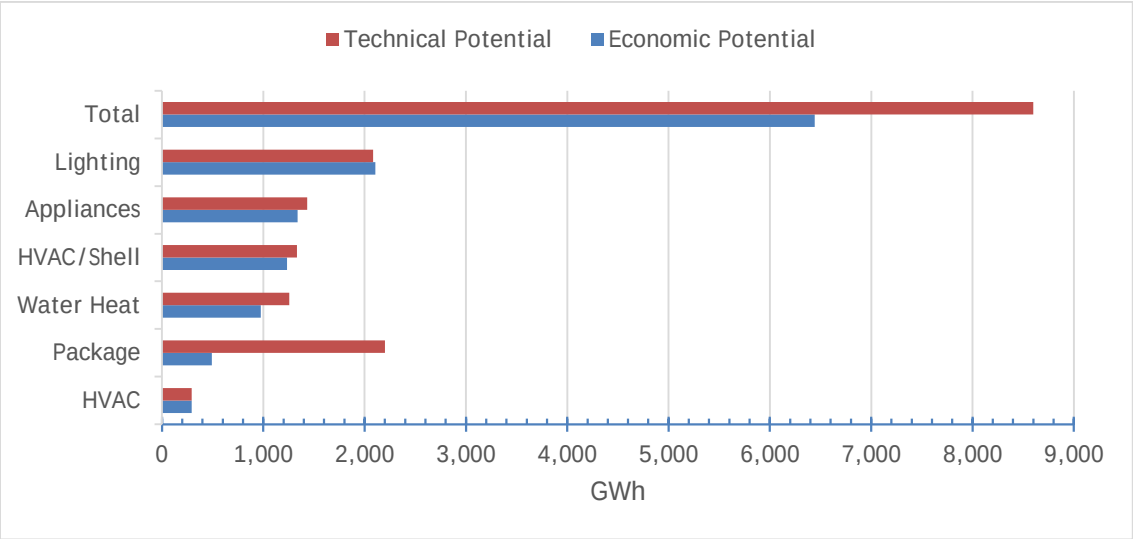


Figure 14. Residential Technical and Economic Potential Summer Peak Demand Savings at Meter – 2036 by End Use

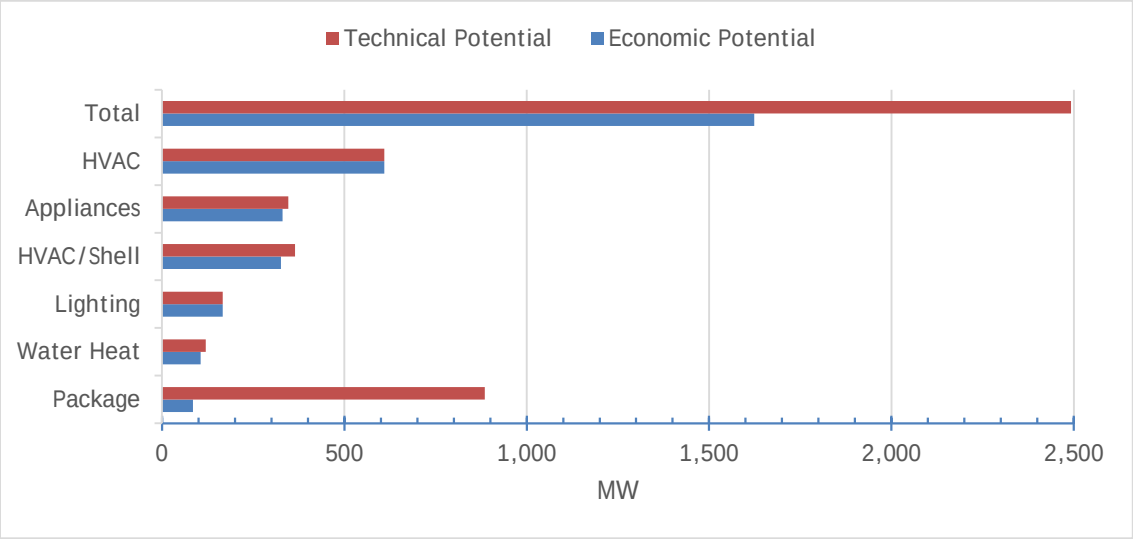


Figure 15. Residential Economic Potential Energy Savings at Meter – 2036 by End Use (GWh)

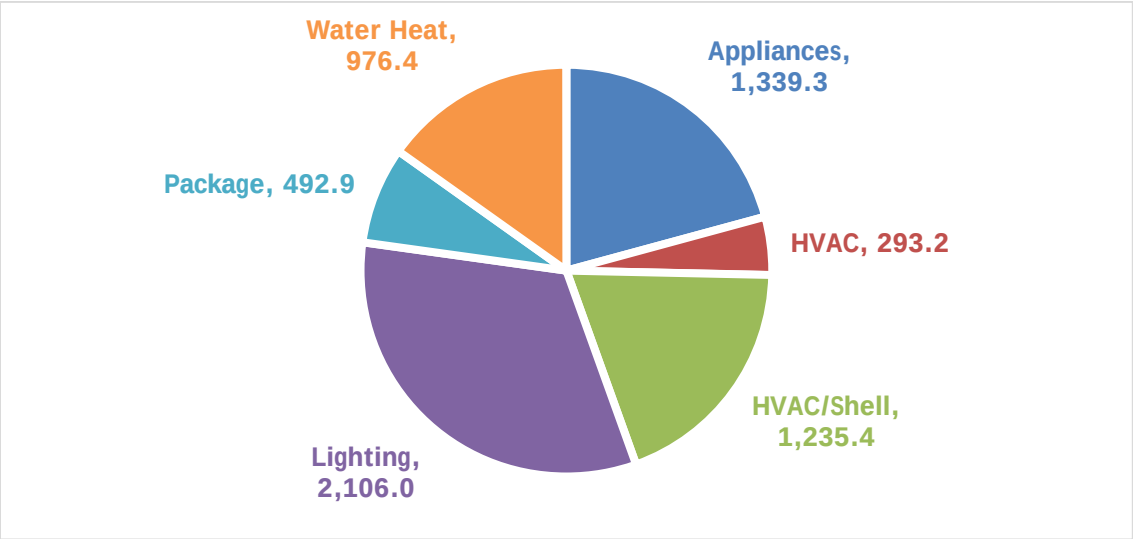
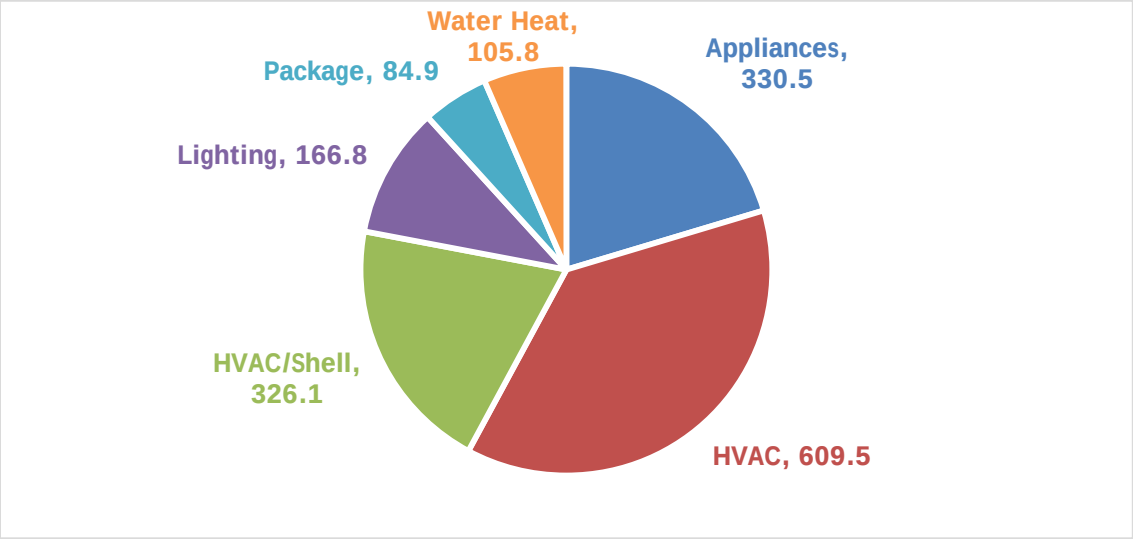


Figure 16. Residential Economic Potential Summer Peak Demand Savings at Meter – 2036 by End Use (MW)



A.4.2 Commercial and Industrial EE/PDR Potential Results

This section provides the EE/PDR potential results for the non-residential sector. The total and annual incremental non-residential achievable EE/PDR potential results for the twenty years (2017 to 2036) are shown in Table 37 and Table 38. The energy values shown are for the EE/PDR measures' first-year at meter energy savings, the incremental demand savings are the summer peak demand savings, and the program costs are the total estimated EE/PDR program budgets for a given year, including rebate or other customer incentive costs, as well as administrative and implementation costs.

The total twenty-year estimated non-residential market potential in 2036 is about 4,790 GWh in cumulative annual savings at meter and about 803 MW of cumulative annual summer peak demand. The annual incremental energy savings at meter starts at 0.9 percent, and peaks out in 2028 at about 1.0 percent of AEP Ohio's forecast annual non-residential energy sales (annual impacts begin to decline slowly thereafter as markets are saturated). Savings are predominantly from lighting and HVAC, followed by industrial, refrigeration, process, motors, agriculture and other measures. These results assume a net-to-gross impact ratio of 1.0, whereby free ridership is assumed for this analysis to be offset by spillover impacts.

Table 39 to Table 41 show projected non-residential incremental costs, Technical Potential, and Economic Potential over the twenty-year time period.

Table 37. Market Potential Scenario: 2017 – 2036 Commercial and Industrial Cumulative Annual Savings at Meter

Non-Residential Cumulative Market Potential																				
Energy Potential (GWh)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
HVAC	53.2	102.7	151.6	200.0	247.3	294.7	341.0	381.0	426.8	466.4	512.2	561.3	613.1	663.7	711.9	754.5	799.6	841.9	882.5	923.0
Lighting	66.3	131.2	191.2	250.2	306.5	364.8	419.3	476.0	536.4	594.2	653.1	714.3	777.3	840.0	895.2	943.6	988.6	1,031.3	1,071.0	1,109.1
Motors	8.1	16.2	24.6	34.4	45.1	56.7	68.6	81.0	93.2	105.4	117.5	129.6	141.5	152.8	163.5	170.7	171.4	172.0	172.4	172.4
Other	62.9	121.3	179.0	235.9	294.0	354.9	408.9	461.7	515.2	570.2	628.0	687.1	747.1	806.0	859.9	900.5	941.7	982.3	1,021.2	1,057.5
Process	8.9	15.3	22.0	29.9	38.8	46.9	54.2	61.6	69.5	78.3	87.4	96.5	105.4	114.0	120.3	123.2	125.3	127.7	130.0	131.8
Refrigeration	12.9	25.7	38.5	52.9	69.0	86.4	104.9	124.6	145.1	165.9	187.2	208.7	230.0	251.7	271.8	286.8	296.6	304.7	311.5	318.1
Industrial	60.8	126.1	186.3	228.8	265.9	309.5	349.3	396.7	441.6	493.2	542.0	598.6	651.5	711.9	769.9	832.6	882.9	936.2	983.0	1,033.4
Agriculture	1.7	3.3	5.1	6.8	8.6	10.5	12.6	14.8	17.1	19.6	22.3	24.8	27.5	30.1	32.8	35.2	37.7	40.1	42.4	44.7
Total	**274.8**	**541.8**	**798.1**	**1,038.9**	**1,275.0**	**1,524.4**	**1,758.7**	**1,997.4**	**2,244.8**	**2,493.2**	**2,749.6**	**3,021.0**	**3,293.4**	**3,570.2**	**3,825.3**	**4,047.0**	**4,243.8**	**4,436.3**	**4,614.1**	**4,790.0**
% of Sector Forecast	**0.9%**	**1.8%**	**2.6%**	**3.3%**	**4.1%**	**4.9%**	**5.6%**	**6.3%**	**7.1%**	**7.8%**	**8.6%**	**9.4%**	**10.2%**	**11.0%**	**11.7%**	**12.4%**	**12.9%**	**13.5%**	**13.9%**	**14.4%**
Demand Potential (MW)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
HVAC	27.3	51.6	74.8	96.2	115.2	134.7	154.2	168.8	186.1	196.1	208.4	222.1	237.2	250.4	261.1	269.3	277.8	283.8	288.8	293.9
Lighting	12.0	23.2	33.3	42.8	51.3	60.4	70.1	80.4	91.2	100.6	110.2	120.2	130.6	140.3	149.5	157.4	164.8	171.6	177.7	183.2
Motors	1.3	2.6	4.0	5.6	7.3	9.2	11.1	13.1	15.1	17.1	19.1	21.0	23.0	24.8	26.5	27.6	27.7	27.7	27.7	27.7
Other	7.3	10.7	14.2	17.4	20.3	23.2	25.7	28.4	31.4	34.6	38.2	41.8	45.5	49.1	52.9	55.8	58.7	61.6	64.5	67.1
Process	1.7	2.8	4.0	5.4	7.0	8.4	9.7	11.1	12.5	14.2	15.8	17.5	19.2	20.8	22.0	22.6	23.1	23.6	24.1	24.6
Refrigeration	1.8	3.5	5.3	7.3	9.6	12.1	14.8	17.7	20.7	23.8	26.9	30.2	33.4	36.7	39.7	41.7	42.6	43.4	44.1	44.8
Industrial	9.5	19.5	28.7	35.1	40.4	46.7	52.5	59.5	66.2	73.8	81.1	89.5	97.4	106.4	115.2	124.6	132.1	140.0	147.0	154.4
Agriculture	0.3	0.6	0.8	1.1	1.4	1.7	2.1	2.4	2.8	3.2	3.6	4.1	4.5	4.9	5.4	5.8	6.2	6.6	6.9	7.3
Total	**61.1**	**114.6**	**165.2**	**210.8**	**252.5**	**296.4**	**340.3**	**381.4**	**426.0**	**463.4**	**503.3**	**546.4**	**590.7**	**633.4**	**672.2**	**704.8**	**733.0**	**758.4**	**780.9**	**803.0**
% of Sector Forecast	**1.1%**	**2.1%**	**3.0%**	**3.8%**	**4.5%**	**5.3%**	**6.0%**	**6.7%**	**7.4%**	**8.1%**	**8.7%**	**9.4%**	**10.1%**	**10.8%**	**11.4%**	**12.1%**	**12.3%**	**12.7%**	**13.0%**	**12.9%**

Table 38. Market Potential Scenario: 2017 – 2036 Commercial and Industrial Incremental Annual Savings at Meter

Non-Residential Incremental Market Potential																				
Energy Potential (GWh)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
HVAC	53.2	49.5	48.9	48.4	47.3	47.4	48.6	52.0	55.8	58.2	59.6	60.9	62.0	60.1	58.4	53.2	51.7	49.0	47.1	46.6
Lighting	66.3	64.9	60.0	59.0	56.3	58.4	54.6	57.9	61.5	65.1	66.3	68.8	70.9	69.9	63.6	56.6	55.6	54.4	51.8	49.4
Motors	8.1	8.1	8.4	9.9	10.6	11.6	12.0	12.4	12.2	12.2	12.1	12.1	11.9	11.3	10.7	7.1	1.8	1.8	1.6	1.4
Other	62.9	67.3	66.6	66.3	67.9	71.8	70.6	69.8	70.2	70.6	72.8	75.5	76.8	76.6	72.7	60.2	61.1	60.6	58.8	56.0
Process	8.9	6.4	6.7	8.0	8.8	8.2	7.4	7.6	8.1	9.0	9.3	9.3	9.1	8.9	6.6	3.3	3.2	3.2	3.1	2.7
Refrigeration	12.9	12.8	12.7	14.4	16.1	17.5	18.4	19.7	20.4	21.0	21.3	21.6	21.4	22.0	20.3	15.2	10.6	9.4	8.0	7.8
Industrial	60.8	65.4	60.2	43.5	38.2	44.7	42.7	50.4	47.8	55.2	52.6	60.5	57.0	64.6	62.3	67.1	60.6	64.4	57.2	58.3
Agriculture	1.7	1.7	1.8	1.7	1.8	2.0	2.0	2.2	2.3	2.5	2.6	2.8	2.9	2.8	2.9	2.7	2.7	2.7	2.7	2.6
Total	**274.8**	**276.0**	**265.3**	**251.2**	**247.1**	**261.4**	**256.3**	**272.0**	**278.4**	**293.7**	**296.8**	**311.7**	**312.1**	**316.3**	**297.5**	**265.4**	**247.3**	**245.4**	**230.3**	**225.0**
% of Sector Forecast	**0.9%**	**0.9%**	**0.9%**	**0.8%**	**0.8%**	**0.8%**	**0.8%**	**0.9%**	**0.9%**	**0.9%**	**0.9%**	**1.0%**	**1.0%**	**1.0%**	**0.9%**	**0.8%**	**0.8%**	**0.7%**	**0.7%**	**0.7%**
Demand Potential (MW)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
HVAC	27.3	24.3	23.2	21.3	19.0	19.5	19.7	20.9	21.5	22.1	22.2	22.1	22.1	19.0	17.1	14.7	13.5	11.0	9.7	9.5
Lighting	12.0	11.2	10.1	9.4	8.5	9.1	9.7	10.4	11.0	11.4	11.5	11.8	12.0	11.0	10.6	9.5	9.3	8.9	8.2	7.5
Motors	1.3	1.3	1.4	1.6	1.7	1.9	1.9	2.0	2.0	2.0	2.0	2.0	1.9	1.8	1.7	1.1	0.2	0.2	0.2	0.2
Other	7.3	7.4	7.4	7.4	7.4	7.7	7.8	8.0	8.3	8.5	8.7	9.0	9.1	9.1	9.2	8.6	8.7	8.7	8.6	8.5
Process	1.7	1.2	1.2	1.4	1.6	1.5	1.3	1.4	1.5	1.7	1.7	1.7	1.7	1.7	1.3	0.7	0.7	0.7	0.7	0.6
Refrigeration	1.8	1.8	1.8	2.0	2.3	2.5	2.7	2.9	3.0	3.1	3.2	3.2	3.3	3.3	3.0	2.0	1.1	1.0	0.9	0.8
Industrial	9.5	10.1	9.2	6.5	5.5	6.4	6.2	7.4	7.1	8.1	7.8	8.9	8.5	9.6	9.3	10.0	9.1	9.6	8.5	8.6
Agriculture	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4
Total	**61.1**	**57.5**	**54.5**	**50.0**	**46.3**	**48.9**	**49.8**	**53.3**	**54.7**	**57.2**	**57.5**	**59.3**	**59.0**	**55.9**	**52.7**	**47.0**	**43.1**	**40.5**	**37.2**	**36.1**
% of Sector Forecast	**1.1%**	**1.0%**	**1.0%**	**0.9%**	**0.8%**	**0.9%**	**0.9%**	**0.9%**	**1.0%**	**1.0%**	**1.0%**	**1.0%**	**1.0%**	**1.0%**	**0.9%**	**0.8%**	**0.7%**	**0.7%**	**0.6%**	**0.6%**

Table 39. Market Potential Scenario: 2017 – 2036 Commercial and Industrial Incremental Costs

Non-Residential - Administrative ($M) by End-Use																				
Administrative ($M)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
HVAC	$3.5	$3.3	$3.4	$3.4	$3.5	$3.6	$3.7	$4.0	$4.4	$4.7	$4.9	$5.0	$5.2	$5.1	$5.1	$4.8	$4.5	$3.9	$3.5	$3.4
Lighting	$5.3	$5.4	$5.2	$5.2	$5.1	$5.4	$5.5	$5.8	$6.1	$6.3	$6.4	$6.6	$6.8	$6.8	$5.0	$4.6	$4.6	$4.5	$4.1	$3.7
Motors	$0.4	$0.4	$0.4	$0.5	$0.5	$0.6	$0.6	$0.6	$0.6	$0.6	$0.6	$0.6	$0.6	$0.6	$0.5	$0.4	$0.1	$0.1	$0.1	$0.1
Other	$4.4	$4.8	$4.6	$4.3	$4.2	$4.3	$4.2	$4.2	$4.3	$4.4	$4.5	$4.7	$4.7	$4.6	$4.3	$3.3	$3.3	$3.3	$3.1	$3.0
Process	$0.5	$0.3	$0.4	$0.4	$0.5	$0.4	$0.4	$0.4	$0.4	$0.5	$0.5	$0.5	$0.5	$0.5	$0.4	$0.2	$0.2	$0.2	$0.2	$0.2
Refrigeration	$1.2	$1.2	$1.1	$1.2	$1.3	$1.4	$1.4	$1.5	$1.6	$1.6	$1.7	$1.7	$1.7	$1.7	$1.5	$1.2	$0.9	$0.8	$0.6	$0.6
Industrial	$3.4	$3.6	$3.4	$2.6	$2.3	$2.7	$2.5	$2.9	$2.8	$3.2	$3.0	$3.4	$3.2	$3.6	$3.5	$3.8	$3.4	$3.6	$3.3	$3.3
Agriculture	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3
Total	**$18.8**	**$19.2**	**$18.6**	**$17.8**	**$17.6**	**$18.6**	**$18.6**	**$19.7**	**$20.5**	**$21.5**	**$21.9**	**$22.8**	**$23.0**	**$23.1**	**$20.7**	**$18.6**	**$17.3**	**$16.7**	**$15.1**	**$14.6**
Non-Residential - Incentive ($M) by End-Use																				
Incentive ($M)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
HVAC	$9.2	$8.6	$8.6	$8.5	$8.6	$8.6	$8.9	$9.6	$10.5	$11.1	$11.5	$11.9	$12.3	$12.3	$12.4	$11.6	$11.6	$11.4	$11.3	$11.3
Lighting	$3.5	$3.7	$3.7	$4.0	$4.2	$4.3	$4.5	$4.8	$5.0	$5.4	$5.6	$5.9	$6.1	$6.3	$6.7	$6.1	$6.1	$6.0	$5.9	$5.8
Motors	$0.9	$0.9	$1.0	$1.1	$1.2	$1.3	$1.4	$1.4	$1.4	$1.4	$1.4	$1.4	$1.4	$1.3	$1.2	$0.8	$0.2	$0.2	$0.2	$0.2
Other	$2.9	$3.0	$3.0	$3.1	$3.2	$3.5	$3.3	$3.2	$3.1	$3.1	$3.3	$3.5	$3.7	$3.7	$3.3	$2.4	$2.5	$2.6	$2.5	$2.4
Process	$0.7	$0.5	$0.5	$0.5	$0.6	$0.6	$0.5	$0.5	$0.6	$0.6	$0.7	$0.7	$0.7	$0.7	$0.6	$0.4	$0.4	$0.4	$0.4	$0.3
Refrigeration	$0.8	$0.8	$0.8	$0.9	$1.0	$1.1	$1.2	$1.3	$1.3	$1.3	$1.4	$1.4	$1.4	$1.9	$1.8	$1.4	$1.0	$0.9	$0.6	$0.8
Industrial	$4.7	$5.0	$4.5	$3.0	$2.4	$2.7	$2.7	$3.0	$3.1	$3.3	$3.5	$3.8	$3.9	$4.0	$4.2	$4.2	$4.1	$4.0	$3.8	$3.5
Agriculture	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.1	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2	$0.2
Total	**$22.7**	**$22.5**	**$22.0**	**$21.2**	**$21.4**	**$22.1**	**$22.7**	**$23.9**	**$25.1**	**$26.4**	**$27.4**	**$28.7**	**$29.6**	**$30.3**	**$30.4**	**$27.1**	**$25.9**	**$25.7**	**$24.9**	**$24.5**
Non-Residential - Administrative ($M) + Incentive ($M) by End-Use																				
Administrative ($M) + Incentive ($M)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
HVAC	$12.6	$11.9	$11.9	$11.9	$12.1	$12.2	$12.6	$13.6	$14.9	$15.7	$16.4	$16.9	$17.5	$17.4	$17.5	$16.4	$16.0	$15.3	$14.7	$14.8
Lighting	$8.8	$9.0	$8.9	$9.2	$9.3	$9.7	$10.0	$10.6	$11.1	$11.7	$12.0	$12.5	$12.9	$13.0	$11.8	$10.8	$10.6	$10.5	$10.0	$9.5
Motors	$1.4	$1.3	$1.4	$1.6	$1.8	$1.9	$2.0	$2.1	$2.0	$2.0	$2.0	$2.0	$2.0	$1.9	$1.8	$1.2	$0.3	$0.3	$0.3	$0.2
Other	$7.3	$7.8	$7.5	$7.4	$7.4	$7.8	$7.6	$7.4	$7.4	$7.4	$7.8	$8.2	$8.4	$8.3	$7.6	$5.7	$5.8	$5.9	$5.7	$5.4
Process	$1.2	$0.8	$0.8	$1.0	$1.1	$1.0	$0.9	$0.9	$1.0	$1.1	$1.1	$1.2	$1.1	$1.1	$0.9	$0.6	$0.5	$0.6	$0.5	$0.5
Refrigeration	$1.9	$1.9	$1.9	$2.1	$2.3	$2.5	$2.6	$2.8	$2.9	$3.0	$3.0	$3.1	$3.1	$3.6	$3.3	$2.6	$1.9	$1.7	$1.3	$1.4
Industrial	$8.0	$8.6	$7.9	$5.5	$4.7	$5.3	$5.3	$5.9	$5.9	$6.5	$6.5	$7.2	$7.1	$7.6	$7.7	$8.0	$7.5	$7.7	$7.1	$6.8
Agriculture	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3	$0.4	$0.4	$0.4	$0.4	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.4	$0.4
Total	**$41.6**	**$41.7**	**$40.6**	**$39.0**	**$38.9**	**$40.7**	**$41.3**	**$43.6**	**$45.6**	**$48.0**	**$49.3**	**$51.5**	**$52.5**	**$53.4**	**$51.1**	**$45.7**	**$43.3**	**$42.4**	**$40.0**	**$39.1**

Table 40. Commercial & Industrial Technical Potential Scenario: 2017 – 2036 Savings at Meter

Non-Residential Technical Potential																				
Energy Potential (GWh)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
HVAC	1,919.1	2,030.4	2,145.2	2,234.7	2,324.7	2,415.3	2,506.9	2,599.5	2,693.0	2,784.6	2,877.1	2,970.7	3,065.3	3,154.0	3,243.9	3,334.9	3,427.2	3,520.7	3,614.2	3,709.1
Lighting	2,152.2	2,471.9	2,796.4	3,006.0	3,175.0	3,449.0	3,592.6	3,737.4	3,882.3	3,963.8	4,046.9	4,131.4	4,216.8	4,304.0	4,392.3	4,481.9	4,573.1	4,665.5	4,759.5	4,855.0
Motors	238.8	245.1	251.2	257.1	263.0	268.6	274.2	279.6	284.8	290.0	295.0	299.9	304.6	309.2	306.1	303.1	300.0	297.0	294.1	291.1
Other	2,749.7	2,874.3	2,997.3	3,117.7	3,236.1	3,352.5	3,466.5	3,578.4	3,589.0	3,594.4	3,576.6	3,559.3	3,541.3	3,523.9	3,506.9	3,490.4	3,474.4	3,458.9	3,443.8	3,429.2
Process	174.5	187.4	200.2	212.9	225.6	238.0	250.4	262.7	270.6	274.5	278.5	282.4	286.3	287.0	287.8	288.6	289.5	290.4	291.4	292.5
Refrigeration	460.5	474.8	489.6	504.7	519.8	535.1	550.4	565.8	581.3	596.9	607.7	618.7	629.9	641.3	653.0	664.8	676.8	689.0	701.4	714.0
Industrial	9,055.8	9,551.5	10,055.0	10,281.9	10,513.3	10,736.9	10,930.1	11,124.3	11,318.9	11,303.3	11,286.9	11,271.8	11,255.0	11,175.1	11,096.3	11,017.9	10,942.4	10,866.7	10,792.9	10,722.6
Agriculture	212.1	212.1	212.1	212.0	212.0	212.0	211.9	211.9	211.7	211.5	211.3	211.0	210.8	210.6	210.4	210.2	210.0	209.8	209.6	209.4
Total	**16,962.8**	**18,047.4**	**19,147.0**	**19,827.1**	**20,469.4**	**21,207.4**	**21,783.1**	**22,359.6**	**22,831.5**	**23,018.9**	**23,179.9**	**23,345.1**	**23,510.1**	**23,605.2**	**23,696.6**	**23,791.8**	**23,893.4**	**23,998.1**	**24,106.8**	**24,222.8**
% of Sector Forecast	**55.0%**	**58.4%**	**61.8%**	**63.8%**	**65.5%**	**67.6%**	**69.1%**	**70.6%**	**71.8%**	**72.1%**	**72.3%**	**72.5%**	**72.7%**	**72.7%**	**72.7%**	**72.8%**	**72.8%**	**72.8%**	**72.8%**	**72.8%**
Demand Potential (MW)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
HVAC	326.6	364.9	403.6	437.6	471.2	504.6	538.2	572.0	605.8	636.9	668.0	699.3	730.9	757.9	785.2	812.8	840.6	868.9	895.9	923.4
Lighting	417.4	453.0	489.0	494.6	489.5	511.2	524.9	538.7	552.4	559.3	566.3	573.4	580.7	588.2	595.8	603.5	611.4	619.5	627.7	636.1
Motors	39.4	40.1	40.8	41.5	42.2	42.8	43.5	44.1	44.7	45.3	45.8	46.4	46.9	47.4	47.0	46.5	46.0	45.6	45.1	44.7
Other	282.7	289.2	295.6	301.8	308.0	314.0	319.9	325.7	324.8	323.8	322.1	320.4	318.8	317.2	315.7	314.2	312.7	311.3	309.9	308.6
Process	33.0	35.5	37.9	40.4	42.8	45.2	47.6	50.0	51.8	52.7	53.7	54.7	55.7	56.0	56.4	56.9	57.3	57.7	58.2	58.7
Refrigeration	62.5	64.0	65.6	67.1	68.7	70.3	72.0	73.6	75.3	76.9	78.2	79.5	80.8	82.2	83.5	84.9	86.4	87.8	89.3	90.8
Industrial	1,159.3	1,207.0	1,256.9	1,284.0	1,311.6	1,338.3	1,364.0	1,389.8	1,415.3	1,417.3	1,419.6	1,421.5	1,423.4	1,416.2	1,409.2	1,402.2	1,395.6	1,388.9	1,382.6	1,377.0
Agriculture	41.2	41.1	41.1	41.0	41.0	41.0	40.9	40.9	40.8	40.8	40.7	40.7	40.7	40.6	40.6	40.5	40.5	40.5	40.4	40.4
Total	**2,362.2**	**2,494.8**	**2,630.5**	**2,708.1**	**2,775.0**	**2,867.5**	**2,951.0**	**3,034.7**	**3,110.8**	**3,153.0**	**3,194.5**	**3,235.9**	**3,277.8**	**3,305.8**	**3,333.4**	**3,361.5**	**3,390.5**	**3,420.2**	**3,449.2**	**3,479.6**
% of Sector Forecast	**42.5%**	**44.8%**	**47.2%**	**48.6%**	**49.5%**	**51.6%**	**52.0%**	**53.4%**	**54.4%**	**54.9%**	**55.4%**	**55.6%**	**56.2%**	**56.5%**	**56.8%**	**57.6%**	**57.0%**	**57.4%**	**57.6%**	**56.1%**

Table 41. Commercial & Industrial Economic Potential Scenario: 2017 – 2036 Savings at Meter

Non-Residential Economic Potential																				
Energy Potential (GWh)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
HVAC	433.3	529.8	1,691.9	1,757.8	1,852.0	1,935.9	2,020.3	2,105.9	2,192.3	2,277.1	2,362.8	2,450.4	2,540.2	2,623.3	2,706.3	2,818.1	2,903.5	2,990.2	3,065.7	3,152.8
Lighting	1,105.1	1,665.3	2,239.8	2,446.1	2,526.6	2,646.3	2,700.5	2,779.6	2,926.0	2,966.5	3,031.5	3,160.8	3,247.2	3,295.8	3,441.1	3,599.0	3,671.8	3,781.7	3,865.6	3,943.4
Motors	238.8	245.1	251.2	257.1	263.0	268.6	274.2	279.6	284.8	290.0	295.0	299.9	304.6	309.2	306.1	303.1	300.0	297.0	294.1	291.1
Other	2,379.0	2,492.7	2,892.3	2,996.9	3,101.5	3,257.0	3,358.4	3,455.4	3,448.5	3,438.5	3,405.4	3,372.5	3,338.7	3,305.4	3,272.3	3,239.6	3,207.2	3,175.1	3,146.1	3,114.6
Process	168.3	181.0	193.6	206.1	218.6	228.5	248.6	260.7	268.6	272.5	276.5	280.4	284.4	285.1	285.9	288.6	289.5	290.4	291.4	292.5
Refrigeration	392.5	422.1	433.0	448.6	464.3	475.2	491.1	507.1	527.4	543.5	554.8	566.4	578.2	590.1	606.7	619.0	631.4	644.1	657.0	670.0
Industrial	6,914.2	7,510.4	9,600.0	9,981.6	10,283.0	10,559.9	10,753.9	10,912.7	11,108.9	11,093.6	11,077.6	11,062.9	11,046.5	10,967.2	10,888.9	10,811.0	10,760.8	10,690.8	10,622.3	10,552.1
Agriculture	177.8	177.7	177.5	177.3	177.1	179.8	179.6	179.4	179.3	180.9	180.7	180.5	180.3	180.1	180.0	179.8	179.6	179.4	209.6	209.4
Total	**11,809.0**	**13,223.9**	**17,479.3**	**18,271.6**	**18,886.0**	**19,551.2**	**20,026.6**	**20,480.3**	**20,935.7**	**21,062.5**	**21,184.2**	**21,373.6**	**21,520.1**	**21,556.1**	**21,687.4**	**21,858.2**	**21,943.8**	**22,048.8**	**22,151.8**	**22,225.9**
% of Sector Forecast	**38.3%**	**42.8%**	**56.4%**	**58.8%**	**60.5%**	**62.3%**	**63.5%**	**64.6%**	**65.8%**	**66.0%**	**66.1%**	**66.4%**	**66.5%**	**66.4%**	**66.6%**	**66.9%**	**66.8%**	**66.9%**	**66.9%**	**66.8%**
Demand Potential (MW)	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
HVAC	254.4	286.4	318.9	347.5	379.9	409.0	437.5	467.1	496.6	523.1	549.9	577.2	607.7	631.0	654.7	680.7	704.7	729.2	752.3	775.8
Lighting	336.3	420.6	465.7	469.4	465.4	479.4	492.0	500.9	515.5	521.6	529.5	549.5	556.6	563.9	572.9	580.5	588.2	601.8	610.1	618.5
Motors	39.4	40.1	40.8	41.5	42.2	42.8	43.5	44.1	44.7	45.3	45.8	46.4	46.9	47.4	47.0	46.5	46.0	45.6	45.1	44.7
Other	276.7	282.0	287.1	292.2	297.0	305.4	310.0	314.5	312.2	309.9	306.8	303.7	300.7	297.6	294.7	291.7	288.8	285.9	283.1	280.2
Process	32.2	34.6	37.1	39.5	41.9	44.1	47.3	49.7	51.5	52.5	53.4	54.4	55.4	55.8	56.2	56.9	57.3	57.7	58.2	58.7
Refrigeration	56.1	59.2	60.3	61.9	63.6	64.8	66.5	68.1	70.3	72.0	73.3	74.7	76.1	77.5	79.5	80.9	82.4	83.9	85.4	86.9
Industrial	1,120.1	1,167.9	1,229.2	1,256.3	1,283.9	1,310.6	1,336.3	1,362.1	1,387.6	1,389.6	1,391.8	1,393.8	1,395.7	1,388.5	1,381.5	1,374.5	1,367.8	1,361.2	1,354.9	1,349.3
Agriculture	29.7	29.7	29.6	29.6	29.6	29.5	29.5	29.5	29.5	29.4	29.4	29.4	29.3	29.3	29.3	29.3	29.2	29.2	40.4	40.4
Total	**2,144.8**	**2,320.4**	**2,468.7**	**2,537.9**	**2,603.4**	**2,685.6**	**2,762.6**	**2,836.0**	**2,907.8**	**2,943.3**	**2,980.0**	**3,029.0**	**3,068.3**	**3,091.0**	**3,115.6**	**3,140.9**	**3,164.4**	**3,194.5**	**3,229.4**	**3,254.4**
% of Sector Forecast	**38.6%**	**41.7%**	**44.3%**	**45.5%**	**46.4%**	**48.3%**	**48.7%**	**49.9%**	**50.8%**	**51.3%**	**51.7%**	**52.1%**	**52.6%**	**52.8%**	**53.0%**	**53.9%**	**53.2%**	**53.6%**	**53.9%**	**52.5%**

A.4.2.1 Commercial and Industrial Energy Efficiency Results by End Use

Figure 17 through
Figure 20 show energy and peak demand savings for the first year (2017) and in year twenty (2036) for different potential scenarios. Industrial measures, followed by non-residential lighting measures, account for most of the total estimated non-residential energy conservation potential throughout the twenty year (2017 to 2036) forecast period. HVAC followed by non-residential lighting account for most of the total estimated non-residential demand conservation potential throughout the period.

Figure 17. Commercial and Industrial Cumulative Annual Market Potential Energy Savings by End Use 2017 (GWh)

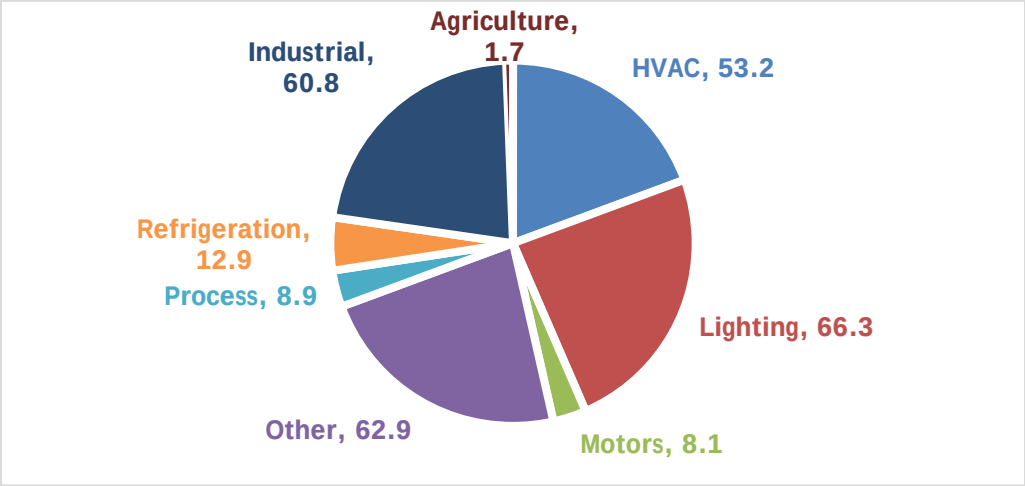


Figure 18. Commercial and Industrial Cumulative Annual Market Potential Summer Peak Demand Savings by End Use 2017 (MW)

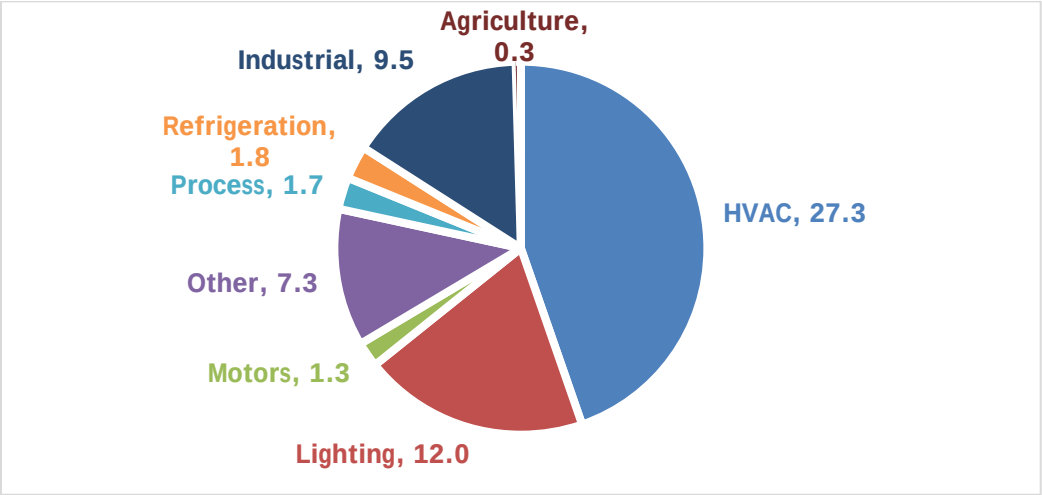


Figure 19. Commercial and Industrial Cumulative Annual Market Potential Energy Savings at Meter by End Use 2036 (GWh)

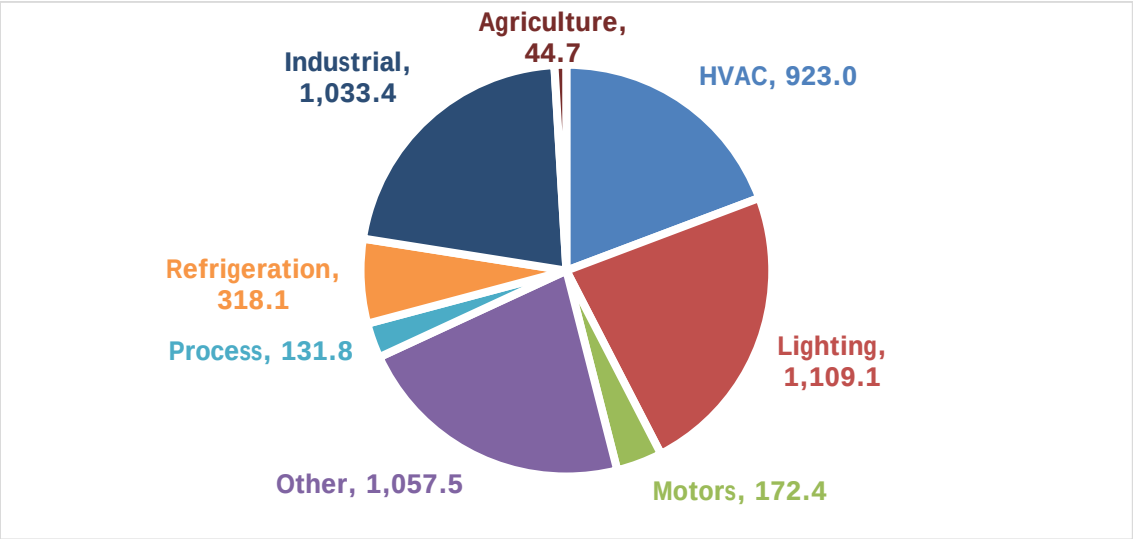


Figure 20. Commercial and Industrial Cumulative Annual Market Potential Summer Peak Demand Savings at Meter by End Use 2036 (MW)

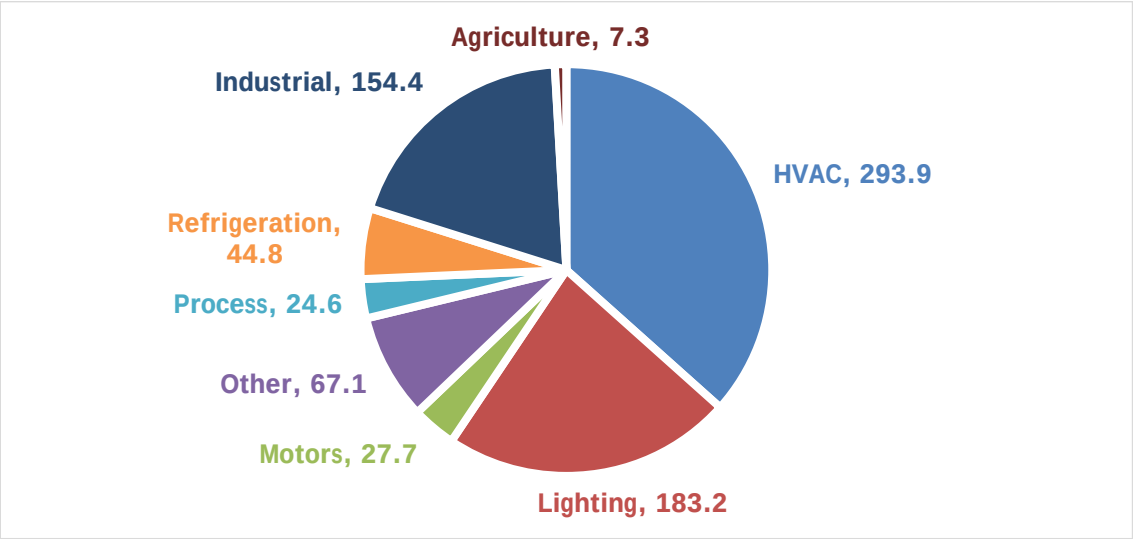


Figure 21 through Figure 26 present commercial and industrial sector results for the Market, Economic and Technical Potentials for the twenty-year period (2017 to 2036) and in year twenty (2036). In 2036, industrial measures account for most of the economic potential energy and demand savings while non-residential lighting and HVAC represent the most energy and demand market potential savings respectively.

Total technical and economic potential energy and demand savings through 2036 are projected primarily from industrial measures with the other end uses providing less savings. The end use contribution to economic potential energy and peak demand savings in 2036 is projected to be mostly from industrial measures, followed by HVAC and lighting measures.

Figure 21. Commercial and Industrial Cumulative Annual Market and Economic Potential Energy Savings at Meter – 2036 by End Use

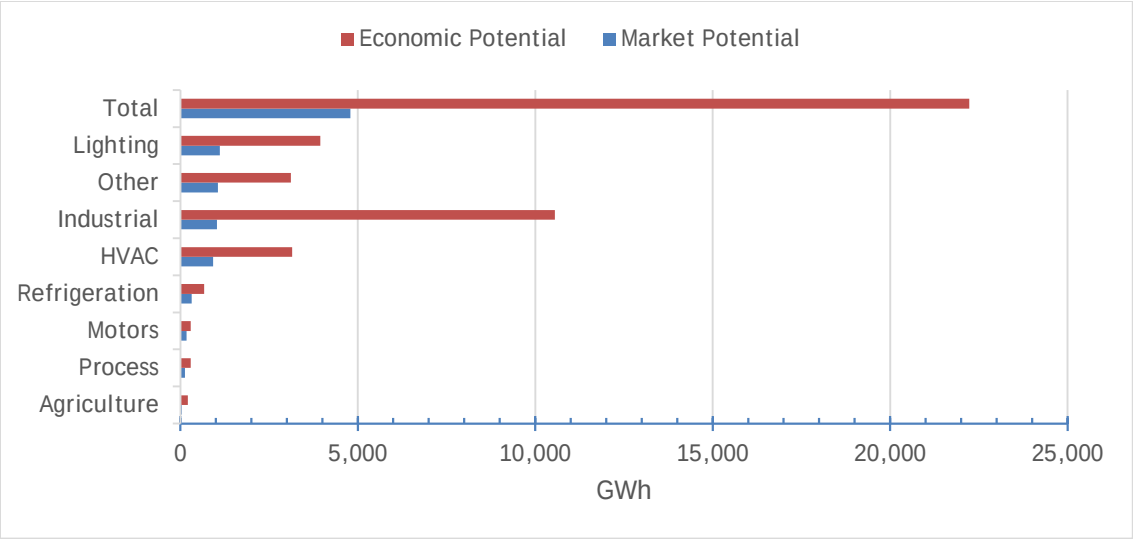


Figure 22. Commercial and Industrial Cumulative Annual Market and Economic Potential Summer Peak Demand Savings at Meter – 2036 by End Use

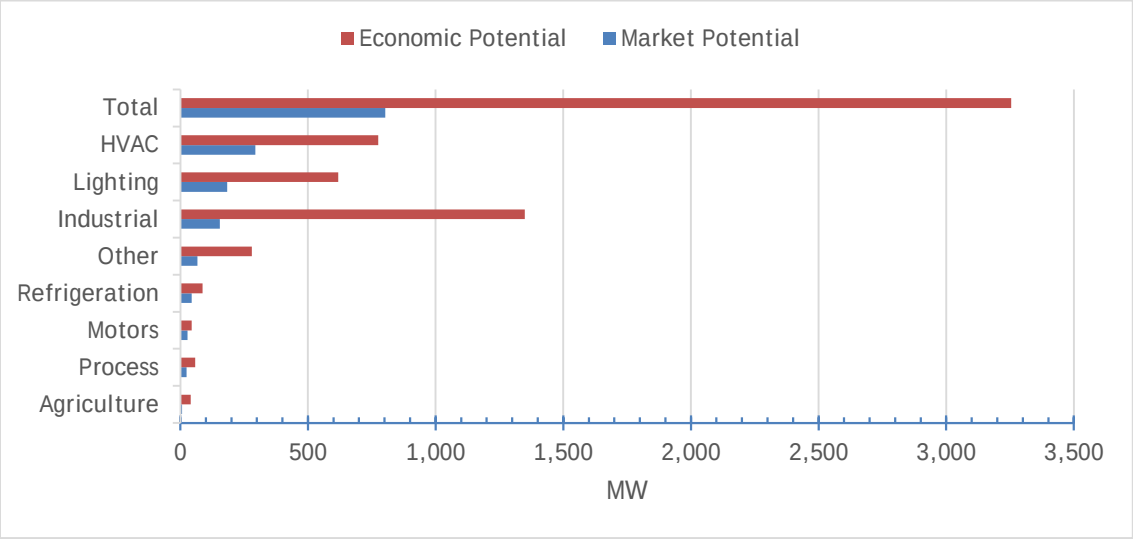


Figure 23. Commercial and Industrial Technical and Economic Potential Energy Savings at Meter – 2036 by End Use

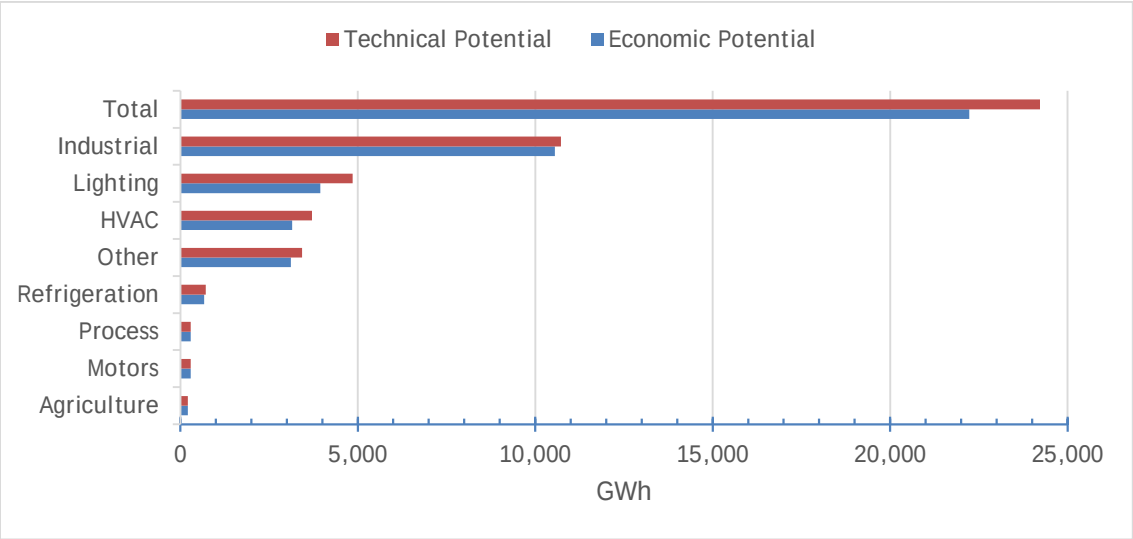


Figure 24. Commercial and Industrial Technical and Economic Potential Summer Peak Demand Savings at Meter – 2036 by End Use

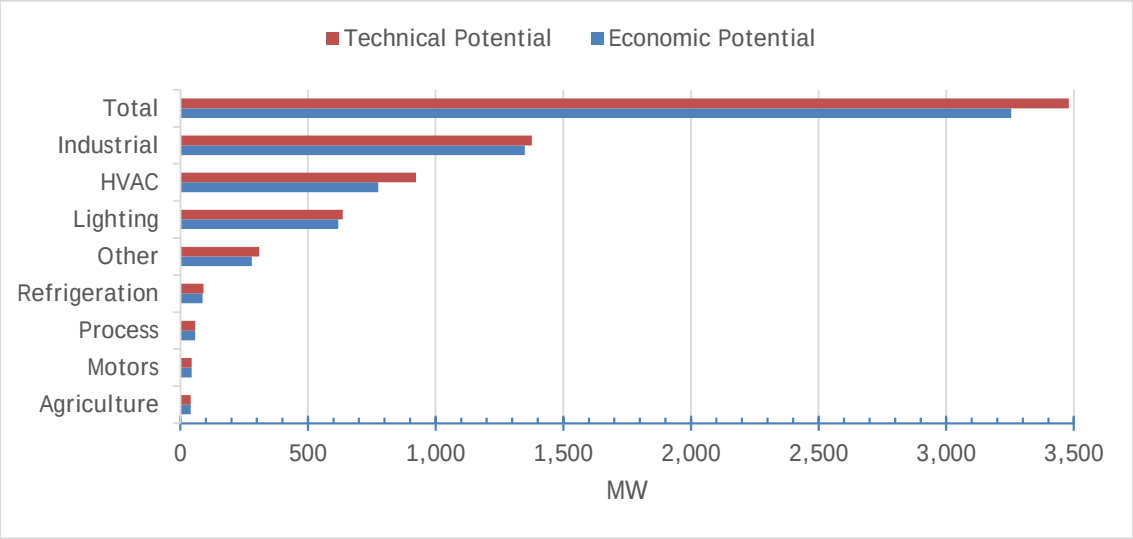


Figure 25. Commercial and Industrial Economic Potential Annual Energy Savings at Meter by End Use 2036 (GWh)

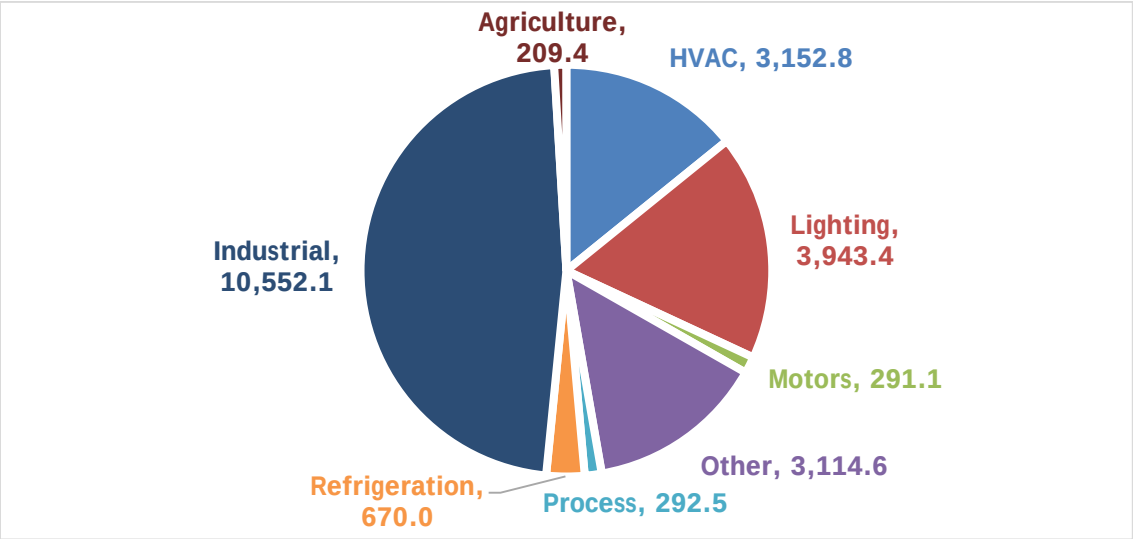
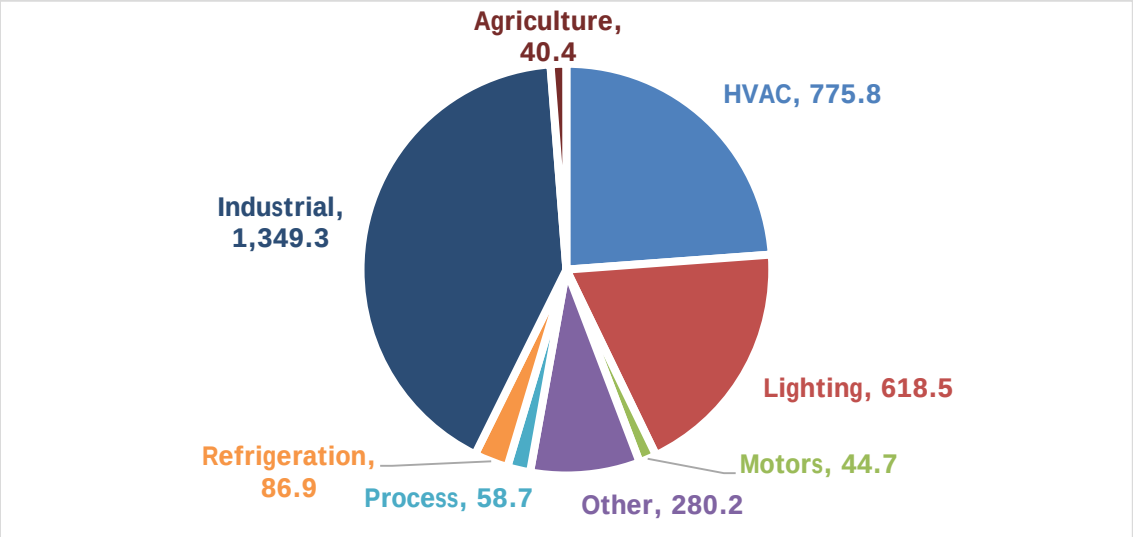


Figure 26. Commercial and Industrial Economic Potential Annual Summer Peak Demand Savings at Meter by End Use 2036 (MW)



B. Benchmarking EE/PDR Programs

B.1 EE/PDR Benchmarking Results

To ensure that the demand side management (DSM) potential estimates developed are reasonable and appropriate, and to identify the best practices of DSM programs, AEP Ohio conducted a benchmarking assessment on other utilities' DSM programs, in Ohio and in neighboring states, that have similar DSM requirements and Plans and available data about them. To identify common best practices of top performers, the analysis compared detailed program results by customer sector of those utilities identified as achieving high levels of DSM savings for below-median costs.

Error! Reference source not found. shows the 2014 and 2015 median EE/PDR benchmarking data for AEP Ohio and twelve other Midwest utilities, including overall spending, savings, costs, and energy costs. Appendix B provides more benchmarking results.

Table 42. 2012 EE/PDR Benchmarking Data

	Spending as Percent of Revenue	Energy Savings as Percent of Sales	Peak Demand Savings as Percent of Peak Demand	Retail Cost of Energy $/kWh	Cost of First Year Savings (1)	
					$/kWh	$/kW
All Region Median 2014	1.4%	1.1%	0.8%	$0.10	$0.12	$963
AEP Ohio 2014	1.7%	1.5%	1.0%	$0.10	$0.12	$946
AEP Ohio 2015 (2)	1.5%	1.2%	0.8%	$0.10	$0.12	$981

(1) Note: Cost of First Year Savings is not comparable to a supply-side investment and is only used to compare programs and Plans at a high level for reasonableness of cost.
(2) AEP Ohio 2015 results have not been evaluated.

In 2014, the utilities with the largest relative energy savings and below-median costs achieved energy savings at about 1.4 percent of annual sales. The utilities with the largest relative peak demand savings and below-median costs saved about 1.1 percent of peak demand. AEP Ohio saved more than the median amount of savings from the utilities' benchmarked in 2014 and 2015, and AEP Ohio's program costs were lower than the median program costs.

B.2 Benchmarking Presentation

AEP Ohio EE/PDR Portfolio Benchmarking

April 1, 2016

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Table of Contents

1 Methodology and Scope
2 2014 Benchmarking
3 References

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Table of Contents

1 Methodology and Scope
2 2014 Benchmarking
3 References

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EE/PDR Benchmarking Goals

- Ensure EE/PDR potential estimates are reasonable and appropriate
- Identify best practice programs by benchmarking comparable regional utility portfolios
- Identify common best practices of top performers
- Analysis compares program savings results by customer sector for utilities identified to have high savings achievement at below-median cost
- Benchmarked 2014 EE/PDR programs along with AEP Ohio's 2015 EE/PDR programs

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Overview

- Navigant benchmarked 13 Midwest IOUs or neighboring states
- Savings data collected
  - 2014, verified ex post at meter and gross
  - AEP Ohio's 2015 results are *ex ante* (are not yet evaluated)
- Savings and spending on demand response (DR) programs not included

State	Organization
OH	AEP Ohio '14
	AEP Ohio '15
	Dayton P&L
	First Energy OH
IL	Ameren IL
	ComEd IL
MD	BGE
MI	Consumers Energy MI
	Detroit Edison
PA	Allegheny PA
	Duquesne
	First Energy PA
	PECO
	PPL Electric Utilities

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Data Collection

- Portfolio spending and savings results were collected from utility annual reports and supplemented by targeted requests as necessary
- Baseline sales and revenue sourced from EIA Form 861
- IL, MD, OH, and PA utilities' C&I retail revenue data reflect both energy and delivery EIA statistics. Since not all delivery revenue was reported, Navigant applied ratio of energy's $/kWh (revenue ÷ retail kWh sales) to delivery's retail kWh sales volume to estimate total C&I revenue
- Portfolio savings and spending are normalized to enable comparison
  - EE/PDR savings and spending are normalized for the same program year baseline kWh sales, peak kW and revenue
  - AEP Ohio's 2015 savings and spending are normalized by 2014 baseline kWh sales, peak kW and revenue

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Caveats

- Benchmarking is not a horse race, but is useful to identify which organizations and programs to analyze more closely
- Given variation in legislation or regulatory requirements, program offerings, and reporting practices across portfolios, no benchmarking can achieve strict apples-to-apples comparison
- Different organizations aggregate and allocate costs differently (e.g., key account manager time), so results are indicative, particularly regarding cost per first year kWh saved
- Analysis provides better understanding to inform cost-effective program design and identify which utilities to assess further
- Analysis identified performance benchmarks, based on actual program results, to aid in potential model calibration

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Table of Contents

1 Methodology and Scope
2 2014 Benchmarking - Overall
3 References

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2014 Overall Results

	Spending as % of Revenue	Energy Savings as % of Sales	Peak Demand Savings as % of Peak Demand	Retail Cost of Energy $/kWh	Cost of First Year Savings	
					$/kWh	$/kW
All Utilities Median	1.4%	1.1%	0.8%	$0.10	$0.12	$963
AEP Ohio 2014	1.7%	1.5%	1.0%	$0.10	$0.12	$946
AEP Ohio 2015	1.5%	1.2%	0.8%	$0.10	$0.12	$981

Note: AEP Ohio's 2015 results have not been evaluated
2014 baseline data used to normalize 2015 savings and spending

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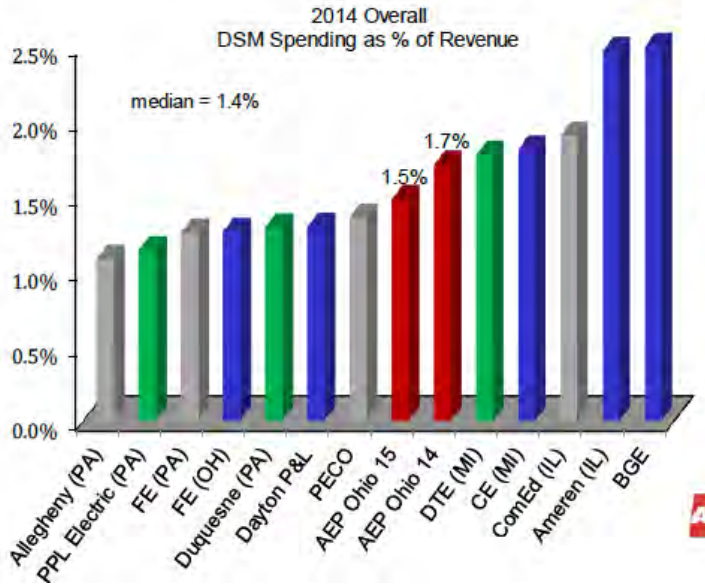
2014 Overall Results – Spending

AEP Ohio 2014 & 2015 overall EE/PDR spending (as % of revenue) are above median



2015 JD Power Scores

JD Power Score Range	Bar Color
671+	Green
661 – 670	Blue
651 – 660	Gray
631 – 640	Red

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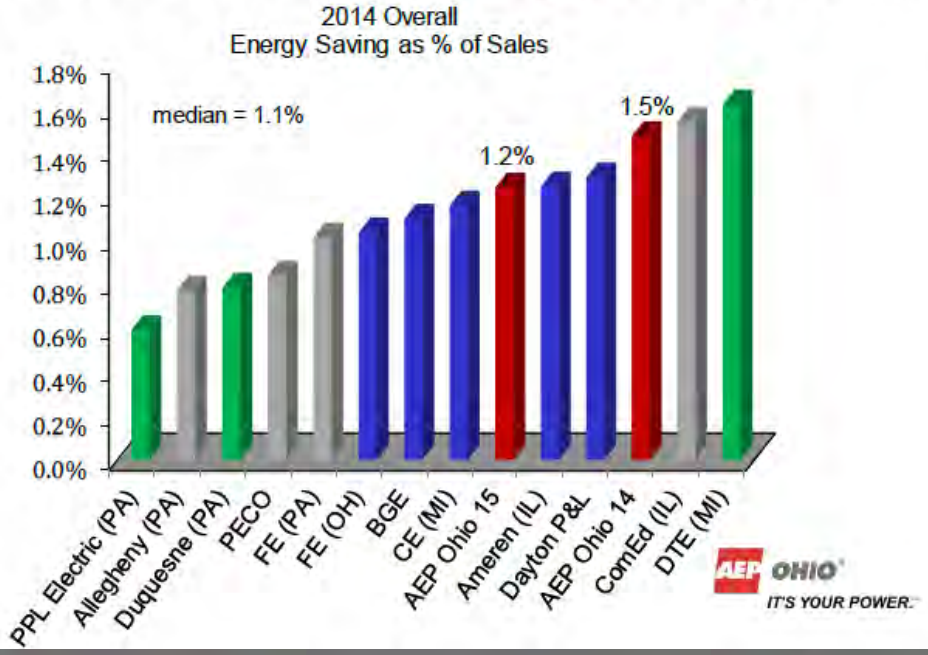
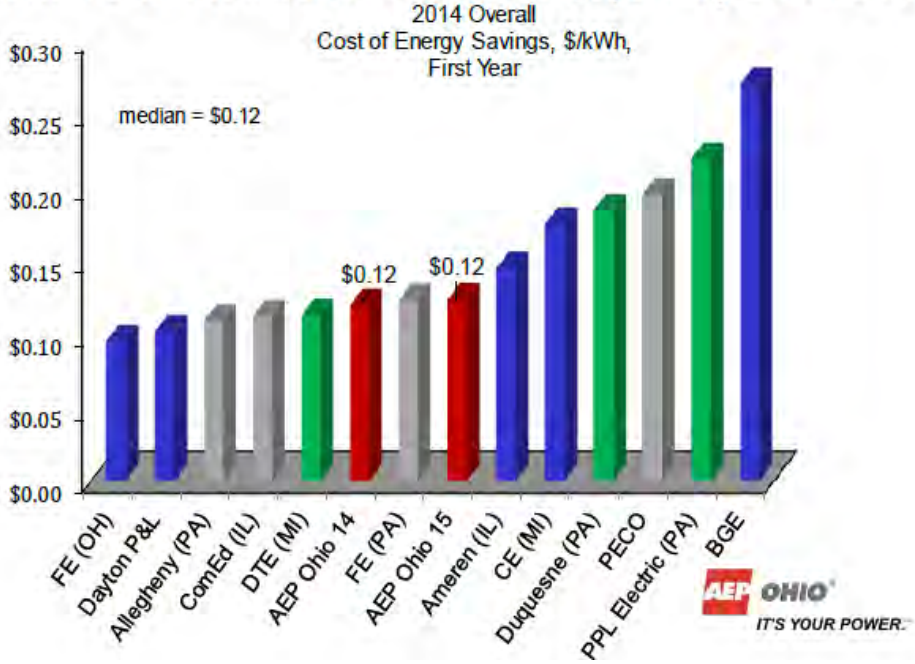
2014 Overall Results – Energy Savings

AEP Ohio 2014 & 2015 overall EE/PDR savings (as % of sales) are above median

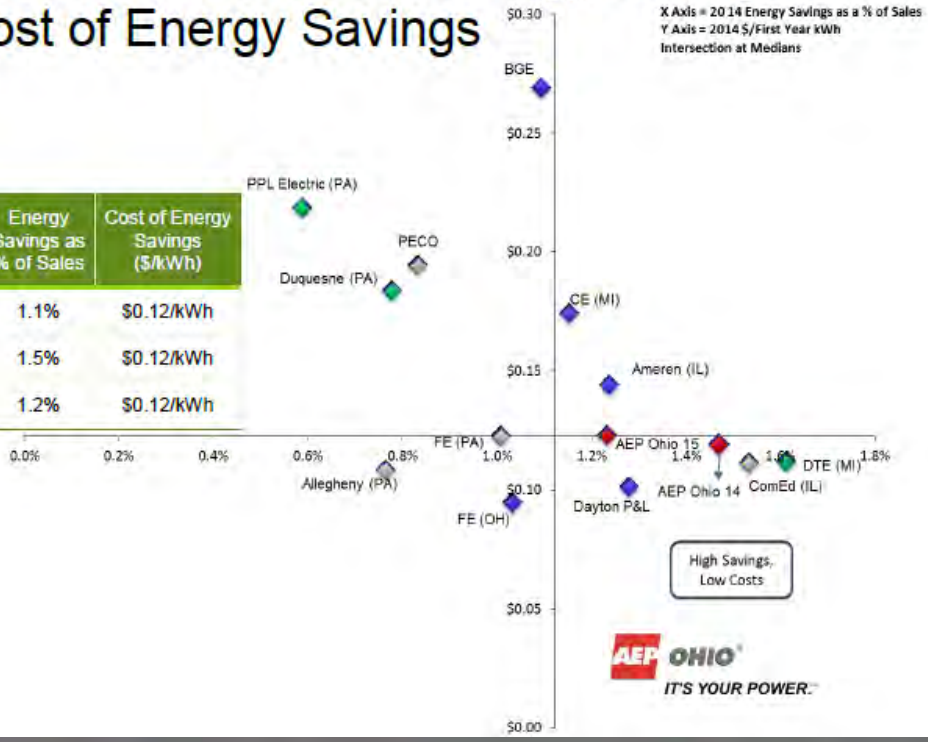


2014 Overall Results – Cost of Energy Savings

AEP Ohio 2014 & 2015 cost of overall EE/PDR savings per first year kWh are at median



2014 Overall Results – Energy Savings & Cost of Energy Savings



Overall	Energy Savings as % of Sales	Cost of Energy Savings ($/kWh)
All Utilities Median	1.1%	$0.12/kWh
AEP Ohio 2014	1.5%	$0.12/kWh
AEP Ohio 2015	1.2%	$0.12/kWh

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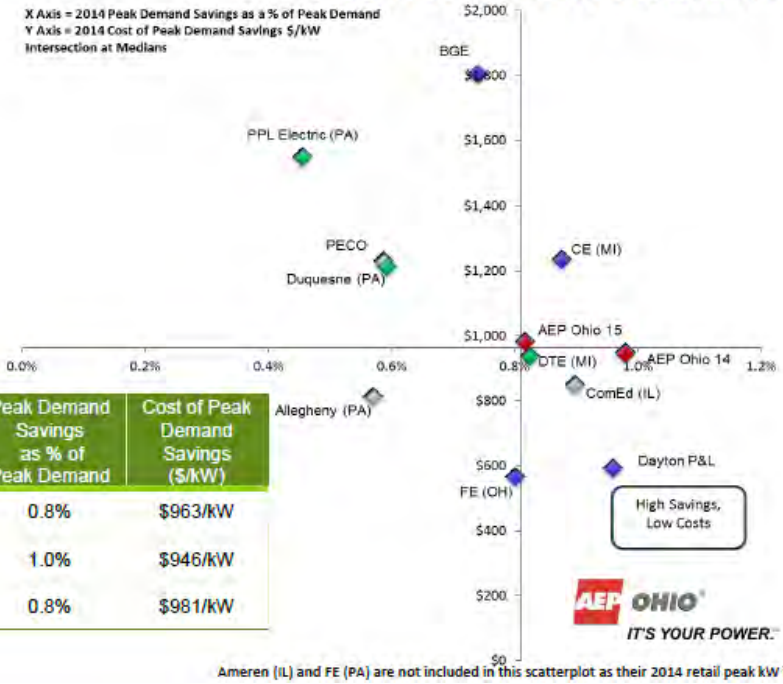
2014 Overall Results – Peak Demand Savings & Cost of Peak Demand



Overall	Peak Demand Savings as % of Peak Demand	Cost of Peak Demand Savings ($/kW)
All Utilities Median	0.8%	$963/kW
AEP Ohio 2014	1.0%	$946/kW
AEP Ohio 2015	0.8%	$981/kW

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Ameren (IL) and FE (PA) are not included in this scatterplot as their 2014 retail peak kW is not available.

Table of Contents

1 Methodology and Scope
2 2014 Benchmarking – C&I
3 References

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2014 C&I Results

	Spending as % of Revenue	Energy Savings as % of Sales	Peak Demand Savings as % of Peak Demand	Cost of First Year Savings	
				$/kWh	$/kW
All Utilities Median	1.2%	1.0%	0.7%	$0.12	$888
AEP Ohio 2014	1.3%	1.1%	0.7%	$0.11	$941
AEP Ohio 2015	1.4%	1.1%	0.7%	$0.12	$991

Note: AEP Ohio's 2015 results have not been evaluated
2014 baseline data used to normalize 2015 savings and spending

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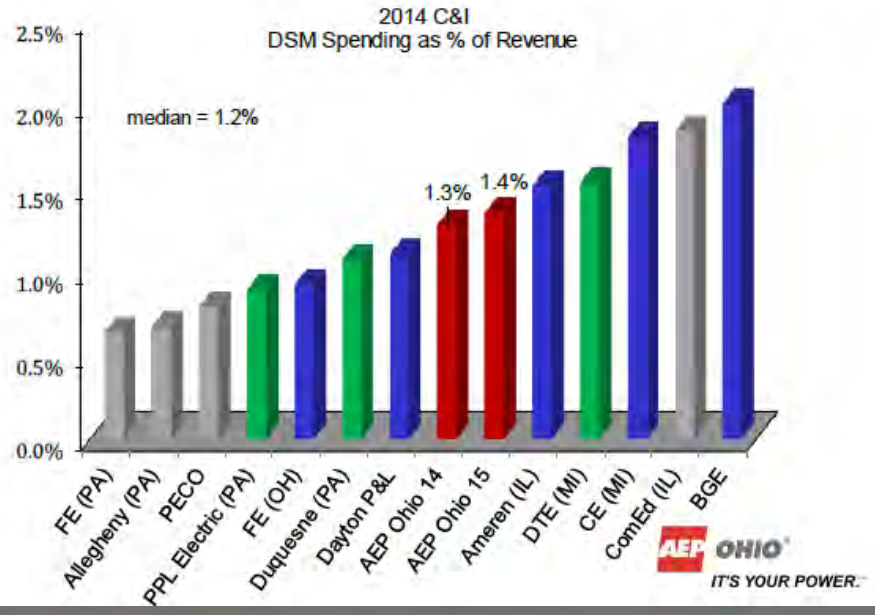
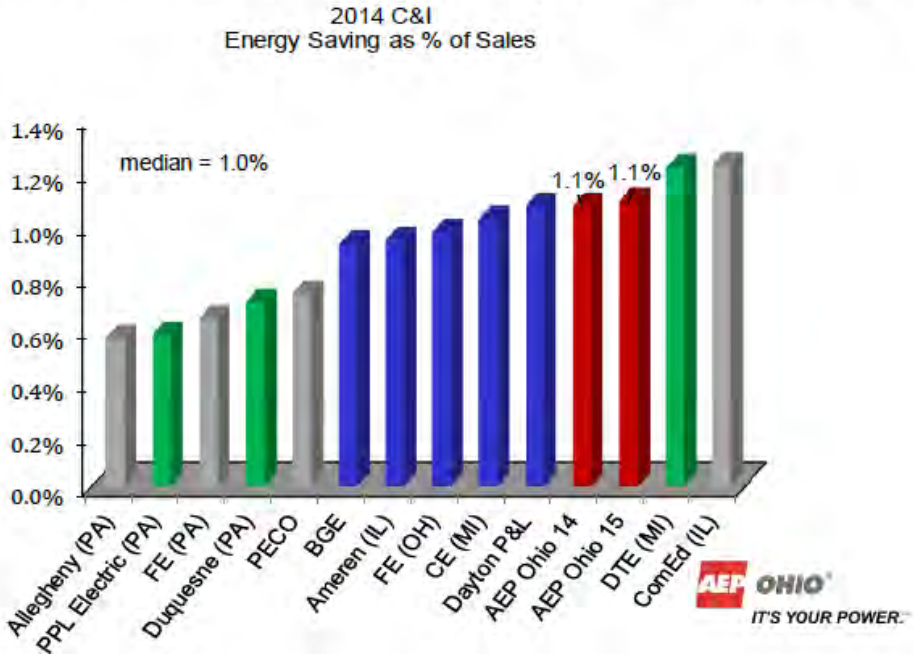
2014 C&I Results – Spending

AEP Ohio 2014 & 2015 C&I EE/PDR spending (as % of revenue) are above median



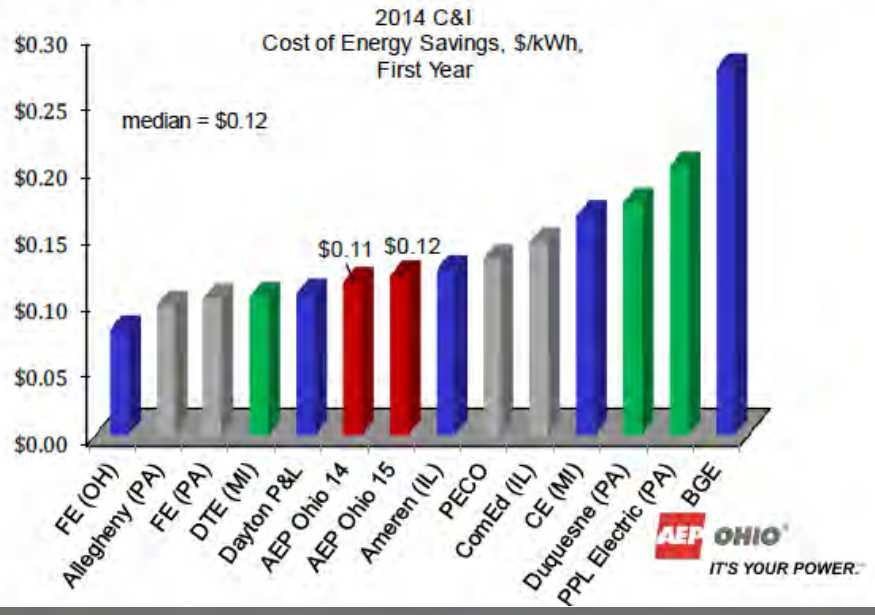
2014 C&I Results – Energy Savings

AEP Ohio 2014 & 2015 C&I EE/PDR energy savings (as % of sales) are above median



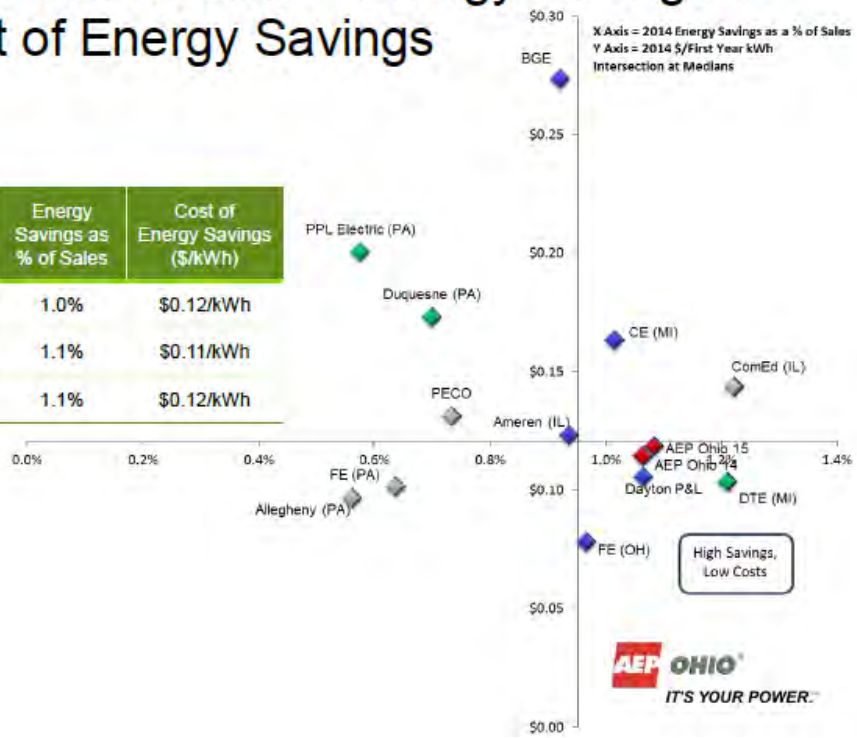
2014 C&I Results – Cost of Energy Savings

- AEP Ohio 2014 cost of C&I EE/PDR savings per first year kWh is below median
- 2015 is at median



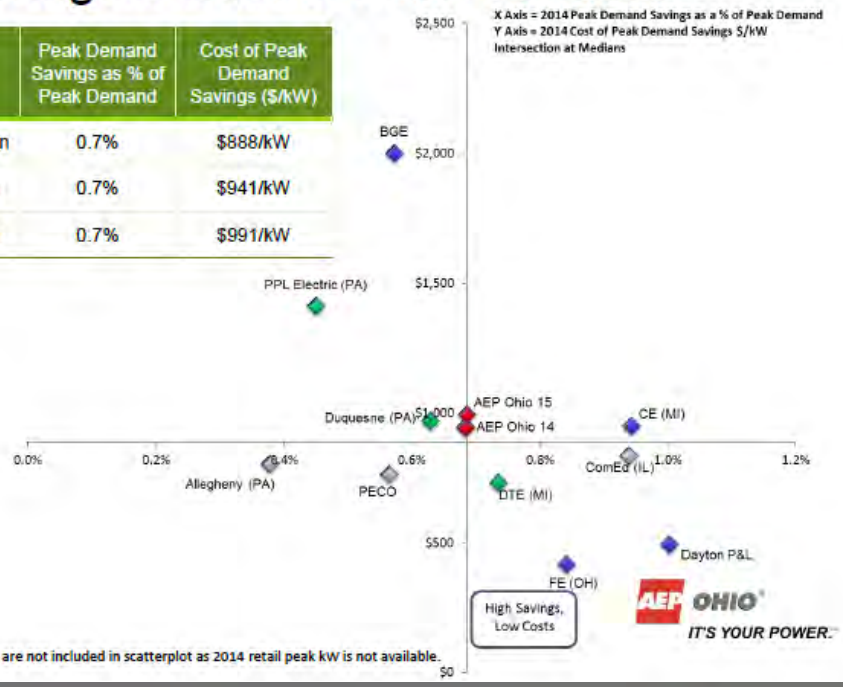
2014 C&I Results – Energy Savings & Cost of Energy Savings

C&I	Energy Savings as % of Sales	Cost of Energy Savings ($/kWh)
All Utilities Median	1.0%	$0.12/kWh
AEP Ohio 2014	1.1%	$0.11/kWh
AEP Ohio 2015	1.1%	$0.12/kWh



2014 C&I Results – Peak Demand Savings & Cost of Peak Demand

C&I	Peak Demand Savings as % of Peak Demand	Cost of Peak Demand Savings ($/kW)
All Utilities Median	0.7%	$888/kW
AEP Ohio 2014	0.7%	$941/kW
AEP Ohio 2015	0.7%	$991/kW



Ameren (IL) and FE (PA) are not included in scatterplot as 2014 retail peak kW is not available.

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Table of Contents

1 Methodology and Scope
2 2014 Benchmarking – Residential
3 References

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2014 Residential Results

	Spending as % of Revenue	Energy Savings as % of Sales	Peak Demand Savings as % of Peak Demand	Cost of First Year Savings	
				$/kWh	$/kW
All Utilities Median	2.1%	1.5%	0.9%	$0.13	$1,179
AEP Ohio 2014	2.4%	2.3%	1.6%	$0.12	$949
AEP Ohio 2015	1.7%	1.5%	1.1%	$0.13	$969

Note: AEP Ohio's 2015 results have not been evaluated
2014 baseline data was used to normalize 2015 savings and spending

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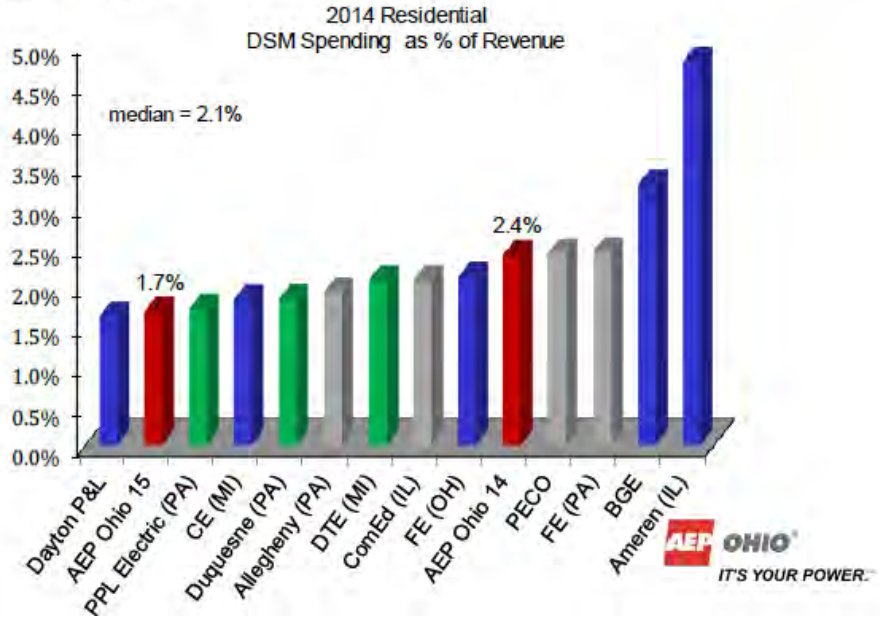
2014 Residential Results – Spending

- AEP Ohio 2014 residential EE/PDR spending (as % of revenue) is above median
- 2015 is below median



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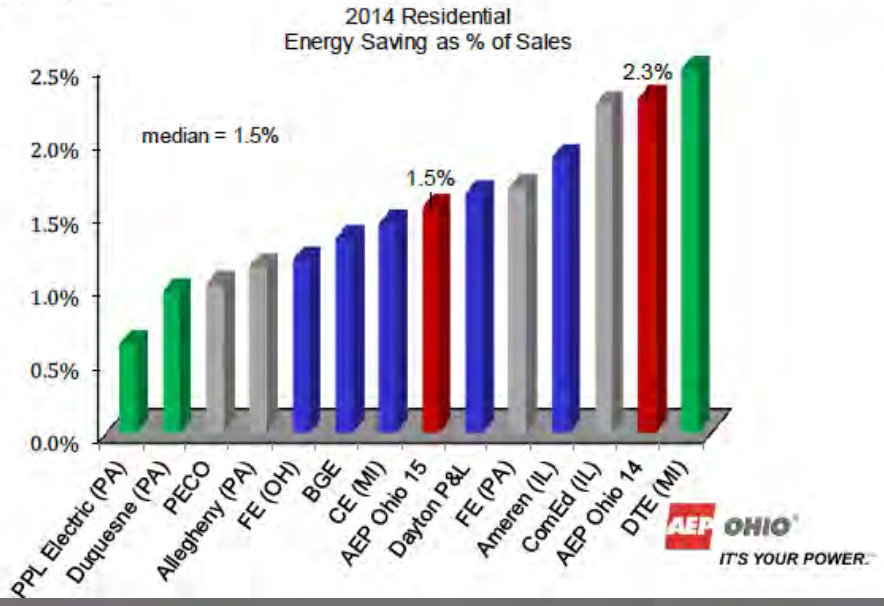
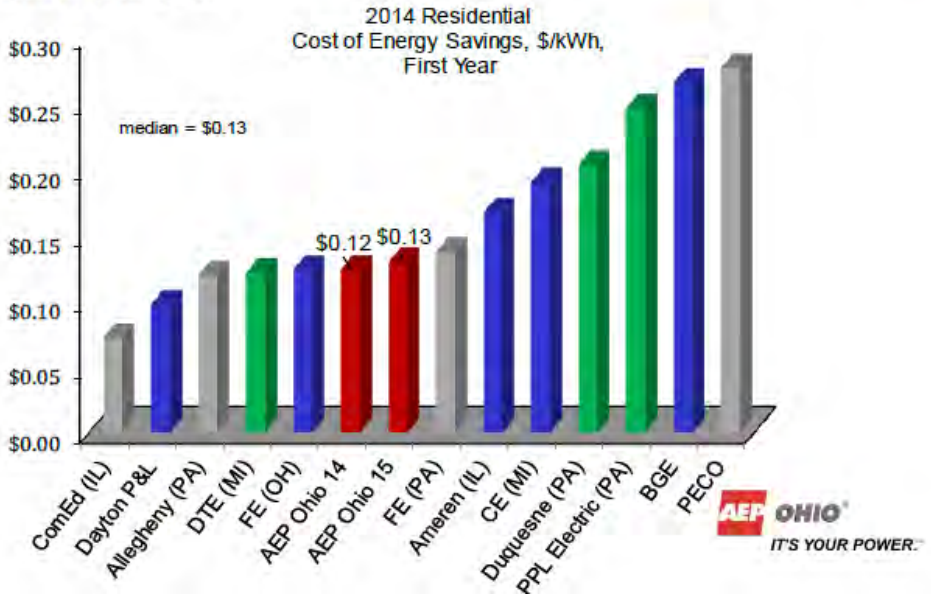
2014 Residential Results – Energy Savings

- AEP Ohio 2014 residential EE/PDR savings (as % of sales) is above median
- 2015 is at median



2014 Residential Results – Cost of Energy Savings

- AEP Ohio 2014 cost of res. EE/PDR savings per first year kWh is below median
- 2015 is at median



2014 Residential Results – Energy Savings & Cost of Energy Savings

Residential	Energy Savings as % of Sales	Cost of Energy Savings ($/kWh)
All Utilities Median	1.5%	$0.13/kWh
AEP Ohio 2014	2.3%	$0.12/kWh
AEP Ohio 2015	1.5%	$0.13/kWh

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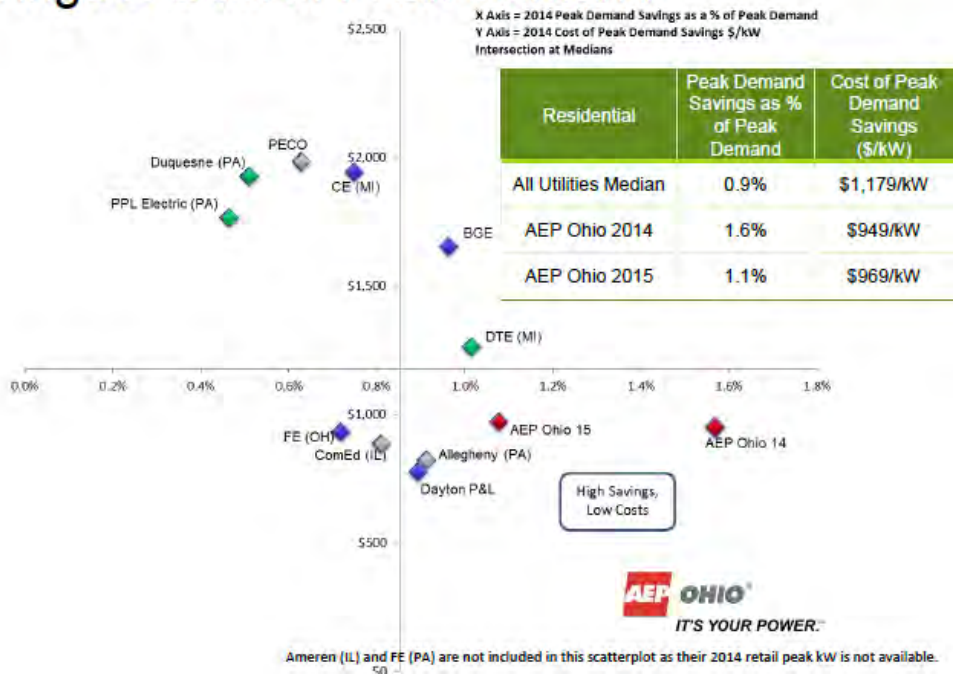
2014 Residential Results – Peak Demand Savings & Cost of Peak Demand



Residential	Peak Demand Savings as % of Peak Demand	Cost of Peak Demand Savings ($/kW)
All Utilities Median	0.9%	$1,179/kW
AEP Ohio 2014	1.6%	$949/kW
AEP Ohio 2015	1.1%	$969/kW

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Ameren (IL) and FE (PA) are not included in this scatterplot as their 2014 retail peak kW is not available.

Table of Contents

1 Methodology and Scope
2 2014 Benchmarking
3 References

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C. EE/PDR Measure Descriptions and Characterizations

C.1 Overview

This Appendix describes a sample of the primary DSM measures analyzed for this study and the methods used to estimate savings. Each measure record includes energy savings, gross demand savings, code minimum energy and demand, incremental cost, and measure life. Baselines affected by current or anticipated future code changes, known as a 'dual baseline' scenario, were also modeled where applicable. Residential and non-residential measures were analyzed using similar methods. Measures are analyzed by sector to account for variation in usage patterns and density for different building types.

This section reports common elements of the analysis. Subsequent sections discuss the residential and non-residential measures and analysis methods in more detail. Measure characterizations for all sectors include the following parameters:

- **Measure Description –** A unique and brief description of the efficient technology
- **Baseline Description –** A brief description of the assumed market baseline technology, dependent on the Decision Type
- **Decision Type –** Describes the motivation of the customer with respect to installation of the efficient measure. Typically one of the following: Retrofit (Early Replacement or added controls for energy efficiency), Dual Baseline, Replace on Burnout (End of Life), New Construction.
- **Unit –** Unit by which savings and costs are reported, such as 'per fixture' for a lighting fixture retrofit.
- **Measure Life** – Expected number of years of normal use of the efficient technology before failure. Values primarily sourced from the 2015 AEP Ohio Prescriptive Measures Savings Workpapers, which frequently reference the CA DEER database and the Ohio, Pennsylvania, and Vermont TRMs.
- **Energy Impact (kWh/Unit**) – Energy savings for one unit of the measure in kilowatt-hours per year, and baseline energy impact for the code minimum technology. All savings estimates are 'at the meter'.
- **Coincident Summer Peak Impact (W/Unit) –** Ohio coincident peak demand savings for one unit of the measure in Watts per year, and baseline demand for the code minimum technology. All savings estimates are 'at the meter', and based on the Ohio system summer coincident peak hours of 3 PM to 6 PM, weekday non-holidays in June, July, and August.
- **Base Incentive ($/Unit) –** Incentive, in dollars, for one unit of the measure. AEP prescriptive incentive values are used when applicable.

- **Technology Cost ($/Unit) –** Per-unit incremental cost of the efficient technology. For replace-on-burnout scenarios this is the incremental difference between the retail cost of the baseline technology and the retail cost of the efficient option. For all other cases (Low Income, early replacement, and retrofit), this is the full retail cost of the efficient option plus any labor costs for installation.

AEP Ohio and Navigant researched material and labor costs for each measure and calculated incremental costs. Incremental costs are primarily based on the 2015 AEP Ohio Prescriptive Measures Savings Workpapers, though non-residential lighting measures typically utilize Navigant engineering estimates. Where measures can be purchased from national retailers, such as room air conditioners, retail prices form the basis of incremental costs.

C.2 Residential Measure Characterizations

Residential measure analysis is reported for new single-family homes, existing single-family homes, and residential multi-family homes. Savings for each housing type were evaluated for three primary HVAC systems: gas furnace/air conditioning (AC), electric resistance/AC, and air & ground source heat pumps. A combination of the resources outlined in section C.1., other secondary sources, and engineering calculations were used to estimate measure savings.

For both climate-dependent and climate-independent EE/PDR measures, Navigant evaluated the energy and demand savings and incremental costs using engineering calculations based on the 2010 Ohio Technical Reference Manual (TRM) when available, TRM characterizations from nearby states, and other secondary research. Savings algorithms used for measures characterized in the previous AEP Ohio Plan Design study were reviewed and adjusted to account for changes in code and baseline technologies and incremental cost if applicable. For residential new construction, Navigant used aggregate data from REMRate modeling software for Ohio.

Lighting estimates are primarily based on differences in installed lamp wattage and residential usage patterns combined with HVAC interactive effects as determined with simulation models. Savings for appliances are based on secondary sources such as ENERGY STAR® calculators and commercial product reports. For climate dependent measures such as HVAC and thermal shell improvements, savings for each climate zone were modified based on Heating Degree Days ("HDD"), and Cooling Degree Days or Hours ("CDD" or "CDH") designated in the Ohio TRM.

C.2.1 Residential Water Heating Measures

Energy and demand savings from hot water savings can be achieved through a variety of measures and occur by reducing the quantity of hot water consumed or by improving the efficiency of the water heating/storage/distribution process.

Efficient Water Heaters

Traditional electric water heaters have an overall Energy Factor of about 0.90 including standby losses. High efficiency electric units achieve 95% efficiency (0.95 Energy Factor) with improved jacket insulation and heat traps that minimize thermosiphoning into under-insulated distribution pipes. The savings estimate for the high-efficiency unit is calculated from the total hot water energy use and the unit efficiencies. Base case electric energy factor (EF) is assumed to be 0.904, and the efficient case EF is 0.95.

Heat Pump Water Heaters

Heat pump water heaters remove thermal energy from the surrounding air and use it to heat water, in contrast with conventional water heaters that use typically either gas burners or electric resistance heating coils to heat water. The baseline technology is an electric resistance water heater with an Energy Factor of 0.904, while the efficient measure can record significant savings with a 2.0 energy factor or greater.

Instantaneous or Tankless Electric Water Heaters

Instantaneous or on-demand tankless water heaters achieve savings over traditional storage water heaters by only producing hot water when desired thereby avoiding standby losses. Instantaneous water heaters are modeled with a 0.99 energy factor as compared with a baseline electric water heater's 0.904 energy factor.

DHW Tank Wrap

This measure applies to the installation of an insulated tank wrap or tank 'blanket' to existing residential electric hot water heaters. The base case for this measure is a standard residential storage type electric water heater with no external insulation wrap.

Hot Water Storage Tank Temperature Gauge

Adding this gauge to a typical residential storage-type DHW system without a gauge allows the user to appropriately setback the unit's water temperature setting and realize commensurate savings.

Low-Flow Shower Heads

Low flow shower heads use an orifice plate inside the fixture or other means to restrict water flow and reduce consumption of hot water compared to a baseline showerhead technology without significantly impacting perceived flow. A low-flow showerhead, modeled at 1.25 gallons per minute (GPM), can achieve savings in homes with an electric water heater, – electric resistance or heat pump storage types and instantaneous heaters. The baseline showerhead consumes 2.87 GPM.

Low Flow Faucet Aerators
Low Flow Faucet aerators reduce flow while introducing air into the water as it leaves the faucet. A low flow faucet aerator reduces flow from 2.2 GPM baseline to 1.5 GPM and can be installed on either the kitchen or bathroom faucet.

Hot Water Pipe Insulation
Pre-formed segments of foam insulation are placed around hot water distribution pipes to minimize heat loss. While useful for the entire length of hot water piping, this measure is most cost-effective in the first 10 feet of pipe extending from the hot water heater. Engineering estimates of steady state heat loss from the pipes to conditioned indoor air were used to estimate savings.

Drain Water Heat Recovery
These systems recover some of the lost thermal energy from the drain pipe and preheat the cold water service to the water heater. Savings are based on US Department of Energy information and manufacturer case studies. Engineering calculations based on the effectiveness of an average of six commercially-available drain water heat recovery systems were used to estimate savings. Water consumption is based on residential usage for showers from TRMs and other secondary research.

Consortium for Energy Efficiency (CEE) Tier 3 Clothes Washers
CEE Tier 3 clothes washers must be certified with a modified energy factor (MEF) of >=2.2. The federal baseline standard is 1.26MEF. CEE lists qualifying washers on a monthly basis.

ENERGY STAR Dishwashers
Until January 2016, federal standard required a minimum Energy Factor (EF) of 0.46 for standard models and 0.62 for compact models to qualify as ENERGY STAR. As of January 2016, ENERGY STAR qualifies dishwashers according to annual water and energy consumption. Standard-size models must consume ≤ 270 kWh/year and consume less than 3.5 gallons of water per cycle. Compact models must consume ≤ 23 kWh/year and ≤ 3.1 gallons per cycle based on average domestic usage. Savings is not climate dependent and is based on ENERGY STAR estimates.

C.2.2 Residential HVAC & Shell Measures

HVAC savings can be achieved by improving the building shell, optimizing thermostat settings, and/or improving the efficiency of the equipment and distribution process.

Since HVAC savings are climate dependent, most of the savings for the following measures were determined by establishing the baseline reference home to reflect the baseline option, then modifying that reference home to reflect the improved efficiency case. Savings are calculated as the difference between the two. Incremental costs are mostly based from the Ohio, Pennsylvania, and Vermont TRMs and typically reflect assumptions from the CA DEER database. Where measures can be purchased from

national retailers, such as window A/C units, retail prices and cost studies form the basis of incremental costs.

ENERGY STAR Residential Window/Room Air Conditioners

ENERGY STAR room air conditioners must be at least 10 percent more efficient than standard U.S. models, which are defined as units with a minimum Combined Energy Efficiency Ratio (CEER) rating of 8.9-10.9 depending upon the size and type of the unit. Minimum efficiency standards for room air conditioners range from 9.9 EER to 12.1 CEER depending on the unit size and type. Savings are determined by simulation models improving equipment from 9.8 to 10.7 EER.

ENERGY STAR Residential Air Source Heat Pumps

ENERGY STAR air source heat pumps are units with minimum Seasonal Energy Efficient Rating (SEER) rating of 15.0 for split systems (15.0 for packaged units as well), EER ratings of 12.5 for split systems (12 for packaged units), and heating system performance factors of 8.5/8.2 or higher. Since 2006, federal minimum efficiency standards for heat pumps are 13 SEER and 7.7 HSPF. Savings is determined by modeling.

High Efficiency Central Air Conditioning

Since 2006, the federal minimum efficiency standard for central air conditioners is 13 SEER. The efficient, ENERGY STAR certified Central A/C units are SEER 15 and 12.5 EER for split systems, as well as ENERGY STAR SEER 15.0/12.0 EER for single package equipment. Energy savings is modeled for homes with Electric Heat and Non-Electric Heat.

HVAC Diagnostic Repair, Testing, and Maintenance/Tune-up

Many residential and commercial HVAC systems are not operating as efficiently as possible due to inadequate maintenance. The package of services includes ensuring proper refrigerant charge, lubrication, cleanliness, and fan operation. The savings estimate assumes that the tune-up improves efficiency by 5 percent, which is consistent with refrigerant over-charge and undercharge savings.

HVAC Duct Sealing, Operations and Maintenance

Many HVAC ducts are not sealed well and leak conditioned air into conditioned and unconditioned spaces such as basements and attics, failing to properly deliver heating and cooling to the occupied areas of the home. Duct sealing reduces such heat loss and reduces required fan power. Savings estimates are determined by modeling well sealed ductwork vs. systems with typical leakage, about five percent.

Ceiling Insulation

Ceiling insulation includes both insulating uninsulated and under-insulated roof areas. Savings are calculated from simulations replacing R-25 with R-30 or R-45 ceiling insulation.

Wall Insulation

Wall insulation is most cost-effective when insulating un-insulated wall areas. Savings are determined from simulations retrofitting an uninsulated R-4 wall with R-11 insulation.

Efficient Windows

Efficient windows are defined using their NFRC-rated whole window U-value and Solar Heat Gain Coefficient (SHGC). Often these are either triple-pane windows, or double-pane windows with Low-E coatings and low SHGC. Reducing the SHGC of glazing will reduce the cooling load for the building, but increasing the heating load over a longer time period, so this is usually not cost-effective, especially for electrically heated homes. Savings are determined from modeling the replacement of double-pane baseline windows with triple-pane models.

Comprehensive Shell Air Sealing/Reduced ACH

The measure includes caulking, weather stripping, and sealing other visible cracks and penetrations in the building shell and thermal envelope. Without the addition of mechanical ventilation to introduce fresh air and manage moisture levels indoor air quality can deteriorate, so a lower limit of 0.30 air-changes per hour (ACH) is advised. Savings are determined for electric heat and heat pump heating by modeling a base case of 0.6 ACH vs. an efficient case of 0.3 ACH.

Ground Source Heat Pumps

Ground source heat pumps use the ground and ground water instead of the air as a thermal heat source and sink for heating and cooling. Ground temperatures are more constant over the course of the year, so ground source heat pumps can operate much more efficiently than air source heat pumps during the hottest and coldest parts of the year. Savings are determined by simulating a 4.6 Coefficient of Performance (COP) ground source heat pump against a standard SEER 14, 11 EER air source heat pump.

C.2.3 Residential Appliance and Additional Measures

Minimum refrigerator and freezer efficiency has progressed substantially in the past 20 years, with older units consuming at least twice as much energy as a comparable new machine. Other home appliances have also become more efficient and the federal ENERGY STAR rating program identifies equipment that significantly improve on minimum standards.

ENERGY STAR Refrigerators and Freezers

ENERGY STAR refrigerators must exceed current federal minimum energy efficiency standards by at least 20 percent (for full- and compact-sized refrigerators). ENERGY STAR freezers must exceed minimum energy efficiency standards by at least 10 percent for full-sized units and 20 percent for compact units. ENERGY STAR and CEE Tier2/3 compliant units are modeled vs baseline code-compliant units.

Remove Secondary Refrigerators and Freezers

Second refrigerators and freezers are often older and less efficient appliances. For example, the most common refrigerator sold in 1990 used between 60-70 kWh per cubic foot, compared to typical current models that use less than 26 kWh per cubic foot. Savings are modeled by retiring these older, inefficient units and using TRM-based assumptions on how many of these are replaced with standard efficiency or Energy Star new units.

Smart Power Strips

Smart power strips automatically shut down plug-in devices that are not in use. A smart power strip typically has a control outlet, several associated slave outlets, and one or more that are always on. A primary appliance is plugged in to the control outlet and its peripherals are plugged into the slave outlets so that when the primary appliance is shut down, the smart power strip automatically shuts down the power to the peripherals. In a home office environment, a computer could be plugged into the control outlet, and a monitor, printer, speakers, and task lamp could be plugged into the slave outlets. Five and seven-plug smart strips replace a standard baseline power strip without smart strip capabilities.

Variable Speed Drive Pool Pumps

This measure replaces a single speed pool pump and motor with a new variable speed pump and motor. The savings is deemed in the Ohio TRM, p.118 and assumes 100 days of operation per year.

Premium Efficiency Pool Pumps

This measure describes the installation of a residential 1.5HP premium efficiency single speed pool pump motor in place of a standard single speed motor of equivalent horsepower operating 6 hours per day, 100 days per year.

Convection Oven

Convection ovens replace traditional ovens in the home. Convection ovens have a small fan within the oven that circulates hot oven air, thus enhancing heat transfer to food and reducing cook times and permitting use of slightly lower cooking temperatures.

ENERGY STAR Home Electronics: Cable Boxes, Computer Monitors & TVs

Home electronics represent an increasing proportion of home electricity use. These devices can consume significant power while in use and continue to use significant power while shut-down or in stand-by. ENERGY STAR equipment must have lower operating power use and must reduce power use substantially when 'off' and not in use. Different ENERGY STAR standards apply by size and component type.

ECM Fan Motor

Baseline permanent split capacitor (PSC) HVAC motors are frequently used in HVAC applications where variable speeds are desired (e.g. fans). Replacing these with an electronically commutated motor (ECM) offers higher operating efficiency and energy savings in a variety of residential HVAC applications.

Programmable Electronic Baseboard Thermostat

Programmable thermostats for electric baseboard heating are used primarily to modify temperature set-points during specified unoccupied and nighttime hours. These units replace a manual thermostat baseline. NEST consumer controls are also modeled, for replacement of manual thermostats and standard programmable thermostats, and offer a user-friendly interface and "smart" programming that can achieve higher savings than traditional programmable controls or manual thermostats.

Bathroom Ventilating Fan

This measure captures the energy savings from replacing a code minimum ventilation fan with a more efficient ENERGY STAR 50 CFM bathroom ventilation fan which draws a maximum of 35 watts.

ENERGY STAR Doors

This measure captures the energy savings from replacing the average existing doors, 1.75" thick wood, R-3.2, with ENERGY STAR rated doors with R values between R-3.5 and R-5, depending on the amount of glazing.

The ENERGY STAR Torchiere

This measure captures the energy savings from replacing a baseline halogen floor lamps with ENERGY STAR labeled fluorescent version. ENERGY STAR torchieres last longer than halogen torchieres, remain cooler and use less energy. Over the life of one bulb, a consumer can save up to $125.

ENERGY STAR Manufactured Homes

An ENERGY STAR qualified manufactured home is a home that has been designed, produced, and installed in accordance with ENERGY STAR's guidelines by an ENERGY STAR certified plant.[8] These units offer improved performance over baseline non ENERGY STAR manufactured homes across a series of home performance aspects.

HERS Energy Rated Home

A Home Energy Rating System ("HERS")-based home energy rating is the product of an analysis of a home's energy performance and scaled on the Home Energy Rating System (HERS) index. The HERS index is a nationally recognized scoring system for measuring a home's energy performance. The baseline HERS rating for a new home is between 80 and 100, and a zero-energy home would receive a score of 0. Existing homes typically have HERS 100 or higher ratings. Efficient new homes are modeled at scores of 65, 70, and 85 over various heating system types.

ENERGY STAR 3.0 Qualified Home

This packaged new construction program offers incentives to reach ENERGY STAR 3.0 specifications. Homes may earn an ENERGY STAR rating based on the V3.0 guidelines

[8] See: https://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.pt_builder_manufactured. Accessed 3/14.

using an ENERGY STAR prescriptive of performance path. The baseline is code construction.

Whole House Residential Retrofit

This package incentive available through the Energy Path Homes program, is targeted toward lower tier new construction and existing homes that would not be able to cost-effectively reach ENERGY STAR 3.0 specifications. Savings is calculated based on minimally code compliant new construction or the tested performance before improvement of existing homes.

C.2.3.1 New Construction / ENERGY STAR Homes

For this analysis, aggregate REMRate modeling data for Ohio were used to determine average energy and demand savings for ENERGY STAR homes. To determine savings, REMRate compares the as-built home to an appropriate baseline reference homes in two scenarios. The first scenario represents the Energy Path program track, usually for existing homes with a pre-improvement HERS score of 100 or higher, but also for new construction that meets the previous ENERGY STAR standards, but not ENERGY STAR 3.0 standards. The second scenario applies mostly to new construction ENERGY STAR 3.0 compliant homes that employ high performance thermal shell construction, higher efficiency HVAC systems and high efficiency lighting and appliances. These homes are compared to a minimally code-compliant home of the same dimensions. Average costs for each scenario were also derived from actual participating homes in Ohio.

C.3 Residential Measure Characteristics by Program

Table 43. Residential Measure Characteristics (at meter savings)

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
A/C Cycling	0 hours of control	Air Conditioning Control - Res	CTR	Per Home	481	2.08	1	$30.00	$100.00	$47.08
Refrigerator Retirement	Secondary Refrigerator	Appliance Recycling	REM	Refrigerator	727	0.15	8	$140.00	$0.00	$29.78
Freezer Retirement	Secondary Freezer	Appliance Recycling	REM	Freezer	640	0.16	8	$140.00	$0.00	$26.23
Air Source Heat Pump SEER 14.5, COP 2.49	Electric Resistance Forced Air Furnace	Community Assistance	RET	Ton	2,707	0.02	18	$1,006.25	$1,006.25	$1,524.92
ENERGY STAR® Window / Room AC (DUB)	EER 8.5 Window AC	Community Assistance	DUB	Unit	68	1.38	12	$29.90	$29.90	$38.29
Reduced ACHnat 0.3 - Heat Pump	ACH 0.6	Community Assistance	RET	Home	1,712	0.01	15	$530.00	$530.00	$964.61
Reduced ACHnat 0.3 - Central A/C - Non-EL Heat	ACH 0.6	Community Assistance	RET	Home	17	0.90	15	$530.00	$530.00	$9.59
Reduced ACHnat 0.3 - Central A/C - EL Heat	ACH 0.6	Community Assistance	RET	Home	3,407	0.00	15	$530.00	$530.00	$1,919.62
Ceiling Ins. R-30 - Heat Pump	R-25 Ceiling	Community Assistance	RET	1000 sqft footprint	98	0.02	20	$700.00	$700.00	$55.39
Ceiling Ins. R-30 - Central A/C - Non-EL Heat	R-25 Ceiling	Community Assistance	RET	1000 sqft footprint	2	0.90	20	$700.00	$700.00	$1.23
Ceiling Ins. R-30 - Central A/C - EL Heat	R-25 Ceiling	Community Assistance	RET	1000 sqft footprint	194	0.01	20	$700.00	$700.00	$109.55
Ceiling Insul R-45 - Heat Pump	R-25 Ceiling	Community Assistance	RET	1000 sqft footprint	262	0.02	20	$890.00	$890.00	$147.71
Ceiling Insul R-45 - Central A/C - Non-EL Heat	R-25 Ceiling	Community Assistance	RET	1000 sqft footprint	6	0.90	20	$890.00	$890.00	$3.28
Ceiling Insul R-45 - Central A/C - EL Heat	R-25 Ceiling	Community Assistance	RET	1000 sqft footprint	519	0.01	20	$890.00	$890.00	$292.14
Wall Insul. R-11 - Heat Pump	Un-Insulated Wall	Community Assistance	RET	1000 sqft wall area	2,028	0.05	25	$1,300.00	$1,300.00	$1,142.43
Wall Insul. R-11 - Central A/C - Non-EL Heat	Un-Insulated Wall	Community Assistance	RET	1000 sqft wall area	45	2.33	25	$1,300.00	$1,300.00	$25.37
Wall Insul. R-11 - Central A/C - EL Heat	Un-Insulated Wall	Community Assistance	RET	1000 sqft wall area	4,011	0.01	25	$1,300.00	$1,300.00	$2,259.49
Underbelly Insulation R-19 - Heat Pump	Un-Insulated Floor	Community Assistance	RET	100 sqft floor area	221	0.02	25	$122.00	$122.00	$124.63
Underbelly Insulation R-19 - Central A/C - EL Heat	Un-Insulated Floor	Community Assistance	RET	100 sqft floor area	438	0.01	25	$122.00	$122.00	$246.49
1W LED Night Light	7W Incandescent Light	Community Assistance	ROB	Lamp	20	0.00	8	$2.00	$2.00	$11.27
LED Lighting 8W - Indoor	60W Incandescent	Community Assistance	ROB	Lamp	38	0.08	15	$5.41	$5.41	$21.61

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
LED Lighting 8W - Outdoor	60W Incandescent	Community Assistance	ROB	Lamp	41	0.00	15	$5.41	$5.41	$23.03
LED Lighting 15W - Indoor	Mix of 75W and 100W incandescent	Community Assistance	ROB	Lamp	62	0.08	15	$8.59	$8.59	$35.16
LED Lighting 15W - Outdoor	Mix of 75W and 100W incandescent	Community Assistance	ROB	Lamp	67	0.00	15	$8.59	$8.59	$37.51
High Eff. Elec. Water Heat - Tank - .95 EF (DUB)	Average Existing Electric Water Heater - 0.90 EF	Community Assistance	DUB	Unit	176	0.09	20	$287.15	$287.15	$99.43
Heat Pump Water Heater - 2.0 EF	Standard Electric Water Heater - .945 EF	Community Assistance	ROB	Unit	1,685	0.09	10	$888.50	$888.50	$949.07
Heat Pump Water Heater - 2.0 EF (DUB)	Average Existing Electric Water Heater - 0.90 EF	Community Assistance	DUB	Unit	1,844	0.09	10	$492.39	$492.39	$1,039.03
Instantaneous Electric Water Heater - .99 EF	Standard Electric Water Heater - .945 EF	Community Assistance	ROB	Unit	145	0.09	13	$666.80	$666.80	$81.78
Instantaneous Electric Water Heater - .99 EF (DUB)	Average Existing Electric Water Heater - 0.90 EF	Community Assistance	DUB	Unit	305	0.09	13	$476.11	$476.11	$171.74
DHW Pipe Insulation R-4 10 feet	10 feet of uninsulated (R-1) Hot Water Pipe	Community Assistance	RET	10 Linear Feet	266	0.11	15	$55.00	$55.00	$149.86
Low Flow Faucet Aerator, 1.5 GPM - EDHW	Average Existing Stock Aerator (2.2 GPM)	Community Assistance	RET	Faucet	25	0.12	12	$2.80	$2.80	$13.80
Low Flow (1.25 GPM) showerhead	2.87 GPM Showerhead	Community Assistance	RET	Shower	237	0.11	9	$11.00	$11.00	$133.52
Efficient Refrigerator (ENERGY STAR® or Better) (DUB)	Average Existing Refrigerator	Community Assistance	DUB	Refrigerator	231	0.15	17	$832.88	$832.88	$129.92
Refrigerator Retirement	Secondary Refrigerator	Community Assistance	REM	Refrigerator	727	0.15	8	$140.00	$0.00	$409.50
ECM Fan Motor - Heat Pump	Std PSC HVAC Motor	Community Assistance	RET	Home	675	0.20	18	$90.68	$90.68	$380.27
ECM Fan Motor - Central A/C - Non-EL Heat	Std PSC HVAC Motor	Community Assistance	RET	Home	675	0.20	18	$90.68	$90.68	$380.27
ECM Fan Motor - Central A/C - EL Heat	Std PSC HVAC Motor	Community Assistance	RET	Home	675	0.20	18	$90.68	$90.68	$380.27
Shower Start/Stop	No Start/Stop on Shower	Community Assistance	RET	Unit	245	0.11	5	$24.95	$24.95	$138.11
Weatherstripping and Door Sweep	No Weatherstripping	e3smart	RET	Home	82	0.12	11	$1.00	$1.00	$8.35
1W LED Night Light	7W Incandescent Light	e3smart	RET	Lamp	20	0.00	8	$2.00	$2.00	$2.05
LED Lighting 8W - Indoor for Kit	60W Incandescent	e3smart	RET	Lamp	41	0.08	15	$5.41	$5.41	$4.20

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
LED Lighting 8W - Outdoor for Kit	60W Incandescent	e3smart	RET	Lamp	41	0.00	15	$5.41	$5.41	$4.19
LED Lighting 15W - Indoor for Kit	Mix of 75W and 100W incandescent	e3smart	RET	Lamp	62	0.08	15	$8.59	$8.59	$6.39
LED Lighting 15W - Outdoor for Kit	Mix of 75W and 100W incandescent	e3smart	RET	Lamp	67	0.00	15	$8.59	$8.59	$6.82
Low Flow (1.25 GPM) showerhead	2.87 GPM Showerhead	e3smart	RET	Shower	237	0.11	9	$2.75	$2.75	$24.28
Hot Water Temp Gauge (Tank Temperature Turn Down)	No Temp Gauge	e3smart	RET	Unit	151	0.09	4	$1.00	$1.00	$15.50
Low Flow Faucet Aerator, 1.5 GPM - EDHW -Kitchen	Average Existing Stock Aerator (2.2 GPM)	e3smart	RET	Faucet	25	0.12	12	$0.50	$0.50	$2.51
Low Flow Faucet Aerator, 1.5 GPM - EDHW - Bathroom	Average Existing Stock Aerator (2.2 GPM)	e3smart	RET	Faucet	42	0.12	12	$0.50	$0.50	$4.30
LED Lighting 8W - Indoor	60W Incandescent	Efficient Products	ROB	Lamp	38	0.08	15	$3.25	$5.41	$1.96
LED Lighting 8W - Outdoor	60W Incandescent	Efficient Products	ROB	Lamp	41	0.00	15	$3.25	$5.41	$2.09
LED Lighting 15W - Indoor	Mix of 75W and 100W incandescent	Efficient Products	ROB	Lamp	62	0.08	15	$5.00	$8.59	$3.20
LED Lighting 15W - Outdoor	Mix of 75W and 100W incandescent	Efficient Products	ROB	Lamp	67	0.00	15	$5.00	$8.59	$3.41
LED Lighting 8W - Indoor (CFL Base)	13W CFL	Efficient Products	ROB	Lamp	3	0.09	15	$3.25	$3.78	$0.16
LED Lighting 8W - Outdoor (CFL Base)	13W CFL	Efficient Products	ROB	Lamp	4	0.00	15	$3.25	$3.78	$0.22
LED Lighting 12W - Indoor (CFL Base)	23W CFL	Efficient Products	ROB	Lamp	6	0.09	15	$3.75	$3.78	$0.31
LED Lighting 12W - Outdoor (CFL Base)	23W CFL	Efficient Products	ROB	Lamp	9	0.00	15	$3.75	$3.78	$0.45
5W Chandelier LED bulb	20 -25W Incandescent Chandelier/Specialty Bulb	Efficient Products	ROB	Lamp	20	0.09	15	$3.75	$7.50	$1.01
Hardwired Dimmer Switch	Two 60W Bulbs without Dimmer Switch	Efficient Products	RET	Dimmer	24	0.21	10	$8.00	$30.00	$1.23
Indoor Wall-mounted Motion Sensor	Two 60W Bulbs without a Motion Sensor	Efficient Products	RET	Sensor	39	0.13	8	$20.00	$42.00	$2.01
Indoor Fixture-mounted Motion Sensor	Two 60W Bulbs without a Motion Sensor	Efficient Products	RET	Sensor	29	0.18	8	$20.00	$66.00	$1.47
Outdoor Motion Sensor	No Motion Sensor	Efficient Products	RET	Sensor	56	0.00	8	$20.00	$33.00	$2.86

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Solar Water Heat (DUB)	Average Existing Electric Water Heater - 0.90 EF	Efficient Products	DUB	Unit	2,442	0.16	20	$2,250.00	$4,479.21	$125.05
DHW Pipe Insulation R-4 10 feet	10 feet of uninsulated (R-1) Hot Water Pipe	Efficient Products	RET	10 Linear Feet	266	0.11	15	$30.00	$55.00	$13.62
Low Flow Faucet Aerator, 1.5 GPM - EDHW	Average Existing Stock Aerator (2.2 GPM)	Efficient Products	RET	Faucet	25	0.12	12	$2.80	$2.80	$1.25
Low Flow (1.25 GPM) showerhead	2.87 GPM Showerhead	Efficient Products	RET	Shower	192	0.11	9	$6.00	$6.00	$9.83
VSD Pool Pump	Code Efficiency One Speed Pump	Efficient Products	ROB	Pump	1,170	1.46	10	$200.00	$750.00	$59.92
Premium Efficiency Pool Pumps	Code Efficiency One Speed Pump	Efficient Products	ROB	Pump	409	1.40	10	$25.00	$50.00	$20.95
Heavy Duty Outdoor Timer for Pool Pump	Pool Pump Run Continuously Without Timer	Efficient Products	RET	Pump	131	2.33	10	$25.00	$200.00	$6.69
Efficient Refrigerator (ENERGY STAR® or Better)	Code-Compliant Refrigerator	Efficient Products	ROB	Refrigerator	104	0.18	17	$50.00	$89.75	$5.30
Efficient Refrigerator (ENERGY STAR® or Better) (DUB)	Average Existing Refrigerator	Efficient Products	DUB	Refrigerator	231	0.15	17	$37.53	$37.53	$11.81
ENERGY STAR® Freezer	Code Freezer	Efficient Products	ROB	Freezer	36	0.16	11	$10.00	$35.00	$1.85
ENERGY STAR® Freezer (DUB)	Average Existing Freezer	Efficient Products	DUB	Freezer	256	0.16	11	$10.00	$72.17	$13.13
ENERGY STAR® Dehumidifier	Non-ENERGY STAR® Dehumidifier	Efficient Products	ROB	Dehumidifier	207	0.23	12	$25.00	$60.00	$10.58
5-plug Smart Strip Power Bar	No Sensor Power Strip	Efficient Products	RET	Power Strip	57	0.11	4	$10.00	$16.00	$2.89
7-plug Smart Strip Power Bar	No Sensor Power Strip	Efficient Products	RET	Power Strip	103	0.12	4	$10.00	$26.00	$5.26
ENERGY STAR® v. 5.3 Television	Code Compliant TV	Efficient Products	ROB	TV	272	0.15	6	$1.00	$1.00	$13.90
ENERGY STAR® Most Efficient Television	Code Compliant TV	Efficient Products	ROB	TV	314	0.15	6	$1.00	$1.00	$16.09
ENERGY STAR® Set Top Boxes	Non-ENERGY STAR® Set Top Boxes	Efficient Products	ROB	Box	62	0.07	5	$19.01	$19.01	$3.16
ENERGY STAR® Monitor	Code Compliant Monitor	Efficient Products	ROB	Monitor	14	0.13	5	$11.00	$11.00	$0.72
ENERGY STAR® Dishwasher - Elec DHW	Code Compliant Dishwasher (2013 Code)	Efficient Products	ROB	Dishwasher	37	0.10	11	$25.00	$50.00	$1.89
ENERGY STAR® Dishwasher - Elec DHW (DUB)	Average Existing Dishwasher (2010 Code)	Efficient Products	DUB	Dishwasher	85	0.10	11	$14.78	$14.78	$4.35

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
ENERGY STAR® Dishwasher - Non-EL DHW	Code Compliant Dishwasher (2013 Code)	Efficient Products	ROB	Dishwasher	16	0.10	11	$25.00	$50.00	$0.83
ENERGY STAR® Dishwasher - Non-EL DHW (DUB)	Average Existing Dishwasher (2010 Code)	Efficient Products	DUB	Dishwasher	64	0.10	11	$14.78	$14.78	$3.29
Convection Oven	Conventional Oven	Efficient Products	ROB	Oven	67	0.54	12	$50.00	$50.00	$3.45
Clothes Washer - Tier 3 >= 2.2 MEF-w/gas or no dry	Fed Standard 1.72 MEF	Efficient Products	ROB	Unit	130	0.14	11	$50.00	$101.43	$6.64
Clothes Washer - Tier 3 >= 2.2 MEF-w/gas or no dry (DUB)	Average Existing Clothes Washer (1.04 MEF)	Efficient Products	DUB	Unit	173	0.14	11	$29.98	$29.98	$8.86
Clothes Washer - Tier 3 >= 2.2 MEF-w/elec dry	Fed Standard 1.72 MEF	Efficient Products	ROB	Unit	393	0.14	11	$50.00	$101.43	$20.12
Clothes Washer - Tier 3 >= 2.2 MEF-w/elec dry (DUB)	Average Existing Clothes Washer (1.04 MEF)	Efficient Products	DUB	Unit	524	0.11	11	$29.98	$29.98	$26.84
Heat Pump Clothes Dryer (CEF >= 5.0) (Elec Dry)	Standard Vented Electric Dryer (CEF = 3.73)	Efficient Products	ROB	Unit	137	0.18	14	$350.00	$350.00	$7.00
ENERGY STAR® Air Purifier/Cleaner	Non-ENERGY STAR® Air Purifier/Cleaner	Efficient Products	ROB	Purifier	569	0.11	9	$50.00	$70.00	$29.15
High Performance Circulating Pump (DHW)	Conventional Circulator Pump on HW tank	Efficient Products	ROB	Pump	354	0.09	15	$50.00	$300.00	$18.13
Home Energy Report	No Report	HER	BEH	Home	200	0.05	1	$0.00	$0.00	$4.00
Tier 1 GSHP, Closed Loop, water to air	SEER 14, 11 EER Air Source Heat Pump	In-Home Energy	ROB	Ton	518	0.07	18	$500.00	$1,203.00	$199.12
Tier 1 GSHP, Closed Loop, water to air (DUB)	SEER 10, Air Source Heat Pump	In-Home Energy	DUB	Ton	829	0.19	18	$500.00	$525.00	$318.25
Tier 2 GSHP, Closed Loop, water to air	SEER 14, 11 EER Air Source Heat Pump	In-Home Energy	ROB	Ton	653	0.10	18	$500.00	$1,203.00	$250.85
Tier 2 GSHP, Closed Loop, water to air (DUB)	SEER 10, Air Source Heat Pump	In-Home Energy	DUB	Ton	963	0.19	18	$500.00	$525.00	$369.98
Tier 3 GSHP, Closed Loop, water to air	SEER 14, 11 EER Air Source Heat Pump	In-Home Energy	ROB	Ton	712	0.11	18	$500.00	$1,203.00	$273.55
Tier 3 GSHP, Closed Loop, water to air (DUB)	SEER 10, Air Source Heat Pump	In-Home Energy	DUB	Ton	1,022	0.19	18	$500.00	$525.00	$392.68

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Tier 1 GSHP, Open Loop, water to air	SEER 14, 11 EER Air Source Heat Pump	In-Home Energy	ROB	Ton	691	0.10	18	$500.00	$1,203.00	$265.45
Tier 1 GSHP, Open Loop, water to air (DUB)	SEER 10, Air Source Heat Pump	In-Home Energy	DUB	Ton	1,001	0.19	18	$500.00	$525.00	$384.57
Tier 2 GSHP, Open Loop, water to air	SEER 14, 11 EER Air Source Heat Pump	In-Home Energy	ROB	Ton	801	0.12	18	$500.00	$1,203.00	$307.49
Tier 2 GSHP, Open Loop, water to air (DUB)	SEER 10, Air Source Heat Pump	In-Home Energy	DUB	Ton	1,111	0.19	18	$500.00	$525.00	$426.62
Tier 3 GSHP, Open Loop, water to air	SEER 14, 11 EER Air Source Heat Pump	In-Home Energy	ROB	Ton	936	0.14	18	$500.00	$1,203.00	$359.42
Tier 3 GSHP, Open Loop, water to air (DUB)	SEER 10, Air Source Heat Pump	In-Home Energy	DUB	Ton	1,246	0.20	18	$500.00	$525.00	$478.54
Air Source Heat Pump SEER 15, COP 2.49	SEER 14, 11 EER Air Source Heat Pump	In-Home Energy	ROB	Ton	95	0.48	18	$200.00	$274.15	$36.35
Air Source Heat Pump SEER 15, COP 2.49 (DUB)	SEER 10, Air Source Heat Pump	In-Home Energy	DUB	Ton	662	0.25	18	$119.64	$119.64	$254.44
SEER 15 CAC - Non-EL Heat	SEER 13.0 CAC	In-Home Energy	ROB	Ton	68	0.90	18	$50.00	$184.25	$26.10
SEER 15 CAC - Non-EL Heat (DUB)	SEER 10.0 CAC	In-Home Energy	DUB	Ton	221	0.90	18	$50.00	$80.41	$84.81
SEER 15 CAC - EL Heat	SEER 13.0 CAC	In-Home Energy	ROB	Ton	68	0.90	18	$100.00	$184.25	$26.10
SEER 15 CAC - EL Heat (DUB)	SEER 10.0 CAC	In-Home Energy	DUB	Ton	221	0.90	18	$80.41	$80.41	$84.81
Ductless Mini Split HP SEER 15	Ductless Mini Split HP SEER 13	In-Home Energy	ROB	Ton	76	1.29	15	$25.00	$50.00	$29.23
Ductless Mini Split HP SEER 18	Ductless Mini Split HP SEER 13	In-Home Energy	ROB	Ton	159	1.29	15	$200.00	$377.11	$60.90
ENERGY STAR® Window / Room AC	CEER 10.9 Window AC	In-Home Energy	ROB	Unit	17	1.27	12	$16.19	$16.19	$6.40
ENERGY STAR® Window / Room AC (DUB)	EER 8.5 Window AC	In-Home Energy	DUB	Unit	68	1.27	12	$25.00	$29.90	$26.10
Ground Source Heat Pump (Elec Res Base)	Electric Baseboard Heating	In-Home Energy	RET	Ton	3,118	0.01	18	$2,000.00	$6,031.03	$1,197.66
ENERGY STAR® Air Source Heat Pump (Elec Res Base)	Electric Baseboard Heating	In-Home Energy	RET	Ton	2,612	0.02	18	$500.00	$1,809.31	$1,003.37
ECM Fan Motor - Heat Pump	Std PSC HVAC Motor	In-Home Energy	RET	Home	675	0.20	18	$50.00	$90.68	$259.28
ECM Fan Motor - Central A/C - Non-EL Heat	Std PSC HVAC Motor	In-Home Energy	RET	Home	675	0.20	18	$50.00	$90.68	$259.28
ECM Fan Motor - Central A/C - EL Heat	Std PSC HVAC Motor	In-Home Energy	RET	Home	675	0.20	18	$50.00	$90.68	$259.28
Duct Sealing and Insulation - Heat Pump	Leaky Un-Insulated Ducts	In-Home Energy	RET	Home	1,511	0.02	20	$70.00	$760.00	$580.48
Duct Sealing and Insulation - CAC - Non-EL Heat	Leaky Un-Insulated Ducts	In-Home Energy	RET	Home	35	0.98	20	$70.00	$760.00	$13.46
Duct Sealing and Insulation - CAC - EL Heat	Leaky Un-Insulated Ducts	In-Home Energy	RET	Home	3,430	0.01	20	$70.00	$760.00	$1,317.60

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
CAC Tune-Up	No Tune-Up	In-Home Energy	RET	Ton	30	0.40	5	$25.00	$192.50	$11.57
NEST Consumer Controls - Heat Pump - (DUB)	Non-Programmable Thermostat	In-Home Energy	DUB	Home	804	0.00	15	$70.00	$98.61	$308.79
NEST Consumer Controls - Non-EL Heat - (DUB)	Non-Programmable Thermostat	In-Home Energy	DUB	Home	50	0.00	15	$35.00	$98.61	$19.39
Reduced ACHnat 0.3 - Heat Pump	ACH 0.6	In-Home Energy	RET	Home	1,712	0.01	15	$200.00	$530.00	$657.69
Reduced ACHnat 0.3 - Central A/C - Non-EL Heat	ACH 0.6	In-Home Energy	RET	Home	17	0.90	15	$50.00	$530.00	$6.54
Reduced ACHnat 0.3 - Central A/C - EL Heat	ACH 0.6	In-Home Energy	RET	Home	3,407	0.00	15	$200.00	$530.00	$1,308.83
ENERGY STAR® 50 CFM Bathroom Ventilating Fan	Code-Compliant Ventilating Fan	In-Home Energy	ROB	Fan	88	0.11	19	$20.00	$43.50	$33.80
Solar Attic Ventilation Fans	Passive Ventilation	In-Home Energy	RET	Fan	8	0.98	10	$10.00	$500.00	$3.15
Ceiling Ins. R-30 - Heat Pump	R-25 Ceiling	In-Home Energy	RET	1000 sqft footprint	98	0.02	20	$225.00	$700.00	$37.77
Ceiling Ins. R-30 - Central A/C - Non-EL Heat	R-25 Ceiling	In-Home Energy	RET	1000 sqft footprint	2	0.90	20	$225.00	$700.00	$0.84
Ceiling Ins. R-30 - Central A/C - EL Heat	R-25 Ceiling	In-Home Energy	RET	1000 sqft footprint	194	0.01	20	$225.00	$700.00	$74.69
Ceiling Insul R-45 - Heat Pump	R-25 Ceiling	In-Home Energy	RET	1000 sqft footprint	262	0.02	20	$225.00	$890.00	$100.71
Ceiling Insul R-45 - Central A/C - Non-EL Heat	R-25 Ceiling	In-Home Energy	RET	1000 sqft footprint	6	0.90	20	$90.00	$890.00	$2.24
Ceiling Insul R-45 - Central A/C - EL Heat	R-25 Ceiling	In-Home Energy	RET	1000 sqft footprint	519	0.01	20	$225.00	$890.00	$199.18
Wall Insul. R-11 - Heat Pump	Un-Insulated Wall	In-Home Energy	RET	1000 sqft wall area	2,028	0.05	25	$225.00	$1,300.00	$778.93
Wall Insul. R-11 - Central A/C - Non-EL Heat	Un-Insulated Wall	In-Home Energy	RET	1000 sqft wall area	45	2.33	25	$225.00	$1,300.00	$17.30
Wall Insul. R-11 - Central A/C - EL Heat	Un-Insulated Wall	In-Home Energy	RET	1000 sqft wall area	4,011	0.01	25	$225.00	$1,300.00	$1,540.56
ENERGY STAR® Double Pane Windows - Heat Pump (DUB)	Single Pane Windows	In-Home Energy	DUB	100 sqft window area	847	0.17	25	$82.36	$82.36	$325.35
ENERGY STAR® Double Pane Windows - Central A/C - Non-EL Heat (DUB)	Single Pane Windows	In-Home Energy	DUB	100 sqft window area	294	0.50	25	$82.36	$82.36	$112.93
ENERGY STAR® Double Pane Windows - Central A/C - EL Heat (DUB)	Single Pane Windows	In-Home Energy	DUB	100 sqft window area	999	0.15	25	$82.36	$82.36	$383.60
Triple Pane Windows - Heat Pump (DUB)	Single Pane Windows	In-Home Energy	DUB	100 sqft window area	1,439	0.15	25	$137.27	$137.27	$552.92
Triple Pane Windows - Central A/C - Non-EL Heat	Single Pane Windows	In-Home Energy	DUB	100 sqft window area	464	0.48	25	$90.00	$137.27	$178.11

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
(DUB)										
Triple Pane Windows - Central A/C - EL Heat (DUB)	Single Pane Windows	In-Home Energy	DUB	100 sqft window area	2,415	0.09	25	$137.27	$137.27	$927.74
Window Film (west facing windows)	No Film	In-Home Energy	RET	100 sqft window area	178	0.53	10	$200.00	$267.00	$68.52
ENERGY STAR® Door - Heat Pump	Average Existing Door (1.75 " thick wood, R-3.2)	In-Home Energy	RET	Door	30	0.02	20	$15.00	$64.71	$11.61
ENERGY STAR® Door - Non-EL Heat	Average Existing Door (1.75 " thick wood, R-3.2)	In-Home Energy	RET	Door	1	0.98	20	$15.00	$64.71	$0.26
ENERGY STAR® Door - EL Heat	Average Existing Door (1.75 " thick wood, R-3.2)	In-Home Energy	RET	Door	60	0.01	20	$15.00	$64.71	$22.97
1W LED Night Light	7W Incandescent Light	In-Home Energy	RET	Lamp	20	0.00	8	$1.00	$2.00	$7.68
LED Holiday Lights (300 bulb string)	300 x 0.48 W Incandescent Lights	In-Home Energy	RET	300 bulb string	26	0.00	15	$5.00	$10.00	$10.09
High Eff. Elec. Water Heat - Tank - .95 EF (DUB)	Average Existing Electric Water Heater - 0.90 EF	In-Home Energy	DUB	Unit	176	0.09	20	$50.00	$287.15	$67.79
Heat Pump Water Heater - 2.0 EF	Standard Electric Water Heater - .945 EF	In-Home Energy	ROB	Unit	1,685	0.09	10	$500.00	$888.50	$647.09
Heat Pump Water Heater - 2.0 EF (DUB)	Average Existing Electric Water Heater - 0.90 EF	In-Home Energy	DUB	Unit	1,844	0.09	10	$242.39	$242.39	$708.43
Instantaneous Electric Water Heater - .99 EF	Standard Electric Water Heater - .945 EF	In-Home Energy	ROB	Unit	145	0.09	13	$400.00	$666.80	$55.76
Instantaneous Electric Water Heater - .99 EF (DUB)	Average Existing Electric Water Heater - 0.90 EF	In-Home Energy	DUB	Unit	305	0.09	13	$226.11	$226.11	$117.10
Drain Water Heat Recovery (42% efficient or higher)	No Heat Recovery	In-Home Energy	RET	Unit	391	0.00	25	$250.00	$760.00	$150.05
Shower Start/Stop	No Start/Stop on Shower	In-Home Energy	RET	Unit	245	0.11	5	$10.00	$24.95	$94.17
Waterbed Insulating Pad	No Pad	In-Home Energy	RET	Pad	490	0.01	6	$17.50	$35.00	$188.22
Residential Solar PV	Average Ohio Home w/o Solar PV	In-Home Energy	RET	kW Output	1,202	0.58	25	$1,000.00	$10,000.00	$461.59

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
ENERGY STAR® Manufactured Homes - EL Heat	Average Manufactured Home	Manufactured Home	NEW	Home	11,947	0.04	20	$2,500.00	$5,000.00	$1,223.74
Reduced ACHnat 0.3 - Heat Pump	ACH 0.6	New Home	NEW	Home	1,712	0.01	15	$200.00	$530.00	$526.15
Reduced ACHnat 0.3 - Central A/C - Non-EL Heat	ACH 0.6	New Home	NEW	Home	17	0.90	15	$50.00	$530.00	$5.23
Reduced ACHnat 0.3 - Central A/C - EL Heat	ACH 0.6	New Home	NEW	Home	3,407	0.00	15	$200.00	$530.00	$1,047.07
ENERGY STAR® 50 CFM Bathroom Ventilating Fan	Code-Compliant Ventilating Fan	New Home	NEW	Fan	88	0.11	19	$20.00	$43.50	$27.04
ENERGY STAR® Double Pane Windows - Heat Pump	Double Pane Windows	New Home	NEW	100 sqft window area	363	0.17	25	$50.00	$150.00	$111.55
ENERGY STAR® Double Pane Windows - Central A/C - Non-EL Heat	Double Pane Windows	New Home	NEW	100 sqft window area	126	0.50	25	$50.00	$150.00	$38.72
ENERGY STAR® Double Pane Windows - Central A/C - EL Heat	Double Pane Windows	New Home	NEW	100 sqft window area	428	0.15	25	$50.00	$150.00	$131.52
Triple Pane Windows - Heat Pump	Double Pane Windows	New Home	NEW	100 sqft window area	617	0.15	25	$180.00	$250.00	$189.57
Triple Pane Windows - Central A/C - Non-EL Heat	Double Pane Windows	New Home	NEW	100 sqft window area	199	0.48	25	$75.00	$250.00	$61.07
Triple Pane Windows - Central A/C - EL Heat	Double Pane Windows	New Home	NEW	100 sqft window area	1,035	0.09	25	$90.00	$250.00	$318.08
Heat Pump Water Heater - 2.0 EF	Standard Electric Water Heater - .945 EF	New Home	NEW	Unit	1,685	0.09	10	$125.00	$888.50	$517.67
Drain Water Heat Recovery (42% efficient or higher)	No Heat Recovery	New Home	NEW	Unit	391	0.00	25	$250.00	$660.00	$120.04
ENERGY STAR® 3.0 Qualified Home - Heat Pump	Code Construction	New Home	NEW	Home	3,389	0.15	20	$1,000.00	$2,329.00	$1,041.26
ENERGY STAR® 3.0 Qualified Home - Central A/C - Non-EL Heat	Code Construction	New Home	NEW	Home	1,259	0.39	20	$1,000.00	$2,329.00	$387.03
ENERGY STAR® 2.0/2.5 Qualified Home - Heat Pump	Code Construction	New Home	NEW	Home	3,393	0.16	20	$500.00	$1,674.00	$1,042.62
ENERGY STAR® 2.0/2.5 Qualified Home - Central A/C - Non-EL Heat	Code Construction	New Home	NEW	Home	1,135	0.47	20	$500.00	$1,674.00	$348.80

C.4 Non-Residential DSM Measure Characterizations

Non-residential measure analysis is reported for the commercial and industrial sectors across all EE/PDR programs. A combination of the resources outlined in section C.4.1, other secondary sources, and engineering calculations were used to estimate measure savings.

C.4.1 Sources Used for the Analysis

Navigant used the following sources to inform the EE measure characterizations in the Plan:

- 2015 AEP Ohio Prescriptive Measures Savings Workpapers.
- Draft Ohio Technical Resource Manual, VEIC 2010
- Pennsylvania Technical Resource Manual
- Vermont Technical Resource Manual
- Mid-Atlantic Technical Resource Manual
- International Energy Conservation Code (IECC) 2015
- ANSI/ASHRAE/IES Standard 90.1 - 2013
- H.R. 6 (110th): Energy Independence and Security Act of 2007 – (Incandescent lighting baselines). California Database for Energy Efficient Resources (DEER), 2008, 2011.
- Efficiency Nova Scotia 2016-2018 DSM Plan
- https://www.energystar.gov/
- RS Means Electrical Labor Rates and Install Cost Data for Columbus, OH
- "Energy Use of Doored and Open Vertical Refrigerated Display Cases", Purdue University School of Mechanical Engineering, 2010
- AEP Ohio Program Applications:
  - 2014_AEP_All_Measures_Prescriptive_Custom_Application.pdf
  - 2014_AEP_New_Construction_Application2.pdf
- Navigant Retrocommissioning (RCx) program research
- Northwest Power ProCost spreadsheet, motor rewind costs and savings
- Efficiency Nova Scotia (ENSC) process motor baseline research
  - 2010 Ohio Energy Summary Statistics. Sources: U.S. Energy Information Administration, Form EIA-860, "Annual Electric Generator Report."
  - U.S. Energy Information Administration, Form EIA-861, "Annual Electric Power Industry Report."

  - U.S. Energy Information Administration, Form EIA-923, "Power Plant Operations Report" and predecessor forms.
- Enerdata Global Energy Intelligence http://www.enerdata.net/
- Ohio Hospital Association (OHA) Member, Hospital Energy Characterization and Census Data, Energent Solutions.
- Ohio Farm Bureau

C.4.2 Measure Characterization Overview

This section describes the majority of the non-residential energy efficiency measures analyzed for this study and the methods used to estimate savings. The section is organized by major end-uses such as motors, HVAC, food service, and refrigeration/custom. The measures are a mixture of prescriptive and custom measures which may be applicable across different programs including new construction and major renovation. Navigant chose to represent the commercial and industrial sector with eight segments: Industrial, School, Healthcare, Other, Office, Retail Non-Food, C&I Multifamily, and Data Center. The 'Other' category includes building types such as grocery, warehouse, and agricultural.

For both climate-dependent and climate-independent EE/PDR measures, Navigant evaluated the energy and demand savings and incremental costs using engineering calculations based on the 2010 Ohio Technical Reference Manual (TRM), the 2015 AEP Ohio Prescriptive Measures Savings Workpapers, and other secondary research. For climate dependent measures, the 2015 AEP Ohio Prescriptive Measures Savings Workpapers contain detailed savings estimates based on comprehensive, representative whole building eQuest energy models. Lighting estimates are primarily based on differences in installed lamp wattage combined with HVAC interactive effects. Savings for appliances are based on secondary sources such as ENERGY STAR calculators and commercial product reports.

C.4.3 Lighting Measures – Non-Residential

The following lighting measures are often part of utilities' prescriptive non-residential lighting energy efficiency programs. The major inputs for the impact estimates are the same for both baseline and efficient technologies: equipment connected Watts, hours of operation and interaction with HVAC equipment for commercial applications.

Measure costs and measure lives are based on the California DEER database. Costs are adjusted to the AEP Ohio area by regional cost factors from RS Means Cost Data.

Compact Fluorescent Lamp – Screw-in and Hard-wired Fixtures
CFLs are the most common alternatives to standard incandescent lamps. CFLs are generally about four times as efficient as incandescent lamps, and last up to ten times

as long. CFLs can either be self-ballasted screw-in replacements for incandescent lamps or pin-based lamps for ballasted fixtures designed for CFL technology. The measure life for a screw-in CFL varies by application but is modeled at 2.5 years. Pin-based lamps in CFL fixtures are assumed to last the life of the fixture, because failed lamps must be replaced with comparable CFLs.

T8 Lamps and Electronic Ballasts – High-Performance (HPT8)

HPT8 lamps and electronic ballasts have the same market as regular T8 systems. HPT8 systems gain efficiency over regular T8 systems by the co-development of lamps and ballasts that optimize the efficiency of the system when used together. HPT8 technology is compared versus both a T12 and standard T8 baseline. This measure falls under the general lighting category, and indirect heating and cooling impacts are included and are estimated using the 2010 Ohio Technical Reference Manual (TRM) mechanical cooling interaction factor and fossil fuel impact calculation.

T5 Lamps and Electronic Ballasts

T5 lamps and electronic ballasts are a newer linear fluorescent lighting system. T5 fluorescent lamps are 5/8" in diameter, thinner than both T8 lamps and T12 lamps. T5 lighting systems are primarily used in new construction and high-bay, high-output situations and are not typically appropriate for most relamp/reballast situations as they require fixture modification to accommodate the smaller lamp ends and often return lower lumens per watt values than HPT8s. This measure falls under the general lighting category, and indirect heating and cooling impacts are included and are estimated using the 2010 Ohio Technical Reference Manual (TRM) mechanical cooling interaction factor and fossil fuel impact calculation.

Daylight Sensors

Interior ambient lighting systems are frequently designed assuming no contribution from ambient daylight. In areas where daylight is available, electric light may be unnecessary. Closed loop daylight sensor-based control systems monitor the total light present (electric and natural) in the occupied space, and dim the electric ambient lighting as needed to limit the amount of total light in the space, saving energy. Dimming can be continuous or step dimming, and will turn the electric light off completely if not needed. Savings were based on the 2015 AEP Ohio Prescriptive Measures Savings Workpapers. Indirect heating and cooling impacts are included and are estimated using the 2010 Ohio Technical Reference Manual (TRM) mechanical cooling interaction factor and fossil fuel impact calculation.

Occupancy Sensors

Occupancy sensors automatically turn off the lights in a room, corridor, or other area when unoccupied. Occupancy sensors may be direct wired without manual control, or packaged together with a manual wall switch. Savings estimates are based on a percentage reduction in consumption per connected load per the 2015 AEP Ohio Prescriptive Measures Savings Workpapers. Indirect heating and cooling impacts are

included and are estimated using the 2010 Ohio Technical Reference Manual (TRM) mechanical cooling interaction factor and fossil fuel impact calculation.

Time Clocks and Photocells

Time clocks and photocells are controls generally used for exterior lighting, although time switches may be found controlling common area lighting in large facilities. These controls turn off lights based on daily or weekly schedules and/or ambient lighting levels. Savings estimates are based on a reduced runtime using this technology on a connected load, according to the 2015 AEP Ohio Prescriptive Measures Savings Workpapers.

Permanent Lamp Removal (Delamping)

Per AEP Ohio prescriptive & custom program guidelines, delamping modeled for this report covers both lamp removal during a T12-T8 retrofit (i.e. reducing the quantity of lamps between the baseline and retrofit case) and also removal from existing T8 fixtures. Delamping for AEP programs requires the permanent removal and disposal of lamp holders and unused ballasts from the fixture, and that lighting levels post delamping meet IESNA recommended light levels. This measure is intended for areas that are currently over-lit, and measure life is 5 years. Indirect heating and cooling impacts are included and are estimated using the 2010 Ohio Technical Reference Manual (TRM) mechanical cooling interaction factor and fossil fuel impact calculation.

LED Exit Signs

LED exit signs are among the most efficient types of exit signs on the market. They generally only draw about 2W of power, compared with 11W or more for CFLs, the baseline technology used in this study. Indirect heating and cooling impacts are included and are estimated using the 2010 Ohio Technical Reference Manual (TRM) mechanical cooling interaction factor and fossil fuel impact calculation.

High-Bay Fluorescent Lights

High-bay lighting is used in industrial settings for general ambient light. T5 and T8 fluorescent lamps can be used in place of more traditional high-intensity discharge (HID) lamps in specially designed fixtures. The advantages include higher efficacy (lumens/Watt), greater lumen maintenance over the lamp life, no re-strike delay, and better controllability. Savings are determined based on annual consumption by sector type vs. an HID baseline.

LED Troffers

LED troffers are linear LED fixtures used to replace standard linear fluorescent fixtures. LED troffers have the same applications as linear fluorescents with even higher efficacy. LEDs also have a greater lifetime than fluorescent and incandescent fixtures, reducing maintenance and replacement costs. Savings are determined based on annual consumption by sector type vs. a standard T8 baseline.

C.4.4 Non-Residential Motors and Other

VFDs for HVAC Application

VFDs for HVAC applications take advantage of the fluid affinity laws that describe a nominal cubed relationship between fluid flow and power. These variable torque applications have a more predictable usage pattern than VFDs in industrial processes and conveyance applications, saving energy by reducing system fluid flows to the minimum needed to serve heating, cooling, or ventilation loads. The primary baseline technologies for HVAC VFDs are constant flow bypass and throttling for liquid pumping systems and vortex dampers for airside fan system applications. VFDs are required by energy codes for new construction and major renovation applications above certain motor sizes. Typically, coincident peak summer savings would be expected to be low for HVAC VFDs since cooling and ventilation loads are high for fully occupied buildings in the summer.

Compressed Air Controls

Frequently called the fourth utility (after electricity, gas, and water), compressed air systems have many savings opportunities, including: system pressure turndown, leak repair, efficient motors and compressors, staging, pressure optimization, receiver tank installation, low loss drains, and efficient air drying. Savings are typically listed per system horsepower relative to an existing system baseline. Savings, including coincident demand savings, are strongly dependent on the type of end use for the system.

VFD on Air Compressors

VFDs on air compressors are more efficient than load/no load controls or variable displacement controls for the most common kinds of industrial air compressors – rotary screw and centrifugal. Since compressed air is used in so many diverse processes at a site, use of a centralized compressed air distribution system is considered more predictable than stand-alone VFD controlled units. The baseline technology for air compressor VFDs is flow modulation with slide or "pop-it" valves. Savings, including coincident demand savings, are strongly dependent on the type of end use for the system.

C.4.5 Non-Residential Food Service Measures

Energy use intensity in restaurants is very high. In response to this the U.S. Department of Energy has developed guidelines for best practices to reduce equipment energy costs. The ENERGY STAR program now identifies equipment that uses significantly less energy than standard practice.

Convection Ovens

These ovens save energy by circulating air inside the oven to enhance heat transfer to the food. As a result cooking times are shorter and lower temperatures are needed to cook food. These ovens are frequently used in commercial kitchens and replace

traditional ovens. The baseline technology for this equipment is typically the least efficient commercially available equipment fulfilling the same function.

ENERGY STAR Cooking Equipment
Several kinds of equipment in commercial kitchens have been addressed by the ENERGY STAR program. In addition to convection ovens, noted above, griddles, steamers, holding cabinets and fryers have ENERGY STAR alternatives. The baseline technology for this equipment is typically the standard efficiency commercially available equipment fulfilling the same function.

Advanced Pre-Rinse Spray Nozzle
Advanced spray valves of 2.2 GPM or less focus their spray patterns more effectively and remove stuck-on food efficiently, saving operator time and approximately $300 a year in water and water heating costs.

Vending Machine Controls
Vending machine controls can be integrated with built-in and/or after-market occupancy sensors to reduce display lighting and optimize refrigeration cycles to reduce energy use during periods of low use. Beverage companies have contributed input to make these devices effective while maintaining product quality and market visibility. Vending Machine controls can be either aftermarket retrofits or ENERGY STAR Vending Machines with factory-installed control software and sensors. The baseline equipment is a standard refrigerated beverage vending machine with no controls.

C.4.6 Non-Residential HVAC Measures

The following measures address building construction materials and equipment relevant to cooling, heating, ventilation, and domestic hot water loads.

In the AEP Ohio Commercial and Industrial sectors, space heating is split between natural gas and electric heat. Electric heating equipment includes primarily heat pumps with some electric resistance. Navigant analyzed savings using each heating type where appropriate.

HVAC savings can occur by reducing the heating and cooling load with insulation, air sealing and programmable thermostats, or by improving the efficiency of the equipment and/or distribution process. In general, measures which improve equipment efficiency or reduce building loads generate the most savings during periods of highest use. Measures which generate savings through the use through the use of load matching controls typically generate savings during periods of lowest building loads.

HVAC savings for building envelope measures were primarily determined based on the 2011 Ohio potential study, which used eQUEST computer energy simulations. Savings are the difference between the simulation with the efficient technology and the simulation with existing equipment. For new construction and major renovation

measures, savings were updated in 2015 using engineering estimates relative to minimally code-compliant products. Incremental costs are mostly based on the DEER database adjusted with RS Means Mechanical Cost Data 'location factors' to reflect Ohio labor and/or equipment costs. Measure life for these items are based on the American Society of Heating Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE) depreciation lives and the California DEER database.

Efficient Packaged Commercial Air Conditioning and Heat Pump Systems
Standard efficiency units are specified as units minimally complying with the ASHRAE Standard 90.1 2013. Navigant specified efficient unit EER ratings based on the the 2015 AEP Ohio Prescriptive Measures Savings Workpapers listed efficiencies.

For heat pumps, the efficiency measures are water source and air source heat pumps serving both heating and cooling loads.

Efficient Water-Cooled Chillers
Baseline minimum efficiency standards for water chillers are established by energy codes and standards. Chiller efficiencies exceeding the code minimum requirements save energy through the use of variable speed drives, high efficiency screw compressors, magnetic bearings, and compressor staging for part load operation. It should be noted that chiller plant design, including cooling tower, pumping configuration, design temperature differences, and piping system design, has a direct impact on chiller plant overall efficiency, of which the chiller itself is just one component.

Economizers
Economizers use outside air for cooling instead of operating mechanical cooling compressors on mild days, particularly during the spring and early fall seasons. During peak summer conditions economizers produce no peak demand savings. This efficient measure is introduced in buildings where there is no economizer. For new construction and major renovations, the baseline for this measure is the minimally code compliant economizer requirements applicable based on the unit size and climate zone.

Window Film
Polymer films are applied to the interior of glazing to enhance the glazing attributes which reduces cooling and heating loads on the building. Films will have any combination of the following effects: reduced visible and radiant energy from the sun (solar heat gain and shading), lower glazing U-factor and lower emissivity to keep heat in the building in the winter. The baseline technology is double paned clear glass windows without film, with a U-value of 0.72, and SHGC of 0.73, per the 2015 AEP Ohio Prescriptive Measures Savings Workpapers.

High-Performance Glazing
High-performance glazing is a category of glazing that includes combinations of attributes that reduce solar heat gain and thermal losses through windows through the use of tints, multiple glass panes, low-emissivity films and other coatings and gases

between panes. The baseline technology is tinted double-pane glass; ASHRAE Standard 90.1 2013, U 0.45

Cool Roof

Light-colored or white roofs have a lower solar absorbance, thereby reducing the energy gains through the roof in the summer. This reduces summer cooling loads, but can increase winter heating requirements. The baseline construction is the standard black membrane or build-up for existing buildings, and minimally code compliant constructions for new construction and major renovations.

Above Code Insulation

Improved insulation values slow heat flow into or out of a building, reducing building heating and cooling loads through walls and roofs. Standard insulation for non-residential walls, attics, roofs, can be replaced by insulation that is above the existing R-value. Baseline insulation requirements for new construction and major renovations were based on the minimum requirements of IECC 2012.

Demand Controlled Ventilation (DCV) for Commercial Kitchens, Parking Garages and Offices

Conditioning outdoor air is generally one of the highest loads in a building. Demand Controlled Ventilation (DCV) systems save energy by reducing ventilation airflow, either by damper control or variable speed drive, in order to meet real-time ventilation system requirements which are lower than the design maximum ventilation rate. Generally the required ventilation is determined real-time based on minimum required indoor air quality, or kitchen makeup air requirements for the kitchen hood exhaust. DCV controls may include an occupancy sensor control in addition to CO_2, CO, kitchen hood temperature, or effluent sensors, and controls similar to DCV for VAV systems are set to become required by code for new construction and major renovation projects. The baseline for DCV is 100% of the design outside airflow normally continuously provided when the system is operating. Kitchen DCV savings typically includes savings from both the variable speed makeup air fan and the variable speed kitchen exhaust hood fan.

Hot Water Circulation Pump Control

Domestic hot water pumps typically circulate domestic hot water throughout a commercial or industrial facility continuously so that hot water is almost immediately available at the tap. Pump control time switches, which turn off the pump when it is not required, save pumping energy and reduce thermal stand by losses in the water distribution system. The baseline is a circulation pump without time of day scheduling. It is recommended to select a time switch that will not lose its time of day and scheduled settings on loss of building power. This measure would typically not save energy during the summer coincident demand period.

C.4.7 Refrigeration and Custom Non-Residential Measures

The following section addresses refrigeration measures, and custom measures not addressed above. Refrigeration Measures improve the efficiency of the refrigeration plant and/or reduce the cooling loads that the system must satisfy. Custom measures are those that do not fit in the categories listed above or that have savings that are highly project-specific. Custom measures is a catch-all category that might include special lighting systems, building controls, exceptional HVAC equipment or process improvements at a factory.

ECM motors

Electronically commutated motors (ECM) are fractional horsepower DC motors that are more efficient than the shaded pole or permanent split capacitor (PSC) motors they replace. ECM motors have a variety of applications for HVAC and refrigeration end uses, including furnace fan motors, refrigeration evaporator fan motors, and air cooled condenser fan motors. When used inside refrigeration cases and walk-in coolers, they have the indirect effect of reducing refrigeration loads compared with a baseline motor. Federal legislation has begun to require ECM motors, thus for new construction and major renovation applications, savings for this measure will begin to drop off. This efficient motor measure will generate savings during the summer coincident peak period.

Multi-Line Compressors with Oversized Condensers

Instead of one compressor per refrigeration unit, a multi-line system has several compressors that stage optimally to serve many pieces of equipment or display cases on the retail floor. Oversized condensers more efficiently reject heat from the refrigeration system and reduce the compressor loads. These measures increase the system efficiency or coefficient of performance versus standard equipment. The baseline for this measure is an existing refrigeration system with efficiency of 1.92 kW/ton at 82°F ambient temperature and 1.85 kW/ton @ 70°F ambient temperature.

Outside Air Economizer for Coolers

This measure saves energy by using cold outdoor air instead of mechanical cooling to meet a refrigerated cooler load. When outdoor air temperatures are below the refrigerated cooler setpoint, the compressor is shut down, and outdoor air fans turn on. Compressor energy savings is offset somewhat by outside air supply and exhaust fan energy, as well as destratification or evaporator fans that may need to run to prevent spoilage by maintaining a consistent mixed air temperature throughout the cooler. The baseline for free cooling economizers for coolers is a system with no free cooling and no other compressor controls. This measure will not save energy during the summer coincident demand period.

Evaporator Fan Controllers

Most walk-in cooler and freezer evaporator fan motors run continuously, except during the defrost cycle for freezers which occurs four times per day. Controllers allow the fans to cycle based on cooling demand, shutting evaporator fans off when the setpoint is satisfied and the compressors are not running. The baseline system is a continuously operating system with no other controls.

Floating Head and Suction Pressure Controls

When outdoor temperatures are mild, condensed refrigerant can be permitted to be cooled below default settings to reduce the loads on compressors. The floating head pressure controls replace baseline system fixed head pressure controls. This measure will not save energy during the summer coincident demand period.

Glass Doors

Glass doors are used to reduce losses from low and medium temperature displays to the rest of the retail zones. The baseline is an open case without doors. This measure will generate savings during the summer coincident period.

Anti-Sweat Door Heater Controls (ASHC)

To keep glass clear of condensation so the merchandise is visible, anti-sweat door heaters typically run continuously. Controls cycle heaters based on humidity sensors or on a timed basis, thus maintaining glass clarity with a reduced energy cost. A portion of the ASH energy becomes load on the refrigeration compressors, therefore use of ASHC reduces refrigeration loads. The baseline technology is anti-sweat heaters operating continuously without controls.

Zero Energy Doors

Zero energy doors have a high insulation value, eliminating the need for door/frame heaters. They are typically installed during new construction or major renovations.

LED Display Case Lighting

LED display case lighting saves energy compared with standard fluorescent lighting due to a higher efficacy expressed in lumens/watt. Additionally, lighting equipment inside coolers adds heat. Where lighting operates for hours at a time, replacing fluorescent lighting with LED lighting will reduce the refrigeration load, saving compressor energy. The baseline is existing fluorescent display lighting. Federal rules are beginning to require LED lighting in refrigerated cases for new construction and major renovation, at which point this measure will not be able to claim energy savings.

Energy Management Systems (EMS)

Energy management systems reduce energy consumption by controlling equipment operation and/or scheduling equipment use by the time of day and/or time of year. Savings vary based on controlled equipment and the number and type of control points of the EMS hardware, software, and on the programming level of sophistication. The baseline for EMS system savings is no control or basic electromechanical control, and no

time of day scheduling, as specified in the 2015 AEP Ohio Prescriptive Measures Savings Workpapers.

NEMA Premium Low Voltage Dry Distribution Transformers

This transformer measure saves energy because the technology is more efficient than the federally required minimum electrical transformer efficiency. The measure saves energy whenever the transformer is energized, which is usually around the clock.

Energy Star AC Output Efficient UPS

This measure saves energy because the technology is more efficient than the minimum commercially available efficiency on the market. The measure saves energy whenever the UPS is energized.

Plug Load Occupancy Sensors

This measure saves energy by installing a sensor that determines when an office or cubicle is vacant, and turns off plug loads such as computers, printers and task lamps. Baseline is 50W of task lighting and monitor with no controls.

Hotel Guest Room Energy Management System (GREM)

GREM allows hoteliers to manage guestroom temperatures via a local network or Web-based server, and an occupancy validation such as by key card or occupancy sensor. The baseline system is manual heat/cool set point with fan on/off/auto thermostat.

Behavioral changes

Behavioral change is a new type of measure which saves energy due to people changing typical behaviors with respect to energy use, turning lights appliances or electronics off or unplugging them when not in use. Navigant confined this new measure to the Office building type. The baseline is standard behavior with respect to appliances.

RCx Program

Retro-commissioning (RCx) is a systematic quality assurance process for identifying and improving suboptimal energy performance in an existing building's equipment and control systems. The recommended baseline for retrocommissioning is code minimum requirements, or existing conditions where code does not apply.

Data Center Measures

Data centers use a significant amount of energy, and energy use is increasing every day. Energy efficiency measures specific to data centers include virtualization of applications to reduce the physical number of servers, VFD controls on dedicated data center HVAC supply fans, and efficient UPS replacement. Data center loads are highly variable, and savings should be calculated for applicable measures on a case by case basis.

Electrostatic Anti Scaling Device

Electrostatic anti scale treatment occurs when hard water (including calcium and magnesium) passes through an electrostatic field expressly created by a control unit.

Electronic anti-scale devices are systems which protect plumbing from lime scale deposit, thereby saving energy by reducing pressure drop and improving thermal transfer in chillers. The baseline measure is chiller fouling with no anti scaling device. This measure generates savings during summer peak performance hours.

Cogged or synchronous V-belts on fans
Cogged V-belts have approximately 2% better power transmission efficiency than smooth belts and maintain their efficiency over a wide load range. They achieve these higher efficiencies through reduce bending stress and reduced slippage. Synchronous belts operate with a consistent efficiency of 98% but are more expensive since they require replacement of pulleys to accommodate the toothed belts. Synchronous belts require minimal maintenance and re-tensioning, operate in wet and oily environments, and run nearly slip-free. The baseline technology is standard belts on fans. This measure generates savings whenever the fan is operating.

Process Motor Rewind to Nominal Efficiency, 300 HP through 2500 HP
This measure saves energy by rewinding a process motor to a higher efficiency than for a standard rewind, for high horsepower process motors between 300 HP through 2500 HP. The baseline technology is a standard rewind. This measure saves energy whenever the process is operating.

C.4.8 Non-Residential Agriculture Sector Measures

The following measures are specific to the agricultural sector:

High Volume Low Speed Fans
High volume low speed fans are intended for dairy and cattle holding area applications and are able to move more cubic feet of air per watt than conventional circulation fans. Heat and moisture built-up in confined areas can adversely affect the health of animals, with manure gases further contributing to poor air quality, and necessitate the use of ventilation. The use of high volume low speed fans not only decreases the ventilation energy load in barns, but can also improve the quality of life for animals.

Livestock Waterers
This measure refers to energy efficient and energy-free livestock waterers which utilize increased insulation to limit heat loss and reduce the energy required to keep water from freezing.

Agriculture Heat Pads
Heating pads are typically used for young livestock operations and are most common in farrowing swine and chick hatchery applications. Heating pads will typically replace heat lamps, and are able to deliver heat to the animal more effectively and efficiently.

Tractor Engine Block Heater Timer
Engine block heater timers are plug-in timers that are used to control the engine block heater for tractors and other agricultural equipment prior to start. Engine block heaters

are utilized to improve startup performance in cold temperature. For convenience, heaters are typically plugged-in overnight and are in operation longer than necessary. A timer allows the user to pre-set the heater to come on for only the amount of time necessary to warm the engine block, reducing unnecessary run times.

Dairy Scroll Compressors

Scroll compressors are positive displacement compressors that utilize dual spinning scrolls that continuously compress refrigerant gas more efficiently than the energy intensive reciprocating compressors. This measure reduces the load of the refrigeration system of the milk bulk tank on a dairy farm.

Heat Reclaimer

Heat reclaimers are insulated storage tanks, which utilize heat exchangers to pre-heat water before it enters the conventional water heater. Heat reclaimers, also referred to as compressor heat recovery units, reduce the load on the water heater by using the heat extracted from the milk through the hot gas refrigerant line from the bulk milk tank's refrigeration system compressors to pre-heat water.

Milk Pre-Cooler

Milk pre-coolers, also referred to as plate coolers, are heat exchangers installed in the milk line prior to the bulk tank and used for extracting heat from the milk. Ambient temperature water passes through a series of stainless steel plates in one direction and absorbs heat from the warm milk pumped through the pre-cooler in the opposite direction. Energy savings come from the reduced downstream cooling load on the refrigeration system of the milk bulk tank.

Variable Speed Drive for Milk Vacuum Pump

Milk harvest vacuum pumps are utilized to transfer milk from the milk parlor to a receiver/holding tank. Vacuum pump variable speed drives gauge the amount of vacuum suction needed in the milk parlor and modulate the speed of the pump motor to deliver no more than is required and achieve savings over a single-speed baseline pump.

C.5 Commercial and Industrial Measure Characteristics by Program

Table 44. Commercial and Industrial Measure Characteristics (at meter savings)

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Business Behavior Change	Standard behavior	Business Behavior Change	BEH	Statewide	420,804,000	0.00	1	$3,156,030.00	$3,156,030.00	$10,309,698.00
Intra-company behavioral change re plugloads	Standard practice re plugloads	Business Behavior Change	BEH	Building	1,730	0.99	1	$17.30	$52.00	$42.39
Energy Management System	No Control or Basic Electromechanical Control, no time of day scheduling	Continuous Energy Improvement	RET	1000sf Conditioned Space	2	0.00	15	$1.50	$1.50	$0.21
T8 Delamping	1L4'T8	Continuous Energy Improvement	RET	Lamp	100	0.22	5	$10.63	$21.25	$10.28
Business Behavior Change	Standard behavior	Continuous Energy Improvement	RET	Statewide	420,804,000	0.00	5	$3,156,030.00	$3,156,030.00	$43,103,191.83
Compressed air - Leak Repair 24-Hour Operation	Compressed Air system without leak detection, 24-Hour Operation	Continuous Energy Improvement	RET	sCFM	135	0.09	4	$20.00	$37.33	$13.87
Compressed air - Leak Repair non-24-Hour Operation	Compressed Air system without leak detection, non-24-Hr Operation	Continuous Energy Improvement	RET	sCFM	68	0.19	4	$12.00	$22.40	$6.93
Multiplex system with oversized condenser: 85 Btu/hr of heat rejection per watt of fan, air; 195 Btu/h/Watt evap	Refrigeration system with efficiency of 1.92 kW/ton @ 82°F ambient temperature and 1.85 kW/ton @ 70°F ambient temperature	Continuous Energy Improvement	RET	Tons of Refrigeration	120	0.99	15	$10.00	$45.00	$12.29
Energy Management System	No Control or Basic Electromechanical Control, no time of day scheduling	Continuous Energy Improvement	RET	1000sf Conditioned Space	2	0.00	15	$0.20	$1.50	$0.17
T8 Delamping	1L4'T8	Continuous Energy Improvement	DUB	Lamp	200	0.15	5	$10.63	$21.25	$20.45
2013 OH Data Center Post Retrofit	2013 OH Data Center Avg. Existing Baseline	Data Center	RET	Sqft (DC Floor Area)	49	0.09	5	$2.78	$7.96	$4.04
Data Center PUE <=1.22	2013 Data Center	Data Center	NEW	Sqft (DC Floor	24	0.09	5	$3.74	$7.96	$1.98

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
	Code Minimum Baseline, PUE(kWh) <=1.36, Zone 4 or 5			Area)						
Network PC Management Software	Computers without network power management software	Data Center	NEW	Per Networked Workstation	115	0.00	4	$10.00	$23.00	$9.42
Centrifugal Water Cooled Chiller <300 tons (0.536 kW/ton-IPLV) (DUB)	Centrifugal Water Cooled Chiller <300 tons (0.605 kW/Ton IPLV; 0.700 kW/Ton full load)	Efficient Products for Business	DUB	Rated Tons Cooling	138	1.10	20	$11.00	$148.34	$7.05
Centrifugal Water Cooled Chiller <300 tons (0.536 kW/ton-IPLV)	Centrifugal Chiller <300 tons; Standard ASHRAE 90.1 - 2013: (0.550 kW/Ton IPLV; 0.610 kW/Ton full load)	Efficient Products for Business	ROB	Rated Tons Cooling	12	7.23	20	$11.00	$152.65	$0.60
Centrifugal Water Cooled Chiller >300 tons <600 tons (0.494 kW/ton-IPLV) (DUB)	Centrifugal Water Cooled Chiller >300 tons <600 tons (0.550 kW/Ton IPLV; 0.640 kW/Ton full load)	Efficient Products for Business	DUB	Rated Tons Cooling	47	2.27	20	$11.00	$118.70	$2.41
Centrifugal Water Cooled Chiller >300 tons <600 tons (0.494 kW/ton-IPLV)	Centrifugal Chiller >300 tons <600 tons; ASHRAE 90.1 - 2013: (0.500 kW/Ton IPLV; 0.560 kW/Ton full load)	Efficient Products for Business	ROB	Rated Tons Cooling	5	9.60	20	$11.00	$89.75	$0.26
Centrifugal Water Cooled Chiller >600 tons, (0.485 kW/ton-IPLV) (DUB)	Centrifugal Chiller >600 tons (0.550 kW/Ton IPLV; 0.640 kW/Ton full load)	Efficient Products for Business	DUB	Rated Tons Cooling	55	3.75	20	$11.00	$126.46	$2.80
Centrifugal Water Cooled Chiller >600 tons, (0.485 kW/ton-IPLV)	Centrifugal Chiller >600 tons; ASHRAE 90.1 - 2013: (0.500 kW/Ton IPLV; 0.560 kW/Ton full load)	Efficient Products for Business	ROB	Rated Tons Cooling	13	11.59	20	$11.00	$106.21	$0.65
Air Cooled Chiller <150 Tons, 0.864 kW/ton (IPLV) (DUB)	Air Cooled Chiller <150 Tons, (12.5 Btu/W EER IPLV; 8.8 Btu/W EER full load)	Efficient Products for Business	DUB	Rated Tons Cooling	144	1.50	20	$16.00	$130.69	$7.38

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Air Cooled Chiller <150 Tons, 0.864 kW/ton (IPLV)	Air Cooled Chiller <150 Tons, Std. ASHRAE 90.1 - 2013: (13.7 IPLV (Btu/W); 10.1 EER full load)	Efficient Products for Business	ROB	Rated Tons Cooling	74	1.18	20	$16.00	$127.00	$3.77
Air Cooled Chiller >150 Tons, 0.847 kW/ton (IPLV) (DUB)	Air Cooled Chiller >150 Tons, (12.5 Btu/W EER IPLV; 8.8 Btu/W EER full load or 0.944 kW/ton)	Efficient Products for Business	DUB	Rated Tons Cooling	158	1.31	20	$16.00	$124.84	$8.11
Air Cooled Chiller >150 Tons, 0.847 kW/ton (IPLV)	Air Cooled Chiller >150 Tons, Std. ASHRAE 90.1 - 2013: (14.0 Btu/W IPLV [0.858 kW/ton]; 10.1 EER full load)	Efficient Products for Business	ROB	Rated Tons Cooling	72	1.09	20	$16.00	$127.00	$3.69
Cogged V-belts on fans 5 HP to 100 HP	Standard belts on fans	Efficient Products for Business	ROB	Fan	3,251	0.17	5	$260.09	$519.58	$166.50
Cogged V-belts on fans 5 HP to 100 HP	Standard belts on fans	Efficient Products for Business	RET	Fan	3,251	0.17	5	$260.09	$619.58	$166.50
EC Motor for HVAC - Cooling Only	Shaded Pole or Split Capacitor motor	Efficient Products for Business	ROB	Motor	194	1.24	15	$75.00	$200.00	$9.94
EC Motor for HVAC - Heating and Cooling	Shaded Pole or Split Capacitor motor	Efficient Products for Business	ROB	Motor	656	0.70	15	$75.00	$200.00	$33.60
EC Motor for HVAC - Heating Only	Shaded Pole or Split Capacitor motor	Efficient Products for Business	ROB	Motor	462	0.99	15	$75.00	$200.00	$23.66
Economizer - Chiller / Elec Resist	No Economizer	Efficient Products for Business	RET	Rated Tons Cooling	58	0.00	15	$25.00	$255.00	$2.98
Economizer - Direct Exp / Elec Resist	No Economizer	Efficient Products for Business	RET	Rated Tons Cooling	51	0.00	15	$25.00	$236.40	$2.63
Economizer - Direct Exp / Gas Heat	No Economizer	Efficient Products for Business	RET	Rated Tons Cooling	156	0.00	15	$25.00	$236.40	$7.98
Economizer - Heat Pump	No Economizer	Efficient Products for Business	RET	Rated Tons Cooling	166	0.00	15	$25.00	$236.40	$8.50
Hotel Guest Room Energy Management System (GREM), Electric Cooling, Electric Heating	Manual Heat/Cool Setpoint with Fan On/Off/Auto Thermostat	Efficient Products for Business	RET	Hotel Room Controller	1,117	0.19	15	$32.00	$320.00	$57.21
Hotel Guest Room Energy Management System (GREM), Electric Cooling, NON-Electric Heating	Manual Heat/Cool Setpoint with Fan On/Off/Auto Thermostat	Efficient Products for Business	RET	Hotel Room Controller	334	0.64	15	$32.00	$320.00	$17.11
Package system A/C (>=63.3 tons, minimum	Package system A/C >=63.3 tons, (8.5	Efficient Products for Business	DUB	Rated Tons Cooling	240	0.77	15	$35.00	$107.99	$12.29

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
10.2 EER, 11.4 IEER) - Direct Exp / All Heating Types (DUB)	EER, 9.0 IEER) - Direct Exp / All Heating Types									
Package system A/C (>=63.3 tons, minimum 10.2 EER, 11.4 IEER) - Direct Exp / All Heating Types	ASHRAE 90.1 - 2013: 11.2 IEER (as of 1/1/2016); 9.7 EER	Efficient Products for Business	DUB	Rated Tons Cooling	240	0.41	15	$35.00	$107.99	$12.29
Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER) (DUB)	Existing PTAC/PTHP - 9.4 EER	Efficient Products for Business	DUB	Rated Tons Cooling	286	1.15	15	$30.00	$437.65	$14.64
Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER)	Code PTAC/PTHP - ASHRAE 90.1 - 2013: 10.4 EER	Efficient Products for Business	DUB	Rated Tons Cooling	286	1.29	15	$30.00	$437.65	$14.64
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, >=300 tons, 0.486 kW/Ton (IPLV) (DUB)	0.572 kW/Ton IPLV; 0.688 kW/Ton full load	Efficient Products for Business	DUB	Rated Tons Cooling	72	2.05	20	$11.00	$107.29	$3.70
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, >=300 tons, 0.486 kW/Ton (IPLV)	ASHRAE 90.1 - 2013: Path A: <= 0.520 kW/Ton IPLV; 0.610 kW/Ton full load	Efficient Products for Business	DUB	Rated Tons Cooling	72	3.18	20	$11.00	$107.29	$3.70
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 150 tons to below 300 tons, 0.522 kW/Ton (IPLV) (DUB)	0.594 kW/Ton IPLV; 0.748 kW/Ton full load	Efficient Products for Business	DUB	Rated Tons Cooling	60	2.74	20	$11.00	$136.44	$3.10
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 150 tons to below 300 tons, 0.522 kW/Ton (IPLV)	ASHRAE 90.1 - 2013: Path A: <= 0.540 kW/Ton IPLV; 0.660 kW/Ton full load	Efficient Products for Business	DUB	Rated Tons Cooling	60	3.17	20	$11.00	$136.44	$3.10
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 75 tons to below 150 tons, 0.554 kW/Ton (IPLV) (DUB)	0.616 kW/Ton IPLV; 0.825 kW/Ton full load	Efficient Products for Business	DUB	Rated Tons Cooling	52	3.81	20	$11.00	$162.36	$2.67
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 75 tons to below 150 tons, 0.554 kW/Ton (IPLV)	ASHRAE 90.1 - 2013: Path A: <= 0.560 kW/Ton IPLV; 0.720 kW/Ton full load	Efficient Products for Business	DUB	Rated Tons Cooling	52	5.57	20	$11.00	$162.36	$2.67

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, below 75 tons, 0.567 kW/ton-IPLV (DUB)	0.660 kW/Ton IPLV; 0.858 kW/Ton full load	Efficient Products for Business	DUB	Rated Tons Cooling	78	2.73	20	$11.00	$180.04	$4.00
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, below 75 tons, 0.567 kW/ton-IPLV	ASHRAE 90.1 - 2013: Path A: <= 0.600 kW/Ton IPLV; 0.750 kW/Ton full load	Efficient Products for Business	DUB	Rated Tons Cooling	78	3.01	20	$11.00	$180.04	$4.00
Split/Package system A/C (<65 kBtu/h, 15 SEER) - Direct Exp /All Heating Types (DUB)	Split/Package system A/C (<65 kBtu/h, 11 SEER) - Direct Exp /All Heating Types	Efficient Products for Business	DUB	Rated Tons Cooling	249	1.04	15	$20.00	$969.49	$12.74
Split/Package system A/C (<65 kBtu/h, 15 SEER) - Direct Exp /All Heating Types	Code Split/Packaged A/C (<65 kBtu/h) - ASHRAE 90.1 - 2013: 13 SEER	Efficient Products for Business	ROB	Rated Tons Cooling	105	1.04	15	$20.00	$72.35	$5.39
Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types (DUB)	Split/Packaged Air Conditioner (135 - 240 kBtu/h) 9.5 EER, 10 IEER - Direct Exp /All Heating Types	Efficient Products for Business	DUB	Rated Tons Cooling	237	1.10	15	$35.00	$288.36	$12.13
Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types	Code Split/Packaged A/C (135 - 240 kBtu/h) ASHRAE 90.1 - 2013: 12.2 IEER; 10.8 EER	Efficient Products for Business	ROB	Rated Tons Cooling	52	2.13	15	$35.00	$129.48	$2.65
Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types (DUB)	Split/Packaged Air Conditioner (240 - 760 kBtu/h) 8.5 EER, 9.7 IEER - Direct Exp /All Heating Types	Efficient Products for Business	DUB	Rated Tons Cooling	250	1.31	15	$35.00	$155.74	$12.80
Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types	Code Split/Packaged A/C (240 - 760 kBtu/h) ASHRAE 90.1 - 2013: 11.4 IEER; 9.8 EER	Efficient Products for Business	ROB	Rated Tons Cooling	92	1.54	15	$35.00	$48.56	$4.72
Split/Packaged Air Conditioner (65 - 135 kBtu/h) 12.5 EER, 14 IEER - Direct Exp /All Heating Types (DUB)	Split/Packaged Air Conditioner (65 - 135 kBtu/h) 9.8 EER, 11 IEER - Direct Exp /All Heating Types	Efficient Products for Business	DUB	Rated Tons Cooling	200	1.12	15	$35.00	$426.08	$10.24
Split/Packaged Air Conditioner (65 - 135	Code Split/Packaged A/C (65 - 135 kBtu/h)	Efficient Products for Business	ROB	Rated Tons Cooling	75	1.48	15	$35.00	$277.47	$3.84

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
kBtu/h) 12.5 EER, 14 IEER - Direct Exp /All Heating Types	ASHRAE 90.1 - 2013: 12.7 IEER; 11.0 EER									
Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump (DUB)	Split/Packaged Heat Pump (<65 kBtu/h) SEER 11.0	Efficient Products for Business	DUB	Rated Tons Cooling	720	0.36	15	$20.00	$619.81	$36.88
Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump	Code Split/Packaged Heat Pump (<65 kBtu/h) ASHRAE 90.1 - 2013: 14 SEER	Efficient Products for Business	ROB	Rated Tons Cooling	202	0.25	15	$20.00	$141.96	$10.35
Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump (DUB)	Split/Packaged Heat Pump (240 - 760 kBtu/h) 9.4 IEER, 8.5 EER	Efficient Products for Business	DUB	Rated Tons Cooling	1,036	0.29	15	$35.00	$405.97	$53.08
Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump	Code Split/Packaged Heat Pump (240 - 760 kBtu/h) ASHRAE 90.1 - 2013: 10.4 IEER; 9.3 EER	Efficient Products for Business	ROB	Rated Tons Cooling	546	0.32	15	$35.00	$89.21	$27.99
Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump (DUB)	Split/Packaged Heat Pump (135 - 240 kBtu/h) 10 IEER, 9.5 EER	Efficient Products for Business	DUB	Rated Tons Cooling	958	0.23	15	$35.00	$406.63	$49.06
Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump	Code Split/Packaged Heat Pump (135 - 240 kBtu/h) ASHRAE 90.1 - 2013: 11.4 IEER; 10.4 EER	Efficient Products for Business	ROB	Rated Tons Cooling	370	0.30	15	$35.00	$90.93	$18.94
Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump (DUB)	Split/Packaged Heat Pump (65 - 135 kBtu/h) 10.5 IEER, 9.5 EER	Efficient Products for Business	DUB	Rated Tons Cooling	877	0.30	15	$35.00	$441.07	$44.93
Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump	Code Split/Packaged Heat Pump (65 - 135 kBtu/h) ASHRAE 90.1 - 2013: 12.0 IEER; 10.8 EER	Efficient Products for Business	ROB	Rated Tons Cooling	307	0.36	15	$35.00	$97.43	$15.73
Variable Refrigerant Flow A/C (< 5.4 tons, 14 SEER)	Variable Refrigerant Flow A/C (< 5.4 tons, 13.0 SEER)	Efficient Products for Business	ROB	Rated Tons Cooling	56	0.86	15	$20.00	$150.00	$2.89
Variable Refrigerant Flow A/C (135 - 240 kBtu/h, 12 EER, 13 IEER)	Variable Refrigerant Flow A/C (135 - 240 kBtu/h,11.0 EER, 12.3 IEER)	Efficient Products for Business	ROB	Rated Tons Cooling	45	1.75	15	$20.00	$130.00	$2.30

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Variable Refrigerant Flow A/C (240 - 760 kBtu/h, 10.8 EER, 12.1 IEER)	Variable Refrigerant Flow A/C (240 - 760 kBtu/h, 10.0 EER, 11.1 IEER)	Efficient Products for Business	ROB	Rated Tons Cooling	76	1.26	15	$20.00	$140.00	$3.91
Variable Refrigerant Flow A/C (65 - 135 kBtu/h, 12 EER, 13 IEER)	Variable Refrigerant Flow A/C (65 - 135 kBtu/h, 11.2 EER, 12.5 IEER)	Efficient Products for Business	ROB	Rated Tons Cooling	32	2.04	15	$20.00	$130.00	$1.62
Water Source (water to air) Heat Pump (< 17 kBtu/h) EER 13.4 - Heat Pump (DUB)	Water Source Heat Pump (<17 kBtu/h) EER 10.0	Efficient Products for Business	DUB	Rated Tons Cooling	1,228	0.20	15	$70.00	$668.30	$62.90
Water Source (water to air) Heat Pump (< 17 kBtu/h) EER 13.4 - Heat Pump	Water Source Heat Pump (<17 kBtu/h) ASHRAE 90.1 - 2013: 12.2 EER	Efficient Products for Business	DUB	Rated Tons Cooling	1,228	0.21	15	$70.00	$668.30	$62.90
Water Source (water to air) Heat Pump (>= 17 kBtu/h) EER 14.3 - Heat Pump (DUB)	Water Source Heat Pump (>17 kBtu/h and < 135 kBtu/h) EER 10.5	Efficient Products for Business	DUB	Rated Tons Cooling	1,129	0.20	15	$70.00	$568.30	$57.83
Water Source (water to air) Heat Pump (>= 17 kBtu/h) EER 14.3 - Heat Pump	Water Source Heat Pump (<17 kBtu/h) ASHRAE 90.1 - 2013: 13.0 EER	Efficient Products for Business	DUB	Rated Tons Cooling	1,129	0.21	15	$70.00	$568.30	$57.83
Window Films on Double Pane - Non-North Facing Windows	Double paned clear glass windows without any window film, with a U-value of 0.72, and a SHGC of 0.73	Efficient Products for Business	RET	100 sqft glazed	288	0.33	10	$10.00	$287.00	$14.75
1L4'T5 NLO	1L4'T12	Efficient Products for Business	ROB	Lamp	16	0.16	5	$1.47	$1.47	$0.81
1L4'T8 HP	1L4'T12	Efficient Products for Business	RET	Lamp	20	0.21	5	$2.40	$11.23	$1.01
1L4'T8 HP	1L4'T8 STD	Efficient Products for Business	ROB	Lamp	14	0.21	8	$1.00	$1.00	$0.74
4L4'T5 HLO	400W NS Indoor MH Fixture	Efficient Products for Business	RET	Fixture	590	0.16	5	$28.20	$300.30	$30.21
6L4'T8HP	400W NS Indoor MH Fixture	Efficient Products for Business	ROB	Fixture	716	0.16	11	$70.80	$110.05	$36.68
Daylighting Control + Occ Sensor	Manual Controls	Efficient Products for Business	RET	Watts Controlled, 1 DC, 1 OC	1	0.53	8	$0.10	$1.02	$0.07

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Daylighting Controls	Manual Controls	Efficient Products for Business	RET	Watts Controlled, 1 DC	1	0.47	8	$0.08	$0.47	$0.06
LED Exit Sign (DUB)	25W Incandescent Exit Sign	Efficient Products for Business	DUB	Sign	158	0.12	16	$12.50	$30.86	$8.08
LED Lighting <10W - Indoor	29W Halogen	Efficient Products for Business	ROB	Lamp	84	0.20	8	$1.82	$3.64	$4.32
LED Lighting >=10W - Indoor	43W Halogen	Efficient Products for Business	ROB	Lamp	129	0.28	8	$3.41	$6.81	$6.59
LED Outdoor Wall Pack (15W) TC Control	70W HPS or MH TC Control	Efficient Products for Business	ROB	Fixture	229	0.00	8	$22.00	$370.00	$11.72
LED Outdoor Wall Pack (30W) TC Control	150W HPS or MH TC Control	Efficient Products for Business	ROB	Fixture	499	0.00	8	$48.00	$370.00	$25.57
Occupancy Sensor	No sensor, (4) 4'2LT8	Efficient Products for Business	RET	Watts Controlled, 1 OC	225	0.52	8	$0.08	$121.87	$11.52
Outdoor LED Flood Light (30W), TC Control	150W Halogen Flood, TC Control	Efficient Products for Business	ROB	Fixture	499	0.00	8	$48.00	$240.00	$25.57
Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	365W NS MH OR HPS Fixture, TC Control, Pole/Area Mount	Efficient Products for Business	ROB	Fixture	978	0.00	8	$94.00	$410.00	$50.08
Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	250W NS MH OR HPS Fixture, TC Control, Pole/Area Mount	Efficient Products for Business	ROB	Fixture	925	0.00	8	$86.00	$139.99	$47.35
Permanent T12 Removal During T8 Retrofit	1L4'T12	Efficient Products for Business	RET	Lamp	123	0.19	5	$2.40	$25.00	$6.28
Photocell (Outdoor Lighting)	(4) 70W MH NS, Time Clock	Efficient Products for Business	RET	Watts Controlled, 1 PC	92	0.00	8	$0.08	$94.05	$4.73
Photocell + Timeclock (Outdoor Lighting)	(8) NS 70W MH Lamps, Manual Control	Efficient Products for Business	RET	Watts Controlled, 1 TC, 1 PC	632	0.00	8	$0.04	$293.05	$32.38
T8 Delamping	1L4'T8	Efficient Products for Business	RET	Lamp	96	0.24	5	$9.60	$25.00	$4.93
Time clock (Outdoor Lighting)	(8) 70W NS MH Outdoor Lamps, Manual Control	Efficient Products for Business	RET	Watts Controlled, 1 TC	327	0.00	8	$0.02	$233.05	$16.74
VFD on centrif load - Process or HVAC fans or pumps up to 250 HP	Baseline - mech rest, bypass, cycling or constant	Efficient Products for Business	RET	HP	538	0.17	15	$60.00	$133.00	$27.55
Advanced Pre-Rinse Spray Nozzle, <=1.6 GPM (Elec. HW)	Existing Rinse Spray Nozzle of 2.2 GPM or greater	Efficient Products for Business	RET	Per Sprayer	3,792	0.00	5	$25.00	$100.00	$194.21

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Efficient Open Display Cases	Standard open display cases	Efficient Products for Business	RET	Linear foot case width	40	0.08	10	$155.00	$1,550.00	$2.07
ENERGY STAR Combination Oven	Conventional Oven	Efficient Products for Business	ROB	Unit	18,432	0.02	12	$1,500.00	$3,824.00	$944.00
ENERGY STAR Hot Food Holding Cabinet, Full Size, 16 cu.ft. average	Conventional Holding Cabinet, Full Size	Efficient Products for Business	ROB	Unit	5,256	0.11	12	$300.00	$1,200.00	$269.19
ENERGY STAR Hot Food Holding Cabinet, Half Size, 8 cuft average	Conventional Holding Cabinet, Half Size, 8 cuft average	Efficient Products for Business	ROB	Unit	1,862	0.11	12	$250.00	$900.00	$95.36
ENERGY STAR Refrigerated Beverage Vending Machine with Control Software, average	Standard Refrigerated Beverage Vending Machine, average	Efficient Products for Business	ROB	Average Standard Vending	1,842	0.00	14	$50.00	$200.00	$94.34
ENERGY STAR Refrigerated Beverage Vending Machine without Control Software, average	Standard Refrigerated Beverage Vending Machine, average	Efficient Products for Business	ROB	Average Standard Vending	1,310	0.00	14	$50.00	$200.00	$67.09
ENERGY STAR Steam Cooker - 4 Pan - 100lbs/day	Conventional Steam Cooker	Efficient Products for Business	ROB	Unit	25,545	0.10	12	$400.00	$2,490.00	$1,308.29
ENERGY STAR® Heat Pump Water Heater (EF>2.0)	Standard efficiency electric water heater (EF = 0.90)	Efficient Products for Business	ROB	unit	2,526	0.07	10	$120.00	$762.36	$129.36
High-Efficiency Electric Water Heater (EF>0.93)	Standard efficiency electric water heater (EF = 0.90)	Efficient Products for Business	ROB	unit	148	0.07	10	$35.00	$75.00	$7.59
Neon sign replacement with LED	Neon Sign	Efficient Products for Business	RET	Sign	4	0.20	8	$20.00	$50.00	$0.22
Plug Load Occ Sensors	50W of task lighting and monitor with no controls	Efficient Products for Business	RET	Per Sensor	169	0.00	8	$15.00	$70.00	$8.66
Vending Machine PIR Occupancy Sensor - Cold Drink	No Controls	Efficient Products for Business	RET	Per Machine	1,612	0.00	5	$100.00	$199.83	$82.55
Vending Machine PIR Occupancy Sensor - Snacks	No Controls	Efficient Products for Business	RET	Per Machine	343	0.00	5	$30.00	$80.00	$17.54
Compressed Air - Air Entraining Air Nozzle, 100 psi, 0.25 kW/scfm	Air gun with open end	Efficient Products for Business	RET	Nozzle	1,716	0.14	15	$25.00	$80.00	$87.89
Compressed Air - Air Receiver for Load/No-Load Compressors (>=5 gal/CFM storage), <=300 HP	Air compressor system with storage capacity 1 gal/CFM	Efficient Products for Business	RET	Gallon Increased Storage	44	0.15	10	$1.50	$4.58	$2.27

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Compressed Air - Cycling Air Dryer, <=600scfm, thermal mass	Continuous Air Dryer, less than 600 sCFM	Efficient Products for Business	RET	sCFM	7	0.14	15	$1.50	$3.50	$0.38
Compressed Air - Cycling Air Dryer, <=600scfm, thermal mass	Continuous Air Dryer, less than 600 sCFM	Efficient Products for Business	ROB	sCFM	7	0.14	15	$1.50	$3.00	$0.38
Compressed Air - Low Pressure Drop Filter for Compressed Air Systems, 25HP to 300HP, <500CFM, mist eliminator, <1 psi new	Standard performance compressed air filter	Efficient Products for Business	RET	sCFM	11	0.22	5	$0.80	$2.40	$0.54
Compressed Air - Low Pressure Drop Filter for Compressed Air Systems, 25HP to 300HP, <500CFM, mist eliminator, <1 psi new	Standard performance compressed air filter	Efficient Products for Business	ROB	sCFM	11	0.22	5	$0.80	$1.60	$0.54
Compressed air - no-loss condensate drains	compressor without no-loss condensate drain	Efficient Products for Business	RET	per drain	661	0.23	5	$50.00	$200.00	$33.86
Compressed Air - Variable Speed Drive Air Compressor, new, less than 150 HP	Air compressor without variable speed drive	Efficient Products for Business	RET	Compressor HP	1,227	0.14	15	$90.00	$400.00	$62.85
Compressed Air - Variable Speed Drive Air Compressor, new, less than 150 HP	Air compressor without variable speed drive	Efficient Products for Business	ROB	Compressor HP	1,227	0.14	15	$90.00	$400.00	$62.85
Energy Star Ice Makers (>1000 lbs/day)	Self-Contained Standard Ice Maker (>1000 lbs/day)	Efficient Products for Business	ROB	unit	1,090	0.11	10	$150.00	$435.94	$55.82
Energy Star Ice Makers (101-400 lbs/day)	Self-Contained Standard Ice Maker (101-400lbs/day)	Efficient Products for Business	ROB	unit	251	0.14	10	$100.00	$197.33	$12.88
Energy Star Ice Makers (401-1000 lbs/day)	Self-Contained Standard Ice Maker (401-1000lbs/day)	Efficient Products for Business	ROB	unit	545	0.13	10	$150.00	$326.95	$27.91
Energy Star Ice Making Head (401-1000 lbs/day)	Ice Making Head (501-1000lbs/day)	Efficient Products for Business	ROB	100lbs ice	960	0.14	10	$20.00	$198.00	$49.18
ENERGY STAR, CEE Tier 2 or CEE Tier 3 Commercial Clothes Washer	Standard Commercial Clothes Washer	Efficient Products for Business	ROB	Unit	587	0.31	11	$45.00	$245.00	$30.06
Anti-Sweat Heat (ASH) Controls - freezer and cooler glass reach in or	No Heater Controls-continuous operation	Efficient Products for Business	RET	Linear foot door width	528	0.08	12	$25.00	$150.00	$27.04

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
freezer door only are eligible										
EC Motor: Reach-In Enclosure; blended average of coolers and freezers; no controls	Shaded Pole, no controls	Efficient Products for Business	RET	Motor	622	0.08	15	$35.00	$215.00	$31.86
EC Motor: Walk-In Enclosure; blended average of coolers and freezers; no controls	Shaded Pole, no controls	Efficient Products for Business	RET	Motor	1,244	0.08	15	$50.00	$280.00	$63.71
ENERGY STAR Glass Door Commercial Freezer	Standard Glass Door Commercial Freezer	Efficient Products for Business	ROB	Freezer	2,833	0.08	12	$400.00	$799.37	$145.09
ENERGY STAR Glass Door Commercial Refrigerator	Standard Glass Door Commercial Refrigerator	Efficient Products for Business	ROB	Refrigerator	634	0.08	12	$75.00	$164.00	$32.47
ENERGY STAR Solid Door Commercial Freezer	Standard Solid Door Commercial Freezer	Efficient Products for Business	ROB	Freezer	1,307	0.08	12	$150.00	$299.97	$66.94
ENERGY STAR Solid Door Commercial Refrigerator	Standard Solid Door Commercial Refrigerator	Efficient Products for Business	ROB	Refrigerator	637	0.08	12	$100.00	$199.72	$32.62
Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - ECM	Existing Controls Continuous Operation	Efficient Products for Business	RET	Fan	2,341	0.09	16	$60.00	$172.00	$119.89
Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - Shaded Pole	Existing Controls Continuous Operation	Efficient Products for Business	RET	Fan	5,752	0.08	16	$60.00	$172.00	$294.59
Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - ECM	Existing Controls Continuous Operation	Efficient Products for Business	RET	Fan	741	0.09	16	$60.00	$172.00	$37.95
Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - Shaded Pole	Existing Controls Continuous Operation	Efficient Products for Business	RET	Fan	1,918	0.08	16	$60.00	$172.00	$98.23
Zero Energy Door	Fixed head pressure controls	Efficient Products for Business	RET	Refrigeration HP	496	0.09	15	$35.00	$256.00	$25.40
Glass Doors on Low and Med. Temperature Displays with glass doors	open case, without doors	Efficient Products for Business	RET	Linear foot of case	664	0.09	12	$275.00	$866.00	$34.01
Multiplex system with oversized condenser: 85 Btu/hr of heat rejection per watt of fan, air; 195 Btu/h/Watt evap	Refrigeration system with efficiency of 1.92 kW/ton @ 82°F ambient temperature and	Efficient Products for Business	RET	Tons of Refrigeration	120	0.73	15	$10.00	$45.00	$6.15

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
	1.85 kW/ton @ 70°F ambient temperature									
Outside Air Economizer for Coolers	No OA for coolers, no other controls	Efficient Products for Business	RET	Cooler	5,840	0.24	15	$467.23	$2,387.26	$299.12
Refrigerated Display LED Lighting Strips	Fluorescent Case Lighting System	Efficient Products for Business	RET	Linear foot case door	216	0.11	8	$12.00	$100.00	$11.06
Zero Energy Door	Fixed head pressure controls	Efficient Products for Business	RET	Refrigeration HP	496	0.09	15	$35.00	$256.00	$25.40
LED T8 Tube (4' T8 Replacement)	1L4'T8 STD	Efficient Products for Business	ROB	Lamp	29	0.21	15	$3.89	$7.77	$1.48
LED Troffer	2L4'T8 STD Fixture	Efficient Products for Business	ROB	Fixture	39	0.21	15	$12.37	$24.73	$2.02
T8 Delamping	1L4'T8	Efficient Products for Business	DUB	Lamp	200	0.15	5	$12.50	$25.00	$10.23
Cogged (V) belts on fans 5 HP to 100 HP	Standard belts on fans	Efficient Products for Business	RET	Fan	3,251	0.17	5	$260.09	$619.58	$166.50
Compressed Air - Air Entraining Air Nozzle, 100 psi, 0.25 kW/scfm	Air gun with open end	Efficient Products for Business	RET	Nozzle	2,418	0.14	15	$25.00	$80.00	$123.84
Compressed Air - Air Receiver for Load/No-Load Compressors (>=5 gal/CFM storage), <=300 HP	Air compressor system with storage capacity 1 gal/CFM	Efficient Products for Business	RET	Gallon Increased Storage	62	0.14	10	$1.50	$4.58	$3.20
Compressed Air - Cycling Air Dryer, <=600scfm, thermal mass	Continuous Air Dryer, less than 600 sCFM	Efficient Products for Business	RET	sCFM	10	0.14	15	$1.50	$3.50	$0.54
Compressed Air - Low Pressure Drop Filter for Compressed Air Systems, 25HP to 300HP, <500CFM, mist eliminator, <1 psi new	Standard performance compressed air filter	Efficient Products for Business	RET	sCFM	15	0.21	5	$0.80	$2.40	$0.77
Compressed air - no-loss condensate drains	compressor without no-loss condensate drain	Efficient Products for Business	RET	per drain	931	0.22	5	$50.00	$200.00	$47.68
Compressed Air - Variable Speed Drive Air Compressor, new, less than 150 HP	Air compressor without variable speed drive	Efficient Products for Business	RET	Compressor HP	1,729	0.14	15	$100.00	$400.00	$88.55
Daylighting Control + Occ Sensor	Manual Controls	Efficient Products for Business	RET	Watts Controlled, 1 DC, 1 OC	375	0.20	8	$24.00	$233.87	$19.20
Permanent T12 Removal During T8 Retrofit	1L4'T12	Efficient Products for Business	DUB	Lamp	250	0.15	5	$2.40	$25.00	$12.78

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
VFD on centrif load - Process or HVAC fans or pumps up to 200 HP	Baseline - mech rest, bypass, cycling or constant	Efficient Products for Business	RET	HP	492	0.25	15	$60.00	$133.00	$25.19
1L4'T5 NLO	1L4'T12	Efficient Products for Business	ROB	Lamp	28	0.12	5	$1.47	$1.47	$1.42
1L4'T8 HP	1L4'T12	Efficient Products for Business	RET	Lamp	35	0.12	8	$2.40	$11.23	$1.77
1L4'T8 HP	1L4'T12	Efficient Products for Business	ROB	Lamp	25	0.12	8	$1.00	$1.00	$1.30
Cogged (V) belts on fans 5 HP to 100 HP	Standard belts on fans	Efficient Products for Business	ROB	Fan	3,251	0.06	5	$260.09	$519.58	$166.50
Compressed Air - Cycling Air Dryer, <=600scfm, thermal mass	Continuous Air Dryer, less than 600 sCFM	Efficient Products for Business	ROB	sCFM	10	0.14	15	$1.50	$3.00	$0.54
Compressed Air - Low Pressure Drop Filter for Compressed Air Systems, 25HP to 300HP, <500CFM, mist eliminator, <1 psi new	Standard performance compressed air filter	Efficient Products for Business	ROB	sCFM	15	0.21	5	$0.80	$1.60	$0.77
Compressed Air - Variable Speed Drive Air Compressor, new, less than 150 HP	Air compressor without variable speed drive	Efficient Products for Business	ROB	Compressor HP	1,729	0.14	15	$100.00	$400.00	$88.55
LED Exit Sign	25W Incandescent Exit Sign	Efficient Products for Business	DUB	Sign	61	0.03	16	$20.00	$30.86	$3.13
Occupancy Sensor	No sensor, (4) 4'2LT8	Efficient Products for Business	RET	Watts Controlled, 1 OC	417	0.20	8	$19.20	$121.87	$21.34
Photocell (Outdoor Lighting)	(4) 70W MH NS, Time Clock	Efficient Products for Business	RET	Watts Controlled, 1 PC	1,204	0.00	8	$5.60	$94.05	$61.66
Photocell + Timeclock (Outdoor Lighting)	(8) NS 70W MH Lamps, Manual Control	Efficient Products for Business	RET	Watts Controlled, 1 TC, 1 PC	654	0.00	8	$30.40	$293.05	$33.47
Time clock (Outdoor Lighting)	(8) 70W NS MH Outdoor Lamps, Manual Control	Efficient Products for Business	RET	Watts Controlled, 1 TC	327	0.00	8	$15.20	$182.05	$16.74
4L4'T5 HLO	400W NS Indoor MH Fixture	Efficient Products for Business	ROB	Fixture	1,032	0.12	5	$28.20	$143.05	$52.86
6L4'T8HP	400W NS Indoor MH Fixture	Efficient Products for Business	ROB	Fixture	1,253	0.12	11	$70.80	$110.05	$64.19
LED Lighting <10W - Indoor	40W Incandescent	Efficient Products for Business	DUB	Lamp	208	0.29	7.7	$3.89	$7.77	$10.64

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
LED Lighting >=10W - Indoor	60W Incandescent	Efficient Products for Business	DUB	Lamp	306	0.30	8	$5.24	$10.47	$15.70
LED Outdoor Wall Pack (15W) TC Control	70W HPS or MH TC Control	Efficient Products for Business	ROB	Fixture	229	0.00	7.7	$22.00	$370.00	$11.72
LED Outdoor Wall Pack (30W) TC Control	150W HPS or MH TC Control	Efficient Products for Business	ROB	Fixture	499	0.00	8	$48.00	$370.00	$25.57
Outdoor LED Flood Light (30W), TC Control	150W Halogen Flood, TC Control	Efficient Products for Business	ROB	Fixture	499	0.00	8	$48.00	$240.00	$25.57
Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	365W NS MH OR HPS Fixture, TC Control, Pole/Area Mount	Efficient Products for Business	ROB	Fixture	978	0.00	8	$94.00	$410.00	$50.08
Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	250W NS MH OR HPS Fixture, TC Control, Pole/Area Mount	Efficient Products for Business	ROB	Fixture	925	0.00	7.7	$86.00	$139.99	$47.35
Daylighting Controls	Manual Controls	Efficient Products for Business	RET	Watts Controlled, 1 DC	505	0.36	8	$19.20	$107.51	$25.86
LED T8 Tube (4' T8 Replacement)	1L4'T8 STD	Efficient Products for Business	ROB	Lamp	51	0.12	15	$2.40	$7.77	$2.60
LED Troffer	2L4'T8 STD Fixture	Efficient Products for Business	ROB	Fixture	69	0.12	15	$2.40	$24.73	$3.54
Economizer - Chiller / Elec Resist	No Economizer	Express	RET	Rated Tons Cooling	58	0.00	15	$25.00	$241.94	$14.89
Economizer - Direct Exp / Elec Resist	No Economizer	Express	RET	Rated Tons Cooling	51	0.00	15	$25.00	$241.94	$13.16
Economizer - Direct Exp / Gas Heat	No Economizer	Express	RET	Rated Tons Cooling	156	0.00	15	$25.00	$239.38	$39.91
Economizer - Heat Pump	No Economizer	Express	RET	Rated Tons Cooling	166	0.00	15	$25.00	$239.38	$42.49
Hotel Guest Room Energy Management System (GREM), Electric Cooling, Electric Heating	No sensor	Express	RET	Hotel Room Controller	1,117	0.82	8	$65.00	$260.00	$286.04
Hotel Guest Room Energy Management System (GREM), Electric Cooling, NON-Electric Heating	No sensor	Express	RET	Hotel Room Controller	334	2.74	8	$25.00	$260.00	$85.53
1L4'T5 NLO	1L4'T12	Express	ROB	Lamp	16	0.16	5	$0.74	$1.47	$4.05
1L4'T8 HP	1L4'T12	Express	RET	Lamp	20	0.21	5	$5.62	$11.23	$5.06
1L4'T8 HP	1L4'T8 STD	Express	ROB	Lamp	14	0.21	8	$0.50	$1.00	$3.71
4L4'T5 HLO	400W NS Indoor MH	Express	RET	Fixture	590	0.16	5	$28.20	$300.30	$151.04

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
	Fixture									
6L4'T8HP	400W NS Indoor MH Fixture	Express	ROB	Fixture	716	0.16	11	$70.80	$110.05	$183.41
LED Exit Sign	25W Incandescent Exit Sign	Express	DUB	Sign	158	0.16	16	$12.50	$33.39	$40.38
LED Lighting <10W - Indoor	29W Halogen	Express	ROB	Lamp	84	0.20	8	$3.64	$3.64	$21.62
LED Lighting >=10W - Indoor	43W Halogen	Express	ROB	Lamp	129	0.28	8	$6.81	$6.81	$32.95
LED Outdoor Wall Pack (15W) TC Control	70W HPS or MH TC Control	Express	ROB	Fixture	229	0.00	8	$185.00	$370.00	$58.60
LED Outdoor Wall Pack (30W) TC Control	150W HPS or MH TC Control	Express	ROB	Fixture	499	0.00	8	$185.00	$370.00	$127.86
Occupancy Sensor	No sensor, (4) 4'2LT8	Express	RET	Watts Controlled, 1 OC	225	0.52	8	$0.08	$121.87	$57.58
Outdoor LED Flood Light (30W), TC Control	150W Halogen Flood, TC Control	Express	ROB	Fixture	499	0.00	8	$120.00	$240.00	$127.86
Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	365W NS MH OR HPS Fixture, TC Control, Pole/Area Mount	Express	ROB	Fixture	978	0.00	8	$205.00	$410.00	$250.40
Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	250W NS MH OR HPS Fixture, TC Control, Pole/Area Mount	Express	ROB	Fixture	925	0.00	8	$70.00	$139.99	$236.74
Permanent T12 Removal During T8 Retrofit	1L4'T12	Express	RET	Lamp	157	0.15	5	$12.50	$25.00	$40.13
Photocell (Outdoor Lighting)	(4) 70W MH NS, Time Clock	Express	RET	Watts Controlled, 1 PC	92	0.00	8	$0.02	$94.05	$23.66
Photocell + Timeclock (Outdoor Lighting)	(8) NS 70W MH Lamps, Manual Control	Express	RET	Watts Controlled, 1 TC, 1 PC	632	0.00	8	$0.04	$293.05	$161.88
T8 Delamping	1L4'T8	Express	RET	Lamp	96	0.19	5	$12.50	$25.00	$24.64
Time clock (Outdoor Lighting)	(8) 70W NS MH Outdoor Lamps, Manual Control	Express	RET	Watts Controlled, 1 TC	327	0.00	8	$0.02	$233.05	$83.69
Advanced Pre-Rinse Spray Nozzle, <=1.6 GPM (Elec. HW)	Existing Rinse Spray Nozzle of 2.2 GPM or greater	Express	RET	Per Sprayer	3,792	0.00	5	$63.00	$100.00	$971.04
Vending Machine PIR Occupancy Sensor - Cold Drink	No Controls	Express	RET	Per Machine	1,612	0.00	5	$113.40	$199.83	$412.75

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Vending Machine PIR Occupancy Sensor - Snacks	No Controls	Express	RET	Per Machine	343	0.00	5	$50.40	$80.00	$87.71
Anti-Sweat Heat (ASH) Controls - freezer and cooler glass reach in or freezer door only are eligible	No Heater Controls-continuous operation	Express	RET	Linear foot door width	528	0.08	12	$25.00	$150.00	$135.21
EC Motor: Reach-In Enclosure; blended average of coolers and freezers; no controls	Shaded Pole, no controls	Express	RET	Motor	622	0.08	15	$35.00	$215.00	$159.28
EC Motor: Walk-In Enclosure; blended average of coolers and freezers; no controls	Shaded Pole, no controls	Express	RET	Motor	1,244	0.08	15	$50.00	$280.00	$318.56
Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - ECM	Existing Controls Continuous Operation	Express	RET	Fan	2,341	0.09	16	$60.00	$172.00	$599.47
Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - Shaded Pole	Existing Controls Continuous Operation	Express	RET	Fan	5,752	0.08	16	$60.00	$172.00	$1,472.95
Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - ECM	Existing Controls Continuous Operation	Express	RET	Fan	741	0.09	16	$60.00	$172.00	$189.75
Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - Shaded Pole	Existing Controls Continuous Operation	Express	RET	Fan	1,918	0.08	16	$60.00	$172.00	$491.15
Glass Doors on Low and Med. Temperature Displays with glass doors	open case, without doors	Express	RET	Linear foot of case	664	0.09	12	$275.00	$866.00	$170.03
LED Refrigeration Case Lighting in Freezer & Cooler w/ Doors	Fluorescent Case Lighting System	Express	RET	Linear foot door width	216	0.11	8	$12.00	$104.17	$55.29
LED Refrigeration Case Lighting Open Display Case	Fluorescent Case Lighting System	Express	RET	Linear foot	216	0.11	8	$10.00	$16.67	$55.29
Lighting Controls for Freezer and Cooler w/ Doors	uncontrolled Freezer/Cooler lighting	Express	RET	Linear foot door width	93	0.00	12	$6.67	$6.67	$23.77
Lighting Controls for Open Freezer and Cooler Display case	uncontrolled Freezer/Cooler Display case lighting	Express	RET	Linear foot	93	0.00	12	$6.67	$6.67	$23.77

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
LED T8 Tube (4' T8 Replacement)	1L4'T8 STD	Express	ROB	Lamp	29	0.21	15	$3.89	$7.77	$7.42
LED Troffer	2L4'T8 STD Fixture	Express	ROB	Fixture	39	0.21	15	$12.37	$24.73	$10.11
Air Source Heat Pump SEER 15, COP 2.49 (DUB)	SEER 10, Air Source Heat Pump	Microbusiness	DUB	Rated Tons Cooling	662	0.18	15	$433.49	$433.49	$25.10
CAC Tune-Up	No Tune-Up	Microbusiness	RET	Rated Tons Cooling	30	0.29	5	$25.00	$190.27	$1.14
Ductless Mini Split HP SEER 15	Ductless Mini Split HP SEER 13	Microbusiness	ROB	Rated Tons Cooling	76	1.29	15	$25.00	$50.00	$2.88
ENERGY STAR® Air Source Heat Pump (Elec Res Base)	Electric Baseboard Heating	Microbusiness	RET	Rated Tons Cooling	2,612	0.01	15	$500.00	$1,807.08	$99.00
ENERGY STAR® Window / Room AC (DUB)	EER 8.5 Window AC	Microbusiness	DUB	unit	68	0.94	12	$25.00	$83.08	$2.58
Ground Source Heat Pump (Elec Res Base)	Electric Baseboard Heating	Microbusiness	RET	Rated Tons Cooling	3,118	0.01	15	$2,000.00	$6,028.80	$118.17
SEER 15 CAC - EL Heat (DUB)	SEER 10.0 CAC	Microbusiness	DUB	Rated Tons Cooling	221	0.66	15	$70.00	$70.00	$8.37
SEER 15 CAC - Non-EL Heat (DUB)	SEER 10.0 CAC	Microbusiness	DUB	Rated Tons Cooling	221	0.66	15	$50.00	$70.00	$8.37
Hardwired Dimmer Switch	Two 60W Bulbs without Dimmer Switch	Microbusiness	RET	Dimmer	24	0.16	10	$8.00	$30.00	$0.91
Indoor Fixture-mounted Motion Sensor	Two 60W Bulbs without a Motion Sensor	Microbusiness	RET	Sensor	39	0.10	8	$20.00	$42.00	$1.49
Indoor Wall-mounted Motion Sensor	Two 60W Bulbs without a Motion Sensor	Microbusiness	RET	Sensor	29	0.13	8	$20.00	$66.00	$1.09
Outdoor Motion Sensor	No Motion Sensor	Microbusiness	RET	Sensor	56	0.00	8	$20.00	$33.00	$2.12
Efficient Refrigerator (ENERGY STAR® or Better) (DUB)	Average Existing Refrigerator	Microbusiness	DUB	Refrigerator	231	0.11	17	$37.53	$37.53	$8.74
ENERGY STAR® Monitor	Code Compliant Monitor	Microbusiness	ROB	Monitor	14	0.10	5	$11.00	$11.00	$0.53
DHW Pipe Insulation R-4 10 feet	10 feet of uninsulated (R-1) Hot Water Pipe	Microbusiness	RET	10 Linear Feet	266	0.08	15	$30.00	$55.00	$10.08
ENERGY STAR® Dishwasher (EFO 0.68) - Elec DHW (DUB)	Average Existing Dishwasher (2010 Code)	Microbusiness	DUB	Dishwasher	85	0.08	11	$14.78	$14.78	$3.22
ENERGY STAR® Dishwasher (EFO 0.68) - Non-EL DHW	Average Existing Dishwasher (2010	Microbusiness	DUB	Dishwasher	64	0.08	11	$14.78	$14.78	$2.44

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
(DUB)	Code)									
Heat Pump Water Heater - 2.0 EF	Standard Electric Water Heater - .945 EF	Microbusiness	NEW	Unit	1,685	0.07	10	$125.00	$888.50	$63.85
High Eff. Elec. Water Heat - Tank - .95 EF (DUB)	Average Existing Electric Water Heater - 0.90 EF	Microbusiness	DUB	Unit	176	0.07	15	$50.00	$279.95	$6.69
Instantaneous Electric Water Heater - .99 EF (DUB)	Average Existing Electric Water Heater - 0.90 EF	Microbusiness	DUB	Unit	305	0.07	13	$400.00	$476.11	$11.55
Low Flow (1.25 GPM) showerhead	2.87 GPM Showerhead	Microbusiness	RET	Shower	192	0.08	9	$3.00	$6.00	$7.28
Low Flow Faucet Aerator, 1.5 GPM - EDHW	Average Existing Stock Aerator (2.2 GPM)	Microbusiness	RET	Faucet	25	0.09	12	$2.80	$2.80	$0.93
1L4'T5 NLO	1L4'T12	Microbusiness	ROB	Lamp	16	0.16	5	$1.47	$1.47	$0.60
1L4'T8 HP	1L4'T12	Microbusiness	RET	Lamp	20	0.21	5	$2.40	$11.23	$0.75
1L4'T8 HP	1L4'T8 STD	Microbusiness	ROB	Lamp	14	0.21	8	$1.00	$1.00	$0.55
Daylighting Control + Occ Sensor	Manual Controls	Microbusiness	RET	Watts Controlled, 1 DC, 1 OC	1	0.53	8	$0.10	$1.02	$0.05
Daylighting Controls	Manual Controls	Microbusiness	RET	Watts Controlled, 1 DC	1	0.47	8	$0.08	$0.47	$0.04
LED Exit Sign (DUB)	25W Incandescent Exit Sign	Microbusiness	DUB	Sign	158	0.12	16	$12.50	$30.86	$5.98
LED Lighting <10W - Indoor	29W Halogen	Microbusiness	ROB	Lamp	84	0.20	8	$1.82	$3.64	$3.20
LED Lighting >=10W - Indoor	43W Halogen	Microbusiness	ROB	Lamp	129	0.28	8	$3.41	$6.81	$4.88
Occupancy Sensor	No sensor, (4) 4'2LT8	Microbusiness	RET	Watts Controlled, 1 OC	225	0.52	8	$0.08	$121.87	$8.52
Outdoor LED Flood Light (30W), TC Control	150W Halogen Flood, TC Control	Microbusiness	ROB	Fixture	499	0.00	8	$48.00	$240.00	$18.92
Permanent T12 Removal During T8 Retrofit	1L4'T12	Microbusiness	RET	Lamp	123	0.19	5	$2.40	$25.00	$4.65
Photocell (Outdoor Lighting)	(4) 70W MH NS, Time Clock	Microbusiness	RET	Watts Controlled, 1 PC	92	0.00	8	$0.08	$94.05	$3.50

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Photocell + Timeclock (Outdoor Lighting)	(8) NS 70W MH Lamps, Manual Control	Microbusiness	RET	Watts Controlled, 1 TC, 1 PC	632	0.00	8	$0.04	$293.05	$23.96
T8 Delamping	1L4'T8	Microbusiness	RET	Lamp	96	0.24	5	$9.60	$25.00	$3.65
Time clock (Outdoor Lighting)	(8) 70W NS MH Outdoor Lamps, Manual Control	Microbusiness	RET	Watts Controlled, 1 TC	327	0.00	8	$0.02	$233.05	$12.39
Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER)	Existing PTAC/PTHP - 9.4 EER	New Construction and Major Renovation	NEW	Rated Tons Cooling	161	1.29	15	$30.00	$76.93	$9.55
LED T8 Tube (4' T8 Replacement)	1L4'T8 STD	New Construction and Major Renovation	NEW	Lamp	29	0.21	15	$3.89	$7.77	$1.72
LED Troffer	2L4'T8 STD Fixture	New Construction and Major Renovation	NEW	Fixture	39	0.21	15	$12.37	$24.73	$2.35
Airside Economizer - below 33,000 Btu/h	IECC 2012: not required for systems below 33,000 Btu/h	New Construction and Major Renovation	NEW	Rated Tons Cooling	137	0.00	15	$13.64	$136.40	$8.11
Cogged V-belts on fans 5 HP to 100 HP	Standard belts on fans	New Construction and Major Renovation	NEW	Fan	3,251	0.12	5	$227.58	$500.00	$193.15
Cool Roof, max abs. = 0.3, non-electric heat	ASHRAE 2013 code roof: U=0.032; solar abs. = 0.75(?); emm. = 0.90(?)	New Construction and Major Renovation	NEW	1000 sqft roof	181	0.90	15	$845.50	$5,664.85	$10.77
DCV - Office	Existing building without CO2 Monitor Control	New Construction and Major Renovation	NEW	1000sf	512	0.00	15	$190.00	$190.00	$30.40
Groundwater to Water Heat Pump (>17 kBtu/h and < 135 kBtu/h) EER 18.0 - Heat Pump	ASHRAE 90.1 - 2013: 16.3 EER	New Construction and Major Renovation	NEW	Rated Tons Cooling	275	0.20	15	$80.00	$588.84	$16.34
High Performance Glazing R-5, U 0.20 - Direct Exp / Gas Heat	ASHRAE 90.1-2013: U 0.32 (non-metal framing) U 0.42 metal fixed	New Construction and Major Renovation	NEW	10 sqft glazed	1	0.65	20	$9.15	$91.51	$0.05
High Performance Glazing R-5, U 0.20 - Heat Pump	ASHRAE 90.1-2013: U 0.32 (non-metal framing) U 0.42 metal fixed	New Construction and Major Renovation	NEW	10 sqft glazed	24	0.02	20	$15.55	$91.51	$1.40
High Performance Glazing R-5, U 0.20 - Direct Exp /	ASHRAE 90.1-2013: U 0.32 (non-metal	New Construction and Major	NEW	10 sqft glazed	80	0.01	20	$20.34	$91.51	$4.75

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Elec Resist	framing) U 0.42 metal fixed	Renovation								
Hotel Guest Room Energy Management System (GREM), Electric Cooling, Electric Heating	Manual Heat/Cool Setpoint with Fan On/Off/Auto Thermostat	New Construction and Major Renovation	NEW	Hotel Room Controller	1,117	0.14	15	$26.00	$260.00	$66.36
Hotel Guest Room Energy Management System (GREM), Electric Cooling, NON-Electric Heating	Manual Heat/Cool Setpoint with Fan On/Off/Auto Thermostat	New Construction and Major Renovation	NEW	Hotel Room Controller	334	0.47	15	$26.00	$260.00	$19.84
Improved Ceiling Insulation R45 batt - Direct Exp / Elec Resist	ASHRAE 90.1-2013: R-30	New Construction and Major Renovation	NEW	1000 sqft roof	336	0.01	20	$49.16	$167.15	$19.97
Improved Ceiling Insulation R45 batt - Direct Exp / Gas Heat	ASHRAE 90.1-2013: R-30	New Construction and Major Renovation	NEW	1000 sqft roof	3	0.65	20	$49.16	$167.15	$0.20
Improved Ceiling Insulation R45 batt - Heat Pump	ASHRAE 90.1-2013: R-30	New Construction and Major Renovation	NEW	1000 sqft roof	99	0.02	20	$49.16	$167.15	$5.85
Package system A/C (>=63.3 tons, minimum 10.2 EER, 11.4 IEER) - Direct Exp / All Heating Types	ASHRAE 90.1 - 2013: 11.2 IEER (as of 1/1/2016); 9.7 EER	New Construction and Major Renovation	NEW	Rated Tons Cooling	121	0.37	15	$35.00	$212.00	$7.20
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, >=300 tons, 0.486 kW/Ton (IPLV)	ASHRAE 90.1 - 2013: Path A: <= 0.520 kW/Ton IPLV; 0.610 kW/Ton full load	New Construction and Major Renovation	DUB	Rated Tons Cooling	70	2.14	20	$10.00	$107.29	$4.14
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 150 tons to below 300 tons, 0.522 kW/Ton (IPLV)	ASHRAE 90.1 - 2013: Path A: <= 0.540 kW/Ton IPLV; 0.660 kW/Ton full load	New Construction and Major Renovation	DUB	Rated Tons Cooling	60	3.17	20	$10.00	$136.44	$3.59
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, 75 tons to below 150 tons, 0.554 kW/Ton (IPLV)	ASHRAE 90.1 - 2013: Path A: <= 0.560 kW/Ton IPLV; 0.720 kW/Ton full load	New Construction and Major Renovation	DUB	Rated Tons Cooling	51	3.55	20	$10.00	$162.36	$3.05
Pos. Displacement (scroll, screw, reciprocating) Chillers, Water-Cooled, below 75 tons, 0.567 kW/ton-IPLV	ASHRAE 90.1 - 2013: Path A: <= 0.600 kW/Ton IPLV; 0.750 kW/Ton full load	New Construction and Major Renovation	DUB	Rated Tons Cooling	74	2.35	20	$10.00	$180.04	$4.38

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Split/Package system A/C (<65 kBtu/h, 15 SEER) - Direct Exp /All Heating Types	Code Split/Packaged A/C (<65 kBtu/h) - ASHRAE 90.1 - 2013: 13 SEER	New Construction and Major Renovation	NEW	Rated Tons Cooling	105	0.77	15	$20.00	$72.35	$6.25
Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types	Code Split/Packaged A/C (135 - 240 kBtu/h) ASHRAE 90.1 - 2013: 12.2 IEER; 10.8 EER	New Construction and Major Renovation	NEW	Rated Tons Cooling	52	1.57	15	$35.00	$129.48	$3.07
Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types	Code Split/Packaged A/C (240 - 760 kBtu/h) ASHRAE 90.1 - 2013: 11.4 IEER; 9.8 EER	New Construction and Major Renovation	NEW	Rated Tons Cooling	92	1.14	15	$35.00	$48.56	$5.47
Split/Packaged Air Conditioner (65 - 135 kBtu/h) 12.5 EER, 14 IEER - Direct Exp /All Heating Types	Code Split/Packaged A/C (65 - 135 kBtu/h) ASHRAE 90.1 - 2013: 12.7 IEER; 11.0 EER	New Construction and Major Renovation	NEW	Rated Tons Cooling	75	1.09	15	$35.00	$277.47	$4.46
Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump	Code Split/Packaged Heat Pump (<65 kBtu/h) ASHRAE 90.1 - 2013: 14 SEER	New Construction and Major Renovation	NEW	Rated Tons Cooling	202	0.19	15	$20.00	$141.96	$12.00
Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump	Code Split/Packaged Heat Pump (240 - 760 kBtu/h) ASHRAE 90.1 - 2013: 10.4 IEER; 9.3 EER	New Construction and Major Renovation	NEW	Rated Tons Cooling	546	0.24	15	$35.00	$85.57	$32.46
Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump	Code Split/Packaged Heat Pump (135 - 240 kBtu/h) ASHRAE 90.1 - 2013: 11.4 IEER; 10.4 EER	New Construction and Major Renovation	NEW	Rated Tons Cooling	370	0.22	15	$35.00	$90.93	$21.97
Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump	Code Split/Packaged Heat Pump (65 - 135 kBtu/h) ASHRAE 90.1 - 2013: 12.0 IEER; 10.8 EER	New Construction and Major Renovation	NEW	Rated Tons Cooling	307	0.27	15	$35.00	$89.86	$18.24
Centrifugal Water Cooled Chiller <300 tons (0.536 kW/ton-IPLV)	Centrifugal Chiller <300 tons; Standard ASHRAE 90.1 - 2013: (0.550 kW/Ton IPLV; 0.610 kW/Ton full load)	New Construction and Major Renovation	NEW	Rated Tons Cooling	12	7.23	20	$11.00	$152.65	$0.70

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Centrifugal Water Cooled Chiller >300 tons <600 tons (0.494 kW/ton-IPLV)	Centrifugal Chiller >300 tons <600 tons; ASHRAE 90.1 - 2013: (0.500 kW/Ton IPLV; 0.560 kW/Ton full load)	New Construction and Major Renovation	NEW	Rated Tons Cooling	5	9.60	20	$11.00	$89.75	$0.30
Centrifugal Water Cooled Chiller >600 tons, (0.485 kW/ton-IPLV)	Centrifugal Chiller >600 tons; ASHRAE 90.1 - 2013: (0.500 kW/Ton IPLV; 0.560 kW/Ton full load)	New Construction and Major Renovation	NEW	Rated Tons Cooling	13	11.59	20	$11.00	$106.21	$0.75
Air Cooled Chiller <150 Tons, 0.864 kW/ton (IPLV)	Air Cooled Chiller <150 Tons, Std. ASHRAE 90.1 - 2013: (13.7 IPLV (Btu/W); 10.1 EER full load)	New Construction and Major Renovation	NEW	Rated Tons Cooling	74	1.18	20	$16.00	$127.00	$4.37
Air Cooled Chiller >150 Tons, 0.847 kW/ton (IPLV)	Air Cooled Chiller >150 Tons, Std. ASHRAE 90.1 - 2013: (14.0 Btu/W IPLV [0.858 kW/ton]; 10.1 EER full load)	New Construction and Major Renovation	NEW	Rated Tons Cooling	72	1.09	20	$16.00	$127.00	$4.28
Variable Refrigerant Flow A/C (< 5.4 tons, 14 SEER)	Variable Refrigerant Flow A/C (< 5.4 tons, 13.0 SEER)	New Construction and Major Renovation	NEW	Rated Tons Cooling	56	0.86	15	$20.00	$150.00	$3.35
Variable Refrigerant Flow A/C (135 - 240 kBtu/h, 12 EER, 13 IEER)	Variable Refrigerant Flow A/C (135 - 240 kBtu/h,11.0 EER, 12.3 IEER)	New Construction and Major Renovation	NEW	Rated Tons Cooling	45	1.75	15	$20.00	$130.00	$2.67
Variable Refrigerant Flow A/C (240 - 760 kBtu/h, 10.8 EER, 12.1 IEER)	Variable Refrigerant Flow A/C (240 - 760 kBtu/h, 10.0 EER, 11.1 IEER)	New Construction and Major Renovation	NEW	Rated Tons Cooling	76	1.26	15	$20.00	$140.00	$4.54
Variable Refrigerant Flow A/C (65 - 135 kBtu/h, 12 EER, 13 IEER)	Variable Refrigerant Flow A/C (65 - 135 kBtu/h, 11.2 EER, 12.5 IEER)	New Construction and Major Renovation	NEW	Rated Tons Cooling	32	2.04	15	$20.00	$130.00	$1.88
Water Source (water to water) Heat Pump (< 135 kBtu/h) EER 11.7 - Heat Pump	ASHRAE 90.1 - 2013: 10.6 EER	New Construction and Major Renovation	DUB	Rated Tons Cooling	1,614	0.20	15	$55.85	$55.85	$95.92
Water Source (water to air) Heat Pump (< 17 kBtu/h) EER 13.4 - Heat Pump	Water Source Heat Pump (<17 kBtu/h) ASHRAE 90.1 - 2013:	New Construction and Major Renovation	DUB	Rated Tons Cooling	1,232	0.20	15	$70.00	$668.30	$73.17

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
	12.2 EER									
Water Source (water to air) Heat Pump (>= 17 kBtu/h) EER 14.3 - Heat Pump	Water Source Heat Pump (<17 kBtu/h) ASHRAE 90.1 - 2013: 13.0 EER	New Construction and Major Renovation	DUB	Rated Tons Cooling	1,133	0.20	15	$70.00	$568.30	$67.29
Daylighting Controls	Manual Controls, (4) 2LT8 STD	New Construction and Major Renovation	NEW	Watts Controlled, 1 DC	1	0.88	8	$0.08	$0.29	$0.07
Compressed Air - Controls	new equipment with base level controls	New Construction and Major Renovation	NEW	Compressor HP	494	0.35	15	$100.00	$250.00	$29.35
Evap Fan Controller for Cooler and Freezer Walk-ins with glass reach in - ECM	Existing Controls Continuous Operation	New Construction and Major Renovation	NEW	Fan	2,341	0.12	16	$60.00	$162.00	$139.08
Evap Fan Controller for Cooler and Freezer Walk-ins, no glass - ECM	Existing Controls Continuous Operation	New Construction and Major Renovation	NEW	Fan	741	0.12	16	$60.00	$162.00	$44.02
1L4'T8 HP	1L4'T8 STD	New Construction and Major Renovation	NEW	Lamp	20	0.21	5	$0.39	$0.77	$1.17
4L4'T5 HLO	400W NS Indoor MH Fixture	New Construction and Major Renovation	NEW	Fixture	590	0.16	5	$28.20	$143.05	$35.04
6L4'T8HP	400W NS Indoor MH Fixture	New Construction and Major Renovation	NEW	Fixture	716	0.16	11	$70.80	$110.05	$42.55
LED Lighting <10W - Indoor	29W Halogen	New Construction and Major Renovation	NEW	Lamp	84	0.20	8	$1.82	$3.64	$5.02
LED Lighting >=10W - Indoor	43W Halogen	New Construction and Major Renovation	NEW	Lamp	129	0.28	8	$3.41	$6.81	$7.64
LED Outdoor Wall Pack (15W) TC Control	70W HPS or MH TC Control	New Construction and Major Renovation	NEW	Fixture	229	0.00	8	$185.00	$370.00	$13.60
LED Outdoor Wall Pack (30W) TC Control	150W HPS or MH TC Control	New Construction and Major Renovation	NEW	Fixture	499	0.00	8	$185.00	$370.00	$29.66
Outdoor LED Flood Light (30W), TC Control	150W Halogen Flood, TC Control	New Construction and Major Renovation	NEW	Fixture	499	0.00	8	$120.00	$240.00	$29.66
Outdoor LED Lighting	365W NS MH OR HPS	New Construction	NEW	Fixture	978	0.00	8	$205.00	$410.00	$58.09

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
(130W), TC Control, Pole/Area Mount	Fixture, TC Control, Pole/Area Mount	and Major Renovation								
Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	250W NS MH OR HPS Fixture, TC Control, Pole/Area Mount	New Construction and Major Renovation	NEW	Fixture	925	0.00	8	$70.00	$139.99	$54.92
Compressed Air - Cycling Air Dryer, <=600scfm, thermal mass	Continuous Air Dryer, less than 600 sCFM	New Construction and Major Renovation	NEW	sCFM	7	0.14	15	$1.50	$3.00	$0.44
Compressed Air - Variable Speed Drive Air Compressor, new, less than 150 HP	Air compressor without variable speed drive	New Construction and Major Renovation	NEW	Compressor HP	1,227	0.14	15	$90.00	$400.00	$72.90
Zero Energy Door	Standard Case door	New Construction and Major Renovation	NEW	Case Door	1,885	0.12	10	$145.00	$289.94	$111.99
Cogged (V) belts on fans 5 HP to 100 HP	Standard belts on fans	New Construction and Major Renovation	NEW	Fan	3,251	0.17	5	$227.58	$500.00	$193.15
Daylighting Controls	Manual Controls	New Construction and Major Renovation	NEW	Watts Controlled, 1 DC	505	0.36	8	$30.26	$60.51	$30.00
Compressed Air - Controls	new equipment with base level controls	New Construction and Major Renovation	NEW	Compressor HP	696	0.22	15	$100.00	$199.94	$41.35
Code minimum R-20ci or R-38 batt - Chiller / Elec Resist	Existing R-value	Process Efficiency	RET	1000 sqft roof	642	0.20	20	$51.33	$336.49	$32.86
Code minimum R-20ci or R-38 batt - Chiller / Gas Heat	Existing R-value	Process Efficiency	RET	1000 sqft roof	98	0.07	20	$33.65	$336.49	$5.02
Code minimum R-20ci or R-38 batt - Direct Exp / Elec Resist	Existing R-value	Process Efficiency	RET	1000 sqft roof	297	0.23	20	$76.69	$766.94	$15.20
Code minimum R-20ci or R-38 batt - Direct Exp / Gas Heat	Existing R-value	Process Efficiency	RET	1000 sqft roof	12	3.33	20	$76.69	$766.94	$0.63
Code minimum R-20ci or R-38 batt - Heat Pump	Existing R-value	Process Efficiency	RET	1000 sqft roof	336	0.20	20	$76.69	$766.94	$17.23
Cool Roof - Chiller / Elec Resist	black membrane or built-up	Process Efficiency	RET	1000 sqft roof	1	0.00	15	$19.13	$191.25	$0.05
Cool Roof - Chiller / Gas Heat	black membrane or built-up	Process Efficiency	RET	1000 sqft roof	63	0.05	15	$19.13	$191.25	$3.23
Cool Roof - Direct Exp / Elec Resist	black membrane or built-up	Process Efficiency	RET	1000 sqft roof	30	2.21	15	$76.69	$435.91	$1.56

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Cool Roof - Direct Exp / Gas Heat	black membrane or built-up	Process Efficiency	RET	1000 sqft roof	157	0.44	15	$43.59	$435.91	$8.05
Cool Roof - Heat Pump	black membrane or built-up	Process Efficiency	RET	1000 sqft roof	74	0.91	15	$76.69	$435.91	$3.81
Energy Management System	No Control or Basic Electromechanical Control, no time of day scheduling	Process Efficiency	RET	1000sf Conditioned Space	2	0.00	15	$1.50	$1.50	$0.11
High Performance Glazing - Chiller / Elec Resist	Non-metal framing: Zone 4, U 0.40; Zone 5, U 0.37 Metal framing, fixed: Zone 4 or Zone 5, U 0.47 Metal framing, operable: Zone 4 or Zone 5, U 0.56	Process Efficiency	DUB	10 sqft glazed	365	0.11	20	$29.19	$87.51	$18.69
High Performance Glazing - Chiller / Gas Heat	Non-metal framing: Zone 4, U 0.40; Zone 5, U 0.37 Metal framing, fixed: Zone 4 or Zone 5, U 0.47 Metal framing, operable: Zone 4 or Zone 5, U 0.56	Process Efficiency	DUB	10 sqft glazed	128	0.09	20	$10.21	$78.92	$6.54
High Performance Glazing - Direct Exp / Elec Resist	Non-metal framing: Zone 4, U 0.40; Zone 5, U 0.37 Metal framing, fixed: Zone 4 or Zone 5, U 0.47 Metal framing, operable: Zone 4 or Zone 5, U 0.56	Process Efficiency	DUB	10 sqft glazed	254	0.20	20	$20.34	$103.12	$13.02
High Performance Glazing - Direct Exp / Gas Heat	Non-metal framing: Zone 4, U 0.40; Zone 5, U 0.37 Metal framing, fixed: Zone 4 or Zone 5, U 0.47 Metal framing, operable: Zone 4 or Zone 5, U 0.56	Process Efficiency	DUB	10 sqft glazed	109	0.45	20	$15.15	$103.12	$5.56

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
High Performance Glazing - Heat Pump	Non-metal framing: Zone 4, U 0.40; Zone 5, U 0.37 Metal framing, fixed: Zone 4 or Zone 5, U 0.47 Metal framing, operable: Zone 4 or Zone 5, U 0.56	Process Efficiency	DUB	10 sqft glazed	194	0.27	20	$15.55	$103.12	$9.95
Improved Ceiling Insulation R24ci or R44 batt - Chiller / Elec Resist (DUB)	R-10 above deck R-20 attic	Process Efficiency	DUB	1000 sqft roof	41	0.22	20	$14.45	$180.18	$2.08
Improved Ceiling Insulation R24ci or R44 batt - Chiller / Gas Heat (DUB)	R-10 above deck R-20 attic	Process Efficiency	DUB	1000 sqft roof	5	0.10	20	$14.45	$170.76	$0.28
Improved Ceiling Insulation R24ci or R44 batt - Direct Exp / Elec Resist (DUB)	R-10 above deck R-20 attic	Process Efficiency	DUB	1000 sqft roof	302	0.01	20	$49.16	$410.66	$15.46
Improved Ceiling Insulation R24ci or R44 batt - Direct Exp / Gas Heat (DUB)	R-10 above deck R-20 attic	Process Efficiency	DUB	1000 sqft roof	0.2	14.03	20	$49.16	$410.66	$0.01
Improved Ceiling Insulation R24ci or R44 batt - Heat Pump (DUB)	R-10 above deck R-20 attic	Process Efficiency	DUB	1000 sqft roof	17	0.00	20	$49.16	$410.66	$0.89
Daylighting Controls	Manual Controls, (4) 2LT8 STD	Process Efficiency	RET	Watts Controlled, 1 DC	1	0.43	8	$0.08	$0.47	$0.06
NEMA Premium Efficiency Motor	Standard Efficiency Motor	Process Efficiency	ROB	per horsepower	69	0.13	16	$8.00	$41.57	$3.56
Network PC Management Software	Computers without network power management software	Process Efficiency	RET	Per Networked Workstation	115	0.00	4	$10.00	$23.00	$5.89
Compressed Air - Air Entraining Air Nozzle, 100 psi, 0.25 kW/scfm	Air gun with open end	Process Efficiency	ROB	Nozzle	1,716	0.19	15	$25.00	$80.00	$87.89
Compressed Air - Controls	business as usual	Process Efficiency	RET	Compressor HP	494	0.35	15	$100.00	$370.00	$25.30
Compressed Air - Cycling Air Dryer, >600scfm, all types	Continuous Air Dryer, 600 sCFM or more	Process Efficiency	RET	sCFM	18	0.19	15	$1.50	$2.97	$0.93
Compressed Air - Cycling Air Dryer, >600scfm, all types	Continuous Air Dryer, 600 sCFM or more	Process Efficiency	ROB	sCFM	18	0.19	15	$1.50	$2.47	$0.93

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Compressed Air - Variable Speed Drive Air Compressor, new, greater than 150 HP	Air compressor without variable speed drive	Process Efficiency	RET	Compressor HP	1,227	0.19	15	$90.00	$400.00	$62.85
Compressed Air - Variable Speed Drive Air Compressor, new, greater than 150 HP	Air compressor without variable speed drive	Process Efficiency	ROB	Compressor HP	1,227	0.19	15	$90.00	$400.00	$62.85
Compressed Air - Controls	new equipment with base level controls	Process Efficiency	RET	Compressor HP	696	0.22	15	$100.00	$370.00	$35.65
Compressed Air - Cycling Air Dryer, >600scfm, all types	Continuous Air Dryer, 600 sCFM or more	Process Efficiency	RET	sCFM	26	0.14	15	$1.00	$2.97	$1.31
Compressed Air - Variable Speed Drive Air Compressor, new, greater than 150 HP	Air compressor without variable speed drive	Process Efficiency	RET	Compressor HP	1,729	0.14	15	$100.00	$400.00	$88.55
Energy Management System	No Control or Basic Electromechanical Control, no time of day scheduling	Process Efficiency	RET	sf Conditioned Space	2	0.00	15	$0.20	$1.50	$0.08
Compressed Air - Air Entraining Air Nozzle, 100 psi, 0.25 kW/scfm	Air gun with open end	Process Efficiency	ROB	Nozzle	2,418	0.14	15	$25.00	$80.00	$123.84
Compressed Air - Cycling Air Dryer, >600scfm, all types	Continuous Air Dryer, 600 sCFM or more	Process Efficiency	ROB	sCFM	26	0.14	15	$1.00	$2.47	$1.31
Compressed Air - Variable Speed Drive Air Compressor, new, greater than 150 HP	Air compressor without variable speed drive	Process Efficiency	ROB	Compressor HP	1,729	0.14	15	$100.00	$400.00	$88.55
RCx Program	Code minimum requirements	Retro-Commissioning	RET	Program	4,048,023	0.00	5	$250,000.00	$708,404.06	$435,373.38
Floating Head Pressure Controls; 70F or lower, 1 HP or greater	Fixed head pressure controls	Retro-Commissioning	RET	Refrigeration HP	496	0.13	5	$35.00	$256.00	$53.35
RCx Program	Code minimum requirements	Retro-Commissioning	RET	Program	4,048,023	0.00	5	$250,000.00	$708,404.06	$435,373.38
Self-Direct Program	Standard Practice/Code or Existing as Appropriate	Self-Direct	RET	Project	150,000	0.17	10	$7,500.00	$14,998.68	$6,914.06
Daylighting Controls	Manual Controls	Self-Direct	RET	Watts Controlled, 1	505	0.36	8	$53.76	$107.51	$23.28

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
				DC						
LED Exit Sign	25W Incandescent Exit Sign	Self-Direct	DUB	Sign	61	0.03	16	$15.43	$30.86	$2.82
Occupancy Sensor	No sensor, (4) 4'2LT8	Self-Direct	RET	Watts Controlled, 1 OC	417	0.20	8	$60.94	$121.87	$19.20
Photocell (Outdoor Lighting)	(4) 70W MH NS, Time Clock	Self-Direct	RET	Watts Controlled, 1 PC	1,204	0.00	8	$47.03	$94.05	$55.50
Photocell + Timeclock (Outdoor Lighting)	(8) NS 70W MH Lamps, Manual Control	Self-Direct	RET	Watts Controlled, 1 TC, 1 PC	654	0.00	8	$146.53	$293.05	$30.13
Time clock (Outdoor Lighting)	(8) 70W NS MH Outdoor Lamps, Manual Control	Self-Direct	RET	Watts Controlled, 1 TC	327	0.00	8	$116.53	$233.05	$15.06
4L4'T5 HLO	400W NS Indoor MH Fixture	Self-Direct	ROB	Fixture	1,032	0.12	5	$71.53	$143.05	$47.58
6L4'T8HP	400W NS Indoor MH Fixture	Self-Direct	ROB	Fixture	1,253	0.12	11	$55.03	$110.05	$57.77
LED Lighting <10W - Indoor	40W Incandescent	Self-Direct	ROB	Lamp	84	0.18	7.7	$8.16	$16.32	$3.89
LED Lighting >=10W - Indoor	60W Incandescent	Self-Direct	ROB	Lamp	129	0.18	8	$13.74	$27.49	$5.93
LED Outdoor Wall Pack (15W) TC Control	70W HPS or MH TC Control	Self-Direct	ROB	Fixture	229	0.00	7.7	$185.00	$370.00	$10.55
LED Outdoor Wall Pack (30W) TC Control	150W HPS or MH TC Control	Self-Direct	ROB	Fixture	499	0.00	8	$185.00	$370.00	$23.02
Outdoor LED Flood Light (30W), TC Control	150W Halogen Flood, TC Control	Self-Direct	ROB	Fixture	499	0.00	8	$120.00	$240.00	$23.02
Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	365W NS MH OR HPS Fixture, TC Control, Pole/Area Mount	Self-Direct	ROB	Fixture	978	0.00	8	$205.00	$410.00	$45.07
Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	250W NS MH OR HPS Fixture, TC Control, Pole/Area Mount	Self-Direct	ROB	Fixture	925	0.00	7.7	$70.00	$139.99	$42.61
Self-Direct Program	Standard Practice/Code or Existing as Appropriate	Self-Direct	RET	Project	150,000	0.08	10	$7,500.00	$14,998.68	$6,914.06

C.6 Cross-Sector Measure Characteristics

Cross-sector program include Multifamily, Commercial Multifamily, and Agriculture. These programs include measures from both the residential and commercial sectors. Detailed descriptions of measures in Table 45. Cross-Sector Measure Characteristics can be found in Residential Measure Characterizations and Non-Residential DSM Measure Characterizations.

Table 45. Cross-Sector Measure Characteristics

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Agriculture Heat Pads	Heat Lamps	Agriculture	RET	Unit/swine and hatchery farm	9,747	0.00	5	$892.20	$2,587.38	$988.44
Dairy Scroll Compressors (Agriculture)	Reciprocating compressor	Agriculture	RET	Unit/1000 dairy cows	79,161	0.06	10	$4,294.86	$4,294.86	$8,027.42
Heat Reclaimed Units (Agriculture)	No heat reclamation	Agriculture	RET	Unit/1000 dairy cows	130,800	0.04	10	$15,937.50	$44,037.50	$13,263.92
High Volume Low Speed Fans 16' diameter (Agriculture)	standard high speed fans	Agriculture	RET	Fan/livestock farm	17,749	0.20	10	$800.00	$5,272.00	$1,799.85
High Volume Low Speed Fans 18' diameter(Agriculture)	standard high speed fans	Agriculture	RET	Fan/livestock farm	19,968	0.20	10	$1,000.00	$5,510.00	$2,024.83
High Volume Low Speed Fans 20' diameter (Agriculture)	standard high speed fans	Agriculture	RET	Fan/livestock farm	22,186	0.20	10	$1,200.00	$5,750.00	$2,249.81
High Volume Low Speed Fans 22' diameter (Agriculture)	standard high speed fans	Agriculture	RET	Fan/livestock farm	24,405	0.20	10	$1,400.00	$5,980.00	$2,474.79
High Volume Low Speed Fans 24' diameter (Agriculture)	standard high speed fans	Agriculture	RET	Fan/livestock farm	26,623	0.20	10	$1,600.00	$6,325.00	$2,699.78
Milk Pre-Cooler Heat Exchanger (Chiller Savings) (Agriculture)	No milk pre-cooler	Agriculture	RET	lb. Milk/ Day	101,898	0.12	10	$10,000.00	$51,004.50	$10,333.10
Water Pre-Heat Heat Exchanger (Water Heating Savings)	No water pre-heat	Agriculture	RET	lb. Milk/ Day	3	0.12	10	$0.16	$0.79	$0.25
Tractor Engine Block Heater Timer (Agriculture)	Tractor block heater - no timer 500W	Agriculture	RET	Unit/farm	478	0.00	11	$25.00	$66.36	$48.48
Variable Speed Drive for Milk Vacuum Pump	Constant speed milk vacuum pump	Agriculture	RET	HP/1000 dairy cows	30,032	0.09	15	$2,000.00	$5,850.00	$3,045.43

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Livestock Waterers (Agriculture)	Standard Waterer (Electrically Heated)	Agriculture	ROB	Unit/livestock farm	454	0.00	10	$35.00	$280.00	$46.05
VFD on Dairy Transfer pumps up to 250 HP	Constant speed transfer pump	Agriculture	RET	100 gallons	142	0.03	15	$10.00	$32.86	$14.44
Low Pressure Sprinkler Nozzle,	Standard nozzle	Agriculture	RET	nozzle	9	0.31	15	$0.50	$1.74	$0.94
Switch from sprinkler to Drip Irrigation	Sprinkler irrigation	Agriculture	RET	acre	543	0.37	15	$35.00	$1,000.00	$55.08
Fan thermostat controller (Agriculture)	uncontrolled fan	Agriculture	RET	HP/1000 dairy cows	1,094	0.00	15	$34.48	$34.48	$110.92
HE High-Speed Fan - 24" to 35" diameter	standard high speed fans	Agriculture	RET	Fan/livestock farm	372	0.31	10	$30.00	$150.00	$37.74
HE High-Speed Fan - 36" to 47" diameter	standard high speed fans	Agriculture	RET	Fan/livestock farm	625	0.31	10	$50.00	$175.00	$63.40
HE High-Speed Fan - 48" to 71" diameter	standard high speed fans	Agriculture	RET	Fan/livestock farm	1,122	0.31	10	$100.00	$200.00	$113.81
Air Source Heat Pump SEER 15, COP 2.49 (DUB)	SEER 10, Air Source Heat Pump	Multifamily	DUB	Ton	662	0.25	18	$119.64	$119.64	$203.55
SEER 15 CAC - Non-EL Heat (DUB)	SEER 10.0 CAC	Multifamily	DUB	Ton	221	0.90	18	$50.00	$80.41	$67.85
SEER 15 CAC - EL Heat (DUB)	SEER 10.0 CAC	Multifamily	DUB	Ton	221	0.90	18	$80.41	$80.41	$67.85
ENERGY STAR® Window / Room AC (DUB)	EER 8.5 Window AC	Multifamily	DUB	Unit	68	1.27	12	$25.00	$29.90	$20.88
CAC Tune-Up	No Tune-Up	Multifamily	RET	Ton	30	0.40	5	$25.00	$192.50	$9.25
NEST Consumer Controls - Heat Pump - (DUB)	Non-Programmable Thermostat	Multifamily	DUB	Home	523	0.00	15	$70.00	$98.61	$160.57
NEST Consumer Controls - Non-EL Heat - (DUB)	Non-Programmable Thermostat	Multifamily	DUB	Home	483	0.00	15	$35.00	$98.61	$148.30
NEST Consumer Controls - EL Heat - (DUB)	Non-Programmable Thermostat	Multifamily	DUB	Home	1,045	0.00	15	$70.00	$98.61	$321.15
ENERGY STAR® 50 CFM Bathroom Ventilating Fan	Code-Compliant Ventilating Fan	Multifamily	ROB	Fan	88	0.11	19	$20.00	$43.50	$27.04
Triple Pane Windows - Heat Pump (DUB)	Single Pane Windows	Multifamily	DUB	100 sqft window area	1,439	0.15	25	$137.27	$137.27	$442.34
Triple Pane Windows - Central A/C - Non-EL Heat (DUB)	Single Pane Windows	Multifamily	DUB	100 sqft window area	464	0.48	25	$90.00	$137.27	$142.49
Triple Pane Windows - Central A/C - EL Heat (DUB)	Single Pane Windows	Multifamily	DUB	100 sqft window area	2,415	0.09	25	$137.27	$137.27	$742.19
1W LED Night Light	7W Incandescent Light	Multifamily	RET	Lamp	20	0.00	8	$1.00	$2.00	$6.15

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
LED Lighting 8W - Indoor	60W Incandescent	Multifamily	ROB	Lamp	38	0.08	15	$5.41	$5.41	$11.79
LED Lighting 15W - Indoor	Mix of 75W and 100W incandescent	Multifamily	ROB	Lamp	62	0.08	15	$8.59	$8.59	$19.18
LED Lighting 8W - Indoor (CFL Base)	13W CFL	Multifamily	ROB	Lamp	3	0.09	15	$3.25	$3.78	$0.94
LED Lighting 12W - Indoor (CFL Base)	23W CFL	Multifamily	ROB	Lamp	6	0.09	15	$3.75	$3.78	$1.88
High Eff. Elec. Water Heat - Tank - .95 EF (DUB)	Average Existing Electric Water Heater - 0.90 EF	Multifamily	DUB	Unit	176	0.09	20	$287.15	$287.15	$54.23
Heat Pump Water Heater - 2.0 EF (DUB)	Average Existing Electric Water Heater - 0.90 EF	Multifamily	DUB	Unit	1,844	0.09	10	$492.39	$492.39	$566.74
Instantaneous Electric Water Heater - .99 EF (DUB)	Average Existing Electric Water Heater - 0.90 EF	Multifamily	DUB	Unit	305	0.09	13	$476.11	$476.11	$93.68
DHW Pipe Insulation R-4 10 feet	10 feet of uninsulated (R-1) Hot Water Pipe	Multifamily	RET	10 Linear Feet	266	0.11	15	$55.00	$55.00	$81.74
Low Flow Faucet Aerator, 1.5 GPM - EDHW	Average Existing Stock Aerator (2.2 GPM)	Multifamily	RET	Faucet	25	0.12	12	$2.80	$2.80	$7.53
Low Flow (1.25 GPM) showerhead	2.87 GPM Showerhead	Multifamily	RET	Shower	237	0.11	9	$6.00	$11.00	$72.83
Freezer Retirement	Secondary Freezer	Multifamily	REM	Freezer	640	0.16	8	$140.00	$0.00	$196.76
ENERGY STAR® Set Top Boxes	Non-ENERGY STAR® Set Top Boxes	Multifamily	ROB	Box	62	0.07	5	$19.01	$19.01	$18.98
ENERGY STAR® Dishwasher - Elec DHW	Code Compliant Dishwasher (2013 Code)	Multifamily	ROB	Dishwasher	37	0.10	11	$25.00	$50.00	$11.37
ENERGY STAR® Dishwasher - Elec DHW (DUB)	Average Existing Dishwasher (2010 Code)	Multifamily	DUB	Dishwasher	85	0.10	11	$14.78	$14.78	$26.12
ENERGY STAR® Dishwasher - Non-EL DHW	Code Compliant Dishwasher (2013 Code)	Multifamily	ROB	Dishwasher	16	0.10	11	$25.00	$50.00	$5.00
ENERGY STAR® Dishwasher - Non-EL DHW (DUB)	Average Existing Dishwasher (2010 Code)	Multifamily	DUB	Dishwasher	64	0.10	11	$14.78	$14.78	$19.75
Clothes Washer - Tier 3 >= 2.2 MEF-w/gas or no dry (DUB)	Average Existing Clothes Washer (1.04 MEF)	Multifamily	DUB	Unit	173	0.14	11	$29.98	$29.98	$53.14
Clothes Washer - Tier 3 >= 2.2 MEF-w/elec dry (DUB)	Average Existing Clothes Washer (1.04 MEF)	Multifamily	DUB	Unit	524	0.11	11	$29.98	$29.98	$161.03
Efficient Refrigerator (ENERGY STAR® or Better) (DUB)	Average Existing Refrigerator	Multifamily	DUB	Refrigerator	231	0.15	17	$37.53	$37.53	$70.86
Reduced ACHnat 0.3 - Heat Pump	ACH 0.6	Multifamily	RET	Home	1,712	0.01	15	$200.00	$530.00	$526.15
Reduced ACHnat 0.3 - Central A/C - Non-EL Heat	ACH 0.6	Multifamily	RET	Home	17	0.90	15	$50.00	$530.00	$5.23

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Reduced ACHnat 0.3 - Central A/C - EL Heat	ACH 0.6	Multifamily	RET	Home	3,407	0.00	15	$200.00	$530.00	$1,047.07
Refrigerator Retirement	Secondary Refrigerator	Multifamily	REM	Refrigerator	727	0.15	8	$140.00	$0.00	$223.36
High erformance Circulating Pump (DHW)	Conventional Circulator Pump on HW tank	Multifamily	ROB	Pump	354	0.09	15	$50.00	$300.00	$108.75
LED T8 Tube (4' T8 Replacement)	1L4'T8 STD	Multifamily-Com	ROB	Lamp	29	0.21	15	$3.89	$7.77	$0.59
LED Troffer	2L4'T8 STD Fixture	Multifamily-Com	ROB	Fixture	39	0.21	15	$12.37	$24.73	$0.81
Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER) (DUB)	Existing PTAC/PTHP - 9.4 EER	Multifamily-Com	DUB	Rated Tons Cooling	249	0.77	15	$20.00	$969.49	$5.10
Packaged terminal A/C or Heat Pump (12 kbtuh, 12.7 EER)	Code PTAC/PTHP - ASHRAE 90.1 - 2013: 10.4 EER	Multifamily-Com	ROB	Rated Tons Cooling	105	0.77	15	$20.00	$72.35	$2.16
Split/Package system A/C (<65 kBtu/h, 15 SEER) - Direct Exp /All Heating Types (DUB)	Split/Package system A/C (<65 kBtu/h, 11 SEER) - Direct Exp /All Heating Types	Multifamily-Com	DUB	Rated Tons Cooling	249	0.77	15	$35.00	$969.49	$5.10
Split/Package system A/C (<65 kBtu/h, 15 SEER) - Direct Exp /All Heating Types	Code Split/Packaged A/C (<65 kBtu/h) - ASHRAE 90.1 - 2013: 13 SEER	Multifamily-Com	ROB	Rated Tons Cooling	105	0.77	15	$35.00	$72.35	$2.16
Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types (DUB)	Split/Packaged Air Conditioner (135 - 240 kBtu/h) 9.5 EER, 10 IEER - Direct Exp /All Heating Types	Multifamily-Com	DUB	Rated Tons Cooling	237	0.81	15	$35.00	$288.36	$4.85
Split/Packaged Air Conditioner (135 - 240 kBtu/h) 12 EER, 13 IEER - Direct Exp /All Heating Types	Code Split/Packaged A/C (135 - 240 kBtu/h) ASHRAE 90.1 - 2013: 12.2 IEER; 10.8 EER	Multifamily-Com	ROB	Rated Tons Cooling	52	1.57	15	$35.00	$129.48	$1.06
Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types (DUB)	Split/Packaged Air Conditioner (240 - 760 kBtu/h) 8.5 EER, 9.7 IEER - Direct Exp /All Heating Types	Multifamily-Com	DUB	Rated Tons Cooling	250	0.97	15	$35.00	$155.74	$5.12
Split/Packaged Air Conditioner (240 - 760 kBtu/h) 11.1 EER; 12.7 IEER - Direct Exp /All Heating Types	Code Split/Packaged A/C (240 - 760 kBtu/h) ASHRAE 90.1 - 2013: 11.4 IEER; 9.8 EER	Multifamily-Com	ROB	Rated Tons Cooling	92	1.14	15	$35.00	$48.56	$1.89
Split/Packaged Air	Split/Packaged Air	Multifamily-	DUB	Rated Tons Cooling	200	0.83	15	$20.00	$426.08	$4.09

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Conditioner (65 - 135 kBtu/h) 12.5 EER, 14 IEER - Direct Exp /All Heating Types (DUB)	Conditioner (65 - 135 kBtu/h) 9.8 EER, 11 IEER - Direct Exp /All Heating Types	Com								
Split/Packaged Air Conditioner (65 - 135 kBtu/h) 12.5 EER, 14 IEER - Direct Exp /All Heating Types	Code Split/Packaged A/C (65 - 135 kBtu/h) ASHRAE 90.1 - 2013: 12.7 IEER; 11.0 EER	Multifamily-Com	ROB	Rated Tons Cooling	75	1.09	15	$20.00	$277.47	$1.54
Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump (DUB)	Split/Packaged Heat Pump (<65 kBtu/h) SEER 11.0	Multifamily-Com	DUB	Rated Tons Cooling	720	0.27	15	$35.00	$619.81	$14.75
Split/Packaged Heat Pump (<65 kBtu/h) SEER 15 - Heat Pump	Code Split/Packaged Heat Pump (<65 kBtu/h) ASHRAE 90.1 - 2013: 14 SEER	Multifamily-Com	ROB	Rated Tons Cooling	202	0.19	15	$35.00	$141.96	$4.14
Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump (DUB)	Split/Packaged Heat Pump (135 - 240 kBtu/h) 10 IEER, 9.5 EER	Multifamily-Com	DUB	Rated Tons Cooling	958	0.17	15	$35.00	$406.63	$19.63
Split/Packaged Heat Pump (135 - 240 kBtu/h) EER 11.5 - Heat Pump	Code Split/Packaged Heat Pump (135 - 240 kBtu/h) ASHRAE 90.1 - 2013: 11.4 IEER; 10.4 EER	Multifamily-Com	ROB	Rated Tons Cooling	370	0.22	15	$35.00	$90.93	$7.57
Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump (DUB)	Split/Packaged Heat Pump (240 - 760 kBtu/h) 9.4 IEER, 8.5 EER	Multifamily-Com	DUB	Rated Tons Cooling	1,036	0.21	15	$35.00	$405.97	$21.23
Split/Packaged Heat Pump (>240 kBtu/h) EER 10.8 - Heat Pump	Code Split/Packaged Heat Pump (240 - 760 kBtu/h) ASHRAE 90.1 - 2013: 10.4 IEER; 9.3 EER	Multifamily-Com	ROB	Rated Tons Cooling	546	0.24	15	$35.00	$89.21	$11.19
Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump (DUB).	Split/Packaged Heat Pump (65 - 135 kBtu/h) 10.5 IEER, 9.5 EER	Multifamily-Com	DUB	Rated Tons Cooling	877	0.22	15	$70.00	$441.07	$17.97
Split/Packaged Heat Pump (65 - 135 kBtu/h) EER 12 - Heat Pump	Code Split/Packaged Heat Pump (65 - 135 kBtu/h) ASHRAE 90.1 - 2013: 12.0 IEER; 10.8 EER	Multifamily-Com	ROB	Rated Tons Cooling	307	0.27	15	$70.00	$97.43	$6.29
Water Source (water to air) Heat Pump (< 17 kBtu/h) EER 13.4 - Heat Pump (DUB)	Water Source Heat Pump (<17 kBtu/h) EER 10.0	Multifamily-Com	DUB	Rated Tons Cooling	1,232	0.20	15	$70.00	$668.30	$25.23
Water Source (water to air) Heat Pump (< 17 kBtu/h)	Water Source Heat Pump (<17 kBtu/h)	Multifamily-Com	DUB	Rated Tons Cooling	1,232	0.20	15	$70.00	$668.30	$25.23

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
EER 13.4 - Heat Pump	ASHRAE 90.1 - 2013: 12.2 EER									
Water Source (water to air) Heat Pump (>= 17 kBtu/h) EER 14.3 - Heat Pump (DUB)	Water Source Heat Pump (>17 kBtu/h and < 135 kBtu/h) EER 10.0	Multifamily-Com	DUB	Rated Tons Cooling	1,133	0.20	15	$70.00	$568.30	$23.20
Water Source (water to air) Heat Pump (>= 17 kBtu/h) EER 14.3 - Heat Pump	Water Source Heat Pump (<17 kBtu/h) ASHRAE 90.1 - 2013: 13.0 EER	Multifamily-Com	DUB	Rated Tons Cooling	1,133	0.20	15	$70.00	$568.30	$23.20
1L4'T5 NLO	1L4'T12	Multifamily-Com	ROB	Lamp	16	0.16	5	$0.74	$1.47	$0.32
1L4'T8 HP	1L4'T12	Multifamily-Com	RET	Lamp	20	0.21	5	$5.62	$11.23	$0.40
1L4'T8 HP	1L4'T8 STD	Multifamily-Com	ROB	Lamp	14	0.21	8	$0.89	$1.77	$0.30
4L4'T5 HLO	400W NS Indoor MH Fixture	Multifamily-Com	RET	Fixture	590	0.16	5	$28.20	$300.30	$12.08
6L4'T8HP	400W NS Indoor MH Fixture	Multifamily-Com	ROB	Fixture	716	0.16	11	$70.80	$110.05	$14.67
Daylighting Controls	Manual Controls, (4) 2LT8 STD	Multifamily-Com	RET	Watts Controlled, 1 DC	1	0.66	8	$0.28	$0.55	$0.02
LED Exit Sign	25W Incandescent Exit Sign	Multifamily-Com	DUB	Sign	158	0.16	16	$12.50	$30.86	$3.23
LED Lighting <10W - Indoor	29W Halogen	Multifamily-Com	ROB	Lamp	84	0.20	8	$1.82	$3.64	$1.73
LED Lighting >=10W - Indoor	43W Halogen	Multifamily-Com	ROB	Lamp	129	0.28	8	$3.41	$6.81	$2.64
LED Outdoor Wall Pack (15W) TC Control	70W HPS or MH TC Control	Multifamily-Com	ROB	Fixture	229	0.00	8	$185.00	$370.00	$4.69
LED Outdoor Wall Pack (30W) TC Control	150W HPS or MH TC Control	Multifamily-Com	ROB	Fixture	499	0.00	8	$185.00	$370.00	$10.23
Occupancy Sensor	No sensor, (4) 4'2LT8	Multifamily-Com	RET	Watts Controlled, 1 OC	223	0.52	8	$60.93	$121.87	$4.56
Outdoor LED Flood Light (30W), TC Control	150W Halogen Flood, TC Control	Multifamily-Com	ROB	Fixture	499	0.00	8	$120.00	$240.00	$10.23
Outdoor LED Lighting (130W), TC Control, Pole/Area Mount	365W NS MH OR HPS Fixture, TC Control, Pole/Area Mount	Multifamily-Com	ROB	Fixture	978	0.00	8	$205.00	$410.00	$20.03
Outdoor LED Lighting (80W), TC Control, Pole/Area Mount	250W NS MH OR HPS Fixture, TC Control, Pole/Area Mount	Multifamily-Com	ROB	Fixture	925	0.00	8	$70.00	$139.99	$18.94
Permanent T12 Removal During T8 Retrofit	1L4'T12	Multifamily-Com	RET	Lamp	157	0.15	5	$12.50	$25.00	$3.21

Efficiency Measure	Base Measure	Program	Decision Type	Units	Energy Impact (kWh/unit)	Coincident Summer Peak Impact (W/unit)	Measure Life	Base Incentive ($/unit)	Incremental Cost ($/unit)	Admin Cost ($/unit)
Photocell (Outdoor Lighting)	(4) 70W MH NS, Time Clock	Multifamily-Com	RET	Watts Controlled, 1 PC	92	0.00	8	$47.03	$94.05	$1.89
Photocell + Timeclock (Outdoor Lighting)	(8) NS 70W MH Lamps, Manual Control	Multifamily-Com	RET	Watts Controlled, 1 TC, 1 PC	632	0.00	8	$146.53	$293.05	$12.95
T8 Delamping	1L4'T8	Multifamily-Com	RET	Lamp	96	0.19	5	$12.50	$25.00	$1.97
Time clock (Outdoor Lighting)	(8) 70W NS MH Outdoor Lamps, Manual Control	Multifamily-Com	RET	Watts Controlled, 1 TC	327	0.00	8	$74.03	$148.05	$6.69

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D. ELRAM MODEL METHODOLOGY

The Electricity Resource Assessment Model (ELRAM)

Model Methodology

February, 2016

Submitted by:
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1. INTRODUCTION

The Electricity Resource Assessment Model (ELRAM) is a state of the art electricity energy efficiency potential model designed to estimate technical, economic, and program (market) energy efficiency potential for a utility's service area. Developed by Navigant, the model forecasts energy savings and demand reduction potential within the residential, commercial, and industrial sectors over a forecast period of typically 20 years. Since its initial development in 2007, the model has been used by over 50 different electric utilities across the country to identify future energy efficiency potential.

1.1 Key Design Elements

ELRAM is a stock/flow Excel spreadsheet model based on the integration of energy efficiency measure impacts and costs, utility customer characteristics, utility load forecasts, and utility avoided costs and rate schedules. ELRAM utilizes Excel as the modeling platform due to the transparency in the DSM potential estimation process, and because of the ubiquitous knowledge of the platform in general. Excel also allows the team to customize ELRAM to accommodate the client's unique set of input characteristics and utility data.

The model utilizes a "bottom-up" approach, beginning with study area building stocks, equipment saturation estimates, forecasts of building stock decay and new construction, energy efficiency technology data, past energy efficiency program accomplishments, and decision maker variables that influence the program scenarios.

A key component of ELRAM is the decision maker function used to estimate annual participation in utility programs. ELRAM develops "Measure Payback Response Curves" that are calibrated to historical utility program achievements. These measure level curves are founded on the Bass Diffusion Model developed by Dr. Frank Bass. The Bass Diffusion Model describes the process of the adoption of products as an interaction between users and potential users.

The decision maker function estimates a measure by measure elasticity response to first cost measure payback. The elasticity coefficient is calculated for these measures in the base calibration year using measure-level utility program achievements and first cost measure payback. Utilizing this elasticity based decision process allows for easy to

create scenario options based on changing the size of measure level incentives. In addition, other input variable flexibilities are included within ELRAM to allow for a number of different scenario considerations.

ELRAM also includes, as an option, a sub-model that utilizes measure and end-use load shapes by sector to create estimates of hourly impact from the energy efficiency measures modeled within ELRAM for each hour in the year. When the 8760 sub-model is used, peak demand estimates by load shape category are calculated based on the load shapes and information provided by the utility on when their peak demand occurs. These estimates are expressed as a watt/kWh ratio that is used to estimate ELRAM peak demand results.

1.2 Potential Estimates

The model utilizes these inputs to develop estimates of technical, economic, and market potential. The following figure illustrates these types of energy conservation potential, as defined below:

Technical Potential. ELRAM calculates technical potential as the product of a measure‘s savings per unit, the quantity of applicable units in each facility, and the number of facilities in a utility’s service area. This potential savings assessment includes measures that may not be cost-effective, and therefore provides an upper bound of efficiency potential regardless of cost or market penetration. For measures considered to replace inefficient measures on burnout (ROB), the quantity of applicable units per year is limited to the number that need to be replaced, which is determined by measure life. As time passes, this potential population grows until meeting the full measure life. For non-ROB measures all baseline units are available. No net-to-gross adjustments occur with technical potential.

Economic Potential. ELRAM estimates economic potential as the amount of technical potential that is cost-effective, as defined in this case by the results of the Total Resource Cost (TRC) test. The TRC test is a cost-benefit analysis of relevant energy efficiency measures, excluding market barriers such as lack of consumer knowledge. Benefits include the avoided costs of generation, transmission and distribution investments, avoided fuel costs, and other benefits that may accrue to participants and/or to the utility. Costs vary by economic test but may include incremental technology cost, incentives, administrative costs, and/or lost revenue. The economic

screen is set to 1.0 to determine Economic Potential. ELRAM treats ROB measures the same as with technical potential and there are no net-to-gross adjustments.

Maximum Market Potential. ELRAM screens the amount of economic potential that utility programs *could* capture over the forecast period. The measure level economic screening value for maximum market potential can be set to less than 1.0, but results at the program level must have an overall economic screen of 1.0 or better. This allows the program to include a mix of measures above and below the 1.0 screening threshold. This adjustment factor can vary by program. In addition to the economic screening value and net-to-gross assumptions, maximum market potential includes the effects of decision maker awareness of each measure and if aware, their willingness to install the measure.

Market Potential. ELRAM uses a fourth step for calculating achievable energy savings at the market level using simple payback elasticity. The achievable market potential uses the remaining maximum market potential at the measure level available each year and applies a decision maker simple payback elasticity coefficient to identify yearly savings available in the marketplace. The model calculates this payback elasticity based on historical program achievements and the identified incentive levels by measure. This step provides realistic forecasts of market potential given incentive and program budget levels, which can change over the forecast period.

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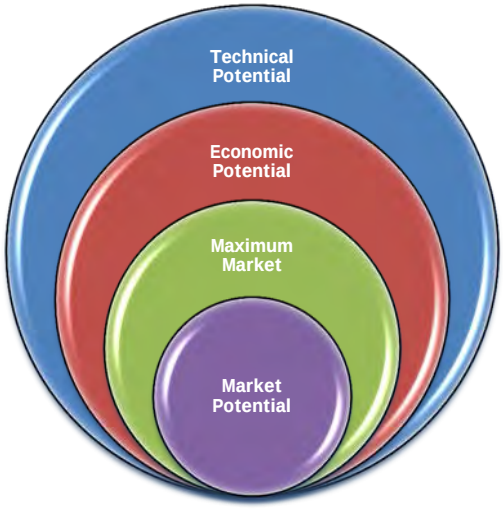
Diagram of Types of Energy Efficiency Potential



Source: Navigant 2015

1.3 Approach to Estimating DSM Potential

ELRAM utilizes "Measure Payback Response Curves" to calculate market potential by year. The method for creating these curves comes from the methodology used for the Bass Diffusion Model developed by Dr. Frank Bass. The Bass Diffusion Model describes the process of the adoption of products as an interaction between users and potential users.

The decision maker function estimates a measure's elasticity response to first cost measure payback calculated in the base calibration year. This base year uses measure-level utility program achievements and first cost measure payback. First cost measure payback does not include any savings from extended measure life of changes in maintenance costs. Utilizing this elasticity based decision process allows the model to create scenario options based on changes to measure level incentives. In addition, ELRAM includes other input variable flexibilities to allow for a number of different scenario considerations including program budget levels and program promotion costs.

1.4 Model Structure and Flow

ELRAM includes nearly 40 distinct worksheets including input, calculation, and output pages, as well as a Scenario Dashboard that offers modelers a quick way to interact

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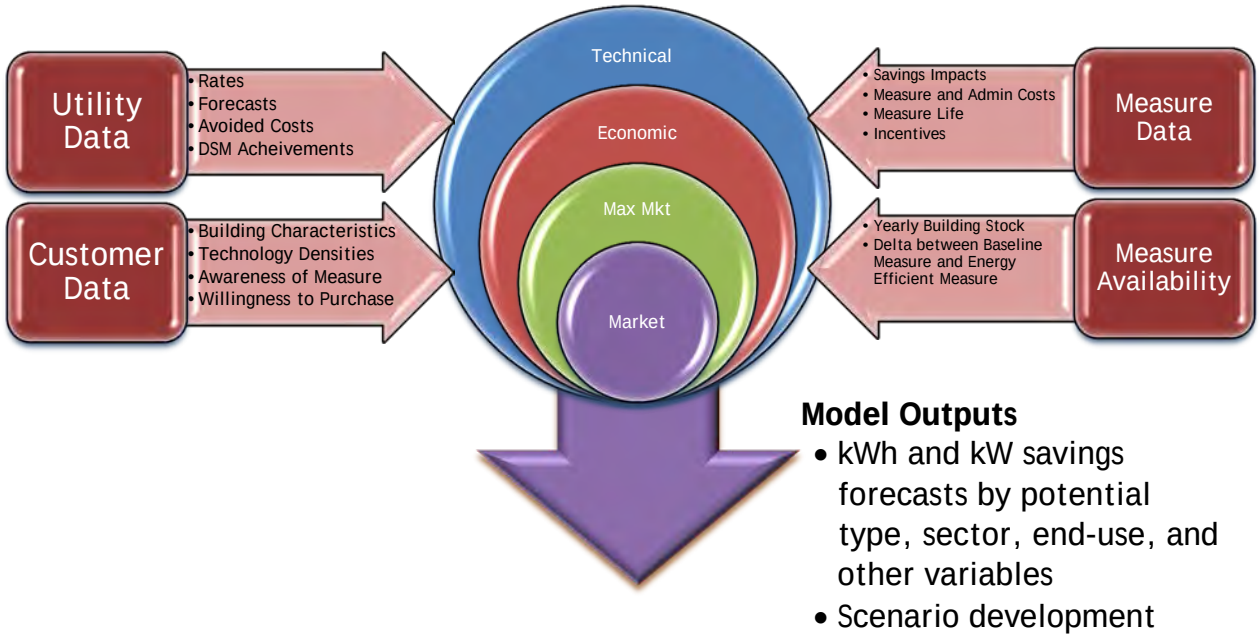
with the model and produce different scenario runs. The variables available on the dashboard include:

- Economic test screens
- Beyond first measure life considerations
- Fiscal variables including:
    - Incentive level
    - Administrative costs
    - Program budget limitations

There is also an "output viewer" connected to the results of the model which allows the client to view potential savings estimates in a variety of ways.

provides a general overview of the data flow through the ELRAM model. The model structure can vary from client to client depending on available data and output needs.



ELRAM Data Flow Overview

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Successful potential savings forecasts rely on high quality and accurate data inputs into ELRAM. These inputs fall into four categories including:

- **Utility Data.** Navigant works closely with the client to gather all utility specific data such as avoided costs, energy (kWh) and demand (kW) forecast estimates, past program savings achievements for use in calibrating ELRAM, customer rate classes, and discount rates.
- **Customer Data.** Navigant conducted onsite audits of a sample of residential and non-residential buildings across the client's service territory. These audits provided data on end-use saturations and technology densities, as well as customer awareness and willingness values.
- **Measure Data.** The Navigant modeling team reviews available Technical Reference Manuals (TRMs) to characterize the measures included in the study. These characteristics include costs, energy and demand use impacts, and measure life for both baseline and energy efficient technologies.
- **Measure Availability.** ELRAM uses building stock inputs along with the availability of technology density each year to estimate potential energy savings throughout the forecast period.

The outputs from ELRAM accomplish multiple objectives, including:

- Determining the total technical, economic, and market potential of energy savings available over the forecast period, both annually and cumulatively; the model calculates these potential estimates at the sector, building type, program type, and end-use classification levels
- Providing guidance for a utility's next energy efficiency goals at an aggregate level, as well as at the measure category level, where appropriate; ELRAM calibrates calculations to past utility achievement levels to ensure continuity with past utility efforts
- Identifying cost-effectiveness using multiple cost effectiveness tests
- Identifying specific costs and benefits, including administrative, incentive, and technology costs, along with avoided cost and reductions in other resource requirement benefits (such as water use reduction)

The remainder of the model is partitioned into five sections:

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- Section 1 – Model results. Separate worksheets are provided that summarize technical, economic, and market potential along with incentive and administrative costs by:
  - Program
  - Building type
  - End-use
  - Load shape category (if applicable)
- Section 1 also includes a worksheet that identifies the top measures in terms of energy saving potential and conservation supply curves.
- Section 2 - Input data and user defined modeling assumptions.
  - Naming Conventions: provides the names used within ELRAM for:
    - Sectors
    - Building types
    - End-use categories
    - Load shape categories
    - Program names
    - Measure level decision types
  - Non-measure level inputs: a series of utility characteristic inputs that includes:
    - Fundamental variables such as start years, T&D adjustments, discount rate
    - Program design information, which includes historical achievements and calibration targets
    - Rates
    - Sector forecasts
    - Building stock forecasts
    - End-use saturations
    - Avoided costs
    - Avoided utility bill costs
    - Codes & Standards impact matrixes
  - Measure level input: detailed measure-level characteristics that includes (among other variables):

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        - Measure and baseline technology names, sectors affected, programs affected, and decision type.
        - Measure life and energy/demand impacts.
        - Measure costs and incentive levels.
        - Baseline and efficient technology density levels.
        - Net-to-gross estimates.
    - Behavior program characteristics by sector.
- Section 3 – Time dependent input variables. A number of input variables are allowed to change over time.
    - Tech-Impact: energy savings by measure.
    - Tech-Cost: incremental measure cost.
    - Incent-Cost: measure-level incentives.
    - Admin-Cost: measure-level administrative costs.
    - W&A: consumer decision maker estimates of measure awareness and if aware, willingness to install.
    - NTG: net-to-gross ratios.
    - Payback: simple first cost payback.
- Section 4 – Calculation Steps for Developing the DSM Potential and Cost Estimates
    - Avoided Cost: calculates the avoided costs by measure for each forecast year.
    - Bill Reduction: calculates how much the electric bill is lowered for each forecast year.
    - Economic Screen: for each measure and each forecast year, the TRC or PAC is calculated.
    - Interactive Adjustment: if a group of measures both affect the same end-use and as a package, have less savings than the sum of the individual measure savings, then there is an adjustment for within end-use interactive effects.
    - Max Market Potential: this is economic potential (including economic screened measure over-rides) adjusted for decision maker measure awareness and if aware, willingness to install.

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  - Units-Max: estimates at the measure-level the number of units available for implementation by year.
  - Calibrate: calculates the decision maker algorithm variables calibrated to historical achievement levels at the measure-level.
  - Units: using the decision make algorithm and the "Units-Max" values, the number of units by measure to be implemented each year.
  - Life End Units: identifies the number of units reaching the end of their measure lifetimes.
  - Life End MWh: identifies the adjustments needed to Cumulative Potential for measure end-of-life and measure re-engagement.
  - DUB Adjust: for measures that are part of early retirement programs, the adjustment to cumulative potential at the end of the first measure life is calculated.
- Section 5 – Final Calculations
  - Cost-Benefits: calculates the different components needed for various cost/benefit tests.
  - Financial Tests: calculates the TRC, PAC, RIM, and PCT financial tests.
  - Tech Potential: calculates the technical potential at the measure-level.
  - Incremental C&S Impacts: calculates the impacts from future codes and standards at the measure-level.
  - Econ Potential: calculates the economic potential at the measure-level.
  - Incremental Potential: calculates the incremental market potential at the measure-level.
  - Cumulative Potential: calculates the cumulative market potential.

1.5 ELRAM Model Features

The model incorporates a number of innovative features including:

- Incorporation of time vectors to allow other key variables to change over time including:
  - Technology cost
  - Administrative cost
  - Incentives
  - Technology impact

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  - Consumer awareness and willingness
  - Net-to-Gross ratios
  - Avoided costs
- The shifting of measure stocks from one program option to another if a technology can be both the efficient option to some measures, but the base option for other, more efficient technologies. For example CFLs can replace incandescent bulbs, but themselves be replaced by more efficient LEDs. The model accounts for this change of CFL stock from one technology to another in order to avoid double counting savings.
- Impacts of known Codes and Standards and the timing of those impacts are included in the modeling structure, estimated at the measure-level.
- Recognition of actions that may take place at the end of measure life that affects both cumulative potential and program participation.
  - The model variable: *Measure Re-engagement* is a percentage estimate of those who continue with the same or more efficient version of the initially-implemented measure. The remainder is assumed to fall back to the baseline efficiency. The model adjusts cumulative potential to account for those who fall back to the baseline efficiency.
  - At the end of measure life (for the re-engagers), the baseline may have become more efficient. Adjustments to cumulative potential are made for any changes.
- The creation of "competition groups" of mutually-exclusive measures which share the same base population but use unique decision-maker adoption rate algorithms to estimate year-by-year market potential. The base population is reduced each year by the sum of the mutually-exclusive measures participation.
- If desired, the ability to assess green-house gas carbon by multiplying estimates of carbon reduction per kWh conserved and the kWh market potential.
- The ability to include the interactive effects on other fuel usage (such as natural gas) when implementing electric measures.
- The ability to create scenarios based on:
  - Various measure incentive levels and/or increased administrative costs (the increase in incentive costs is used as a proxy for increased marketing activity). The incentive and administrative levels can also be modified at the program-level. The start year of the modified incentive and administrative levels is a variable that can be set to any single forecast year.

  - Other scenarios can also be developed using alternative input data, such as avoided costs, energy forecasts, building stock forecasts, and others that may be of interest to the utility.
- The ability to include a number of different avoided costs streams.
- Allowing changes in program administrative costs to affect measure awareness and willingness to install. An increase in administrative costs would be indicative of a promotional/educational campaign.
- Calculation of the basic economic tests (described later) but also calculation (depending which test is selected for screening) of the Total Resource Cost (TRC) test or the Program Administrators Cost (PAC) test for the base year and for each year in the forecast. The TRC or PAC value is used on a yearly basis to screen measures included in the market potential estimates; as technology costs and impacts change over time, so do the TRC or PAC values.
  - The TRC or PAC screening value is a variable set by the user (can be less than 1.0).
  - For emerging technologies, the TRC or PAC screen can be lower than the screen for other measures, if desired by the user.
- Utilization of decision maker awareness and willingness variables, which reveal the market's awareness of an energy efficiency measure, and if aware, the market's willingness to purchase those measures. These variables are used in the consumer choice algorithm. This data is most often collected through a special decision maker survey, taken at the same time as the building and appliance stock characteristics are gathered. Consumer Awareness and Willingness is assumed to grow over time. However, the rate of growth is affected by the size of the incentive and extra marketing activities, if they occur.
- Utilization of historical utility-specific energy efficiency achievements to calibrate model results.
- The ability to create forecasts utilizing historical achievement data for calibration, percent of sales by sector, or user defined calibration targets.
- The tracking of the saturation of efficient measures by year over the forecast period.
- Utilization and wherever possible, direct linkage to statewide or utility-specific deemed energy savings and cost databases.
- Utilization of utility-specific or regionally-specific building characteristics information. These data often come from on-site or telephone based surveys of building and appliance stocks. The model can include as many different building segments and industrial classifications as data allows.

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2. CALCULATING ENERGY EFFICIENCY POTENTIAL

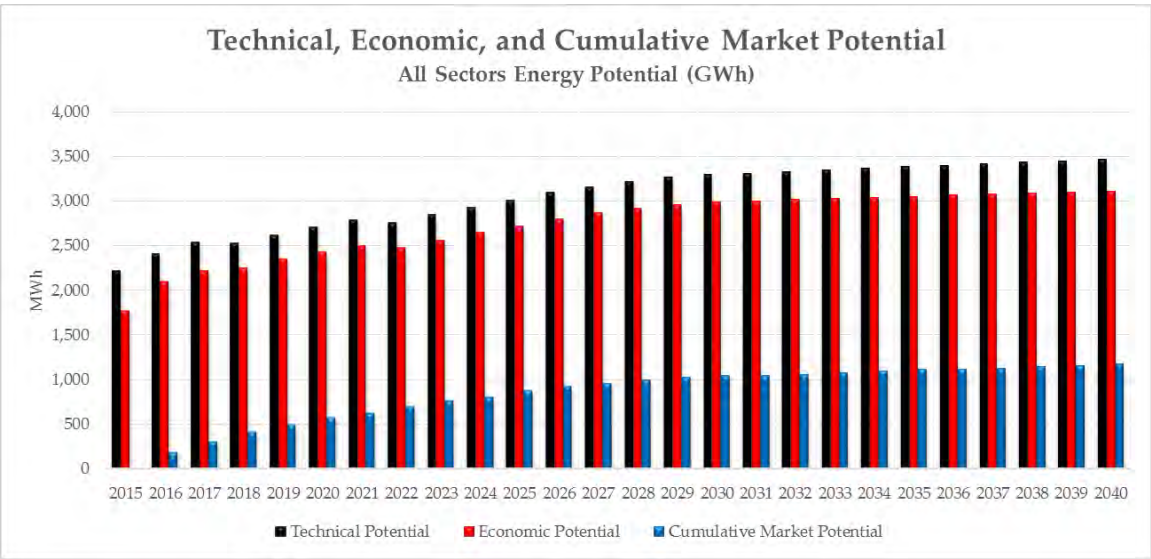
The results of ELRAM are designed to accomplish multiple objectives, including:

- Determining the total cost-effective energy savings available over the forecast period, both annually and cumulatively. The model provides estimates at the sector, program type, and end-use classification levels.
- Providing guidance for the utility's energy efficiency goals at an aggregate level and at the measure category level, where appropriate. As discussed, the ELRAM calculations are calibrated to past utility achievement levels to ensure continuity with past program achievements.

The model partitions it's assessment of each measure into technical, economic and achievable potential. Each assessment includes building stock estimates, technology densities, and measure impacts, with each using a different algorithm.

The following figure illustrates sample results for each type of energy efficiency potential. The next figure illustrates incremental market potential by sector. Additionally, the second figure illustrates total incremental market potential as a percentage of forecast sales.

Sample of Technical, Economic, and Market Potential



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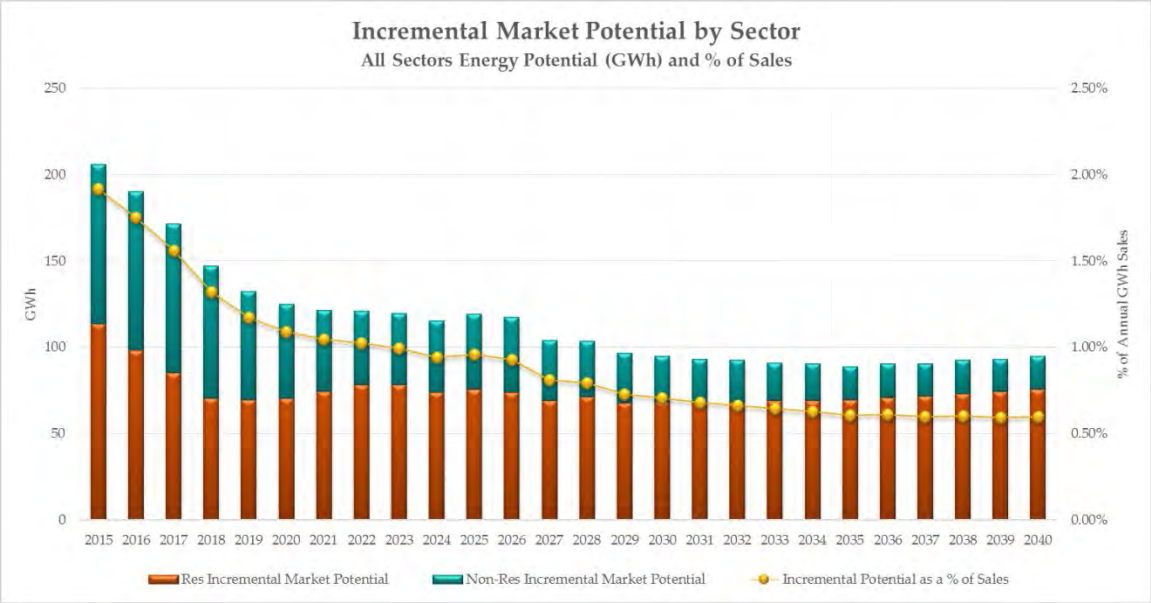
Sample of Incremental Potential by Sector with Percent of Sales



2.1 Measure Types Addressed

ELRAM recognizes the following measure types:

- **Replacement on Burnout (ROB):** Implementation of an energy efficient measure after the existing equipment fails.
- **Retrofit (RET):** Immediate installation of an energy efficient measure that improves the efficiency of an existing technology. The lifetime of the base technology is not a factor as retrofit measures generally do not replace existing technologies. The energy impact is therefore only the amount of improvement to the existing technology.
- **Dual Baseline (DUB):** The dual baseline measure type is an early replacement that replaces an existing technology before the end of useful life; however savings is calculated using a less efficient "as found condition" baseline for the first part of the remaining useful life (RUL), and a "code condition" for the second portion of the RUL. These results in higher initial energy savings under the first baseline, and lower savings under the second baseline once the measure

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would have reached the end of its effective useful life (EUL). Measure costs are also adjusted to reflect the change in baselines.[9]

- **Behavioral Programs (BEH):** Programs designed to influence consumer behavior through the provision of training and/or information. As with emerging technologies, achievable potential is calculated using a Bass diffusion model rather than the traditional measure payback.
- **Low Income (Low):** Measures that are implemented as part of a low income program.
- **New Construction (NEW):** Installation of a measure or package of measures at the time of construction.
- **Demand Response (DR):** Strategies specifically designed to reduce peak demand. There is generally very little energy savings associated with these strategies.

2.2 Financial Tests Calculated

ELRAM calculates several financial tests and measurements, including:

- **Total Resource Cost (TRC):** This test includes all quantifiable costs and benefits of an energy efficiency measure that may accrue to participants or the utility. For example, a measure passing the TRC test is cost effective from this perspective if the sum of its avoided costs and other benefits accruing to participants or the utility are greater than the sum of the measure costs and the utility's administrative costs.
- **Program Administrator Cost Test (PAC):** This test measures the costs of an energy efficiency program based on the costs incurred by the utility (including incentive costs) and excluding any net costs incurred by the participant. For example, a measure passing the PAC test is cost effective from this perspective if the sum of the avoided costs (costs avoided by the measure's energy and demand savings) and other utility benefits are greater than the utility's costs to promote the measure, including incentives provided to customers.
- **Ratepayer Impact Measure Test (RIM):** This test measures what happens to a dwelling or business' electric bills or rates due to changes in utility revenue and operating costs caused by the program. For example, a measure passing the RIM test is cost effective from this perspective if its avoided costs are greater than the sum of the utility's costs and the "lost revenues" caused by the measure.

[9] See the Dual Baseline section 2.6 for more detail.

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- **Participant Cost Test (PCT):** This test measures the quantifiable benefits and costs to the customer due to participation in the program. For example, a measure passing the PCT test is cost effective from this perspective if the reduced electric costs to the participating customer from the measure exceed the after-incentive cost of the measure to the customer.
- **Simple Customer Payback:** This measurement calculates the incremental technology cost divided by the incentive and the reduction in the electric bill. If multi-life benefits and costs are considered, it also includes the PV of future technology costs and future incentives and bill reductions.
- **Levelized Measure Cost/kWh:** This measure multiplies the energy efficiency measure costs by the Capital Recovery Factor, and divides by the first year kWh savings.

ELRAM calculates measure, program, end-use, building type, and overall portfolio level costs and benefits, and when applicable at both the net and gross levels. Net values takes into account free riders by using net-to-gross adjustment values. The costs and benefits calculated include:

- Administrative costs (always gross)
- Avoided cost benefits (always net)
- Other utility benefits (always net)
- Other participant benefits (always net)
- Incentive costs (always gross)
- Incremental technology costs (gross or net)
- Utility bill reductions (gross or net)

Within the "Financial Tests" worksheet, these streams of costs and benefits are converted to a net present value using the discount rate. With this data, four financial tests identified above are calculated.

Total Resource Cost (TRC)[10,11,12]: The TRC test measures the net resource benefits from the perspective of all ratepayers by combining the net benefits of the program to

[10] *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.* October 2001. http://www.energy.ca.gov/greenbuilding/documents/background/07-J_CPUC_STANDARD_PRACTICE_MANUAL.PDF

[11] *CPUC D0606063, Attachment 9.* http://www.cpuc.ca.gov/NR/rdonlyres/101F0713-7277-43A8-883D-8EF2712EFA8A/0/NumericalExamplesNTGAdjtoTRCD0709043.pdf

[12] CPUC http://docs.cpuc.ca.gov/published/final_decision/73172-10.htm

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participants and non-participants. The benefits are meant to be the sum of the avoided costs of the supply-side resources avoided or deferred, and other benefits that accrue to participants or the utility. The TRC costs encompass the cost of the measures/equipment installed, and the costs incurred by the utility. The formulation:

TRC = Benefits / Costs where:

- Benefits = net avoided costs + net other utility benefits + net other participant benefits
- Costs = gross administrative costs + net incremental technology costs

Program Administrator Cost Test (PAC) [10]: Sometimes referred to as the utility cost test, this test compares the utility's avoided cost benefits with energy efficiency program expenditures (incentives plus administrative costs). The formulation:

PAC = Benefits / Costs where:

- Benefits = net avoided costs + net other utility benefits
- Costs = gross administrative costs + gross incentives

Ratepayer Impact Test (RIM): [13] This test measures what happens to customer bills or rates due to changes in utility revenue and operating costs caused by the program. The formulation:

RIM = Benefits / Costs where:

- Benefits = net avoided costs
- Costs = gross administrative costs + gross incentives + net bill reductions

Participant Cost Test (PCT): [14] This test measures the quantifiable benefits and costs to the customer due to participation in the program. The formulation:

PCT = Benefits / Costs where:

- Benefits = gross incentives + gross bill reductions

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[13] *California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects.* October 2001. http://www.energy.ca.gov/greenbuilding/documents/background/07-J_CPUC_STANDARD_PRACTICE_MANUAL.PDF

[14] Ibid.

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- Costs = gross incremental technology costs

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The following table presents the formula for each of the four benefit/cost tests.

Benefit / Cost Test Formulas

Cost Test	Formula	Key of Terms	
Program Administrator Cost Test (PAC)	PAC = (A + B) / (D + E)	A = PV Avoided Costs (always net)	E = PV Incentive Costs (always gross)
Participant Cost Test (PCT)	PCT = (E + gross G) / gross F	B = PV Other Utility Benefits (always net)	F = PV Technology Costs (gross or net)
Rate Impact Measure Cost Test (RIM)	RIM = A / (D + E + net G)	C = PV Other Participant Benefits (always net)	G = PV Bill Reductions (gross or net)
Total Resource Cost Test (TRC)	TRC = (A + B + C) / (D + net F)	D = PV Administrative Costs (always gross)	PV = Present Value

2.3 Approach to Multi-Life Benefits

2.3.1 Multi-Life Benefits

The ELRAM model has the capability of recognizing that the impacts of DSM measures may extend beyond the initial estimate of measure life. Taking this possibility into account can affect benefit/cost ratios, such as the TRC, PCT, PAC, and RIM, by incorporating future expectations of avoided costs, as well as changes in measure costs and impacts, and cumulative energy and demand impact estimates. The estimation of multi-life benefits and determined by the variable:

- **Measure Re-Engagement.** This variable estimates the share of measure installations that continue to provide efficiency benefits at least equal to the initial DSM measure installed. The complimentary share of installations not part of re-engagement is returned to the population totals of available stock for program participation.

There are no new incremental savings accruing from the re-engaging population. However, cumulative savings must be adjusted in two ways. Using as an example a re-engagement rate of 85%, the first adjustment is for the 15% not re-engaging. This 15% goes back to the baseline population and their savings removed from cumulative savings. The second adjustment is for the 85% assumed to be re-engagers. For this group, adjustment to cumulative potential is dependent upon whether the savings are different from what was achieved at the time of the original participation. If unchanged, no changes to cumulative potential. If savings are different, then the cumulative

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potential is adjusted by this delta difference. At the point in time of re-engagement, factors may exist that affect the estimate of continuing DSM measure saving and costs.

- A code or standard (C&S) may have come into effect since the initial point of participation. The effects of the C&S become an attribution issue. Since C&S are mandatory, savings affected by C&S are attributed to the C&S. The share of savings may be 100% or may be a share lower than 100%. If 100%, then no further savings or costs are attributed to the DSM program measure. If the attribution is less than 100%, then the attribution share still applicable to the utility is accounted.
- A measure's estimated energy savings may increase or decrease in the future. For example, LED lighting is still improving in efficacy and, as it does, savings per measure increase. In contrast, appliance recycling programs, such as refrigerator recycling, are expected to have lower savings per unit over time as the population of refrigerators becomes a more recent (more efficient) vintage each passing year.
- A measure's estimated cost may increase or decrease in the future. For example, LEDs and other, newer technologies are expected to decline in cost as these become more popular in the marketplace. The declining cost of CFLs over the past decade is an example of such an effect.

Any changes in energy savings at the point of re-engagement are calculated. These changes in energy savings are applied to the Cumulative Potential and do not affect the Achievable Incremental Potential.

Avoided cost of energy, capacity, and any externality that is quantified are all calculated per measure unit. The impacts are separated into "first life" avoided costs and "beyond first life" avoided costs. The "first life" values are the present value of avoided costs using measure life, the utility discount rate, and the utility's avoided cost stream. The "beyond first life" estimate of avoided cost is calculated only for the population of "re-engagers". For this population, the present value of future avoided costs beyond the first life[15] is calculated starting at this future point in time. This calculation uses any revised future estimate of measure impact, along with measure life, the utility discount rate, and the avoided cost stream appropriate for that time frame. In a similar manner the future cost for incremental technology is calculated.

[15] Several lifetimes may be calculated, depending on the measures estimated life and the length of the forecast period.

NAVIGANT

2.3.2 Codes and Standards Modified Baseline Effects on Cumulative Potential

The effects of codes and standards within the ELRAM model are viewed as an attribution issue between what is credited to codes and standards and what is credited to the DSM program. The "Code Based Impact Change" identifies the specific codes and standards expected to affect measure savings over the forecast period. The effects to measure savings are in the form of time vectors where a specific code and standard is associated with the measures it is expected to affect. The measure effect is in the form of a percent change in savings starting at the point when the code and standard goes into force. As an example, if a specific code and standard effectively reduces saving by 50% starting in the year 2018, the DSM program's first year incremental measure impact would be 100% of the estimated program impact up to the year 2018. Starting in 2018 and thereafter, the utility's share of the measure savings is reduced by 50%, with the other 50% being attributed to the code and standard.

Treating the savings achieved by the DSM program after a code and standard goes into force is done in two parts. First addressed, at the moment the code and standard going into force, is whether there are any adjustments to the first measure lifetime savings, costs, and benefits. The ELRAM model treats these already exiting program achievements, benefits, and costs as unchanged (maintained) over the remaining first lifetime of the measure.

However, at the time of re-engagement, adjustments do occur. For those measures assumed to re-engage after the first lifetime is complete, the measure impacts, benefits, and costs are calculated based on the code and standard adjusted savings level. It is assumed that attribution of the savings transfers to the code and standard at this point forward. To accommodate this, the Cumulative Potential is adjusted downward to reflect the lowered savings resulting from the impact of the code and standard at the time of re-engagement. Additionally, post first lifetime benefits and costs are calculated to reflect the lower savings.

2.4 Mutually Exclusive Measures

Two or more measures that each can replace the same base technology are considered to be mutually exclusive. Examples of mutually-exclusive measures are LED and CFL lamps of the same efficacy being in competition to replace an incandescent lamp.

Mutually-exclusive measures are placed into competition groups with separate competition group identifiers for each group. Within the competition groups, the mutually-exclusive measures share the same base population, but each measure uses its own unique decision-maker adoption rate algorithm to estimate year-by-year achievable potential. The base population is reduced each year by the sum of the mutually-exclusive measures participation.

2.5 Interactive Effects

The energy and demand impacts form DSM measures can be affected by other measures or actions taken. ELRAM recognizes two forms of interactive effects.

The first are interactive effects among measures within the same fuel type and end use. An example of a set of DSM measures that would be considered having interactive effects would be ceiling insulation, wall insulation, a high efficiency furnace, and energy efficient windows. Alone, each of these measures would have a specific energy savings impact. As a group or part of a group, the individual measures have lower savings.

Within ELRAM, a unique interactive effects code is assigned to the set of measures considered to be interactive in this manner. The stand-alone measure impacts are identified as well as the savings if the entire set of interactive measures were implemented. The measure savings used in ELRAM is the pro-rated share of the individual measure savings to the group total. For example, if an interactive measure group included two measures, one with a stand-alone savings of 100 kWh and the other 200 kWh with a group implementation total of 250 kWh, the first measure's model savings is 100/300*250 or 83.3 kWh and the second measure model savings is 200/300*250 or 166.7 kWh.

The second type of interactive effect is among measures from different end-uses that impact the savings of the other. An example would be lighting measures. More efficient lighting produces less waste heat. This results in lower cooling but higher heating loads. The lighting measure energy savings would be increased by how much it reduces electric cooling and increased by how much it increases electric heating. The saturation of electric cooling and heating is taken into account. Effects on other fuels or commodities, such as increased natural gas heating loads or reduced water use, are accounted within the cost effectiveness calculations through increases or decreases in the billing for that fuel or commodity.

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2.6 Dual Baseline Measures

Certain DSM measures are candidates for an early replacement program that utilizes a dual baseline. A dual baseline approach calculates energy savings using a more complex method than is used by the majority of North American DSM administrators. Most jurisdictions use the effective useful life (EUL), or assumed average life of the new measure to calculate the annual savings of the new measure. An example is the replacement of an air conditioning system with one that uses energy more efficiently. For the EUL of the new system (for example, 25 years), the difference in energy use between the new system and the replaced one is claimed as the energy savings.

A dual baseline approach uses, in addition to EUL, the remaining useful life (RUL) of the replaced equipment, which is the length of time the equipment is expected to remain in operation (the length of time until its EUL is at an end). Using a dual baseline approach in the example of the air conditioning system, the difference in energy use between the replaced and new system is claimed as savings only for the RUL of the replaced system. After the RUL (for example 10 years) of the replaced equipment and until the end of the EUL of the new equipment (15 years, if the new system is assumed to have an EUL of 25 years), the difference in energy use between the new system and the standard of equipment at that time is claimed as energy savings. This method takes into account improvements in technology and the market over time; even without an incentive, energy savings for some equipment will occur when old equipment is replaced, because the standard version of newer equipment uses less energy. In the year an energy-efficient measure is installed, if the replaced measure is still in working order, its RUL must be calculated based on its EUL and the length of time it has been in use prior to replacement. The following figure illustrates the two step process.

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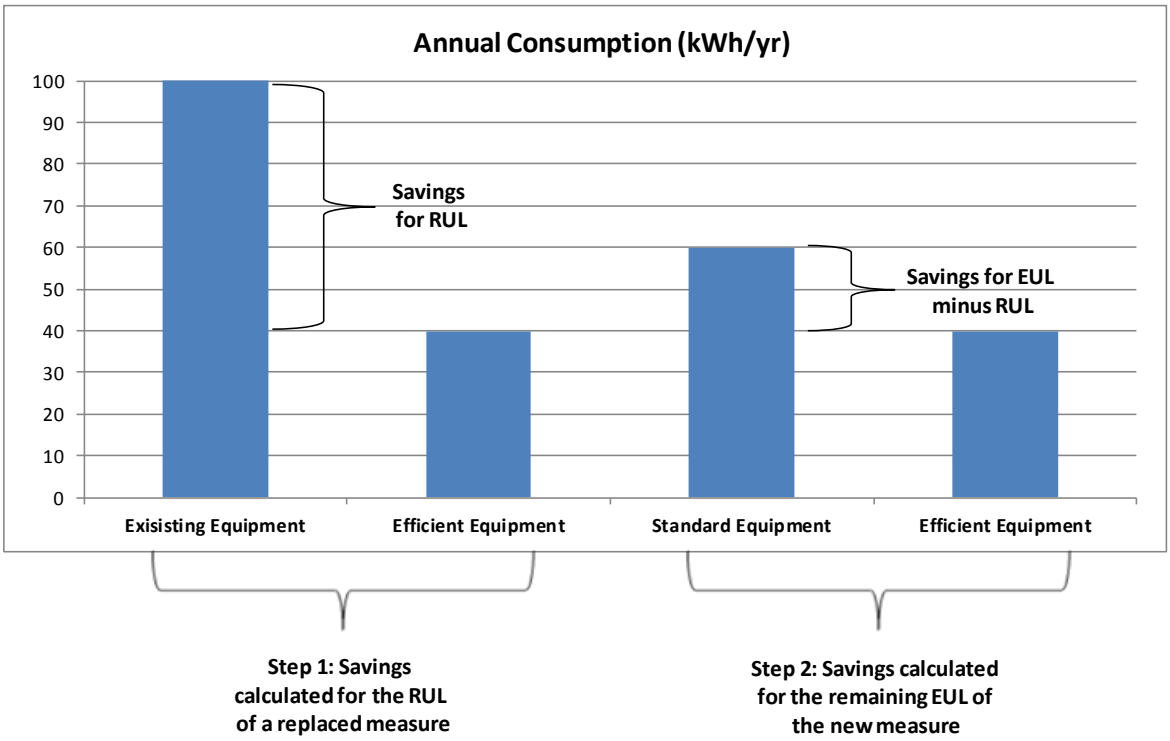
Two-part Calculation of Energy Savings Using a Dual Baseline Approach



Once calculated, energy savings are affected in the following ways:

- When a measure is replaced and it has a RUL, the full unitary savings value (the replaced measure's estimated annual kWh usage minus the new measure's estimated annual kWh usage) is calculated. These savings can be claimed for each year of the RUL of the measure (**Error! Reference source not found.**, step 1).
- When the RUL of the replaced measure expires in the future, a new baseline for annual kWh savings must be used. This baseline is calculated using the most common energy use values for replacement products: either those legislated through codes and standards or those installed by common practice (**Error! Reference source not found.**, step 2).
- If the replaced measure has reached the end of its EUL at the time of replacement, then the current code or most commonly used measure is used to calculate the energy savings, rather than the difference between the new measure and the replaced one.

2.7 Appliance Recycling

Appliance recycling measures need special treatment because of the unique characteristics of the base population. Unlike other base technologies, the used appliance stock available for recycling is constantly being refreshed with new populations of appliances. Due to past improvements to appliance efficiencies (primarily codes and standards), the constantly refreshing population of available appliances for recycling is more efficient (and thus saves less energy) from year to year. Available populations of appliances for recycling may not change significantly from year to year, but the time vector of savings per unit does decline. The cumulative savings are accounted only within the timeframe of the estimated remaining life of the recycled appliance. The re-engagement calculations do not take place for appliance recycling measures.

2.8 Behavior Based Energy Savings Potential

Savings potential from behavior-based initiatives can be included in the ELRAM model by initiative and by building sector. Within ELRAM, behavior-based initiatives are

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defined as those providing information about energy use and efficiency actions, rather than financial incentives, equipment, or services. These initiatives use a variety of implementation strategies including mass media marketing, community-based social marketing, competitions, training, and feedback.[16]

Outcomes from behavior-based initiatives that result in energy savings can be broadly characterized as equipment-based and usage-based:

- **Equipment-based behavior** – Savings from the purchase and installation of higher efficiency equipment, relative to baseline conditions.[17] Examples of equipment-based behavior include the replacement of lights with higher efficiency lights, purchasing Energy Star®-qualified appliances, and purchasing premium efficiency motors. In the ELRAM Model, these savings are modeled at the equipment level as contributions to the percentages of the population that are aware of the measure and that are willing to adopt this measure. Equipment-based behavior can be sub-categorized as:
    - Non-incented equipment-based behavior – The purchase of higher efficiency equipment for which no incentives are provided.
    - Incented equipment-based behavior– The purchase of higher efficiency equipment for which incentives are provided. Also known as —channeling.
- **Usage-based behavior** – Savings from changes in usage and maintenance of existing equipment. Examples of usage-based behavior include turning off lights, unplugging electronics and chargers, programming thermostats, and improving the efficiency of equipment through modified maintenance practices. In the ELRAM model, these savings are modeled as an equipment-independent module with savings unassociated with equipment improvement.

The behavior measure savings used within ELRAM reflect estimates of usage-based and non-incented based behavior. The incented equipment-based behavior is assumed to be addressed by the utility's other incentive-based DSM programs. Currently, the measure life is assumed to be one year, reflecting the need to continually reinforce the behavior program's message to conserve and use energy efficiently.

[16] *Evaluation of Consumer Behavioral Research*, Navigant (Summit Blue Consulting) for the Northwest Energy Efficiency Alliance, April 6, 2010, Page 4.

[17] This could be either the early retirement of older equipment or the installation of high-efficiency equipment at the natural time of installation or replacement.

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2.9 Creating Scenarios Based on Modifying the Incentive Level

A fundamental element of ELRAM is the decision-maker algorithm. The function of measure calibration is to establish for each measure a baseline "Market Factor", which is estimated based on first-cost measure payback and the achieved savings in the base year. This value is an elasticity coefficient used in the forecast period to estimate measure adoption. These incentive levels by measure are generally the actual incentives provided by the utility or they default to an input value, such as 50% of incremental cost. Once the baseline Market Factor is established, the incentive during the forecast period can be modified up or down. Changing the incentive changes the first cost measure payback with corresponding changes in measure adoption rates. These changes in adoption rates are established using the baseline Market Factor, which is unchanged, and the modified first cost measure payback.

The scenario incentive level is expressed as a multiplier to the base scenario incentive. If the base incentives are expressed solely as a percent of incremental technology cost (such as 50%), then a scenario expressed as 25% would represent incentives being cut in half and 75% would represent incentives increasing 1.5 times.

However, if the base incentives include actual incentive levels, then the base case could represent a mix of incentives that are above or below 50% of incremental technology cost. In this situation, the base percentage (such as 50%) would only be applied to measures where either the incentive is unknown or the measure is not yet part of the utility portfolio. For those measures with incentives set at the base case percentage (such as 50%), then a scenario expressed as 25% would represent incentives being cut in half, and 75% would represent incentives increasing 1.5 times. For those measures using actual incentive levels, the scenario expressed as 25% would also represent incentives being cut in half, and 75% would represent incentives increasing 1.5 times. If the current base incentive of 50% represented 25% of incremental cost, the 75% incentive scenario would represent an incentive of 37.5% of incremental cost. Additionally, incentives are capped at 100% of incremental cost. The exception is if the base incentive is already above 100% of incremental cost; in this instance, the incentive does not change.

The year in which the higher or lower incentive level goes into effect is a variable. For instance, if a utility has a mandated goal to achieve about 1.5% of sales of incremental

energy efficiency each year, it may be necessary to increase the incentive in some future year in the forecast when the forecast of market potential begins to fall below the 1.5% of sales goal.

2.9.1 Scenario Adjustments to Consumer Awareness and Willingness

The estimates of future decision maker measure awareness and willingness to install the measure are also affected by changes in the incentive and administrative cost levels. Increased incentive and administrative cost levels correspond to increased awareness and willingness, while decreased incentive and administrative cost levels translate to lower awareness and willingness. Changes to these two costs can be considered independently

The calculations in ELRAM assume that consumer awareness of energy efficiency measures and willingness to install the measures improves over time as long as an incentive is being offered. If no incentive or only a very small incentive is offered, consumer awareness and willingness grows very slowly and reaches a lower maximum awareness and willingness rate compared to the base case. Conversely, higher incentives generally reflect greater marketing of the utility program, which increases consumer awareness and willingness. As the scenario incentive approaches 100%, both the rate of growth in consumer willingness and awareness grow, as do the maximum awareness and willingness values as compared to the base case.

2.9.2 Scenario Adjustments to the Net-to-Gross Ratio

A widespread opinion in energy efficiency program design is that low incentive levels tend to lead to high free-ridership levels, and that increasing incentive levels tends to lower free ridership. In effect, if the incentive was a small percentage of measure cost, one would not expect the incentive to change many customers' decisions about investing in the measure. As a result, the majority of those who participate in the program would be expected to be customers who would have bought the measure with or without the incentive, with a resulting low net-to-gross (NTG) ratio.

As the incentive level is increased, those who would have been free riders will continue to be so, but there will be added participation from those who would not otherwise have bought the measure with a resulting higher NTG ratio.

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Where applicable, ELRAM adjusts NTG values each year in the forecast based on any changes to first cost payback. As a measure's payback changes, either through incentive level changes, changes in measure savings, and/or lower measure costs, the NTG value changes. ELRAM uses the value of (1-NTG) to represent free riders. The formula used to modify NTG from year to year is as follows:

- [(1+(Base Payback - Current Payback) / Current Payback) * Base NTG] / [(1+(Base Payback - Current Payback) / Current Payback) * Base NTG + (1 - Base NTG)]

2.9.3 Sensitivity Assessment

A program administrator is often interested in knowing which variables have the most impact on both estimates of energy savings and costs when considering various scenarios. To provide guidance to the program administrator, sensitivity assessment runs of ELRAM are performed.

The first step in the sensitivity assessment is defining the base condition and identifying the key variables for consideration. Once defined, each key variable is given one or more extreme conditions above and below the base condition. As an example, the following two figures illustrate results from a sensitivity assessment from the perspective of effects on energy savings and program costs; respectively.

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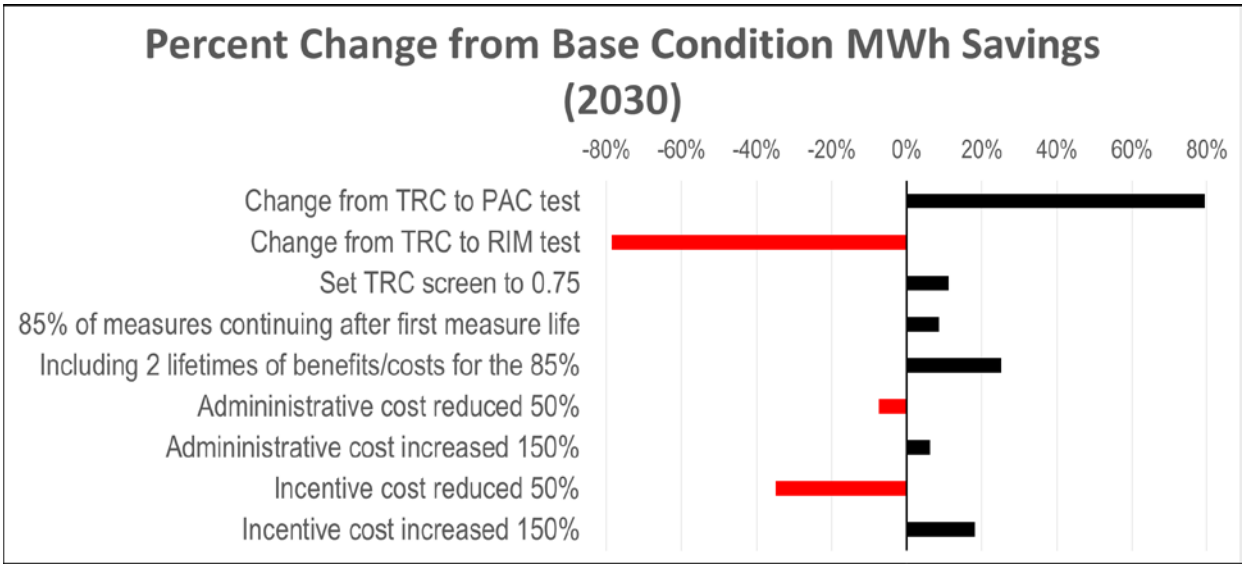
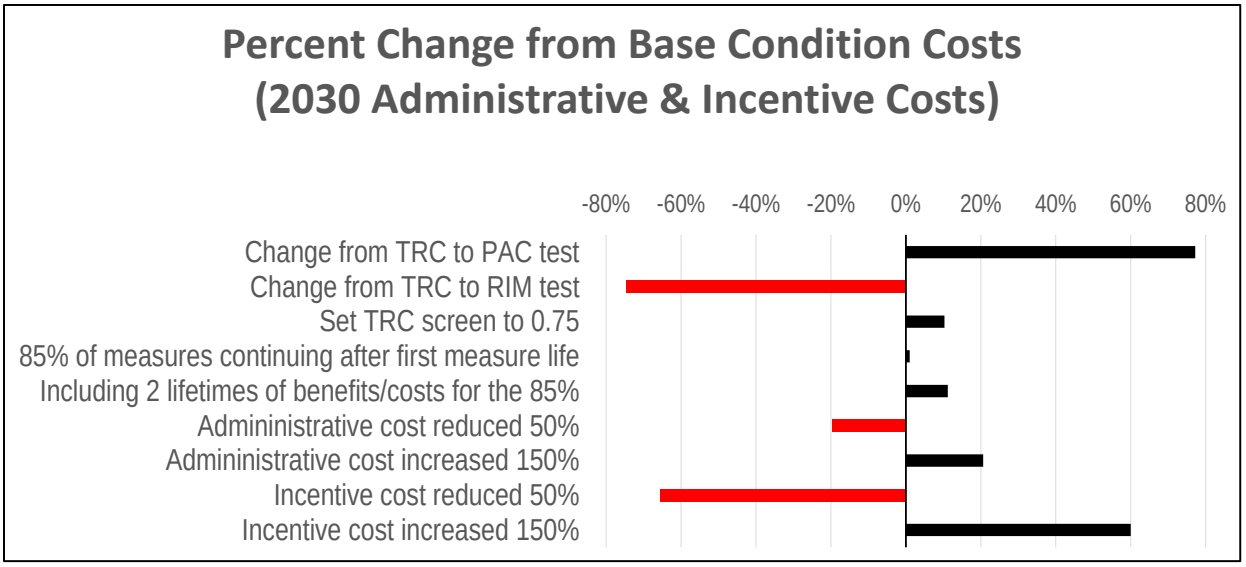
Tornado Chart of Sensitivity Results to Energy Potential



Tornado Chart of Sensitivity Results to Program Costs



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3. Overview of Model Inputs

Model inputs begin with the "Scenario Dashboard" worksheet, which has an orange tab color. The remaining model inputs are split into six separate worksheets. Each have a yellow tab color and include:

- Naming conventions
- Non-measure level inputs
- Measure level inputs
- Residential behavioral program characteristics
- Commercial behavioral program characteristics
- Industrial behavioral program characteristics

3.1 Scenario Dashboard

As the name suggests, most of the variables commonly used in developing scenarios are found in this worksheet. Within this worksheet, one can modify:

- Economic test screens
- Beyond first measure life considerations
- Fiscal variables including:
  - Incentive level
  - Administrative costs
  - Program budget limitations

Immediate feedback on the effects of each change is illustrated in four graphs:

- Total Technical, Economic, and Cumulative Market Potential (MWh)
- Incremental Market Potential (MWh)
- Sector Level Incremental Market Potential (MWh)
- Incremental Market Potential as a Percent of the Sales Forecast

3.2 Naming Conventions

The names of key modeling variables can change from utility to utility. The "Naming Conventions" worksheet identifies the variable names used within a specific utility assessment. The categories of these variable names include:

- Sector name
- Building types/NAICS categories:

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    - Name
    - Identifier
    - Stock treatment (all or single year)
    - Rate schedule
- End-use category
- Load shape category
    - Load shape name
    - Sector
- Program
    - Name
    - Sector
    - Type
- Measure level decision types
    - Name
    - Abbreviation

3.3 Non-Measure Level Inputs

The "Non-Measure Level Inputs" worksheet is where a series of inputs related to utility characteristics are included:

- Fundamental variables such as start years, T&D adjustments, discount rate
- Program design information, which includes historical achievements and calibration targets
- Rates
- Sector forecasts
- Building stock forecasts
- End-use saturations
- Avoided costs
- Avoided utility bill costs
- Codes & Standards impact matrixes

3.4 Measure Level Inputs

The various input technology components are found in the "Measure Level Inputs" worksheet.

Descriptions of each technology input and their role in the potential study calculations are identified below. The sources for each input are listed by measure in the stand-

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alone Measure Input Characterization Sheets (MICS). The MIC sheets identify documentation for each variable by measure along with any supporting calculations by measure. Specific variables may change from client to client. Some of the key variables are as follows:

- **Efficiency Measure** – The measure name.
- **Base Measure** – The base technology for the measure**.**
- **Measure Life** – The measure's effective measure life.
- **Base Technology Measure Life** – The life of the base technology. This is sometimes different than the efficiency measure life.
- **Decision Type** – Identifies the type of program for implementation. Can be retrofit, replace on burnout, behavioral, dual baseline, demand response, or new construction.
- **Modeling Energy Impact (kWh/Unit)** – The starting energy input value used in the model at the first year of the analysis period.
- **Coincident Peak watts/kWh ratio (coincidence factor)** – The ratio of demand to energy used to calculate peak demand potential.
- **On-Peak %** - the estimate percentage of energy use that occurs during the on-peak time frame.
- **If Dual Baseline, kWh/Unit Impact for Remaining Life** – For early retirement measures, this variable identifies the energy savings over the remaining life of the technology replaced.
- **Technology Cost ($/unit)** – The increment or total cost of the efficient technology. The value is incremental if the program is replace-on-burnout. If the program is a retrofit program, the full cost (labor and incremental technology cost) is applied.
- **Incremental Labor Cost ($/unit)** – The extra cost for installing the efficient technology. Generally this only applies to retrofit and new construction decision types.
- **Annual O&M Cost/Savings ($/unit)** – If the efficient technology has different O&M costs than the base technology, it is input here.
- **Base Incentive ($/unit)** – The base year incentive cost per unit. These values are either directly input or are calculated as a percent share of measure incremental cost.
- **Dual Baseline After First Life Measure Cost** – Dual baseline measures have a first life and second life technology cost. The first life technology cost is the full technology cost. The second life technology cost is a percentage adjustment to

first life technology cost that is applied in a present value calculation to reduce measure cost after first life achieved.

- **Technology Efficiency Change over 10 Years** – The percent change in the incremental technology impact over the first ten years of the forecast.
- **Technology Cost Change over 10 Years** – The percent change in the incremental technology cost over the first ten years of the forecast.
- **Energy-use Category** – The grouping of measures into end-use related identifiers.
- **Building Type** – The building type application of this measure.
- **Stock Treatment** – The building type or building type subset applicable for this measure.
- **Program** – The utility program this measure is offered through.
- **Sector –** Identifies the sector within which this program is offered.
- **Program Share** – If a measure is offered through multiple programs, the share of the technology appropriate for this program.
- **Applicability** - This value identifies the share of the building stock in which each measure can be implemented. For many measures, this value is 100%. Some measures have applicability directly input based on the user's knowledge of the measure and building application. For mutually-exclusive measures, applicability will be split in a later step among the competition group measures with the weight being each measure's share of individual TRC to the competition group TRC sum. This weighting is re-done each forecast year as TRC values change.
- **Units** – The common units for the measure such as lamp, refrigerator, home, etc.
- **Base Technology Density** – The number of baseline technology common measure units within a building type (residential), per 1,000 sq. ft. of building space (non-residential), or per kWh (Industrial).
- **Efficient Technology Density** - The number of efficient technology common measure units within a building type (residential), per 1,000 sq. ft. of building space (non-residential), or per kWh (Industrial).
- **Total Maximum Density** - The total of baseline and efficient technology common measure units within a building type (residential), per 1,000 sq. ft. of building space (non-residential), or per kWh (Industrial).
- **Technology Awareness** – The share of decision makers who are aware of the efficient technology Value is directly input.
- **Purchase Willingness** – Of the decision makers who are aware, the share of decision makers willing to install the efficient technology Value is directly input.

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- **Mutually-Exclusive Measure Group Code** – Certain measures compete against each other for installation into the same base technology. An example is LED and CFL lighting competing to replace incandescent lighting. All measures that are considered mutually exclusive are given a unique group code.
- **Within End-Use and Fuel Interactive Effects Group Code –** Measures that have interactive effects within an end-use and fuel type, such as ceiling insulation and weather stripping, are grouped with each group having a unique group code.
- **Total Impacts of all Measures Combined Effects within End-Use and Fuel Interactive Effects Group Code –** Within an end-use interactive effects group, the energy savings from the sum of individual measures is more than the savings when all of the measures are implemented as a package.
- **Outside of End-Use Electric Interactive Effects - Space Heat -** Certain measures installed within one end-use category can affect the energy use in another end-use category. An example is a lighting measure, which reduces cooling load but increases heating load.
- **Outside of End-Use Electric Interactive Effects - Cooling -** Certain measures installed within one end-use category can affect the energy use in another end-use category. An example is a lighting measure, which reduces cooling load but increases heating load.
- **Measure Availability Final Year** – Some measures may be discontinued. This variable identifies the year when this measure is no longer offered through the program.
- **Measure Availability First Year** – Most measures are considered available for program promotion in the first year of the forecast. However, some measures are not available until later years (emerging technologies as an example). This variable indicates the first year of availability.
- **Net-to-Gross Factor** - Used in the Model – A net-to gross value of either 1.0 or a value based on EM&V is input here.
- **Transfer Stocks Out** – The efficient technology of some measures is the base technology of other measures. An example is incandescent, CFL, and LED lighting options. This variable identifies the measure from where this efficient technology becomes the base technology.
- **Transfer Stocks In** – The efficient technology of some measures is the base technology of other measures. An example is incandescent, CFL, and LED lighting options. This variable identifies the measure to where this efficient technology becomes the base technology.

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- **Load Shape Code** – This variable is used by the 8760 sub-model. It identifies the appropriate load shape for this measure.
- **Other Commodity Impacts and Costs** – Many measures have effects on commodities, such as water or carbon mitigation. A series of impacts and cost variables are available for input.

3.5 Behavior Programs

Behavior programs are generally treated differently than other energy efficiency measures. Generally, behavior programs affect both behavioral actions, such as turning down a thermostat, as well as efficiency measure implementation. However, efficiency measure implementation is covered under other measure specific programs. To avoid the possibility of double-counting, only the behavioral actions are considered. Additionally, since behavioral actions often need on-going promotional support, they are given a measure life of one year.

Separate worksheets are provided for behavioral programs by sector. Within each worksheet, behavioral program characteristics and costs are modified to the types of behavioral programs the utility wishes to implement; if any.

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4. TIME DEPENDENT CONSIDERATIONS

Several input variables are allowed to change from year to year over the forecast period. These include:

- Technology impact
- Technology impact for dual baseline (early retirement) measures
- Technology cost
- Administrative cost
- Incentive cost
- Payback
- Net-to-Gross
- Willingness and Awareness

4.1 Technology Impact (Including Dual Baseline Measures)

First year measure impact estimates are input in the "Measure Level Inputs" worksheet. Also input in the "Measure Level Inputs" worksheet is the variable that estimates the change in impacts expected over the next ten years as well as the variable identifying any codes or standards that will affect the measure impacts in the future.

The change in savings over the first ten years of the forecast is pro-rated by year so that full effect is reached by the tenth year. Ten years was selected as the time horizon since the level of uncertainty increases significantly with each passing year.

The codes & standards (C&S) input variable identifies if a C&S will affect this measure and if so, the ratio of savings that can still be attributed to the program and the year when this effect begins.

Estimating these changes to technology impact over time is more complicated for the dual baseline measures. With these measures, the timing of the implementation as well as the remaining measure life of the base technology is considered.

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4.2 Technology Costs

As with technology impacts, first year measure technology cost estimates are input in the "Measure Level Inputs" worksheet. Also input in the "Measure Level Inputs" worksheet is the variable that estimates the change in technology costs expected over the next ten years.

The change in costs over the first ten years of the forecast is pro-rated by year so that full effect is reached by the tenth year. Ten years was selected as the time horizon since the level of uncertainty increases significantly with each passing year.

The extra costs (full measure cost and labor less the present value of incremental cost at the time of normal replace on burnout) associated with the dual baseline measures is included in the technology cost estimate in the "measure Level Inputs" worksheet. Since C&S do not affect the measure costs, a special worksheet is not needed.

4.3 Administrative Costs

First year administrative costs are program specific and input within the "Non-Measure Level Inputs" worksheet. However, like with technology costs, the model allows for administrative cost to change over time. A change in administrative costs is identified as a multiplier in the "Scenario Dashboard" worksheet. The year when the change is to occur is also identified in the "Scenario Dashboard" worksheet. Using lookup tables, the appropriate administrative cost and any change to this cost is identified by measure in this worksheet.

4.4 Incentive Costs

First year incentive costs are input in the "Measure Level Inputs" worksheet. It is preferred that the incentive level input be the incentive actually provided by the utility. However, if that is not known or the measure is not as yet offered, the base incentive is calculated to be 50% of incremental technology cost. A change in incentive costs is identified as a multiplier in the "Scenario Dashboard" worksheet. The year when the change is to occur is also identified in the "Scenario Dashboard" worksheet.

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4.5 Payback

First cost payback is a key component of the Decision Maker algorithm. It consists of the incremental technology cost divided by the incentive and the reduction in the electric bill. If multi-life benefits and costs are considered, it also includes the PV of future technology costs and future incentives and bill reductions. The payback changes over time as each of the components change over time.

4.6 Net-to-Gross (NTG)

Base year NTG values are input in the "Measure Level Inputs" worksheet. However, the NTG values are allowed to change during the forecast period as new NTG studies become available. NTG values are generally program and not measure specific.

4.7 Willingness and Awareness

The first year willingness and awareness variables are input in the "Measure Level Inputs" worksheet. Within the "Willingness and Awareness" worksheet, it is assumed that willingness and awareness improve over time with a maximum value of 85%. The year-by-year improvement follows an "S" curve function.

The shape of the "S" curve changes if there are modifications to administrative or incentive costs. The degree of change from year to year is slower if the incentive and/or administrative cost level drops below the base case incentive and administrative cost levels and higher if above the base case levels.

The following figure illustrates a sampling of changes to the consumer Willingness and Awareness curve over time with changes to the incentive level. The shape of the Willingness and Awareness curve increases more slowly for low incentive scenarios and at a higher rate for high incentive scenarios. The low incentive scenario also has a lower maximum value, while the high incentive scenario has a higher maximum value.

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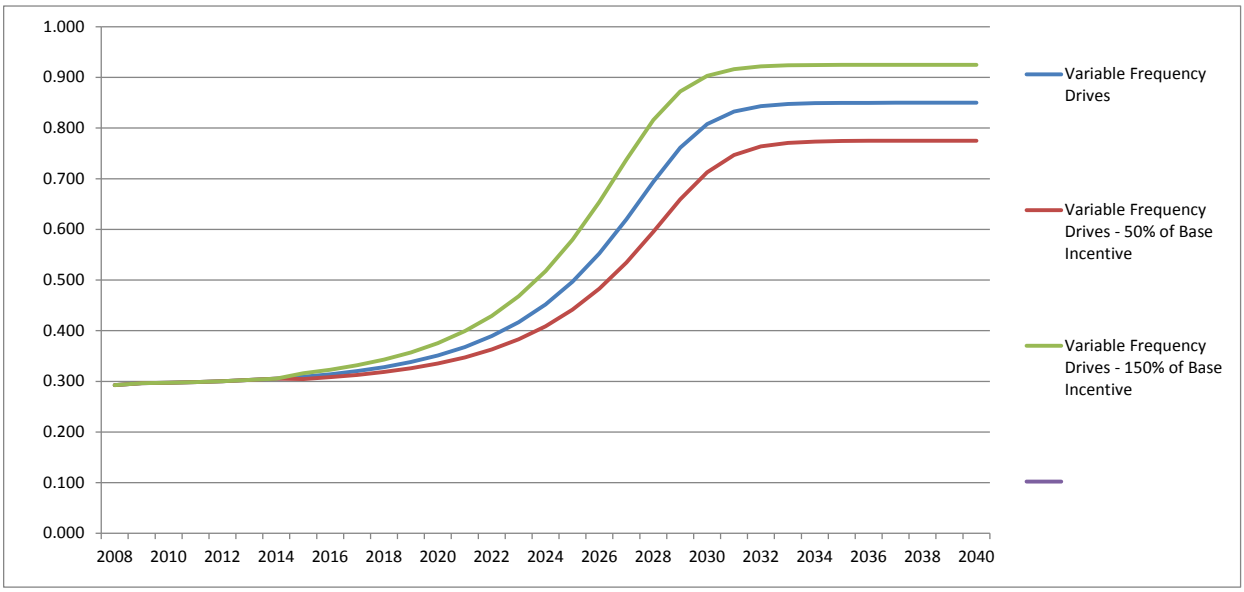
Sampling of Willingness and Awareness Changes Over Time and Incentive Level



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5. Calculation Steps Worksheets

A number of different worksheets are included within ELRAM; each of which represent a step towards the calculation of Technical, Economic, and Market Potential impacts and costs. These worksheets include:

- Avoided cost
- Bill reduction
- Economic screen
- Interactive adjustment
- Maximum market potential
- Maximum available units
- Calibrate
- Market potential units
- Life end units
- Life end MWh
- Dual baseline adjustments

5.1 Avoided Cost

Avoided costs are calculated for energy and demand for the measures implemented based on the direct energy impacts. A matrix of avoided costs by measure life and implementation year for both energy and demand are created in ELRAM using the utility's avoided cost stream. The values within the matrix are calculated to include the first year of avoided cost plus the net present value of avoided costs over the remaining lifetime of the measures. These matrices can be estimated for both on-peak and off-peak timeframes. Additionally, avoided costs are also estimated from "Other Resource and Fuels Avoided Cost" affected by the measure as appropriate.

The amount of avoided costs can extend beyond the first measure life, depending on assumptions regarding customer re-engagement. For those measures where benefits extend beyond the first measure life (as expressed as the percent of re-engagers in the "Scenario Dashboard" worksheet), avoided costs are calculated across another measure lifetime.

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5.2 Bill Reduction

The estimates of utility bill reductions is calculated in a manner similar to avoided costs. Utility bill reductions are calculated for the measures implemented based on the direct energy impacts. A matrix of utility bill reductions by measure life and implementation year for both energy and demand are created in ELRAM using the utility's rate schedules by sector. The values within the matrix are calculated to include the first year of utility bill reduction plus the net present value of bill reductions over the remaining lifetime of the measures.

As with avoided costs, the size of the bill reduction can extend beyond the first measure life, depending on assumptions regarding customer re-engagement. For those measures where benefits extend beyond the first measure life (as expressed as the percent of re-engagers in the "Scenario Dashboard" worksheet), bill reduction estimates are calculated across another measure lifetime.

5.3 Economic Screen

Based on the technology costs and avoided cost benefits, the economic screen (either TRC or PAC depending on which was selected in the "Scenario Dashboard" worksheet) are calculated each year by measure.

Those measures that pass the economic screening test are included in the market potential calculations. Additionally, within this worksheet, there is an override ability to include a measure that is not passing the economic screen or exclude one that is.

Although for market potential there is the ability to over-ride what measures pass the economic test, the economic potential is estimated based only on those measures that have an economic screen value of 1.0 or greater.

5.4 Interactive Adjustment

If a group of measures both affect the same end-use and as a package, have less savings than the sum of the individual measure savings, then there is an adjustment for within end-use interactive effects. The adjustment is applied only to measures that pass the economic screen (including measures being forced to pass).

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5.5 Maximum Market Potential

Maximum market potential (the "Max Market Potential" worksheet) is economic potential (including economic screened measure over-rides) adjusted for decision maker measure awareness and if aware, willingness to install. These estimates at the measure level are needed for the calibration calculations. Calibration is reviewed in more detail in the "Calibration" discussion of Section 5.7 where the "Measure Payback Response Curve" is covered. The measure level maximum market potential estimates represent the variable "M", the number of potential adopters, in the diffusion curve formula.

5.6 Maximum Units

Maximum units (the "Units-Max" worksheet) represent by measure and year all of the baseline technology units available for program participation. The calculations each year include the density value of the base technology multiplied by the appropriate building stocks for the measure, measure applicability within the building stock, and if the measure is offered within more than one program, the program share. For Replace on Burnout (ROB) measures, the total population is divided by the measure life. This calculation reflects that only a share of the total population needs to replace their equipment. In each year after the first year, the total number of available units reduces by the previous year's participants.

This multiplication product each year is then adjusted by the subtraction for participating units from the previous years and the addition of units after they reach the end of measure life who do not re-engage. Also included in the adjustment are the addition, as appropriate, of units from other measures whose efficient technology equals the base technology for this measure through the transfer function.

5.7 Calibration

The "Measure Payback Response Curve", ELRAM's decision-making algorithm, is based on the Bass Diffusion Model[18] developed by Dr. Frank Bass. This model describes the process of the adoption of new products as an interaction between users and potential users. The model is widely used in forecasting, especially product and technology

[18] http://en.wikipedia.org/wiki/Bass_diffusion_model

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forecasting. When forecasting the adoption of energy efficiency technology, the measures are considered to be products for most consumers. Within ELRAM, the "Measure Payback Response Curve" takes the form:

Measure Adoptions (t) = (p + q * market factor * (X(t-1) / M)) * (M - X(t-1))

Where:

- t = Time
- p = The "coefficient of innovation and external influence," such as education and advertising. In performing the research for developing his diffusion curve, Dr. Bass found the average value of "p" to be between 0.01 and 0.03. Within ELRAM, the variable "p" is set to 0.01, but can be modified.
- q = The "coefficient of imitation," which includes internal influence or word-of-mouth effect. Within ELRAM, "q" is based on an exponential function of consumer payback [Exp(0-payback)].
- Market factor is calculated in the calibration year by using the equation above and solving for market factor.
- X(t-1) = Cumulative adoptions up to time "t-1"'. In the calibration year, it equals the measure calibration target.
- M = The number of potential adopters. In the calibration year, it includes all available base technology by measure as identified in the "Units-Max" worksheet.

Within the "Calibration" worksheet, the values for the following Measure Payback Response Curve variables are developed:

- P is set to 0.01 but can be modified
- q (the exponential function utilizing payback)
- Market factor

The "market factor" is the calibration constant that is calculated in the calibration year and used in all succeeding years to estimate measure implementation. It has the following form:

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Market factor = calibration target / ((total available base technology) * EXP (0.0 - Measure Payback))

Where:

- The *calibration target* for each measure is based on historical program achievements. The measure-level data comes from the "Units-Max" worksheet.
- The *total available base technology* is the number of measure units available that, at maximum, could participate in a program. These values are calculated in the "Units-Max" worksheet.
- *Measure payback* is first cost payback with the values calculated in the "Payback" worksheet. The basic calculation for year "n" taking the form:

Payback (n) = (Incremental technology cost – incentive cost (n)) / electric bill reduction (n)

In the calibration year, the model refers to the calibration measure payback values. In each succeeding forecast year, the model re-calculates the first cost payback by measure.

5.8 Market Potential Units

ELRAM calculates stock participation using the Bass diffusion curve decision-maker algorithm as described in Section 5.7. The algorithm depends, in part, on knowing the total number of units that are potentially available to participate in a program by measure and year (from the "Units-Max" worksheet).

The "Units" worksheet calculates the number of measure units included in each year's estimate of market potential. The worksheet uses the "Measure Payback Response Curve" decision maker algorithm to create these estimates. As stated earlier, this algorithm takes the form:

Measure Adoptions (t) = (p + q * market factor * (X(t-1) / M)) * (M - X(t-1))

The variable "M" changes each forecast year, but how it changes varies depending on whether it is a retrofit, replace on burnout, behavioral, dual baseline, demand response, or new construction measure.

- **Retrofit and dual baseline measures:** Total available measure units = Available building stock * (maximum density for the competing technologies – base year efficient technology density) – running sum of previous years of efficient technology units installed + number of non-re-engagers as calculated within the "Units-Max" worksheet.
- **Replace on burnout measures:** Total available measure units = Available building stock / measure life * (maximum density for the competing technologies – base year efficient technology density) – running sum of previous years of efficient technology units installed + number of non-re-engagers as calculated within the "Life_End_Units" worksheet.
- **New construction**: Total available measure units = the new construction building stock for that year.
- **Behavioral and Demand Response measures**: The number of participants each year is generally defined by the utility.

If the modeler initiates scenarios based on changes in incentive levels, the model re-calculates the first cost payback by measure for each year after the first year. The first year value does not change since it is the calibrated market factor. Keeping the market factor constant to its base incentive value ensures that response to changes in payback is observed.

5.9 Life End Units

The "Life_End_Units" worksheet identifies the number of units reaching the end of their measure lifetimes. There are values in this worksheet only if the re-engagement variable set in the "scenario Dashboard" worksheet is greater than 0%. At the end of first measure life, the number of units assumed having an impact beyond the first measure life are calculated.

5.10 Life End MWh

The "Life_End_Mwh" worksheet performs three functions. The first is to identify the energy savings to be removed from Cumulative Potential at the end of first measure life. This function is performed regardless if there are any re-engagers. The initial

energy savings from each measure is removed from cumulative potential at the end of measure life.

The second and third functions are calculated only if there are re-engagers. In the second function, any gains or losses due to changing baselines are added or subtracted from Cumulative Potential. In the third function, the new level of energy savings for the subset of participants re-engaging is calculated and added back to the Cumulative Potential.

5.11 Dual Baseline Adjustments

As discussed in Section 2.6, certain DSM measures are candidates for an early replacement program that utilizes a dual baseline. With these measures, codes and standards defined energy use values are baseline at the time of technology burnout. However, at the time of early replacement, the energy use of the existing technology serves as the baseline. With dual baseline measures, there are higher estimates of energy savings covering the remaining life of the technology replaced, but these savings become lower at the time when the technology would have ceased functioning if not replaced.

Cumulative potential needs to be adjusted to reflect the lower energy savings after remaining measure life of the technology being replaced early is achieved. Calculating the size of these needed adjustments occur in the "DUB_Adjust" worksheet. These calculated adjustments are subtracted from Cumulative Potential.

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6. Calculation Results Worksheets

The last set of calculation worksheets provide the results for technical, economic, market potential, market potential costs, and financial tests. These worksheets include:

- Costs-Benefits
- Financial Tests
- Technical Potential
- Incremental Impacts from C&S
- Economic Potential
- Incremental Market Potential
- Cumulative Potential

6.1 Costs and Benefits Calculations

Within the "Costs-Benefits" worksheet, market potential costs and benefits are calculated. These costs and benefits are computed by year at the measure level as well as the program, end-use, and building type levels. The costs and benefits calculated include:

- Incremental technology cost (both net and gross)
- Administrative costs (gross)
- Incentive costs (gross)
- Avoided cost benefits (net)
- Utility bill reductions (both net and gross)

6.2 Financial Tests

Within the "Financial Tests" worksheet, the streams of costs and benefits are converted to net present values using the discount rate from the "Summary Parameters" worksheet. Using this data, four financial tests are calculated. These include:

- **Total Resource Cost (TRC):** This test includes all quantifiable costs and benefits of an energy efficiency measure, regardless of who accrues these.
- **Program Administrator Cost Test (PAC):** This test measures the net costs of an energy efficiency program as a resource option based on the costs incurred by the utility (including incentive costs) and excluding any net costs incurred by the participant.

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- **Ratepayer Impact Test (RIM):** This test measures what happens to customer bills or rates due to changes in utility revenue and operating costs caused by the program.
- **Participant Cost Test (PCT):** This test measures the quantifiable benefits and costs to the customer due to participation in the program.

Section 2.2 provides a discussion of these tests and **Error! Reference source not found.** illustrates the components of the formulas for each test.

6.3 Technical, Economic, and Market Potential

Each of these forms of efficiency potential is calculated in separate worksheets. Values are provided at the measure level by year. The worksheets are:

- "Tech Potential"
- "Econ Potential"
- "Incremental Potential"
- "Cumulative Potential"

Technical Potential is the product of a measure's savings per unit, the quantity of applicable units in each facility, and the number of facilities in a utility service area. For measures considered to be replace on burnout, the quantity of applicable units per year is limited to the number that need to be replaced, which is determined by measure life. As time passes, this potential population grows until measure life is equaled. For other, non-replace on burnout measures, the full populations of baseline units are considered available.

Economic Potential estimates the amount of technical potential that is "cost-effective," as defined by the results of the economic screening test employed; such as the Total Resource Cost (TRC) test or the Program Administrator Cost (PAC) test. Measures that are economically cost effective are those with test result of 1.0 or greater.

Market potential represents achievable potential given program history, available stocks, available base technologies, and measure impacts. The economic test is employed to screen measures, but the screening value at the measure level can be less than 1.0, such as 0.75. If a screening value of less than 1.0 is used, the economic test value at the program level is reviewed to insure it is 1.0 or greater. The calculations take the form:

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Incremental First Year market potential = Calibrated participant common units * Energy impact/unit * Net-to-gross

Where:

- Calibrated participant common units is calculated in the "Stocks" worksheet
- Energy impact/unit comes from the 'Impact Change-Non-Code" and "Code Based Impact Change" worksheets
- Net-to-gross come from the "NTG" worksheet by measure and year

Cumulative market potential = The running sum of Incremental market potential – the running sum for adjustments to incremental market potential resulting from dual baseline measures – the running sum for adjustments to incremental market potential resulting from measure re-engagement

6.4 Incremental C&S

C&S impacts use the same basic formula as technical potential with the C&S effects at the measure level on and off with the delta the effects being the estimate of C&S impacts. However, the calculations also include the following additional logic (this logic is applied in the "Tech-Impact" worksheet):

- A measure may be impacted by multiple C&S changes over the forecast period. Therefore, the specific years of its applicability and the degree of impact must be determined. In some instances, the incremental population of one C&S overlaps with another
- Because of the possible effect of multiple C&S's affecting the same measure, the appropriate base year for estimating the effects must be tracked and utilized.

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7. OUTPUTS

Within ELRAM are four worksheets that provide technical, economic, and market potential as well as incentive and administrative costs and associate financial tests by the following summary groupings:

- Potential by program
- Potential by sector
- Potential by building type
- Potential by end-use

In addition are two worksheets that summarize model results for input into the 8760 sub-model. The first summarizes cumulative market potential and costs by load shape category. The second disaggregates the cumulative market potential by load shape category into specific building types. This second "by building type" worksheet can be used to develop 8760 load shapes at the substation level if there is information on the number of buildings by substation.

In addition to these six summary worksheets a seventh summary worksheet provides supply curve information. The following table and figure illustrates data available within this worksheet.

The primary source for ELRAM table and graphic results is through a separate workbook called the "Output Viewer". The output viewer is customized for each client but uses pivot tables and direct links to ELRAM to create dozens of different representations of ELRAM results.

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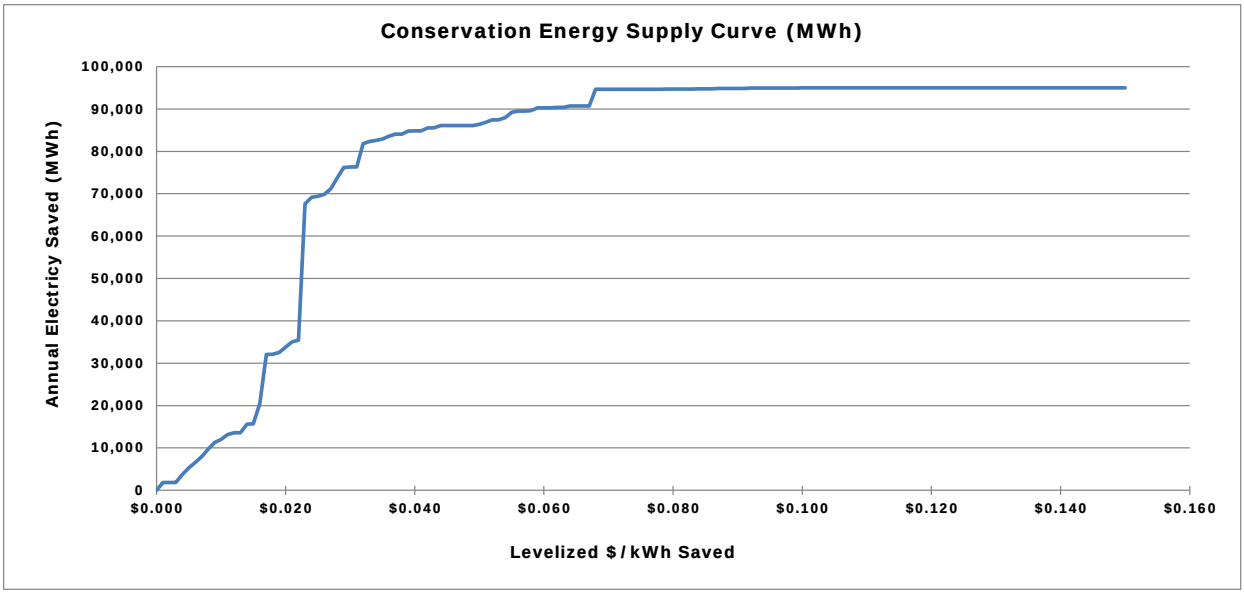
Top 20 Measures in 2014

Rank	Top Twenty Measures - 2014	2014 - Energy Savings (MWh)	2014 - Demand Savings (KW)	Energy % of Total	Demand % of Total
1	COM - Custom Efficiency	19,786	2,878.3	13.9%	8.8%
2	IND - Custom Efficiency	18,465	2,686.1	13.0%	8.2%
3	RES-SF - Home Energy Report	10,000	2,629.7	7.0%	8.1%
4	RES-SF - Advanced Automatic Pellet Combo Boiler	5,811	1,702.2	4.1%	5.2%
5	RES-SF - Certified Wood Boiler or Furnace	4,311	1,570.2	3.0%	4.8%
6	SF - Certified Pellet Boiler or Furnace Supplemented by Baseboard Heat (Whole H	4,301	1,929.1	3.0%	5.9%
7	RES-SF - Energy Star® Regular CFL	2,618	294.7	1.8%	0.9%
8	RES-SF - Freezer Retirement	2,506	447.3	1.8%	1.4%
9	COM - Relamp/Reballast-Retrofit (dual baseline)-BES	2,352	605.3	1.7%	1.9%
10	IND - Relamp/Reballast-Retrofit (dual baseline)-BES	2,269	584.0	1.6%	1.8%
11	COM - Relamp/Reballast-Retrofit (dual baseline)	2,257	580.8	1.6%	1.8%
12	COM - Relamp/Reballast-Retrofit (dual baseline)-BES	2,183	561.9	1.5%	1.7%
13	IND - Relamp/Reballast-Retrofit (dual baseline)	2,179	560.7	1.5%	1.7%
14	RES-SF - Certified Wood Stove	2,164	1,054.2	1.5%	3.2%
15	LI - EnergyStar Refrigerator	2,162	516.9	1.5%	1.6%
16	COM - Relamp/Reballast-Retrofit (dual baseline)	2,095	539.2	1.5%	1.7%
17	RES-SF - Certified Pellet Stove	1,978	1,054.2	1.4%	3.2%
18	RES-SF - Energy Star Air Source Heat Pump	1,863	992.9	1.3%	3.0%
19	COM - Relamp/Reballast-Retrofit (dual baseline)-BES	1,769	455.4	1.2%	1.4%
20	LI - EnergyStar Freezer	1,759	420.5	1.2%	1.3%
	Top 20 Total	**92,827**	**22,064**	**65.4%**	**67.7%**

Technical Potential Supply Curve



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8. Hourly Load Sub-Model

If desired by the utility, ELRAM has a companion 8760 hourly load sub-model. The hourly load sub-model consists of four areas:

- The first is a set of hourly load shapes by sector and end-use/measure category.
- The second is a linked table of forecast results from ELRAM by load shape category.
- The third is the calculated hourly loads for the forecast efficiency measures.
- The fourth is an assessment of non-coincident and coincident peak demand.

The hourly load shapes by measure category may come from the utility directly, a government organization, or from building simulation model output, such as from DOE-2 based eQuest. The load shapes are expressed as the hourly share of the yearly total. The addition of all 8,760 hours equals 1.0.

Output from this 8670 sub-model can be used as input into a production cost model. Additionally, by using the ELRAM information by building type and load shape category, the effects of utility conservation programs can be estimated at the sub-station level.

The following figure provides a graphic example of residential end-use load shapes of a typical January weekday for a northern-based winter peaking utility. All 8,760 hours are populated by end use category, but typical day graphs are included in the sub-model by each of the four seasons to ensure that the dataset appears reasonable.

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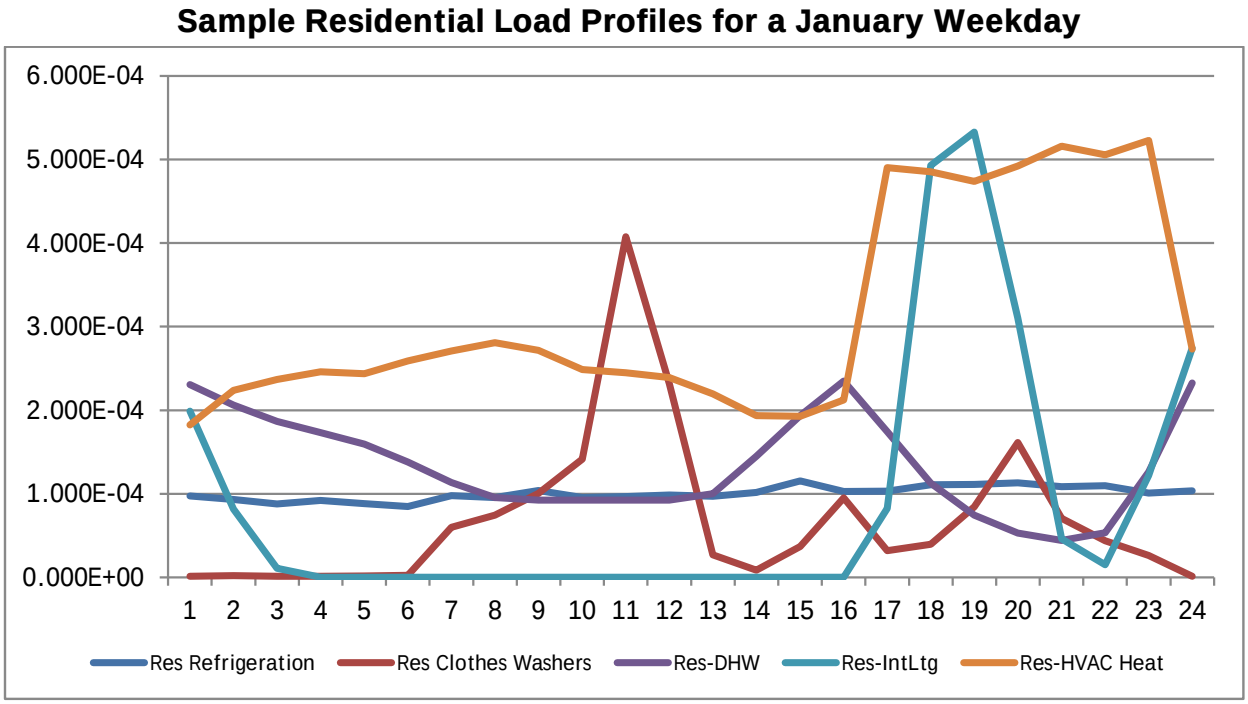

The following figure illustrates the load shapes by month for typical weekdays. Although January is the peak month and 4PM the peak hour, the non-coincident peak month is May, and the non-coincident peak hour is in May at 3PM.

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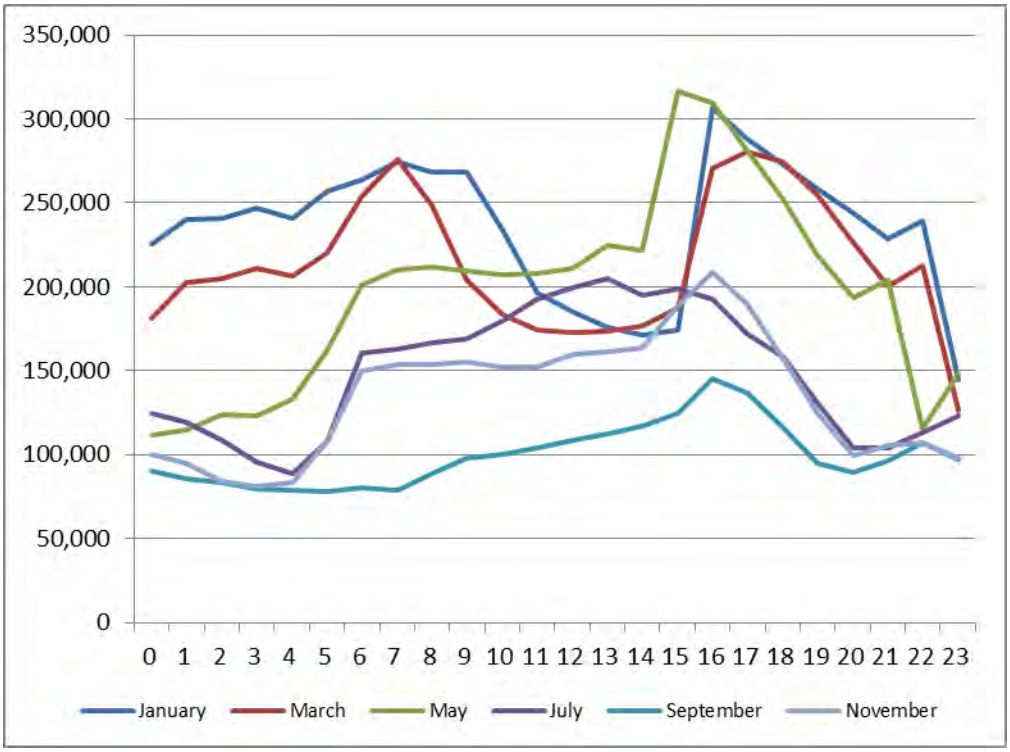
Typical Weekday Hourly Load by Month



AEP Ohio Industry and Peer Group Awards

Year	Award	Presenting Organization	Award Type/Category
2012	26th Annual MAME Award - Best on Site Outdoor Signage	BIA	Marketing Award
	Inspiring Efficiency Award Winner	Midwest Energy Efficiency Alliance (MEEA)	Marketing Award
	Partner of the Year Award - Energy Star New Homes Program	Energy Star	AEP Ohio/Columbia Gas New Homes Program
	Environmental Education	Solid Waste Authority of Central Ohio (SWACO)	Education
	1st Place - Best Outdoor Ad	Esource Utility Ad Award	Marketing program
	2nd Place - Best Ad Campaign	Esource Utility Ad Award	Marketing program
2013	Inspiring Efficiency Award Winner - e3Smart Program	MEEA	Education
	1st Place - Best Radio Ad	Esource Utility Ad Award	Marketing program
	Partner of the Year Award - Energy Star New Homes Program	Energy Star	AEP Ohio/Columbia Gas New Homes Program
	Certified Homes Leadership in Housing Award	Energy Star	AEP Ohio New Homes Program
2014	Gold Winner - Efficiency Crafted Branding Campaign	MARCOM Awards	Marketing/Promo Campaign/Brand Refresh
	Platinum Winner - Efficiency Crafted Website	MARCOM Awards	Website/Information
	Brill Award for Efficient IT - Chemical Abstract Service	Uptime Institute	
	Brill Award - Data Center Program	Uptime Institute	
	Inspiring Efficiency Award - AEP Ohio Water/Wastwater User Group	MEEA	Education Award
	Partner of the Year Award - Sustained Excellence Award	Energy Star	
	28th Annual MAME Awards - Exceptional Digital Design Campaign	BIA	Efficiency Crafted New Homes Program
	Most Successful One-Time Event	BIA	Efficiency Crafted New Homes Program
2015	Innovation Inspiring Efficiency Award - AEP Ohio CEI program	MEEA	
	AESP Outstanding Achievement for Marketing and Communication - Residential Community Energy Savers Pilot Program	Association of Energy Service Professionals (AESP)	Community Energy Savers Pilot Program
	Partner of the Year - Sustained Excellence Award	Energy Star	AEP Ohio/Columbia Gas New Homes Program
	MarCom Awards Platinum Winner - AEP Ohio TV spot series	MARCOM Awards	Marketing Program
	MarCom Awards Platinum Winner - AEP Ohio Radio Spots	MARCOM Awards	Marketing Program
	MarCom Awards Platinum Winner - AEP Ohio Energy Efficiency Awareness TV Campaign	MARCOM Awards	Marketing Program
2016	Innovation Inspiring Efficiency Award - AEP Ohio Bid4efficiency Program	MEEA	
	Partner of the Year - Sustained Excellence Award	Energy Star	AEP Ohio/Columbia Gas New Homes program
	Gold Award for Television Advertising/Series - AEP Ohio Energy Efficiency	Service Industry Advertising (SIA) Awards	
	Gold Award for Radio Advertising /Series - AEP Ohio Energy Efficiency	SIA Awards	
	Silver Award for Total Advertising Campaign - EfficiencyCrafted®	SIA Awards	
	ENERGY STAR® CERTIFIED Home Market Leader Award	EPA	

CERTIFICATE OF SERVICE

In accordance with Rule 4901-1-05, Ohio Administrative Code, the PUCO's e-filing system will electronically serve notice of the filing of this document upon the following parties. In addition, I hereby certify that a service copy of the foregoing Direct Testimony of Jon F. Williams was sent by, or on behalf of, the undersigned counsel to the following parties of record this 15th day of June, 2016, via electronic transmission.

/s/ Steven T. Nourse
Steven T. Nourse

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Case No(s). 16-0574-EL-POR

Summary: Testimony -Direct Testimony of Jon F. Williams on Behalf of Ohio Power Company electronically filed by Mr. Steven T Nourse on behalf of Ohio Power Company