OCC EXHIBIT NO. _____

BEFORE
THE PUBLIC UTILITIES COMMISSION OF OHIO

In the Matter of the Application of Duke Energy Ohio, Inc., for an Increase in Electric Distribution Rates.	)))	Case No. 17-0032-EL-AIR
In the Matter of the application of Duke Energy Ohio, Inc., for Tariff Approval.	))	Case No. 17-0033-EL-ATA
In the Matter of the Application of Duke Energy Ohio, Inc. for Approval to Change Accounting Methods.	))	Case No. 17-0034-EL-AAM
In the Matter of the Application of Duke Energy Ohio, Inc. for Approval to Modify Rider PSR.	)))	Case No. 17-0872-EL-RDR
In the Matter of the Application of Duke Energy Ohio, Inc. for Approval to Amend Rider PSR.	)))	Case No. 17-0873-EL-ATA
In the Matter of the Application of Duke Energy Ohio, Inc. for Approval to Change Accounting Methods.	)))	Case No. 17-0874-EL-AAM
In the Matter of the Application of Duke Energy Ohio, Inc. for Authority to Establish a Standard Service Offer Pursuant to Section 4928.143, Revised Code, in the Form of an Electric Security Plan, Accounting Modifications and Tariffs for Generation Service.	)))))))	Case No. 17-1263-EL-SSO
In the Matter of the Application of Duke Energy Ohio, Inc. for Authority to Amend Its Certified Supplier Tariff, P.U.C.O. No. 20.	))))	Case No. 17-1264-EL-ATA
In the Matter of the Application of Duke Energy Ohio, Inc. for Authority to Defer Vegetation Management Costs.	)))	Case No. 17-1265-EL-AAM

In the Matter of the Application of Duke Energy Ohio, Inc. to Establish Minimum Reliability Performance Standards Pursuant to Chapter 4901:1-10, Ohio Administrative Code.	)))))	Case No. 16-1602-EL-ESS

DIRECT TESTIMONY
OF
PAUL J. ALVAREZ
President, Wired Group

IN OPPOSITION TO THE JOINT STIPULATION AND RECOMMENDATION

On Behalf of
The Office of the Ohio Consumers' Counsel
65 East State Street, 7th Floor
Columbus, Ohio 43215-4213

June 25, 2018

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I. INTRODUCTION, QUALIFICATIONS, PURPOSE, AND PREVIEW

Q1. PLEASE STATE YOUR FULL NAME AND BUSINESS ADDRESS.

A1. My full name is Paul J. Alvarez. My business address is Wired Group, Post Office Box 150963, Lakewood, Colorado, 80215.

Q2. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?

A2. I am the President of the Wired Group, a consultancy specializing in distribution utility performance and value creation.

Q3. PLEASE DESCRIBE YOUR PROFESSIONAL AND EDUCATIONAL BACKGROUND.

A3. My career in the electric utility industry began 17 years ago with Xcel Energy, one of the largest investor-owned utilities in the United States. As product development manager for Xcel, I oversaw the development of electric demand-side management (DSM) programs for residential, commercial, and industrial customers, as well as programs and rates in support of voluntary renewable energy purchases and renewable portfolio standard compliance.

In 2008, I left Xcel to establish a utility practice for the boutique sustainability consulting firm MetaVu. At MetaVu, I led two comprehensive evaluations of smart grid deployment performance: an evaluation of the SmartGridCity™

deployment in Boulder, Colorado for Xcel Energy in 2010,[1] and an evaluation of the Duke Energy Ohio ("Duke") smart grid deployment for the Public Utilities Commission of Ohio ("PUCO") Staff in 2011.[2]

I started the Wired Group in 2012 to focus exclusively on distribution utility performance measurement and utility customer value creation. Since 2012, my team and I have completed detailed, formal reviews of grid modernization plans from 11 investor-owned utilities (IOUs) in regulatory proceedings, and less formal reviews of grid modernization plans from six other IOUs for clients outside of regulatory proceedings or out of professional interest. In addition to leading the Wired Group, I teach post-graduate courses based on my experience. Finally, I am the author of Smart Grid Hype & Reality: A Systems Approach to Maximizing Customer Return on Utility Investment. The book describes the challenges of translating smart grid investments into economic benefits for customers and offers organizational, operational, customer engagement, rate design, and regulatory solutions. The first edition was published in 2014, and the second edition was published earlier this year. I received an undergraduate degree in finance and marketing from Indiana University's Kelley School of

[1] Colorado PUC Case No. 11A-1001E, SmartGridCity™ Demonstration Project Evaluation Summary, Exhibit MGL-1 (filed Dec. 14, 2011).

[2] *In re Application of Duke Energy Ohio, Inc. to Adjust Rider DR-IM & Rider AU for 2010 SmartGrid Costs & Mid-Deployment Review*, Case No. 10-2326-GE-RDR, Duke Energy Ohio Smart Grid Audit and Assessment (June 30, 2011).

Business in 1983, and a master's degree in management from the Kellogg School at Northwestern University in 1991.

Q4. HAVE YOU TESTIFIED PREVIOUSLY BEFORE THE COMMISSION?

A4. No, but I have worked on behalf of the PUCO Staff. I led the evaluation team and prepared the report described above as the Duke Energy Ohio Smart Grid Audit and Assessment. This report is generally known as "the MetaVu report" or "the mid-term review" concerning Duke's first grid modernization project, portions of which are at issue in these cases. I also appeared before the PUCO in PowerForward Phase 2, making a presentation entitled "Getting a Smart Grid for Free."[3] The presentation focused on how to maximize the value of grid modernization investments with the goal of delivering benefits to customers in excess of costs, making it a "cost effective" deployment of advanced metering infrastructure.[4]

[3] *Getting a Smart Grid for Free* (July 26, 2017), *available at* https://www.puco.ohio.gov/puco/assets/File/12_Alvarez.pdf.

[4] *See* R.C. 4928.02(D) ("It is the policy of the state to ... [e]ncourage innovation and market access for cost-effective ... smart grid programs, and implementation of advanced metering infrastructure").

Q5. HAVE YOU TESTIFIED PREVIOUSLY BEFORE OTHER STATE UTILITY COMMISSIONS?

A5. Yes. I have testified regarding distribution business investments, benefits, costs, and performance measurement in cases before multiple state utility commissions, as shown in my full CV provided as Exhibit PJA-1 to this testimony.

Q6. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY?

A6. I am testifying on behalf of the Office of the Ohio Consumers' Counsel ("OCC") in opposition to the April 13, 2018 Stipulation and Recommendation filed in these cases (the "Settlement") and with recommendations for consumer protection.

I understand that the PUCO uses a three-prong test to evaluate whether to approve a settlement. It asks (i) was the settlement was the product of serious bargaining among capable, knowledgeable parties? (ii) does the settlement, as a package, benefit customers and the public interest? and (iii) does the settlement violate any important regulatory principle or practice? In addition to these three criteria, the PUCO also routinely considers whether the parties to the settlement represent diverse interest.

I have examined the direct testimony of Duke witnesses in this case, responses to OCC and other parties' discovery requests, and other relevant documents related to Duke's smart grid proposals in these cases. This includes Duke witness

Schneider's proposal for Duke to replace substantially all of its residential metering system, which consists of electric meters, gas meter data transmitters, and the associated communications network (hereafter referred to as the Echelon metering system, after the name of the electric meter manufacturer). Mr. Schneider refers to this plan as involving two phases, a preliminary "Business Continuity Effort" and a more comprehensive "AMI Transition Plan."[5]

Based on my review of Duke's proposed Business Continuity Plan, AMI Transition Plan, and the Settlement's communications network and billing system enhancement proposals, the Settlement does not benefit customers and thus fails the PUCO's three-prong test. The PUCO should reject the Settlement.

Q7. CAN YOU PLEASE SUMMARIZE YOUR RECOMMENDATIONS?

A7. Yes. I recommend that the PUCO reject the Settlement because it does not benefit customers, is contrary to the public interest, and violates regulatory principles and practices. Under the Settlement, Duke proposes to replace substantially all of its Echelon metering system—which it just finished installing just three years ago[6]—and to charge customers for the cost of the new system, which I project to be about $486 million.

[5] Case No. 17-1263-EL-SSO, Direct Testimony of Donald L. Schneider, Jr. on Behalf of Duke Energy Ohio, Inc. at 9-10, 12-16 (June 1, 2017) ("Schneider" or the "Schneider Testimony"). Mr. Schneider filed substantially the same testimony in Case No. 17-32-EL-AIR. I will generally refer to his SSO testimony.

[6] Case No. 16-1404-EL-RDR, Testimony of Peggy A. Laub on Behalf of Duke Energy Ohio, Inc., Attachment PAL-1, pg. 3, "Plant Additions by Month" (June 29, 2016) (Rider DR-IM calculation).

Specifically, the PUCO should not allow Duke to charge customers the proposed $28.6 million to replace its communications system,[7] the proposed $12.6 million in charges for data access ("billing system enhancements") under component two of the proposed PowerForward Rider (Rider PF),[8] or any other costs related to the Business Continuity Effort and AMI Transition Plan. (I will refer to these proposals and plans collectively as the proposed Echelon metering system replacement.) The PUCO should clarify that any investment to replace the Echelon metering system shall not be charged to customers through the PowerForward Rider (Rider PF), Distribution Capital Investment Rider (Rider DCI or DCI), or any other rider. I also recommend that Connect My Data standard compliance be required in place of any PUCO approval of billing system enhancement Phase 2.

Q8. CAN YOU PLEASE SUMMARIZE YOUR TESTIMONY IN SUPPORT OF YOUR RECOMMENDATIONS?

A8. Yes. I support my recommendations through three arguments:

1. The Settlement's smart grid proposals found primarily under the "Rider PF" heading in the Settlement, are vague and undefined. While the Stipulation specifies recovery of $41.2 million in costs, I estimate the Echelon metering

[7] *See* Settlement at 18 ("Cost recovery of the communications system shall not exceed $28,625,000.").

[8] *See* Settlement at 16-17, Attachment F.

system replacement, of which the stipulated communications network replacement and billing system enhancements are only an incomplete part, will cost customers over $486 million in total. It appears that despite citing only $41.2 million in upgrades for communications network replacement and billing system enhancements, it is Duke's intent to proceed with the full AMI Transition Plan without further PUCO approval.[9]

2. Duke has not demonstrated that Echelon metering system replacement is the most cost-effective way to fix existing metering system shortcomings, or even that the customer benefits of fixing the shortcomings will exceed customer costs. The "benefit-cost analysis" of the Echelon metering system replacement Duke supplied in Case No. 17-0032-EL-AIR (the "rate case") understates the cost to customers of replacing the metering system by $317 million and overstates the cost of maintaining the Echelon metering system by $76 million. The Settlement both harms customers and violates the used and useful principle.

[9] *See* Case No. 17-0032-El-AIR et al., Duke response to OCC-STIP-INT-05-109(b) (attached as exhibit PJA-5).

3. Before approving any metering system replacement, the PUCO should define, and make abundantly clear, functional requirements for new metering systems in Ohio (applicable to Duke) to reduce future financial risks to customers. Done properly, this will reduce the likelihood customers will have to pay for yet another non-functional system in the future.

Q9. PLEASE SUMMARIZE THE BACKGROUND CONCERNING DUKE'S CURRENT METERING SYSTEM AND PROPOSED REPLACEMENT.

A9. Duke finished installing its Echelon metering system just three years ago at a cost of several hundred million dollars, paid in part by Duke customers and in part by taxpayers. The system was subsidized by a $200 million grant from the U.S. Department of Energy as part of the American Reinvestment and Recovery Act of 2009. As described in OCC witness Alexander's testimony, the Echelon metering system has multiple shortcomings relative to Duke's promises in Case No. 07-0589-EL-SSO; relative to Duke's promises in the approved settlement in Case No. 10-2326-GE-RDR; and relative to metering systems installed by other large utilities at the same time Duke installed its Echelon metering system.[10]

[10] *See* Testimony of Barbara Alexander on behalf of the Office of the Ohio Consumers' Counsel (June 25, 2018) (the "Alexander Testimony").

In its initial business case for the Echelon metering system, Duke claimed that the metering system would last 20 years and provided a 20-year benefit-cost analysis based on this claim.[11] Now, though the average age of the Echelon metering system is just six to seven years,[12] Duke is proposing to replace it—at a cost of around $486 million—to correct two primary shortcomings:

1. The Echelon metering system's 140,000 communication nodes use a cellular standard (2G/3G) which Verizon Wireless will allegedly discontinue by 2022; and

2. The number of customers for whom billing-quality, customer energy usage data (CEUD) is available is extremely limited.

I agree with OCC witness Alexander's assessment that customers should not be responsible for paying to correct these and other shortcomings of the Echelon metering system Duke designed and installed with full knowledge of the PUCO and customer performance expectations.[13]

[11] Case No. 07-0589-GA-AIR, Direct Testimony of Christopher D. Kiergan on Behalf of Duke Energy Ohio at 11:11 (July 28, 2008) (the "Kiergan Testimony").

[12] Case No. 17-0032-EL-RDR, Duke's response to OCC-INT-02-044 (regarding Rider DR-IM cost recovery by year) (attached as exhibit PJA-6).

[13] *See* Alexander Testimony.

However, my testimony focuses specifically on the replacement cost issues I believe the PUCO should take into account when considering charges to customers for meter communications network replacement ($28.6 million) and billing system enhancements ($12.6 million) proposed in the Settlement, plus hundreds of millions of dollars more required to complete the full replacement of Duke's Echelon metering system, which harms customers and is not in the public interest.

II. DUKE IS USING STIPULATED APPROVAL OF THE COMMUNICATIONS NETWORK REPLACEMENT AND BILLING SYSTEM ENHANCEMENTS AS THE BASIS TO EXECUTE A $486 MILLION ECHELON METERING SYSTEM REPLACEMENT AT CONSUMER EXPENSE.

Q10. HOW MUCH DOES DUKE PROPOSE TO CHARGE CUSTOMERS FOR ECHELON METERING SYSTEM REPLACEMENT UNDER THE PROPOSED SETTLEMENT?

A10. The Settlement identifies $28.6 million in metering communications system replacement costs and $12.6 million in billing system enhancements. However, I believe these estimates are grossly incomplete and misleading.

Q11. WHY IS THE SETTLEMENT PROPOSAL TO ALLOW DUKE TO RECOVER $28.6 MILLION IN METERING COMMUNICATIONS SYSTEM REPLACEMENT AND $12.6 MILLION IN BILLING SYSTEM ENHANCEMENTS GROSSLY INCOMPLETE AND MISLEADING?

A11. In the rate case, Duke proposed to spend $169.2 million[14] to replace the Echelon metering system it finished installing just a few years ago. Duke claims the Echelon metering system must be replaced to: 1) avoid the cost of upgrading the metering communication system's 140,000 communication nodes from 2G/3G cellular to 4G cellular by 2022; and 2) to increase the number of customers for whom billing-quality, customer energy usage data (CEUD) is available.[15] However, it is clear from discovery that replacing the meter communications system and completing proposed billing system enhancements will not accomplish these objectives. To accomplish these objectives Duke is also proposing to replace 626,000 Echelon electric meters and 419,000 gas meter data transmitters[16] in what Duke witness Schneider calls the Business Continuity Effort (the first 23,700 of the existing meter communications nodes, the first 80,000 of the electric meters, and the first 48,800 of the gas meter data

[14] Schneider Testimony, Attachment DLS-1.

[15] *Id.* at 14:4-9.

[16] *Id.* at 9:1-3.

transmitters)[17] and the AMI Transition Plan (the balance of the nodes, meters, and transmitters).[18]

The Settlement makes no mention of the Business Continuity Effort or the AMI Transition Plan. The Settlement, however, does state that the third component of the proposed PowerForward rider is "an infrastructure modernization plan, which will be filed in a separate proceeding and subject to hearing."[19] When I first reviewed the Settlement, I interpreted this to mean that any further grid modernization efforts beyond the $41.2 million for metering communications system and billing system upgrades would be part of this future proceeding. In other words, Duke would not be allowed to charge customers for the Business Continuity Effort or AMI Transition Plan unless it obtained future PUCO approval.

But through discovery, Duke admitted that it intends to proceed with full Echelon metering system replacement, to include not only the communications system replacement and billing system enhancements specified in the Stipulation, but also all the Echelon electric meters and gas meter data transmitters as proposed in Duke witness Schneider's testimony in the rate case. According to Duke, "The Ohio AMI Transition will proceed as proposed in the Testimony of Donald

[17] *Id.* at 10:10-17.

[18] *Id.* at 13:14-18.

[19] Settlement at 17.

Schneider, while component three of the PowerForward Rider will require a separate proceeding and subject to hearing."[20] So not only is Duke planning to charge customers $41.2 million now, it is also planning to charge them for the entire AMI Transition Plan—at a cost of hundreds of millions of dollars—and then, it will file yet *another* proceeding for *another* grid modernization plan with additional unknown costs to customers.

Q12. SO, IF THE COMMISSION APPROVES THE $41.2 MILLION COST FOR METERING COMMUNICATION SYSTEM REPLACEMENT AND BILLING SYSTEM ENHANCEMENTS, YOUR TESTIMONY IS THAT THE TWO SHORTCOMINGS STILL WON'T BE FIXED, AND TO DO SO WILL ULTIMATELY COST CUSTOMERS $169 MILLION?

A12. No, the situation is dramatically worse than that for customers. Duke projects the total (nominal) cost to replace the Echelon metering system to be $169 million. However, my examination of Duke's cost projection indicates that the ultimate cost to customers of Echelon metering system replacement will be over $486 million, not $169 million. The Settlement's consideration of a $41.2 million meter communications network replacement and billing system enhancements is therefore grossly incomplete and misleading by a factor of more than ten ($486 million divided by $41 million). The PUCO needs to understand that if the Settlement is approved as is, Duke will use such approval as the basis to execute a

[20] Case No. 17-32-EL-AIR, Duke's response to OCC-STIP-INT-03-073(a) (attached as Exhibit PJA-7).

$486 million Echelon metering system replacement proposal that is not actually presented in the Settlement. And then, apparently, Duke will file another grid modernization plan under component three of the PowerForward rider, which will presumably cost customers many tens or hundreds of millions of dollars more.

With so many unknowns and priorities likely to come up as part of the PowerForward proceeding and in any event, the PUCO must carefully pick and choose investments that customers will be asked to pay, weighing benefits relative to costs and whether the services are used and useful and resulted in prudent expenditures. The proposed metering system replacement is no exception, and with its exorbitant costs, must be rigorously scrutinized.

III. THE SETTLEMENT VIOLATES REGULATORY PRINCIPLES AND PRACTICES BECAUSE DUKE HAS NOT DEMONSTRATED THAT THE ECHELON METERING SYSTEM REPLACEMENT IS THE MOST COST-EFFECTIVE WAY TO FIX SYSTEM SHORTCOMINGS, OR EVEN THAT THE CUSTOMER BENEFITS OF FIXING THE SHORTCOMINGS WILL EXCEED CUSTOMER COSTS.

Q13. WHAT IS YOUR OVERALL ASSESSMENT OF DUKE'S PROPOSAL TO REPLACE THE ECHELON METERING SYSTEM?

A13. First, I believe the "Benefit-Cost Analysis" Duke submitted to be fundamentally flawed when viewed from a consumer perspective. Customers will ultimately pay almost three times the cost ($486 million) Duke projects ($169 million) to replace the Echelon metering system. Duke also overstates by $76 million the cost of continuing its Echelon metering system. My calculations indicate that customers will be better off if Duke maintains the Echelon metering system, on both a nominal and net present value ("NPV") basis.

Second, Duke has not rigorously evaluated any of several potentially less costly alternatives that might be available to address the two primary shortcomings of the Echelon metering system: 1) to avoid the cost of upgrading the metering communication system's 140,000 communication nodes from 2G/3G cellular to 4G cellular by 2022; and 2) to increase the number of customers for whom billing-quality CEUD is available. I will describe several such options Duke does not appear to have evaluated.

Finally, Duke's "Benefit-Cost Analysis" simply assumes the Echelon metering system must be replaced, and compares the cost of replacing it to the cost of maintaining it in place. It does not even attempt to calculate the benefits to customers of the proposed new system. A reasonable benefit-cost analysis would compare the incremental customer benefits from replacing the Echelon metering

system to the incremental customer costs of replacing the system. Duke has not provided any analysis indicating whether incremental customer benefits will exceed customer costs. Based on available experience and research, I do not believe a reasonable benefit-cost analysis of Duke's Echelon metering system replacement would indicate customer benefits in excess of customer costs.

A. THE "BENEFIT-COST ANALYSIS" DUKE SUBMITTED WITH ITS ECHELON METERING SYSTEM REPLACEMENT PROPOSAL IS FUNDAMENTALLY FLAWED AND THUS HARMS CUSTOMERS, IS NOT IN THE PUBLIC INTEREST, AND VIOLATES IMPORTANT REGULATORY PRINCIPLES AND PRACTICES.

Q14. WHY DO YOU BELIEVE DUKE'S $169 MILLION ECHELON METERING SYSTEM REPLACEMENT COST PROJECTION TO BE UNDERSTATED BY $317 MILLION?

A14. Duke has ignored many types of costs customers will be forced to pay if the PUCO approves Duke's Echelon metering system replacement proposal. The table below lists the costs Duke's projection ignores, and quantifies the amounts in nominal and net present value terms (using a 7.54% discount rate)[21] over 15

[21] *See* Settlement at 7 ("Overall Rate of Return").

years (the Average Service Life of the new system).[22] The carrying charge on the book value of assets to be retired prematurely if the Echelon metering system replacement proceeds is calculated over ten years per the PUCO Staff's recommendation.[23]

Table 1: Customer costs ignored in Duke's metering system replacement projection

($ in millions) Customer Cost Ignored in Duke's Projections	**Net Present Value**	**Nominal Value**
AMI Business Continuity Effort Capital Spending[24]	$ 24.136	$ 24.136
Book Value of Equipment to be Retired Prematurely[25]	125.011	144.874
Carrying Charge on "AMI Transition Plan" Capital	55.847	86.023
Carrying Charge on "AMI Business Continuity Effort" Capital	10.143	14.519
Carrying Charge on Book Value of Equipment to be Retired Prematurely (10 years, not 15 per Staff Report)	40.326	56.025
AMI Business Continuity Effort O&M Spending[26]	0.061	0.061
TOTALS (does not foot exactly due to rounding)	$255.523	$325.638

The Net Present Value calculations can be found in Exhibit PJA-2; the Carrying Charge calculations can be found in Exhibit PJA-3; and the Net Book Value calculations can be found in Exhibit PJA-4, all of which are attached to this testimony.

[22] Case No. 17-32-EL-AIR, Schedule B-3.2, page 2, line 20, "Utility of the Future Meters," column "Average Service Life".

[23] Case No. 17-32-EL-AIR, PUCO Staff Report of Investigation at 11 (Sept. 26, 2017) (the "Staff Report").

[24] Case No. 17-32-EL-AIR, Duke's response to OCC-INT-09-184(a) (attached as Exhibit PJA-8).

[25] Exhibit PJA-4.

[26] Exhibit PJA-8.

Q15. WHY SHOULD THE AMI BUSINESS CONTINUITY EFFORT CAPITAL SPENDING BE INCLUDED IN METERING SYSTEM REPLACEMENT COSTS?

A15. The Business Continuity Effort is indistinguishable from the AMI Transition Plan. Both involve the replacement of the existing metering communications network nodes, electric meters, and gas meter data transmitters, so both types of cost should be included in any metering system replacement analysis. Duke's $169.2 million projection for AMI Transition Plan costs did not include Business Continuity Effort costs.[27] Failing to include Business Continuity Effort costs underestimates the cost of Echelon metering system replacement customers will ultimately be forced to pay if approved by the PUCO.

Q16. WHY SHOULD THE BOOK VALUE OF EQUIPMENT THAT IS PREMATURELY BEING RETIRED BE INCLUDED IN ECHELON METERING SYSTEM REPLACEMENT COSTS?

A16. According to the original smart meter business case in Case No. 07-0589-GA-AIR, the Echelon metering system was projected to deliver benefits to customers for 20 years.[28] Now, at an average age of about one-third of that,[29] Duke is proposing to retire the Echelon metering system. Customers are being deprived

[27] Schneider Testimony, Attachment DLS-1.

[28] Kiergan Testimony at 11:11.

[29] Exhibit PJA-6.

of two-thirds of the useful life of a metering system they will continue to (but should not) pay for in rates until 2031 (ten years from the date the last of the Echelon metering system is replaced if approved).[30] If customers are being asked to reimburse Duke's capital expense, profits, and federal income taxes, on equipment to be removed from service prematurely at Duke's request, ignoring such costs in a metering system replacement analysis is not justified. Furthermore, asking customers to pay for Echelon meters which have been removed from service is a clear violation of the "used and useful" principle. Indeed, the Massachusetts Department of Public Utilities recently rejected the smart meter deployments of all three investor-owned utilities in that state, citing the high cost of prematurely-retired assets as a primary consideration.[31] Failing to include the cost of prematurely-retired equipment underestimates the cost of Echelon metering system replacement that customers will ultimately be forced to pay if approved by the PUCO.

Q17. WHY SHOULD CARRYING CHARGES BE INCLUDED IN ECHELON METERING SYSTEM REPLACEMENT COSTS?

A17. Duke's Echelon metering system replacement cost projections do not include carrying charges that customers will have to pay.[32] Duke profits, federal income

[30] Staff Report at 11.

[31] Massachusetts Department of Public Utilities, DPU 15-120, 15-121, 15-122, Order at 121-22 (May 10, 2018).

[32] Case No. 17-32-EL-AIR, Duke's response to OCC-INT-02-007(f) (attached as Exhibit PJA-9).

taxes on Duke profits, and interest expense on Duke debt, are all carrying charges ultimately paid by customers. Failing to include carrying charges underestimates the cost of Echelon metering system replacement that customers will ultimately be forced to pay if approved by the PUCO.

Q18. YOU CLAIMED EARLIER THAT YOUR ECHELON METERING SYSTEM REPLACEMENT COST ESTIMATE WAS $317 MILLION HIGHER THAN DUKE'S PROJECTION. WHY IS THAT SO?

A18. Duke's "Benefit-Cost Analysis" used a 20-year benefit-cost period. Based on the experience with the Echelon metering system (6-7 year service life if replacement is approved), the Staff Report (15-year service life),[33] and Duke's own depreciation schedule (15-year service life),[34] I consider 15 years to be a better estimate of the new system's service life, and therefore a more appropriate benefit-cost time period. As indicated above, I used a 15-year period to calculate the table. To compare "apples to apples," I recalculated Duke's cost projection including only 15 years' cost, not 20 years' cost, from details provided by Duke in discovery.[35] Removing five years' costs from Duke's cost projection resulted in a nominal cost reduction of $8.455 million. The reconciliation is: $325.637 million

[33] Staff Report at 11.

[34] Case No. 17-0032-EL-AIR. Schedule B-3.2, page 2, line 20, "Utility of the Future Meters", column "Average Service Life".

[35] Case No. 17-32-EL-AIR, Duke's response to OCC-INT-02-009(a) (attached as Exhibit PJA-10).

in nominal cost increases less $8.455 million in nominal cost decreases results in a $317.182 million net increase above Duke projections.

Q19. WHY DO YOU BELIEVE DUKE OVERSTATED (BY $76 MILLION) THE COST OF CONTINUING THE ECHELON METERING SYSTEM?

A19. In its "Benefit-Cost Analysis," Duke projects that it would cost $326.2 million (in nominal dollars) to continue the Echelon metering system but only $169.2 million (in nominal dollars) to complete the AMI Transition Plan.[36] As I have already described above, the $169.2 million projection grossly underestimates the cost of replacing Duke's Echelon metering system under the proposed Business Continuity Effort and AMI Transition Plan. At the same time, however, Duke's $326.2 million projected cost of maintaining the Echelon metering system is overstated by $76 million.

Duke calculated the $326.2 million cost to continue its current node-based meter communications system using a 20-year benefit period, despite the fact that the average service life of the new metering system is only 15 years (see immediately preceding paragraph). I note that in the original smart meter benefit-cost analysis Duke submitted in Case No. 07-0589-GA-AIR, Duke also used a 20-year period to calculate benefits for meters which Duke depreciated over an average service life of only 15 years. These are the same meters it is now proposing to replace

[36] Schneider Testimony, Attachment DLS-1.

after just 6-7 years.) The period used to calculate cost avoidance should be the same as the average service life of the replacement metering system, as the replacement metering system may not avoid costs for customers beyond its average service life. I recalculated Duke's projection using 15 years' cost avoidance, not 20 years' cost avoidance, from details provided by Duke in discovery.[37] Removing five years' cost avoidance from Duke's cost projection resulted in a nominal benefit reduction of $76.7 million, consisting of reductions in several types of avoided cost benefits as indicated in the table below. Details of the 15-year benefit calculations are available in Exhibit PJA-2 attached to this testimony.

Table 2: Reductions in Avoided Cost Benefits Resulting from a 5-year Reduction in the Benefit Period

($ in millions) **Reductions in Avoided Cost Benefits By Eliminating Benefit Years 16-20**	**15-Year Nominal Value**	**20-Year Nominal Value[38]**	**Benefit Over-statement**
NES Headend Upgrades not avoided	$ 7.944	$ 10.589	$ 2.645
Cellular Data Backhaul Costs not avoided	22.992	33.217	10.225
Communications Device Failure Cost not avoided	71.772	118.384	46.612
Vendor Maintenance Cost not avoided	38.789	56.039	17.250
TOTALS	$141.497	$218.229	**$76.732**

[37] Exhibit PJA-10.

[38] Schneider Testimony, Attachment DLS-1.

Q20. CAN YOU PROVIDE A SUMMARY COMPARING YOUR VERSION OF DUKE WITNESS SCHNEIDER ATTACHMENT DLS-1 TO THE ORIGINAL?

A20. Yes. Please see the table below. Making the adjustments described in the above testimony, the nominal cost Duke projects for Echelon metering system replacement balloons from $169.2 million to $486 million, far in excess of the cost to maintain the Echelon metering system of $249.5 million. The figures on a net present value basis are just as striking, as the proposal cost Duke projects balloons from $134.7 million to $388.6 million, far in excess of the cost to maintain the Echelon metering system of $172.8 million. To summarize, Duke's proposed Echelon metering system replacement is not the most cost-effective way to address the shortcomings of that system, evaluated on either a nominal or net present value basis.

Q21. GIVEN YOUR ANALYSIS, WHAT DO YOU CONCLUDE ABOUT DUKE'S PROPOSAL TO REPLACE THE ECHELON METERING SYSTEM?

A21. My analysis indicates Duke's proposal to replace the Echelon metering system harms customers. Further, Staff's recommendation that prematurely retired Echelon meters be amortized in rates over a 10-year period violates the used and useful principle. These are reasons enough to reject the Settlement, but there are others I cover in the rest of my testimony.

Table 3: Summary of Recommended Adjustments to Metering System Replacement Cost Analysis

Total (All Electric and Gas Costs)						
Discount Rate (DEO before tax)	**7.54%**	(Per STIP dated April 13, 2018. Page 7.	(Exh. PJA-2)	(Exh. DLS-1)	(Exh. PJA-2)	(Exh. DLS-1)
			OCC NPV (15 years)	**Duke NPV (20 years)**	**OCC Nominal (15 years)**	**Duke Nominal (20 years)**
	A. Continue Node Environment (Benefits of Metering System Replacement)					
	O&M	4G Communication Node Upgrade	78,966,119	78,694,632	91,162,500	91,162,500
		EDMS to MDM Conversion	14,177,147	14,140,117	15,800,000	15,800,000
		Long-term Communication Node Solution	929,887	928,247	1,000,000	1,000,000
		NES Headend Upgrades	5,677,870	5,123,981	7,943,599	10,589,310
	-	Monthly Cellular Cost	12,971,408	15,487,719	22,991,529	33,216,510
	-	Communication Device Failures	38,166,258	49,779,269	71,772,140	118,383,860
	-	Vendor Maintenance	21,884,016	26,129,276	38,788,928	56,039,456
			172,772,705	**190,283,241**	**249,458,696**	**326,191,636**
	B.1. Transition to Mesh Environment (Costs of Metering System Replacement)					
	Capital	Ohio AMI Transition	123,737,702	123,299,685	143,398,848	143,398,848
	O&M	Monthly Cellular Cost	5,302,259	6,418,755	9,704,845	14,237,970
		Communication Device Failures	274,337	372,557	536,810	930,746
		Vendor Maintenance	3,745,063	4,615,356	7,115,800	10,644,198
			133,059,361	**134,706,353**	**160,756,303**	**169,211,762**
	B.2. Costs Duke Failed To Include In Transition to Mesh Environment					
	Capital	Business Continuity Effort (OCC-INT-09-184 in 17-0032)	24,136,045	24,136,045	24,136,045	24,136,045
(see Exh. PJA-4)	Capital	BV meters/data transmitters retired early	125,010,893	125,010,893	144,874,341	144,874,341
(see Exh. PJA-3)	Carrying Charges	on "Ohio AMI Transition" Capital	55,846,923	55,846,923	86,022,733	86,022,733
"	Carrying Charges	on "Business Continuity Effort" Capital	10,143,153	10,143,153	14,519,167	14,519,167
"	Carrying Charges	on meters/data transmitters retired prematurely per April 13 Stip	40,325,710	40,325,710	56,024,959	56,024,959
	O&M	Business Continuity Effort (OCC-INT-09-184 in 17-0032)	60,506	60,506	60,506	60,506
			255,523,231	**255,523,231**	**325,637,752**	**325,637,752**
	Total Cost of Transition to Mesh Environment (B.1 + B.2)		**388,582,591**	**390,229,584**	**486,394,054**	**494,849,514**

B. DUKE HAS NOT RIGOROUSLY EVALUATED ANY OF SEVERAL POTENTIALLY LESS COSTLY ALTERNATIVES THAT MIGHT BE AVAILABLE TO ADDRESS THE PRIMARY SHORTCOMINGS OF THE ECHELON METERING SYSTEM

Q22. DID DUKE RIGOROUSLY EVALUATE OTHER, POTENTIALLY LESS COSTLY ALTERNATIVES THAT MIGHT BE AVAILABLE TO ADDRESS THE PRIMARY SHORTCOMINGS OF THE ECHELON METERING SYSTEM FOR THE BENEFIT OF CONSUMERS?

A22. No. In discovery, when asked for the cost analyses for several types of alternative solutions my experience indicates might be reasonable, Duke replied that it had not prepared cost analyses for any of the types of alternatives I described.

Q23. WHAT TYPES OF ALTERNATIVE SOLUTIONS DID YOU CONSIDER?

A23. One example I can cite is the potential use of Duke's existing Energy Data Management System (EDMS) for billing-quality CEUD. EDMS is a database offered by Oracle to manage the data from existing electric meters. Although EDMS could have performed the Validation, Estimation, and Editing ("VEE") software routines required to produce billing-quality data, Duke simply chose not to purchase this capability.[39] Thus, the current barrier to generating billing-quality

[39] Case No. 17-32-EL-AIR, Duke's response to OCC-INT-02-036 (attached as Exhibit PJA-11).

CEUD for large numbers of customers is self-imposed by Duke and is unrelated to Duke's Echelon electric meters or communications network.

Due to EDMS VEE limitations, Duke has been installing new Itron smart meters for residential customers with "special" billing needs, such as those on residential time-of-use rates. Data from Itron smart meters is routed to a different Oracle database, the Meter Data Management (MDM) system, because it does offer the sophisticated VEE software routines required for billing-quality CEUD. It is possible that a translation program could be written to "map" the individual elements from an EDMS data record into the corresponding elements in an MDM-compatible data record, at potentially a much lower cost to consumers. From there, MDM's VEE routines could deliver billing-quality CEUD without having to change out the existing communications network, electric meters, and gas meter data transmitters. In fact, this is precisely how Duke developed bills for customers in its time of use ("TOU") pilot programs using the Echelon metering system.[40] Yet Duke appears not to have considered this option at all and did not evaluate whether such an approach would be more cost-effective for customers while still providing them the same capabilities.[41] If the PUCO were to reject Echelon metering system replacement, Duke would have ample incentive to consider less costly solutions.

[40] Case No. 17-32-EL-AIR, Duke's response to OCC-INT-06-124 (attached as Exhibit PJA-12).

[41] Case No. 17-32-EL-AIR, Duke's response to OCC-INT-02-021 (attached as Exhibit PJA-13).

As another example, Duke could evaluate if customized VEE software routines could be written for EDMS, thereby delivering billing-quality CEUD without having to replace the Echelon metering system. Again, Duke did not even consider this option or what it might cost compared to Duke's proposal to replace the Echelon metering system.

To summarize, I've described at least three alternatives (purchase EDMS VEE; translate meter data from EDMS format into MDM-compatible format for VEE; or custom-build a VEE routine for EDMS) to providing billing-quality CEUD without replacing the Echelon metering system at a cost to customers of $486 million. Duke did not consider any of these options, or any others.[42] It simply decided on a capital-intensive approach of replacing the Echelon metering system in advance of the end of their useful lives. Duke's proposal is not likely the least-cost approach and does not benefit Duke customers; it would harm customers. Duke's proposal does benefit Duke shareholders, at customer expense.

[42] *Id*. *See also* Schneider Deposition at 61:14-17 (transcript filed Jan. 17, 2018) ("Q. What alternatives did Duke consider to this node upgrade. A. We didn't really consider any other alternatives.").

Q24. DO YOU HAVE ANY OTHER EXAMPLES OF POTENTIAL ALTERNATIVE SOLUTIONS FOR WHICH DUKE DID NOT COMPLETE A COST ANALYSIS?

A24. Yes. The meter communications network replacement proposal offers another good example. There are many ways for a utility to read its meters wirelessly. Plausible alternatives to upgrading 140,000 meter communications network nodes to 4G cellular from 2G/3G cellular, or to replacing 626,000 electric meters and 419,000 gas meter data transmitters, include:

1. Replacing the communications network cards in the existing electric meters with cards that could communicate directly with the public 4G cellular network (as Duke currently does for nearly 12,000 of its Ohio meters);[43]
2. Replacing the communications network cards in the existing electric meters with cards that could be read by the new Cisco Connected Grid Routers;
3. Replacing the communications network, including the communications cards in the existing electric meters, with the private 4G LTE network now supported by Ericsson (Ericsson acquired Ambient, the manufacturer of the existing meter communications network nodes, out of bankruptcy in 2014).

[43] Case No. 17-32-EL-AIR, Duke's response to OCC-STIP-INT-05-127 (attached as Exhibit PJA-14).

Again, Duke did not consider any of these options.[44]

Q25. ARE YOU RECOMMENDING THAT DUKE IMPLEMENT THESE ALTERNATIVES TO ADDRESS SHORTCOMINGS IN ITS ECHELON METERING SYSTEM?

A25. No. These are only examples of potential solutions Duke should be considering. These examples demonstrate that Duke's replacement proposal is not the only way to address the shortcomings of the Echelon metering system. A variety of viable, less capital-intensive alternatives should be fully examined before the PUCO approves a proposal. This is especially true because the solution Duke has chosen will end up costing customers an additional $486 million. Protection of consumers warrants consideration of options that could result in lower charges on their electric bills.

Q26. WHAT ARE THE IMPLICATIONS OF DUKE'S FAILURE TO EVALUATE ANY OF SEVERAL ALTERNATIVES LESS COSTLY THAN ECHELON SYSTEM REPLACEMENT?

A26. Duke has not proven that its proposal to replace the Echelon metering system benefits customers or is in the public interest. Further, Staff's recommendation that prematurely retired Echelon meters be amortized in rates over a 10-year

[44] Exhibit PJA-9 (Duke's response to OCC INT-02-007(c)).

period violates the used and useful principle. The used and useful principle protects customers from being charged for assets that are not being used.

C. DUKE'S "BENEFIT-COST ANALYSIS" SIMPLY ASSUMES THE ECHELON METERING SYSTEM MUST BE REPLACED, COMPARING THE COST OF REPLACING IT TO THE COST OF MAINTAINING IT IN PLACE. THIS IS NOT A REASONABLE, CUSTOMER-ORIENTED BENEFIT-COST ANALYSIS, THOUGH NO SUCH ANALYSIS IS LIKELY TO SHOW SYSTEM REPLACEMENT TO BE ECONOMICALLY FAVORABLE TO CUSTOMERS.

Q27. WHAT IS YOUR DEFINITION OF A CUSTOMER-ORIENTED BENEFIT-COST ANALYSIS?

A27. A customer-oriented benefit-cost analysis should compare the incremental, economic benefits of an action to customers to the incremental costs of that action to customers. This is consistent with Ohio Revised Code 4928.02(D), which specifies that it is state policy to encourage "cost effective . . . implementation of advanced metering infrastructure."

Q28. ISN'T THAT WHAT DUKE PROVIDED IN WITNESS SCHNEIDER'S ATTACHMENT DLS-1?

A28. No. DLS-1 simply compares the cost of maintaining the Echelon metering system in place for 20 years to the cost of replacing it.[45] DLS-1 is therefore just a cost comparison and, as described earlier in this testimony, it understates the cost of replacement and overstates the cost of maintaining the Echelon metering system. DLS-1 does so to such an extent that it masks the fact that replacing the Echelon metering system represents an economic harm to consumers. DLS-1 also ignores costs which would violate the used and useful principle, which protects customers from being charged for assets (Echelon meters) removed from service.

Q29. IN YOUR OPINION, WHAT WOULD BE REQUIRED TO UPGRADE ATTACHMENT DLS-1 TO A CUSTOMER-ORIENTED COST BENEFIT ANALYSIS?

A29. First, I believe Duke would need to complete a rigorous analysis of all potential options available to deliver the benefits it proposes to deliver, proposing the most cost-effective option evaluated. As described above, this is missing from Duke's "benefit-cost analysis." The determination of the most cost-effective options must involve consideration of all costs, including the cost of any replacement already completed (the business continuity effort); assets for which customers are

[45] *See* Deposition of Donald Schneider at 57:12-18 (transcript filed Jan. 17, 2018) (acknowledging that attached DLS-1 "does not purport to compare the benefits" of the AMI Transition Plan to the benefits of maintaining the Echelon metering system).

paying in rates but will be unable to use (prematurely-retired assets); and carrying charges customers will be forced to pay. As described earlier, these are also missing from Duke's "benefit-cost analysis".

Q30. WHAT ABOUT INCREMENTAL BENEFITS? SHOULDN'T THOSE ALSO BE INCLUDED IN A CUSTOMER-ORIENTED BENEFIT-COST ANALYSIS?

A30. Yes, incremental benefits should also be included in a customer-oriented benefit-cost analysis. However, as described in OCC witness Alexander's testimony, many of the benefits that Duke promises from its AMI Transition Plan are the same benefits that Duke promised in Case No. 07-0589-GA-AIR and 10-2326-GE-RDR, but still have not been delivered to customers.[46] As these benefits should already have been delivered to customers, it would be unfair to count them as benefits to customers from Duke's proposal to replace the Echelon metering system. Moreover, customers should not be expected to pay for Duke's smart grid deployment that did not benefit customers as promised and is now proposed to be replaced.

[46] *See* Alexander Testimony.

Q31. WOULDN YOU AGREE THAT BILLING-QUALITY CEUD, AND THE TIME-VARYING RATES ENABLED, OFFER POTENTIAL ECONOMIC BENEFITS TO DUKE CUSTOMERS?

A31. I think the key word there is "potential." While I believe there is potential for time-varying rates to be valuable in theory, in practice they have been a complete failure for delivering benefits to Duke's customers in excess of costs.

Q32. PLEASE EXPLAIN WHY YOU BELIEVE TIME-VARYING RATES HAVE FAILED TO DELIVER BENEFITS TO CUSTOMERS IN EXCESS OF COST.

A32. There are three determinants to the size of benefits from time-varying rates:

Time-Varying Rate Benefit Size	=	Value of System Peak Capacity Cost Avoidance ($/MW)	X	Number of Customers Participating in Such Rates	X	Size of Behavior Change per Participating Customer

All of these determinants are problematic in Duke's current situation, and indeed in many utilities' situations. As a result, any metering system replacement costing $486 million would be very unlikely to deliver benefits in excess of costs for customers.

Q33. WHY IS THE VALUE OF SYSTEM PEAK CAPACITY COST AVOIDANCE PROBLEMATIC?

A33. Two reasons. First, excess capacity in the PJM market has driven capacity prices down, making time-varying rates designed to reduce system peak less beneficial. Second, not all time-varying rates reduce demand at system peak. There is no research indicating that the most popular time-varying rates offered by competitive retail electric suppliers ("marketers") in other markets, such as "Free Saturdays," reduce system peak demand.

Q34. BUT WHAT ABOUT THE NEW ENERGY AND CAPACITY MARKET SETTLEMENT PROCESSES PROPOSED IN DUKE WITNESS NICHOLSON'S TESTIMONY? WON'T THAT ENCOURAGE MARKETERS TO OFFER RATES THAT REDUCE SYSTEM PEAK?

A34. Perhaps. But marketers can also cover high settlement costs for their customers by raising rates per kWh. Getting customers to participate in rates that actually reduce system peak is a huge challenge. In fact, such rates are so unattractive to most customers that the marketing cost to recruit them swallows up much or most of the available economic benefit potential. My experience as a product developer and product manager confirms these difficulties. Products and services which make consumers' lives easier or more convenient, from smart phones to Amazon.com, have a history of success. Time-varying rates are more complex for consumers, and require more time and effort to manage. These time-varying

rate attributes are the antithesis of easy and convenient, which is why time-varying rates designed to reduce system peak are such a tough sell to consumers and of such low benefit in a smart meter benefit-cost analysis.

Q35. WHAT EVIDENCE DO YOU HAVE THAT CUSTOMER PARTICIPATION RATES ARE PROBLEMATIC?

A35. Probably the most compelling is Duke's own experience with time-varying rates in Ohio. The pilots conducted in 2011 secured only 619 participants,[47] and Duke proposed to cancel its optional "TD" (Time of Day) residential rate without complaint.[48] Research indicates Duke's experience is not unique. In a study of 12 large smart meter deployments nationwide, an average participation rate in voluntary time-varying rate programs of less than 15% was observed.[49] Regulators are beginning to question the viability of smart metering investments given the questionable value of time-varying rates. The Massachusetts Department of Public Utilities recently rejected the smart meter deployments of all three investor-owned utilities in that state, citing uncertainty surrounding the value of time-varying rates in a retail choice state as a primary consideration.[50] It

[47] *Overview of Duke Energy Ohio's Experience with Time Differentiated Rates.* Duke Energy Ohio presentation to the Ohio Smart Grid Collaborative. Slide 10. May 24, 2012 (attached as Exhibit PJA-15).

[48] *Notice of Application to The Public Utilities Commission Of Ohio For An Increase In Electric Rates To All Jurisdictional Customers For Duke Energy Ohio, Inc.* Case No. 17-0032-EL-AIR. Page 3.

[49] Todd, A., P. Cappers, and C. Goldman. *Residential Customer Enrollment in Time-based Rate and Enabling Technology Programs: Smart Grid Investment Grant Consumer Behavior Study Analysis*. Lawrence Berkeley National Laboratory, LBNL-6247E. Figure ES-6, page XXV. June 5, 2013.

[50] Massachusetts DPU 15-120 through 15-122. Order dated May 10, 2018. Pages 1-2.

is also worthwhile to note that the benefit-cost analyses of many initial smart meter deployments, including Duke's Ohio deployment, benefitted from huge grants from the American Recovery and Reinvestment Act of 2009. The $200 million grant (at taxpayer expense) that Duke received to subsidize the Echelon metering system will not be available to artificially improve the benefit-cost analysis for the metering system replacement Duke is now proposing.

Q36. WHAT OF DUKE'S PLANS FOR HOME ENERGY MANAGEMENT SYSTEMS? WILL THAT HELP WITH THE SIZE OF BEHAVIOR CHANGE PER PARTICIPATING CUSTOMER?

A36. Research indicates that automation of residential load control increases the size of customer response to time-varying rates designed to reduce system peak demand. However, I have significant concerns about the potential for consumer harm when a regulated monopoly is offering services to consumers in competitive markets such as home energy management services, particularly when that regulated monopoly can use rate-based assets to secure a competitive advantage.

IV. BEFORE APPROVING ANY METERING SYSTEM REPLACEMENT, THE PUCO SHOULD DEFINE, AND MAKE ABUNDANTLY CLEAR, FUNCTIONAL REQUIREMENTS FOR SUCH SYSTEMS IN OHIO (APPLICABLE TO DUKE) TO REDUCE FUTURE FINANCIAL RISKS TO CUSTOMERS.

Q37. PLEASE DESCRIBE THE DEFINING CHARACTERISTICS OF UTILITY METERING SYSTEMS FROM THE PERSPECTIVE OF A FORMER PRODUCT DEVELOPER.

A37. As we have seen in the Duke metering system saga, metering systems are enablers or limiters of critical capabilities for electric distribution companies and their customers. Metering systems are characterized by huge costs ($486 million equates to about $773 per residential customer over 15 years)[51] and long-term inflexibility. Any investment of significant consequence and enormous size that is difficult to change entails a great deal of risk. It is not wise to leave decisions as significant as metering system design solely in the hands of monopoly utilities. Rather, significant stakeholder and regulator involvement in design and performance is warranted. Stakeholder engagement will increase transparency, result in a better end product, and reduce economic risk for customers and shareholders.

[51] Based on a residential customer count of 629,102 per Duke Energy Ohio's 2016 Form 861 submitted to the U.S. Energy Information Administration.

Q38. AS SOMEONE WHO WAS INVOLVED IN THE DUKE METERING SYSTEM DEPLOYMENT FAIRLY EARLY, WHAT LESSONS DO YOU BELIEVE HAVE BEEN LEARNED?

A38. I believe the reason the existing metering system has such significant shortcomings. And the fact that the PUCO is even considering Duke's proposal to replace a metering system installed just a few years ago at a cost of hundreds of millions of dollars, is due to a lack of adequate functional specifications and enforcement. In the free market, corporate executives expect product developers to define the capabilities of a successful product (i.e., what it helps a user accomplish); detail product attributes (i.e. what it will weigh or how much it will cost); confirm these through market research (i.e., stakeholder input); and faithfully follow these specifications as the product is built (i.e., design compliance). In Duke's Ohio metering system planning, design, and build stages, all of these steps seem to have been missed. Duke knew that billing-quality customer energy usage data is important, but did not specify how many customers should have the capability, or what those customers (or their third party suppliers) might need from the system to actually reduce system peak. Duke claimed the metering system would last for 20 years, but it failed to look 20 years (or even 10 years) ahead. In addition, the PUCO has failed to aggressively enforce the functional specifications that were defined in the approved settlement in Case No. 10-2326-GE-RDR.

Q39. WHAT DO THESE LESSONS MEAN FOR THE PUCO TODAY REGARDING DUKE'S METERING SYSTEM SHORTCOMINGS?

A39. The PUCO still has an opportunity to impose consumer protections by rejecting or modifying the Settlement. The single most important role the PUCO can fulfill regarding Duke's metering system shortcomings is to ensure the same mistakes are not made twice. The PUCO should not approve the meter communications network replacement and billing system enhancements in the Stipulation—and by implication should not approve the entire $486 million Echelon metering system replacement plan. There should be a full and clear defining of functional specifications and imposing of other consumer protections for such plans, before it can be decided if any approval is warranted. Otherwise, there is the potential for the consumer concerns I have identified to be repeated in a future case.

Q40. COMPETITIVE ELECTRIC MARKETS HAVE BEEN HELD BACK IN SOUTHWEST OHIO UNNECESSARILY FOR YEARS ALREADY. WHAT NEW SPECIFICATIONS WOULD WE IDENTIFY, DETAIL, AND CONFIRM WITH ALLOWING FURTHER STAKEHOLDER INPUT?

A40. I do not agree with a premise that time-varying rates are essential for competitive electric markets. However, setting this issue aside, I believe there are many important questions to be resolved which would almost certainly impact metering system choices. For example, there are outstanding data access, communications bandwidth, and communications latency specifications that could impact the type

of metering system that are needed to meet stakeholders' needs. Examples include:

1. Should the communications network support the potential need for thousands of customers and authorized third parties to access interval data in near-real time, simultaneously, to automate load management/demand response event participation?

2. If not, does Duke's home energy management system proposals to communicate with smart meters via proprietary wireless home gateways for near-real time data access[52] constitute the use of rate-based meters to provide competitive advantages in markets for unregulated services?

3. Should Duke be required to comply with the Connect My Data standard? The Connect My Data standard would satisfy the needs expressed by proposed billing system enhancement Phase 2 (the automation of data access authorization by customers and retrieval by third parties)[53]

[52] Case No. 17-0032-EL-AIR. Testimony of Duke witness Weintraub at 12:16.

[53] Settlement, Attachment F.

while facilitating data access to all customers at about the same cost.

4. What opportunities does the approaching 5G revolution offer for Duke meter communications, as well as for load management by consumers, Duke, and third-party energy management services providers? (I note that the Rhode Island PUC is examining this question in its Power Sector Transformation proceeding.)[54]

I also suggest some big policy questions related to metering systems be addressed (which the Rhode Island PUC is also examining):[55]

1. Should customers have the option to purchase a meter that provides billing-quality customer energy usage data? Why should every customer pay $773 over 15 years to make billing-quality customer energy usage data available to the few that may have an interest?

2. Is it necessary for the utility to own the communications networks to systems (like meters) not critical to reliability

[54] Rhode Island Power Sector Transformation. Phase 1 Interagency Report to the Governor. Pages 36-39. November 2017.

[55] *Id.* at 40-41.

or safety, particularly given that meter communications are clearly not a core utility competency?

I am sure stakeholders and other experts could come up with many more good questions in need of answers. I understand that marketers have been promised billing-quality CEUD for several years, and that these continued delays are frustrating to them. However, Duke is responsible for the shortcomings of the existing system, not customers. I do not believe customers should incur the costs required to address the shortcomings of the system Duke designed, but customers would be even more aggrieved if the PUCO were to approve a second dysfunctional metering system. In fact, if Duke's metering system replacement proposal is approved, it would effectively reward Duke for poor management decisions with earnings growth. The message it sends to Duke and every other utility in the state is that it does not matter if it makes critically wrong, imprudent decisions on smart grid because when things go badly, a utility can simply come back to the PUCO and seek to charge its monopoly customers hundreds of millions of dollars more for a new system.

Q41. ASSUME A METERING SYSTEM SPECIFICATION PROCEEDING WERE HELD. HOW WOULD THAT HELP THE COMMISSION DECIDE WHAT TO DO ABOUT DUKE'S ECHELON METERING SYSTEM?

A41. Once ideal functional specifications have been established, and the benefits of each quantified where possible, the shortcomings of and fixes to the Echelon

metering system can be examined in a new light. Using the specifications and value propositions as evaluation criteria, the pros and cons of various approaches to addressing the shortcomings could be considered with greater clarity. For example, answers to the questions listed above might make clear that a less capital-intensive solution to providing billing-quality customer energy usage data should be pursued in the short term, allowing the existing metering system to continue until 5G arrives (perhaps as early as 2020) while still enabling optional time-varying rates for those with an interest. Such a proceeding could also be used to more rigorously evaluate, in a transparent manner, all options available to addressing the shortcomings of the Echelon metering system in order to find the most advantageous approach for the least cost to customers.

V. SUMMARY AND RECOMMENDATIONS

Q42. PLEASE SUMMARIZE YOUR TESTIMONY.

A42. For all the reasons identified in this testimony, the Settlement should be rejected as a package because it harms customers. Specifically, in this testimony I have provided information in support of the following points:

1. Duke is using stipulated approval of the communications network replacement and billing system enhancements ($41.2 million) as the basis to execute a $486 million meter system replacement proposal.

2. Duke has not demonstrated that replacing the Echelon metering system is the most cost-effective way to fix system shortcomings, or even that the customer benefits of fixing the shortcomings will exceed customer costs. As a result, Duke has not proven its replacement proposal benefits customers. Further, the PUCO Staff's recommendation that prematurely retired Echelon meters be amortized in rates over a 10-year period violates the used and useful principle. I support this point with three arguments:

   a. Considering $325 million in customer costs Duke ignored and $76 million in overstated costs of continuing the current system, my analysis indicates that Echelon metering system replacement is not the most cost-effective approach to addressing the shortcomings of the system.

   b. Duke did not rigorously evaluate several potentially viable and less costly approaches to securing billing-quality CEUD and avoiding upgrades to 140,000 meter communication nodes without replacing the Echelon meters.

c. Even a proper benefit-cost analysis is unlikely to deliver a favorable benefit-cost analysis for Echelon metering system replacement given the uncertainties around the level of benefit from the time-varying rates that billing-quality CEUD makes possible.

3. Before approving any metering system replacement, the Commission should define, and make abundantly clear, functional requirements for metering systems in Ohio (applicable to Duke) to reduce future financial risks to customers.

Q43. BASED ON THIS TESTIMONY, WHAT ARE YOUR RECOMMENDATIONS?

A43. I recommend that, regarding the issues I have addressed, the Commission should:

1. Reject the Settlement or at least eliminate the portions of the Settlement that propose charging consumers for Communications Network Replacement and Billing System Enhancements totaling $41.2 million.

2. Clarify to Duke in a written Order that:

a. Duke's investments in the AMI Business Continuity Effort and AMI Transition Plan have not been approved;

b. Duke is not permitted to charge customers for replacement of the Echelon metering system in Rider PF, Rider DCI, or any other rider; and

c. If Duke chooses to make any of these investments anyway, it does so at its own risk.

3. Clearly define functional specifications and policies for metering systems in Ohio as soon as possible, ideally with stakeholder input on this consumer issue. A distinct proceeding would be ideal for a transparent investigation and examination regarding the best way to address for Duke and its customers the shortcomings of the Echelon metering system.

4. Require Connect My Data standard compliance if the Commission deems Phase 2 of proposed billing system enhancements appropriate, as Connect My Data compliance will benefit more customers for a similar cost.

Q44. DOES THIS CONCLUDE YOUR TESTIMONY?

A44. Yes, it does. I reserve the right to incorporate new information that may subsequently become available through outstanding discovery or otherwise.

CERTIFICATE OF SERVICE

I hereby certify that a true copy of the foregoing *Direct Testimony of Paul J. Alvarez on Behalf of the Office of the Ohio Consumers' Counsel* was served via electronic transmission to the persons listed below on this 25th day of June 2018.

/s/ William J. Michael
William J. Michael
Assistant Consumers' Counsel

SERVICE LIST

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Case No. 17-0032-EL-AIR et al.	
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Profile

After 15 years in Fortune 500 product development and product management, including P&L responsibility, Mr. Alvarez entered the utility industry by way of demand-side management rate and program development, marketing, and impact measurement in 2001. He has since designed renewable portfolio standard compliance and distributed generation rates and incentive programs. These experiences led to unique projects involving the measurement of grid modernization costs and benefits (energy, capacity, operating savings, revenue capture, reliability, environmental, and customer experience), which revealed the limitations of current utility regulatory and governance models. Mr. Alvarez currently serves as the President of the Wired Group, a boutique consultancy serving consumer and environmental advocates, regulators, associations, and suppliers.

Research Projects, Thought Leadership, Regulatory Appearances

Support for Considering Grid Modernization Investments in a Distinct Proceeding. Testimony before the North Carolina Utilities Commission on behalf of the Environmental Defense Fund. E-2 Sub 1142, October 18, 2017; also E-7 Sub 1146, January 19, 2018.

Evaluation of Southern California Edison's Request to invest $2.3 Billion in Its Grid to Accommodate Distributed Energy Resources. Testimony before the California Public Utilities Commission on behalf of The Utility Reform Network in A16-09-001. May 2, 2017.

Evaluation of National Grid's Massachusetts Smart Meter Deployment Plan. Testimony before the Massachusetts Department of Public Utilities on behalf of the Attorney General in 15-120. March 10, 2017.

Evaluation of Eversource's Smart Meter Deployment Plan. Testimony before the Massachusetts Department of Public Utilities on behalf of the Attorney General in 15-122. March 10, 2017.

Evaluation of Kentucky Utilities/Louisville Gas & Electric Smart Meter Deployment Plan. Testimony before the Kentucky Public Service Commission on behalf of the Attorney General, 2016-00370 & 371. March 3, 2017. Also 2018-00005. May 18, 2018.

Recommendations on Metropolitan Edison's Grid Modernization Plan. Testimony before the Pennsylvania Public Utilities Commission on behalf of the Environmental Defense Fund in R-2016-2547449. July 21, 2016.

Arguments to Consider Duke Energy's Smart Meter CPCN Request in the Context of a Rate Case. Testimony before the Kentucky Public Service Commission on behalf of the Attorney General in 2016-00152. July 18, 2016.

Arguments to Reject Pacific Gas & Electric's Request to Invest $100 Million in Its Grid to Accommodate Distributed Energy Resources. Testimony before the California Public Utilities Commission on behalf of The Utility Reform Network, A15-09-001. April 29, 2016

Arguments to Reject Westar Energy's Proposal to Mandate a Rate Specific to Distributed Generation-Owning Customers. Testimony before the Kansas Corporation Commission on behalf of the Environmental Defense Fund, case 15-WSEE-115-RTS. July 9, 2015.

Regulatory Reform Proposal to Base a Significant Portion of Utility Compensation on Performance in the Public Interest. Testimony before the Maryland PSC on behalf of the Coalition for Utility Reform, case 9361. December 8, 2014.

Best Practices in Grid Modernization Capability Optimization: Visioning, Strategic Planning, and New Capability Portfolio Management. Top-5 US utility; client confidential. 2014.

Smart Grid Economic and Environmental Benefits: A Review and Synthesis of Research on Smart Grid Benefits and Costs. Secondary research report prepared for the Smart Grid Consumer Collaborative. October 8, 2013. Companion piece: Smart Grid Technical and Economic Concepts for Consumers.

Duke Energy Ohio Smart Grid Audit and Assessment. Primary research report prepared for the Public Utilities Commission of Ohio case 10-2326-GE. June 30, 2011.

SmartGridCity™ Demonstration Project Evaluation Summary. Primary research report prepared for Xcel Energy. Colorado Public Utilities Commission case 11A-1001E. Filed December 14, 2011 as Exhibit MGL-1. Report dated October 21, 2011.

Books

Smart Grid Hype & Reality: A Systems Approach to Maximizing Customer Return on Utility Investment. First edition 327 pages, 2014. Second edition 358 pages, 2018. ISBN 978-0-615-88795-1. Wired Group Publishing.

Noteworthy Publications

Measuring Distribution Performance? Benchmarking Warrants Your Attention. With Sean Ericson. Electricity Journal. Volume 31 (April, 2018), pages 1-6.

Busting Myths: Investor-Owned Utility Performance Can be Credibly Benchmarked. With Joel Leonard. Electricity Journal. Volume 30 (October, 2017), pages 45-48.

Price Cap Electric Ratemaking: Does it Merit Consideration? With Bill Steele. Electricity Journal. Volume 30, (October, 2017), pages 1-7.

Integrated Distribution Planning: An Idea Whose Time has Come. Public Utilities Fortnightly. Nov, 2014. Republished in the ICER Chronicle, 3rd Edition, March, 2015.

Maximizing Customer Benefits: Performance Measurement and Action Steps for Smart Grid Investments. Public Utilities Fortnightly. January, 2012.

Buying Into Solar: Rewards, Challenges, and Options for Rate-Based Investments. Public Utilities Fortnightly. December, 2009.

Smart Grid Regulation: Why Should We Switch to Performance-based Compensation? Smart Grid News. August 15, 2014.

A Better Way to Recover Smart Grid Costs. Smart Grid News. September 3, 2014.

Is This the Future? Simple Methods for Smart Grid Regulation. Smart Grid News. October 2, 2014.

The True Cost of Smart Grid Capabilities. Intelligent Utility. June 30, 2014.

Noteworthy Presentations

NASUCA Mid-Year Meeting. *Utility Evaluator™ Software: Benchmarking Distribution Utility Performance Using Publicly-Available Data.* New Orleans, LA. June 7, 2016.

NARUC Committee on Energy Resources and the Environment. *How big data can lead to better decisions for utilities, customers, and regulators***.** Washington DC. February 15, 2016.

National Conference of Regulatory Attorneys 2014 Annual Meeting. *Smart Grid Hype & Reality.* Columbus, Ohio. June 16, 2014.

NASUCA 2013 Annual Conference. *A Review and Synthesis of Research on Smart Grid Benefits and Costs.* Orlando. November 18, 2013.

NARUC Subcommittee on Energy Resources and the Environment. *The Distributed Generation (R)Evolution.* Orlando. November 17, 2013.

IEEE Power and Energy Society, ISGT 2013. *Distribution Performance Measures that Drive Customer Benefits.* Washington DC. February 26, 2013.

Canadian Electric Institute 2013 Annual Distribution Conference. *The (Smart Grid) Story So Far: Costs, Benefits, Risks, Best Practices, and Missed Opportunities.* Keynote. Toronto, Canada. January 23, 2013.

Great Lakes Smart Grid Symposium. *What Smart Grid Deployment Evaluations are Telling Us.* Chicago. September 26, 2012.

Mid-Atlantic Distributed Resource Initiative. *Smart Grid Deployment Evaluations: Findings and Implications for Regulators and Utilities.* Philadelphia. April 20, 2012.

DistribuTECH 2012. *Lessons Learned: Utility and Regulator Perspectives.* Panel Moderator. January 25, 2012.

DistribuTECH 2012. *Optimizing the Value of Smart Grid Investments.* Half-day course. January 23, 2012.

NARUC Subcommittee on Electricity. *Maximizing Smart Grid Customer Benefits: Measurement and Other Implications for IOUs and Regulators.* St. Louis. Nov. 13, 2011.

Teaching

Post-graduate Adjunct Professor. University of Colorado, Global Energy Management Program. Course: Renewable Energy Commercialization: Electric Technologies, Markets, and Policy.

Guest Lecturer. Michigan State University, Institute for Public Utilities. Courses: Performance Measurement of Distribution Utility Businesses; Introduction to Grid Modernization.

Education

Master of Management, 1991, Kellogg School of Management, Northwestern University. Concentrations: Accounting, Finance, Information Systems, and International Business.

Bachelor's Degree in Business Administration, 1984, Kelley School of Business, Indiana University. Concentrations: Marketing and Finance.

Certifications

New Product Development Professional. Product Development and Management Association. 2007.

Total (All Electric and Gas Costs)

Discount Rate (DEO before tax)	7.54%	(Per STIP dated April 13, 2018. Page 7.	NPV	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	TOTAL
		Continue Node Environment																	
	O&M	4G Communication Node Upgrade	**78,966,119**	30,387,500	30,387,500	30,387,500					-	-	-	-	-	-	-	-	91,162,500
		EDMS to MDM Conversion	**14,177,147**	7,900,000	7,900,000		-	-	-	-	-	-	-	-	-	-	-	-	15,800,000
		Long-term Communication Node Solution	**929,887**	1,000,000		-	-	-	-	-	-	-	-	-	-	-	-	-	1,000,000
		NES Headend Upgrades	**5,677,870**	800,000		848,720		900,407		955,242		1,013,416		1,075,133		1,140,609		1,210,072	7,943,599
	2,441,904	Monthly Cellular Cost	**12,971,408**	1,236,176	1,273,261	1,311,459	1,350,803	1,391,327	1,433,067	1,476,059	1,520,340	1,565,951	1,612,929	1,661,317	1,711,157	1,762,491	1,815,366	1,869,827	22,991,529
	703,038	Communication Device Failures	**38,166,258**	2,531,878	3,027,026	3,197,096	3,475,274	3,712,735	3,966,676	4,238,251	4,528,697	4,839,336	5,171,583	5,526,953	6,215,848	6,644,434	7,102,926	7,593,428	71,772,140
	2,323,152	Vendor Maintenance	**21,884,016**	2,085,548	2,148,114	2,212,558	2,278,935	2,347,303	2,417,722	2,490,253	2,564,961	2,641,910	2,721,167	2,802,802	2,886,886	2,973,493	3,062,698	3,154,578	38,788,928
			172,772,705	**45,941,102**	**44,735,901**	**37,957,333**	**7,105,012**	**8,351,771**	**7,817,464**	**9,159,805**	**8,613,999**	**10,060,612**	**9,505,679**	**11,066,206**	**10,813,891**	**12,521,026**	**11,980,990**	**13,827,905**	**249,458,696**
		Transition to Mesh Environment																	
	Capital	Ohio AMI Transition	**123,737,702**	32,657,008	73,503,945	34,944,977	2,292,918			-	-	-	-	-	-	-	-	-	143,398,848
	O&M	Monthly Cellular Cost	**5,302,259**	144,045	480,306	581,420	598,863	616,828	635,333	654,393	674,025	694,246	715,073	736,525	758,621	781,380	804,821	828,966	9,704,845
		Communication Device Failures	**274,337**	5,540	16,510	21,815	24,243	25,042	25,868	36,419	37,794	39,225	41,963	44,990	48,343	52,064	56,198	60,798	536,810
		Vendor Maintenance	**3,745,063**	-	115,427	385,041	466,130	480,114	494,517	509,353	524,633	540,372	556,584	573,281	590,480	608,194	626,440	645,233	7,115,800
			133,059,361	**32,806,593**	**74,116,188**	**35,933,253**	**3,382,153**	**1,121,984**	**1,155,719**	**1,200,165**	**1,236,452**	**1,273,843**	**1,313,619**	**1,354,796**	**1,397,444**	**1,441,637**	**1,487,459**	**1,534,996**	**160,756,303**
		Costs Duke Failed To Include In Transition to Mesh Environment																	
	Capital	Business Continuity Effort (OCC-INT-09-184 in 17-0032)	**24,136,045**	24,136,045															24,136,045
(See Exhibit PJA-4)	Capital	Value of nodes/meters/data transmitters retired prematurely	**125,010,893**	32,993,030	74,260,259	35,304,541	2,316,511												144,874,341
(See Exhibit PJA-3)	Carrying Costs	on "Ohio AMI Transition" Capital	**55,846,923**	2,619,333	8,327,797	10,522,435	9,897,934	9,076,388	8,254,842	7,433,296	6,611,750	5,790,204	4,968,658	4,147,111	3,325,565	2,504,019	1,682,473	860,927	86,022,733
"	Carrying Costs	on "Business Continuity Effort" Capital	**10,143,153**	1,935,889	1,797,611	1,659,333	1,521,056	1,382,778	1,244,500	1,106,222	967,944	829,667	691,389	553,111	414,833	276,556	138,278	(0)	14,519,167
"	Carrying Costs	on nodes/meters/data transmitters retired prematurely	**40,325,710**	2,551,774	8,011,743	9,820,599	8,774,673	7,529,673	6,284,674	5,039,675	3,794,676	2,549,677	1,304,678	343,209	19,907	0	-	-	56,024,959
	O&M	Business Continuity Effort (OCC-INT-09-184 in 17-0032)	**60,506**	60,506															60,506
			255,523,231	**64,296,578**	**92,397,410**	**57,306,909**	**22,510,173**	**17,988,840**	**15,784,017**	**13,579,194**	**11,374,371**	**9,169,547**	**6,964,724**	**5,043,432**	**3,760,306**	**2,780,575**	**1,820,751**	**860,927**	**325,637,752**

ASSUMPTIONS																			
Overall ROR (Equity & Debt)	7.54%																		
ROE Percentage	9.84%																		
Equity Percentage	50.75%																		
Debt Percentage	49.25%																		
Interest Percentage (imputed)	5.18%																		
Federal Income Tax Rate	21%																		
Useful Life: New Equipment	15	years																	
Amortization: Retired Equipmer	10	years																	
CARRYING COSTS: AMI Transition Plan Capital																			
			NPV	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	TOTAL
	Investments	2019		32,657,008	32,657,008	32,657,008	32,657,008	32,657,008	32,657,008	32,657,008	32,657,008	32,657,008	32,657,008	32,657,008	32,657,008	32,657,008	32,657,008	32,657,008	
		2020			73,503,945	73,503,945	73,503,945	73,503,945	73,503,945	73,503,945	73,503,945	73,503,945	73,503,945	73,503,945	73,503,945	73,503,945	73,503,945	73,503,945	
		2021				34,944,977	34,944,977	34,944,977	34,944,977	34,944,977	34,944,977	34,944,977	34,944,977	34,944,977	34,944,977	34,944,977	34,944,977	34,944,977	
		2022					2,292,918	2,292,918	2,292,918	2,292,918	2,292,918	2,292,918	2,292,918	2,292,918	2,292,918	2,292,918	2,292,918	2,292,918	
	Depreciation	on 2019		2,177,134	2,177,134	2,177,134	2,177,134	2,177,134	2,177,134	2,177,134	2,177,134	2,177,134	2,177,134	2,177,134	2,177,134	2,177,134	2,177,134	2,177,134	32,657,008
		on 2020			4,900,263	4,900,263	4,900,263	4,900,263	4,900,263	4,900,263	4,900,263	4,900,263	4,900,263	4,900,263	4,900,263	4,900,263	4,900,263	4,900,263	68,603,682
		on 2021				2,329,665	2,329,665	2,329,665	2,329,665	2,329,665	2,329,665	2,329,665	2,329,665	2,329,665	2,329,665	2,329,665	2,329,665	2,329,665	30,285,647
		on 2022					152,861	152,861	152,861	152,861	152,861	152,861	152,861	152,861	152,861	152,861	152,861	152,861	1,834,334
	Book Value	on 2019		30,479,874	28,302,740	26,125,606	23,948,473	21,771,339	19,594,205	17,417,071	15,239,937	13,062,803	10,885,669	8,708,535	6,531,402	4,354,268	2,177,134	(0)	
		on 2020			68,603,682	63,703,419	58,803,156	53,902,893	49,002,630	44,102,367	39,202,104	34,301,841	29,401,578	24,501,315	19,601,052	14,700,789	9,800,526	4,900,263	
		on 2021				32,615,312	30,285,647	27,955,982	25,626,316	23,296,651	20,966,986	18,637,321	16,307,656	13,977,991	11,648,326	9,318,661	6,988,995	4,659,330	
		on 2022					2,140,057	1,987,196	1,834,334	1,681,473	1,528,612	1,375,751	1,222,890	1,070,028	917,167	764,306	611,445	458,584	
	Total Book Value			30,479,874	96,906,422	122,444,337	115,177,332	105,617,409	96,057,486	86,497,562	76,937,639	67,377,716	57,817,793	48,257,870	38,697,946	29,138,023	19,578,100	10,018,177	
																			-
	Profits (BV X Equity % X ROE)			1,522,104	4,839,313	6,114,625	5,751,726	5,274,322	4,796,919	4,319,515	3,842,112	3,364,708	2,887,305	2,409,901	1,932,498	1,455,095	977,691	500,288	49,988,122
	Taxes on Profits			319,642	1,016,256	1,284,071	1,207,862	1,107,608	1,007,353	907,098	806,843	706,589	606,334	506,079	405,825	305,570	205,315	105,060	10,497,506
	Interest Exp. (BV X Debt % X Int Rate)			777,587	2,472,228	3,123,739	2,938,347	2,694,459	2,450,571	2,206,683	1,962,795	1,718,907	1,475,019	1,231,131	987,243	743,355	499,467	255,579	25,537,106
Carrying Costs on AMI Tranisition Plan Capital			**55,846,923**	**2,619,333**	**8,327,797**	**10,522,435**	**9,897,934**	**9,076,388**	**8,254,842**	**7,433,296**	**6,611,750**	**5,790,204**	**4,968,658**	**4,147,111**	**3,325,565**	**2,504,019**	**1,682,473**	**860,927**	**86,022,733**
CARRYING COSTS: Business Continuity Effort Capital																			
			NPV	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	TOTAL
	Investments	2019		24,136,045	22,526,975	20,917,906	19,308,836	17,699,766	16,090,697	14,481,627	12,872,557	11,263,488	9,654,418	8,045,348	6,436,279	4,827,209	3,218,139	1,609,070	
	Depreciation	on 2019		1,609,070	1,609,070	1,609,070	1,609,070	1,609,070	1,609,070	1,609,070	1,609,070	1,609,070	1,609,070	1,609,070	1,609,070	1,609,070	1,609,070	1,609,070	24,136,045
	Book Value	on 2019		22,526,975	20,917,906	19,308,836	17,699,766	16,090,697	14,481,627	12,872,557	11,263,488	9,654,418	8,045,348	6,436,279	4,827,209	3,218,139	1,609,070	(0)	
	Profits			1,124,952	1,044,598	964,245	883,891	803,537	723,183	642,830	562,476	482,122	401,769	321,415	241,061	160,707	80,354	(0)	8,437,141
	Taxes on Profits			236,240	219,366	202,491	185,617	168,743	151,869	134,994	118,120	101,246	84,371	67,497	50,623	33,749	16,874	(0)	1,771,800
	Interest Expense			574,697	533,647	492,597	451,548	410,498	369,448	328,398	287,348	246,299	205,249	164,199	123,149	82,100	41,050	(0)	4,310,227
Carrying Costs on Business Continuity Effort Capital			**10,143,153**	**1,935,889**	**1,797,611**	**1,659,333**	**1,521,056**	**1,382,778**	**1,244,500**	**1,106,222**	**967,944**	**829,667**	**691,389**	**553,111**	**414,833**	**276,556**	**138,278**	**(0)**	**14,519,167**
CARRYING COSTS: Meters and Data Transmitters Retired Early																			
			NPV	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	TOTAL
(see PJA-4 for book value, and	Retirements	2019		32,993,030	32,993,030	32,993,030	32,993,030	32,993,030	32,993,030	32,993,030	32,993,030	32,993,030	32,993,030	32,993,030	32,993,030	32,993,030	32,993,030	32,993,030	
PJA-2 for spread through		2020			74,260,259	74,260,259	74,260,259	74,260,259	74,260,259	74,260,259	74,260,259	74,260,259	74,260,259	74,260,259	74,260,259	74,260,259	74,260,259	74,260,259	
retirement years 2019-2022)		2021				35,304,541	35,304,541	35,304,541	35,304,541	35,304,541	35,304,541	35,304,541	35,304,541	35,304,541	35,304,541	35,304,541	35,304,541	35,304,541	
		2022					2,316,511	2,316,511	2,316,511	2,316,511	2,316,511	2,316,511	2,316,511	2,316,511	2,316,511	2,316,511	2,316,511	2,316,511	
(10 years per Staff Report, p. 11)	Amortization	on 2019		3,299,303	3,299,303	3,299,303	3,299,303	3,299,303	3,299,303	3,299,303	3,299,303	3,299,303	3,299,303	3,299,303	3,299,303	3,299,303	3,299,303	3,299,303	49,489,545
		on 2020			7,426,026	7,426,026	7,426,026	7,426,026	7,426,026	7,426,026	7,426,026	7,426,026	7,426,026	7,426,026	7,426,026	7,426,026	7,426,026	7,426,026	103,964,363
		on 2021				3,530,454	3,530,454	3,530,454	3,530,454	3,530,454	3,530,454	3,530,454	3,530,454	3,530,454	3,530,454	3,530,454	3,530,454	3,530,454	45,895,903
		on 2022					231,651	231,651	231,651	231,651	231,651	231,651	231,651	231,651	231,651	231,651	231,651	231,651	2,779,813
	Book Value	on 2019		29,693,727	26,394,424	23,095,121	19,795,818	16,496,515	13,197,212	9,897,909	6,598,606	3,299,303	-	-	-	-	-	-	
		on 2020			66,834,233	59,408,207	51,982,181	44,556,155	37,130,129	29,704,104	22,278,078	14,852,052	7,426,026	-	-	-	-	-	
		on 2021				31,774,087	28,243,633	24,713,179	21,182,725	17,652,271	14,121,816	10,591,362	7,060,908	3,530,454	(0)	-	-	-	
		on 2022					2,084,860	1,853,209	1,621,558	1,389,906	1,158,255	926,604	694,953	463,302	231,651	0	-	-	
	Total Book Value			29,693,727	93,228,657	114,277,415	102,106,492	87,619,058	73,131,624	58,644,190	44,156,756	29,669,321	15,181,887	3,993,756	231,651	0	-	-	
																			-
	Profits			1,482,845	4,655,653	5,706,786	5,098,994	4,375,521	3,652,047	2,928,574	2,205,100	1,481,627	758,153	199,440	11,568	0	-	-	32,556,307
	Taxes on Profits			311,398	977,687	1,198,425	1,070,789	918,859	766,930	615,000	463,071	311,142	159,212	41,882	2,429	0	-	-	6,836,824
	Interest Expense			757,532	2,378,403	2,915,388	2,604,890	2,235,294	1,865,697	1,496,101	1,126,505	756,909	387,313	101,887	5,910	0	-	-	16,631,828
Carrying Costs on Meters & Transmitters Retired Early			**40,325,710**	**2,551,774**	**8,011,743**	**9,820,599**	**8,774,673**	**7,529,673**	**6,284,674**	**5,039,675**	**3,794,676**	**2,549,677**	**1,304,678**	**343,209**	**19,907**	**0**	**-**	**-**	**56,024,959**
SUMMARY: Profits and Taxes (for information only)																			
			NPV	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	TOTAL
Profits				4,129,901	10,539,564	12,785,656	11,734,611	10,453,380	9,172,149	7,890,919	6,609,688	5,328,457	4,047,227	2,930,757	2,185,127	1,615,802	1,058,045	500,288	90,981,570
Taxes on Profits				867,279	2,213,308	2,684,988	2,464,268	2,195,210	1,926,151	1,657,093	1,388,034	1,118,976	849,918	615,459	458,877	339,318	222,189	105,060	19,106,130
TOTAL Profits and Taxes			**74,754,391**	**4,997,181**	**12,752,872**	**15,470,643**	**14,198,879**	**12,648,590**	**11,098,301**	**9,548,011**	**7,997,722**	**6,447,433**	**4,897,144**	**3,546,215**	**2,644,004**	**1,955,120**	**1,280,234**	**605,348**	**110,087,699**

	Original Plant	Accumulated Depreciation	Net Book Value	Date	Source
Comm Nodes	101,758,692	27,879,807	73,878,885	6/30/2016	Case No. 17-0032-EL-AIR, Schedule B-3.2, page 3, line 16
Echelon Meters	68,730,098	19,505,785	49,224,313	6/30/2016	Case No. 17-0032-EL-AIR, Schedule B-3.2, page 2, line 21
Gas Meter Data Transmitters	n/a	n/a	21,771,143	12/31/2016	Case No. 17-690-GA-RDR. Testimony of Peggy A. Laub, Attachment PAL-1, page 2. March 24, 2017
			144,874,341		

Summary: Testimony Direct Testimony of Paul J. Alvarez in Opposition to the Joint Stipulation and Recommendation on Behalf of The Office of the Ohio Consumers' Counsel electronically filed by Ms. Jamie Williams on behalf of Michael, William Mr.