LARGE FILING SEPERATOR SHEET

CASE NUMBER:
07-589-GA-AIR
07-590-GA-ALT
07-591-GA-AAM

FILE DATE: 3/7/2008

SECTION: 1 of 2

NUMBER OF PAGES: 167

DESCRIPTION OF DOCUMENT: Transcript
Volume I Exhibits

Exhibits

1   BEFORE THE PUBLIC UTILITIES COMMISSION OF OHIO

2   - - -

3   In the Matter of the   :
     Application of Duke Energy:
4   Ohio, Inc., for an   : Case No. 07-589-GA-AIR
     Increase in Gas Rates.   :
5
     In the Matter of the   :
6   Application of Duke Energy:
     Ohio, Inc., for Approval   :
7   of an Alternative Rate   : Case No. 07-590-GA-ALT
     Plan for its Gas   :
8   Distribution Service.   :

9   In the Matter of the   :
     Application of Duke Energy:
10   Ohio, Inc., for Approval   : Case No. 07-591-GA-AAM
     to Change Accounting   :
11   Methods.   :

12   - - -

13   PROCEEDINGS

14   before Mr. Richard Bulgrin and Ms. Greta See,

15   Attorney Examiners, at the Public Utilities

16   Commission of Ohio, 180 East Broad Street, Room 11-C,

17   Columbus, Ohio, called at 9 a.m. on Wednesday,

18   March 5, 2008.

19   - - -

20   VOLUME I

21   - - -

22   ARMSTRONG & OKEY, INC.
         185 South Fifth Street, Suite 101
23   Columbus, Ohio 43215-5201
           (614) 224-9481 - (800) 223-9481
24   Fax - (614) 224-5724
                         - - -

EXHIBIT

Case Number **07-589-GA-AIR**
07-590-GA-ALT
07-591-GA-AAM

The following exhibit(s) were prefiled and can be located with the pleadings:

Exhibits	Date Filed
COMPANY EXHIBITS	
8 Direct Testimony of Roger A. Morin	8/1/2007
10 Direct Testimony of James A. Riddle	8/1/2007
11 Direct Testimony of Paul G. Smith	8/1/2007
13 Direct Testimony of Donald L. Storck	8/1/2007
14 Direct Testimony of Patricia K. Walker	8/1/2007
15 Direct Testimony of William Don Wathen, Jr.	8/1/2007
16 Direct Testimony of James E. Ziolkowski	8/1/2007
17 Supplemental Testimony of Gary J. Hebbler	1/30/2008
18 Supplemental Testimony of Roger A. Morin	1/30/2008
COMPANY EXHIBITS	
19 Supplemental Testimony of Paul G. Smith	1/30/2008
20 Supplemental Testimony of Donald L. Storck	1/30/2008
21 Supplemental Testimony of William Don Wathen, Jr.	1/30/2008
22 Second Supplemental Testimony of Donald L. Storck	2/22/2008

Case Number _07-589-GA-AIR_
07-590-GA-ALT
07-591-GA-AAM

The following exhibit(s) were prefiled and can be located with the pleadings:

Exhibits	Date Filed

COMPANY EXHIBITS

23	Second Supplemental Testimony of Roger A. Morin	2/22/08
24	Supplemental Testimony of Gary J. Hebbler	2/22/08
25	Supplemental Testimony of James A. Riddle	2/22/08
26	Second Supplemental Testimony of William Don Wathen, Jr.	2/22/08
27	Direct Testimony of Mathew Smith	2/22/08
28	Direct Testimony of C. James O'Connor	2/22/08
29	Settlement Supporting Testimony of Paul G. Smith	2/22/08

STAFF EXHIBITS

1	Staff Report	12/20/2007
2	Prefiled Testimony of J. Edward Hess	2/28/2008
3	Prefiled Testimony of Stephen E. Puican	2/28/2008
4	Blue Ridge Consulting Report	12/20/2007

JOINT EXHIBIT

1	Stipulation and Recommendation	2/28/2008

The following exhibit(s) were prefiled and can be located with the pleadings:

Exhibits	Date Filed
COMPANY EXHIBITS	
1 Direct Testimony of Keith G. Butler	8/1/2008
2 Direct Testimony of Carl J. Council, Jr.	8/1/2008
3 Direct Testimony of Brian P. Davey	8/1/2008
4 Direct Testimony of Stephen G. De May	8/1/2008
5 Direct Testimony of Gary J. Hebbler	8/1/2008
6 Direct Testimony of Sandra P. Meyer	8/1/2008
7 Direct Testimony of David W. Mohler	8/1/2008
8 Direct Testimony of Roger A. Morin	8/1/2008
9 Direct Testimony of Laura Gwen Pate	8/1/2008

EXHIBIT

From: "Finnigan, John" <john.finnigan@duke-energy.com>
To: "LARRY SAUER" <SAUER@occ.state.oh.us>
Date: 1/10/2008 3:58:09 PM
Subject: FW: FW: Annual Residential Usage - Staff Request #17-075

Larry,

Here is our response to your informal question relating to budget billing.

Thanks,
John

John J. Finnigan, Jr.
Associate General Counsel
Duke Energy Shared Services, Inc.
(513) 419-1843
(513) 419-1846 fax
John.Finnigan@duke-energy.com

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authorized and may be unlawful.

-----Original Message-----
From: Ziolkowski, Jim
Sent: Thursday, January 10, 2008 3:35 PM
To: Finnigan, John
Cc: Storck, Don; Berg, Kelly
Subject: FW: FW: Annual Residential Usage - Staff Request #17-075

John,

Per Kelly's message below, DE OH has 73,757 residential gas customers on budget billing, as of today.

Jim Ziolkowski
513 419-5337

-----Original Message-----
From: Berg, Kelly
Sent: Thursday, January 10, 2008 3:31 PM
To: Ziolkowski, Jim
Subject: RE: FW: Annual Residential Usage - Staff Request #17-075

As a snapshot in time (today) there are 73757 Ohio residential gas customers on BBP.

Kelly

OCC Exhibit
7

-----Original Message-----
From: Ziolkowski, Jim
Sent: Thursday, January 10, 2008 9:02 AM
To: Berg, Kelly
Cc: Storck, Don
Subject: FW: FW: Annual Residential Usage - Staff Request #17-075

Kelly,

As we discussed, here's the data request from the OCC:

"Can you tell me how many of Duke's residential natural gas customers are currently on budget billing?"

Since this is from the OCC and is related to the OH gas case, we should provide them with the number of DE OH residential gas customers that are on budget billing.

Thanks,

Jim Z.

-----Original Message-----
From: Finnigan, John
Sent: Thursday, January 10, 2008 8:14 AM
To: Ziolkowski, Jim; Smith, Paul - Rates
Subject: FW: FW: Annual Residential Usage - Staff Request #17-075

Jim,

Could you please provide this data for me, and I'll forward to Larry?

Thanks,
John

John J. Finnigan, Jr.
Associate General Counsel
Duke Energy Shared Services, Inc.
(513) 419-1843
(513) 419-1846 fax
John.Finnigan@duke-energy.com

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-----Original Message-----

From: LARRY SAUER [mailto:SAUER@occ.state.oh.us]
Sent: Thursday, January 10, 2008 8:10 AM
To: Finnigan, John
Cc: KATHY HAGANS
Subject: Re: FW: Annual Residential Usage - Staff Request #17-075

John,

Can you tell me how many of Duke's residential natural gas customers are currently on budget billing?

Thank you.

CONFIDENTIAL NOTICE:

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ADDRESSED AND MAY CONTAIN CONFIDENTIAL AND/OR PRIVILEGED LEGAL, GOVERNMENTAL
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THIS MESSAGE. THEN IMMEDIATELY DELETE THIS COMMUNICATION AND ALL COPIES OF THIS
COMMUNICATION. THANK YOU.

Larry S. Sauer
Assistant Consumers' Counsel
10 West Broad Street
Suite 1800
Columbus, Ohio 43215-3485
(614) 466-1312

>>> "Finnigan, John" <john.finnigan@duke-energy.com> 1/9/2008 5:31 PM
>>>
Larry,

Please see Paul Smith's message below, and the attached data request.
This relates to the issue we discussed at yesterday's meeting about the numbers of customers at higher
usage levels. Please let me know whether the OCC would be willing to consider a SFV rate design with
different usage blocks than the Staff recommended.

Also, as to revenue decoupling, we'd like to know what amount of an increase in the customer charge the
OCC would agree to.

Thanks,

John

EXHIBIT

Duke Energy.

<u>VIA ELECTRONIC MAIL AND OVERNIGHT DELIVERY</u>

September 17, 2007

Mr. William Wright
Assistant Attorney General
The Public Utilities Commission of Ohio
180 East Broad Street
Columbus, Ohio 43255-0573

Re: In the Matter of the Application of Duke Energy Ohio, Inc. for an Increase in Gas Rates
PUCO Case No. 07-0589-GA-AIR

In the Matter of the Application of Duke Energy Ohio, Inc. for Approval of an Alternative Rate Plan for its Gas Distribution Service
PUCO Case No. 07-0590-GA-ALT

In the Matter of the Application of Duke Energy Ohio, Inc. for Approval to Change Accounting Methods
PUCO Case No. 07-0591-GA-AAM

Dear Mr. Wright:

Enclosed is Duke Energy Ohio, Inc.'s response to No. 16 of the PUCO's Third Set of Staff Data Requests in the above-referenced cases. In addition, I have sent a copy to you via email.

Should you have any questions, please call me at (513) 287-3601.

Thank you.

Sincerely,

John J. Finnigan, Jr.
Associate General Counsel

JJF/bjl
cc: Michael L. Kurtz (w/encl. and by email)
     David F. Boehm (w/encl. and by email)
     John M. Dosker (w/encl. and by email)
     David C. Rinebolt (w/encl. and by email)
     Larry S. Sauer (w/encl. and by email)
     Colleen L. Mooney (w/encl. and by email)
     John W. Bentine (w/encl. and by email)
     Thomas J. O'Brien (w/encl. and by email)
     Steve Puican (w/encl. and by email)

OCC Exhibit 8

217540

PUCO Staff Data Requests
Duke Energy Ohio, Inc.
Case No. 07-589-GA-AIR
Date Received: August 27, 2007
Response Due: September 12, 2007

STAFF-DR-03-016

REQUEST:

For each applicable rate schedule, provide the monthly Order Granted Base Revenues that would result from approval of the application. Provide the methodology for calculating these monthly Order Granted Base Revenues.

How would these initial Order Granted Base Revenues account for the proposal to phase in the elimination of inter-class "rate disparities" over three years?

For each applicable rate schedule, provide a projection of annual Rider SD rate levels and total revenues generated for the first five years the rider would be in effect. Provide the customer and usage forecasts upon which that projection is based.

RESPONSE:

See Attachment Staff-DR-03-016(a), which provides monthly Order Granted Base Revenues that would result from approval of the application for Year 1 (Phase 1), Year 2 (Phase 2) and Year 3 (Phase 3). Base Revenues consist of: (1) a customer charge calculated by multiplying the number of customers times the proposed monthly customer charge; and (2) a commodity charge, which is calculated by multiplying Mcf sales times the appropriate rate per Mcf.

These initial Order Granted Base Revenues if approved as filed would result in the elimination of the inter-class rate disparities by shifting revenue among classes over a three year period as explained in Mr. Storck's testimony.

See Attachment Staff-DR-03-016(b) for a projection of annual Rider SD for rates RS/RFT and GS/FT for the first five years the rider would be in effect. Staff-DR-03-016(b), pages 3 through 14 provide the customer and usage forecasts.

WITNESS RESPONSIBLE: Donald L. Storck

Rider SD Calculation
Rate RS / RFT
2008 - 2012

Line No.	Description	2008 $	2009 $	2010 $	2011 $	2012 $	Source
1	Actual Base Revenues	138,132,151	144,492,950	151,003,629	151,711,413	152,331,740	Forecast
2	Weather Normalization	0	0	0	0	0	
3	Add: DSM Lost Revenues	0	0	0	0	0	
4	Weather Normalized Actual Base Revenues	138,132,151	144,492,950	151,003,629	151,711,413	152,331,740	
5	Order Granted Base Revenues	143,214,762 (1)	149,318,698 (2)	155,241,217 (3)	155,241,217 (3)	155,241,217 (3)	WPE-4h
6	Add: Customer Growth Base Revenues	1,580,255	3,296,734	5,081,138	6,688,517	8,230,257	
7	Adjusted Order Granted Base Revenues	144,795,017	152,615,422	160,322,355	161,929,734	163,471,474	
8	Sales Decoupling Revenue - Increase / (Decrease)	6,662,866	8,122,432	9,318,726	10,218,321	11,139,734	(Line 6 - Line 3)
9	Annual Increase / (Decrease) per Customer	$ 16.79	$ 20.24	$ 22.98	$ 24.95	$ 26.95	

Change In Base Revenue Due to Customer Growth

Line No.	Description	2008	2009	2010	2011	2012	Source
10	Actual Customer Count	396,931	401,287	405,449	409,514	413,413	Forecast
11	Order Granted Customer Count	392,599	392,599	392,599	392,599	392,599	WPE-4d
12	Customer Growth	4,332	8,688	12,850	16,915	20,814	
13	Order Granted Base Revenue per Customer	$ 364.79	$ 380.33	$ 395.42	$ 395.42	$ 395.42	(Line 4 / Line 10)
14	Customer Growth Base Revenue	$ 1,580,255	$ 3,296,734	$ 5,081,138	$ 6,688,517	$ 8,230,257	(Line 11 * Line 12)

(1) Year 1 - 33% subsidy / excess reduction.
(2) Year 2 - 67% subsidy / excess reduction.
(3) Year 3 - 100% subsidy / excess reduction.

Rider SD Calculation
Rate GS / FT
2008 - 2012

Line No.	Description	2008	2009	2010	2011	2012	Source
		$	$	$	$	$	
1	Actual Base Revenues	60,680,008	54,523,447	49,023,487	49,184,024	49,124,574	Forecast
2	Weather Normalization	0	0	0	0	0	
3	Weather Normalized Actual Base Revenues	60,680,008	54,523,447	49,023,487	49,184,024	49,124,574	
4	Order Granted Base Revenues	59,544,940 (1)	53,798,621 (2)	48,223,761 (3)	48,223,761 (3)	48,223,761 (3)	WPE-4h
5	Add: Customer Growth Base Revenues	391,076	1,074,727	1,524,955	1,932,587	2,277,166	
6	Adjusted Order Granted Base Revenues	59,936,016	54,873,348	49,748,716	50,156,348	50,500,928	
7	Sales Decoupling Revenue - Increase / (Decrease)	(753,992)	349,901	725,229	972,324	1,376,355	(Line 6 - Line 3)
8	Annual Increase / (Decrease) per Customer	$ (22.78)	$ 10.43	$ 21.38	$ 28.43	$ 39.98	

Change In Base Revenue Due to Customer Growth

Line No.	Description	2008	2009	2010	2011	2012	Source
9	Actual Customer Count	33,104	33,545	33,928	34,205	34,441	Forecast
10	Order Granted Customer Count	32,888	32,888	32,888	32,888	32,888	WPE-4d
11	Customer Growth	216	657	1,040	1,318	1,553	(Line 9 - Line 10)
12	Order Granted Base Revenue per Customer	$ 1,810.54	$ 1,635.81	$ 1,466.30	$ 1,466.30	$ 1,466.30	(Line 4 / Line 10)
13	Customer Growth Base Revenue	$ 391,076	$ 1,074,727	$ 1,524,955	$ 1,932,587	$ 2,277,166	(Line 11 * Line 12)

(1) Year 1 - 33% subsidy / excess reduction.
(2) Year 2 - 67% subsidy / excess reduction.
(3) Year 3 - 100% subsidy / excess reduction.

DUKE ENERGY OHIO, INC
CASE NO 07-589-GA-AIR
MCF SALES FORECAST
2007-2012

	FY07 Jan	FY07 Feb	FY07 Mar	FY07 Apr	FY07 May	FY07 Jun	FY07 Jul	FY07 Aug	FY07 Sep	FY07 Oct	FY07 Nov	FY07 Dec
Residential - Sales	5,124,058	4,622,082	3,848,595	2,418,599	1,216,066	701,588	520,897	469,104	504,523	795,916	1,836,141	3,634,018
Commercial - Sales	1,565,350	1,500,417	1,271,476	871,288	446,368	301,741	234,232	204,112	217,152	301,755	643,584	1,148,142
Commercial Residential - Sales	467,999	387,797	310,327	187,431	87,418	58,790	53,128	60,456	61,271	83,314	152,761	331,833
Electric Generation	0	0	0	0	0	0	0	0	0	0	0	0
Inter-Dept Less Elec Gener - Sales	9,486	12,333	11,578	8,899	6,574	3,209	7,215	4,967	2,460	5,829	11,983	15,467
Industrial - Sales	255,928	230,424	230,337	162,415	117,250	109,321	103,613	130,193	109,052	111,993	148,241	227,439
OPA - Sales	239,509	212,422	174,219	129,269	79,673	57,965	50,803	53,453	53,957	70,144	119,149	182,944
Commercial - Firm Transportation	972,027	917,336	761,162	498,025	271,266	170,896	140,905	133,698	141,450	204,550	412,741	767,263
Industrial - Firm Transportation	341,368	331,872	183,915	216,416	163,914	140,282	125,624	130,832	129,818	143,898	194,220	212,944
OPA - Firm Transportation	304,505	288,134	242,858	166,855	101,278	74,876	66,692	65,754	68,568	85,318	144,412	239,685
Residential - Firm Transportation	783,039	721,974	593,859	380,704	198,996	111,380	90,768	82,579	88,940	141,782	318,533	615,280
Commercial - Interruptible Transportation	233,510	223,588	202,797	180,146	141,404	122,486	113,818	115,986	117,482	128,044	151,582	203,170
Industrial - Interruptible Transportation	1,374,371	1,357,105	1,320,202	1,248,894	1,189,148	1,169,093	1,167,961	1,171,064	1,172,642	1,191,326	1,249,576	1,343,991
OPA - Interruptible Transportation	191,911	181,593	153,059	105,158	63,829	47,190	41,818	41,183	42,928	53,460	90,593	150,585
Other Public Utilities	3,871	3,259	3,422	3,350	3,416	3,354	3,474	3,424	3,370	3,625	3,232	3,403
Street Lighting - Sales												
Company Use MCF	4,629	5,560	5,939	4,074	1,894	1,250	1,550	1,201	344	1,600	3,212	5,947

DUKE ENERGY OHIO, INC
CASE NO 07-589-GA-AIR
MCF SALES FORECAST
2007-2012

	FY08 Jan	FY08 Feb	FY08 Mar	FY08 Apr	FY08 May	FY08 Jun	FY08 Jul	FY08 Aug	FY08 Sep	FY08 Oct	FY08 Nov	FY08 Dec
Residential - Sales	5,096,639	4,586,708	3,789,206	2,372,771	1,194,741	690,756	517,913	466,681	503,231	794,732	1,833,974	3,634,891
Commercial - Sales	1,552,598	1,486,252	1,241,709	850,322	439,061	297,774	232,937	203,164	217,248	301,768	643,802	1,150,736
Commercial Residential - Sales	464,187	394,136	303,061	182,921	85,988	58,017	52,834	60,176	61,299	83,317	152,812	332,583
Electric Generation	0	0	0	0	0	0	0	0	0	0	0	0
Inter-Dept Less Elec Genate - Sales	19,556	14,537	9,360	7,502	5,542	2,705	6,083	4,187	2,074	4,914	10,101	13,039
Industrial - Sales	277,200	240,455	214,157	150,703	104,939	96,506	90,755	96,258	95,859	98,089	129,696	199,697
OPA - Sales	242,239	209,511	180,696	132,864	79,918	54,766	48,417	51,871	52,938	68,792	117,230	183,607
Commercial - Firm Transportation	1,005,282	940,367	779,601	510,920	275,430	173,527	140,753	133,552	141,509	204,342	412,328	766,552
Industrial - Firm Transportation	322,650	313,079	267,970	204,177	153,592	132,270	118,421	123,330	122,369	139,419	183,098	257,322
OPA - Firm Transportation	306,022	289,477	243,963	167,603	102,056	75,456	64,822	65,886	68,706	85,489	144,706	240,182
Residential - Firm Transportation	839,466	772,772	635,145	406,969	212,269	119,034	98,503	82,340	88,696	141,402	317,681	613,674
Commercial - Interruptible Transportation	234,879	224,899	203,986	181,203	142,233	123,204	114,486	116,666	118,172	128,795	152,471	204,361
Industrial - Interruptible Transportation	1,428,919	1,396,347	1,339,973	1,257,380	1,191,184	1,168,396	1,166,438	1,170,904	1,176,031	1,198,943	1,263,119	1,366,472
OPA - Interruptible Transportation	192,309	181,969	153,376	105,375	63,962	47,288	41,905	41,264	43,017	53,571	90,781	150,897
Other Public Utilities	3,426	3,334	3,459	3,386	3,453	3,398	3,512	3,461	3,407	3,462	3,270	3,440
Street Lighting - Sales	7,943	6,798	4,894	3,357	1,561	1,030	1,277	989	284	1,318	2,647	4,900
Company Use MCF												

DUKE ENERGY OHIO, INC
CASE NO. 07-589-GA-AIR
MCF SALES FORECAST
2007-2012

	FY09 Jan	FY09 Feb	FY09 Mar	FY09 Apr	FY09 May	FY09 Jun	FY09 Jul	FY09 Aug	FY09 Sep	FY09 Oct	FY09 Nov	FY09 Dec
Residential - Sales	5,099,326	4,587,315	3,191,201	2,377,134	1,197,525	692,234	518,931	467,557	504,134	796,039	1,836,979	3,642,351
Commercial - Sales	1,550,849	1,485,248	1,242,390	853,560	441,022	299,100	233,998	204,127	218,295	303,158	646,577	1,156,205
Commercial Residential - Sales	463,664	383,877	303,227	183,618	86,371	58,276	53,075	60,461	61,594	83,701	133,471	334,163
Electric Generation	0	0	0	0	0	0	0	0	0	0	0	0
Inter-Dept Less Elec Gener - Sales	19,556	14,537	9,760	7,502	5,542	2,705	6,083	4,187	2,074	4,914	10,101	13,039
Industrial - Sales	249,178	214,932	191,589	135,923	95,582	88,932	84,473	90,443	90,798	93,882	125,197	194,158
OPA - Sales	241,044	208,618	181,416	132,322	70,692	54,842	49,177	52,793	53,909	70,060	119,473	187,311
Commercial - Firm Transportation	1,007,186	942,173	781,117	511,944	275,977	173,871	141,034	133,821	141,597	204,753	413,160	768,072
Industrial - Firm Transportation	297,718	288,639	247,300	188,371	141,695	122,024	109,245	113,776	112,891	128,618	168,934	237,424
OPA - Firm Transportation	307,698	291,063	245,303	168,521	102,615	73,870	67,191	66,249	69,084	85,961	145,505	241,507
Residential - Firm Transportation	839,626	772,918	635,684	407,101	212,349	119,079	90,537	82,372	88,730	141,457	317,800	613,911
Commercial - Interruptible Transportation	238,498	228,364	207,128	183,994	144,424	125,102	116,250	118,463	119,992	130,779	154,820	207,509
Industrial - Interruptible Transportation	1,464,723	1,436,970	1,382,999	1,301,142	1,234,497	1,212,673	1,212,709	1,219,468	1,226,904	1,253,277	1,322,783	1,433,357
OPA - Interruptible Transportation	193,364	182,968	154,218	105,953	64,313	47,548	42,135	41,495	43,253	53,865	91,279	151,726
Other Public Utilities	3,426	3,334	3,459	3,386	3,453	3,390	3,512	3,461	3,407	3,462	3,270	3,440
Street Lighting - Sales	7,945	6,798	4,894	3,357	1,561	1,030	1,277	989	284	1,318	2,647	4,900
Company Use MCF												

DUKE ENERGY OHIO, INC.
CASE NO 07-589-GA-AIR
MCF SALES FORECAST
2007-2012

	FY10 Jan	FY10 Feb	FY10 Mar	FY10 Apr	FY10 May	FY10 Jun	FY10 Jul	FY10 Aug	FY10 Sep	FY10 Oct	FY10 Nov	FY10 Dec
Residential - Sales	5,125,390	4,614,145	3,812,409	2,389,532	1,203,231	695,346	521,193	469,552	506,273	799,448	1,045,316	3,660,273
Commercial - Sales	1,561,015	1,495,030	1,250,494	859,376	444,038	301,117	235,563	205,480	219,755	305,135	650,637	1,163,216
Commercial Residential - Sales	466,703	386,605	305,206	184,869	86,962	58,669	53,429	60,862	62,006	84,247	154,435	336,190
Electric Generation	0	0	0	0	0	0	0	0	0	0	0	0
Inter-Dept Less Elec Gener - Sales	19,556	14,537	9,760	7,502	5,542	2,705	6,083	4,187	2,074	4,914	10,101	13,039
Industrial - Sales	231,560	202,889	183,676	131,905	93,622	87,353	83,550	89,853	98,614	94,260	126,163	195,916
OPA - Sales	242,097	209,059	182,094	135,048	81,362	56,011	50,247	53,884	54,972	71,393	121,685	190,826
Commercial - Firm Transportation	1,013,754	948,317	786,209	515,283	277,779	175,006	141,954	134,693	142,521	206,089	415,851	773,073
Industrial - Firm Transportation	289,926	281,261	240,844	183,430	137,974	118,820	106,376	110,788	109,926	125,242	164,505	231,203
OPA - Firm Transportation	311,571	294,729	248,390	170,646	103,910	76,837	68,039	67,086	69,957	87,046	147,340	244,550
Residential - Firm Transportation	843,271	776,321	638,674	408,883	213,278	119,595	90,931	82,731	89,115	142,073	319,183	616,593
Commercial - Interruptible Transportation	241,225	230,996	209,498	186,098	146,076	126,533	117,579	119,818	121,364	132,274	156,591	209,383
Industrial - Interruptible Transportation	1,536,820	1,506,902	1,448,319	1,359,710	1,286,951	1,260,880	1,257,412	1,260,846	1,264,999	1,288,474	1,356,304	1,466,193
OPA - Interruptible Transportation	195,881	185,273	156,161	107,289	65,123	48,147	43,666	42,018	43,798	54,544	92,430	153,637
Other Public Utilities	3,426	3,334	3,334	3,459	3,386	3,453	3,390	3,512	3,461	3,407	3,462	3,440
Street Lighting - Sales												
Company Use MCF	7,945	6,798	4,894	3,357	1,561	1,050	1,277	989	284	1,318	2,647	4,900

DUKE ENERGY OHIO, INC
CASE NO 07-589-GA-AIR
MCF SALES FORECAST
2007-2012

	FY11 Jan	FY11 Feb	FY11 Mar	FY11 Apr	FY11 May	FY11 Jun	FY11 Jul	FY11 Aug	FY11 Sep	FY11 Oct	FY11 Nov	FY11 Dec
Residential - Sales	5,154,049	4,652,487	3,873,158	2,412,554	1,208,293	699,759	525,051	471,554	505,934	796,499	1,826,974	3,626,721
Commercial - Sales	1,567,197	1,512,481	1,281,166	864,082	446,031	304,130	237,834	206,083	218,743	302,699	636,800	1,146,442
Commercial Residential - Sales	468,551	390,916	312,692	185,881	87,353	59,256	53,044	61,040	61,721	83,575	151,151	331,342
Electric Generation	0	0	0	0	0	0	0	0	0	0	0	0
Inter-Dept Less Elec Gener - Sales	19,556	14,537	9,760	7,502	5,542	2,705	6,083	4,187	2,074	4,914	10,101	13,039
Industrial - Sales	227,840	202,415	190,188	136,073	96,010	90,086	85,998	91,430	90,486	91,913	117,160	178,286
OPA - Sales	246,613	212,831	185,185	135,371	84,124	61,080	50,642	54,118	56,487	73,286	121,737	185,034
Commercial - Firm Transportation	1,017,484	951,930	789,367	517,193	278,801	175,661	142,487	135,187	109,855	143,016	417,151	775,636
Industrial - Firm Transportation	287,495	278,897	238,846	181,887	136,813	117,819	105,480	109,855	67,910	109,008	163,120	229,255
OPA - Firm Transportation	315,412	298,359	251,451	172,746	105,195	77,787	68,878	68,878	83,028	70,821	149,150	247,548
Residential - Firm Transportation	846,324	779,367	641,383	418,471	214,045	129,037	91,274	91,274	128,976	89,412	320,077	618,326
Commercial - Interruptible Transportation	243,596	233,207	211,522	187,899	147,487	127,755	118,315	118,315	120,214	122,536	158,104	211,910
Industrial - Interruptible Transportation	1,567,664	1,534,927	1,473,816	1,383,354	1,308,965	1,282,029	1,277,620	1,277,620	1,280,214	1,283,540	1,374,908	1,485,739
OPA - Interruptible Transportation	198,212	187,556	158,085	108,610	65,926	48,740	43,191	43,191	42,336	44,338	93,568	155,530
Other Public Utilities	3,426	3,334	3,459	3,386	3,453	3,390	3,312	3,461	3,461	3,407	3,270	3,460
Street Lighting - Sales					3,357	1,561	1,030	1,277	989	294	1,318	2,647	4,900
Company Use MCF	7,945	6,798	4,894	3,357								

DUKE ENERGY OHIO, INC.
CASE NO 07-589-GA-AIR
MCF SALES FORECAST
2007-2012

	FY12 Jan	FY12 Feb	FY12 Mar	FY12 Apr	FY12 May	FY12 Jun	FY12 Jul	FY12 Aug	FY12 Sep	FY12 Oct	FY12 Nov	FY12 Dec
Residential - Sales	5,159,496	4,673,998	3,890,366	2,422,083	1,212,409	701,973	526,657	472,954	507,391	798,830	1,832,922	3,640,300
Commercial - Sales	1,570,676	1,515,854	1,284,059	865,999	447,013	304,800	238,349	206,518	219,193	303,306	638,029	1,148,626
Commercial Residential - Sales	469,592	391,787	313,397	186,291	87,543	59,386	54,061	61,169	61,847	83,742	151,442	331,973
Electric Generation	0	0	0	0	0	0	0	0	0	0	0	0
Inter-Dept Less Elec Gener - Sales	19,556	14,537	9,760	7,502	5,542	2,705	6,083	4,187	2,074	4,914	10,101	13,039
Industrial - Sales	216,077	194,979	185,704	134,267	94,932	88,601	84,209	89,200	87,988	89,107	113,195	171,891
OPA - Sales	243,323	197,696	177,813	139,029	86,414	62,810	52,151	55,643	58,086	75,297	124,801	189,732
Commercial - Firm Transportation	1,019,670	953,977	791,062	518,302	279,400	176,038	142,792	131,476	143,323	207,230	418,044	777,298
Industrial - Firm Transportation	278,953	270,591	231,767	176,477	132,736	114,308	102,337	106,580	105,753	120,485	158,265	222,437
OPA - Firm Transportation	314,594	297,568	250,793	172,307	104,931	77,593	68,703	63,740	70,646	87,901	148,775	246,920
Residential - Firm Transportation	848,421	781,372	643,109	411,570	214,618	120,356	91,514	83,347	89,658	142,904	320,934	619,995
Commercial - Interruptible Transportation	245,800	235,355	213,470	189,628	148,846	128,932	119,809	122,090	123,665	134,783	159,561	213,862
Industrial - Interruptible Transportation	1,587,881	1,534,507	1,492,601	1,400,524	1,334,791	1,297,138	1,292,807	1,294,575	1,299,095	1,322,642	1,391,742	1,504,023
OPA - Interruptible Transportation	197,702	187,072	157,677	108,330	65,256	48,614	43,080	42,436	44,224	55,072	93,326	155,129
Other Public Utilities												
Street Lighting - Sales	3,626	3,334	3,459	3,386	3,453	3,390	3,512	3,461	3,407	3,462	3,270	3,440
Company Use MCF	7,945	6,798	4,894	3,357	1,561	1,030	1,277	989	284	1,318	2,647	4,900

DUKE ENERGY OHIO, INC
CASE NO 07-589-GA-AIR
CUSTOMER FORECAST
2007-2012

	FY07 Jan	FY07 Feb	FY07 Mar	FY07 Apr	FY07 May	FY07 Jun	FY07 Jul	FY07 Aug	FY07 Sep	FY07 Oct	FY07 Nov	FY07 Dec
Residential	334,579	335,108	335,562	335,708	335,305	335,331	332,682	332,829	332,934	333,470	334,074	335,063
Commercial	22,640	22,690	22,731	22,713	22,671	22,666	22,709	22,777	22,768	22,803	22,980	22,934
Commercial Residential	7,877	7,952	8,028	8,077	8,090	8,083	8,040	7,943	7,860	7,822	7,804	7,907
Electric Generation	0	0	0	0	0	0	0	0	0	0	0	0
Inter-Dept Less Elec Gener	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	1,163	1,169	1,173	1,174	1,176	1,178	1,179	1,180	1,181	1,179	1,181	1,181
OPA	855	868	873	876	878	879	879	881	881	886	885	886
Commercial - Firm Transportation	7,074	7,102	7,129	7,137	7,130	7,127	7,127	7,120	7,099	7,098	7,134	7,148
Industrial - Firm Transportation	415	417	418	419	420	420	420	421	421	420	422	422
OPA - Firm Transportation	551	559	562	564	566	567	567	570	570	570	571	571
Residential - Firm Transportation	48,237	48,313	48,379	48,399	48,342	48,345	51,397	51,419	51,432	51,511	51,598	51,740
Commercial - Interruptible Transportation	29	29	29	29	29	29	29	29	29	29	29	29
Industrial - Interruptible Transportation	125	124	124	124	124	124	124	124	124	124	124	124
OPA - Interruptible Transportation	10	10	10	10	10	10	10	10	10	10	10	10
Other Public Utilities	0	0	0	0	0	0	0	0	0	0	0	0
Street Lighting	7	7	7	7	7	7	7	7	7	7	7	7

DUKE ENERGY OHIO, INC.
CASE NO. 07-589-GA-AIR
CUSTOMER FORECAST
2007-2012

	FY08 Jan	FY08 Feb	FY08 Mar	FY08 Apr	FY08 May	FY08 Jun	FY08 Jul	FY08 Aug	FY08 Sep	FY08 Oct	FY08 Nov	FY08 Dec
Residential	335,616	336,187	336,692	336,895	336,554	336,642	336,500	336,708	336,854	337,415	338,023	339,013
Commercial	22,896	22,842	22,803	22,738	22,677	22,671	22,740	22,850	22,890	22,979	23,205	23,187
Commercial Residential	7,966	8,005	8,054	8,087	8,091	8,085	8,051	7,969	7,902	7,882	7,880	7,994
Electric Generation	0	0	0	0	0	0	0	0	0	0	0	0
Inter-Dept Less Elec Gener	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	1,180	1,180	1,180	1,181	1,182	1,182	1,183	1,184	1,186	1,184	1,188	1,188
Industrial	882	891	893	895	894	893	892	895	895	897	898	899
OPA	7,154	7,150	7,153	7,146	7,132	7,129	7,137	7,143	7,137	7,153	7,206	7,229
Commercial - Firm Transportation	422	422	422	422	422	422	423	423	424	423	424	425
Industrial - Firm Transportation	567	574	575	575	575	575	574	576	575	578	579	579
OPA - Firm Transportation	51,820	51,902	51,975	52,004	51,955	51,969	51,947	51,978	51,998	52,080	52,168	52,310
Residential - Firm Transportation	29	29	29	29	29	29	29	29	29	29	29	29
Commercial - Interruptible Transportation	124	124	124	124	124	124	124	124	124	124	124	124
Industrial - Interruptible Transportation	10	10	10	10	10	10	10	10	10	10	10	10
OPA - Interruptible Transportation	0	0	0	0	0	0	0	0	0	0	0	0
Other Public Utilities	0	0	0	0	0	0	0	0	0	0	0	0
Street Lighting	7	7	7	7	7	7	7	7	7	7	7	7

DUKE ENERGY OHIO, INC
CASE NO 07-589-GA-AIR
CUSTOMER FORECAST
2007-2012

	FY09 Jan	FY09 Feb	FY09 Mar	FY09 Apr	FY09 May	FY09 Jun	FY09 Jul	FY09 Aug	FY09 Sep	FY09 Oct	FY09 Nov	FY09 Dec
Residential	339,534	340,084	340,556	340,710	340,304	340,337	340,144	340,310	340,421	340,959	341,552	342,533
Commercial	23,168	23,121	23,092	23,034	22,979	22,979	23,054	23,171	23,215	23,309	23,543	23,526
Commercial Residential	8,060	8,103	8,156	8,192	8,198	8,195	8,163	8,080	8,015	7,995	7,995	8,111
Electric Generation	0	0	0	0	0	0	0	0	0	0	0	0
Inter-Dept Less Elec Gener	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	1,189	1,190	1,190	1,190	1,191	1,192	1,193	1,194	1,196	1,194	1,200	1,199
OPA	894	903	904	906	905	904	904	906	906	909	911	911
Commercial - Firm Transportation	7,239	7,239	7,243	7,239	7,227	7,226	7,236	7,244	7,240	7,257	7,309	7,333
Industrial - Firm Transportation	425	425	426	426	426	427	427	427	427	427	427	428
OPA - Firm Transportation	576	583	584	584	584	584	583	586	586	587	588	588
Residential - Firm Transportation	52,386	52,463	52,533	52,554	52,495	52,502	52,472	52,497	52,512	52,591	52,676	52,817
Commercial - Interruptible Transportation	29	29	29	29	29	29	29	29	29	29	29	29
Industrial - Interruptible Transportation	124	124	124	124	124	124	124	124	124	124	124	124
OPA - Interruptible Transportation	10	10	10	10	10	10	10	10	10	10	10	10
Other Public Utilities	0	0	0	0	0	0	0	0	0	0	0	0
Street Lighting	7	7	7	7	7	7	7	7	7	7	7	7

DUKE ENERGY OHIO, INC
CASE NO 07-589-GA-AIR
CUSTOMER FORECAST
2007-2012

	FY10 Jan	FY10 Feb	FY10 Mar	FY10 Apr	FY10 May	FY10 Jun	FY10 Jul	FY10 Aug	FY10 Sep	FY10 Oct	FY10 Nov	FY10 Dec
Residential	343,129	343,671	344,138	344,290	343,879	343,912	343,713	343,875	343,981	344,518	345,108	346,087
Commercial	23,499	23,447	23,405	23,334	23,267	23,254	23,317	23,422	23,455	23,541	23,767	23,746
Commercial Residential	8,176	8,217	8,267	8,299	8,301	8,295	8,256	8,164	8,098	8,075	8,072	8,187
Electric Generation	0	0	0	0	0	0	0	0	0	0	0	0
Inter-Dept Less Elec Gener	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	1,201	1,202	1,200	1,202	1,202	1,202	1,202	1,203	1,204	1,202	1,204	1,205
OPA	907	915	917	917	917	915	913	917	916	919	919	919
Commercial - Firm Transportation	7,342	7,337	7,340	7,332	7,315	7,311	7,316	7,321	7,312	7,326	7,378	7,401
Industrial - Firm Transportation	427	427	428	428	428	428	428	428	428	427	429	429
OPA - Firm Transportation	584	591	591	592	591	591	590	591	591	592	594	594
Residential - Firm Transportation	52,983	52,981	53,049	53,070	53,011	53,016	52,987	53,011	53,025	53,103	53,188	53,330
Commercial - Interruptible Transportation	29	29	29	29	29	29	29	29	29	29	29	29
Industrial - Interruptible Transportation	124	124	124	124	124	124	124	124	124	124	124	124
OPA - Interruptible Transportation	10	10	10	10	10	10	10	10	10	10	10	10
Other Public Utilities	0	0	0	0	0	0	0	0	0	0	0	0
Street Lighting	7	7	7	7	7	7	7	7	7	7	7	7

DUKE ENERGY OHIO, INC
CASE NO 07-589-GA-AIR
CUSTOMER FORECAST
2007-2012

	FY11 Jan	FY11 Feb	FY11 Mar	FY11 Apr	FY11 May	FY11 Jun	FY11 Jul	FY11 Aug	FY11 Sep	FY11 Oct	FY11 Nov	FY11 Dec
Residential	346,686	347,218	347,677	347,814	347,383	347,402	347,188	347,341	347,435	347,966	348,552	349,530
Commercial	23,719	23,662	23,618	23,545	23,421	23,434	23,514	23,618	23,648	23,731	23,957	23,935
Commercial Residential	8,252	8,292	8,341	8,373	8,374	8,365	8,325	8,236	8,164	8,140	8,136	8,252
Electric Generation	0	0	0	0	0	0	0	0	0	0	0	0
Inter-Dept Less Elec Gener	1,204	1,204	1,204	1,204	1,204	1,203	1,204	1,204	1,205	1,203	1,206	1,206
Industrial	914	923	915	925	924	923	920	922	920	922	922	921
OPA	7,409	7,405	7,406	7,396	7,390	7,374	7,380	7,382	7,373	7,387	7,439	7,460
Commercial - Firm Transportation	430	430	430	430	430	430	430	430	430	429	430	430
Industrial - Firm Transportation	590	596	596	596	596	595	594	595	595	595	595	595
OPA - Firm Transportation	53,416	53,494	53,558	53,579	53,517	53,528	53,489	53,511	53,524	53,602	53,685	53,826
Residential - Firm Transportation	29	29	29	29	29	29	29	29	29	29	29	29
Commercial - Interruptible Transportation	124	124	124	124	124	124	124	124	124	124	124	124
Industrial - Interruptible Transportation	10	10	10	10	10	10	10	10	10	10	10	10
OPA - Interruptible Transportation	0	0	0	0	0	0	0	0	0	0	0	0
Other Public Utilities	7	7	7	7	7	7	7	7	7	7	7	7
Street Lighting												

DUKE ENERGY OHIO, INC
CASE NO. 07-589-GA-AIR
CUSTOMER FORECAST
2007-2012

	FY12 Jan	FY12 Feb	FY12 Mar	FY12 Apr	FY12 May	FY12 Jun	FY12 Jul	FY12 Aug	FY12 Sep	FY12 Oct	FY12 Nov	FY12 Dec
Residential	350,114	350,641	351,088	351,213	350,763	350,765	350,531	350,667	350,743	351,260	351,830	352,798
Commercial	23,907	23,848	23,804	23,728	23,653	23,637	23,697	23,799	23,829	23,912	24,140	24,116
Commercial Residential	8,318	8,358	8,407	8,438	8,439	8,430	8,300	8,299	8,227	8,202	8,198	8,314
Electric Generation	0	0	0	0	0	0	0	0	0	0	0	0
Inter-Dept Less Elec Gener	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	1,206	1,206	1,206	1,206	1,205	1,205	1,205	1,205	1,205	1,203	1,206	1,205
OPA	915	923	923	922	920	918	913	917	915	916	915	915
Commercial - Firm Transportation	7,468	7,464	7,465	7,456	7,439	7,432	7,436	7,440	7,430	7,443	7,495	7,516
Industrial - Firm Transportation	430	430	430	430	430	430	430	430	430	429	430	430
OPA - Firm Transportation	990	595	595	595	594	592	591	591	590	591	591	590
Residential - Firm Transportation	53,911	53,986	54,051	54,070	54,005	54,005	53,971	53,991	54,002	54,076	54,158	54,298
Commercial - Interruptible Transportation	29	29	29	29	29	29	29	29	29	29	29	29
Industrial - Interruptible Transportation	124	124	124	124	124	124	124	124	124	124	124	124
OPA - Interruptible Transportation	10	10	10	10	10	10	10	18	10	10	10	10
Other Public Utilities	0	0	0	0	0	0	0	0	0	0	0	0
Street Lighting	7	7	7	7	7	7	7	7	7	7	7	7

EXHIBIT

Ohio Consumers' Counsel
Fourth Set Interrogatories
Duke Energy Ohio, Inc.
PUCO Case No. 07-589-GA-AIR
PUCO Case No. 07-590-GA-ALT
PUCO Case No. 07-591-GA-AAM
Date Received: August 29, 2007
Response Due: September 18, 2007

OCC-INT-04-094

REQUEST:

94. Referring to the testimony of witness Ziolkowski, Attachments JEZ-4, page 1, does the "Total Customers" amount include both transportation and sales residential customers?

RESPONSE:

The "Total Customers" amount shown on this attachment includes only Rate RS (sales) customers.

WITNESS RESPONSIBLE: James E. Ziolkowski

OCC Exhibit

Ohio Consumers' Counsel
Fourth Set Interrogatories
Duke Energy Ohio, Inc.
PUCO Case No. 07-589-GA-AIR
PUCO Case No. 07-590-GA-ALT
PUCO Case No. 07-591-GA-AAM
Date Received: August 29, 2007
Response Due: September 18, 2007

OCC-INT-04-095

REQUEST:

95.   If the response to the Interrogatory No. 94 is affirmative, what is the reason for such a large difference between the number of total residential customers reported in DE-Ohio's Annual Report to the PUCO, Schedule 33 of 380,774 and 342,507 as used on *Attachment JEZ-4, page 1*?

RESPONSE:

The residential customer count shown in Attachment JEZ-4, page 1 excludes Residential Firm Transportation customers. The total number of sales and transportation customers from workpaper WPE-4d is 392,599.

See Attachment OCC-INT-04-095 for a revised version of Attachment JEZ-4, page 1 that includes both sales and transportation customer counts is shown below.

WITNESS RESPONSIBLE: James E. Ziolkowski

DUKE ENERGY OHIO
CASE NO. 07-589-GA-AIR
RESIDENTIAL SERVICE
CUSTOMER CHARGE ANALYSIS / MINIMUM BILL RATIONALE
12 MONTHS ENDING DECEMBER 31, 2007

DATA: 3 MONTHS ACTUAL & 9 MONTHS ESTIMATED	SCHEDULE E-3.1
TYPE OF FILING: "X" ORIGINAL UPDATED REVISED	PAGE 1 OF 3
WORK PAPER REFERENCE NO(S).: SCHEDULE E-3.2b, WPE-4d	WITNESS RESPONSIBLE:
	J. E. ZIOLKOWSKI

LINE NO	DESCRIPTION	AMOUNT
1	Rate Base	215,512,417
2	Operating Expense	71,772,537
3	Return @ 8.73%	18,814,234
4	Operating Expense plus Return	90,586,771
5	Less Revenue Credits	1,594,102
6	Customer Cost Component (Revenue Requirement)	88,992,669
7	Total Customers	392,599
8	Annual Revenue / Customer	$ 226.68
9	Monthly Revenue / Customer	$ 18.89

EXHIBIT

Time Warner Cable Tests Data-Usage Rate Structure

Thursday , January 17, 2008

Associated Press

NEW YORK —

Time Warner Cable will experiment with a new pricing structure for high-speed Internet access later this year, charging customers based on how much data they download, a company spokesman said Wednesday.

The company, the second-largest cable provider in the United States, will start a trial in Beaumont, Texas, in which it will sell new Internet customers tiered levels of service based on how much data they download per month, rather than the usual fixed-price packages with unlimited downloads.

Company spokesman Alex Dudley said the trial was aimed at improving the network performance by making it more costly for heavy users of large downloads.

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Dudley said that a small group of super-heavy users of downloads, around 5 percent of the customer base, can account for up to 50 percent of network capacity.

Dudley said he did not know what the pricing tiers would be nor the download limits. He said the heavy users were likely using the network to download large amounts of video, most likely in high definition.

It was not clear when exactly the trial would begin, but Dudley said it would likely be around the second quarter.

The tiered pricing would only affect new customers in Beaumont, not existing ones.

Time Warner Cable is a subsidiary of Time Warner Inc., the world's largest media company.

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DCC Exhibit
10

EXHIBIT

Meteorological Data For The Current Year

Normals, Means, And Extremes

EXHIBIT

DUKE ENERGY OHIO
CASE NO. 07-589-GA-AIR
SALES STATISTICS-TOTAL COMPANY
GAS SALES
2002 - 2012

DATA: 3 MONTHS ACTUAL & 9 MONTHS ESTIMATED
TYPE OF FILING "X" ORIGINAL UPDATED REVISED
WORK PAPER REFERENCE NO(S).

LINE NO.	DESCRIPTION	MOST RECENT FIVE CALENDAR YEARS					TEST YEAR	FIVE PROJECTED CALENDAR YEARS				
		2002	2003	2004	2005	2006		2008	2009	2010	2011	2012
1	SALES BY CUSTOMER											
2	CLASSIFIED (A)											
3	REGULATED -											
4	RESIDENTIAL											
5	COMMERCIAL											
6	INDUSTRIAL											
7	OTHER											
8	TOTAL RETAIL											
9	TRANSPORTATION -											
10	RESIDENTIAL											
11	COMMERCIAL											
12	INDUSTRIAL											
13	OTHER											
14	TOTAL TRANSPORTATION											
15												
16	TOTAL RETAIL SALES (MCF)											
17												
18	NO. OF CUSTOMERS BY											
19	CLASS (YEAR END)											
20	REGULATED -											
21	RESIDENTIAL											
22	COMMERCIAL											
23	INDUSTRIAL											
24	OTHER											
25	TOTAL RETAIL											
26	TRANSPORTATION -											
27	RESIDENTIAL											
28	COMMERCIAL											
29	INDUSTRIAL											
30	OTHER											
31	TOTAL TRANSPORTATION											
32												
33	TOTAL RETAIL CUSTOMERS											

(A) Contains Billed and Unbilled Sales.

DUKE ENERGY OHIO
CASE NO. 07-589-GA-AIR
SALES STATISTICS-TOTAL COMPANY
GAS SALES
2002 - 2012

DATA: 3 MONTHS ACTUAL & 9 MONTHS ESTIMATED
TYPE OF FILING: "X" ORIGINAL UPDATED REVISED
WORK PAPER REFERENCE NO(S).

LINE NO.	DESCRIPTION	MOST RECENT FIVE CALENDAR YEARS						TEST YEAR	FIVE PROJECTED CALENDAR YEARS				
		2002	2003	2004	2005	2006	2007		2008	2009	2010	2011	2012
1	NO. OF CUSTOMERS BY												
2	CLASS (AVERAGE)												
3	REGULATED -												
4	RESIDENTIAL												
5	COMMERCIAL												
6	INDUSTRIAL												
7	OTHER												
8	TOTAL RETAIL												
9	TRANSPORTATION -												
10	RESIDENTIAL												
11	COMMERCIAL												
12	INDUSTRIAL												
13	OTHER												
14	TOTAL TRANSPORTATION												
15													
16	AVERAGE SALES PER												
17	CUSTOMER -												
18	REGULATED -												
19	RESIDENTIAL												
20	COMMERCIAL												
21	INDUSTRIAL												
22	TRANSPORTATION -												
23	RESIDENTIAL												
24	COMMERCIAL												
25	INDUSTRIAL												

EXHIBIT

Ohio Consumers' Counsel
Eighth Set Production of Documents
Duke Energy Ohio, Inc.
PUCO Case No. 07-589-GA-AIR
PUCO Case No. 07-590-GA-ALT
PUCO Case No. 07-591-GA-AAM
Date Received: November 16, 2007
Response Due:
December 6, 2007

OCC-POD-08-119

REQUEST:

Please provide a copy of any reports of surveys in the Company's possession over the last 25 years that contains information regarding the number of residential customers by housing unit (single family, apartment, multi-family, etc.) and sized (square foot) of dwelling.

RESPONSE:

Duke Energy Ohio does not routinely perform such surveys and does not have any such surveys in its current files. The Company has not performed a search of all closed files for such customer surveys because it would be extremely time-consuming and unduly burdensome to do so.

WITNESS RESPONSIBLE: James E. Ziolkowski

EXHIBIT

Duke Energy.

Feb. 28, 2008

CONTACT: Steve Brash
Phone: 513-419-5966
24-Hour: 704-382-8333

Duke Energy Ohio Announces Settlement in Gas Rate Application

CINCINNATI – Duke Energy Ohio announced today that it has reached a settlement agreement with the Staff of the Public Utilities Commission of Ohio (PUCO) and all intervening parties on its request for an increase in natural gas base rates.

The settlement calls for an annual revenue increase of $18.2 million overall, or 3 percent, compared with the company's original application of $34.1 million, or 5.8 percent. In addition to the Staff, intervenors joining in the agreement are the City of Cincinnati, Direct Energy, Integrys Energy Services, Interstate Gas Supply, the Kroger Co., the Office of Consumers' Counsel, Ohio Energy Group, Ohio Partners for Affordable Energy, People Working Cooperatively and Stand Energy.

The agreement will permit continued recovery of costs through 2018 for Duke Energy Ohio's accelerated main replacement program, which will improve the reliability and safety of the natural gas delivery system by replacing cast iron and bare steel mains, some of which were installed more than 130 years ago. The settlement also allows for recovery of costs of an additional safety program to replace certain types of risers that connect the gas service line to the gas meter.

"This application was required to continue the existing funding mechanism for investment in the gas delivery system so that we can improve its reliability and safety," said Sandra Meyer, president of Duke Energy Ohio. "We are about halfway through our

- more -

accelerated main replacement program and have already seen a 21 percent reduction in leaks on our system."

The settlement does not resolve the proposal of the company and PUCO Staff to move the fixed charges of providing gas service, such as capital investment in pipes and regulating equipment, billing and meter reading, to a monthly fixed charge rather than including them in the per unit charges. This design helps lower costs associated with usage and will minimize bills during times of extreme weather. This issue will be litigated in an evidentiary hearing at the PUCO in March.

For a residential customer using 10,800 cubic feet of natural gas, the proposed movement of the fixed charges out of the usage rate results in no increase to the current bill of $145.71. The actual amount of the bill will depend on the cost of natural gas at the time the increases take effect and the final rates approved by the PUCO. Natural gas costs are billed to customers at the company's cost or at the customer's agreed upon price with an alternative supplier, in either case without profit to Duke Energy Ohio.

"Duke Energy Ohio provides several resources to help customers manage their energy bills," said Meyer. "These include rebates on high-efficiency gas furnaces, energy audits, conservation tips and payment assistance programs." Under the settlement, funding for the low-income weatherization program would increase by 50 percent from $2 million to $3 million annually. More information is available on these programs at www.duke-energy.com.

If the settlement is approved, a pilot program will provide a $4 credit against the monthly fixed charge for low income customers at or below 175 percent of the federal poverty guideline who do not participate in the Percentage of Income Payment Plan. The credit would result in most of these customers seeing a reduction from their current bill. The pilot will be limited to the first 5,000 income-qualified customers to enroll.

- more -

Another benefit to customers under the settlement is that Duke Energy Ohio will take over responsibility for the individual service line from the gas main in the street to the meter. Previously, customers were responsible for the costs of repairing any leaks or damage that occurred to the service line. With this new approach, Duke Energy Ohio, rather than customers, will handle such repairs.

To foster gas customer choice, Duke Energy Ohio has also agreed to move approximately $5 million of carrying costs associated with gas inventory from the base rate to the Gas Cost Recovery mechanism. This prevents customers who have switched to alternate suppliers from paying these costs twice, once to their suppliers and a second time to Duke Energy Ohio, because all customers pay the base delivery rate. Currently, more than 94,000 Duke Energy Ohio customers receive their gas supply from an alternate supplier.

The settlement is subject to the review and approval of the PUCO. Duke Energy Ohio and the parties to the agreement may withdraw it if the PUCO alters the settlement in a manner unacceptable to them.

Duke Energy's Ohio operations deliver safe, reliable and competitively priced electricity to more than 680,000 electric customers and natural gas service to approximately 420,000 customers.

Duke Energy, one of the largest electric power companies in the United States, supplies and delivers energy to approximately 4 million U.S. customers. The company has approximately 36,000 megawatts of electric generating capacity in the Midwest and the Carolinas, and natural gas distribution services in Ohio and Kentucky. In addition, Duke Energy has more than 4,000 megawatts of electric generation in Latin America, and is a joint-venture partner in a U.S. real estate company. Headquartered in Charlotte, N.C., Duke Energy is a Fortune 500 company traded on the New York Stock Exchange under the symbol DUK. More information about the company is available on the Internet at: www.duke-energy.com.

EXHIBIT

PUCO Staff Data Requests
Duke Energy Ohio, Inc.
Case No. 07-589-GA-AIR
Date Received: November 17, 2007
Response Due: December 10, 2007

STAFF-DR-17-075

REQUEST:

For years 1, 2 and 3, using rates as provided below and using usage data based on January through December 2006 data, provide a breakdown of how many bills fall into usage levels for each class including the percentage of total customers (residential and non-residential) for those applicable usage levels.

a. Year 1 - Residential & Residential Firm Transpiration   Fixed Rate 20.00, volumetric rate 1.539416
    Year 2-   "   "   "   25.00, "   "   "   "   .99103
    Year 3 -   "   "   "   28.00, "   "   "   "   .733022

b. Year 1 -General Service & Firm Transportation   Fixed Rate 61.25, volumetric rate 1.535269
    Year 2-   "   "   "   78.50, "   "   "   "   .99052
    Year 3 -   "   "   "   79.50, "   "   "   "   .731475

RESPONSE:

See Attachment Staff-DR-17-075. Without knowing the planned rate design for IT customers, the Company is unable to determine the exact breakdown of usage levels for IT customers.

WITNESS RESPONSIBLE: James E. Ziolkowski

Duke Energy Ohio
Analysis of Proposed Year 3 Rates Proposed in Staff Data Request 17 - Based On Jan Through Dec 2006 Billing Data

Note: Size Categorized By Annual CCF
"Norm" Means Non-PIPP
"PIPP" Means PIPP Accounts
"12 Bills" Means 12 Bills For 2006

35,323 accounts excluded due to other than 12 bills

SIZE	Data	STATUS 12 Bills Norm Non-Res	RATE Residential	12 Bills Norm Total	12 Bills PIPP Non-Res	PIPP Residential	12 Bills PIPP Total	Grand Total	Running Total % of Total Customers Res	Non-Res	Total
Less than 50	Sum of NUM ACCTS	1,037	9,475	10,512		23	23	10,535	2.6302%	3.6151%	2.6072%
	Sum of ANN REV	$990,145	$3,107,024	$4,097,170		$7,764	$7,764	$4,194,933			
	Average of AVG ANN CCF	11	18	15		21	21	17			
	Sum of ANNREV/ACCT/12	$79.57	$26.12	$33.19		$28.13	$28.13	$33.18			
50 to 500	Sum of NUM ACCTS	5,118	79,973	85,091	1	1,509	1,510	87,601	24.2398%	24.9468%	24.2669%
	Sum of ANN REV	$5,961,189	$28,850,971	$34,812,161	$989	$546,766	$547,752	$35,359,913			
	Average of AVG ANN CCF	278	388	308	438	359	359	353			
	Sum of ANNREV/ACCT/12	$81.20	$30.06	$33.70	$82.17	$30.19	$30.23	$33.64			
500 to 1000	Sum of NUM ACCTS	5,008	201,883	206,589		4,384	4,384	211,073	78.1313%	42.3985%	78.5235%
	Sum of ANN REV	$5,042,137	$78,566,487	$83,607,824		$1,713,275	$1,713,275	$85,320,899			
	Average of AVG ANN CCF	729	731	729		748	748	735			
	Sum of ANNREV/ACCT/12	$83.93	$32.40	$33.71		$32.57	$32.57	$33.69			
1000 to 1500	Sum of NUM ACCTS	2,908	54,280	57,188		2,577	2,577	59,765	94.2776%	62.5392%	91.3139%
	Sum of ANN REV	$3,033,499	$22,919,707	$25,953,206		$1,094,973	$1,094,973	$27,048,179			
	Average of AVG ANN CCF	1,229	1,177	1,203		1,213	1,213	1,206			
	Sum of ANNREV/ACCT/12	$88.90	$35.19	$37.82		$35.41	$35.41	$37.72			
1500 to 2000	Sum of NUM ACCTS	1,990	10,137	12,127		978	978	13,105	97.2364%	58.4690%	94.5571%
	Sum of ANN REV	$2,151,208	$4,669,528	$6,820,736		$460,714	$460,714	$7,271,450			
	Average of AVG ANN CCF	1,739	1,700	1,718		1,703	1,703	1,713			
	Sum of ANNREV/ACCT/12	$90.08	$38.38	$46.87		$39.40	$39.40	$46.24			
2000 to 2500	Sum of NUM ACCTS	1,425	3,715	5,140		333	333	5,473	98.3169%	64.4341%	95.9116%
	Sum of ANN REV	$1,563,097	$1,852,076	$3,446,173		$165,672	$165,672	$3,610,844			
	Average of AVG ANN CCF	2,242	2,217	2,226		2,203	2,203	2,221			
	Sum of ANNREV/ACCT/12	$93.16	$41.54	$55.88		$41.46	$41.46	$54.98			
2500 to 3000	Sum of NUM ACCTS	1,142	1,836	2,978		133	133	3,111	98.8419%	68.4166%	96.5816%
	Sum of ANN REV	$1,318,825	$982,658	$2,301,484		$70,975	$70,975	$2,372,459			
	Average of AVG ANN CCF	2,742	2,720	2,731		2,696	2,696	2,710			
	Sum of ANNREV/ACCT/12	$96.21	$44.02	$64.40		$44.47	$44.47	$63.55			
3000 to 3500	Sum of NUM ACCTS	659	1,001	1,660		54	54	1,944	99.1235%	71.5147%	97.1620%
	Sum of ANN REV	$1,068,706	$972,913	$1,531,709		$30,982	$30,982	$1,662,691			
	Average of AVG ANN CCF	3,240	3,224	3,232		3,243	3,243	3,238			
	Sum of ANNREV/ACCT/12	$99.25	$47.70	$71.94		$47.81	$47.81	$71.27			
3500 to 4000	Sum of NUM ACCTS	745	637	1,382		12	12	1,394	99.2954%	74.1119%	97.5076%
	Sum of ANN REV	$914,811	$388,178	$1,302,766		$7,349	$7,349	$1,310,137			
	Average of AVG ANN CCF	3,741	3,790	3,735		3,771	3,771	3,747			
	Sum of ANNREV/ACCT/12	$102.31	$50.78	$78.58		$51.03	$51.03	$78.33			
4000 to 4500	Sum of NUM ACCTS	679	439	1,118		8	8	1,126	99.4145%	76.4790%	97.7683%
	Sum of ANN REV	$858,456	$284,114	$1,142,570		$5,150	$5,150	$1,147,720			
	Average of AVG ANN CCF	4,242	4,245	4,244		4,199	4,199	4,229			
	Sum of ANNREV/ACCT/12	$105.38	$53.93	$85.18		$53.65	$53.65	$84.94			
4500 to 5000	Sum of NUM ACCTS	567	351	918		1	1	919	99.5109%	78.4285%	98.0137%
	Sum of ANN REV	$724,796	$246,632	$971,431		$676	$676	$972,107			
	Average of AVG ANN CCF	4,747	4,736	4,739		4,640	4,640	4,708			
	Sum of ANNREV/ACCT/12	$106.44	$58.03	$88.18		$59.34	$59.34	$88.15			
5000 to 5500	Sum of NUM ACCTS	432	318	750		3	3	753	99.5954%	79.9269%	98.2001%

SIZE	Data	STATUS	RATE	12 Bills Norm Total	12 Bills PIPP		12 Bills PIPP Total	Grand Total	Running Total % of Total Customers		
		12 Bills Norm			Non-Res	Residential			Res	Non-Res	Total
		Non-Res	Residential								
5500 to 6000	Sum of ANN REV	$677,738	$228,767	$906,505		$2,205	$2,205	$908,711			
	Average of AVG ANN CCF	5,241	5,330	5,298		5,448	5,448	5,306			
	Sum of ANNREV/ACCT/12	$111.45	$58.95	$89.61		$61.28	$61.28	$89.50	99.6625%	81.3526%	98.3627%
	Sum of NUM ACCTS	409	245	654		3	3	657			
6000 to 6500	Sum of ANN REV	$562,420	$185,533	$747,943		$2,284	$2,284	$750,207			
	Average of AVG ANN CCF	5,757	5,747	5,752		5,712	5,712	5,736			
	Sum of ANNREV/ACCT/12	$114.59	$63.10	$96.30		$62.89	$62.89	$95.18	99.7171%	82.6774%	98.6074%
	Sum of NUM ACCTS	390	205	595				595			
6500 to 7000	Sum of ANN REV	$536,257	$102,389	$698,647				$698,647			
	Average of AVG ANN CCF	6,250	6,223	6,237				6,237			
	Sum of ANNREV/ACCT/12	$117.80	$68.01	$99.52				$99.52	99.7621%	83.7880%	98.6280%
	Sum of NUM ACCTS	318	169	487				487			
7000 to 7500	Sum of ANN REV	$460,520	$140,422	$600,942				$600,942			
	Average of AVG ANN CCF	6,756	6,751	6,754				6,754			
	Sum of ANNREV/ACCT/12	$120.68	$69.24	$102.83				$102.83	99.7941%	84.7859%	98.7272%
	Sum of NUM ACCTS	281	119	400		1	1	401			
7500 to 8000	Sum of ANN REV	$417,053	$103,031	$520,084		$858	$858	$520,911			
	Average of AVG ANN CCF	7,246	7,224	7,238		7,116	7,116	7,199			
	Sum of ANNREV/ACCT/12	$123.68	$72.13	$108.34		$71.47	$71.47	$108.25	99.8205%	85.6197%	98.8123%
	Sum of NUM ACCTS	245	99	344				344			
8000 to 8500	Sum of ANN REV	$372,735	$89,371	$462,105		7,744	7,744	$462,105			
	Average of AVG ANN CCF	7,756	7,731	7,744				7,744			
	Sum of ANNREV/ACCT/12	$126.78	$75.23	$111.94				$111.94	99.8394%	86.4110%	98.8691%
	Sum of NUM ACCTS	227	71	298				298			
8500 to 9000	Sum of ANN REV	$353,438	$66,657	$420,094				$420,094			
	Average of AVG ANN CCF	8,243	8,224	8,234				8,234			
	Sum of ANNREV/ACCT/12	$129.75	$78.24	$117.48				$117.48	99.8532%	87.0639%	98.9467%
	Sum of NUM ACCTS	193	52	245				245			
9000 to 9500	Sum of ANN REV	$307,716	$60,831	$368,547		8,753	8,753	$368,547			
	Average of AVG ANN CCF	8,766	8,753	8,753				8,753			
	Sum of ANNREV/ACCT/12	$132.87	$81.48	$121.98				$121.98	99.8841%	87.7849%	99.0103%
	Sum of NUM ACCTS	201	56	257				257			
9500 to 10000	Sum of ANN REV	$327,890	$66,706	$394,455		9,248	9,248	$394,455			
	Average of AVG ANN CCF	9,244	9,252	9,248				9,248			
	Sum of ANNREV/ACCT/12	$135.85	$84.52	$124.65				$124.65	99.8809%	88.3633%	99.0633%
	Sum of NUM ACCTS	166	48	214				214			
10,000 to 20,000	Sum of ANN REV	$276,074	$50,495	$327,199		8,765	8,765	$327,199			
	Average of AVG ANN CCF	9,744	8,707	9,755				8,765			
	Sum of ANNREV/ACCT/12	$136.89	$87.68	$127.40				$127.40	99.9758%	94.3176%	99.5741%
	Sum of NUM ACCTS	1,706	358	2,064				2,064			
20,000 to 30,000	Sum of ANN REV	$3,381,342	$468,009	$3,850,351		13,708	13,708	$3,850,351			
	Average of AVG ANN CCF	14,032	13,389	13,706				13,708			
	Sum of ANNREV/ACCT/12	$194.98	$100.79	$166.46				$166.46	99.9923%	95.5365%	99.7471%
	Sum of NUM ACCTS	637	62	699				699			
30,000 to 40,000	Sum of ANN REV	$1,730,884	$129,958	$1,860,843		24,155	24,155	$1,860,843			
	Average of AVG ANN CCF	24,209	24,012	24,155				24,155			
	Sum of ANNREV/ACCT/12	$227.61	$174.97	$222.92				$222.92	99.9981%	97.6503%	99.8315%
	Sum of NUM ACCTS	318	22	341				341			
40,000 to 50,000	Sum of ANN REV	$1,105,221	$82,528	$1,187,748		34,256	34,256	$1,187,748			
	Average of AVG ANN CCF	34,325	34,168	34,256				34,256			
	Sum of ANNREV/ACCT/12	$245.172	$259.64	$265.37				$265.37	99.9992%	98.3490%	99.8815%
	Sum of NUM ACCTS	198	4	202				202			
	Sum of ANN REV	$837,431	$14,318	$851,796				$851,796			
	Average of AVG ANN CCF	44,782	44,239	44,811				44,811			
	Sum of ANNREV/ACCT/12	$353.46	$329.94	$351.40				$351.40			

2 of 9

STATUS	RATE	12 Bills Norm		12 Bills Norm Total	12 Bills PIPP		12 Bills PIPP Total	Grand Total	Running Total % of Total Customers		
SIZE	Data	Non-Res	Residential		Non-Res	Residential			Res	Non-Res	Total
50,000 to 60,000	Sum of NUM ACCTS	94	1	95				95	99.9995%	94.8883%	99.9050%
	Sum of ANN REV	$485,962	$4,613	$470,576				$470,576			
	Average of AVG ANN CCF	54,726	58,350	56,538				56,538			
	Sum of ANNREV/ACCT/12	$413.09	$384.43	$412.79				$412.79			
60,000 to 70,000	Sum of NUM ACCTS	78		78				78	99.9996%	98.9332%	99.9238%
	Sum of ANN REV	$432,324		$432,324				$432,324			
	Average of AVG ANN CCF	64,725		64,725				64,725			
	Sum of ANNREV/ACCT/12	$474.04		$474.04				$474.04			
70,000 to 80,000	Sum of NUM ACCTS	46	1	49				49	99.9997%	99.1006%	99.9399%
	Sum of ANN REV	$307,576	$5,508	$313,083				$313,083			
	Average of AVG ANN CCF	74,559	70,567	72,668				72,668			
	Sum of ANNREV/ACCT/12	$533.98	$459.00	$532.45				$532.45			
80,000 to 90,000	Sum of NUM ACCTS	44		44				44	99.9997%	99.2540%	99.9468%
	Sum of ANN REV	$314,156		$314,156				$314,156			
	Average of AVG ANN CCF	84,598		84,598				84,598			
	Sum of ANNREV/ACCT/12	$594.99		$594.99				$594.99			
90,000 to 100,000	Sum of NUM ACCTS	38		38				38	99.9997%	99.3795%	99.9857%
	Sum of ANN REV	$282,031		$282,031				$282,031			
	Average of AVG ANN CCF	94,059		94,059				94,059			
	Sum of ANNREV/ACCT/12	$652.85		$652.85				$652.85			
100,000 to 110,000	Sum of NUM ACCTS	26		26				26	99.9997%	99.4701%	99.9831%
	Sum of ANN REV	$225,060		$225,060				$225,060			
	Average of AVG ANN CCF	105,307		105,307				105,307			
	Sum of ANNREV/ACCT/12	$721.41		$721.41				$721.41			
110,000 to 120,000	Sum of NUM ACCTS	16	1	17				17	100.0000%	99.8239%	99.9663%
	Sum of ANN REV	$149,494	$8,435	$157,922				$157,922			
	Average of AVG ANN CCF	114,963	110,526	112,608				112,608			
	Sum of ANNREV/ACCT/12	$778.66	$703.15	$774.13				$774.13			
More than 120,000	Sum of NUM ACCTS	136		136				136	100.0000%	100.0000%	100.0000%
	Sum of ANN REV	$2,677,311		$2,677,311				$2,677,311			
	Average of AVG ANN CCF	256,087		256,087				256,087			
	Sum of ANNREV/ACCT/12	$1,840.51		$1,840.51				$1,840.51			
Total Sum of NUM ACCTS		28,094	385,356	394,050	1	10,019	10,020	404,070	100.0000%	100.0000%	100.0000%
Total Sum of ANN REV		$39,799,337	$144,315,396	$184,114,733	$969	$4,099,622	$4,100,608	$188,215,341			
Total Sum of ANNREV/ACCT/12		$118.09	$32.93	$38.94	$82.17	$34.10	$34.10	$38.82			

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Duke Energy Ohio
Analysis of Proposed Year 2 Rates Proposed in Staff Data Request 17 - Based On Jan Through Dec 2006 Billing Data

Note: Size Categorized By Annual CCF
"Norm" Means Non-PIPP
"PIPP" Means PIPP Accounts
"12 Bills" Means 12 Bills For 2006

36,323 accounts excluded due to other than 12 bills

SIZE	Data	12 Bills Norm Non-Res	12 Bills Norm Residential	12 Bills Norm Total	12 Bills PIPP Non-Res	12 Bills PIPP Residential	12 Bills PIPP Total	Grand Total	Running Total % Res	Running Total % Non-Res	Running Total % Total
Less than 50	Sum of NUM ACCTS	1,037	9,478	10,512		23	23	10,535	2.5362%	3.8151%	2.5072%
	Sum of ANN REV	$978,001	$2,860,649	$3,836,651		$8,948	$8,948	$3,846,599			
	Average of AVG ANN CCF	11	19	15		21	21	17			
	Sum of ANNREV/ACCT/12	$78.59	$25.16	$30.43		$25.18	$25.18	$30.42			
50 to 500	Sum of NUM ACCTS	6,118	79,973	86,091	1	1,509	1,510	87,601	24.2366%	24.9489%	24.2889%
	Sum of ANN REV	$6,931,906	$26,668,176	$33,600,782	$966	$906,430	$907,415	$33,108,197			
	Average of AVG ANN CCF	276	336	308	438	359	359	333			
	Sum of ANNREV/ACCT/12	$80.80	$27.19	$31.58	$82.12	$27.97	$28.09	$31.50			
500 to 1000	Sum of NUM ACCTS	5,005	201,683	206,688		4,384	4,384	211,072	79.1313%	42.3985%	76.5236%
	Sum of ANN REV	$5,073,413	$75,108,287	$80,182,680		$1,640,014	$1,640,014	$81,822,604			
	Average of AVG ANN CCF	728	731	729		748	748	733			
	Sum of ANNREV/ACCT/12	$84.51	$31.03	$32.33		$31.17	$31.17	$32.30			
1000 to 1500	Sum of NUM ACCTS	2,906	54,280	57,186		2,577	2,577	59,763	94.2776%	62.5292%	91.3139%
	Sum of ANN REV	$3,091,120	$22,613,459	$25,704,579		$1,082,839	$1,082,839	$26,787,418			
	Average of AVG ANN CCF	1,229	1,177	1,203		1,213	1,213	1,206			
	Sum of ANNREV/ACCT/12	$88.64	$34.72	$37.46		$35.02	$35.02	$37.36			
1500 to 2000	Sum of NUM ACCTS	1,990	10,137	12,127		978	978	13,105	97.2396%	59.4669%	94.5571%
	Sum of ANN REV	$2,216,437	$4,748,330	$6,966,166		$458,464	$458,464	$7,424,641			
	Average of AVG ANN CCF	1,738	1,700	1,716		1,703	1,703	1,713			
	Sum of ANNREV/ACCT/12	$92.83	$39.04	$47.87		$39.07	$39.07	$47.21			
2000 to 2500	Sum of NUM ACCTS	1,425	3,715	5,140		333	333	5,473	98.3109%	64.4344%	95.9116%
	Sum of ANN REV	$1,656,741	$1,930,972	$3,589,414		$172,814	$172,814	$3,762,228			
	Average of AVG ANN CCF	2,242	2,217	2,229		2,203	2,203	2,221			
	Sum of ANNREV/ACCT/12	$97.00	$43.31	$58.20		$43.20	$43.20	$57.28			
2500 to 3000	Sum of NUM ACCTS	1,142	1,836	2,978		133	133	3,111	98.9415%	68.4165%	96.6615%
	Sum of ANN REV	$1,385,941	$1,045,708	$2,431,649		$75,439	$75,439	$2,507,089			
	Average of AVG ANN CCF	2,742	2,720	2,731		2,699	2,699	2,719			
	Sum of ANNREV/ACCT/12	$101.13	$47.46	$68.04		$47.27	$47.27	$67.16			
3000 to 3500	Sum of NUM ACCTS	889	1,001	1,890		54	54	1,944	99.1225%	71.5147%	97.1629%
	Sum of ANN REV	$1,122,741	$620,147	$1,742,889		$33,557	$33,557	$1,776,446			
	Average of AVG ANN CCF	3,240	3,224	3,232		3,243	3,243	3,235			
	Sum of ANNREV/ACCT/12	$105.24	$51.63	$76.85		$51.79	$51.79	$76.15			
3500 to 4000	Sum of NUM ACCTS	745	637	1,382		12	12	1,394	99.2064%	74.1110%	97.5078%
	Sum of ANN REV	$977,673	$426,841	$1,404,414		$8,084	$8,084	$1,412,499			
	Average of AVG ANN CCF	3,741	3,730	3,735		3,771	3,771	3,747			
	Sum of ANNREV/ACCT/12	$109.38	$55.80	$84.66		$55.14	$55.14	$84.44			
4000 to 4500	Sum of NUM ACCTS	670	439	1,109		8	8	1,126	99.4145%	76.4780%	97.7883%
	Sum of ANN REV	$924,922	$316,393	$1,241,315		$5,729	$5,729	$1,247,044			
	Average of AVG ANN CCF	4,242	4,248	4,244		4,199	4,199	4,229			
	Sum of ANNREV/ACCT/12	$113.52	$60.04	$82.52		$59.68	$59.68	$82.29			
4500 to 5000	Sum of NUM ACCTS	567	351	918		9	9	919	99.5106%	78.4208%	98.0137%
	Sum of ANN REV	$786,613	$277,751	$1,064,365		$760	$760	$1,065,124			
	Average of AVG ANN CCF	4,747	4,738	4,742		4,640	4,640	4,708			
	Sum of ANNREV/ACCT/12	$117.68	$64.13	$96.62		$63.32	$63.32	$96.59			
5000 to 5500	Sum of NUM ACCTS	432	318	750		3	3	753	99.5964%	79.9268%	98.2001%

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SIZE	Data	12 Bills Norm Non-Res	12 Bills Norm Residential	12 Bills Norm Total	12 Bills PIPP Non-Res	12 Bills PIPP Residential	12 Bills PIPP Total	Grand Total	Running Total % Res	Running Total % Non-Res	Running Total % Total
	Sum of ANN REV	$631,203	$260,232	$891,436		$2,520	$2,520	$893,954			
	Average of AVG ANN CCF	5,241	5,230	5,239		5,448	5,448	5,309			
	Sum of ANNREV/ACCT/12	$121.76	$68.19	$99.06		$68.99	$68.99	$98.93			
5500 to 6000	Sum of NUM ACCTS	409	245	654		3	3	657	99.6625%	81.3526%	98.3527%
	Sum of ANN REV	$618,507	$213,026	$831,533		$2,568	$2,568	$834,133			
	Average of AVG ANN CCF	5,757	5,747	5,752		5,712	5,712	5,738			
	Sum of ANNREV/ACCT/12	$126.02	$72.46	$105.88		$72.17	$72.17	$105.60			
6000 to 6500	Sum of NUM ACCTS	380	206	586				586	99.7171%	82.6774%	98.5074%
	Sum of ANN REV	$593,225	$187,922	$781,147				$781,147			
	Average of AVG ANN CCF	6,250	6,223	6,237				6,237			
	Sum of ANNREV/ACCT/12	$130.09	$78.39	$111.27				$111.27			
6500 to 7000	Sum of NUM ACCTS	318	169	487				487	99.7621%	83.7860%	98.6280%
	Sum of ANN REV	$612,357	$103,777	$676,134				$676,134			
	Average of AVG ANN CCF	6,756	6,751	6,754				6,754			
	Sum of ANNREV/ACCT/12	$134.27	$80.76	$115.70				$115.70			
7000 to 7500	Sum of NUM ACCTS	281	119	400		1	1	401	99.7941%	84.7850%	98.7272%
	Sum of ANN REV	$466,440	$120,897	$567,336		$1,006	$1,006	$568,343			
	Average of AVG ANN CCF	7,750	7,234	7,299		7,116	7,116	7,196			
	Sum of ANNREV/ACCT/12	$138.33	$84.86	$122.39		$83.77	$83.77	$122.27			
7500 to 8000	Sum of NUM ACCTS	245	99	344				344	99.8205%	85.6197%	98.8123%
	Sum of ANN REV	$419,022	$106,555	$524,577				$524,577			
	Average of AVG ANN CCF	7,758	7,731	7,744				7,744			
	Sum of ANNREV/ACCT/12	$142.53	$88.85	$127.09				$127.09			
8000 to 8500	Sum of NUM ACCTS	237	71	298				298	99.8394%	86.4110%	98.8661%
	Sum of ANN REV	$399,166	$79,187	$478,353				$478,353			
	Average of AVG ANN CCF	8,243	8,224	8,234				8,234			
	Sum of ANNREV/ACCT/12	$140.54	$92.02	$133.77				$133.77			
8500 to 9000	Sum of NUM ACCTS	193	52	245				245	99.8532%	87.0893%	98.9467%
	Sum of ANN REV	$349,170	$60,701	$409,871				$409,871			
	Average of AVG ANN CCF	8,755	8,752	8,753				8,753			
	Sum of ANNREV/ACCT/12	$150.76	$97.28	$139.41				$139.41			
9000 to 9500	Sum of NUM ACCTS	201	56	257				257	99.8681%	87.7849%	98.0103%
	Sum of ANN REV	$373,378	$68,147	$441,525				$441,525			
	Average of AVG ANN CCF	9,244	9,252	9,246				9,246			
	Sum of ANNREV/ACCT/12	$154.80	$101.41	$143.17				$143.17			
9500 to 10000	Sum of NUM ACCTS	166	48	214				214	99.8809%	88.3633%	98.0833%
	Sum of ANN REV	$316,661	$60,903	$377,444				$377,444			
	Average of AVG ANN CCF	9,744	9,767	9,755				9,755			
	Sum of ANNREV/ACCT/12	$158.93	$108.98	$146.99				$146.99			
10,000 to 20,000	Sum of NUM ACCTS	1,708	356	2,064				2,064	99.9759%	94.3176%	98.9741%
	Sum of ANN REV	$3,981,268	$578,172	$4,559,440				$4,559,440			
	Average of AVG ANN CCF	14,022	13,399	13,708				13,708			
	Sum of ANNREV/ACCT/12	$184.25	$135.57	$184.13				$184.13			
20,000 to 30,000	Sum of NUM ACCTS	637	62	699				699	99.9923%	96.5303%	98.7471%
	Sum of ANN REV	$2,133,194	$166,136	$2,299,330				$2,299,330			
	Average of AVG ANN CCF	24,298	24,012	24,159				24,159			
	Sum of ANNREV/ACCT/12	$279.07	$223.30	$274.12				$274.12			
30,000 to 40,000	Sum of NUM ACCTS	319	22	341				341	99.9981%	97.6503%	98.8315%
	Sum of ANN REV	$1,386,022	$81,139	$1,466,161				$1,466,161			
	Average of AVG ANN CCF	34,323	34,188	34,359				34,359			
	Sum of ANNREV/ACCT/12	$381.61	$307.58	$358.30				$358.30			
40,000 to 50,000	Sum of NUM ACCTS	198	4	202				202	99.9992%	98.3406%	98.8615%
	Sum of ANN REV	$1,064,797	$18,737	$1,063,534				$1,063,534			
	Average of AVG ANN CCF	44,762	44,239	44,511				44,511			
	Sum of ANNREV/ACCT/12	$448.18	$390.55	$447.00				$447.00			

SIZE	Data	STATUS	RATE		12 Bills Norm Total	12 Bills PIPP		12 Bills PIPP Total	Grand Total	Running Total % of Total Customers		
		12 Bills Norm				Non-Res	Residential			Res	Non-Res	Total
		Non-Res	Residential									
50,000 to 60,000	Sum of NUM ACCTS	94	1		95				95	99.9995%	99.6883%	99.9050%
	Sum of ANN REV	$598,083	$6,083		$604,176				$604,175			
	Average of AVG ANN CCF	54,726	58,350		56,538				56,538			
	Sum of ANNREV/ACCT/12	$530.22	$506.89		$529.98				$529.98			
60,000 to 70,000	Sum of NUM ACCTS	76			76				76	99.9995%	98.9332%	99.9238%
	Sum of ANN REV	$558,639			$558,639				$558,639			
	Average of AVG ANN CCF	64,725			64,725				64,725			
	Sum of ANNREV/ACCT/12	$612.76			$612.76				$612.76			
70,000 to 80,000	Sum of NUM ACCTS	48	1		49				49	99.9997%	99.1006%	99.9359%
	Sum of ANN REV	$399,707	$7,292		$406,999				$406,999			
	Average of AVG ANN CCF	74,669	70,557		72,558				72,558			
	Sum of ANNREV/ACCT/12	$693.94	$607.70		$892.18				$892.18			
80,000 to 90,000	Sum of NUM ACCTS	44			44				44	99.9997%	99.2540%	99.9446%
	Sum of ANN REV	$410,018			$410,018				$410,018			
	Average of AVG ANN CCF	84,568			84,568				84,568			
	Sum of ANNREV/ACCT/12	$776.55			$776.55				$776.55			
90,000 to 100,000	Sum of NUM ACCTS	36			36				36	99.9997%	99.3795%	99.9557%
	Sum of ANN REV	$369,315			$369,315				$369,315			
	Average of AVG ANN CCF	94,069			94,069				94,069			
	Sum of ANNREV/ACCT/12	$854.90			$854.00				$854.90			
100,000 to 110,000	Sum of NUM ACCTS	28			28				28	99.9997%	99.4701%	99.9621%
	Sum of ANN REV	$285,694			$285,694				$285,694			
	Average of AVG ANN CCF	105,307			105,307				105,307			
	Sum of ANNREV/ACCT/12	$847.74			$847.74				$847.74			
110,000 to 120,000	Sum of NUM ACCTS	16	1		17				17	100.0000%	99.5299%	99.9653%
	Sum of ANN REV	$196,825	$11,253		$208,079				$208,079			
	Average of AVG ANN CCF	114,663	110,526		112,605				112,605			
	Sum of ANNREV/ACCT/12	$1,025.13	$937.75		$1,019.99				$1,019.99			
More than 120,000	Sum of NUM ACCTS	135			135				135	100.0000%	100.0000%	100.0000%
	Sum of ANN REV	$3,577,676			$3,577,676				$3,577,676			
	Average of AVG ANN CCF	288,067			288,087				290,067			
	Sum of ANNREV/ACCT/12	$2,192.33			$2,192.33				$2,192.33			
Total Sum of NUM ACCTS		23,684	395,366		394,050		10,019	10,020	404,070	100.0000%	100.0000%	100.0000%
Total Sum of ANN REV		$43,000,628	$139,608,087		$182,608,613	$906	$3,997,022	$3,998,009	$186,604,911			
Total Sum of ANNREV/ACCT/12		$127.23	$31.99		$38.62	$3.12	$53.16	$33.25	$38.48			

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Analysis of Proposed Year 1 Rates Proposed In Staff Data Request 17 - Based On Jan Through Dec 2006 Billing Data

Note: Size Categorized By Annual CCF
"Norm" Means Non-PIPP
"PIPP" Means PIPP Accounts
"12 Bills" Means 12 Bills For 2006

35,323   accounts excluded due to other than 12 bills

		STATUS	RATE			12 Bills PIPP		12 Bills PIPP Total	Grand Total		Running Total % of Total Customers		
		12 Bills Norm		12 Bills Norm Total	12 Bills PIPP Non-Res	Residential					Res	Non-Res	Total
SIZE	Data	Non-Res	Residential										
Less than 50	Sum of NUM ACCTS	1,037	9,475	10,512		23	23	10,635		2.5303%	3.6151%	2.6072%
	Sum of ANN REV	$763,973	$2,302,182	$3,066,160		$5,566	$5,566	$3,071,761				
	Average of AVG ANN CCF	11	19	15		21	21	17				
	Sum of ANNREVHACCT/12	$61.39	$20.25	$24.31		$20.27	$20.27	$24.30				
50 to 500	Sum of NUM ACCTS	8,118	79,873	88,991		1,518	1,510	87,501	24.2385%	24.9458%	24.2888%
	Sum of ANN REV	$4,758,285	$23,381,800	$28,110,085	1	$445,422	$446,424	$28,556,509			
	Average of AVG ANN CCF	276	338	306	$402 438	389	389	369			
	Sum of ANNREV/ACCT/12	$64.81	$24.33	$27.21	$60.45	$24.64	$24.64	$27.17			
500 to 1000	Sum of NUM ACCTS	5,009	201,689	206,688		4,384	4,384	211,073	79.1313%	43.3985%	78.5236%
	Sum of ANN REV	$4,338,576	$71,984,947	$78,323,523		$1,556,710	$1,556,710	$78,880,232			
	Average of AVG ANN CCF	728	731	729		748	748	735			
	Sum of ANNREV/ACCT/12	$70.88	$23.37	$30.37		$29.59	$29.59	$30.35			
1000 to 1500	Sum of NUM ACCTS	2,906	34,260	37,166		2,577	2,577	59,763	97.2366%	52.5293%	81.3130%
	Sum of ANN REV	$2,684,082	$22,859,063	$25,543,145		$1,099,613	$1,099,613	$26,642,758			
	Average of AVG ANN CCF	1,229	1,177	1,209		1,213	1,213	1,209			
	Sum of ANNREV/ACCT/12	$79.97	$35.09	$37.22		$35.56	$35.56	$37.16			
1500 to 2000	Sum of NUM ACCTS	1,980	10,157	12,127		978	978	13,105	97.3306%	59.4666%	94.6571%
	Sum of ANN REV	$1,998,135	$6,098,342	$7,078,477		$491,153	$491,153	$7,570,631			
	Average of AVG ANN CCF	1,736	1,700	1,718		1,703	1,703	1,713			
	Sum of ANNREV/ACCT/12	$83.48	$41.81	$48.66		$41.85	$41.85	$48.14			
2000 to 2500	Sum of NUM ACCTS	1,428	3,716	5,140		333	333	5,473	98.3106%	64.4344%	93.9116%
	Sum of ANN REV	$1,357,770	$2,159,712	$3,597,481		$192,571	$192,571	$3,690,052			
	Average of AVG ANN CCF	2,242	2,217	2,229		2,203	2,203	2,221			
	Sum of ANNREV/ACCT/12	$59.93	$45.48	$58.95		$49.27	$49.27	$59.24			
2500 to 3000	Sum of NUM ACCTS	1,142	1,836	2,978		133	133	3,111	98.8416%	68.4165%	98.5615%
	Sum of ANN REV	$1,320,133	$1,208,406	$2,528,638		$87,125	$87,125	$2,615,664			
	Average of AVG ANN CCF	2,742	2,729	2,731		2,698	2,698	2,718			
	Sum of ANNREV/ACCT/12	$96.33	$54.89	$70.79		$54.59	$54.59	$70.00			
3000 to 3500	Sum of NUM ACCTS	860	1,091	1,950		54	54	1,944	99.1225%	71.5147%	97.1628%
	Sum of ANN REV	$1,095,834	$737,074	$1,832,909		$39,921	$39,921	$1,872,620			
	Average of AVG ANN CCF	3,240	3,224	3,232		3,243	3,243	3,236			
	Sum of ANNREV/ACCT/12	$102.70	$61.33	$80.81		$61.61	$61.61	$80.27			
3500 to 4000	Sum of NUM ACCTS	745	637	1,382		12	12	1,394	99.2954%	74.1119%	97.5078%
	Sum of ANN REV	$978,494	$516,602	$1,494,096		$9,846	$9,846	$1,503,942			
	Average of AVG ANN CCF	3,741	3,730	3,735		3,771	3,771	3,747			
	Sum of ANNREV/ACCT/12	$109.12	$67.54	$90.09		$88.37	$88.37	$89.91			
4000 to 4500	Sum of NUM ACCTS	679	439	1,118		8	8	1,186	99.4145%	76.4790%	97.7883%
	Sum of ANN REV	$941,275	$392,253	$1,333,528		$7,091	$7,091	$1,340,619			
	Average of AVG ANN CCF	4,242	4,246	4,244		4,199	4,199	4,229			
	Sum of ANNREV/ACCT/12	$115.52	$74.46	$99.40		$73.87	$73.87	$99.22			
4500 to 5000	Sum of NUM ACCTS	587	329	916		7	7	919	99.5109%	78.4209%	98.0137%
	Sum of ANN REV	$816,380	$349,857	$1,166,217		$954	$954	$1,165,172			
	Average of AVG ANN CCF	4,747	4,736	4,742		4,640	4,640	4,708			
	Sum of ANNREV/ACCT/12	$121.99	$80.78	$109.77		$79.52	$79.52	$109.75			
5000 to 5500	Sum of NUM ACCTS	483	318	760		3	3	763	99.5904%	79.9288%	98.2001%

	STATUS	RATE		12 Bills Norm Total	12 Bills PHPP		12 Bills PHPP Total	Grand Total	Running Total % of Total Customers		
	12 Bills Norm				Non-Res	Residential			Res	Non-Res	Total
SIZE	Data	Non-Res	Residential								
	Sum of ANN REV	$665,113	$332,362	$997,475		$3,236	$3,236	$1,000,710			
	Average of AVG ANN CCF	5,241	5,230	5,236		5,448	5,448	5,306			
	Sum of ANNREV/ACCT/12	$128.30	$87.10	$110.83		$89.89	$89.89	$110.75	99.6625%	81.3526%	98.3627%
5500 to 6000	Sum of NUM ACCTS	409	245	664		3	3	657			
	Sum of ANN REV	$662,111	$275,536	$937,647		$3,358	$3,358	$941,005			
	Average of AVG ANN CCF	6,767	5,747	5,752		5,712	5,712	5,738			
	Sum of ANNREV/ACCT/12	$134.90	$93.72	$119.48		$93.27	$93.27	$119.36	98.7171%	82.8774%	98.5074%
6000 to 6500	Sum of NUM ACCTS	380	205	585				585			
	Sum of ANN REV	$643,962	$245,576	$889,630				$889,530			
	Average of AVG ANN CCF	6,250	6,223	6,237				6,237			
	Sum of ANNREV/ACCT/12	$141.22	$99.63	$126.71				$126.71	98.7621%	83.7980%	98.6290%
6500 to 7000	Sum of NUM ACCTS	318	169	487				487			
	Sum of ANN REV	$563,564	$216,206	$779,771				$779,771			
	Average of AVG ANN CCF	6,756	6,761	6,754				6,754			
	Sum of ANNREV/ACCT/12	$147.98	$106.81	$133.43				$133.43	98.7941%	84.7658%	98.7272%
7000 to 7500	Sum of NUM ACCTS	281	119	400		1	1	401			
	Sum of ANN REV	$519,222	$180,128	$680,128		$1,335	$1,335	$681,458			
	Average of AVG ANN CCF	7,248	7,224	7,238		7,116	7,116	7,106			
	Sum of ANNREV/ACCT/12	$183.08	$112.66	$141.69		$111.29	$111.29	$141.62	98.8205%	85.6197%	98.8123%
7500 to 8000	Sum of NUM ACCTS	245	99	344				344			
	Sum of ANN REV	$471,827	$141,589	$613,416				$613,416			
	Average of AVG ANN CCF	7,756	7,731	7,744				7,744			
	Sum of ANNREV/ACCT/12	$160.49	$119.18	$148.60				$148.60	98.8394%	86.4110%	98.8661%
8000 to 8500	Sum of NUM ACCTS	227	71	298				298			
	Sum of ANN REV	$454,134	$106,927	$561,061				$561,061			
	Average of AVG ANN CCF	8,243	8,234	8,234				8,234			
	Sum of ANNREV/ACCT/12	$166.72	$125.50	$156.90				$156.90	98.8532%	87.0838%	98.9467%
8500 to 9000	Sum of NUM ACCTS	193	52	245				245			
	Sum of ANN REV	$401,253	$82,537	$483,600				$483,600			
	Average of AVG ANN CCF	8,785	8,752	8,753				8,753			
	Sum of ANNREV/ACCT/12	$173.26	$132.27	$164.56				$164.56	98.8681%	87.7844%	98.9109%
9000 to 9500	Sum of NUM ACCTS	201	56	257				257			
	Sum of ANN REV	$432,984	$93,200	$526,184				$526,184			
	Average of AVG ANN CCF	9,244	9,262	9,248				9,248			
	Sum of ANNREV/ACCT/12	$179.51	$138.69	$170.62				$170.62	98.8996%	88.9633%	98.9633%
9500 to 10000	Sum of NUM ACCTS	166	48	214				214			
	Sum of ANN REV	$370,328	$83,693	$454,021				$454,021			
	Average of AVG ANN CCF	9,744	9,767	9,755				9,755			
	Sum of ANNREV/ACCT/12	$185.91	$145.30	$176.68				$176.68	98.9758%	94.3176%	98.9741%
10,000 to 20,000	Sum of NUM ACCTS	1,706	356	2,064				2,064			
	Sum of ANN REV	$4,932,408	$818,198	$5,751,606				$5,751,606			
	Average of AVG ANN CCF	14,022	13,399	13,700				13,700			
	Sum of ANNREV/ACCT/12	$240.95	$191.76	$232.22				$232.22	98.9923%	96.5383%	98.7471%
20,000 to 30,000	Sum of NUM ACCTS	637	62	699				699			
	Sum of ANN REV	$2,844,504	$244,055	$3,088,559				$3,088,559			
	Average of AVG ANN CCF	24,298	24,012	24,165				24,165			
	Sum of ANNREV/ACCT/12	$372.12	$328.03	$368.21				$368.21	98.9981%	97.6503%	98.8315%
30,000 to 40,000	Sum of NUM ACCTS	319	22	341				341			
	Sum of ANN REV	$1,916,436	$121,066	$2,036,502				$2,036,502			
	Average of AVG ANN CCF	34,323	34,188	34,256				34,256			
	Sum of ANNREV/ACCT/12	$500.38	$459.39	$497.66				$497.66	98.9980%	98.3490%	98.8615%
40,000 to 50,000	Sum of NUM ACCTS	198	4	202				202			
	Sum of ANN REV	$1,506,833	$28,201	$1,535,034				$1,535,034			
	Average of AVG ANN CCF	44,762	44,238	44,511				44,511			
	Sum of ANNREV/ACCT/12	$634.18	$587.52	$633.38				$633.38			

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SIZE	Data	STATUS 12 Bills Norm Non-Res	RATE Residential	12 Bills Norm Total	12 Bills PIPP Non-Res	Residential	12 Bills PIPP Total	Grand Total	Running Total % of Total Customers Res	Non-Res	Total
50,000 to 60,000	Sum of NUM ACCTS	94	1	95				95	99.9995%	99.6683%	99.9050%
	Sum of ANN REV	$858,865	$9,222	$868,088				$868,088			
	Average of AVG ANN CCF	54,728	58,360	56,538				56,538			
	Sum of ANNREV/ACCT/12	$781.41	$768.54	$781.48				$781.48			
60,000 to 70,000	Sum of NUM ACCTS	78		78				78	99.9995%	99.9332%	99.9238%
	Sum of ANN REV	$811,075		$811,075				$811,075			
	Average of AVG ANN CCF	64,725		64,725				64,725			
	Sum of ANNREV/ACCT/12	$866.34		$869.34				$869.34			
70,000 to 80,000	Sum of NUM ACCTS	48	1	49				49	99.9997%	99.1005%	99.9359%
	Sum of ANN REV	$584,728	$11,102	$595,829				$595,829			
	Average of AVG ANN CCF	74,569	70,557	72,558				72,558			
	Sum of ANNREV/ACCT/12	$1,015.15	$925.14	$1,013.32				$1,013.32			
80,000 to 90,000	Sum of NUM ACCTS	44		44				44	99.9997%	98.2540%	99.9488%
	Sum of ANN REV	$503,609		$503,609				$503,609			
	Average of AVG ANN CCF	84,568		84,568				84,568			
	Sum of ANNREV/ACCT/12	$1,143.20		$1,143.20				$1,143.20			
90,000 to 100,000	Sum of NUM ACCTS	36		36				36	99.9997%	99.3786%	99.9557%
	Sum of ANN REV	$546,323		$546,323				$546,323			
	Average of AVG ANN CCF	94,059		94,059				94,059			
	Sum of ANNREV/ACCT/12	$1,264.64		$1,264.64				$1,264.64			
100,000 to 110,000	Sum of NUM ACCTS	26		26				26	99.9997%	99.4701%	99.9631%
	Sum of ANN REV	$439,484		$439,484				$439,484			
	Average of AVG ANN CCF	105,307		105,307				105,307			
	Sum of ANNREV/ACCT/12	$1,409.54		$1,409.54				$1,409.54			
110,000 to 120,000	Sum of NUM ACCTS	16	1	17				17	100.0000%	99.5259%	99.9663%
	Sum of ANN REV	$293,471	$17,255	$310,725				$310,725			
	Average of AVG ANN CCF	114,643	110,826	112,805				112,805			
	Sum of ANNREV/ACCT/12	$1,528.49	$1,437.09	$1,523.16				$1,523.16			
More than 120,000	Sum of NUM ACCTS	135		135				135	100.0000%	100.0000%	100.0000%
	Sum of ANN REV	$5,449,968		$5,448,968				$5,448,968			
	Average of AVG ANN CCF	266,087		266,087				266,087			
	Sum of ANNREV/ACCT/12	$3,337.60		$3,337.60				$3,337.60			
Total Sum of NUM ACCTS		29,884	366,386	396,269		1	10,019	10,020	404,070	100.0000%	100.0000%
Total Sum of ANN REV		$47,061,988	$133,069,178	$180,131,704		$403	$3,044,430	$3,045,233	$184,076,998	100.0000%	100.0000%
Total Sum of ANNREV/ACCT/12		$136.31	$30.24	$37.00		$33.66	$33.31	$33.31	$37.96		

EXHIBIT

Report

Ohio Home Weatherization Assistance Program Impact Evaluation

Prepared for:
Ohio Office of Energy Efficiency

July 6, 2006

quantec *Raising the bar in analytics*

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1.   Executive Summary

This impact evaluation focuses on the 2003 Program Year (PY03) of Ohio's Home Weatherization Assistance Program (HWAP, the Program).

Program Overview

HWAP is designed to accomplish three primary objectives:

- Increase the energy efficiency of dwellings owned or occupied by low-income persons
- Reduce participants' total residential energy expenditures
- Improve participants' health and safety

Since 1977, HWAP and its predecessor programs have been implemented by the Ohio Department of Development (ODOD). In 1991, the Office of Energy Efficiency (OEE) was created within ODOD to oversee the implementation of HWAP. Ohio's HWAP is delivered through a network of 58 community and local government organizations (Agencies). Households with incomes of 150% or less of the Federal Poverty Level are eligible to receive the following services:

- An inspection or audit to determine what energy-efficiency measures are appropriate
- Client energy education to empower HWAP recipients to take specific actions
- Installation of weatherization and any necessary health and safety measures
- Final inspection of the measure installation

Since 1981, Ohio has supplemented Department of Energy (DOE) Weatherization Assistance Program (WAP) funds with 15% of the Low Income Home Energy Assistance Program (LIHEAP) funds. Those funds are distributed to Ohio by the U.S. Department of Health and Human Services (HHS) for its Home Energy Assistance Program (HEAP). Ohio was the first state to legislatively mandate the 15% set-aside for weatherization.

Evaluation Overview

This impact evaluation was conducted in conjunction with a Program process evaluation and training evaluation, which have been completed and are reported on separately. All three studies were performed by Quantec, LLC. The last evaluation of Ohio's HWAP addressed the PY94 Program.

This evaluation was designed to answer specific questions in the following categories:

- Impacts of HWAP only
- Impacts of HWAP implemented in conjunction with other programs
- HWAP cost and cost effectiveness

- Non-energy benefits of HWAP

To address these questions, the impact evaluation plan was developed with the following components:

- Billing analysis to evaluate Program impacts on consumption of natural gas (and other fossils fuels) and electricity

- Payment analysis to examine whether the Program made bill payment easier for participants

- Disconnection and collection action analysis to determine whether participants were less likely to have utility service disconnected

- Non-energy benefit analysis to evaluate environmental, economic, and health benefits of the Program

- Benefit-cost analysis to assess Program cost effectiveness

- Site visits to explore what factors might have contributed to the poor energy performance of a sample of homes participating in the Program

Major Findings

Cost-Effectiveness

Our evaluation determined that the Program is cost-effective overall, from both a Program perspective and societal perspective. This was determined by evaluating benefit-cost ratios from both these perspectives for selected home and fuel types as well as the Program overall, with administration costs distributed equally across all homes weatherized. The Program perspective benefit-cost ratio was 1.10 and the societal perspective ratio was 1.87. Although the benefit-cost ratio was less than one for certain groups of participants, the overall ratios for all participants were greater than one. The net benefits from the Program perspective were $3,039,742 and they were $26,872,722 from the societal perspective. The majority of individual measures installed through the Program were also found to be cost-effective.

Natural Gas Savings

Gas savings were determined by analyzing gas usage data from four utilities – Columbia Gas, Dominion, Cincinnati Gas and Electric (Cinergy), and Vectren – representing 98% of gas heated participants.

We determined that HWAP participants reduced their gas consumption an average of 326 therms per year for single-family homes (including mobile homes), or 25% of their pre consumption. The non-participant group reduced their usage 58 therms, or approximately 5% of their pre consumption. The non-participant savings were likely due in part to the large increase in gas rates between the pre and post Program period, i.e., between 2002 and 2004/2005. The participant gross savings compare favorably with the 315 therm (23% of pre) savings estimated in the 1994 evaluation. Net savings for participants' were calculated by subtracting the non-

participant savings from the gross participant savings resulting in net savings of 268 therms per year.

For the one utility where we were able estimate energy savings for customers receiving joint utility-HWAP weatherization to those receiving HWAP only the net natural gas savings increased by 90 therms per year for the jointly treated homes, or about a 30% increase in the energy savings.

Electricity Savings

The electricity savings analysis approach was similar to that used for gas-heated homes. This analysis included both homes heated with electricity and those heated with fuels other than electricity. For electrically-heated homes, we obtained data from American Electric Power (AEP), which accounted for 74% of the electrically-heated homes. For homes not heated with electricity, we obtained billing data from AEP and Cinergy.

The net savings for electrically heated single-family homes were 1,473 kWh per year and multifamily homes saved 572 kWh. Single-family gas-heated homes had net savings of 303 kWh and multifamily homes saved 201 kWh.

Payment Behavior

Payment data were provided by all utilities. We examined the effect of the Program on participation in the Ohio Percentage of Income Payment Plan (PIPP). The customer net shortfall (payment shortfall before accounting for fuel assistance funds) for PIPP participants declined 53% and for non-PIPP participants it declined 16%. The results of our analysis are consistent with the PY94 findings, where there was a 47% reduction in the net customer shortfall for regular PIPP, a 42% for intermittent PIPP, and a 28% reduction for no PIPP. The PY03 results are higher for the PIPP group, and lower for the non-PIPP group. Overall, HWAP participation resulted in a 19% net reduction in the households with bills over 10% of their income. Hence, it appears that, due to HWAP Program participation, the number of participants that needed to stay on PIPP declined.

Non-Energy Benefits

HWAP provides numerous non-energy benefits in the areas of economic impact, environmental benefits, forced mobility, and health and safety benefits. Our economic impact analysis concluded that for PY03, the Program created about 403 net job-years of employment and added $17.7 million to the Ohio economy. Though these numbers are small compared to Ohio's economy and work force as a whole, this analysis shows that HWAP has a positive effect on Ohio's economy. In measuring environmental benefits, we assigned dollar values to the three most substantial air emission reductions based on relevant market values as of December 2005. As markets for emission reductions continue to emerge, values should continue to rise, so assuming a constant value for emissions provides a conservative estimate for societal benefits. Over the life of weatherization, the societal benefit in 2003 was $2,533,447.

Causes of Poor Performance

One objective of this study was to examine what factors might be contributing to the poor performance of some homes in the Program. We identified and conduct site visits to homes that saved less than predicted, with the hypothesis that factors such as poor quality of work, some unanticipated failure of a measure, measures that were not identified for installation that could have been effective, or unusual occupant behavior could be identified to explain the poor performance.

For the homes we visited, we found that inadequate measure installation was a primary factor causing poor performance. Where measures were not fully or adequately installed, actual savings would have fallen below estimates of expected savings. In terms of missed opportunities and the number of technician's comments, air sealing ranked at the top of the list of possible reasons for low energy savings. Many cases of inadequate or missing air sealing were reported.

Comparison to Other Programs

The results from this evaluation compare favorably to similar studies of other WAP evaluations from around the United States for gas-heated, single-family homes. Half of the programs with higher savings also had higher pre-use, which tends to drive up savings. We concluded that Ohio has one of the most successful programs in the nation in terms of energy savings when compared with recent studies from Iowa, Wisconsin, and Illinois. The results of this evaluation are also close to the national meta evaluation estimates of 23% savings and 305 therms saved for gas-heated single-family homes.

Recommendations

As a result of the findings presented in this report, recommendations were generated with regard to the questions posed for the study. These recommendations are intended to provide a guide to OEE on potential Program improvements to maximize the impact of HWAP dollars.

Obtaining Applicant Energy Histories

Many studies have shown (including this one) that pre-consumption is the biggest factor in energy savings potential through weatherization. In light of this, it would be worthwhile for OEE to acquire applicant energy usage histories and group them based on pre-consumption with the highest consumers being the top priority.

Measure Installation Based on Pre-Consumption

All HWAP measures, except furnace tune-up, are worth installing in high-usage houses when deemed necessary; however, fewer measures are cost effective for medium- and low-consumption homes. Furnace replacement, tune-up, and other measures (water heater and duct insulation) were not found to be cost effective for medium consumption homes and only air leakage reduction and wall and attic insulation were found to be cost effective for low

consumers. By following this guide to measure installation, OEE should be able to maximize energy saved per dollar spent.

Combo Job Tracking

It is currently extremely difficult to determine if a weatherization job received money jointly from HWAP and a utility program. Data must be received from both OEE and the given utility and then merged together based on household data (account number, social security number, etc.). Altering the Building Weatherization Report (BWR) to include either a "combo job" checkbox or a field to capture the utility name would allow for much easier tracking of these jobs. This information could be stored in the Program database (OATS) and would be readily available to compare joint weatherization to HWAP-only weatherization.

Labor Cost Tracking

In order for an accurate calculation of measure cost effectiveness, the full cost of a measure's installation must be tracked. Currently, the BWR records material costs by measure, but all labor costs are combined. In this evaluation, a regression was required to estimate labor costs by installed measure, but the need for such an approach could be avoided with measure-level labor cost tracking.

2. Introduction

This report presents an impact evaluation of Ohio's implementation of the national Weatherization Assistance Program for Low-Income Persons (or WAP), commonly referred to in Ohio as the Home Weatherization Assistance Program (HWAP, the Program). The report focuses on Program Year 2003.

Program Overview

HWAP is implemented in accordance with regulations promulgated by the U.S. Department of Energy (DOE) in 10CFR Part 440. According to the purpose and scope of the Program, it is designed to accomplish three objectives:

- Increase the energy efficiency of dwellings owned or occupied by low-income persons
- Reduce participants' total residential energy expenditures
- Improve participants' health and safety

DOE regulations (10 CFR Part 440, Section 440.16(b)) further provide that efforts to accomplish these objectives shall ensure that priority is given to five specific particularly vulnerable populations of low-income energy users:

- The elderly
- Persons with disabilities
- Families with children
- High residential energy users
- Households with high energy burdens

HWAP has provided weatherization services to low-income households in Ohio since 1977. Since 1992, HWAP has been implemented at the state level by the Office of Energy Efficiency (OEE) in the Ohio Department of Development (ODOD).

Eligibility for HWAP services in Ohio is based on household income. The state uses 150% of the Federal poverty guidelines as the upper income limit for eligibility; this is higher than the minimum of 125% established by DOE, allowing more households to qualify. DOE's regulations permit states to set a higher level based on the Home Energy Assistance Program (HEAP) eligibility requirements.[1]

Since the inception of Ohio's HWAP, the primary source of funding has been DOE. Since 1981, Ohio has supplemented DOE funds with 15% of the funds that the U.S. Department of Health

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[1] This program is usually referred to as the Low Income Home Energy Assistance Program (LIHEAP) at the Federal level.

and Human Services (HHS) distributes to Ohio for HEAP.[2] Ohio was the first state to legislatively mandate the 15% set-aside for weatherization.

HWAP services are provided at no cost to qualified households and include:

- An inspection or audit to determine what energy efficiency measures are appropriate and if other repairs are necessary before weatherization can be conducted

- Client energy education to help empower HWAP recipients to take specific actions that will result in increased control of their energy consumption, energy costs, and comfort

- Installation of weatherization and any necessary health and safety measures

- Final inspection of the measure installation

Utilities also offer programs that expand the overall weatherization activities in the state.

OEE is the central HWAP organization in Ohio. It provides overall guidance, requirements (for example, through the Weatherization Program Standards), policy, and oversight; secures and distributes federal funds; and provides the interface with the federal funding agencies.

Ohio's HWAP is delivered through a network of community and local government organizations. These include Community Action Organizations (CAOs), local government entities and community-based non-profit organizations (CBOs). OEE disburses the funds to these groups (hereafter, Agencies), which then have the responsibility of delivering the weatherization services. Some Agencies ("grantees") contract with OEE and, in turn, subcontract to other Agencies (delegates) that implement weatherization. The actual services are delivered by implementing Agency staff and, in some cases, private contractors hired by the Agency.

The Agencies are responsible for meeting specific targets in delivering the HWAP services. These targets include production (number of housing units weatherized) and average cost per weatherized unit.

HWAP requires skilled staff to implement weatherization effectively, so training is an important component of the Program. The Ohio Weatherization Training Center (OWTC) provides training to Agency weatherization staff. The Corporation for Ohio Appalachian Development (COAD) runs the center. OEE staff also provides training through their Training and Technical Assistance (T&TA) activities.

For several years, HWAP funds have been allocated to Agencies based on a stability factor that takes into account the allocation the Agency received in 1994. In addition, the allocation takes into account two elements: the percent of households that are income-qualified for HWAP and the percent of qualified households that spend more than 25% of their income on energy (their energy burden). These percentages are based on census data for the Agency's service area.

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[2] HEAP is administered by the Office of Community Services, a separate office within ODOD.

Evaluation Overview

In August 2004 the OEE released a request for proposals (RFP) for an impact evaluation and process evaluation of HWAP's 2003 Program Year (PY03). The last evaluation was conducted on the 1994 Program Year (PY94) and this RFP was issued to evaluate whether the Program had improved, remained static, or regressed since the previous evaluation.

The key questions to be answered in this impact evaluation are:

HWAP Only

- What is the impact of HWAP on the gas and electric usage of participants?

- What is the impact of HWAP on participants in the Ohio Percentage of Income Payment Plan (PIPP) ability to avoid service disconnection?

- How do the impacts of HWAP compare to previous evaluations and to other weatherization efforts in Ohio and nationally?

- What potential does HWAP have for collecting consumption histories for its customers? How effectively is this potential being used? Would it be an effective system for identifying households (based on usage information, customer shortfall, etc.) who have the most to gain from participation in the program?

HWAP and Utility Programs

- How do energy savings differ for houses jointly treated with utility funding vs. HWAP-only houses?

- What percentage of HWAP completions during PY03 received multiple services?

Cost and Cost Effectiveness

- Is HWAP cost effective and how do the costs of the PY03 HWAP compare to costs identified in previous evaluations and to other weatherization efforts in Ohio and nationally?

- What effect does HWAP have on the need for PIPP subsidies?

Non-Energy Benefits

- What impact does HWAP have on the economy of Ohio in terms of job creation and avoided energy imports?

- What are the environmental impacts associated with the energy savings produced by HWAP?

- What other non-energy benefits does HWAP provide?

To address these questions, this impact evaluation plan was developed with the following components:

- Billing analysis to evaluate Program impacts on electricity and gas consumption

- Payment analysis to examine whether the Program made bill payment easier for participants

- Disconnection and collection action analysis to determine whether participants were less likely to have utility service disconnected

- Non-energy benefit analysis to evaluate environmental, economic, and health benefits of the Program

- Benefit-cost analysis

- Site visits to explore persistence of measures, quality of weatherization and missed opportunities in poorly performing weatherized homes

Report Contents

Chapter 3 describes HWAP PY03 in terms of budget, homes weatherized, and participant characteristics. Chapter 4 presents the results of the gas billing analysis. Chapter 5 presents the results of the electric billing analysis. Chapter 6 analyzes HWAP's effect on payment behavior: customer shortfall, disconnections, collections, and PIPP participation. Chapter 7 explains the non-energy benefits of HWAP and calculates the societal benefits. Chapter 8 analyzes the success of the Program from the perspective of cost effectiveness. Chapter 9 presents the findings from home site visits that were performed to examine reasons for low savings among certain participants. Chapter 10 compares the results from this study to those from other studies. Chapter 11 presents the recommendations resulting from this evaluation. Appendix A: presents the results of a geographic information system (GIS) study we conducted to examine the relationships among geographic and demographic characteristics and the Program. Appendixes B through E present more details on our analysis methodologies.

3. Program Description

Program Funding History and Participant Characteristics

Program funding and the number of completed units for 2000-2004 are shown in Figure 1.[3] Although Program funding rose for most of this period, an increase in the maximum allowed cost per home caused the number of homes weatherized to fall and then stay nearly constant.

Figure 1. Program Spending and Production
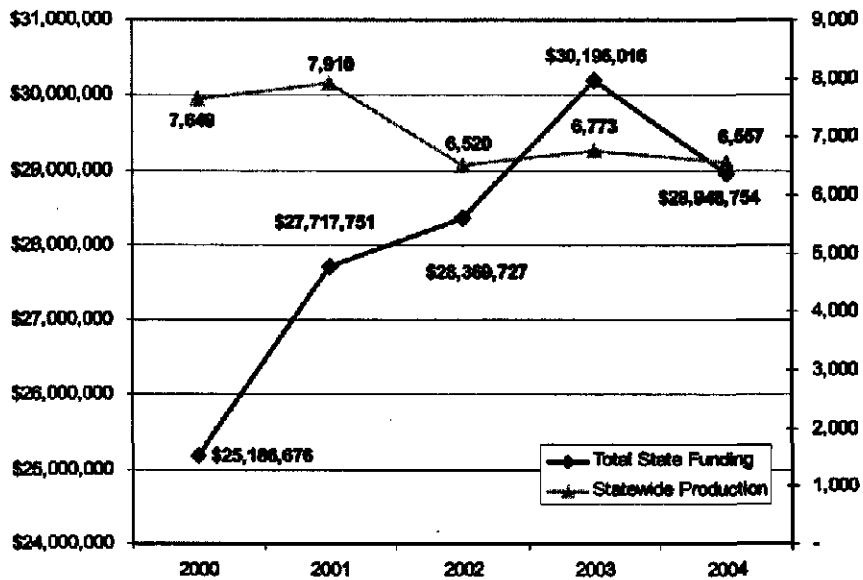
All participant information is tracked in the OEE Activity Tracking System (OATS) database. In PY03, the Program provided weatherization services to 6,411 housing units in 5,609 buildings representing 15,093 people.[4] Table 1 shows participant characteristics across housing types.

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[3] For detailed funding information see Process Evaluation.

[4] The number of homes differs from the number shown in Figure 1 because of the way multifamily homes are tracked. If a multiplex has one eligible participant, but has shell work done, then all units are counted towards the PY03 6,773 total shown in Table 1. However, only 6,411 eligible participants were served, so this is the number that will be used for total participants throughout this report.

Table 1. Participant Characteristics by Housing Type

Characteristic	Site-Built Single-Family	Mobile Home[5]	Multifamily	All Units
Total Units	3,803	1,401	1,207	6,411
Home Characteristics				
Living Area (sq. ft.)	1,440	938	856	1,220
Built pre-1939	78%	0%	77%	42%
Forced Air Heat Distribution	89%	97%	77%	89%
Demographics				
Renter	16%	9%	100%*	30%
Mean Annual Income	$12,268	$10,825	$8,455	$11,235
Household Size	2.52	2.21	1.50	2.3
Senior	35%	29%	34%	33%
Person w/ Disability	32%	38%	35%	34%

* Ownership is not tracked for multifamily homes, though it can be assumed that close to 100% are renters.

Heating fuels by home type are shown in Figure 2. For site-built and multifamily homes, gas and electric comprise almost all space heating (89% and 100%, respectively), while only 67% of mobile homes are heated by one of these fuels.

Figure 2. Space Heating Fuel Distribution by Home Type
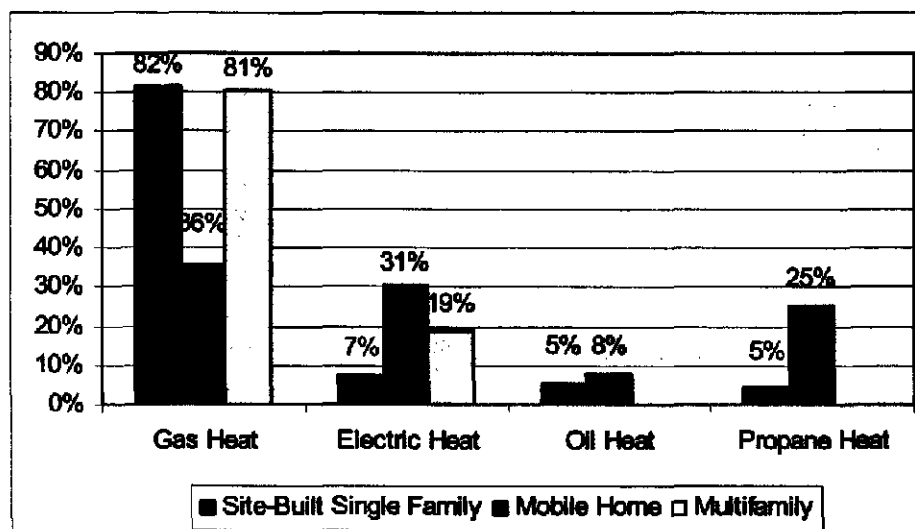
Figure 3 shows the distribution of participants by home type and space heating fuel, where all fuels besides gas and electricity have been combined into "other." As in the 1994 evaluation, single-family gas heat accounted for almost half of the participants, and thus provided most of

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[5] Although such homes built after 1974 should be called "manufactured homes" based on the National Manufactured Home Construction and Safety Standards Act of 1974, the term "mobile home" is used to be consistent with the previous evaluation.

the data for the gas analysis. Conversely, mobile home and multifamily electric accounts represented 70% of all electrically heated homes, and played a large role in that analysis.

Figure 3. Space Heating Fuel Distribution by Home Type and Fuel
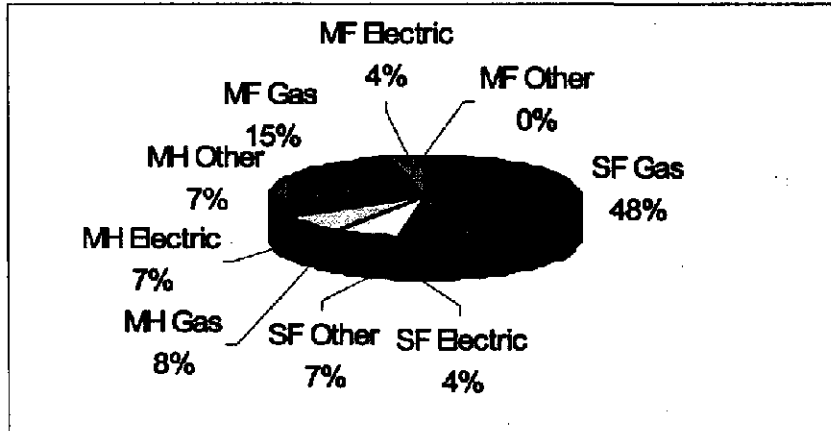
Program Treatments

All job costs for a home are recorded on a Building Weatherization Report (BWR) and entered into the OATS database, allowing for measure tracking across Program homes. Figure 4 shows the percent of homes that received given measures across building types.[6] The data in Figure 4 are based on cases where any funds on individual jobs were listed in the measure category shown. Measure installation rates for site-built and multifamily homes are similar, but rates for mobile homes differ greatly for wall, window, and floor procedures, and they receive more health and safety work.

It was not possible to compare these results with those from the PY94 evaluation because the way the measures were counted in the study was not defined in the report. Measure costs are presented in Chapter 8 of this report.

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[6] Multifamily measures are reported at the building level, not the unit level.

Figure 4. Percentage of Homes Receiving Given Measure by House Type
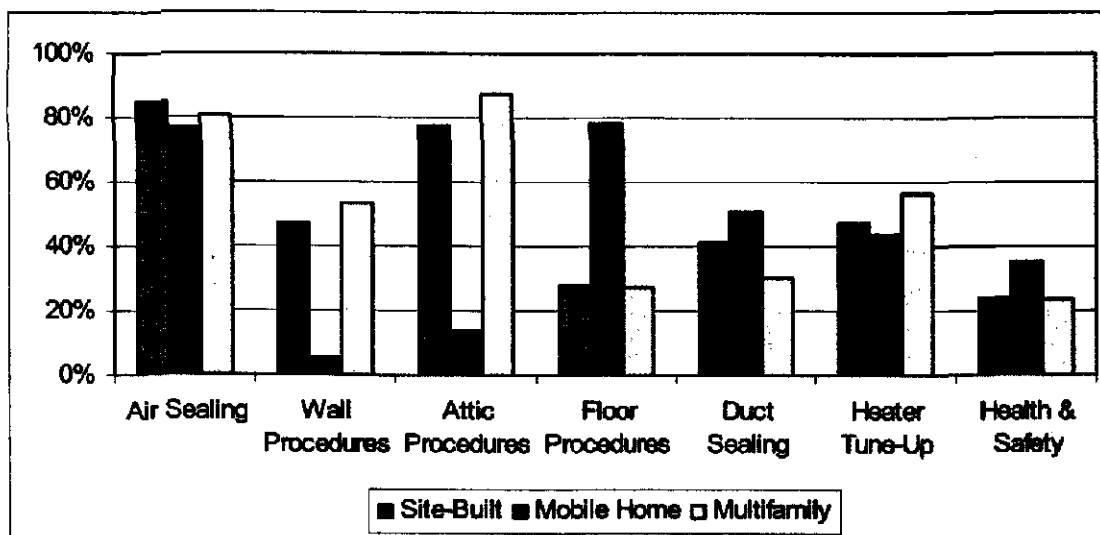
Utility Weatherization Programs

Many Ohio utilities offer weatherization programs in addition to HWAP. For an eligible home, an Agency can use both HWAP and utility funds to cover the cost of weatherization. Weatherization data were obtained from Columbia Gas for those homes that were jointly treated through HWAP and the WarmChoice program and this information was used to closely examine savings and measures for jointly treated homes.[7]

WarmChoice provides more specific data on health and safety problems than OATS, and Table 2 compares the frequency of these problems to PY94. Since 1994, occurrences of all of these health and safety problems have remained constant or decreased.

Table 2. Utility Weatherization Programs WarmChoice Health and Safety Problems Comparison between 1994 and 2003

	1994 Evaluation	Current Evaluation
Gas Leak	17%	12%
Combustion Venting Problems	39%	33%
Cracked Heat Exchanger	21%	18%
One or More of the Above	60%	50%
Carbon Monoxide >150ppm in Flue	6%	<1%
Unsafe Wiring	10%	10%
Any of the Above Safety Problems	64%	55%

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7   We requested utility program participation data from all utilities, but only received data from Columbia Gas on their WarmChoice program regarding participation .

4. Gas Savings

The weather-adjusted (normalized) annual energy consumption for the 2003 HWAP participants and a matching group of non-participants was estimated using a modeling approach similar to the PRInceton Scorekeeping Method (PRISM™). A fixed reference temperature base of 65°F was used in this analysis.[8] House level savings (difference in normalized annual consumption, DNAC) are then calculated as the difference between normalized pre-annual consumption (PRENAC) and normalized post-annual consumption (POSTNAC).

We obtained gas usage data from four utilities – Columbia Gas, Dominion, Cincinnati Gas and Electric (Cinergy), and Vectren – representing 98% of gas heated participants (see Appendix B Figure A.1 for more detail). Approximately 79% of these accounts were matched with utility records.

Almost two thirds of these matched accounts had sufficient data in the pre and post period for billing analysis and provided reasonably reliable results (see Appendix B for more details on data screening and attrition).

After the weather normalized usage was obtained, non-participants were matched at the utility level to quartiles of participants' pre consumption. The non-participant selection process is described in detail in section E of Appendix B.

Findings

Table 3 below summarizes the results of the gas billing analysis. HWAP participants saved an average of 326 therms per year for single-family homes (including mobile homes), or 25% of their pre consumption. The non-participant group saved 58 therms, or approximately 5% of their pre consumption. The non-participant savings are likely due in part to the large increase in gas rates from 2002 to 2004-2005 (see Table 4). The participant gross savings compare favorably with the 315 therm (23% of pre) savings in the 1994 evaluation. However, the net savings of 268 therms are about 20% lower, because of the reduction in consumption observed for non-participants.

The multifamily savings are considerably lower than estimated in the PY94 analysis, which showed average gross annual savings of 213 therms (20% of pre). The gross savings are now 101 therms (13% of pre), and the net savings are 83 therms (11% of pre). The main factor in the lower savings is that the pre consumption for multifamily homes is considerably lower for the PY03 participants (756 therms vs. 1,049 therms in the PY94 evaluation). The multifamily houses in the PY03 analysis are also smaller (856 sq. ft. vs. 952 sq. ft. in the PY94 evaluation). Moreover, the homes in the current evaluation were more efficient to begin with, using

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[8] In the 1994 analysis, the PRISM reference temperature (τ) was allowed to take on any value. If the reference temperature (τ) is not fixed, then PRISM can produce unrealistic values as low as 40°F and as high as 80°F. To alleviate this problem, we opted for this simpler specification, because it generally provided similar savings estimates to PRISM. The regression model used in our analysis is equivalent to a PRISM model with fixed τ.

0.88 therms per square foot, while the 1994 evaluation homes were using 1.10 therms per square foot.

Table 3. Gas Usage and Savings Summary Results

	# Units	Pre Therms	Post Therms	Savings (Therms) (90% confidence level relative precision)	% Savings	Temperature Dependent Savings
Single-Family Houses						
Participants	1,625	1,290	964	326 (±4%)	25.3%	30.0%
Non-Participants	3,520	1,288	1,230	58 (±10%)	4.5%	5.4%
Net Savings[9]				268 (±5%)	20.8%	24.7%
Multifamily (per unit)						
Participants	514	756	655	101 (±21%)	13.4%	17.8%
Non-Participants	*	*	*	18*	2.4%	
Net Savings				*83 (±23%)*	*11.0%*	*14.6%*

The precisions of these estimates are also listed in parentheses. For the single-family estimate the relative precision is 5% at the 90% confidence level. For multifamily homes the precision is 23% at the 90% confidence level.

A separate multifamily non-participant group was not available because the HEAP database did not contain building type information for non-participants. We applied the savings percentage for single-family non-participants to estimate the comparison group multifamily savings of 18 therms.[10] As shown in the table, this approach gives an estimate of multifamily non-participant savings of 2.4%. This appeared to be reasonable given the relationships we found between home pre usage, home size, and energy savings that are discussed later.

The temperature-dependent savings summarize the savings as a percentage of the weather sensitive load. These savings are estimated to be the percent of space heating end use, although some water heating usage is also likely included. Thus, the single-family gross savings represent about 30% of temperature dependent usage, while the net savings represent nearly 25%.

The single-family gross savings percentage is higher than the 1994 evaluation (25.3% vs. 22.6%), but the net savings percentage is lower due to the adjustment for non-participant savings. In the 1994 evaluation, non-participants increased consumption from pre to post. However, as Table 3 shows, in this evaluation, non-participants actually decreased gas usage from pre to post. The most likely explanation for this difference is the rise in utility gas rates from the pre to the post period. Table 4 shows a comparison of average gas rates between the pre

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[9] Single family includes both site-built homes and mobile homes. Site-built homes saved 282 therms, or 21.2% of pre consumption, and mobile homes saved 90 therms or 11.4% of pre consumption.

[10] The non-participant savings are obtained from the single family savings ratios of non-participants to participants, i.e., (58/326) * 101 = 18 therms.

and post period for major Ohio utilities.[11] It is clear that rates rose substantially between the pre and post periods. Averaged over the utilities shown, rates increased by 71%.

Table 4. Utility Rates in Pre and Post Periods[12]

Utility	$/therm Average during Period		
	Pre	Post	% change
Columbia Gas	$0.60	$0.91	53%
Dominion	$0.46	$0.89	94%
Vectren	$0.50	$0.78	57%
Cinergy	$0.42	$0.75	79%
Average	$0.49	$0.83	71%

Visual representations comparing the pre and post usage and savings for single-family participants are presented in Figure 5 through Figure 7. The y-axis represents the frequency of customers in each consumption/savings group. As can be seen in Figure 5, the distributions in the non-participant and participant groups matched very closely. This was a direct result of the strategy used to select non-participants.

Figure 5. Comparison of Single-Family Pre-Period Usage (PRENAC)
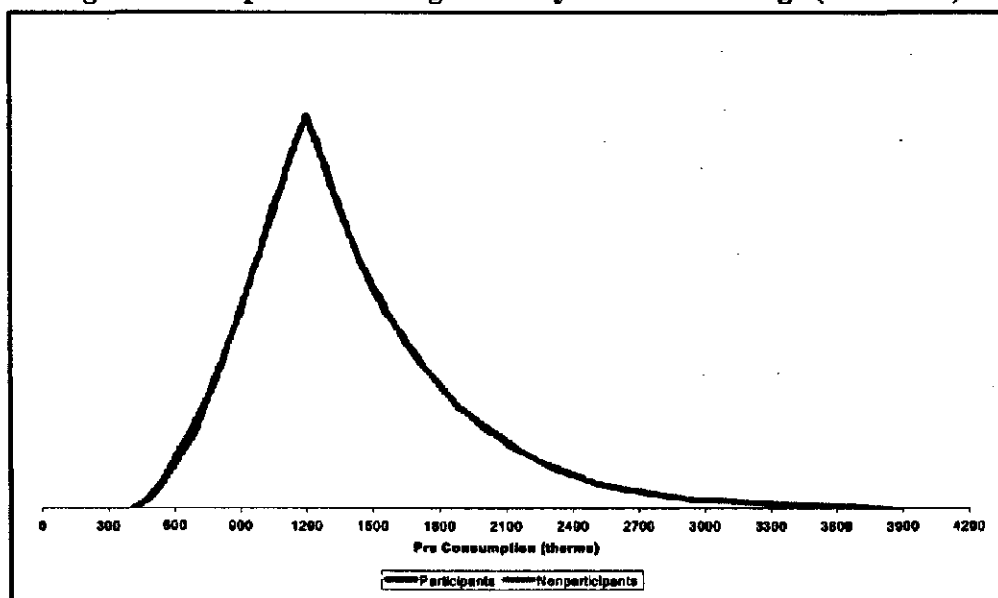
Figure 6 shows post-period usage. The participant group has shifted consumption much more than the non-participants. The savings distribution is found in Figure 7, and shows the increased savings from participation.

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[11]   Based on data from Ohio Consumers' Counsel.

[12]   The pre period was from February 2002 to February 2003; the post period was from April 2004 to April 2005.

Figure 6. Comparison of Single-Family Post-Period Usage (POSTNAC)
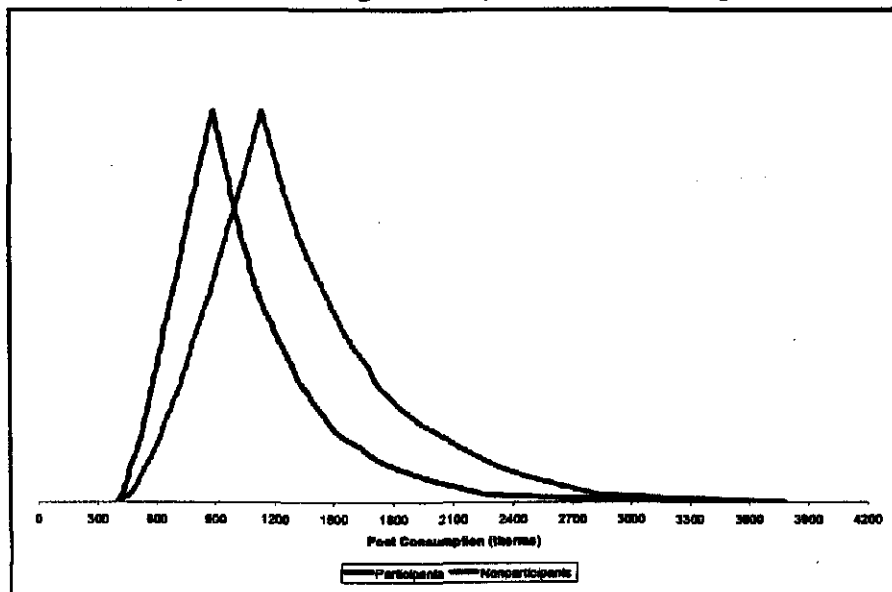
Figure 7. Comparison of Single-Family Savings (DNAC)
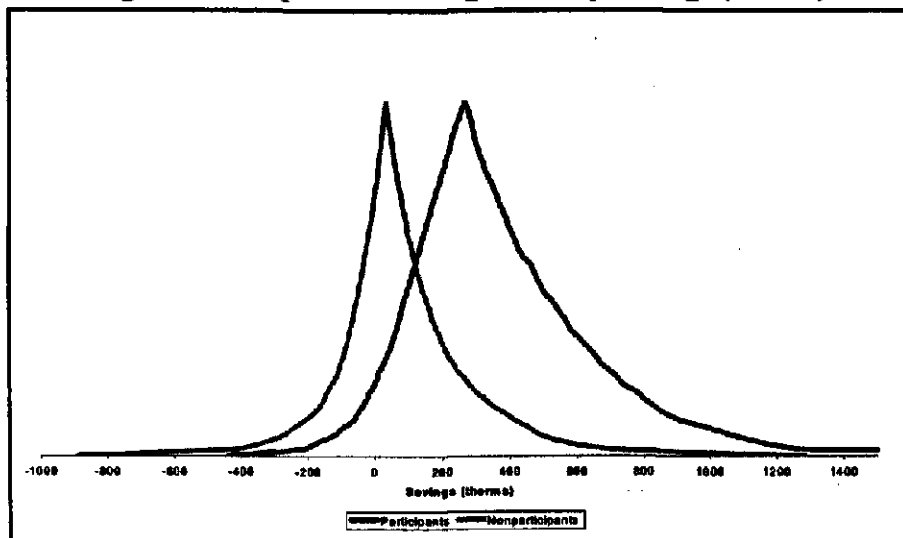
Figure 8 presents the distribution of single-family percent savings. The largest percent of homes saved 20% to 30% of pre-period consumption, followed by an almost equal group that saved 10% to 20%. About 5% of participants saved more than 50% of pre-period consumption; less than 10% of participants increased consumption.

Figure 8. Distribution of Single-Family Gross Gas Savings
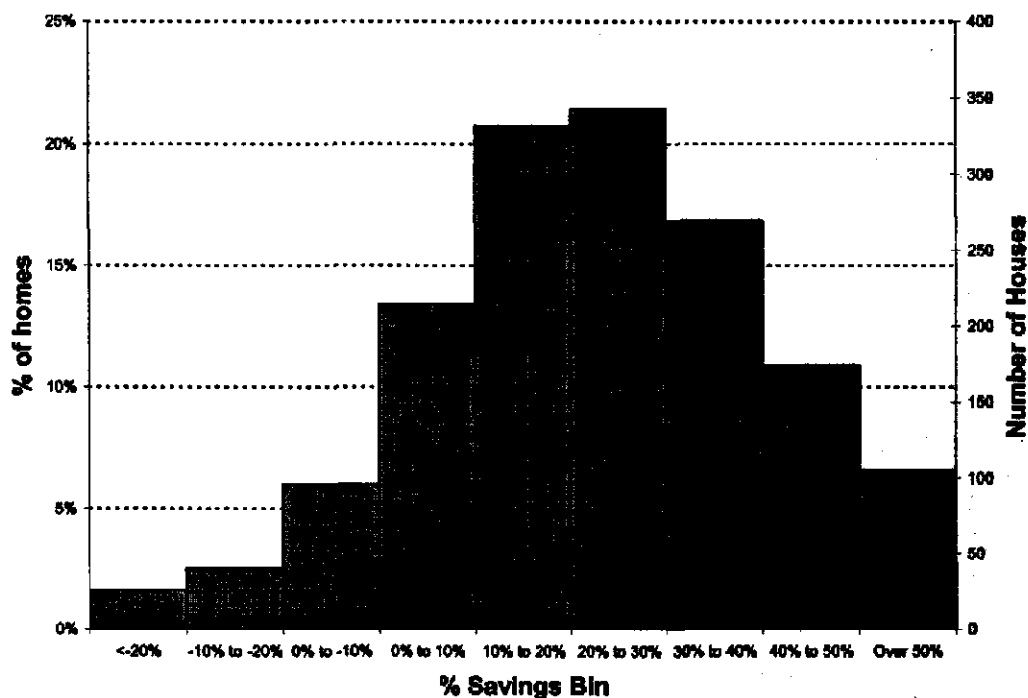
Figure 9 summarizes the pre-period consumption distribution and the PIPP mix in single-family homes. The average pre-period consumption was 1,290 therms, and the median was 1,200 therms. About 29% had usage under 1,000 therms. About 17% of participants have usages over 1,800 therms. As can also be seen from this chart, as consumption increases the PIPP share of the homes increases noticeably.

Figure 9. Distribution of Pre Usage by PIPP Status (Single-Family Participants)
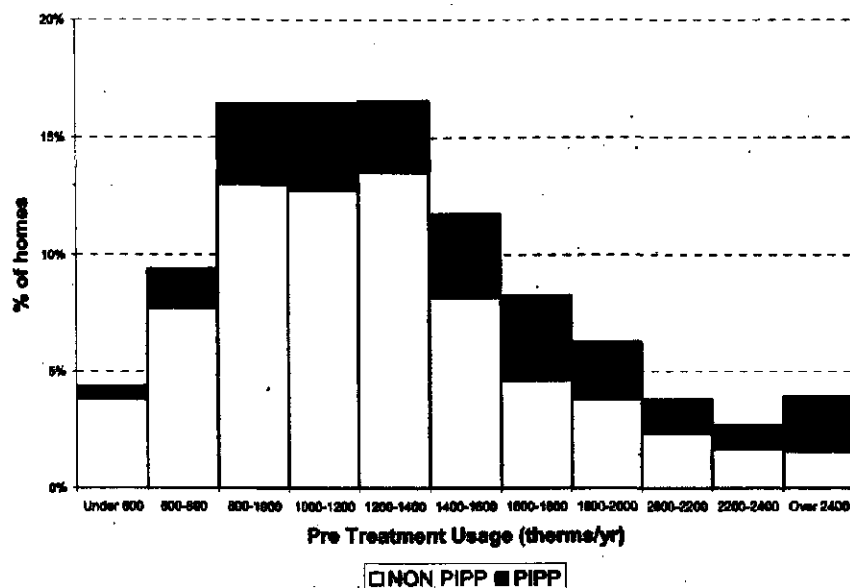
Utility-Specific Results

Figure 10 shows the utility-level net participant savings estimates. The single-family savings range from 231 therms for Cinergy customers to 282 therms for Columbia Gas customers (including Warm-Choice) and include the effects of HWAP and utility weatherization. Sample sizes of single-family participants by utility ranged from 88 to 748 (see Table 5). The multifamily savings could not be separated by utility because of large error bands in estimation due to small sample sizes.

Figure 10. Net Savings by Utility
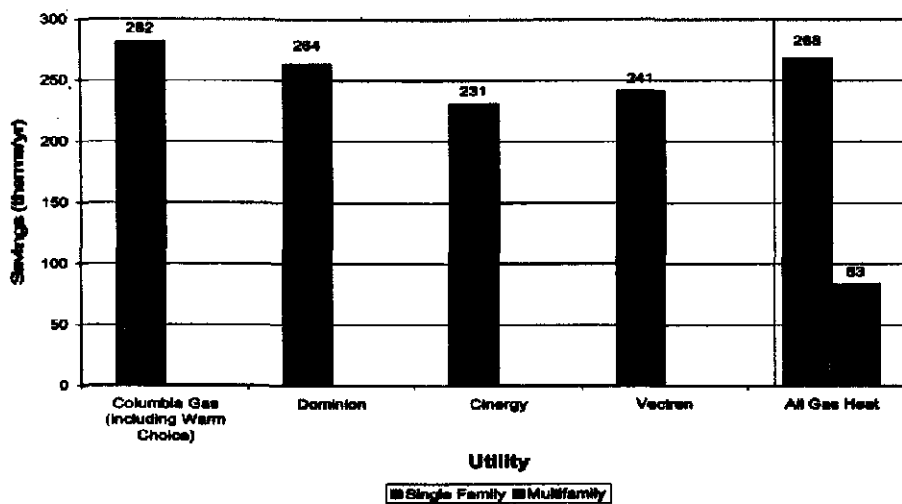
Figure 11 presents the net percent savings estimates for participants by utility. The net savings range from 20% to 22%, with an average of 21%. The Columbia Gas percent savings are highest, primarily because they include savings from joint weatherization through WarmChoice.

Figure 11. Net Percent Savings by Utility
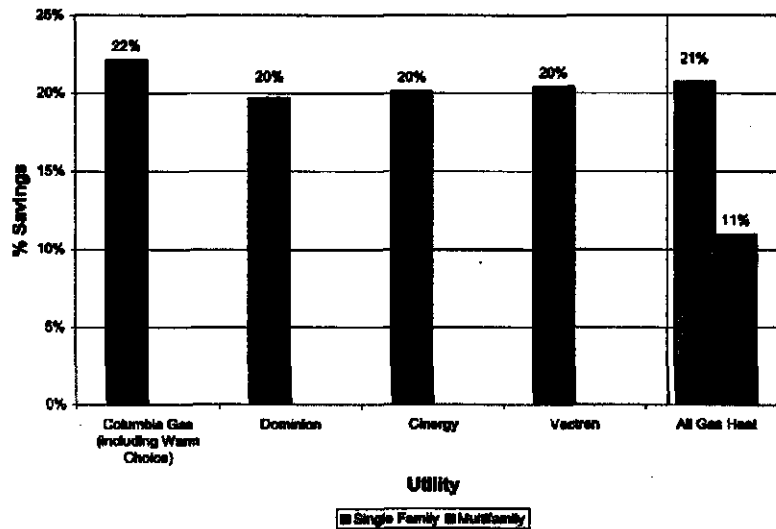
Table 5 gives more details on the utility specific estimates. As can be seen from this table, the pre-consumption values for participants and non-participants are almost identical at the utility level because they were matched by usage quartiles. Cinergy and Vectren HWAP participants had the smallest pre-period usages and the lowest net savings estimates (231 therms and 241 therms, respectively). These two utilities also had the smallest sample sizes and largest error bands.

Table 5. Gas Usage and Net Savings Summary by Utility

	# Units	Pre Therms	Post Therms	Savings (Therms) (90% Confidence Level Relative Precision)	% Savings	Temperature Dependent Savings
Single-Family Houses (Columbia Gas)						
Participants	681	1,274	918	356 (±6%)	27.9%	32.9%
Non-participants	1,108	1,269	1,195	74 (±14%)	5.8%	6.9%
Net Savings				282 (±9%)	22.1%	26.1%
Single-Family Houses (Dominion)						
Participants	748	1,337	1,024	313 (±5%)	23.4%	28.1%
Non-participants	1,218	1,338	1,289	49 (±18%)	3.7%	4.5%
Net Savings				264 (±7%)	19.7%	23.6%
Single-Family Houses (Cinergy)						
Participants	108	1,147	893	254 (±17%)	22.1%	25.8%
Non-participants	176	1,146	1,123	23 (±109%)	2.0%	2.3%
Net Savings				231 (±20%)	20.1%	23.4%
Single-Family Houses (Vectren)						
Participants	88	1,180	890	290 (±19%)	24.6%	28.9%
Non-participants	142	1,181	1,132	49 (±45%)	4.2%	4.9%
Net Savings				241 (±26%)	20.4%	24.1%
Single-Family Houses (Overall)						
Participants	1,625	1,290	964	326 (±4%)	25.3%	30.0%
Non-participants	3,520	1,288	1,230	58 (±10%)	4.5%	5.4%
Net Savings				268 (±5%)	20.8%	24.7%

Factors Associated with Savings

One of the study objectives was to assess patterns in usage and savings to help provide insight into what causes high or low savings. Table 6 summarizes the characteristics of high and low savings of single-family gas heated participants. High savers are defined as the top quartile of savings (savings greater than 482 therms/year) and low savers are defined as the bottom quartile (savings less than 107 therms/year).

The high savers had much higher pre usage (1,811 therms) than the low savers (951 therms). The high savers had gross savings of 767 therms, or 42% of their pre. The low savers had no savings on average. The high savers had a higher proportion of measures installed, particularly for wall insulation and furnace replacement – two of the measures associated with highest savings. The blower door percent reduction was 39%[13] for high savers and 27%[14] for low savers. Moreover, the high savers had leakier houses to begin with (as shown by the air leakage per square foot values). They also received more utility weatherization, and none of the high savers are in the mobile home category. The measure installed cost is double that of the low savers.

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[13] (5089-3111)/5089 = 39% reduction

[14] (3286-2383)/3286 = 27% reduction

Table 6. Characteristics of High and Low Savers

Characteristic	High Savers	Low Savers
Pre-Use (therms/yr)	1,811	951
Savings (therms/yr)	767	-2
Savings (% of total pre-use)	42%	0%
Square Footage	1,485	1,290
Pre-Use per Sqft	1.34	0.79
Attic insulated	89%	65%
Walls Insulated	71%	33%
Furnace Replaced	34%	17%
Air Leakage Pre-CFM50	5,089	3,286
Air Leakage Post-CFM50	3,111	2,383
Air Leakage Pre-CFM50 per sqft	3.82	2.77
Air Leakage Post-CFM50 per sqft	2.31	2.01
Utility Weatherization	57%	37%
Mobile Homes	0%	16%
Total Job Costs[15]	*$3,833*	*$1,934*

In order to examine the differences between high savers and low savers in more detail the two groups were further separated into high- and low-usage categories.

As Table 7 shows, in homes in the high usage group (over 1,800 therms), the highest savers tended to have more measures installed. A large proportion (46%) of high savers in the high usage group also received a new heating system, while only 8% of the lowest quartile savers received a heating system. Also, high savers received more wall insulation. Results showed leakage decreased 40% between pre and post blower door tests in those homes categorized as high usage-high savers, but decreased to only 28% for the high usage-low savers. Thus, houses with larger leakage reductions were associated with higher savings.

In the low usage group (under 1,000 therms) those that saved most tended to have a higher proportion of wall insulation, and the heating system was replaced more often. Also 20% of the lowest savers were mobile homes.

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[15] From BWR data and WarmChoice excluding administration costs.

Table 7. Characteristics of High and Low Savers by Usage Group

Characteristics	High Usage (>1800 therms)		Low Usage (<1000 therms)	
	High Savers	Low Savers	High Savers	Low Savers
Pre-Use (ccf/yr)	2,471	2,188	875	715
Savings (ccf/yr)	1,284	189	310	-60
Savings (% of total pre-use)	52%	9%	35%	-8%
Square Footage	1,555	1,706	1,197	1,156
Pre-Use per Sqft	4.53	3.69	2.94	2.82
Attic Insulated	87%	79%	83%	60%
Walls Insulated	70%	54%	52%	27%
Furnace Replaced	46%	8%	29%	17%
Air Leakage Pre-CFM50	6,205	5,825	3,185	2,940
Air Leakage Post-CFM50	3,616	4,167	2,155	2,247
Air Leakage Pre-CFM50 per sqft	2.57	2.68	1.98	2.07
Air Leakage Post-CFM50 per sqft	1.81	1.38	0.82	0.67
Utility Weatherization	68%	50%	51%	37%
Mobile Homes	0%	0%	8%	19%
Total Job Costs	*$4,433*	*$3,007*	*$2,699*	*$1,581*

Figure 12 shows how net gas savings varied with several key variables. The results are presented in more detail in Table 8. The participants that received utility weatherization saved an additional 90 therms on average.[16] The participants that were also on PIPP saved 318 therms vs. 233 therms for non-PIPP. The main driver for the higher savings is the higher pre consumption for PIPP.

Mobile homes saved considerably less (90 therms) compared to site-built homes (282 therms). Based on usage groups, customers with the highest usage (above 1,800 therms) saved the most (580 therms), customers with medium usage (1,000-1,800 therms) saved 284 therms, and customer in the low usage group (under 1,000 therms) saved only 98 therms.

With regard to weatherization measures, those houses receiving wall insulation saved on average approximately 333 therms versus 192 therms for those that did not. This cannot be interpreted necessarily to mean that wall insulation alone produces these additional savings since other measures could be associated with the addition of wall insulation or the characteristics of houses receiving wall insulation could be different. Similarly, homes that received furnace replacements saved more than those without heating system replacements (350 therms vs. 241 therms).

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[16] This is based only on WarmChoice participation.

Figure 12. Net Savings by Key Variables (Average Savings=268 therms)
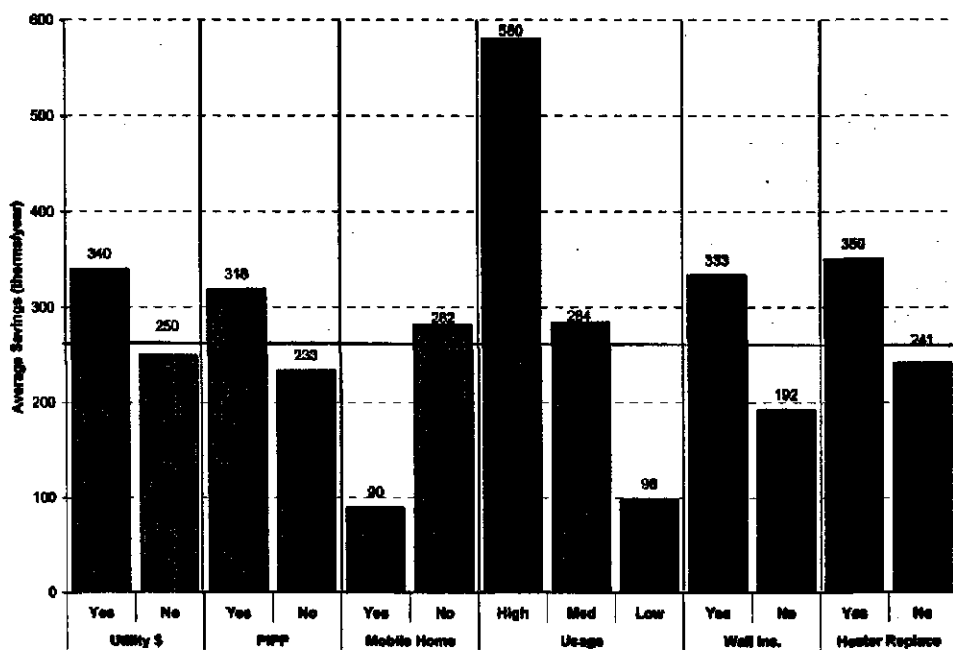
Table 8. Net Savings Details by Key Variables

Group	% of Units	Pre-Use	Net Savings (therms) (90% Confidence Level Relative Precision)	% Savings
Utility Weatherization[17,18]				
Joint Treatment w/Utility	47%	1,309	340 (±9%)	26.0%
HWAP only	53%	1,243	250 (±10%)	20.1%
PIPP Participation				
PIPP Participation	26%	1,480	318 (±9%)	21.5%
Never PIPP	74%	1,211	233 (±5%)	19.2%
Mobile Homes vs. Site-Built				
Site-Built Houses	93%	1,330	282 (±4%)	21.2%
Mobile Homes	7%	783	90 (±19%)	11.4%
Pre-Treatment Usage				
High Use (>1800)	16%	2,245	580 (±6%)	25.9%
Mid Use (1000-1800)	51%	1,336	284 (±4%)	21.2%
Low Use(<1000)	34%	774	98 (±9%)	12.7%
Wall Insulation				
Walls Insulated	54%	1,406	333 (±5%)	23.7%
No Wall Insulation	46%	1,155	192 (±7%)	16.6%
Furnace Replacement				
Furnace Replaced	32%	1,342	350 (±8%)	26.1%
Furnace not Replaced	68%	1,273	241 (±5%)	19.0%

The net savings by pre-usage groups are summarized in Figure 13. In this chart the net savings are calculated as the difference between the participants and non-participants within each usage subgroup.

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[17] An evaluation of Columbia Gas's 1997 WarmChoice Program (*Impact Evaluation of the 1997-1998 WarmChoice Program*, Tom Zimmer and Richard Sims, Columbia Gas of Ohio, July 2000) estimated savings for jointly treated homes of 33.7% as opposed to 14.5% for jobs only receiving HWAP work. However, the pre consumption for the HWAP-only sample in that study was about 400 therms (nearly 30%) less than either the WarmChoice-only or jointly treated sample pre consumption, thus suggesting there were some fundamental differences between the homes in the samples. Furthermore, there were only 30 homes in the HWAP-only sample in that study, whereas our sample was comprised of nearly 900 homes. Consequently, we do not believe those results can be compared directly with our estimates.

[18] Note that the distribution by joint treatment and HWAP-only is based only on Columbia Gas customers so these results cannot be used to estimate the savings across all utilities.

Figure 13. Single-Family Net Savings by Pre-Usage (Average Savings=268 therms)
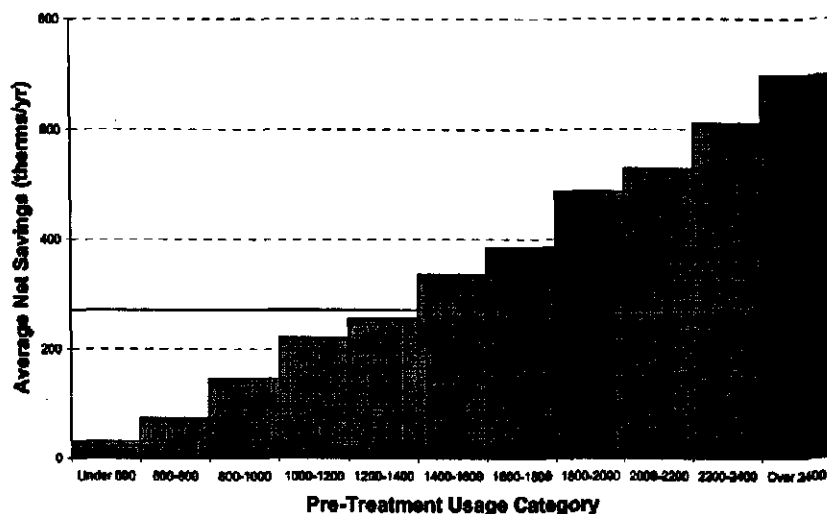
Measure Savings Estimates

Figure 14 shows the relationship between energy savings and the installed measure cost. Average savings are associated with measure installation costs of $2,000 to $3,000. Since measure cost is likely to be higher for larger homes and larger homes are likely to have higher pre usage levels, higher measure costs would be expected to be correlated with higher savings.

Figure 14. Net Savings by Total Measure Cost (Average Savings=268 therms)
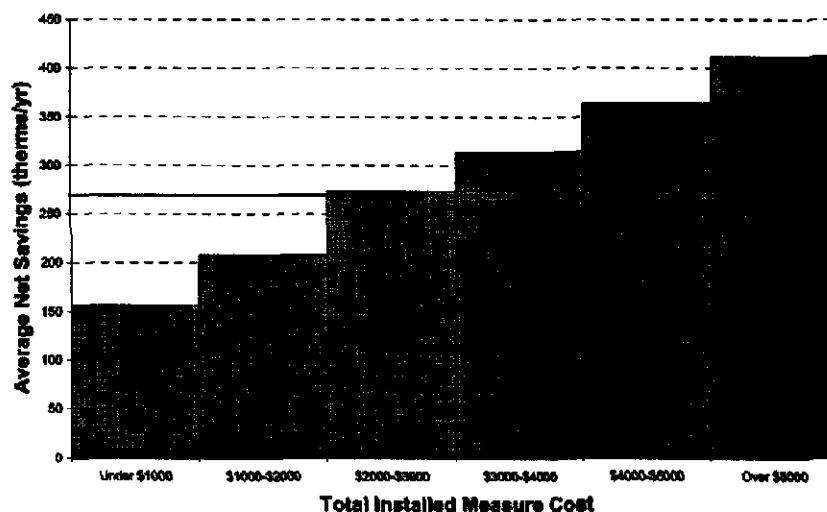
We conducted analyses to attempt to further disaggregate the savings by measure, by pre consumption level using two methods: a standard regression based approach, and a Monte Carlo

regression simulation. The reader should note that in the remainder of this report we use the terms "floor insulation," "sidewall insulation," and "attic insulation" to refer to the categories used in the BWRs for floor, sidewall, and attic measures, respectively. Though the weatherization measures in these categories usually included insulation, some of the measures implemented in the floor, wall, and attic components were more limited. The data did not specify, however, whether the measures included insulation or not so we adopted the convention of using the term "insulation" to refer to any measure implemented in the individual building shell components.

The standard regression model approach was reliable for measures with low installation rates (duct insulation, floor insulation, and furnace replacement). This approach, however, was not reliable for measures with high installation rates (air leakage reduction, attic insulation, furnace tune-up and repair, wall insulation) because the models were unable to disaggregate measure impacts due to collinearity (i.e., several measures were installed together in over 80% of the homes).[19]

For the measures where collinearity was a problem in the standard regression models, we used a Monte Carlo regression simulation approach to better disaggregate the measure savings estimates. This consisted of drawing 500 random samples from the groups installing a measure. Separate samples were drawn by measure and by pre consumption level group. For each of the 500 sub-samples, the same dummy variable regression model was run on the sample subset with all measures accounted for in the regression. The average of the 500 coefficients for the measure of interest was used to obtain the measure-specific savings estimate. This led to more reasonable savings estimates for those measures with high installation rates.

Table 9 summarizes the results of the savings results of the regression / Monte Carlo regression simulation analysis for site-built homes. See Appendix E: for information about the Monte Carlo methodology.

Table 9. Measure Level Savings by Pre Group

	Low Usage		Medium Usage		High Usage	
	Savings	% of Pre	Savings	% of Pre	Savings	% of Pre
Air Leakage Reduction*	70	8.5%	113	9.1%	144	7.5%
Attic Insulation*	52	6.3%	45	3.6%	153	8.0%
Duct Insulation	6	0.7%	-21	-1.7%	51	2.7%
Floor Insulation	11	1.3%	46	3.7%	78	4.2%
Furnace Replacement	74	8.8%	118	9.4%	217	11.1%
Furnace Tune-Up & Repair*	-6	-0.7%	35	2.8%	64	3.3%
Wall Insulation*	78	9.4%	169	13.6%	252	7.2%
Water Heater Insulation**	-16	-2.0%	26	2.1%	0	0%

* Monte Carlo sub-sample regression approach was used.

** Monte Carlo sub-sample regression approach yielded unreasonable values so standard regression approach was used instead.

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[19] Regression model results can be found in Appendix E.

The relative installation rates were combined with the estimates in Table 9 to provide average savings per participant (i.e., accounting for penetration rates of each measure). Results are summarized in Figure 15. In the low usage group most of the savings are achieved in homes that install air leakage measures (36%), attic insulation (27%), and wall insulation (22%). These account for 85% of the total savings in this group. Furnace replacement measures account for most of the remaining savings. Similarly, in the middle and high usage groups, most of the savings are from air leakage reduction, attic insulation, and wall insulation.

Figure 15. Percent Savings Contribution by Measure and Pre Usage Group
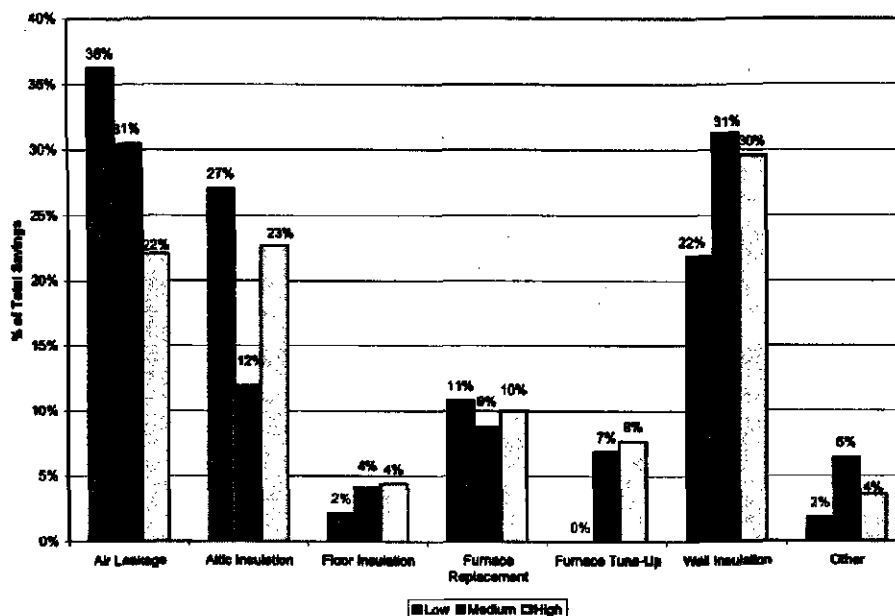
PIPP Usage and Savings

We analyzed PIPP results using an approach similar to that used for the 1994 analysis. PIPP participants saved 35% more and used 20% more energy than non-PIPP participants.

The PIPP group has changed in composition since the PY94 report. It appears that because of large gas utility rate increases even lower usage customers are turning to PIPP for assistance.

Comparing the PIPP and non-PIPP participants, the PIPP participants:

- Have 30% leakier houses based on blower door tests
- Have more occupants (2.6 vs. 2.1)
- Are less likely to have senior occupants (13% vs. 43%)
- Are 13% less likely to live in mobile homes
- Have lower incomes (10% less)

- Are slightly more likely to install wall insulation (56% vs. 51%)

These differences are not as large as they were in the 1994 analysis.

Sample Representativeness

Table 10 compares the final single-family analysis sample with the attrition group (i.e., the participants dropped from the analysis from screens such as unreasonable PRISM parameters insufficient data, and unavailability of data). Generally, the sample participants installed more measures. For example, 54% installed wall insulation vs. 45% in the attrition group. The air leakage reduction was similar for the two groups. Utility weatherization was more common in the analysis sample. The average measure costs are fairly similar between the two groups.

It is likely that most of the differences are associated with the smaller proportion of mobile homes in the analysis sample. There are fewer mobile homes in the final analysis sample (7%) than in the sample of homes that were dropped (18%). Our analysis showed that mobile homes tended to be smaller, consumed less energy, had fewer measures installed, and saved less energy than site-built houses. However, the data and analysis screens we used dropped a larger share of them from our analysis sample so they were underrepresented in the analysis sample and overrepresented in the attrition group. When we estimated Program savings, however, these differences introduced no bias because our estimated savings were developed by housing type and the overall savings estimates reflected the population shares of each housing type.

Table 10. Characteristics of the Sample and Attrition Groups (Single-Family Gas Heat)

Characteristics	Analysis Sample	Attrition Group
# Units	1,625	1,965
Attic Insulated	79%	69%
Walls Insulated	54%	45%
Furnace Replaced	24%	21%
Air Leakage Pre CFM50	4,033	3,983
Air Leakage Post CFM50	2,698	2,636
Utility Weatherization	47%	35%
Mobile Homes	7%	18%
Job Costs (HWAP measures only)	$1,897	$1,774
Job Costs (HWAP Health/Safety)	$1,528	$1,373
Total Job Costs (HWAP)	$2,369	$2,218

Air Leakage and Energy Savings by Agency

To be consistent with the 1994 analysis, we examined the relationship between average percent air leakage reduction and average percent energy savings at the Agency level. Figure 16 presents the results of our analysis. These results are presented for illustrative purposes and, as would be expected, show a correlation between air leakage reduction and energy savings. A similar trend was observed in the PY94 Program evaluation. The data show that the average leakage reduction

varies widely – from about 15% to over 40%. Average energy savings range from about 10% to a little more than 40%.

Figure 16. Agency Level Air Leakage Reduction and Percent Gas Savings
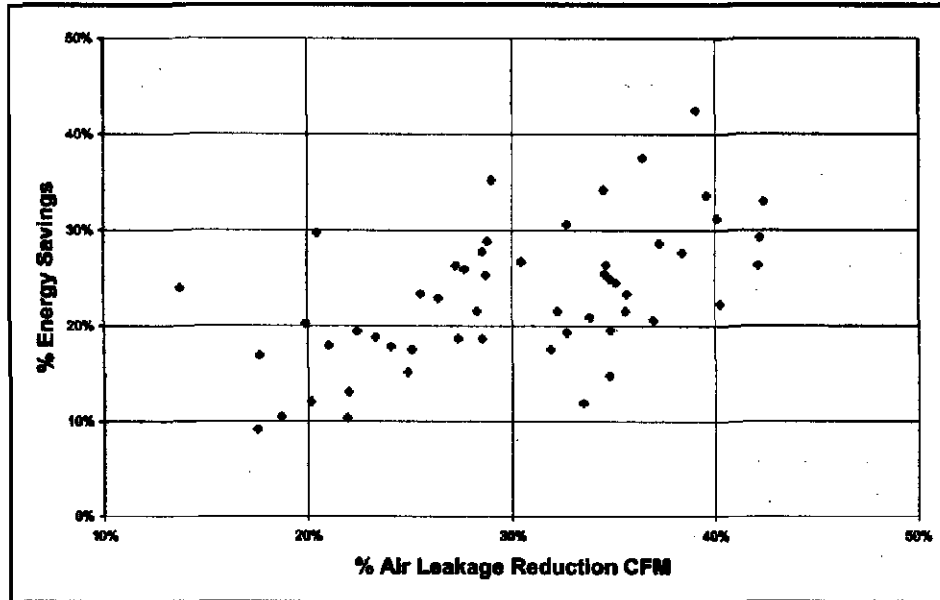
5. Electricity Savings

This chapter presents our analysis and findings on Program impacts on electricity usage. The approach was similar to that used for gas-heated homes. Our analysis included both homes heated with electricity and those heated with fuels other than electricity.

For electrically heated homes, we obtained data from American Electric Power (AEP). For homes not heated with electricity, we obtained billing data from AEP and Cinergy.

Findings

Electric billing data for electrically heated homes were obtained from AEP only. This utility accounted for 74% of the electrically heated homes. For the gas heating model, electric billing data were received from AEP and Cinergy. Billing data were not available directly for First Energy and Dayton Power & Light. We were, however, able to obtain billing data for PIPP participants from the HEAP database. With the inclusion of these accounts, about 50% of the gas-heated home accounts were matched up for the electricity analysis.[20]

Figure 17 below summarizes the net electricity savings results by utility and space heating fuel. Electrically heated single-family homes saved 1,473 kWh per year and multifamily homes saved 572 kWh. Single-family gas-heated homes saved 303 kWh and multifamily homes saved 201 kWh. Results were unreliable at the utility level for gas-heated homes, and the standard errors for these estimates are quite large so no conclusions should be drawn about how savings varied by utility. The overall average is the best estimate of gas-heated electric savings.

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[20] Some participants and non-participants also received services under the Electric Partnership Program (EPP). All HWAP electric savings estimates exclude any savings that are due to EPP.

Figure 17. Electricity Savings Summary by Utility
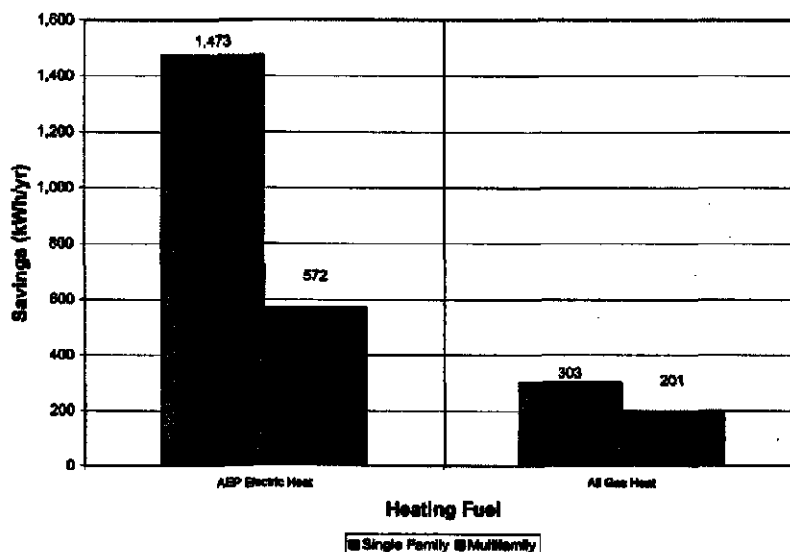
Electricity Savings in Electrically Heated Homes

Electricity savings in electrically heated homes were obtained by using PRISM heating and cooling models.

The electric heat savings are summarized in Table 11. The gross savings estimates for the single-family participants are nearly 2,500 kWh. This is a considerably higher estimate than the 1994 analysis. The non-participants, however, are saving 1,016 kWh in the post period.[21] The net savings are 1,473 kWh, which is lower than the 2,002 kWh estimate from the 1994 report.

The estimate of net savings for multifamily homes is 572 kWh, lower than the 895 kWh estimate from the 1994 report. Again, the gross savings are actually higher than in 1994; however, after the non-participant savings are accounted for, the net savings are lower.

The sample sizes in the electric heat analysis are rather low, hence there is a larger error band in the estimates.

Figure 18 shows the distribution of participant and non-participant total savings.

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[21]   Electricity prices did not rise between the pre and post Program periods as they did for natural gas because an electricity rate freeze was in effect. Consequently, changes in electricity prices would not account for the observed savings in non-participant homes. The savings presented are also net of EPP participation. Regardless of the cause, it is important to control for changes in the energy use of the non-participants.

Table 11. Electricity – Electric Heat Usage and Savings Summary Results

	# Units	Pre kWh	Post kWh	Savings (kWh) (90% Confidence Level Relative Precision)	% Savings	% Temperature Dependent Savings
Single-family Houses						
Participants	213	22,282	19,793	2,489 (±15%)	11.2%	22.7%
Non-Participants	105	22,136	21,120	1,016 (±38%)	4.6%	9.7%
Net Savings[22]				1,473 (±48%)	6.6%	13.0%
Multi Family (per unit)						
Participants	77	11,728	10,761	967 (±33%)	8.2%	16.8%
Non-Participants	*	*	*	395*		
Net Savings				572 (±33%)	4.9%	9.7%

* Home type is not available for non-participants. Single-family participant to non-participant savings percent used.

Figure 18. Electric Heat Savings Participant and Non-Participant Comparison
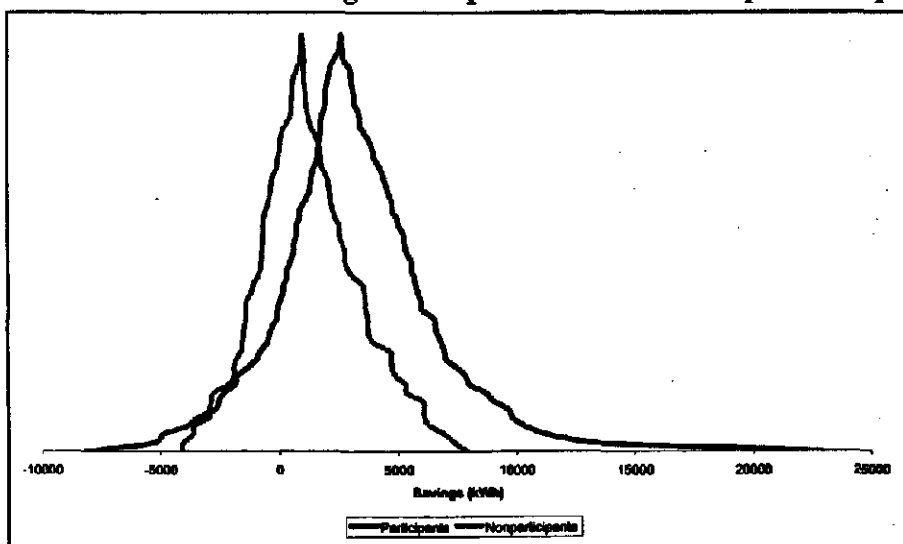
Electricity Savings in Gas-Heated Homes

A pooled fixed-effects model was used to estimate the electric savings for gas-heated homes. PRISM could not be used since temperature-dependent usage was not expected. This model is described in more detail in section D of Appendix B.

In Table 12, participants in single-family homes saved approximately 139 kWh; however, the non-participants with gas heat actually increased consumption. It is possible that the non-

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[22] Single-family includes both site-built homes and mobile homes. Site-built homes saved 1,251 kWh or 5.8% of pre consumption, and mobile homes saved 1,584 kWh or 7.0% of pre consumption.

participant increase of 164 kWh was caused by a stronger reliance on electric backup heat to counteract higher gas prices in the post period. As a result, participants saved a net of 303 kWh from HWAP participation.

For multifamily units, there was a gross reduction of 92 kWh, although the error band on the estimate is large. Again, applying the single-family participant savings percentage to multifamily non-participants, we estimated that the multifamily non-participants with gas heat increased consumption by 109 kWh. Adding these two values provides the net savings estimate of 201 kWh for multifamily homes.

Table 12. Gas-Heated Homes Electricity Usage and Savings Summary Results

	# Units	Pre kWh	Post kWh	Savings (kWh) (90% Confidence Level Relative Precision)	% Savings
Single-Family Houses					
Participants	839	9,635	9,496	139 (±64%)	1.4%
Non-Participants	1,425	9,597	9,761	-164 (±39%)	-1.7%
Net Savings[23]				303 (±36%)	3.2%
Multifamily (per unit)					
Participants	237	6,362	6,268	92	1.4%
Non-Participants	*	*	*	-109*	
Net Savings				201	3.2%

* Home type is not available for non-participants. Single-family participant to non-participant savings percent used.

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[23] Single-family includes both site-built homes and mobile homes. Site-built homes saved 326 kWh or 3.4% of pre consumption, and mobile homes saved 105 kWh or 1.2% of pre consumption.

6. Payment Behavior

Bills, Payments, Customer Shortfall and PIPP Shortfalls

Payment data were provided by all utilities. The Cinergy payment data were received, but they could not be included in the payment analysis because they did not include billed amounts, and some of the additional assistance payment amounts were missing. This analysis could not be separated out for electrically heated customers because of small sample sizes.

The payment data were merged with the final sites from the billing analysis. This allowed for a better non-participant match to the participants.

Under PIPP, if a customer heats with gas, he pays only 10% of his monthly household income to the gas company and 5% to the electric company.

There is a drop-off of fuel assistance funds used by non-participants from the pre to post periods for the PIPP group.[24] This tends to exaggerate the net savings. A more reliable indicator is the customer shortfall estimate based on payment amounts and billed amounts only, without taking into account fuel assistance.

In Table 13, we can see that for PIPP:

- Pre-period bills were similar: $1,255 for HWAP participants and $1,280 for non-participants

- In the post period, there is actually a reduction in bills to $1,184 for participants, even with the higher rates. The effects of the rate increase are more than offset by participation in the Program.

- For the non-participants, however, the bills have gone up significantly to $1,512, mainly due to the increase in rates.

- The customer payment amounts are similar between participants and non-participants in the pre period, and both groups are paying more in the post period.

- In terms of percentage paid, participants paid 56% of their pre period bill, and this improved to 62%, excluding other fuel assistance. The non-participants, on the other hand, paid 53% of their bill in the pre period and this decreased to 47% in the post period.

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[24] We were not able to separate the PIPP group into regular PIPP and intermittent PIPP, as in the 1994 evaluation, because this type of detail was not available for all utilities. Customers with PIPP status unknown are not included in the payment analysis.

- The gross customer shortfall for the participants with PIPP was $102, or a 19% improvement, but, taking into account the change in the shortfall for non-participants, the net reduction was $290, or a 53% improvement.[25]

For non-PIPP customers:

- The pre period retail bills for participants and non-participants were similar at about $1,000.

- The participant post period bills decreased to $940, but the non-participants' bills went up.

- In terms of percent of bill paid, the participants paid 77% in the pre period, and 85% in the post period.

- Non-participants were also able to keep up with their bills, paying 74% of their bills in the pre period and 82% of their bills in the post period. As a result, the net customer shortfall reduction is only $36 (a 16% reduction).

These results are consistent with the PY94 findings, where there was a 47% reduction in the customer shortfall for regular PIPP, a 42% reduction for intermittent PIPP, and a 28% reduction for non-PIPP customers. The PY03 results are higher for the PIPP group, and lower for the non-PIPP group.

Table 13. Annual Bill and Payment Impacts of HWAP by PIPP Status

	Participants			Non-Participants			Net $ Savings
	Pre $	Post $	$ Saved	Pre $	Post $	$ Saved	
PIPP (541 Participants, 798 Non-participants)							
Full Retail Bill	$1,255	$1,184	$71	$1,280	$1,512	-$232	$303
Customer Payments	$706	$737	-$31	$674	$718	-$44	$13
Customer Shortfall	$549	$447	$102	$606	$794	-$188	$290
Fuel Assistance	$132	$141	-$9	$171	$148	$23	-$31
Net Shortfall	$417	$306	$110	$435	$646	-$211	$321
NON-PIPP (964 Participants, 1426 Non-participants)							
Full Retail Bill	$1,017	$940	$77	$946	$1,046	-$100	$177
Customer Payments	$788	$801	-$13	$704	$858	-$154	$141
Customer Shortfall	$229	$139	$90	$242	$188	$54	$36
Fuel Assistance	$94	$89	$5	$123	$122	$1	$4
Net Shortfall	$135	$50	$85	$119	$66	$53	$32

The societal benefit of payment impacts is a one-time decrease in the participant shortfall. After weighting based on PIPP participation, the total customer shortfall benefits are $649,819.

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[25] The percent improvement is even more pronounced if fuel assistance is included; however, as mentioned above, this is not such a reliable indicator because non-participants received less assistance in the post.

Disconnections and Collections

The effects of the program on disconnection and collection actions for participants and non-participants are summarized in Table 14. In the pre period, about 6% of all participants had disconnections. The disconnection rate was reduced to 5% in the post period, or a 16% reduction. The non-participants, on the other hand, had disconnections increasing from 5% to nearly 7%, or a 34% increase. Adjusting for the disconnection rate changes of non-participants, the net impact was an average decrease of about 50% in the disconnections experienced by participants.

While disconnection data were available for all utilities except Dominion, collections data were available for only one utility (Vectren), and the data seemed questionable. Both participants and non-participants received more collections notices in the post period. In addition, collection actions were much more frequent among the participants than the non-participants during the pre period. Overall, there was a net decrease of 55% in collection actions associated with Program participation. However, for the reasons mentioned here, we did not consider this to be a very reliable estimate.

Table 14. Disconnections and Collections Actions

	# Cases	Pre	Post	Reduction	% Reduction
Disconnections (% cases with disconnections)					
Participants	1,111	6.0%	5.0%	1.0%	16.4%
Non-Participants	1,660	5.2%	6.9%	-1.7%	-33.7%
Net Reduction	2,771				50.1%
Collection Actions (% cases with action)					
Participants	209	49.6%	65.9%	-16.3%	-32.8%
Non-Participants	306	17.4%	32.7%	-15.3%	-88.2%
Net Reduction	515				55.4%

For the purpose of valuing disconnection and collection benefits, we assumed a societal benefit value of $100 per avoided disconnection with a benefit lifetime of ten years and attributed no benefits to the change in collection actions. This method is consistent with the 1994 evaluation. Using this approach, the total lifetime societal benefit is $162,724.

HWAP and PIPP Participation Rates

Table 15 summarizes the percent of customers with gas heat whose gas bills exceed 10% of their income. As expected, the proportion among PIPP customers is much larger, so they are less able to pay their higher bills.[26] The table shows that for PIPP customers the proportion of HWAP participants with bills exceeding 10% of their income dropped between the pre and post periods,

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[26] Note that the gas bill amount used in this table is based on the amount that would be due if customers were not in PIPP. Since those customers identified as PIPP participants were flagged in the database as participants at some unspecified point in time and could have been unqualified at other times or dropped out of PIPP, the percent of PIPP participants with bills greater than 10% of income can be less than 100%.

even with the large increase in natural gas rates. The percent of non-participants that had bills exceeding 10% of their income, on the other hand, increased substantially.

For the non-PIPP group, similar patterns were observed. The percent of HWAP participants with high bills relative to their income declined, and the percent of non-participants rose.

Overall, HWAP participation resulted in a 19% net reduction in the households with bills over 10% of their income. Hence, it appears that, due to HWAP Program participation, the number of participants that needed to stay on PIPP declined.

**Table 15. Households with Gas Bills More Than 10% of Income,
HWAP Participants vs. Non-Participants**

	% with Gas Bills >10% of Income		
	Pre	Post	%Reduction
PIPP (n=541) Participants	66.5%	63.3%	5%
PIPP (n=798) Non-participants	73.9%	80.2%	-9%
PIPP (n=1339) Net % Reduction			14%
Never PIPP (n=964) Participants	39.5%	35.7%	10%
Never PIPP (n=1426) Non-Participants	44.5%	51.4%	-15%
Never PIPP (n=2390) Net % Reduction			25%
All Cases (n=1505) Participants	49.6%	46.0%	7%
All Cases (n=2224) Non-Participants	55.0%	61.7%	-12%
All Cases (n=3729) Net % Reduction			19%

7. Non-Energy Benefits

In addition to the benefits already discussed in Chapters 4 through 6 of this report, HWAP also provides numerous non-energy benefits. This chapter identifies these benefits and explains the analysis performed to quantify these benefits. For the purpose of valuing benefits, the life of weatherization is assumed to be 20 years, with a discount rate of 3.2%.[27]

Economic Impacts

HWAP affects the economy in several ways:

- It uses tax money to pay salaries and buy products used in the weatherization process.

- Participants have lower energy bills and are able to use the extra money to purchase goods and services in other economic sectors.

- Utilities receive less revenue due to lower energy bills for participants.

Input-output modeling was used to quantify the effect of each of these monetary shifts individually, as well as the impact on the Ohio economy as a whole.[28] This method of modeling allows for an in-depth look at individual economic segments, as well as the effect that the entire economy sees. The economy is represented as a matrix that relates industries to each other so that effects of events can be tracked. In this case, these events are Program spending, changes in household spending, reduced utility revenue, etc. When an event is specified, the matrix tracks all direct, indirect, and induced effects on the economy. For example, the direct effect of participants having lower energy bills is effectively an increase in household income. The indirect effects are the redistribution of this income across the economy, thus creating more jobs in the industries where households are spending money. These new jobs create another increase in household income for the new employees and the induced effects are the redistribution of this new income across the economy. For the purpose of this evaluation, direct, indirect, and induced benefits have all been used to determine the benefits to the Ohio economy.

Table 16 summarizes the events that are caused by HWAP. Because the funding to pay for Program activities ultimately comes from tax dollars, this has been modeled as a decrease to household income. This money is then distributed to certain industries that provide the materials and labor for weatherization. Modeling participant utility bill savings and utility lost revenue is somewhat more complex, because they do not completely offset one another. Although the participants' savings are equal to their full avoided utility payments, this amount is not all lost revenues to the utility because reduced sales to customers are offset by the amount that the utility reduces its purchases of required fuel or energy. Because the total energy savings are small in comparison to total energy sales in Ohio, it is assumed that this will have no effect on ratepayers' payments towards the utilities' fixed costs and that the portion of rates that are fixed is lost revenue to the utilities. To be consistent with the 1994 evaluation, we assume that 30% of natural

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[27] These assumptions are consistent with the Oak Ridge meta evaluation.

[28] IMPLAN Professional 2.0 was used for this analysis, utilizing state-level data for Ohio from 2002.

gas, propane, and fuel oil rates and prices are due to fixed costs, while 70% of electricity rates are assumed due to fixed costs.

Table 16. Economic Input Summary

Event	Value (2003 dollars $Millions)
Installation Labor	18.0
Admin and Support Labor	7.3
Insulation Materials	2.0
General Weatherization Materials	1.9
Space Heating System Materials	1.6
Window and Door Materials	0.1
Total Program Spending	30.8
Change in Household Income to Fund Program	-30.8
Lifetime Avoided Gas Payments	24.1
Lifetime Avoided Electric Payments	4.2
Lifetime Avoided Propane Payments	3.4
Lifetime Avoided Fuel Oil Payments	2.2
Total Lifetime Avoided Payments	33.8
Lifetime Gas Provider Lost Revenue	-7.2

Lifetime Propane Provider Lost Revenue	-0.7
Lifetime Fuel Oil Provider Lost Revenue	-0.4
Change in Fuel Provider Revenue	-11.3

* Differences between sums and totals are due to rounding

When all of these inputs are run through the model, the output is expressed in value added to the Ohio economy and job-years created. Table 17 provides a detailed summary of the economic benefits of HWAP.

Table 17. Economic Output

	Value Added (2003 $ Million)				Employment
	Personal Income	Property Income	Indirect Business Taxes	Total	
Program Spending	16.8	6.7	1.3	24.7	449
Reduced Household Expenditures	-10.6	-6.9	-1.9	-19.4	-380
Fuel Provider Lost Revenue	-3.8	-3.9	-1.2	-9.0	-79
Increased Household Expenditures	12.0	7.3	2.0	21.4	393
Total	*14.4*	*3.1*	*0.2*	*17.7*	*403*

These results show that in 2003, the Program created about 403 net job-years of employment and added $17.7 million to the Ohio economy. Though these numbers are small compared to Ohio's economy and work force as a whole, this analysis shows that HWAP has a positive effect on Ohio's economy.

Environmental Benefits

Reducing participants' energy consumption also reduces the amount of pollution created by electricity generation and fuel use. In order to determine the total amount of avoided pollution and assign a dollar value to this environmental benefit, four steps were necessary:

1. Calculate the total Program energy savings by fuel

2. Apply Ohio electricity generation statistics to determine the amount of fuel that was saved because of avoided electricity demand

3. Use Clean Air and Climate Protection Software to calculate the avoided emissions attributable to the Program

4. Obtain dollar values by pollutant to determine societal benefit

To accomplish the first task, gas and electric savings by building type were summed across all HWAP participants. For participants heating with oil or propane, savings were assumed to be the same as gas and a conversion was performed to determine the quantity of these fuels saved. Similarly, it was assumed that electric savings for oil and propane participants was the same as for gas participants.

Next, the Environmental Protection Agency's Emission and Generation Resource Integrated Database (eGrid v2.01) was used to obtain Ohio-specific electric generation data. Table 18 shows both the amount of each fuel saved by participants and the amount saved due to avoided electric generation.

Table 18. Total Energy Savings by Fuel Type

Fuel Type	Annual Participant Savings	Annual Avoided Fuel Use to Generate Electricity	Annual Total Savings	Lifetime Savings
Total Electricity (MWh)	2,605	---	2,605	52,095,290
Natural Gas (therms)	994,815	1,422	996,238	19,924,758
Propane (gallons)	90,206	---	90,206	1,804,126
Fuel Oil (gallons)	50,174	448	50,621	1,012,426
Coal (tons)	---	818	818	16,364

Dollar values were assigned to the three most substantial air emission reductions based on relevant market values as of December 2005, and are summarized in Table 19. As markets for emission reductions continue to emerge, values should continue to rise, so assuming a constant value for emissions provides a conservative estimate for societal benefits. Over the life of weatherization, the societal benefit in 2003 was $2,533,447.

Table 19. Avoided Emissions and Societal Benefits

Pollutant	Lifetime Avoided Emission (tons)	Value Per Ton ($)	Societal Benefit (2005 $)
Carbon Dioxide	188,060	$1.81[a]	$257,164
NOx	420	$1,950[b]	$817,258
SOx	1,140	$1,630[c]	$1,400,475
Carbon Monoxide	140		
Volatile Organic Compounds	20		
Particulate Matter	100		
Total			*$2,533,447*

a   Value from the Chicago Climate Exchange: December 2, 2005

b   Value from Seattle NOx price curve: December 9, 2005

c   Value from Seattle SOx price curve: December 9, 2005

Forced Mobility

Because of the energy burden on low income households, when bills get unmanageable, families are often left with no choice but to move to a new home. Weatherization programs can have an effect on this "forced mobility" because of the reduction in monthly energy bills. A 2002 study by Oak Ridge National Laboratory estimated that the benefit to a family of not having to move could be as high as $1,460.[29]

To determine whether participants moved less frequently than they would have had their homes not been weatherized, an analysis was done based on 2003 HEAP participants. This analysis investigated whether a participant moved between the pre and post period. The database was, therefore, pared down to those households that participated in HEAP every year from 2002 to 2004. For participants meeting this requirement, addresses were compared between 2002 and 2004. Using this method, it is not possible to know how many times a participant moved in this span, only whether or not a move occurred. Once it had been determined if a move occurred, HWAP participants were compared to non-participants to see if there was a difference in mobility. About 20% (19.9%) of non-participants moved in this period, compared to 12.6% of participants. This indicates a net difference of 7.3%, or 466 HWAP participants who avoided moving as a result of the Program.

Renters are far more likely to move than owners and any differences in the home ownership rates between the HWAP and HEAP samples could affect these results. Because the HEAP database did not contain data indicating whether a participant owned or rented, it cannot be determined whether the home ownership percentage differed between HWAP participants and the HEAP participants. Because of this, the decrease in mobility cannot confidently be attributed to HWAP and to be conservative, the value of this benefit will be left out of the cost effectiveness analysis.

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[29]   Non-energy benefits from the weatherization assistance program: a summary of findings from the recent literature, Oak Ridge National Laboratory, April 2002

Health and Safety Benefits

It is extremely difficult to quantify and assign dollar values to health and safety benefits. As in the 1994 evaluation, the assumption was made that if the benefits of the health and safety work did not at least equal the costs, the work would not have been performed. Therefore, the benefits and the costs are assumed to be equal, providing a conservative estimate of health and safety benefits.

8. Cost Effectiveness

Cost effectiveness is a crucial component in determining whether a program was successful. The question in this case is: Do the benefits of HWAP outweigh its costs? By summing up all Program benefits and dividing this number by the corresponding costs, a Benefit-Cost (BC) ratio is obtained. If this ratio is greater than one, then the Program's benefits outweigh its costs and the Program is said to be cost effective.

Program Benefit-Cost Analysis

To determine Program costs, it is not sufficient to merely look at the amount that the state of Ohio spends on HWAP. Because many HWAP jobs receive a combination of funding from Ohio and a utility, it is important to include the money that utilities spend on HWAP jobs in a calculation of the total cost of the Program.

Program benefits are analyzed in Chapters 4 through 7 of this report. They include the direct and indirect effects of the reduction of participant energy consumption and the economic effects of HWAP spending. Table 20 summarizes all costs and benefits of the PY03 HWAP that we were able to estimate.

Table 20. PY03 Program Costs and Benefits

Costs	
HWAP Actual Expenditure	$28,709,172[a]
Columbia Gas WarmChoice	$1,448,669
Dominion Housewarming	$624,266
Total	$30,782,107
Benefits	
Lifetime Participant Avoided Energy Payments	$33,827,839[b]
Economic	$17,747,363
Health and Safety	$2,739,626
Environmental	$2,533,447
Impacts on Arrears	$649,819[c]
Disconnections	$162,724[d]
Total	$57,660,818

a   The budget is broken into its components in Table D.1.
b   A detailed summary of participant savings is provided in Table D.2.
c   The societal benefit of payment impacts is a one-time decrease in participant shortfall.
d   A societal benefit value of $100 per avoided disconnection with a benefit lifetime of 10 years was assumed. This method is consistent with the 1994 evaluation. See Chapter 7 for in-depth disconnection analysis.

Benefit-cost ratios were calculated from two different perspectives:

- *The Program Perspective* considers only the discounted value of energy savings and total Program costs

- *The Societal Perspective* considers all benefits, including non-energy, and total Program costs

Table 21 presents the benefit-cost ratios from both these perspectives for selected home and fuel types as well as the Program overall, with administration costs distributed equally across all homes weatherized. This table shows that HWAP is cost effective overall from both perspectives, with both BC ratios greater than one. Weatherization of single-family homes is cost effective in all cases, except from the Program perspective for those heated with electricity. From the Program perspective, weatherization of mobile homes is not cost effective for any heating fuel type; from the societal perspective, however, weatherization of mobile homes is cost effective for all space heating types. Weatherization of multifamily homes is cost effective in all cases from the societal perspective, but not from the Program perspective.

Table 21. Benefit-Cost Ratios and Net Benefits by Home and Fuel Type

Space Heating Fuel Type	Home Type	Program Perspective		Societal Perspective	
		BC Ratio	Net Benefits	BC Ratio	Net Benefits
Gas	Single-family	1.22	$4,087,715	1.85	$15,767,954
	Mobile Home	0.58	-$836,680	1.52	$1,053,328
	Multifamily	0.62	-$1,375,450	1.61	$2,196,662
Electric	Single-family	0.70	-$240,887	2.01	$802,396
	Mobile Home	0.83	-$218,272	2.08	$1,407,133
	Multifamily	0.62	-$155,124	2.69	$684,039
Propane	Single-family	2.54	$1,301,623	3.31	$1,955,565
	Mobile Home	0.92	-$120,965	1.80	$1,205,820
Fuel Oil	Single-family	1.63	$769,570	2.27	$1,552,032
	Mobile Home	0.66	-$171,787	1.48	$247,794
Overall		*1.10*	*$3,039,742*	*1.87*	*$26,872,722*

Measure Level Benefit-Cost Analysis

In Chapter 4, an analysis of gas savings by measure was presented, and these numbers can be combined with measure costs to calculate BC ratios at the measure level. Because the OATS database doesn't track labor costs at the measure level, a regression model was employed to disaggregate labor to the measure level. This model used total labor cost as the dependent variable, and measure installation variables (1=installed, 0= not installed) as the independent variables. Table 22 summarizes average cost components by usage group for site-built single-family gas heated homes.

Table 22. Measure, Labor, and Total Installed Costs by Usage Category, Site-Built Gas Heated Homes

	Low Usage			Medium Usage			High Usage		
	Materials	Labor	Total	Materials	Labor	Total	Materials	Labor	Total
Air Leakage Reduction	$96	$113	$209	$107	$91	$198	$141	$224	$365
Attic Insulation	$355	$254	$610	$403	$354	$757	$454	$526	$980
Duct Insulation	$35	$124	$159	$34	$104	$137	$37	$114	$151
Floor Insulation	$193	$207	$400	$141	$151	$292	$130	$140	$270
Furnace Replacement	$1,045	$551	$1,596	$1,125	$813	$1,938	$1,278	$1,144	$2,422
Furnace Tune-Up & Repair	$187	$283	$470	$197	$347	$544	$222	$489	$711
Wall Insulation	$248	$426	$674	$324	$469	$793	$394	$632	$1,026
Water Heater Insulation	$21	$62	$83	$19	$168	$187	$19	$163	$182

Because savings and costs are so dependent on home size and usage group, the cost-benefit analysis was performed by usage group, and the BC ratios are show in Figure 19.[30] Here are the key findings from this analysis:

- Air leakage measures are cost effective in all cases, although they are even more so for homes with higher usage.

- Attic insulation measures are typically cost effective.[31]

- Wall insulation measures are cost effective for all usage groups.

- Floor insulation is not cost effective for site-built homes with small usage (less than 1,000 therms per year), but highly cost effective otherwise.

- Furnace replacement is cost effective only for high use homes.

- Furnace tune-up is not cost effective for any group.

- Other measures (duct insulation and water heating wrap) are not cost effective, however they are most cost-effective for the highest usage group.

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[30] A $1.00 per therm rate was assumed in the benefit-cost calculations.

[31] We note that the attic insulation measures installed in medium-usage homes did not meet the cost-effectiveness test, primarily because the estimated measure-level energy savings for these homes were less than the savings in either low- or high-usage homes. We conducted additional analyses with this group, but could not fully explain this result. It is likely that the collinearity effects could not be completely eliminated, even with the Monte Carlo approach employed. Without further analysis, we note that this finding is more likely to be attributable to the problem of separating out the effects of multiple measures than poor performance of attic insulation measures in medium-usage homes.

Figure 19. Site Built Single-Family Measure-Level Cost Effectiveness by Natural Gas Usage Category[32]
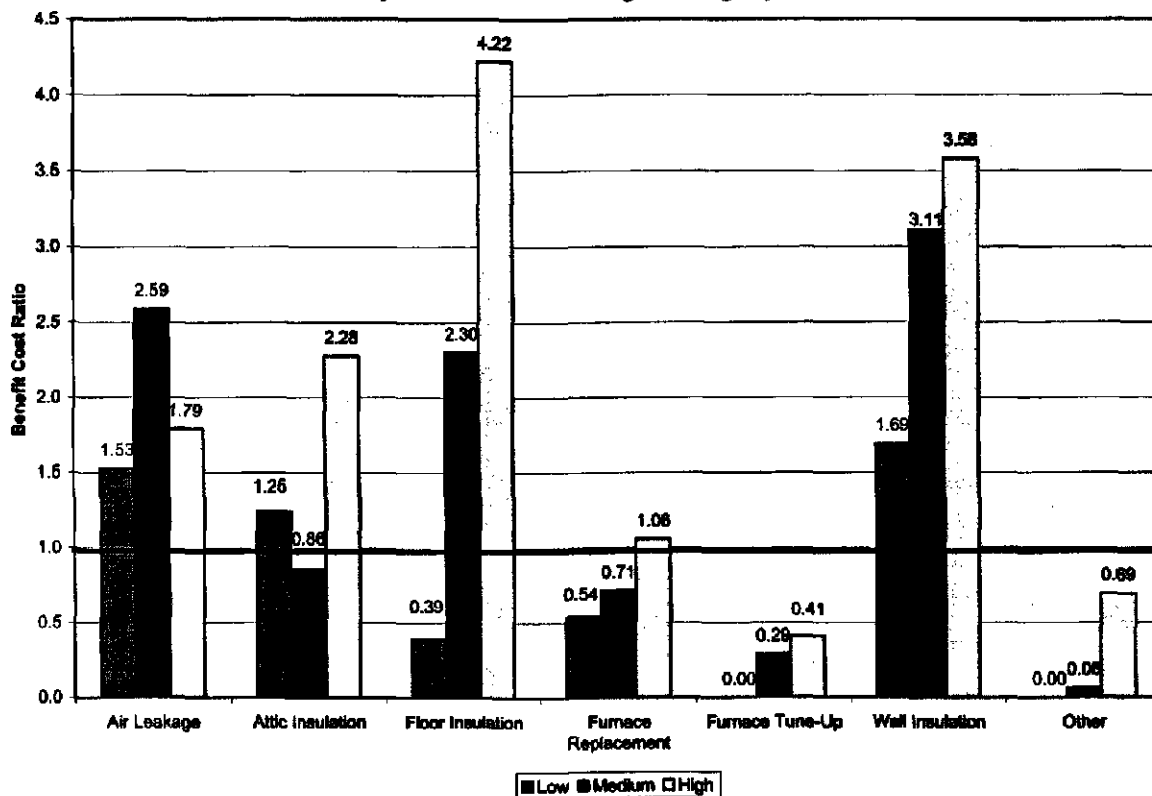
A different way to look at how well the measures are performing relative to their cost is to examine the payback period of the measures. Figure 20 summarizes the payback period and assumed measure life for each measure by usage category. All measures except furnace tune-up pay for themselves before they expire for high users. In addition, most measures pay for themselves in low- and medium-usage households, with some notable exceptions being floor insulation in low usage and furnace replacement for both low and medium usage levels.

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[32] This figure includes site-built homes only.

Figure 20. Site Built Single-Family Measure Payback Time
by Natural Gas Usage Category[33]
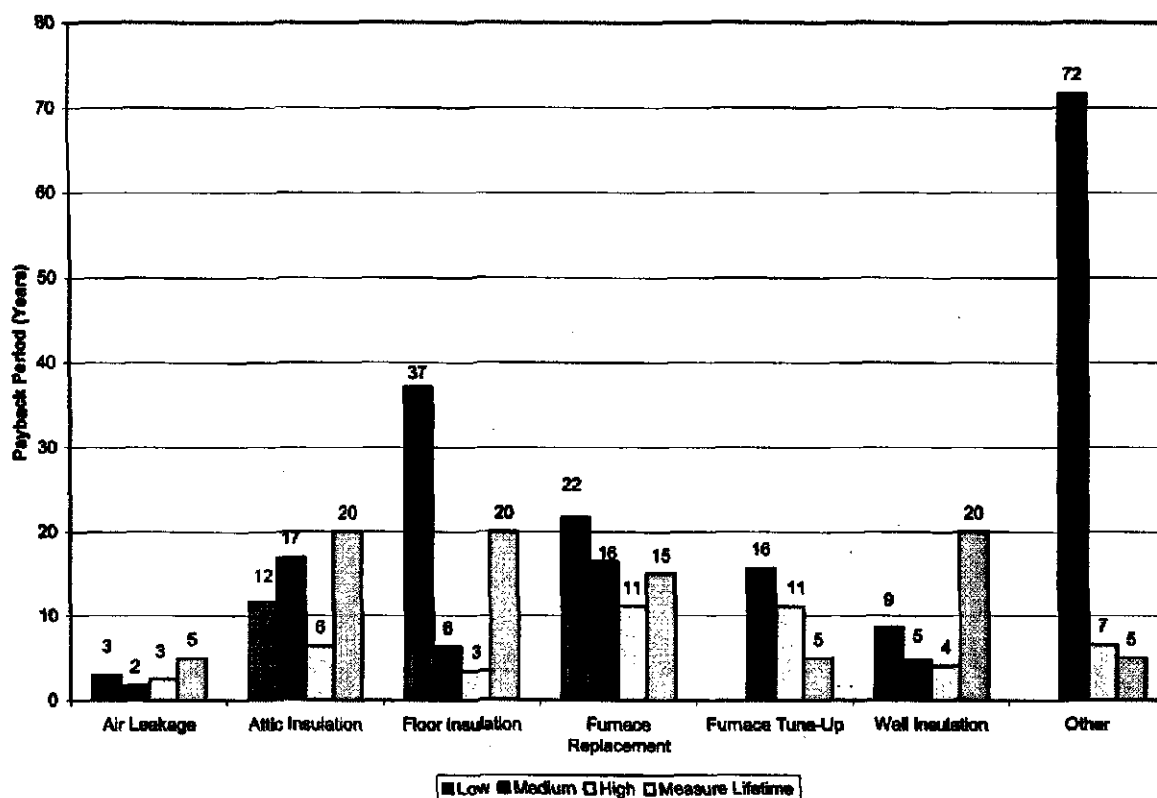
Examining the results of this analysis may be an effective way of maximizing energy savings if the pre-consumption category is known at the time of weatherization.

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[33] This figure includes site-built homes only. The bars for low usage furnace tune-up and other measures are not shown in this figure because the savings are negative.

9. Causes of Poor Performance

One objective of this study was to examine what factors might be contributing to the poor performance of some homes in the Program. We used the analysis described in Chapter 4 to identify and then conduct site visits to homes that saved less than predicted. Three screens were used to identify homes for the sample. Our hypothesis was that factors such as poor quality of work, some unanticipated failure of a measure, measures that were not identified for installation that could have been effective, or unusual occupant behavior could be identified to explain the poor performance.

Once we had selected poorly performing homes, a telephone screening process was used to identify and exclude homes that had been remodeled to increase the size or where additional people had moved in since the time of weatherization. These factors could cause increased energy use but were exogenous changes that were unrelated to the Program. Very few homes were screened out using these criteria. We offered households $30 as an incentive to participate and in the end, 52 homes received site visits. Visits were made in three phases and included homes in Columbus, Dayton, Toledo, Cleveland, Akron, Springfield, Marion, and Findlay.

Inspection tasks included measure installation verification, an assessment of the quality of workmanship, identification of missed energy saving opportunities, and an assessment of the relative energy saving potential of the missed opportunities.[34] A blower door test was conducted and results were compared with the original test results.

For the homes we visited, we found that inadequate measure installation was a primary factor causing poor performance. The expected energy savings were computed based on all measures being fully installed that were reported installed. Therefore, where measures were not fully or adequately installed, actual savings would have fallen below estimates of expected savings.

In terms of missed opportunities and the number of technician's comments, air sealing ranked at the top of the list of possible reasons for low energy savings. Many cases of inadequate or missing air sealing were reported. Likewise, if a measure was listed as installed, it was assumed to be fully installed. Our technicians' comments about the quality of work identified areas where insulation, for example, was not fully installed. Where measures were not completely installed (a missed section of floor, wall, or attic, for example), lower energy savings would result.

The estimates of expected savings also assumed that other measures in the home were in good operating condition, including windows and heating systems. While window replacements were rarely qualified measures under the Program, windows that were broken, leaky, or otherwise in poor condition at the time of the site visit impacted the amount of savings the home was able to

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[34] For the purposes of this review, we defined missed opportunities as measures that were not listed as installed in each home, but that our field technicians believed would have been applicable. Note that some missed opportunity window and door measures were not eligible under the terms of the Program, but they were identified during the site visits because of their potential impacts and effect on factors such as air leakage.

achieve. Heating systems that required repair, replacement, or a tune-up also lowered the home's ability to save energy.

Overall, the quality and completeness of the measures installed were factors leading to fewer energy savings than originally estimated, based on the measures installed.

Overall Findings

The quality of each measure and its installation were rated on a scale from 1 to 5, with 1 being low and 5 being high quality. Missed opportunities were recorded and the relative value of the missed energy savings ranked on a scale from 1 to 5, with 1 being low savings potential and 5 being high savings potential. That is, if the factor was given a rating of 5, its potential to save energy was high if it had been specified and installed properly. The ranking was subjective and determined by our experienced field technicians. The objective was to rate the potential benefits of installing the measures that were not originally listed as installed so that the relative savings potential could be compared across measures.

The field technicians rated the performance of installed measures at the time of the field verification. In most cases, the ratings reflected the quality of the original weatherization work. However, in a few cases (for example, instances of broken windows), the condition could have deteriorated since weatherization occurred. Under these circumstances, it was not possible to determine whether the savings opportunity had been missed originally or the condition had deteriorated since weatherization took place. Regardless of the situation, our primary purpose was to identify what factors were contributing to poor energy performance so these cases were all documented and reported.

The site verification identified and documented factors that we believe could have contributed to the poor performance of these homes. In some cases, occupant actions could have contributed to poor performance and we made notes of obvious cases, but the focus was on physical characteristics of the building when the site visit was conducted. All of these homes were under-performing and we strived to identify causes related to weatherization that could explain their poor performance.

Table 23 shows that 202 measures were listed as installed in the 52 homes. We were able to verify the installation of 182, or 90%, of the measures. This table orders measures from most to least number installed as reported in the Program tracking database.

Figure 21 shows the distribution of the number of measures installed per home. Twenty-seven percent of the homes in the sample had three measures installed and 23% had five.

Table 23. Number of Measures Installed and Verified

	No. Measures Installed	No. Measures Verified	Percent Verified
Air Leakage	46	45	98%
Water Heater Insulation	42	36	86%
Tune-Up and or Repairs	35	29	83%
Attic Procedures	29	26	90%
Sidewall Procedures	14	13	93%
Duct Insulation	13	11	85%
Heating System Work	10	9	90%
Floor Procedures	8	7	88%
Secondary Window Procedures	2	2	100%
Replacement Door	2	2	100%
Replacement Sash Window Unit	1	1	100%
Total	*202*	*182*	*90%*

Note: "Number of Measures Installed" is the quantity reported in the Program tracking database. Our
sample included 52 homes.

Figure 21. Number of Measures Installed
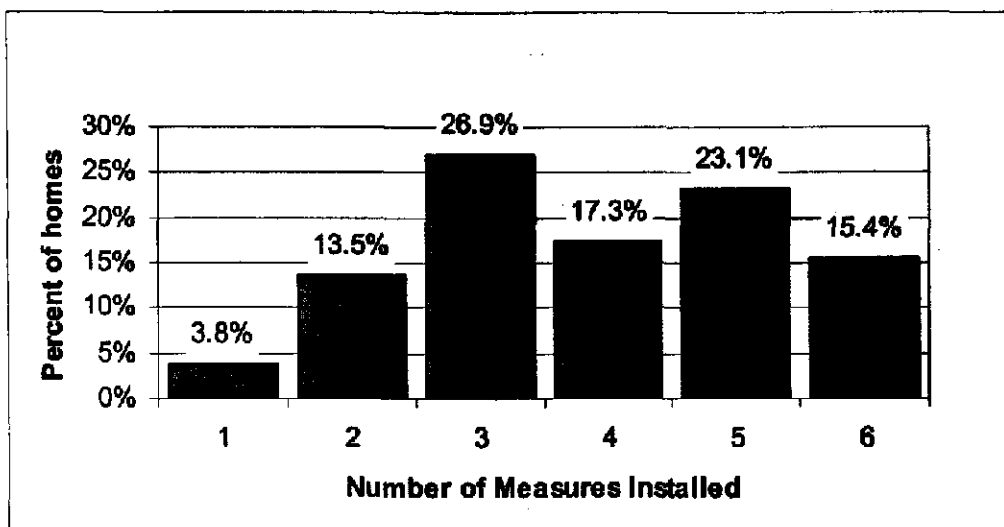
As noted earlier, we defined missed opportunities as weatherization measures that were not listed
as installed in a home, but, in the judgment of our field technicians, would have been effective if
installed. As stated earlier, some of the measures we identified were window and door measures
that might not have met the Program's qualification criteria. This issue is discussed below.

Figure 22 shows the distribution of the number of missed opportunities per home. Ten homes
(19%) had no missed opportunities that we were able to identify that could cause the poor
performance observed in the analysis. Nineteen homes (37%) had one, and 13 (25%) had two

opportunities for efficiency improvements that were not selected for the homes and could be contributing to poor performance.

Figure 22. Number of Missed Opportunities
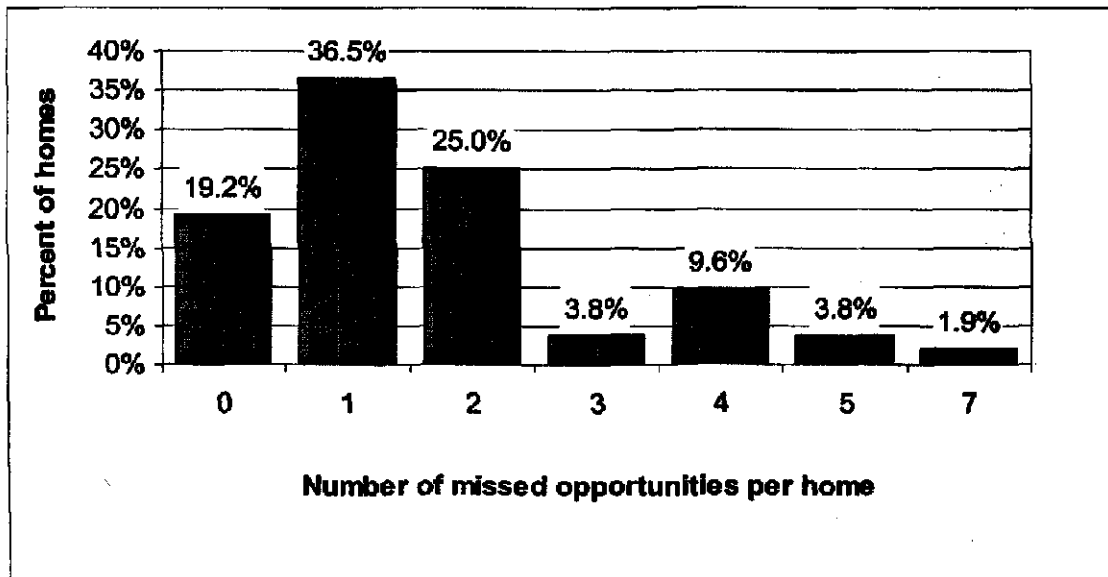
Our field technicians also rated the potential energy savings of each missed opportunity identified on a scale from 1 to 5, with 5 being the largest energy savings potential. The assessment was a subjective judgment based on professional experience. Table 24 shows the number of missed opportunities and their energy-saving potential. Although the number of missed attic insulation performance measures was small, they had the highest mean rating for potential savings. Air sealing, heating system, sidewall[35] and floor insulation measures followed as the next four highest ranking missed opportunities. Of these four, however, only heating system performance factors that could lead to reduced savings occurred very frequently (27% of the homes).

Table 24 includes window sash replacement and secondary window replacements missed opportunities although some might not have been qualified under the terms of the Program. When the prime window is intact, window replacements are not an allowable measure under HWAP. The Program permits replacements only where window sashes cannot be repaired or are missing. Similarly, replacement doors rarely qualify under HWAP. We elected to include these measures in our assessment, however. The counts for these measures are based on the technician's observations that replacements could have been completed and could possibly have caused poor energy performance in these homes.

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[35] Sidewall insulation was observed with an infrared camera. The objective was to identify voids, and not to determine the density of the insulation installed.

Table 24. Savings Potential Ranking of Missed Opportunities

	No. Homes	Minimum Rating	Maximum Rating	Mean Rating
Attic Insulation	3	4	5	4.3
Air Sealing	4	2	4	3.5
Heating System	14	2	5	3.4
Floor Insulation	7	2	5	2.7
Sidewall Insulation	8	1	4	2.3
Duct Insulation	5	1	3	2.0
Tune-Up or Repairs	2	2	2	2.0
Replacement Window	17	1	2	1.7
Water Heater Insulation	4	1	2	1.7
Replacement Sash Window	12	1	2	1.5
Replacement Door	14	1	3	1.3

The field technicians recorded comments about the conditions observed for measures that were installed and reasons that might have led to low energy savings. Comments were recorded for each measure examined. Some comments referred to more than one problem for each measure. For example, if air sealing was inadequate for rim joists and was not present around a chimney bypass, the comment was recorded under both rim joists and air sealing.

Table 25 summarizes comments and groups them by topic. The most common comments (42) were about air sealing. Typical air sealing problems included air sealing missing or inadequate around chimney and plumbing bypasses, wall tops, windows, and kneewall bottoms. These comments help to explain the quality rating for each measure discussed later.

Table 25. Field Technician Comments

Type of comment	Number of comments
Air sealing inadequate or not installed: chimney bypass, plumbing bypass, attic wall tops, kneewall bottoms, attic hatch, duct boots. Leaky windows or windows with inadequate air sealing	42
Furnace old & inefficient, would benefit from replacement	15
Windows broken (4) or single pane windows that could have had a storm window installed (11)	15
Rim joist insulation missing or inadequate	14
Doors in poor condition	14
Weatherstripping missing or poorly installed	10
Floor insulation inadequate, not installed, or improperly installed	8
Sidewall insulation voids, missing altogether, or improperly installed	7
Attic insulation missing or inadequate	7
Duct leaks, incomplete duct insulation, no duct sealing	6
Water heater insulation improperly installed, tape problems	6
Tune-up & repair-no evidence	5
Kneewalls not insulated, or inadequate insulation	4

Findings by Measure

The following sections discuss site visit findings for each measure at these selected poorly performing homes. The measures are discussed in the order listed in Table 23, starting with the measures most commonly installed.

Discussions for each measure include the count of the measures installed and verified, factors that could lead to poor performance, and the ranking for energy savings potential from these factors. The graphs summarize the information for each measure. The values shown for "% Missed Opportunity" are based on our field technicians' estimates of the number of homes that, in their judgment, could have benefited from including the measure even though it was not listed as one of the measures installed in the home through the Program. For each measure, the discussion and quantification are based on the measure as a whole. Comments recorded by the field technician are also provided.

Air Leakage and Blower Door Findings

Figure 23 shows that air leakage measures were listed as installed in 88% of the homes. We were unable to verify that the measures had been installed in about 5% of the homes. On a scale from 1 to 5, the average rating for the air leakage work quality was just average at 2.6. Three (6%) of the homes in our sample were identified as additional homes that could have benefited from air leakage measures. The potential for energy savings in the missed opportunity cases was relatively high, a 3.5 average on a scale from 1 to 5.

Figure 23. Air Leakage Results
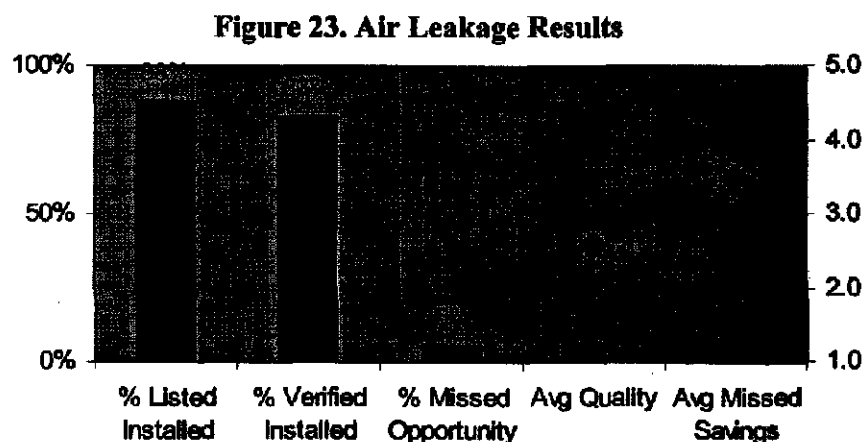
The main factor lowering the installation quality score was rim joist problems. Fourteen of the homes were determined to have rim joist sealing problems, usually missed sealing at penetrations. The second most common quality problem was weather stripping; six houses were identified where weather stripping was either incomplete or poorly done. Five of the homes had problems associated with windows and air leakage. The problems included broken windows and poor sealing around windows. Only one house was observed that had duct leakage problems.

Results from the original blower door tests were available for 47 of the 52 homes. We were able to conduct follow-up tests on 40 of these homes to compare leakage rates now with those measured earlier. The follow-up blower door tests were conducted with the home in the same configuration as the original pre and post tests. Where both basement-door-open and basement-door-closed tests were conducted, the door-open results were used to compute the percent change from the original pre-test.

Table 26 shows cases where data were available for both the original and follow-up tests. When the weatherization work was done, the blower door tests showed a 31% reduction in CFM50 on average. In our follow-up tests, blower door results showed, on average, a 21% reduction from the original pre-weatherization result.[36] The Program also establishes leakage reduction targets called OVERALLS; based on our tests, 22 of the 40 homes met these targets when we tested them.

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[36]   A blower door is used to test how leaky a home is. CFM50 is the airflow, measured in cubic feet per minute, needed to create a change in building pressure at 50 pascals. The larger the CFM50, the more airflow through the building. Leakiness is often computed as the number of air changes per hour. Air changes per hour at 50 pascals is computed as (CFM50 x 60) / building volume in cubic feet.

Table 26. Pre-Weatherization and Post Blower Door Results

Original Blower Door Tests		Follow-up Blower Door Tests		Percent Change In cfm50 from Original Pre Test		OVERALLS
Pre Test cfm50	Post Test cfm50	Basement Door Open cfm50	Basement Door Closed cfm50	Original Pre to Original Post Test	Original Pre to Follow-up Post Test	Does follow-up test meet OVERALLS?
7054	2328	5625	.	-67%	-20%	No
2001	1738	1700	.	-13%	-15%	Yes
3855	2712	3800	.	-26%	4%	No
4090	4106	3600	.	0%	-12%	No
1499	995	2030	.	-34%	35%	Yes
2704	2240	2700	.	-17%	0%	Yes
2066	1921	2000	.	-7%	-3%	Yes
1800	1497	2000	.	-17%	11%	Yes
6930	5441	6900	.	-21%	0%	No
6683	3578	4250	.	-46%	-36%	No
3651	1135	.	3100	-69%	-15%	No
4030	1990	.	2000	-51%	-50%	Yes
1215	1093	.	1250	-10%	3%	Yes
4826	3743	4400	3750	-22%	-9%	No
7012	5183	6400	5800	-26%	-9%	No
5617	2529	2150	2300	-55%	-62%	Yes
3780	2587	.	1920	-32%	-49%	Yes
3122	1893	1950	1830	-39%	-38%	Yes
3038	2226	.	2200	-27%	-28%	No
2450	1907	1650	1575	-22%	-33%	Yes
4480	2980	4600	4200	-33%	3%	No
4829	3076	3800	2900	-36%	-21%	No
4215	3412	2800	2400	-19%	-34%	Yes
1914	1395	1400	.	-27%	-27%	Yes
3009	2610	2000	.	-13%	-34%	Yes
3038	2591	2300	2240	-15%	-24%	No
8125	7231	6500	5500	-11%	-20%	No
2595	1382	2975	1720	-47%	15%	Yes
1990	1555	1600	.	-22%	-20%	Yes
12063	4919	5100	.	-59%	-58%	Yes
3107	2423	2500	2230	-22%	-20%	No
5271	2119	2300	.	-60%	-56%	Yes
3177	2376	2200	.	-25%	-31%	Yes
2635	2311	2300	.	-12%	-13%	Yes
4339	3418	3300	.	-21%	-24%	No
3038	2635	3100	.	-13%	2%	No
3713	2455	2240	2100	-34%	-40%	Yes
5764	2009	6100	5300	-65%	8%	No
9503	5255	6000	5800	-45%	-37%	No
4196	1798	1550	.	-57%	-63%	Yes

To better understand what factors might have contributed to an increase in leakage, we reviewed the technician's comments for the 25 homes where the blower door results degraded. For most of these homes, the comments identified missed air sealing opportunities. In other homes, windows and knee wall hatches were not closing properly. One home had open windows in the conditioned attic and the thermostat was set to 85 degrees. Another home had a hole in the ceiling. The fireplace damper was missing at one home and there was significant leakage around the glass doors. At other homes where the blower door readings degraded there were no apparent explanations; the work was done well, or there was minimal work to do.

Table 27 shows the percent reduction in 10% ranges of the blower door results from the pre-weatherization to the post weatherization periods. The "Original" column refers to the change in the blower door reading just after weatherization work was done on the home. The "Follow-Up" column refers to the measurements during our site visits and shows the change from the pre-weatherization result to the follow-up site visit result. The data suggest overall that the leakage in the homes had gradually increased since the original tests were done after weatherization. The table includes all homes with both the original and follow-up test results.

Table 27. Original and Follow-Up Blower Door Results

Reduction in CFM50 Reading	Original	Follow-Up
<=10%	3	10
>10% and <=20%	10	6
> 20 and <= 30%	11	7
> 30 and <= 40%	6	8
> 40 and <= 50%	3	5
> 50 and <= 60%	5	4
> 60 and <= 70%	3	1
Total	*41*	*41*

Water Heater Insulation Findings

Figure 24 shows that 81% of the homes in our sample were listed as having had water heater insulation installed. We verified water heater insulation was present in 69% of the homes. The average quality of the work was rated quite high at 4.2 on the 5-point scale. An additional 8% of the homes were determined to have missed opportunities in water heater insulation, but the likely energy savings were considered to be relatively small.

A small number of wrapped water heaters exhibited problems with the tape holding the blanket coming off either partially or completely. Only part of the water heater was wrapped in other installations. In a couple of homes, the technicians noted that the water pipes were wrapped as well.

Figure 24. Water Heater Insulation Results

| | % Listed Installed | % Verified Installed | % Missed Opportunity | Avg Quality | Avg Missed Savings |
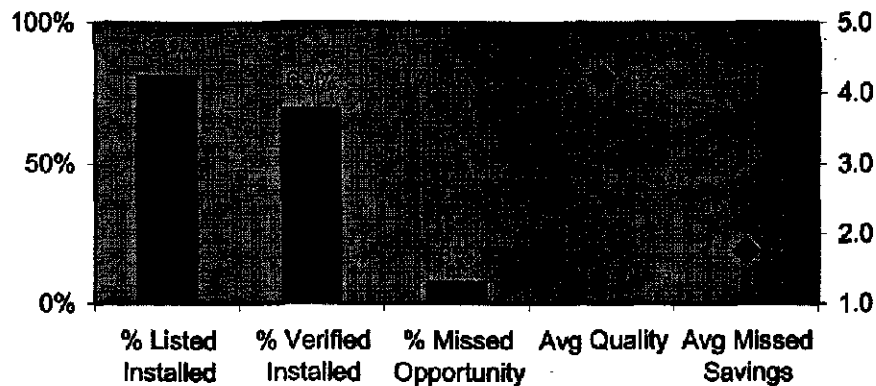
Tune Up and Repairs

Figure 25 shows that 67% of the sample homes (35) were reported to have tune ups or repairs done to the heating system. We verified that procedures were completed in 56% of the sample (29 homes). Where the tune up or repair could not be verified, the field technician noted there was no evidence of work being done. Where the procedure could be verified, the average quality of the work was rated 3.1 on a scale of 1 to 5. In one case the field technician recorded health and safety concerns noting the existing chimney needed modification. There were no missed opportunities identified.

Figure 25. Tune Up and Repair Procedures Results

| | % Listed Installed | % Verified Installed | % Missed Opportunity | Avg Quality | Avg Missed Savings |
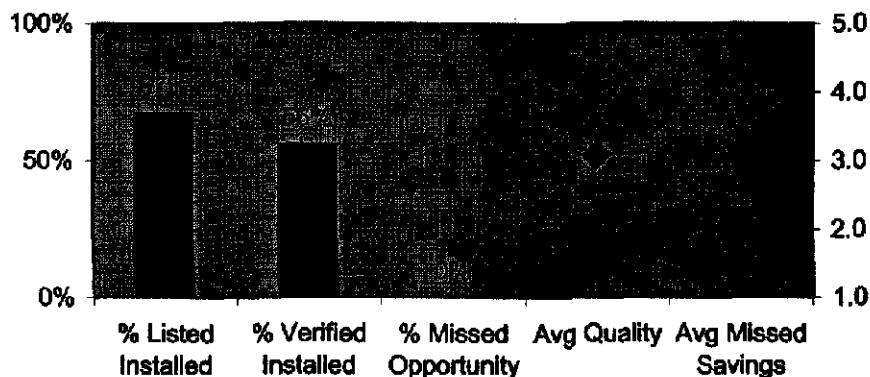
Attic Procedures Findings

A little over half (56%) the homes we visited were listed as having attic measures (basically ceiling insulation) installed. As shown in Figure 26, we were able to verify that exactly half the homes had ceiling insulation installed. The average quality of the work was a little above average. We found an additional 6% that, in our technicians' judgment, could have benefited

from ceiling insulation. The energy savings potential was considered to be relatively high (4.3 on a 5-point scale).

Figure 26. Attic Procedures Results
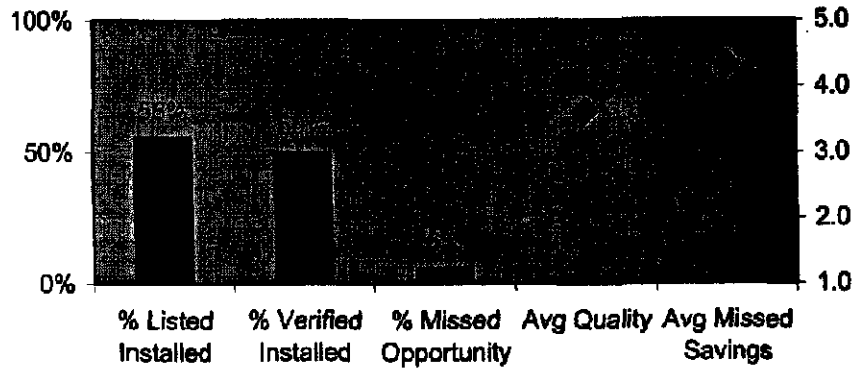
Although most of the field technician's comments about the quality of the attic work were positive, there were a few problems identified. There was no pattern to the defects observed. In one case, knee walls were not insulated. In another, the insulation was observed to not be uniform in the attic. There were a couple cases with poor overall work quality. In one case of especially shoddy work, the crew blew insulation about 4 to 6 inches above the floor without moving anything and put holes in the knee walls and did not repair them. One homeowner reported that they had refused to let the workers insulate the attic since the installers had left a big mess from their other work. In some cases, the weather stripping was not adequately installed around access hatches.

Sidewall Procedures Findings

Figure 27 shows that about one-fourth of our sample homes were reported to have sidewall measures. As noted earlier, sidewall insulation was observed with an infrared camera. The objective was to identify voids, and not to determine the density of the insulation installed. We verified installation in all but one of the cases. The one exception was a home with solid brick walls where wall insulation was impossible, and there was no evidence of rim joist insulation. Overall, the quality of the sidewall work was rated to be above average. In 17% of the homes, our field technician identified sidewall missed opportunities. The average estimated energy savings benefits associated with these potential missed opportunities were ranked relatively low, however, at 2.4 on the 5-point scale.

Figure 27. Sidewall Procedures Results
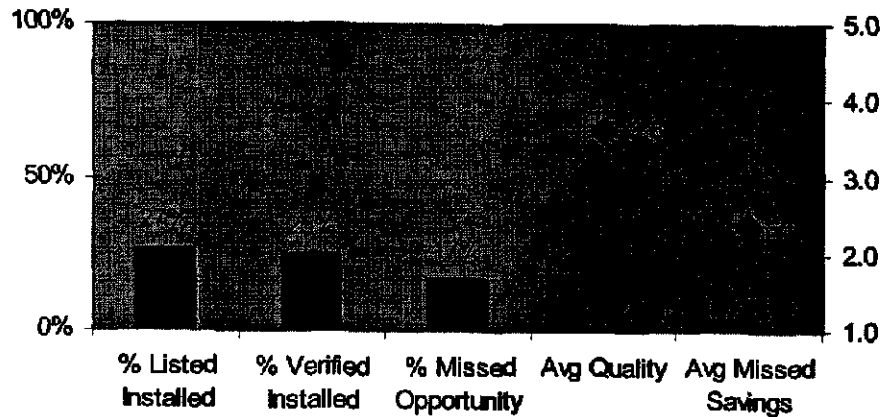
Although the sidewall procedures work received above average quality ratings, we identified specific defects in 5 of the 13 homes with wall insulation added. Our technicians used an infrared camera to identify voids in the insulation. Two had gaps near windows and the others had voids in a variety of locations, including, for example, the upper portion of a second floor wall.

Duct Insulation and Duct Sealing Findings

As shown in Figure 28, 25% (13) of the homes in our sample were reported to have duct insulation installed. Duct insulation was verified in 20% of the homes; we were unable to verify installation in three homes. Overall the average rating for the quality of the work was only 2.5 on the 5-point scale. An additional 10% of the homes were identified as having missed opportunities for installing duct insulation. We estimated that for those cases where duct insulation was a missed opportunity the probable savings from the measure were relatively low - an average of 2.0 on the 5-point scale.

Figure 28. Duct Insulation Results
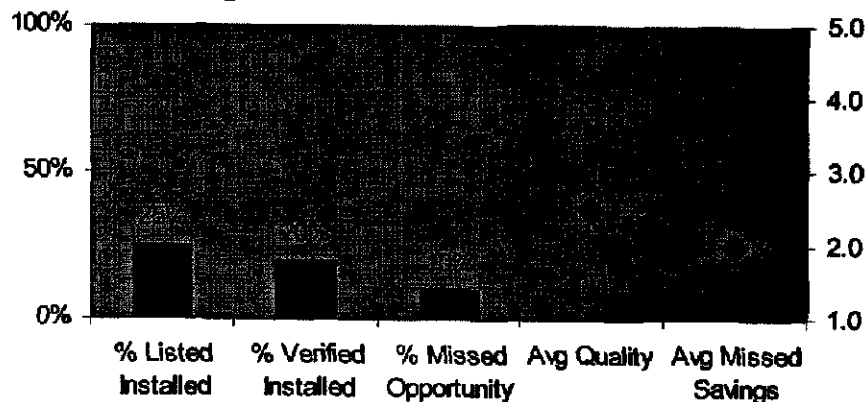
The main problem with duct insulation was incomplete work. For example, one home had the ducts in the attic insulated, but those in the crawlspace were not. The field technicians did not conduct duct leakage tests, but reported three cases where there was no duct sealing observed at all.

Heating System Findings

As noted in the earlier discussion about energy savings in this report, heating system replacements were much more likely among the high energy savers than the low savers. In our sample of low savers, 19% were listed as having heating system work done including replacements, as shown in Figure 29. We verified that 17% had heating system work completed. The average quality of the work received a high rating of 3.8 on the 5-point scale. We identified an additional 29% of the homes that, in our field technicians' judgment, could have benefited from heating system work and estimated that the savings from this measure would have been relatively high, 3.4 on the 5-point scale.

Most of the cases identified where our field technicians observed that there were missed opportunities with the heating system were homes with very old and inefficient heating systems. One was described as "an old floor unit to heat the entire house" and another was described in the field notes as follows: "Ancient gravity furnace. No blower." The remaining missed opportunities were cases where replacing the existing standard-efficiency furnace with a high-efficiency unit would have been justified in the opinion of the technician who conducted the on-site verification.

Figure 29. Heating System Work Results
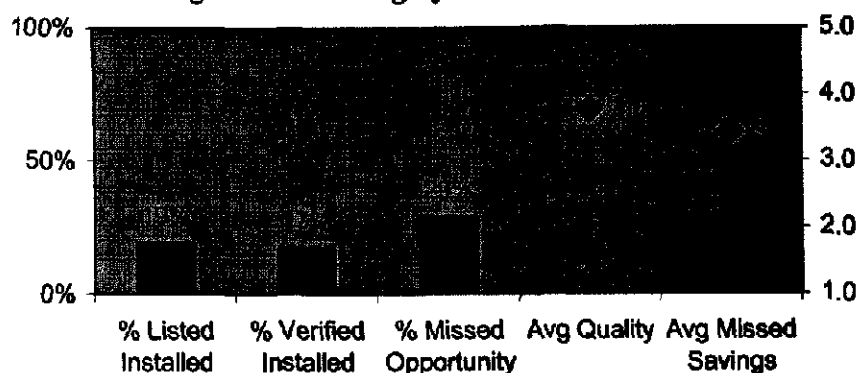
Floor Procedures Findings

Figure 30 shows that floor procedures (typically insulation) were listed as installed in 15% of our sample homes. We were able to verify the procedures in all but one home. Overall, the quality of the work was below average. An additional 12% of the homes were identified as missed opportunities that could have benefited from application of floor insulation procedures. For example, our technician observed an uninsulated crawlspace and uninsulated cantilevered floors in some cases.

Figure 30. Floor Procedures Results
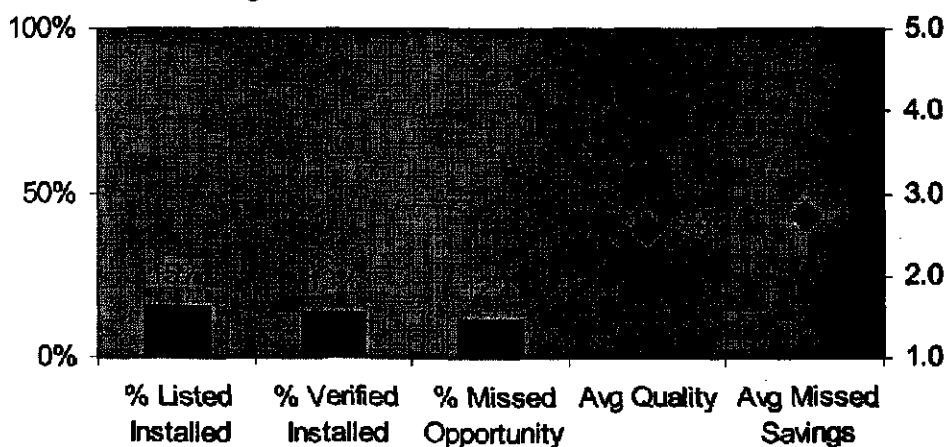
Most of the houses had one or more defects in the floor insulation. Most common was insulation that was not installed over the entire floor area, often because of accessibility problems. In one house with a basement, our field technician felt that the basement was not really part of the conditioned space and should have been insulated. In another case, R-11 batts were installed when R-19 would have been justified. In addition, the batts were installed incorrectly.

Secondary Window Procedures Findings

As Figure 31 shows, only 4% (2) of the homes in our sample were listed as having secondary window procedures and we verified these during the site visits. Secondary window procedures include repairs to broken windows or installation of storm windows on single-pane windows. The verified installations received relatively high quality ratings. The field technicians noted that they believed an additional 17 sites (33%) would have benefited from secondary window procedures. Comments typically said that the existing windows in these cases were single-pane wood framed windows. As noted previously, however, replacement of a window just because it was single-paned was not a qualified measure under the Program. Average missed savings for window missed opportunities were ranked low at 1.8 on a scale of 1 to 5.

Figure 31. Secondary Window Procedures Results
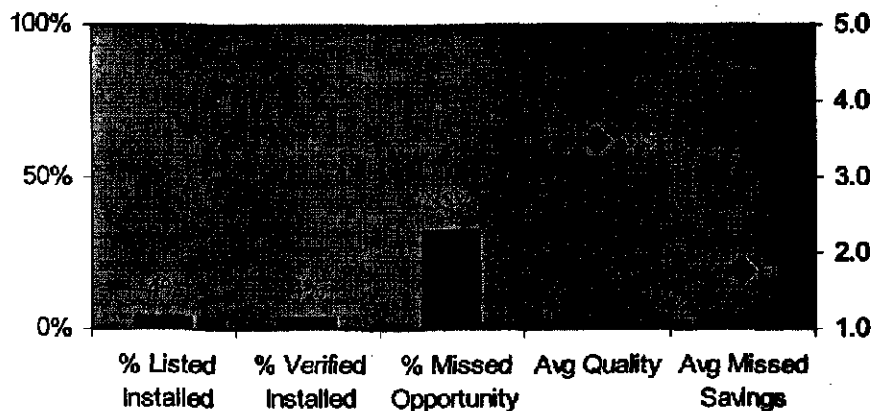
Replacement Door Findings

As shown in Figure 32, door replacements occurred in only 4% (2) of the houses in our sample. The work was considered to be of relatively high quality. Replacement doors rarely qualify for replacement in the Program; however, we identified another 27% of the homes that could have benefited from replacement doors based on our field technicians' observations. The likely energy savings from replacement doors were relatively small.

The missed opportunities were mostly doors that were very old, in poor condition, and leaky. In two cases, repairs had been made to the doors, but the repairs were inadequate.

Figure 32. Replacement Door Results
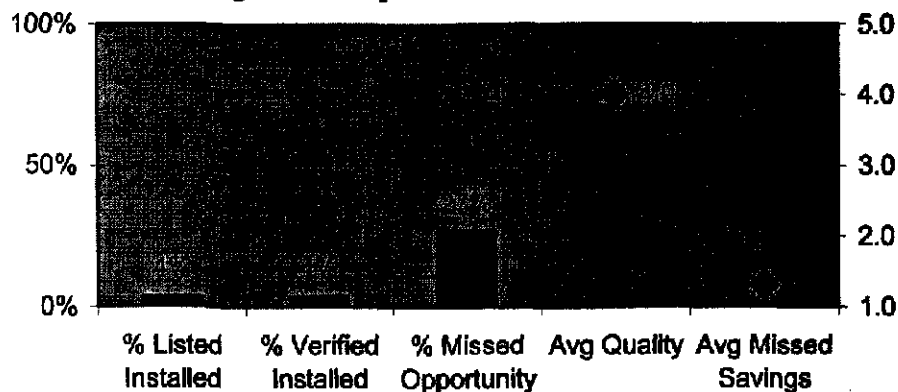
Replacement Sash Window

As noted earlier, when the prime window is intact, window replacements are not an allowable measure under HWAP. The Program permits replacements only where window sashes cannot be

repaired or are missing. For the homes in our sample, one window sash was listed as replaced and our technician verified the installation. However, the field technicians identified 12 additional sites where windows were in poor condition and they believed a case could have been made for replacing them. Of course, the condition of these windows could have deteriorated since weatherization had occurred; for purposes of our study, however, it was important to identify these cases as possible contributors to poor energy performance.

The site visit results are shown in Figure 33. The 12 cases are shown as potential missed opportunities, comprising 23% of our sample. Despite the large number of such cases, the technicians rated the energy savings potential to be quite small (1.6 on the 5-point scale). The quality of the one window replacement was given a low rating.

Figure 33. Replacement Sash Window Results
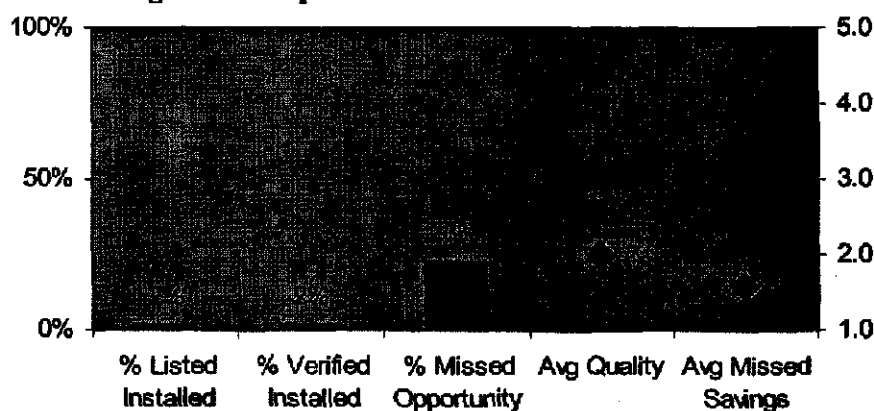
10. Comparison to Other Low Income Weatherization Programs

This chapter summarizes HWAP results and compares them to similar programs in terms of energy savings and cost effectiveness.

Gas Savings

Table 28 presents findings from other WAP evaluations from around the United States for gas-heated, single-family homes.[37] The table shows that the results from this evaluation compare favorably to similar studies and that half of the programs with higher savings also had higher pre-use, which will tend to drive up savings.

Table 28. National WAP Gas Savings Results, Single-Family Homes

Study	Year	# Units Analyzed	Pre-Use (therms)	Savings (therms)	% Savings
Current Evaluation	2003	1,825	1,290	268	21%
National	1989	3,873	1,334	173	13%
Oak Ridge National Meta Evaluation	1993-2003	n/a	1,330	305	23%
Colorado	1994	3,431	1,230	185	15%
Illinois	2003	2,056	1,551	198	13%
Iowa	2004	633	1,194	295	25%
Kansas	1993	165	1,283	191	15%
North Dakota	1992	182	1,200	160	13%
Ohio	1994	2,209	1,395	324	23%
Vermont	1998-2000	25	1,116	145	13%
Washington	1997	71	852	230	27%
Wisconsin	2001-2003	8,252	1040	156	15%

Figure 34 and Figure 35 provide graphical representations of percent net savings and absolute net savings, respectively. These figures show again that Ohio has one of the most successful programs in the nation in terms of energy savings. Due to the recent rise in gas rates, the best comparisons are likely with the most recent studies, namely Iowa, Wisconsin (2001-2003), and Illinois.

The results of this evaluation are also close to the national meta evaluation estimates of 23% savings and 305 therms saved.

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[37] Most of the values shown are from a presentation by Michael Blasnik at the U.S. DOE National Weatherization Conference in Atlanta, Georgia, December 12-16, 2005.

Figure 34. Comparison of Gas Percent Savings in Current Evaluation to Other Programs
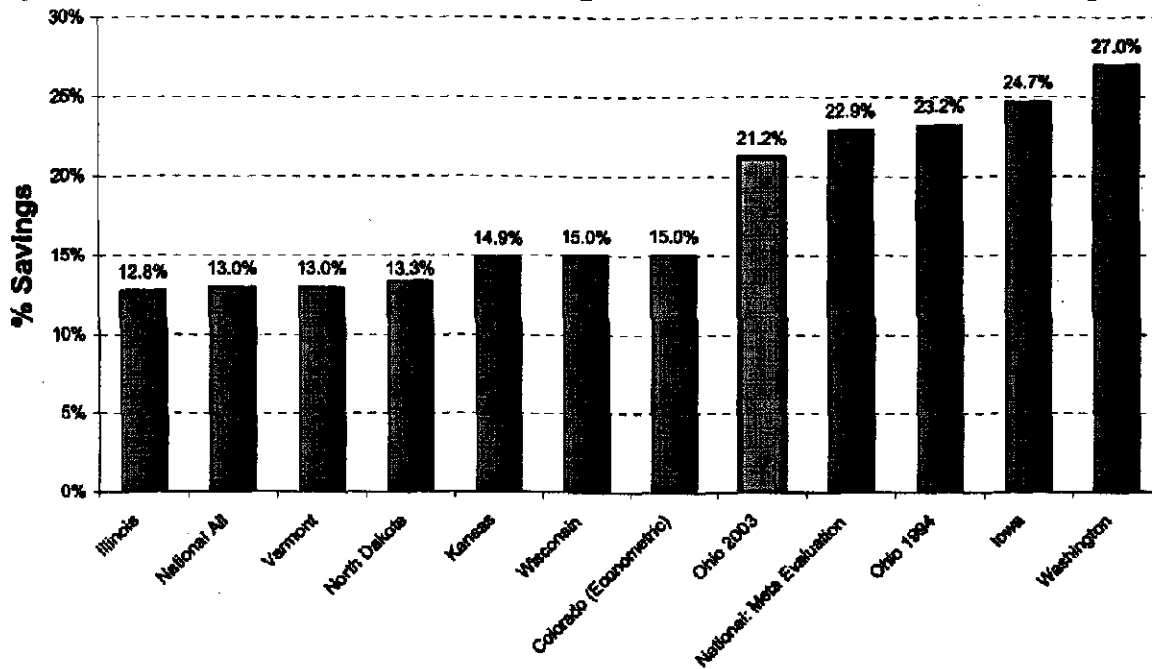
Figure 35. Comparison of Gas Net Savings in Current Evaluation with Other Programs
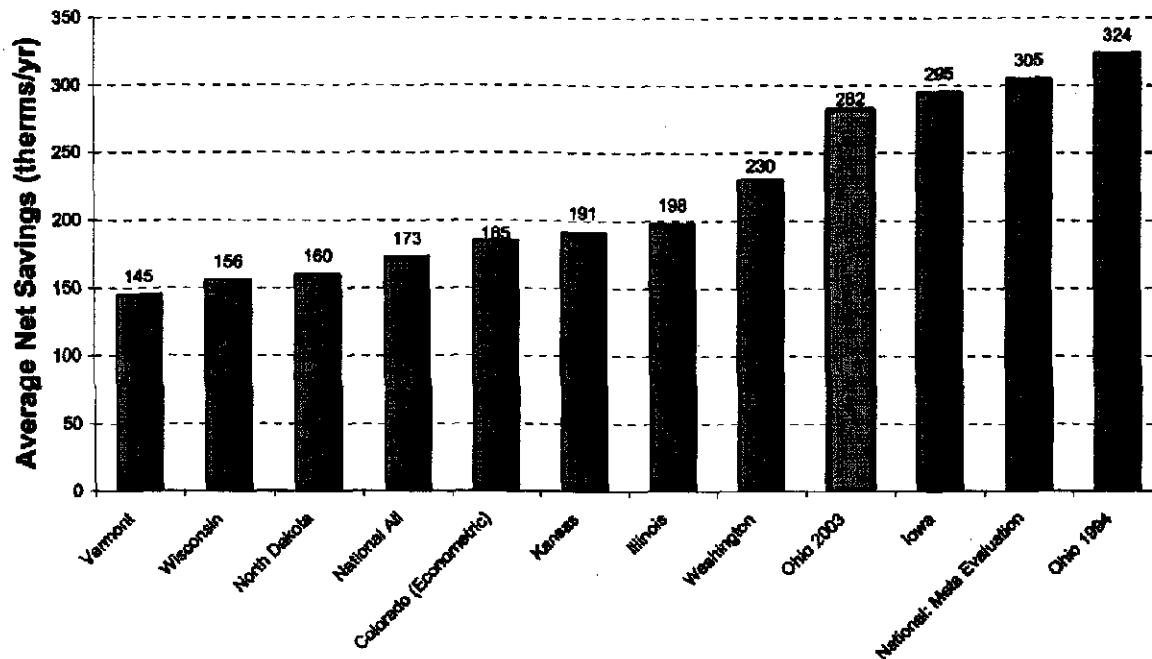
Electricity Savings

Table 29 summarizes total electric heat savings results from this evaluation as well as similar programs. Single-family homes with electric heat saved 1,473 kWh or 7% of pre in the current evaluation. Based on previous evaluations, the Ohio PY03 weatherization program single-family electric savings (electrically heated) are lower than other evaluations both in terms of net percent savings (Figure 36) and absolute net savings (Figure 37). However, the 7% percent savings estimate is relatively close to the 9% estimated in the HWAP PY94 evaluation.

Table 29. Comparison of Electric Savings Results

Study	Year	# Units	Pre-Use (kWh)	Savings (kWh)	% Savings
Current Evaluation	2003	213	22,282	1,473	6.6%
National	1989	426	14,972	1,830	12.2%
Oak Ridge National Meta Evaluation	1993-2003	n/a	19,919	2,153	10.8%
Ohio	1994	150	21,542	2,002	9.3%

The estimates from our evaluation, are also lower than the National WAP Evaluation with an estimate of 11% savings and 2,153 kWh saved. The savings are lower in magnitude than the 1,830 kWh estimated in the National Meta Evaluation conducted by Oak Ridge National Laboratory study.

Figure 36. Comparison of Electric Percent Savings in Current Evaluation with Other Programs
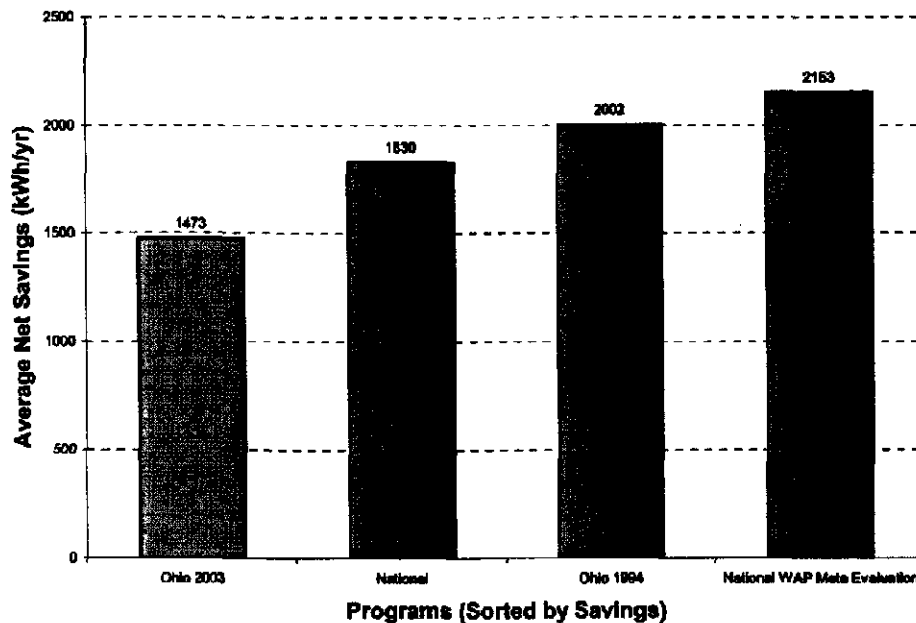
Figure 37. Comparison of Electric Net Savings in Current Evaluation with Other Programs
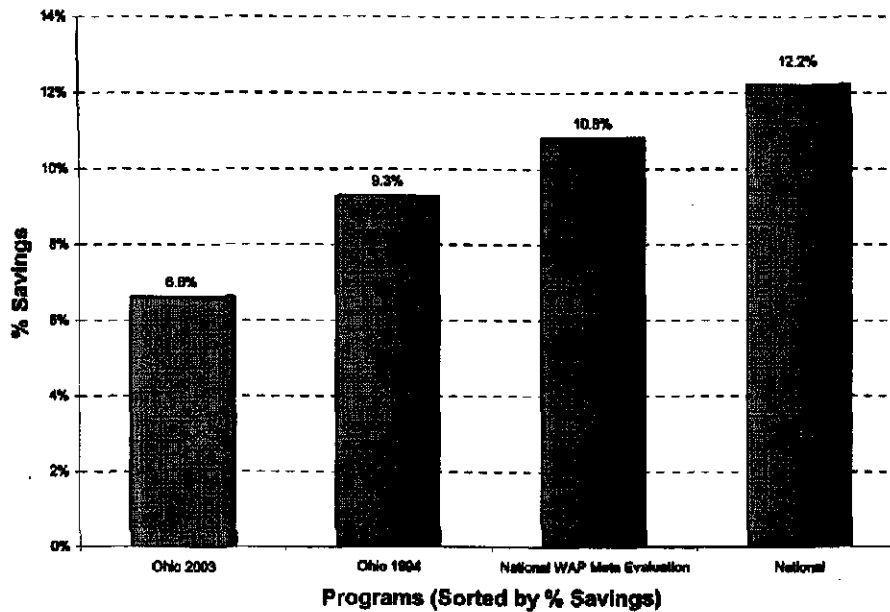
Cost Effectiveness

As described in Chapter 8, cost effectiveness was computed from several different perspectives. Results for single-family gas-heated homes are compared to similar programs in Table 30. This evaluation compares very favorably to the other studies, particularly from the program perspective. The benefit-cost ratios are higher for the current Program than the estimates from the 1994 evaluation based on both tests. From the societal perspective, the current evaluation produced a lower benefit-cost ratio than the national meta evaluation. The current Ohio evaluation showed both higher Program costs per home and larger energy benefits than the national study.

Table 30. Comparison of Cost Effectiveness Results for Gas-Heated Single-Family Homes

Program	Year	Program Perspective	Societal Perspective
Current Evaluation	2003	1.10	1.87
Oak Ridge National Meta Evaluation	1993-2003	1.30	2.70
Ohio	1994	0.88	0.90*
Washington	1997	0.74	1.20

* Includes only energy and disconnection benefits.

11. Recommendations

As a result of the findings presented in earlier chapters of this report, recommendations were generated with regard to the questions posed in the RFP. These recommendations are intended to provide a guide to OEE on potential Program improvements to maximize the impact of HWAP dollars.

Obtaining Applicant Energy Histories

Many studies have shown (including this one) that pre-consumption is the biggest factor in energy savings potential through weatherization. In light of this, it would be worthwhile for OEE to acquire applicant energy usage histories and group them based on pre-consumption with the highest consumers being the top priority.

This would require some extra work on the part of OEE to contact utilities, but Quantec was able to obtain a very high percentage of requested records from utilities, and the Ohio Department of Development already tracks energy consumption for PIPP participants on HEAP.

In addition, OEE might consider proactively seeking utility data for low-income families and using this information to let agencies know which homes to target to maximize energy savings through weatherization. The mechanism and implications of doing this should be investigated further.

Measure Installation Based on Pre-Consumption

Figure 38 (also presented in Chapter 8) displays the measure-level cost effectiveness by pre-consumption for single-family gas homes and provides a guide for determining which measures should be installed once billing histories are obtained. All measures, except furnace tune-up, are worth installing in high-usage houses when deemed necessary, however, fewer measures are cost effective for medium- and low-consumption homes. Furnace replacement, tune-up, and other measures (water heater and duct insulation) were not found to be cost effective for medium consumption homes and only air leakage reduction and wall and attic insulation were found to be cost effective for low consumers. By following this guide to measure installation, OEE should be able to maximize energy saved per dollar spent.[38]

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[38] Please note that the results for attic insulation in medium-usage homes did not appear to be consistent with the observed trends in the benefit-cost ratio. The low benefit-cost ratio resulted from the relatively low savings estimated for this measure in medium-usage homes. We thoroughly reviewed these values and reestimated them using different samples, but the results did not change. Although they appeared to be stable, we do not believe they provide sufficient evidence to question the cost effectiveness of attic insulation in medium-usage homes.

Figure 38. Measure-Level Cost Effectiveness
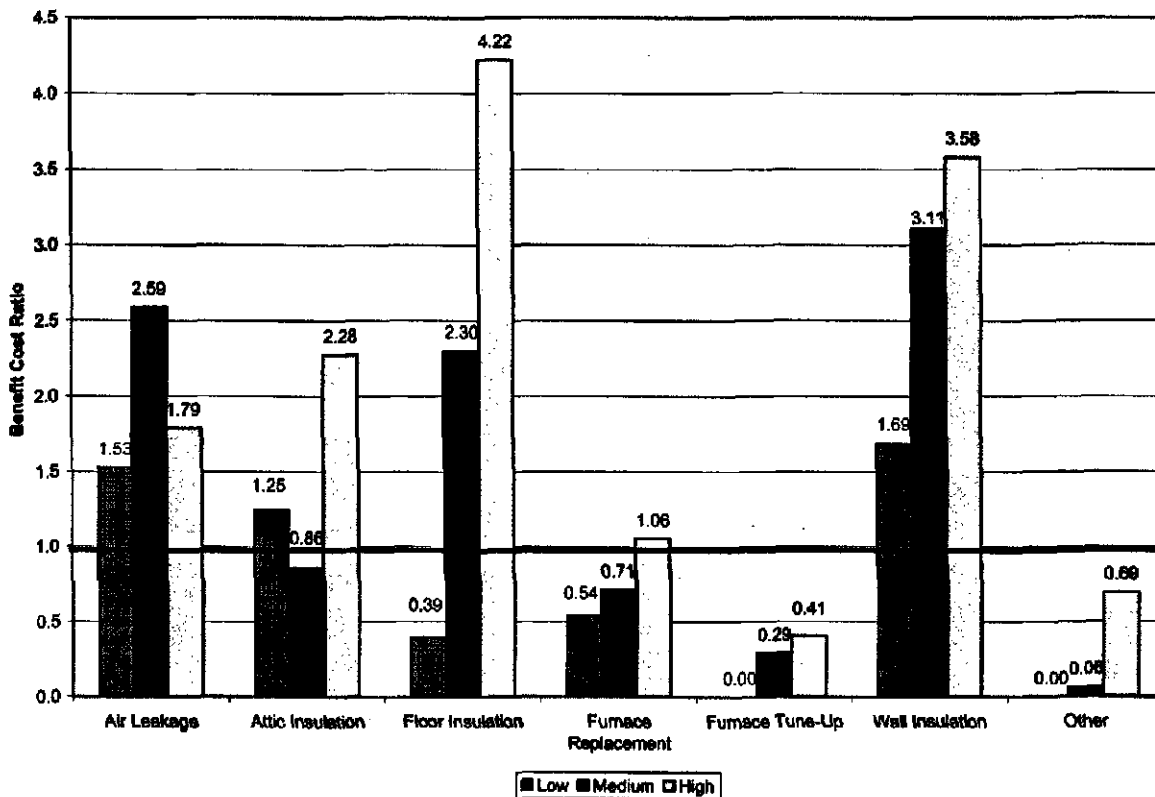
Combo Job Tracking

It is currently extremely difficult to determine if a weatherization job received money jointly from HWAP and a utility. Data must be received from both OEE and the given utility and then merged together based on home data (account number, social security number, etc.). Altering the BWR to include either a "combo job" checkbox or a field to capture the utility name would allow for much easier tracking of these jobs. This information could be stored in the OATS database and would be readily available to compare joint weatherization to HWAP-only weatherization.

Labor Cost Tracking

In order for an accurate calculation of measure cost effectiveness, the full cost of a measure's installation must be tracked. Currently, the BWR records material costs by measure, but all labor costs are combined. In this evaluation, a regression was required to estimate labor costs by installed measure, but this estimation could be avoided with measure-level labor cost tracking.

Appendix A: GIS Data by County

In an effort to provide a new perspective on HWAP, Quantec utilized ArcGIS, a geographic information systems (GIS) mapping program. Using GIS, it is possible to assess the spatial relationships of HWAP elements such as eligibility, participation, and Agency location. Specifically, this aspect of the evaluation sought to understand where the need for HWAP services is greatest, what percentage of those eligible have been served, and how the Program Agency locations and service territories spatially relate to areas exhibiting high or low levels of saturation. This section offers a series of county-level maps exploring these relationships, as well as a brief analysis of the findings and suggestions for the future application of GIS.

Data

To develop maps, data from the following sources were utilized:

- *OATS Database*: The Program database provided historical data used to map participation by county.

- *2000 United States Census*: The Census was utilized to access county-level population, income, and poverty information.

- *GIS Data:* These data provided geographical information for the state of Ohio, including its counties, and cities.

Methodology

To calculate the percentage of eligible households HWAP has served to date, it was necessary to first determine the number of households in each county that meet the Program's income eligibility requirements. While the 2000 United States Census identified the number of households living at or below 100% of the Federal Poverty Guideline (FPG), precise Census data are not available regarding the severity of household poverty at the Program's eligibility threshold of 150%. To overcome this, Quantec utilized other Census data available on the distribution of households by income stratum and average household size, to extrapolate the number of households at 150% of the FPG for each county.

Results

Map 1, which presents the percentage of total households in each county meeting the Program's income eligibility standards, provides an overview of how poverty differs across the state. As evident in the map, the percentage of eligible households ranges dramatically by county, with a low of 11.6% in Delaware County and a high of 40.1% in Athens County. Generally, the highest percentages of Program-eligible households were exhibited in the Appalachian counties of southeastern Ohio. In addition, with the exception of Franklin County, each of the counties containing larger metropolitan cities have Program eligibility rates exceeding 22.7%. A table providing the precise eligibility rate for each county is provided at the end of this appendix.

Map 1. Percent of Households Eligible for HWAP by County

Ohio Poverty By County

Legend

HHs Living Below 150% FPG

- 11.6 - 20.7%
- 20.8 - 22.6%
- 22.7 - 26.6%
- 26.7 - 31.0%
- 31.1 - 40.1%

Data:
OATS Database, 2000 U.S. Census
Created:
quantec, December 16, 2005
(Quintile Distribution)

0   25   50   100 Miles
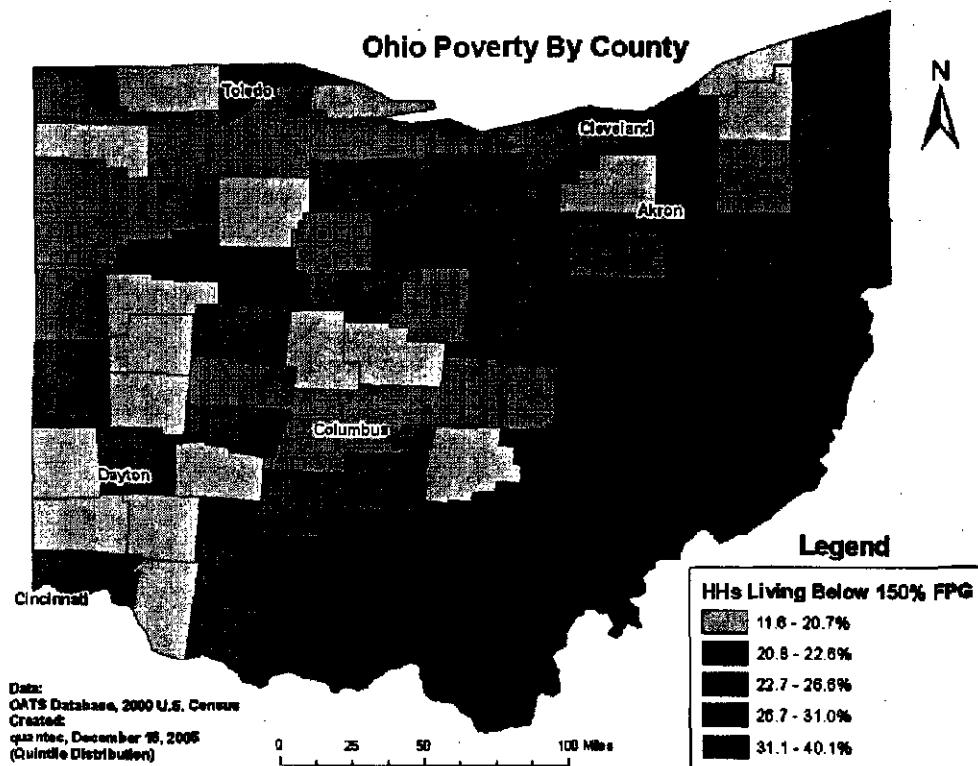
By combining the findings presented in Map 1 and data from OATS regarding participation from 1997 to 2004, it is possible to determine the percent of Program-eligible households served by HWAP during this eight year period. Since valid data regarding their county of residence were not available for 17% of the participants in the OATS database, participants without county data were assigned to a county based on their Agency's distribution of weatherization jobs by county. Assuming the occurrence of missing data is equally distributed across counties at the Agency level, this approach accounts for data deficiencies and calibrates the findings to represent the actual level of service in each county. The results of this analysis are provided in Map 2.

Similar to Map 1, the percentage of eligible households served differs greatly by county, ranging from 1.5% to 15.2%. To highlight this variation, Map 2 indicates counties exhibiting low percentages of households served with warmer colors, such as red, orange, and yellow, and those that have reached a greater percentage of such households with cooler colors, such as yellow and green. Utilizing this color approach allows for quick identification of activity in each county and also provides insight into the severity of the issue.

Generally, it appears that HWAP has been more successful reaching higher percentages of eligible households in the state's rural counties. While this makes intuitive sense since those counties have fewer eligible households, they are also more geographically dispersed. The Program's success in such counties constitutes a clear effort to reach the rural poor. Conversely, there remains a higher percentage of un-served eligible households in more populated counties.

In particular, there appears to be a cluster of counties in the northeast portion of the state that exhibit lower levels of Program saturation. Similar to eligibility by county, a table providing the exact percentage of eligible households served in each county is provided at the end of this appendix.

Map 2. Program Saturation (1997-2004) by County

Ohio Weatherization Assistance Program 1997 - 2004

Legend

Percent of Eligible HHs Served

- 1.4 - 3.9%
- 4.0 - 4.6%
- 4.7 - 5.2%
- 5.3 - 5.7%
- 5.8 - 6.4%
- 6.5 - 6.7%
- 6.9 - 7.5%
- 7.6 - 8.7%
- 8.8 - 10.5%
- 10.8 - 15.2%

Data:
OATS Database, 2000 U.S. Census
Created:
quantec, June 14, 2006
(Decile Distribution)

0   25   50   100 Miles
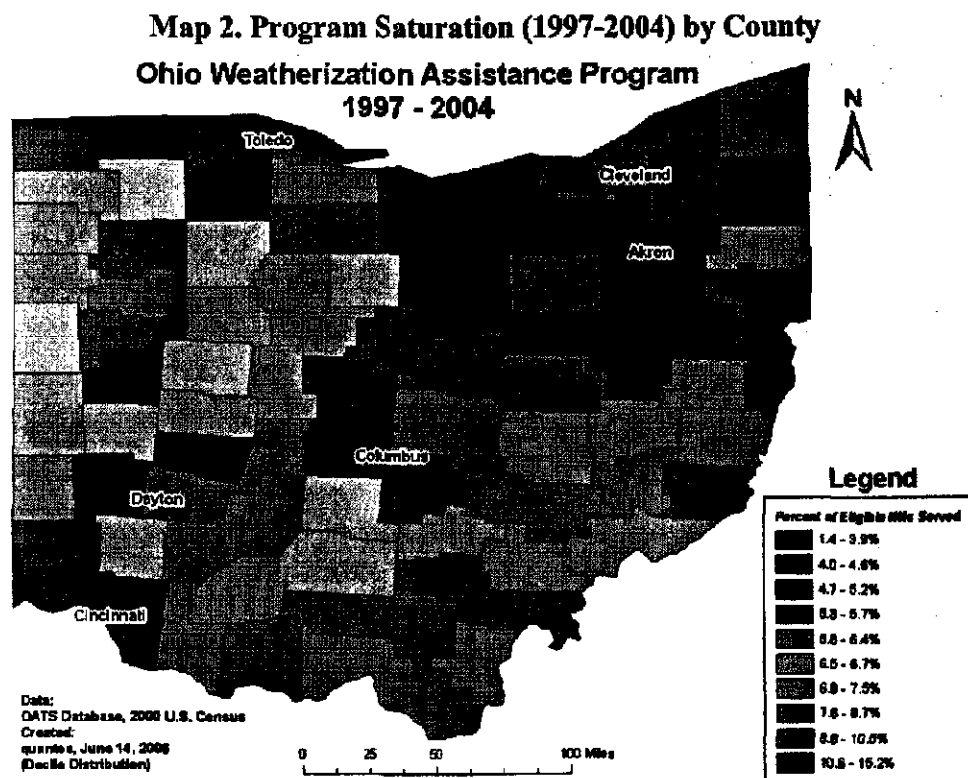
To assess how levels of Program saturation relate to Agency location, each of the participating agencies were added to Map 2. Once located, a 20-mile radius was generated around each Agency to simulate that Agency's approximate service territory. Aggregating each of the Agency radii yields an estimated assessment of the portion of the state within 20 miles of a participating Agency. The aggregated radii can be geographically placed on top of Map 2. It should be noted that metropolitan areas with multiple agencies within 20 miles will produce overlapping radii.

Overall, as seen in Map 3, the resulting Agency radii clearly cover a significant portion of the state. While there appear to be few areas of low Program saturation not within 20 miles of an Agency, there are also several areas outside the same range that are well-served.

Map 3. Program Saturation (1997-2004) and Approximated Agency Coverage

Ohio Weatherization Assistance Program
1997 - 2004
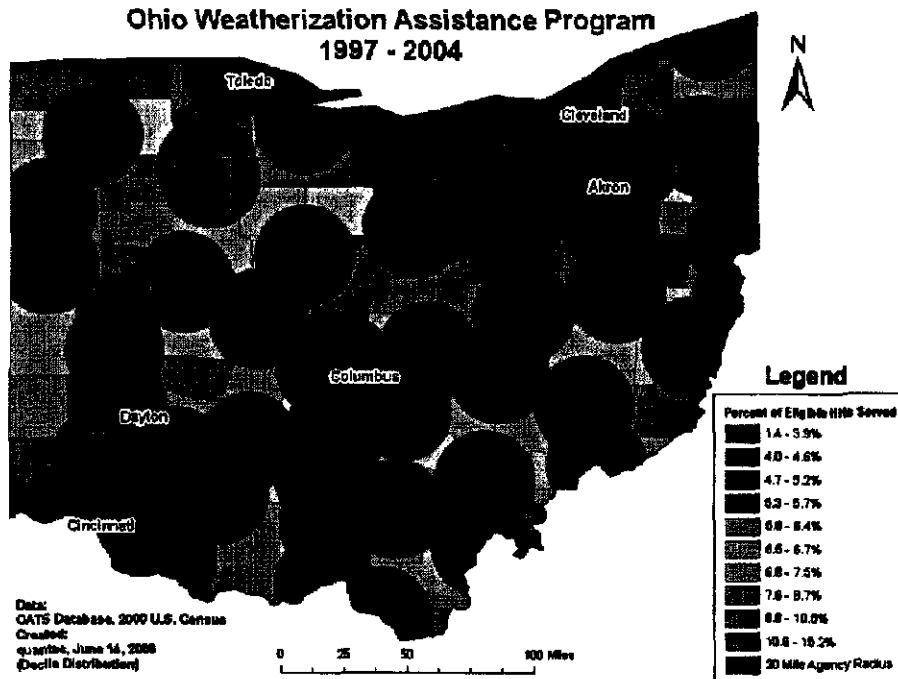
Potential Future Applications

As demonstrated, GIS offers a new perspective from which to assess this Program. GIS has many possible applications for program evaluation. The following is a brief list of possible uses for this tool in evaluating HWAP:

- Investigate Program saturation and Agency coverage at a smaller scale in metropolitan areas, utilizing geo-coding (block group or census tract level)

- Collect any additional historic Program data not included in the OATS database, and determine overall Program saturation

- Geographically represent other Program attributes, such as funding allocations, participant types, and weatherization measures received

- Calculate the number of eligible homes within a specific distance of agencies

- Utilize Agency-specific radii for the creation of a more accurate assessment of Program reach

- Use maps to replace large, cumbersome tables for reporting and presentation, where appropriate

Table A.1. County Data

County	Percentage of Total Households Eligible for HWAP	Percentage of Eligible Households Served
Adams	38.1%	12.5%
Allen	28.1%	5.3%
Ashland	24.7%	3.0%
Ashtabula	28.9%	8.7%
Athens	40.1%	6.7%
Auglaize	20.6%	4.8%
Belmont	35.8%	7.2%
Brown	26.6%	9.9%
Butler	19.7%	4.6%
Carroll	29.1%	3.7%
Champaign	21.7%	6.4%
Clark	24.6%	4.4%
Clermont	18.6%	4.3%
Clinton	23.6%	15.2%
Columbiana	30.5%	5.6%
Coshocton	28.8%	15.0%
Crawford	27.4%	6.6%
Cuyahoga	26.7%	5.7%
Darke	25.0%	9.0%
Defiance	19.7%	6.1%
Delaware	11.6%	4.6%
Erie	22.4%	4.5%
Fairfield	18.6%	5.0%
Fayette	25.3%	12.8%
Franklin	22.2%	4.4%
Fulton	18.5%	4.0%
Gallia	36.8%	7.3%
Geauga	13.4%	5.2%
Greene	19.5%	5.6%
Guernsey	35.4%	7.5%
Hamilton	25.1%	3.9%
Hancock	20.6%	6.9%
Hardin	30.6%	6.1%
Harrison	33.8%	7.4%
Henry	21.0%	6.7%
Highland	30.3%	8.4%
Hocking	31.0%	6.7%
Holmes	37.7%	3.9%
Huron	23.4%	3.1%
Jackson	35.8%	9.8%
Jefferson	33.8%	5.7%
Knox	25.8%	5.3%
Lake	17.0%	1.4%
Lawrence	38.1%	8.3%
Licking	21.6%	6.1%

County	Percentage of Total Households Eligible for HWAP	Percentage of Eligible Households Served
Logan	23.4%	7.4%
Lorain	21.8%	4.0%
Lucas	27.9%	4.7%
Madison	20.8%	5.4%
Mahoning	30.1%	6.7%
Marion	25.4%	8.0%
Medina	14.4%	3.1%
Meigs	39.9%	10.5%
Mercer	22.0%	6.8%
Miami	20.8%	6.4%
Monroe	34.6%	5.7%
Montgomery	24.5%	3.9%
Morgan	38.3%	8.1%
Morrow	22.5%	5.2%
Muskingum	29.6%	6.5%
Noble	33.0%	8.7%
Ottawa	19.8%	5.7%
Paulding	22.6%	8.8%
Perry	30.1%	8.4%
Pickaway	23.2%	6.5%
Pike	35.7%	10.9%
Portage	21.7%	5.1%
Preble	20.7%	5.5%
Putnam	20.8%	4.8%
Richland	26.9%	4.6%
Ross	28.3%	6.6%
Sandusky	22.3%	9.7%
Scioto	38.8%	6.4%
Seneca	25.4%	4.7%
Shelby	19.9%	2.9%
Stark	24.6%	3.3%
Summit	23.5%	3.9%
Trumbull	26.2%	4.3%
Tuscarawas	27.6%	5.0%
Union	16.9%	9.0%
Van Wert	21.3%	10.8%
Vinton	37.2%	11.2%
Warren	13.7%	6.0%
Washington	29.5%	6.5%
Wayne	22.5%	5.3%
Williams	22.2%	5.2%
Wood	22.0%	3.8%
Wyandot	22.5%	5.8%

Appendix B: Methodology Details

The billing analysis methodology included the following steps:

A. Collect participant and non-participant billing data from utilities

B. Clean & prepare billing data & weather data

C. Establish pre and post periods

D. Weather-normalize consumption and aggregate to annual level

E. Select non-participant group by utility

F. Compare participants to non-participants to calculate Program savings

Each of these steps is described in more detail below.

A. Collect Participant and Non-Participant Billing Data from Utilities

For the gas analysis, data were received from Dominion, Columbia Gas, Vectren, and Cincinnati Gas & Electric (Cinergy). These utilities represented 98% of the gas billing data from the utilities. Figure B.1 summarizes the distribution of gas-heated homes.

Figure B.1. Distribution of Gas Utilities for Gas-Heated Homes
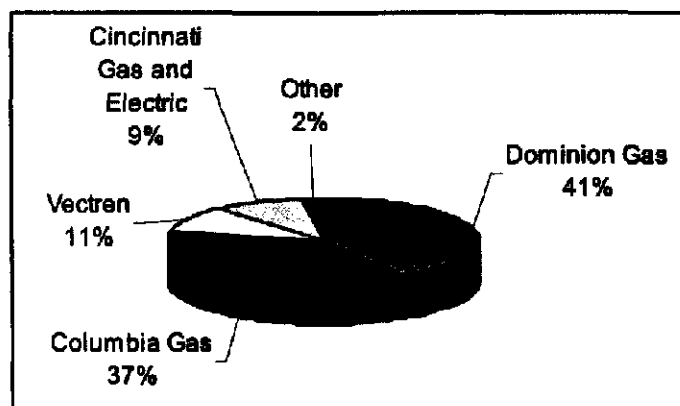
Figure B.2 summarizes the distribution of electrically heated homes by electric utility. For the electric (electrically heated) analysis, data was received from AEP and Cincinnati Gas & Electric (Cinergy). The electric analysis was performed using the AEP customers, since this utility was the only one that had sufficient non-participants for non-participant selection. AEP represents 74% of the electric billing data for electrically heated homes from the utilities.

Figure B.2. Distribution of Electric Utilities for Electrically-Heated Homes

Dayton Power and Light 6%
Cincinnati Gas and Electric 5%
Columbus Southern Power 1%
First Energy 14%
AEP 74%
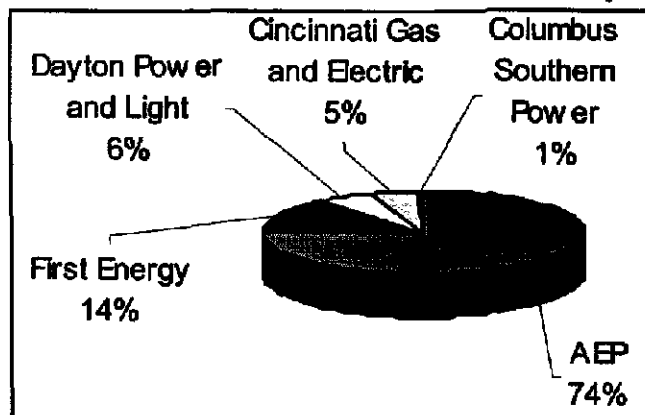
Figure B.3 summarizes the distribution of participating gas-heated homes by electric utility. For the electric (gas-heated) analysis, we received data from AEP and Cinergy. These two utilities represent only 33% of the gas-heated accounts. The analysis was, however, augmented with HEAP billing data for PIPP participants for First Energy and Dayton Power & Light. This allowed a 36% matching rate for Dayton and First Energy (i.e. 1,000 accounts out of 2,779 accounts requested). [39]

Overall, electric billing data was available for 53% of gas heat accounts. Even with the small percentage there are plenty of sites available for the analysis since natural gas heating is predominant - representing about 80% of electric accounts.

Figure B.3. Distribution of Electric Utilities for Gas-Heated Homes

Dayton Power and Light 13%
Other 2%
First Energy 42%
Cincinnati Gas and Electric 18%
AEP 25%

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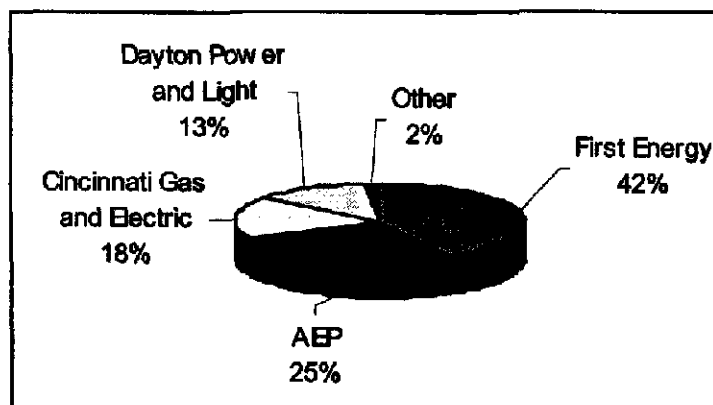
[39] The savings for this group was similar to the AEP/Cinergy savings.

B. Clean and Prepare Billing Data

This is one of the most complex tasks of the billing analysis. It involves examining the billing data, cleaning the data, imputing missing readings, examining vacancies, and estimating readings.

The tasks below summarize typical data cleaning methods that were employed.

1. Plot usages by account to find unusual readings
2. Check for estimated readings
3. Impute missing readings
4. Check for vacancies
5. Check for disconnections
6. Test for completeness of billing data

In Test 1, the average daily consumption is plotted against time at the monthly level. If there are outliers, missing readings (Test 3), prolonged vacant periods (Test 4), or periods of disconnections (Test 5) then this check will find these readings.

Test 2 is a check of estimated readings. Sometimes a reading will be classified as an estimated reading. These will usually cause a spike in usage relating to the estimated reading, after which the subsequent reading may either be too low or too high. In order to solve this problem, the estimated reading and the reading following were averaged. In effect, this is equivalent to combining the two readings into one reading spanning approximately 60 days.

Test 3 is a fill with missing readings. If there were missing readings, typically they were filled in with the average of the average daily consumption (ADC) of the readings before and after the missing period.

Test 4 is a check for vacancies. Sometimes it is evident from the plots that there is a vacant period. Such readings would show a large drop in usage in either the post or pre period exaggerating or diminishing savings. These gaps in the data are assigned to missing values.

Test 5 is a test for disconnections. Sometimes a customer will be disconnected, or choose to be disconnected. These readings may be coded either as 0 usages or gaps in the billing data. These may confound the billing analysis results. A test was performed on the models, and an indicator variable was included to test for the effects of disconnections. The savings were not affected by disconnections.

Test 6 is to check for completeness of data. This is performed after the data have been cleaned as much as possible. There still may be extended missing periods in the pre or post periods. One of the data attrition screens required all accounts to have at least 300 days in both the pre and post periods. This is necessary, because, for example, if the entire winter usage bills are missing from the pre period, this can cause the average normalized annual consumption (NAC) to be unusually low – confounding the analysis.

Weather Data. The daily weather data were obtained from weather stations for the period from January 1999 through July 2005. Accounts were mapped to their nearest station based on zip code. We used the following 10 Ohio weather stations in our analysis: Akron, Cincinnati, Cleveland, Columbus, Dayton, Findlay, Mansfield, Toledo, Youngstown, and Zanesville.

Base-65 heating degree days and cooling degree days were computed from the average daily temperature. In the billing analysis, these were matched to the billing data periods to obtain the exact total for each billing period.

Thirty year normal weather data were obtained from the NOAA (TMY) database for the period 1961 through1990 for the weather stations used in our study.[40]

C. Assigning Pre and Post Analysis Period Dates

The recorded 2003 Program installation dates varied by participant from April 2003 to April 2004. Figure B.4 summarizes the definitions for pre and post that we used in our analysis. Typically, billing data during a 60 day window before and after the recorded installation dates are not used because of possible inaccuracies in the recorded installation dates. This was possible for the pre period because billing data were obtained for at least a year prior to the beginning of the PY03 Program. For the post period this was not always possible, however, since some of the billing data were received early. As a result, we started the post period immediately after the last installation for some of the utilities.[41]

Our definition of pre and post periods assures perfect comparability between participants and non-participants, which can be a problem with other methods of adjusting the pre and post periods.

Figure B.4. Pre and Post Period Definitions

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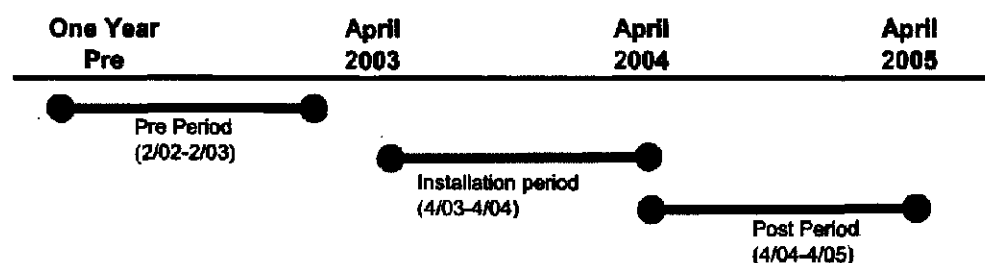
[40] We used this historical weather data because we had a zip code mapping tied directly to these 1961-1990 normals. These normals are very close to the 1970-2000 normals. On average there is a only 0.5% difference between the two series for the 10 Ohio Stations.

[41] For some utilities where we received the billing data later, we were able to provide a 60 day window in the post period as well. Even so, a small percentage of participants actually installed in 3/04, 4/04, so this is not a big problem to begin with. Since our non-participant group is not selected from previous or future year participants as in the 1994 analysis, and pre and post periods are defined identically between participants and non-participants, the post period differences of a few months should not affect the savings.

D. Weather-Normalize Consumption and Aggregate to Annual Level

The weather normalization models varied by fuel and heat source.

Gas - Gas Heat Model. For the gas modeling, our approach is equivalent to a PRISM model, with the fixed heating reference temperature (tau) at 65 degrees. In this modeling approach - account level models are run for the pre period and post periods. For each customer i and calendar month t,

$$ADC_{it} = \alpha_i + \beta_1 AVGHDD_{it} + \varepsilon_{it}$$

Where,

- α_i is the intercept for each participant (or non-participant). This represents the base load (non-heating usage) in the pre or post period

- β_1 is the heating slope in the pre or post period

- ADC_{it} is the average daily consumption during the pre (post) program period

- $AVGHDD_{it}$, is average daily heating degree days (base 65) pre (post) period based on home location

- ε_{it} is the error term

From the model above, the weather normalized annual consumption (NAC) for the pre or post period is computed as follows:

$$NAC_i = \alpha_i * 365.25 + \beta_1 * LRHDD_i + \varepsilon_{it}$$

Where, for each customer i,

- α_i is the base load for each participant (or non-participant). This represents the average daily base load (non-heating usage) from the model

- β_1 is the heating slope in the pre or post period from the model

- NAC_i is the pre(post) period normalized annual consumption

- $LRHDD_i$, is the annual long run heating degree days (base 65) based on home location

- ε_{it} is the error term

Electricity – Electric Heat Model. For the electricity, electric heat model we used a PRISM heating and cooling model – with fixed tau at 65 degrees. This model is not as reliable as the heating-only model because of the complexity in separating out the cooling and heating usage. If the customer does not have cooling usage then the cooling coefficient will be nearly 0.

Again account level models are run for the pre period and post periods. For each customer i and calendar month t,

$$ADC_{it} = \alpha_i + \beta_1 AVGHDD_{it} + \beta_2 AVGCDD_{it} + \varepsilon_{it}$$

Where,

- α_i is the intercept for each participant (or non-participant). This represents the base load (non-heating usage) in the pre or post period

- β_1 is the heating slope in the pre or post period

- β_2 is the cooling slope in the pre or post period

- ADC_{it} is the average daily consumption during the pre (post) Program period

- $AVGHDD_{it}$, is average daily heating degree days (base 65) pre (post) period based on home location

- $AVGCDD_{it}$, is average daily cooling degree days (base 65) pre (post) period based on home location

- ε_{it} is the error term

From the model above, the weather normalized annual consumption (NAC) for the pre and post periods is computed as follows:

$$NAC_i = \alpha_i * 365.25 + \beta_1 \cdot LRHDD_i + \beta_2 \cdot LRCDD_i + \varepsilon_{it}$$

Where, for each customer i,

- α_i is the base load for each participant (or non-participant). This represents the average daily base load (non-heating usage) from the model

- β_1 is the heating slope in the pre or post period from the model

- β_2 is the cooling slope in the pre or post period from the model

- NAC_i is the pre(post) period normalized annual consumption

- $LRHDD_i$, is the annual long run heating degree days (base 65) based on home location

- $LRCDD_i$, is the annual long run cooling degree days (base 65) based on home location

- ε_{it} is the error term

Savings for the PRISM type models for a given participant (non-participant) are obtained as the difference in NAC (DNAC) between the pre period or post period.

Electricity - Gas Heat Model. For the electricity gas-heat model, account level normalization would not be appropriate since the PRISM models detect savings related to temperature-sensitive components (heating and cooling), and these are not expected. Instead fixed effects pooled panel models were developed by grouping together the participants and non-participants, and accounting for overall weather differences in pre and post usages.

Using energy consumption during the post-installation period as the dependent variable and weather and a pre post dummy as independent variables, this approach involves estimating a regression model for both the participant and non-participant groups with the following specification:

$$ADC_{it} = \alpha_i + \beta_1 AVGHDD_{it} + \beta_2 AVGCDD_{it} + \beta_3 POST_{it} + \beta_4 EPP\_POST_{it} + \varepsilon_{it}$$

Where, for each customer i and calendar month t,

- α_i is a unique intercept for each participant (or non-participant), derived by estimating the relationship using the ANCOVA (fixed-effects) procedure

- ADC_{it} is the average daily consumption during the pre- and post-Program periods

- $AVGHDD_{it}$, is average daily heating degree days (base 65) based on home location

- $AVGCDD_{it}$ is the average daily cooling degree days (base 65) based on home location

- $POST_t$ is a dummy variable that represents the savings - change in usage from pre to post period is (1 in the post period, and 0 in the pre period).

- EPP_POST_t is a dummy variable that accounts for savings due to participation in the EPP program. This removes the EPP related savings from the POST variable - change in usage from pre to post period for EPP customers is (1 for EPP customers in the post period, and 0 otherwise).

- ε_{it} is the error term

The net savings are then calculated as the difference between participant and non-participant savings.

E. Select Non-Participant Group by Utility

After the weather normalization was complete, the average pre usage for the non-participants was found to be significantly different than the participant usage – even at the average level. There was no opportunity to screen the non-participants initially to match the participants because billing data were not available at the time of the data request.

In order to address this issue, single-family participants were assigned to quartiles at the utility level based on their pre period NAC (PRENAC) or raw usage (gas heat in the case of electric utilities). The non-participants then were assigned to the corresponding participant quartile. Finally, a random sample of non-participants was chosen that then matched the usages in the participant groups.

We note that the non-participant group may include some multifamily homes in the smallest quartiles because home type is not identified in the HEAP database from which non-participants were drawn and, thus we could not exclude them. This, however, is not likely to have had much effect on the analysis, since the probability of selecting a multifamily home is relatively small. We do have housing type for the participants and this group is composed of 81% single-family/mobile home units.

Some of the characteristic differences between participants and non-participants are illustrated in Table B.1. The process described above matched non-participants' average pre usage almost identically to participants' average usage. The non-participants were different in other ways.

There were some differences in the characteristics of the two groups: non-participants tended to have fewer occupants, lower incomes, and a smaller percentage of people with a disability.

Table B.1. Comparison of Participants to Final Non-Participants, Gas Heating

Characteristics	Sample Participants	Non-Participants
# Units	1,625	2,644
Pre-Use (therms/yr)	1,290	1,288
Number of Occupants	2.25	1.84
Average Income	$10,731	$9,454
% On PIPP program	20%	24%
% With Handicapped Occupant	2.7%	1.8%
% With Disability	16.6%	12.8%

F. Compare Participants to Non-Participants to Calculate Program Savings

After the non-participant matching was complete, the savings were obtained from the regression models (either PRISM or the fixed effects model as described in section D of Appendix E:). The gross savings were obtained straight from the models. Next, the gross participant savings were adjusted for changes in non-participant usage to yield net savings estimates.

In most cases, we applied the overall non-participant net-to-gross ratio to calculate net savings estimates. The only exceptions were in the case of utility-level results and the comparisons of pre Program consumption by usage range. In both these situations, the data were available to make the net-to-gross adjustment for the specific groups being investigated.

Furthermore, in order to develop the final electric savings estimates; regression models were run that removed the impact of EPP. Otherwise the savings would be biased upwards by the effect of EPP on electricity usage.

Appendix C: Data Collection, Cleaning, and Sample Attrition

Data attrition estimates were obtained for the three models. A balance between obtaining and retaining good quality data and keeping the data as unmodified as possible was maintained. The following screens were used in the analysis:

- *Utility did not participate in the evaluation.* Either the billing data were not available, or the utility data did not have enough accounts to merit a data request.

- *Accounts were not matched by the utility.* In these cases, we requested the data, but never received the data for the accounts because the utility could not find selected account based on matches of account number, social security number, or address.

- *Insufficient usage data in the pre or post period.* Accounts with less than 300 days in either pre or post periods were dropped (less than 10 months of data).

- *Infeasible PRISM parameters or usage.*[42] This screen includes negative heating slope, negative cooling slope, or negative baseload (intercept). In the gas analysis NACs under 400 therms or over 5000 therms were dropped. For electricity models with electric heat NACs under 5000 kWh were dropped. For electricity analysis with gas heat any account with raw annual usage over 30000 kWh was dropped.

- *Outliers, defined as cases with percent savings more than 2.2 interquartile ranges (i.e., the distance between the 75th and the 25th percentiles) from the median savings for the analysis group.* This is equivalent to a 3 standard deviations cutoff in normally distributed datasets. For the electricity, gas heat model any accounts that showed savings of more than 30% of pre were dropped instead, since normalized annual consumption was not available.[43]

- *Non-participants only – data matching to participant quartiles.* These are non-participants that were not matched with participant quartiles.

Tables C.1 and C.2 summarize the attritions for participants and non-participants. For the gas heat analysis, almost half of participants are kept in the analysis. In Table C.1 about 25% of electric gas heat participants remain, and 31% of electric: electric heat remain in the analysis. Table C.2 drops many cases in the participant quartile matching process.

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[42] An R-square screen of 0.75, used in the 1994 evaluation, was not used in our analysis. In the current evaluation, applying this screen causes a 6% reduction in net savings, but drops 30% of the participants. This suggests that this is a very restrictive screen. If the screen is relaxed to an r-square of 0.5, the savings are almost identical, but about 10% of the participants are dropped. In the end, this screen was not employed, because this screen removed too many accounts.

[43] Since the measures only affect the baseload, it was very improbable that a 30% reduction in usage would occur. Less than 5% of cases were dropped by this screen.

In general, most of the attrition is caused by having insufficient data in the pre or post periods due to missing data or vacancies. Not many cases, however, are dropped out as outliers or due to infeasible PRISM parameters or usages.

Table C.1. Participant Attrition

	Gas: Gas Heat		Electric: Gas Heat*		Electric: Electric Heat*	
	Removed	Remaining	Removed	Remaining	Removed	Remaining
Population (total units)	4,535		4,535		926	
Utility Not Requested or Bills Not Available From Utility	247	4288 (95%)	1032	3503 (77%)	307	619 (67%)
Accounts Not Matched by Utility or Usage	889	3399 (75%)	500	3003 (66%)	86	533 (58%)
Insufficient Billing Data Pre or Post	996	2403 (53%)	1796	1207 (27%)	182	351 (38%)
Infeasible PRISM Parameters	59	2344 (52%)	0	1207 (27%)	41	310 (33%)
Outliers	195	2149 (47%)	131	1076 (24%)	20	290 (31%)
Final Analysis Sample**	2,149 (47%)		1,076 (24%)		290 (31%)	

Table C.2. Non-Participant Attrition

	Gas: Gas Heat		Electric: Gas Heat*		Electric: Electric Heat*	
	Removed	Remaining	Removed	Remaining	Removed	Remaining
Sample Requested (Total Units)	8,304		8,304		1,466	
Utility Not Requested or Bills Not Available From Utility	415	7,889 (95%)	1907	6,397 (77%)	486	980 (67%)
Accounts Not Matched by Utility or Usage	557	7,332 (88%)	597	5,800 (70%)	191	789 (54%)
Insufficient Billing Data Pre or Post	1744	5,588 (67%)	2934	2,866 (35%)	284	505 (34%)
Infeasible PRISM Parameters	121	5,467 (66%)	0	2,866 (35%)	14	491 (32%)
Outliers	627	4,840 (58%)	370	2,496 (30%)	34	457 (31%)
Participant Usage Quartile Matching	1320	3,520 (42%)	1071	1,425 (17%)	352	105 (7%)
Final Analysis Sample**	3520 (42%)		1425 (17%)		105 (7%)	

Appendix D: Benefit-Cost Analysis Tables

Table D.1 provides a detailed summary of PY03 actual state spending, not including utility weatherization expenditures.

Table D.1. PY03 Spending

Cost Category	Amount
Agency Direct Admin	$1,445,975
Agency Indirect Admin	$626,129
Agency Additional Admin	$225,763
Agency Liability	$236,051
Agency Labor	$15,264,062
Agency-Other Support	$2,632,667
Agency Indirect	$36,648
Agency Materials	$3,544,508
Agency T&TA	$285,250
Agency Single Audit	$71,180
Agency Health and Safety	$2,739,626
OWTC	$542,517
OEE T & TA	$384,102
OEE Admin Costs	$674,694
Total Program Spending	$28,709,172

Table D.2 presents the results of the monetary savings results of the billing analysis. Gas and electric rates are based on monthly PUCO utility rate surveys, while propane and fuel oil rates are from the Northeast-Midwest Institute.

Table D.2. Summary of Participant Avoided Energy Payments

	Single-Family	Mobile Home	Multifamily	All Buildings
Number of Gas Heated Participants	3,090	500	945	4,535
Net Gas Savings per participant (therms)	282	90	83	
Total Gas Savings (therms)	871,380	45,000	78,435	994,815
Lifetime Avoided Gas Payments (2003 dollars)				$24,070,580
Number of Non-Electrically Heated Participants	3,470	962	947	5,379
Electric Savings for Non-Electrically Heated Homes	326	105	201	
Total Electric Savings for Non-Electrically Heated (kWh)	1,131,195	101,034	189,918	1,422,147
Lifetime Avoided Electric Payments for Non-Electric Heat (2003 dollars)				$2,268,010
Number of Electrically Heated Participants	278	430	222	928
Net Electric Savings per participant (kWh)	1,251	1,584	705	
Total Electric Heated Electricity Savings (kWh)	345,189	680,919	156,510	1,182,618
Lifetime Avoided Electric Payments for Electric Heat (2003 dollars)				$1,886,845
Number of Propane Heated Participants	173	351	0	524
Net Propane Savings per participant (gallons)	316	101	93	
Total Propane Savings (gallons)	54,753	35,454	0	90,206
Lifetime Avoided Propane Payments (2003 dollars)				$3,393,017
Number of Fuel Oil Heated Participants	207	111	2	320
Net Fuel Oil Savings per participant (gallons)	206	66	61	
Total Fuel Oil Savings (gallons)	42,738	7,314	122	50,174
Lifetime Avoided Fuel Oil Payments (2003 dollars)				$2,208,387
Total Lifetime Avoided Payments (2003 dollars)				$33,827,839

Appendix E: Regression Based Measure Level Results

Table E.1 summarizes the results of the regression model approach with dummy variables for each measure. This approach tended to overstate the savings associated with air sealing and attic insulation. This problem occurs because the installation rates for these measures is relatively high (over 80%), and the model cannot differentiate sufficiently among the effects of air sealing, attic insulation, and wall insulation. This problem, known as collinearity, results from high correlations between independent variables and leads to inaccurate savings estimates and increases the error of the estimates.

Table E.1. Measure Level Regression Savings Estimates by Pre Group

	Low Usage		Medium Usage		High Usage	
	Savings	% of Pre	Savings	% of Pre	Savings	% of Pre
Air Leakage Reduction	71	8.6%	137	11.1%	286	15.0%
Attic Insulation	50	6.1%	51	4.1%	109	5.7%
Duct Insulation	6	0.7%	-21	-1.7%	51	2.7%
Floor Insulation	11	1.3%	46	3.7%	78	4.2%
Heat Replacement	74	8.8%	118	9.4%	217	11.1%
Furnace Tune-Up and Repair	-4	-0.5%	26	2.1%	46	2.4%
Wall Insulation	61	7.4%	108	8.8%	105	5.5%
Water Heater Insulation	-16	-2.0%	26	2.1%	0	0.0%

The regression approach did not yield accurate measure savings impacts for measures such as air leakage and air sealing, because the installation rate was over 85% for both of them, and the model could not separate the effect for the two measures correctly due to collinearity.

To get around this problem, a Monte Carlo regression analysis approach was used to estimate the measure level impacts for measures with high installation rates. In this approach, 500 (Monte Carlo) random samples were drawn from the group of homes installing a measure for each usage category. The sample size for each of the 500 samples of those installing a measure was equal to the sample size of those that did not install the measure. Samples were drawn by measure and by pre consumption level group. A separate measure level regression model was then run for each of 500 sub-samples, and the coefficients were saved. Finally, the coefficients for the measure of interest were averaged across the 500 samples to obtain the savings estimate.

As an example, in the high consumption group, there were 513 participants. Of these, 458 (89%) received air leakage reduction measures and 55 (11%) did not. The savings were developed by running the measure-level regression model with all measure dummy variables included; the 55 who did not receive the air leakage measure were combined with a random sample of 55 participants that did receive the air leakage measure. This process was repeated 500 times by varying the random sample of participants receiving the air leakage measure. We used the average coefficient of the air leakage measure across the 500 samples as the Monte Carlo regression estimate; this value was 286 therms.

EXHIBIT

%NG [30] - NATURAL GAS   LAST: 9.39   CHANGE: ▲ 0.04   HIGH: 9.50   LOW: 9.25   3/1/2008

'93 '94 '95 '96 '97 '98 '99 '00 '01 '02 '03 '04 '05 '06 '07 '08 Monthl

5 min   15 min   30 min   60 min   Daily   Weekly   Monthly

Source:
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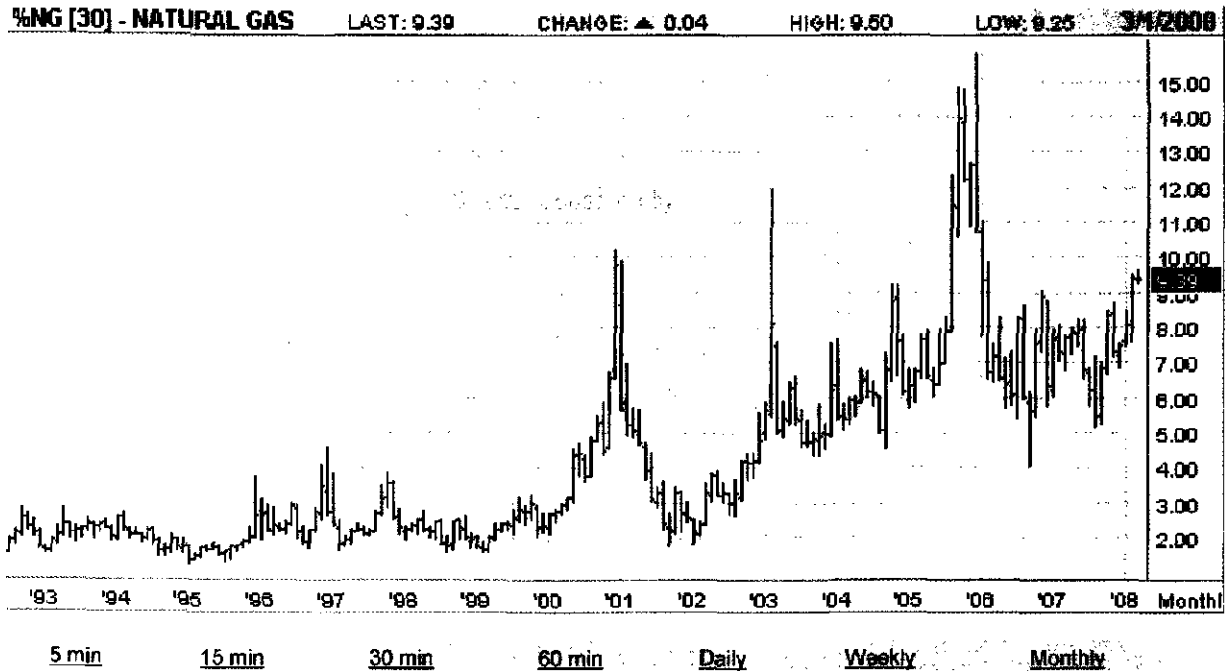
EXHIBIT

DOE/EIA-M067(2007)

Model Documentation Report:
Residential Sector Demand Module of the
National Energy Modeling System

April 2007

Office of Integrated Analysis and Forecasting
Energy Information Administration
U.S. Department of Energy
Washington, DC 20585

Update Information

This is the twelfth edition of the *Model Documentation Report: Residential Sector Demand Module of the National Energy Modeling System (NEMS)*. It reflects changes made to the module over the past year for the *Annual Energy Outlook 2007*. These changes include:

- A new TV, set-top box, and VCR/DVD sub-module that includes stock-accounting methodology and tracks TV use and type over time.
- Incorporating shell efficiency coefficients for new construction of multi-family housing based on results from using new building simulation software (REM-Design).
- The addition of several new appliance categories, including: Ceiling fans, coffee makers, microwave ovens, spas, security systems, rechargeable electronics, and home audio equipment.
- Updates to the heating share algorithm for new construction.
- Updates to the HVAC system choice algorithm for new construction.
- Updates to the heating shares and square footage based on new Census Bureau data.

Table of Contents

Tables

Figures

1. Introduction

Purpose of this Report

This report documents the objectives, analytical approach, and structure of the National Energy Modeling System (NEMS) Residential Sector Demand Module. The report catalogues and describes the model assumptions, computational methodology, parameter estimation techniques, and FORTRAN source code.

This document serves three purposes. First, it is a reference document that provides a detailed description for energy analysts, other users, and the public. Second, this report meets the legal requirement of the Energy Information Administration (EIA) to provide adequate documentation in support of its reports according to Public Law 93-275, section 57(b)(1). Third, it facilitates continuity in model development by providing documentation from which energy analysts can undertake model enhancements, data updates, and parameter refinements.

Model Summary

The NEMS Residential Sector Demand Module is currently used in developing long-term projections and energy policy analysis over the time horizon of 2001 through 2030. The model generates projections of energy demand, which is used interchangeably with the concept of energy consumption in this document, for the residential sector by end-use service, fuel type, and Census Division. If the user defines alternative input and parameter assumptions, the policy impacts that result from the introduction of new technologies, market incentives, and regulatory changes can be estimated using the module.

The Residential Sector Demand Module uses inputs from the NEMS system to generate outputs needed in the NEMS integration process. The inputs required by the Residential Sector Demand Module from the NEMS system include energy prices and macroeconomic indicators. These inputs are used by the module to generate energy consumption by fuel type and Census Division in the residential sector. The NEMS system uses these projections to compute equilibrium energy prices and quantities.

The Residential Sector Demand Module is an analytic tool to address current and proposed legislation, private sector initiatives, and technological developments that affect the residential sector. Examples of policy analyses include assessing the potential impacts of the following:

- New end-use technologies
- Changes in fuel prices due to tax policies
- Changes in equipment energy efficiency standards
- Financial incentives for energy efficiency investments
- Financial incentives for renewable energy investments

Archival Media

The Residential Sector Demand Module has been archived as part of the NEMS production runs that generate the *Annual Energy Outlook 2007 (AEO2007)* on a compact disc.

Model Contact

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Report Organization

Chapter 2 of this report discusses the purpose of the Residential Sector Demand Module, with specific details on the objectives, primary inputs and outputs, and relationship of the module to other modules in the NEMS system. Chapter 3 describes the rationale behind the design, fundamental assumptions regarding consumer behavior, module structure, and alternative modeling approaches. Chapter 4 describes the NEMS Residential Sector Demand Module structure, including flowcharts and major sub-routines.

Appendices to this report document the variables and equations contained in the FORTRAN source code. Appendix A consists of a model abstract. Appendix B provides support to the mathematical representation of the source code equations. Appendix C contains the key computations and equations for the model. Appendix D catalogues the input data used to generate projections in list and cross-tabular formats. Appendix E discusses the data quality issues. Appendix F is a bibliography of reference materials used in the development process.

2. Model Purpose

Module Objectives

The NEMS Residential Sector Demand Module has three fundamental objectives. First, the module generates disaggregated projections of energy demand in the residential sector for the period of 2001 through 2030 by housing and fuel type, Census Division, and end-use service. Second, it is a policy analysis tool that can assess the impacts of changes in energy markets, building and equipment technologies, and regulatory initiatives that affect the residential sector. Third, the module is an integral component of the NEMS system, it provides inputs to the Electricity Market Module, Natural Gas Transmission and Distribution Module, and Petroleum Market Module of NEMS, and contributes to the calculation of the overall energy supply and demand balance.

The Residential Sector Demand Module projects residential sector energy demands in six sequential steps. These steps produce information on housing stocks, technology choices, appliance stocks, building shell integrity, distributed generation, and energy consumption. The module uses a stock-vintaging approach that allows the user to monitor equipment stock and equipment efficiency over time.

The module design allows the user to conduct a variety of policy analyses. Technological advancement in equipment design and efficiency, as well as first-cost incentive programs (such as rebates used in demand-side management programs), can be modified at the equipment level. Housing stock attrition and equipment retirement assumptions can be modified to reflect varying equipment decay rates. Building shell characteristics can be modified to reflect varying policy options for building codes or the impact of energy-efficient mortgages.

Projected residential fuel demands generated by the Residential Sector Demand Module are used by the NEMS system in the calculation of the demand and supply equilibrium state. In addition, the NEMS supply modules use the residential sector outputs to determine the patterns of consumption and the resulting prices for energy delivered to the residential sector.

Module Input and Output

Inputs

The primary module inputs include fuel prices, housing stock characteristics, housing starts, population, and technology characteristics. The technology characteristics used in the module include installed capital costs, equipment efficiency, and expected equipment lifetimes. The major inputs by module component are as follows:

Housing Stock Component

    Housing starts

    Existing housing stock for 2001 (based on RECS 2001 data)

    Housing stock attrition rates

    Housing floor area trends (new and existing)

Technology Choice Component

    Equipment capital cost

    Equipment energy efficiency

    Market share of new appliances

    Efficiency of retiring equipment

    Appliance penetration factors

Appliance Stock Component

    Expected equipment minimum and maximum lifetimes

    Base year appliance market shares

    Equipment saturation level

Building Shell Component

    Maximum level of shell integrity

    Price elasticity of shell integrity

    Rate of improvement in existing housing shell integrity

    Cost and efficiency of various building shell measures for new construction

Distributed Generation Component

    Equipment Cost

    Equipment Efficiency

Solar Insolation Values

System Penetration Parameters

Energy Consumption Component

Unit energy consumption (UEC)

Heating and cooling degree-days

Expected fuel savings based upon the Energy Policy Act of 2005 (EPACT05)

Population

Personal disposable income

Outputs

The primary module output is projected residential sector energy consumption by fuel type, end-use service, and Census Division. The module also projects housing stock and energy consumption per household. In addition, the module can produce a disaggregated projection of appliance stock and efficiency for most of the major appliances used in a home. The types of appliances included in this projection are:

Heat pumps (electric air-source, natural gas, and ground-source)

Furnaces (electric, natural gas, LPG, and distillate)

Hydronic heating systems (natural gas, distillate, and kerosene)

Wood stoves

Air conditioners (central and room)

Dishwashers

Water heaters (electric, natural gas, distillate, LPG, and solar)

Ranges/Ovens (electric, natural gas, and LPG)

Clothes dryers (electric and natural gas)

Refrigerators

Freezers

Clothes Washers

Lighting (incandescent, fluorescent, torchiere)

Fuel Cells

Solar Photovoltaic Systems

Variable Classification

The NEMS modules are designed to provide and use system data at the nine Census Division level of aggregation. The input data available from the Residential Energy Consumption Survey (RECS) performed by EIA (which forms the basis for the Residential Sector Demand Module) and other sources are designed to be statistically significant at various levels, some of which are above the nine Census Division level. Another factor that drives the level of aggregation of the module variables is the technical constraints of the computing system required in order to run the NEMS model within a reasonable turnaround time. The key variables in the NEMS Residential Sector Demand Module have the following dimensions:

Census Divisions

1. New England
2. Middle Atlantic
3. East North Central
4. West North Central
5. South Atlantic
6. East South Central
7. West South Central
8. Mountain
9. Pacific

Housing Types

1. Single-Family
2. Multifamily
3. Mobile Home

End-Use Services

1. Space Heating
2. Space Cooling
3. Clothes Washers
4. Dishwashers
5. Water Heating
6. Cooking
7. Clothes Drying
8. Refrigeration
9. Freezing
10. Lighting
11. Color TVs
12. Personal Computers
13. Furnace Fans
14. Other Appliances
15. Secondary Space Heating
16. Distributed Generation

Fuels

1. Distillate
2. LPG
3. Natural Gas
4. Electricity
5. Kerosene
6. Wood
7. Geothermal
8. Coal
9. Solar

Relationship to Other Models

The Residential Sector Demand Module uses data from the Macroeconomic Activity Module (MAM) of the NEMS system. MAM provides projected population, personal disposable income, and housing starts by Census Division and housing type. The Residential Sector Demand Module uses fuel price projections generated by the NEMS supply modules previously listed as key drivers to calculate operating costs for technology selections, existing building shell integrity improvements, and short-term behavioral responses. The NEMS supply modules use the residential sector outputs to determine the fuel mix and the resulting prices for energy delivered to the residential sector.

3. Model Rationale

Theoretical Approach

The NEMS Residential Sector Demand Module is an integrated dynamic modeling system based on accounting principles and residential consumer behavior issues that generate projections of residential sector energy demand, appliance stocks, and market shares.

The Residential Sector Demand Module is a housing and equipment stock model. The stock of households and the corresponding energy consuming equipment are tracked for each year of the projection. The housing stock changes each projection year as houses are retired from the stock and new construction is added. The equipment stock changes each projection year as appliances fail and are replaced, through increases in the saturation of existing appliances, and as new technologies enter the market. A logistic function[1] is used to estimate the market shares of competing technologies within each service category. Market shares are determined for new construction equipment decisions as well as for replacement decisions. The Technology Choice Component of the module weights the relative installed capital and operating costs of each equipment type to allocate the relative market share of the technology within the service, region, and housing type. This approach is implemented in new housing for the services of space conditioning (heating, cooling, building shell), clothes washers, dishwashers, water heating, cooking, clothes drying, lighting, food refrigeration, and food freezing. It is also implemented for replacement equipment in single family housing for space heating, heat pump air conditioning, water heating, cooking, and clothes drying. Color televisions, furnace fans, personal computers, set-top boxes, VCR/DVD, home audio equipment, ceiling fans, microwave ovens, spas, security systems, coffee makers, rechargeable devices, distributed generation, and miscellaneous equipment choices are modeled based upon alternative technology assumptions discussed below.

Base year information developed from the 2001 RECS data base forms the foundation of modeling changes to the equipment and housing stock over the projection period. Market share information from RECS is used to estimate the number and type of replacements and additions to the equipment stock. The choice between the capital cost and the first year's operating cost determines the market

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[1] This function is described in depth in Appendix B.

share within a given service. Market shares are also modeled as functions of the corresponding fuel prices, expected level of equipment usage, and equipment efficiency characteristics.

Building shell integrity is also considered in the projection of end-use consumption. Building shell integrity in existing homes is sensitive to real price increases over base year price levels for space conditioning fuels. Final residential sector energy consumption is determined as a function of the equipment and housing stock, average unit energy consumption, weighted equipment characteristics, and building shell integrity improvements.

General Model Assumptions

The Residential Sector Demand Module assumes that the residential energy marketplace has the following characteristics:

- Equipment lifetime is limited by a minimum and maximum number of years. All equipment is assumed to survive a minimum number of years, and no equipment is assumed to survive beyond the maximum number of years. The equipment retirement rate is defined by a linear decay function.

- The equipment contained in a retiring housing structure is assumed to retire when the structure is removed from the housing stock. Zero salvage value for equipment is assumed.

- Space heaters, air conditioners, water heaters, stoves, and clothes dryers may be replaced (up to an input percentage) with competing technologies in single-family homes. Switching is based on a technology choice component, retail cost of new equipment, and switching cost.

- New housing stock building shell efficiency is a function of the life-cylce cost of competing building shell packages.

- Life-cycle costs used in the cost calculations for new home HVAC systems are computed over a 7-year time horizon with a discount rate of 20 percent.[2]

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[2] This assumption is currently under review for AEO 2008.

- Two housing vintages are assumed: pre-2002 (existing housing) and post-2001 (new housing).

- The type of fuel used for water heating and cooking in new housing units is assumed to be a function of the main space heating fuel in most cases. For example, if natural gas is the main space heating fuel, then it is assumed that natural gas will be the water heating fuel. However, only 65 percent of those homes are assumed to use natural gas as the main cooking fuel. This is based on recent RECs data. If an oil or electric furnace is installed as the main space heating system, then electricity will be the water heating and cooking fuel.

- The type of fuel used for cooking and water heating when replacing retiring equipment in single-family homes is based on an input percentage of those who may switch and a technology choice-switching algorithm. Replacements are with the same technology in multifamily and mobile homes.

- Housing units are removed from the housing stock at a constant rate over time. The survival rates for housing stock types are assumed to be 99.7 percent for single-family homes, 99.8 percent for multifamily homes, and 97.5 percent for mobile homes. These rates are based on an analysis of historical household growth and housing starts.

- It is assumed that a constant 1.2 percent of existing housing units are renovated each year, increasing the square footage of the heated living area by about one-third.

- Projected new home heating fuel shares are based on the Census Bureau's new construction data and vary over time due to changes in life-cycle cost for each of the 11 heating system types.

- It is assumed that the volumetric size of new construction is larger than existing homes, which increases the heating and cooling loads in new construction, all else equal.