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Electric Energy Efficiency Potential for Pennsylvania

Final Report

Prepared for:
Pennsylvania Public Utility Commission

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1 EXECUTIVE SUMMARY

Act 129 of 2008 ("the Act" or "Act 129") was signed into law on October 15, 2008 and took effect 30 days thereafter on November 14, 2008. Among other things, the Act created an energy efficiency and conservation program for Pennsylvania, codified in the Pennsylvania Public Utility Code at Sections 2806.1 and 2806.2, 66 Pa. C.S. §§ 2806.1 and 2806.2. This program required an Electric Distribution Company (EDC) with at least 100,000 customers to adopt a plan, approved by the Commission, to reduce electric consumption by at least one percent (1%) of its expected consumption for the period June 1, 2009 through May 31, 2010, adjusted for weather and extraordinary loads. This one percent (1%) reduction was to be accomplished by May 31, 2011. By May 31, 2013, the total annual weather-normalized consumption is to be reduced by a minimum of three percent (3%). Also, by May 31, 2013, peak demand is to be reduced by a minimum of four-and-a-half percent (4.5%) of the EDC's annual system peak demand in the 100 hours of highest demand, measured against the EDC's peak demand during the period of June 1, 2007 through May 31, 2008. By November 30, 2013, the Commission is to assess the cost effectiveness of the program and set additional incremental reductions in electric consumption if the benefits of the program exceed its costs.

Pennsylvania Act 129 also required the Commission to evaluate, by November 30, 2013, and every five years thereafter, the costs and benefits of the program established for the prior plan period and set additional incremental reductions in electric consumption if the benefits of the program exceed its costs. This evaluation is to be consistent with a total resource cost test or a cost-benefit analysis determined by the Commission. The purpose of this energy efficiency potential study is to determine the remaining opportunities for cost effective electricity savings in the service areas of the seven electric distribution companies in Pennsylvania that are subject to the energy efficiency requirements of Act 129. This detailed report presents results of the technical, economic, and achievable potential for electric energy efficiency programs in the service areas of Pennsylvania's seven EDCs for the three time periods:

- The three-year period from June 1, 2013 through May 31, 2016,
- The five-year period from June 1, 2013 through May 31, 2018, and
- The ten-year period from June 1, 2013 through May 31, 2023

In addition, program potential for electric energy efficiency programs was calculated for the three and five-year time periods noted above.

All results were developed using customized residential and commercial/industrial (C&I) sector-level potential assessment analytic models and Pennsylvania-specific cost effectiveness criteria including the most recent Pennsylvania EDC avoided cost projections for electricity and other fuels. To help inform these energy efficiency potential models, up-to-date energy efficiency measure data were primarily obtained from the following recent studies:

1) Pennsylvania Technical Reference Manual, June 2012
2) Mid-Atlantic Technical Reference Manual 2.0, July 2011
3) Pennsylvania Statewide Evaluator Residential and Commercial/Industrial Baseline Studies, April 2012
4) PECO Baseline Study, February 2011
5) Northeast Energy Efficiency Partnership (NEEP) Incremental Cost Study Report, 2011
6) Appliance saturation studies conducted by the Pennsylvania EDCs

The above data sources provided valuable information regarding the current saturation, costs, savings and useful lives of electrical efficiency measures considered in this study.

The results of this study provide detailed information on energy efficiency measures that are the most cost effective and have the greatest potential kWh and kW savings in the service areas of the Pennsylvania EDCs. The data used for this report were the best available at the time this analysis was developed. As building and appliance codes and energy efficiency standards change, and as energy prices fluctuate, additional opportunities for energy efficiency may occur while current practices may become outdated.

1.1 COST EFFECTIVENESS FINDINGS

Act 129 of 2008 states the following about determining cost effectiveness for subsequent versions of Act 129 programs:

> "By November 30, 2013, and every five years thereafter, the Commission shall evaluate the costs and benefits of the program established under subsection (A) and of approved energy efficiency and conservation plans submitted to the program. The evaluation shall be consistent with a Total Resource Cost test or a cost-benefit analysis determined by the commission. If the Commission determines that the benefits of the program exceed the costs, the Commission shall adopt additional required incremental reductions in consumption."

This study concludes that continuing electric energy efficiency programs in a Phase 2 of Act 129 will continue to be very cost effective for Pennsylvania ratepayers. Table 1-1 and 1-2 show the Total Resource Cost test benefit-cost ratios for the Achievable Potential scenarios #1 and #2 for the three, five, and ten-year implementation periods starting on June 1, 2013. The TRC ratios statewide for Achievable Potential scenario #1 are 1.75, 1.83 and 1.95 for the three-year, five-year and ten-year time periods respectively. The TRC ratios statewide for Achievable Potential scenario #2 are 1.73, 1.85 and 1.97 for these three time periods.

Table 1-1: Total Resource Cost Test Benefit-Cost Ratios for Achievable Potential Scenario #1 For 3-Year, 5-Year, and 10-Year Implementation Periods

	TRC Benefits		TRC Costs		TRC Ratio
3-Year Period	$	4,236,649,800.37	$	2,415,984,248.08	1.75
5-Year Period	$	8,349,633,190.47	$	4,571,820,105.28	1.83
10-Year Period	$	21,026,641,589.24	$	10,759,165,841.58	1.95

Table 1-2: Total Resource Cost Test Benefit-Cost Ratios for Achievable Potential Scenario #2 For 3-Year, 5-Year, and 10-Year Implementation Periods

	TRC Benefits		TRC Costs		TRC Ratio
3-Year Period	$	3,799,475,599.64	$	2,202,502,753.00	1.73
5-Year Period	$	4,540,392,369.13	$	2,450,743,984.66	1.85
10-Year Period	$	9,455,821,361.87	$	4,808,941,993.06	1.97

In addition, the Statewide Evaluation Team did calculate a TRC ratio for each energy efficiency measure considered in this study. Only energy efficiency measures that had a TRC ratio greater than or equal to 1.0 were retained in the economic, achievable and program potential savings estimates.

1.2 STUDY SCOPE

The study examines the potential to reduce electric consumption and peak demand through the implementation of energy efficiency technologies and practices in residential, commercial, and industrial facilities in Pennsylvania. This study assesses electric energy efficiency potential throughout the Pennsylvania EDC service areas over ten years, from 2013 through 2023.

The study had the following main objectives:

- Evaluate the electric energy efficiency technical, economic, achievable and program potential savings in the overall Commonwealth of Pennsylvania, as well as in seven specific EDC service areas;
- Calculate the Total Resource Cost Test ("TRC") benefit-cost ratio for the achievable potential savings for electric energy efficiency measures and programs and determine the electric energy efficiency economic potential savings for Pennsylvania homes and businesses.

The scope of this study distinguishes among four types of energy efficiency potential; (1) technical, (2) economic, (3) achievable, and (4) program potential. The definitions used in this study for energy efficiency potential estimates were obtained directly from a recent National Action Plan for Energy Efficiency (NAPEE) report and are as follows:

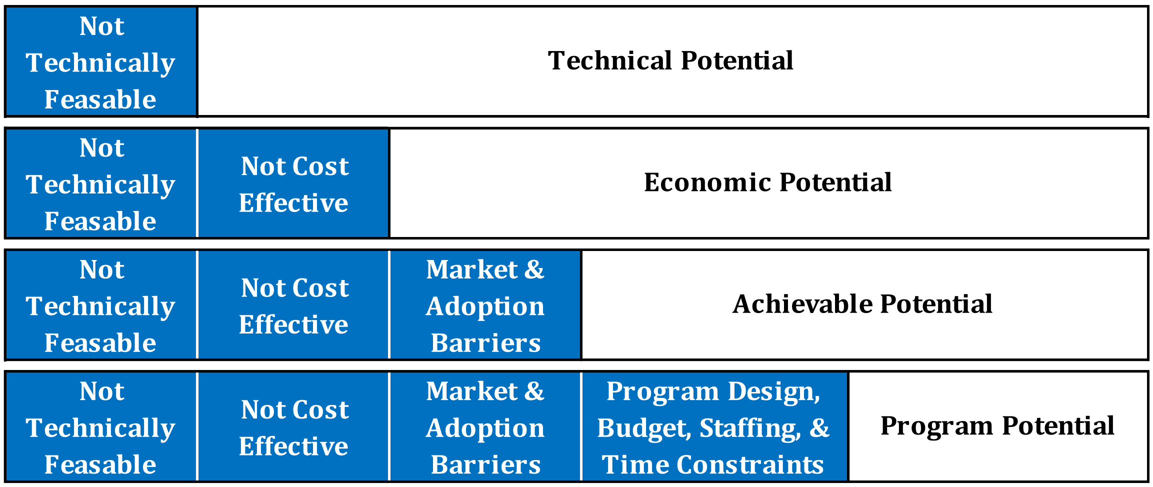
- **Technical Potential** is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency measures. It is often estimated as a "snapshot" in time assuming immediate implementation of all technologically feasible energy saving measures, with additional efficiency opportunities assumed as they arise from activities such as new construction.[1]
- **Economic Potential** refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources. Both technical and economic potential are theoretical numbers that assume immediate implementation of efficiency measures, with no regard for the gradual "ramping up" process of real-life programs. In addition, they ignore market barriers to ensuring actual implementation of efficiency. Finally, they only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration, etc.) that would be necessary to capture them.[2]
- **Achievable Potential** is the amount of energy use that efficiency can realistically be expected to displace assuming the most aggressive program scenario possible (e.g., providing end-users with payments for the entire incremental cost of more efficient equipment). This is often referred to as maximum achievable potential. Achievable potential takes into account real-world barriers to convincing end-users to adopt efficiency measures, the non-measure costs of delivering programs (for administration, marketing, tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time.[3] This study considers two main scenarios for analysis:
    - Scenario #1 is based on paying incentives equal to 100% of measure incremental costs
    - Scenario #2 is based on EDCs paying incentive levels comparable to those in effect during Program Year 2.
- **Program Potential** refers to the efficiency potential possible given specific program funding levels and designs. Often, program potential studies are referred to as "achievable" in contrast to "maximum achievable." In effect, they estimate the achievable potential from a given set of programs and funding. Program potential studies can consider scenarios ranging from a single program to a full portfolio of programs. A typical potential study may report a range of results based on different program funding levels.

[1] National Action Plan for Energy Efficiency, "Guide for Conducting Energy Efficiency Potential Studies" (November 2007), page 2-4. For purposes of this study, GDS and Nexant have used the definitions exactly as listed in the 2007 NAPEE report without making any modifications.
[2] Id
[3] Id

- Scenario #1 is based on funding levels of 2% of 2006 utility electric revenues (this is the funding cap specified in Act 129 legislation).
- Scenario #2 is based on annual savings equal to 1% of aggregate 2011 actual retail kWh sales.

Figure 1-1 below provides a graphical representation of the relationship of the various definitions of energy efficiency potential.

Figure 1-1: Types of Energy Efficiency Potential[4]



Limitations to the scope of study: As with any assessment of energy efficiency potential, this study necessarily builds on a large number of assumptions and data sources, including the following:

- Energy efficiency measure lives, measure savings and measure costs
- The discount rate for determining the net present value of future savings
- Projected penetration rates for energy efficiency measures
- Projections of electric generation avoided costs for electric capacity and energy as defined in the 2009 and 2011 Pennsylvania PUC Total Resource Cost Test (TRC) Orders.
- Future changes to current codes and standards

While the Pennsylvania Statewide Evaluation Team (SWE) has sought to use the best and most current available data, there are many assumptions where there may be reasonable alternative assumptions that would yield somewhat different results. Furthermore, while the lists of energy efficiency measures examined in this study represent most commercially available measures, these measure lists are not exhaustive. Finally there was no attempt to place a dollar value on some difficult to quantify benefits arising from installation of some measures, such as increased comfort or increased safety, which may in turn support some personal choices to implement particular measures that may otherwise not be cost-effective or only marginally so.

1.3 REPORT ORGANIZATION

The remainder of this report is organized in the following nine sections as follows:

Section 1: Executive Summary provides an overview of initial findings from the potential study and outlines the remainder of the report

Section 2: Glossary of Terms defines key terminology used in the report.

[4] Reproduced from "Guide to Resource Planning with Energy Efficiency" November 2007. US EPA. Figure 2-1.

Section 3: Introduction highlights the purpose of this study and the importance of energy efficiency.

Section 4: Characterization of Pennsylvania Service Areas provides an overview of the Pennsylvania EDC service areas and a brief discussion of the historical and forecasted electric energy sales by sector as well as peak demand.

Section 5: Methodology details the approach used to develop the estimates of technical, economic, achievable and program potential for electric energy efficiency savings.

Section 6: Residential Energy Efficiency Potential Estimates (2012-2023) provides a breakdown of the technical, economic, and achievable potential in the residential sector.

Section 7: Commercial and Industrial Energy Efficiency Potential Estimates (2012-2023) provides a breakdown of the technical, economic, and achievable in the C&I sectors.

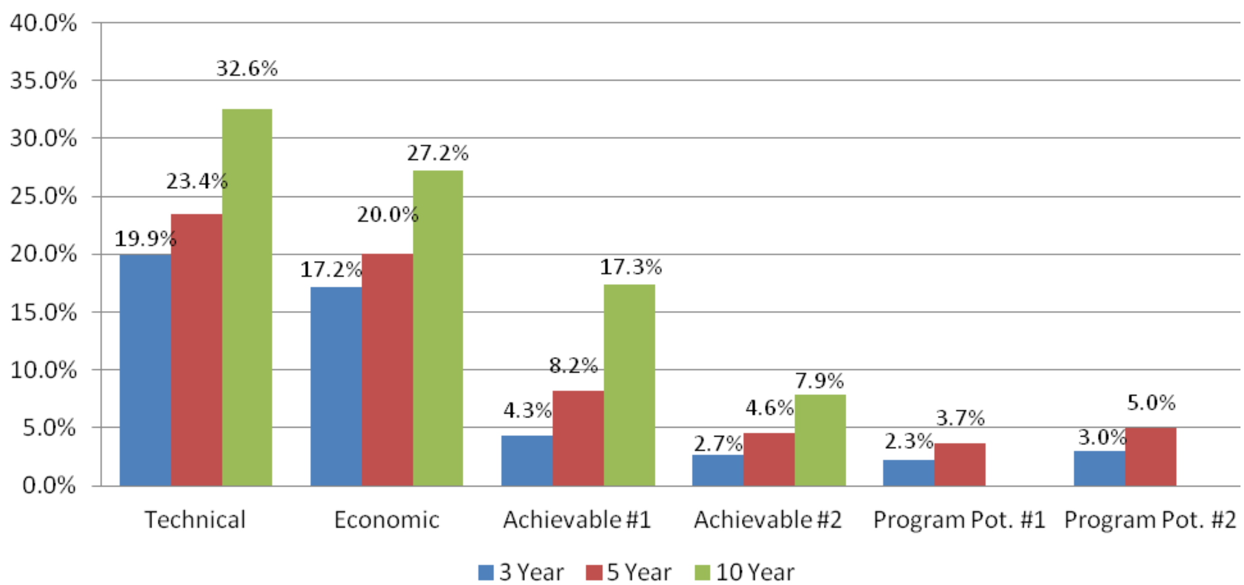
Section 8: Program Energy Efficiency Potential Estimates (June 2013-May 2018) provides detailed information on the program potential in the residential, commercial and industrial sectors.

Section 9: Conclusions presents the final discussion regarding potential for energy efficiency savings through 2023.

1.4 RESULTS OVERVIEW

This study examined over 579 energy efficiency measures in the residential, commercial and industrial sectors combined**.** Three hundred and seventeen measures were included in the residential sector energy efficiency potential analysis. For the non-residential sector, there were 262 total measures included in the potential energy savings analysis. Of these 262 measures, 95 were considered in the industrial model and 167 were included in the commercial model. The 262 is a count of the individual measures included; many measures had overlap between different segments and were counted as one measure.

Figure 1-2: Energy Efficiency Potential Savings Summary for Commonwealth of Pennsylvania



(Energy Efficiency Potential as a Percent of Forecasted Pennsylvania kWh Sales For the Baseline Period of June 2009 through May 2010)

Figure 1-2, presented above, shows that cost effective electric energy efficiency resources can play a significantly expanded role in the Pennsylvania energy resource mix over the next 10 years. For the region of the Commonwealth of Pennsylvania served by the seven electric distribution companies covered by Act 129, the technical potential in 2016 and in 2018 for energy efficiency is 19.9% and 23.4%, respectively, of forecasted kWh sales for the 2010 baseline period for this study.[5] The energy efficiency savings for economic potential and achievable potential scenario #2 in 2016 are 17.2% and 2.7% of forecasted kWh sales for the 2010 baseline period. The energy efficiency savings for economic potential and achievable potential scenario #2 in 2018 are 20% and 4.6% of forecasted kWh sales for the 2010 baseline period.

Estimation of program potential for Phase 2 of Act 129 utilizes both residential and non-residential potential savings. Because achievable potential scenario #2 is based on Phase 1 performance, this achievable scenario was utilized as the starting point for the determination of program potential. A detailed description of the methodology to estimate both program potential scenarios is included in section 8 of this report.

The three-year and five-year program potential scenario #1 energy savings and budget values are found in Table 1-3 and Table 1-4 for each EDC and statewide. Program potential scenario #1 considered an annual spending ceiling that limits the program spending to 2% of 2006 annual revenue as described within Act 129. Consequently, the SWE recommends that the savings targets for Phase 2 be based on the program potential 1 scenario presented in Table 1-3 or Table 1-4 below. The SWE Team finds that so long as the Pennsylvania Technical Reference Manual continues to be updated annually during Phase 2 of the Act 129 programs, then there is no clear advantage of one of these scenarios over the other (all other things held constant).

Table 1-3: Program Potential Scenario 1 2013-2016 Cumulative Savings and Budget

EDC	3 Year Spending Ceiling (total portfolio)	3 Year Program Potential Savings (MWh)	3 Year Program Acquisition Cost ($/MWh)	3 Year % of 2009/10 Forecast	Probable Range of 2009/10 Forecast
Duquesne	$58,637,855	276,722	$211.90	2.0%	1.7% - 2.5%
Met-Ed	$74,600,676	337,753	$220.87	2.3%	2.0% - 2.7%
Penelec	$68,924,232	318,813	$216.19	2.2%	1.9% - 2.7%
Penn Power	$19,979,352	95,502	$209.20	2.0%	1.7% - 2.5%
PPL	$184,504,128	821,072	$224.71	2.1%	1.9% - 2.7%
PECO	$256,185,476	1,125,851	$227.55	2.9%	2.6% - 3.1%
West Penn	$70,687,404	337,533	$209.42	1.6%	1.4% - 2.1%
Statewide	***$733,519,122***	***3,313,247***	***$221.39***	***2.3%***	***2.0% - 2.7%***

[5] For purposes of this study, the baseline period sales are forecast kWh sales for each EDC for the period June 1, 2009 through May 31, 2010. Forecasted 2009/2010 kWh sales were used to allow the same baseline to establish compliance targets on a cumulative basis from Phase 1 to Phase 2, which also allows adding kWh savings from Phase 1 to Phase 2. All energy and demand savings presented in this report are at the end-consumer (meter) level unless specifically noted otherwise in this report.

Table 1-4: Program Potential Scenario 1 2013-2018 Cumulative Savings and Budget

EDC	*5 Year Spending Ceiling (total portfolio)*	*5 Year Program Potential Savings (MWh)*	*5 Year Program Acquisition Cost ($/MWh)*	*5 Year % of 2009/10 Forecast*	*Probable Range of 2009/10 Forecast*
Duquesne	$97,729,758	442,451	$220.88	3.1%	2.8% - 4.2%
Met-Ed	$124,334,460	540,210	$230.16	3.6%	3.4% - 4.5%
Penelec	$114,873,720	513,332	$223.78	3.6%	3.2% - 4.4%
Penn Power	$33,298,920	154,500	$215.53	3.2%	2.8% - 4.1%
PPL	$307,506,880	1,332,001	$230.86	3.5%	3.2% - 4.5%
PECO	$426,975,793	1,884,517	$226.57	4.8%	4.3% - 5.2%
West Penn	$117,812,340	547,332	$215.25	2.6%	2.3% - 3.5%
Statewide	***$1,222,531,870***	***5,414,343***	***$225.80***	***3.7%***	***3.3% - 4.5%***

The uncertainty ranges presented are largely based on outcomes of this study supplemented with research of other regional (non-Pennsylvania) utilities' program forecasts, and SWE's industry experience. There are several key observations to be noted within these program potential savings and budgets:

- For the three year period (2013-2016), program potential scenario 1 estimated MWh savings are 2.3% of forecast sales. Over the five year period (2013-2018) program potential scenario 1 estimated MWh savings are 3.7% of forecast sales.
- Program potential savings are less than currently expected with Phase 1 implementation. This is largely due to the impacts of federal legislation, changing baseline conditions and increasing saturation of energy efficient equipment.
- Expected program costs are considerably higher than current Phase 1 implementation. Statewide estimated acquisition costs for 2013-2018 are 62% higher than current acquisition costs.

1.5 ENERGY EFFICIENCY POTENTIAL SAVINGS DETAIL

Table 1-5 and Table 1-6 below show the energy efficiency potential savings by EDC and customer class in 2016 and 2018. Section 6 (Residential Sector Energy Efficiency Potential Estimates) and Section 7 (Commercial & Industrial Sector Energy Efficiency Potential Estimates) include additional detail of energy efficiency potential by EDC in 2023.

Table 1-5: Energy Efficiency Potential Savings Detail (by EDC and Customer Class) for 2016[6]

	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2	Program Potential Scenario#1	Program Potential Scenario#2
ALL SECTORS COMBINED						
State-wide						
Energy (MWh)	**29,201,604**	**25,224,866**	**6,339,540**	**3,999,960**	**3,313,247**	**4,399,854**
% of 2010 MWh Sales	***19.9%***	***17.2%***	***4.3%***	***2.7%***	***2.3%***	***3.0%***
Summer MW	**6,028.2**	**4,581.2**	**1,418.9**	**816.6**	**664.2**	**900.5**
Duquesne Territory						
Energy (MWh)	2,854,052	2,454,905	673,803	412,981	276,722	422,565
% of 2010 MWh Sales	*20.3%*	*17.4%*	*4.8%*	*2.9%*	*2.0%*	*3.0%*
Summer MW	595.2	409.8	126.3	75.3	50.4	77.0
Met-Ed Territory						
Energy (MWh)	2,683,130	2,362,083	595,265	378,339	337,753	445,951
% of 2010 MWh Sales	*18.0%*	*15.9%*	*4.0%*	*2.5%*	*2.3%*	*3.0%*
Summer MW	525.1	418.3	135.1	74.7	66.7	88.0

6 The baseline kWh sales for this study are a forecast for the period June 1, 2009 to May 1, 2010.

	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2	Program Potential Scenario#1	Program Potential Scenario#2
Penelec Territory						
Energy (MWh)	2,498,934	2,229,523	593,366	371,169	318,813	431,979
% of 2010 MWh Sales	*17.4%*	*15.5%*	*4.1%*	*2.6%*	*2.2%*	*3.0%*
Summer MW	498.1	433.9	144.3	79.9	68.6	93.0
Penn Power Territory						
Energy (MWh)	782,602	691,036	175,450	110,399	95,502	143,188
% of 2010 MWh Sales	*16.4%*	*14.5%*	*3.7%*	*2.3%*	*2.0%*	*3.0%*
Summer MW	161.1	129.9	44.3	23.7	20.5	30.7
West Penn Power Territory						
Energy (MWh)	3,525,181	3,096,353	810,312	502,889	337,533	628,160
% of 2010 MWh Sales	*16.8%*	*14.8%*	*3.9%*	*2.4%*	*1.6%*	*3.0%*
Summer MW	784.3	695.6	221.4	123.9	83.1	154.7
PECO Territory						
Energy (MWh)	8,585,180	6,977,563	1,714,520	1,081,205	1,125,851	1,181,580
% of 2010 MWh Sales	*21.8%*	*17.7%*	*4.4%*	*2.7%*	*2.9%*	*3.0%*
Summer MW	1,831.5	1,146.3	296.1	183.8	191.3	200.8
PPL Territory						
Energy (MWh)	8,272,524	7,413,402	1,776,823	1,142,977	821,072	1,146,431
% of 2010 MWh Sales	*21.6%*	*19.4%*	*4.6%*	*3.0%*	*2.1%*	*3.0%*
Summer MW	1,632.8	1,347.4	451.4	255.4	183.5	256.2
RESIDENTIAL SECTOR ONLY						
State-wide						
Energy (MWh)	**21,847,632**	**19,163,895**	**2,997,353**	**2,227,067**	**1,840,617**	**2,443,862**
% of 2010 MWh Sales	***40.3%***	***35.4%***	***5.5%***	***4.1%***	***3.4%***	***4.5%***
Summer MW	**4,583.5**	**3,333.1**	**630.6**	**451.5**	**369.4**	**497.7**
Duquesne Territory						
Energy (MWh)	1,951,950	1,738,874	273,619	203,534	136,380	208,258
% of 2010 MWh Sales	*46.6%*	*41.5%*	*6.5%*	*4.9%*	*3.3%*	*5.0%*
Summer MW	438.1	281.3	51.2	37.7	25.3	38.6
Met-Ed Territory						
Energy (MWh)	2,015,625	1,802,165	288,988	214,558	191,542	252,901
% of 2010 MWh Sales	*32.5%*	*29.5%*	*4.7%*	*3.5%*	*3.1%*	*4.1%*
Summer MW	391.1	299.9	56.6	40.0	35.7	47.2
Penelec Territory						
Energy (MWh)	1,780,538	1,618,293	257,169	192,379	165,242	223,896
% of 2010 MWh Sales	*36.5%*	*33.1%*	*5.3%*	*3.9%*	*3.4%*	*4.6%*
Summer MW	350.2	300.9	55.3	41.0	35.2	47.7
Penn Power Territory						
Energy (MWh)	579,802	521,073	81,325	60,683	52,495	78,706
% of 2010 MWh Sales	*31.4%*	*28.4%*	*4.4%*	*3.3%*	*2.8%*	*4.3%*
Summer MW	112.9	87.2	15.3	11.1	9.6	14.5
West Penn Power Territory						
Energy (MWh)	2,584,323	2,302,869	366,589	270,787	181,749	338,241
% of 2010 MWh Sales	*32.6%*	*29.0%*	*4.6%*	*3.4%*	*2.3%*	*4.3%*
Summer MW	566.2	511.1	100.9	69.9	46.9	87.3
PECO Territory						
Energy (MWh)	6,489,928	5,292,925	791,936	588,433	612,730	643,060
% of 2010 MWh Sales	*46.3%*	*37.8%*	*5.7%*	*4.2%*	*4.4%*	*4.6%*
Summer MW	1,530.5	897.2	150.7	110.9	115.5	121.2
PPL Territory						
Energy (MWh)	6,445,466	5,887,698	937,727	696,694	500,479	698,799
% of 2010 MWh Sales	*42.6%*	*38.9%*	*6.2%*	*4.6%*	*3.3%*	*4.6%*

	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2	Program Potential Scenario#1	Program Potential Scenario#2
Summer MW	1,194.4	955.5	200.5	140.8	101.2	141.2
NON-RESIDENTIAL ONLY						
State-wide						
Energy (MWh)	**7,353,972**	**6,060,971**	**3,342,188**	**1,772,893**	**1,472,630**	**1,955,992**
% of 2010 MWh Sales	***8.0%***	***6.6%***	***3.6%***	***1.9%***	***1.6%***	***2.1%***
Summer MW	**1,444.7**	**1,248.1**	**788.3**	**365.1**	**294.8**	**402.8**
Duquesne Territory						
Energy (MWh)	902,102	716,031	400,184	209,446	140,342	214,307
% of 2010 MWh Sales	*9.1%*	*7.2%*	*4.0%*	*2.1%*	*1.4%*	*2.2%*
Summer MW	157.1	128.4	75.1	37.6	25.2	38.4
Met-Ed Territory						
Energy (MWh)	667,505	559,918	306,278	163,781	146,212	193,050
% of 2010 MWh Sales	*7.7%*	*6.5%*	*3.5%*	*1.9%*	*1.7%*	*2.2%*
Summer MW	134.0	118.4	78.4	34.6	30.9	40.8
Penelec Territory						
Energy (MWh)	718,396	611,230	336,198	178,791	153,571	208,083
% of 2010 MWh Sales	*7.5%*	*6.4%*	*3.5%*	*1.9%*	*1.6%*	*2.2%*
MW	147.9	133.0	88.9	38.9	33.4	45.3
Penn Power Territory						
Energy (MWh)	202,800	169,964	94,125	49,716	43,008	64,482
% of 2010 MWh Sales	*6.9%*	*5.8%*	*3.2%*	*1.7%*	*1.5%*	*2.2%*
Summer MW	48.2	42.7	29.0	12.5	10.8	16.2
West Penn Power Territory						
Energy (MWh)	940,858	793,484	443,723	232,102	155,784	289,919
% of 2010 MWh Sales	*7.2%*	*6.1%*	*3.4%*	*1.8%*	*1.2%*	*2.2%*
Summer MW	218.1	184.5	120.5	54.0	36.2	67.4
PECO Territory						
Energy (MWh)	2,095,252	1,684,639	922,585	492,773	513,120	538,520
% of 2010 MWh Sales	*8.3%*	*6.6%*	*3.6%*	*1.9%*	*2.0%*	*2.1%*
Summer MW	301.0	249.1	145.4	72.9	75.9	79.6
PPL Territory						
Energy (MWh)	1,827,059	1,525,704	839,096	446,283	320,593	447,632
% of 2010 MWh Sales	*7.9%*	*6.6%*	*3.6%*	*1.9%*	*1.4%*	*1.9%*
Summer MW	438.4	391.9	251.0	114.6	82.4	115.0

***Achievable Scenario#1: Assumes 100% Incentives**
***Achievable Scenario#2: Assumes 56% incentives in the residential sector; 34% in the non-residential sector**
***Program Scenario#1: Based on a 2% Funding Cap of 2006 Annual Revenues**
***Program Scenario#2: Based on a target of 1% of 2010 MWh sales**

Table 1-6: Energy Efficiency Potential Savings Detail (by EDC and Customer Class) for 2018[7]

	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2	Program Potential Scenario#1	Program Potential Scenario#2
ALL SECTORS COMBINED						
State-wide						
Energy (MWh)	**34,387,318**	**29,381,754**	**11,996,092**	**6,709,824**	**5,414,343**	**7,333,090**
% of 2010 MWh Sales	***23.4%***	***20.0%***	***8.2%***	***4.6%***	***3.7%***	***5.0%***
Summer MW	**6,277.6**	**4,698.5**	**1,960.6**	**1,110.0**	**885.7**	**1,214.5**
Duquesne Territory						
Energy (MWh)	3,455,263	2,931,409	1,266,180	690,309	442,451	704,275

[7] The baseline kWh sales for this study are a forecast for the period June 1, 2009 to May 1, 2010.

	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2	Program Potential Scenario#1	Program Potential Scenario#2
% of 2010 MWh Sales	*24.5%*	*20.8%*	*9.0%*	*4.9%*	*3.1%*	*5.0%*
Summer MW	653.4	451.0	193.7	109.3	70.0	111.5
Met-Ed Territory						
Energy (MWh)	3,185,148	2,770,502	1,134,581	639,446	540,210	743,252
% of 2010 MWh Sales	*21.4%*	*18.6%*	*7.6%*	*4.3%*	*3.6%*	*5.0%*
Summer MW	531.1	413.1	170.8	96.4	81.5	112.1
Penelec Territory						
Energy (MWh)	3,009,108	2,659,023	1,126,710	624,882	513,332	719,965
% of 2010 MWh Sales	*20.9%*	*18.5%*	*7.8%*	*4.3%*	*3.6%*	*5.0%*
Summer MW	496.4	422.6	173.3	100.3	82.4	115.6
Penn Power Territory						
Energy (MWh)	922,466	807,611	331,725	185,438	154,500	238,647
% of 2010 MWh Sales	*19.3%*	*16.9%*	*7.0%*	*3.9%*	*3.2%*	*5.0%*
Summer MW	156.7	123.6	50.1	28.6	23.8	36.8
West Penn Power Territory						
Energy (MWh)	4,188,219	3,646,136	1,534,925	844,823	547,332	1,046,933
% of 2010 MWh Sales	*20.0%*	*17.4%*	*7.3%*	*4.0%*	*2.6%*	*5.0%*
Summer MW	796.2	689.8	291.8	163.6	106.0	202.8
PECO Territory						
Energy (MWh)	10,068,327	8,126,481	3,256,453	1,818,307	1,884,517	1,969,300
% of 2010 MWh Sales	*25.6%*	*20.6%*	*8.3%*	*4.6%*	*4.8%*	*5.0%*
Summer MW	1,976.4	1,249.1	487.2	279.8	290.0	303.1
PPL Territory						
Energy (MWh)	9,558,787	8,440,592	3,345,517	1,906,619	1,332,001	1,910,718
% of 2010 MWh Sales	*25.0%*	*22.1%*	*8.8%*	*5.0%*	*3.5%*	*5.0%*
Summer MW	1,667.5	1,349.3	593.7	332.0	231.9	332.7
RESIDENTIAL SECTOR ONLY						
State-wide						
Energy (MWh)	**22,049,980**	**19,215,900**	**5,623,449**	**3,736,214**	**3,008,673**	**4,074,270**
% of 2010 MWh Sales	***40.7%***	***35.5%***	***10.4%***	***6.9%***	***5.6%***	***7.5%***
Summer MW	**4,615.9**	**3,339.6**	**1,130.1**	**712.5**	**568.3**	**781.1**
Duquesne Territory						
Energy (MWh)	1,951,950	1,738,874	512,646	341,480	218,870	348,389
% of 2010 MWh Sales	*46.6%*	*41.5%*	*12.2%*	*9.8%*	*5.2%*	*8.3%*
Summer MW	438.1	281.3	91.1	59.6	38.2	60.8
Met-Ed Territory						
Energy (MWh)	2,063,489	1,829,901	548,069	364,312	307,774	423,453
% of 2010 MWh Sales	*33.3%*	*29.5%*	*8.8%*	*5.9%*	*5.0%*	*6.8%*
Summer MW	398.7	302.9	102.9	64.2	54.2	74.6
Penelec Territory						
Energy (MWh)	1,804,715	1,634,442	485,344	325,182	267,133	374,662
% of 2010 MWh Sales	*37.0%*	*33.5%*	*9.9%*	*6.7%*	*5.5%*	*7.7%*
Summer MW	354.2	302.8	99.3	65.3	53.6	75.2
Penn Power Territory						
Energy (MWh)	582,936	523,129	152,960	102,224	85,169	131,556
% of 2010 MWh Sales	*31.6%*	*28.4%*	*8.3%*	*5.5%*	*4.6%*	*7.1%*
Summer MW	113.4	87.4	27.7	18.0	15.0	23.1
West Penn Power Territory						
Energy (MWh)	2,602,440	2,308,932	688,185	453,677	293,922	562,212
% of 2010 MWh Sales	*32.8%*	*29.1%*	*8.7%*	*5.7%*	3.7%	*7.1%*
Summer MW	569.5	511.8	183.1	111.6	72.3	138.3

	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2	Program Potential Scenario#1	Program Potential Scenario#2
PECO Territory						
Energy (MWh)	6,543,125	5,292,925	1,488,047	989,465	1,025,494	1,071,631
% of 2010 MWh Sales	*46.7%*	*37.8%*	*10.6%*	*7.1%*	7.3%	*7.6%*
Summer MW	1,540.1	897.9	270.4	177.1	183.5	191.8
PPL Territory						
Energy (MWh)	6,501,325	5,887,698	1,748,198	1,159,873	810,310	1,162,367
% of 2010 MWh Sales	*43.0%*	*38.9%*	*11.5%*	*7.7%*	5.4%	*7.7%*
Summer MW	1,201.9	955.5	355.7	216.8	151.4	217.2
NON-RESIDENTIAL ONLY						
State-wide						
Energy (MWh)	**12,337,338**	**10,165,854**	**6,372,642**	**2,973,611**	**2,405,670**	**3,258,820**
% of 2010 MWh Sales	***13.3%***	***11.0%***	***6.9%***	***3.2%***	***2.6%***	***3.5%***
Summer MW	**1,661.8**	**1,358.9**	**830.5**	**397.5**	**317.4**	**433.3**
Duquesne Territory						
Energy (MWh)	1,503,313	1,192,536	753,534	348,829	223,581	355,886
% of 2010 MWh Sales	*15.2%*	*12.0%*	*7.6%*	*3.5%*	*2.3%*	*3.6%*
Summer MW	215.2	169.6	102.6	49.6	31.8	50.6
Met-Ed Territory						
Energy (MWh)	1,121,659	940,600	586,513	275,134	232,436	319,799
% of 2010 MWh Sales	*12.9%*	*10.9%*	*6.8%*	*3.2%*	*2.7%*	*3.7%*
Summer MW	132.4	110.3	67.9	32.3	27.2	37.5
Penelec Territory						
Energy (MWh)	1,204,393	1,024,581	641,366	299,700	246,199	345,303
% of 2010 MWh Sales	*12.7%*	*10.8%*	*6.7%*	*3.1%*	*2.6%*	*3.6%*
MW	142.1	119.8	74.0	35.0	28.8	40.4
Penn Power Territory						
Energy (MWh)	339,530	284,482	178,765	83,214	69,331	107,091
% of 2010 MWh Sales	*11.6%*	*9.7%*	*6.1%*	*2.8%*	*2.4%*	*3.7%*
Summer MW	43.3	36.2	22.4	10.6	8.8	13.6
Energy (MWh)	1,585,778	1,337,204	846,740	391,146	253,410	484,721
% of 2010 MWh Sales	*12.2%*	*10.3%*	*6.5%*	*3.0%*	*1.9%*	*3.7%*
Summer MW	226.7	178.0	108.8	52.1	33.7	64.5
PECO Territory						
Energy (MWh)	3,525,202	2,833,556	1,768,406	828,842	859,022	897,669
% of 2010 MWh Sales	*13.9%*	*11.2%*	*7.0%*	*3.3%*	*3.4%*	*3.5%*
Summer MW	436.3	351.3	216.8	102.8	106.5	111.3
PPL Territory						
Energy (MWh)	3,057,462	2,552,894	1,597,319	746,746	521,691	748,352
% of 2010 MWh Sales	*13.2%*	*11.1%*	*6.9%*	*3.2%*	*2.3%*	*3.2%*
Summer MW	465.6	393.8	238.1	115.2	80.5	115.4

***Achievable Scenario#1: Assumes 100% Incentives**
***Achievable Scenario#2: Assumes 56% incentives in the residential sector; 34% in the non-residential sector**
***Program Scenario#1: Based on a 2% Funding Cap of 2006 Annual Revenues**
***Program Scenario#2: Based on a target of 1% of 2010 MWh sales**

2 GLOSSARY OF TERMS[8]

The following list defines many of the key energy efficiency terms used throughout this energy efficiency potential study.

Achievable Potential: The November 2007 National Action Plan for Energy Efficiency "Guide for Conducting Energy Efficiency Potential Studies" defines achievable potential as the amount of energy use that energy efficiency can realistically be expected to displace assuming the most aggressive program scenario possible (*e.g.*, providing end-users with payments for the entire incremental cost of more efficient equipment). This is often referred to as maximum achievable potential. Achievable potential takes into account real-world barriers to convincing end-users to adopt efficiency measures, the non-measure costs of delivering programs (for administration, marketing, tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time.

Achievable Potential Scenario 1 is an achievable potential scenario, and assumes that EDC's pay incentives equal to 100% of measure costs and that 85% market penetration is achieved over the long term (10 years).

Achievable Potential Scenario 2 is an achievable potential scenario, and assumes that the EDC's pay incentives equal to the actual incentive levels in place in Program Year 2 of phase 1 of the Act 129 programs plus a 25% safety margin (with the residential incentive level equal to 56.05% of measure cost and non-residential equal to 34.24% of measure cost). Additionally, over the long term (10 years) a lower market penetration rate of 40% is achieved across all programs due to the lower incentive levels.

Acquisition Costs are defined within this report as program expense dollars spent to acquire first-year energy savings. Program expense dollars include all program costs such as rebates, incentives, administrative costs, marketing, outreach, and evaluation expenditures. Discussion of acquisition cost is useful because of its simplicity (costs divided by first year savings). However, this metric does have important limitations, because it does not reflect the value of the energy savings as a resource. Additional savings parameters would need to be included, specifically measure lifetime, to determine the value of the savings resource.*(see also Resource Acquisition Costs)*

Applicability Factor: The fraction of the applicable dwelling units or businesses that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install CFLs in all light sockets in a home because the CFLs may not fit in every socket in a home).

Avoided Costs: The incremental cost that a utility would have to incur if it did not acquire energy from another source. Thus, it is the cost of producing or delivering power that the utility can avoid by lowering capacity and energy requirements.[9]

Base Case Equipment End-Use Intensity: The electricity used per customer per year by each base-case technology in each market segment. This is the consumption of the electric energy using equipment that the efficient technology replaces or affects. For example, if the efficient measure is a high efficiency light bulb (CFL), the base end-use intensity would be the annual kWh use per bulb per household associated with an incandescent light bulb that provides equivalent lumens to the CFL.

[8] Potential definitions taken from National Action Plan for Energy Efficiency (2007), "Guide for Conducting Energy Efficiency Potential Studies." Prepared by Philip Mosenthal and Jeffrey Loiter, Optimal Energy, Inc.
[9] Green Energy Savings Solutions. https://www.palenergysmart.com/Glossary.html

Base Case Factor: The fraction of the market that is applicable for the efficient technology in a given market segment. For example, for residential lighting, this would be the fraction of all residential electric customers that have electric lighting in their household.

Capital Recovery Rate (CRR): The return of invested capital expressed as an annual rate; often applied in a physical sense to wasting assets with a finite economic life.[10]

Coincidence Factor: The fraction of connected load expected to be "on" and using electricity coincident with the system peak period.

Cost-Effectiveness: A measure of the relevant economic effects resulting from the implementation of an energy efficiency measure. If the benefits are greater than the costs, the measure is said to be cost-effective.

Cumulative Program Inception to Date (CPITD): The cumulative savings achieved by a utility for a particular program since the inception of that program up to the reporting date.

Cumulative Annual: Refers to the overall annual savings occurring in a given year from both new participants and annual savings continuing to result from past participation with energy efficiency measures that are still in place. Cumulative annual does not always equal the sum of all prior year incremental values as some energy efficiency measures have relatively short lives and, as a result, their savings drop off over time.

Commercial Sector: Comprised of non-manufacturing premises typically used to sell a product or provide a service, where electricity is consumed primarily for lighting, space cooling and heating, office equipment and other appliances. Business types are included in section 5 – methodology.

Conservation Voltage Reduction (CVR): A change in the voltage made by a physical adjustment in transformer settings governing voltage at the substation. By adjusting substation voltage, the program impacts hourly energy flows and capacity, including demand coincident with the system peak period(s), included within the top 100 (peak demand) hours on the system load duration curve.[11]

Demand Response: Refers to demand resources involving dynamic hourly load response to market conditions, such as curtailment or load control programs.

Direct Load Control: Activities that can interrupt load at the time of peak by interrupting power supply on consumer premises, usually applied to residential consumers.[12]

Energy Use Intensity (EUI): A unit of measurement that describes a building's energy use. EUI represents the energy consumed by a building relative to its size[13]

Early Replacement: Refers to an efficiency measure or efficiency program that seeks to encourage the replacement of functional equipment before the end of its operating life with higher-efficiency units.

Economic Potential: The November 2007 National Action Plan for Energy Efficiency "Guide for Conducting Energy Efficiency Potential Studies" refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources as economic

[10] Accuval. http://www.accuval.net/insights/glossary/
[11] PECO Quarterly Report Program Year 3. June through August 2011
[12] Independent Energy Producers Association http://www.iepa.com/Glossary.asp
[13] EnergyStar http://www.energystar.gov/index.cfm?fuseaction=buildingcontest.eui

potential. Both technical and economic potential are theoretical numbers that assume immediate implementation of efficiency measures, with no regard for the gradual "ramping up" process of real-life programs. In addition, they ignore market barriers to ensuring actual implementation of efficiency. Finally, they only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration) that would be necessary to capture them.

End-Use: A category of equipment or service that consumes energy (*e.g.*, lighting, refrigeration, heating, process heat, cooling).

Energy Efficiency: Using less energy to provide the same or an improved level of service to the energy consumer in an economically efficient way. Sometimes "conservation" is used as a synonym, but that term is usually taken to mean using less of a resource even if this results in a lower service level (*e.g.*, setting a thermostat lower or reducing lighting levels).

First Year Savings: **S**avings accrued in the first year of the measure's installation. Future benefits are not considered.

Free Driver: Individuals or businesses that adopt an energy efficient product or service because of an energy efficiency program, but are difficult to identify either because they do not receive an incentive or are not aware of the program.

Free Rider: Participants in an energy efficiency program who would have adopted an energy efficiency technology or improvement in the absence of a program or financial incentive.

Gross Savings: Gross energy (or demand) savings are the change in energy consumption or demand that results directly from program-promoted actions (e.g., installing energy-efficient lighting) taken by program participants regardless of the extent or nature of program influence on their actions.

Incentive Costs: A rebate or some form of payment used to encourage people to implement a given demand-side management (DSM) technology. The incentive is calculated as the amount of the technology costs that must be paid by the utility for the participant test to equal one and achieve the desired benefit/cost ratio to drive the market.[14]

Incremental: Savings or costs in a given year associated only with new installations happening in that specific year.

Industrial Sector: Comprised of manufacturing premises typically used for producing and processing goods, where electricity is consumed primarily for operating motors, process cooling and heating, and space heating, ventilation, and air conditioning (HVAC). Business types are included in section 5 – methodology.

Measure: Any action taken to increase energy efficiency, whether through changes in equipment, changes to a building shell, implementation of control strategies, or changes in consumer behavior. Examples are higher-efficiency central air conditioners, occupancy sensor control of lighting, and retro-commissioning. In some cases, bundles of technologies or practices may be modeled as single measures. For example, an ENERGY STAR® ™ home package may be treated as a single measure.

MW: A unit of electrical output, equal to one million watts or one thousand kilowatts. It is typically used to refer to the output of a power plant.

[14] Independent Energy Producers Association http://www.iepa.com/Glossary.asp

MWh: One thousand kilowatt-hours, or one million watt-hours. One MWh is equal to the use of 1,000,000 watts of power in one hour.

Net-to-Gross Ratio: A factor representing net program savings divided by gross program savings that is applied to gross program impacts to convert them into net program load impacts

Net Savings: Net energy or demand savings refer to the portion of gross savings that is attributable to the program. This involves separating out the impacts that are a result of other influences, such as consumer self-motivation. Given the range of influences on consumers' energy consumption, attributing changes to one cause (i.e., a particular program) or another can be quite complex.

Non Incentive Cost: Costs incurred by the utility that do not include incentives paid to the customer (i.e.: administrative costs, program marketing costs, data tracking and reporting, program evaluation, etc.)

Nonparticipant Spillover: Savings from efficiency projects implemented by those who did not directly participate in a program, but which nonetheless occurred due to the influence of the program.

Participant Cost: The cost to the participant to participate in an energy efficiency program.

Participant Spillover: Additional energy efficiency actions taken by program participants as a result of program influence, but actions that go beyond those directly subsidized or required by the program.[15]

Participant Test: The participant test assesses the benefits and costs from a participant's perspective such as the reduction in customers' bills, incentives paid to the customer by the utility, and tax credits received, as compared to out-of-pocket customer expenses such as costs of equipment purchase, and operation and maintenance costs

Portfolio: Either a collection of similar programs addressing the same market, technology, or mechanisms; or the set of all programs conducted by one energy efficiency organization or utility.

Program: A mechanism for encouraging energy efficiency that may be funded by a variety of sources and pursued by a wide range of approaches (typically includes multiple energy efficiency measures).

Program Potential: The November 2007 National Action Plan for Energy Efficiency 'Guide for Conducting Energy Efficiency Potential Studies refers to the efficiency potential possible given specific program funding levels and designs. Often, program potential studies are referred to as "achievable" in contrast to "maximum achievable." In effect, they estimate the achievable potential from a given set of programs and funding. Program potential studies can consider scenarios ranging from a single program to a full portfolio of programs. A typical potential study may report a range of results based on different program funding levels.

- Program Potential Scenario 1 is based on Achievable Potential scenario 2, and is based on the implementation of a cap on annual utility expenditures on energy efficiency programs of 2 percent of 2006 actual Pennsylvania EDC utility electric revenues.
- Program Potential Scenario 2 is also based on Achievable Potential scenario 2, but adjusts annual energy efficiency kWh savings so that they are 1% of forecast Pennsylvania EDC annual kWh sales each year.

[15] The definitions of participant and nonparticipant spillover were obtained from the National Action Plan for Energy Efficiency Report titled "Model Energy Efficiency Program Impact Evaluation Guide", November 2007, page ES-4.

Remaining Factor: The fraction of applicable units that have not yet been converted to the electric energy efficiency measure; that is, one minus the fraction of units that already have the energy efficiency measure installed.

Replace-on-burnout: A DSM measure is not implemented until the existing technology it is replacing fails or burns out. An example would be an energy efficient water heater being purchased after the failure of the existing water heater at the end of its useful life.

Resource Acquisition Costs: The cost of energy savings associated with energy efficiency programs, generally expressed in costs per first year saved MWh ($/MWh) or kWh ($/kWh) in this report. Acquisition costs include all utility incentive costs and non-incentive costs (i.e., marketing, administration, etc.). For this calculation, the numerator includes acquisition costs for any new participants in a given year and the denominator includes the associated annual kWh savings for those participants. *(see also Acquisition Costs)*

Retrofit: Refers to an efficiency measure or efficiency program that seeks to encourage the replacement of functional equipment before the end of its operating life with higher-efficiency units (also called "early retirement") or the installation of additional controls, equipment, or materials in existing facilities for purposes of reducing energy consumption (e.g., increased insulation, low flow devices, lighting occupancy controls, economizer ventilation systems).

Savings Factor: The percentage reduction in electricity consumption resulting from application of the efficient technology. The savings factor is used in the formulas to calculate energy efficiency potential.

Technical Potential: The theoretical maximum amount of energy use that could be displaced by energy efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the energy efficiency measures. It is often estimated as a "snapshot" in time assuming immediate implementation of all technologically feasible energy saving measures, with additional efficiency opportunities assumed as they arise from activities such as new construction.

Total Resource Cost Test: The TRC measures the net benefits of the energy efficiency program for a region or service area as a whole. Costs included in the TRC are costs to purchase and install the energy efficiency measure and overhead costs of running the energy efficiency program. The benefits included are the avoided costs of energy and capacity. For purposes of this study, non-electric benefits were not included in the calculation of TRC benefits.

Societal Cost Test: Includes all of the costs and benefits of the TRC test, but it also includes environmental and other non-energy benefits that are not currently valued by the market. The SCT may also include non-energy costs, such as reduced customer comfort levels.

3 INTRODUCTION

This report assesses the potential for energy efficiency programs to assist the Commonwealth of Pennsylvania in meeting future energy service needs. This section of the report provides the following information:

- Defines the term "energy efficiency",
- Describes the general benefits of energy efficiency programs
- Provides results of similar energy efficiency potential studies conducted in other states

3.1 INTRODUCTION TO ENERGY EFFICIENCY

Efficient energy use, often referred to as energy efficiency, is using less energy to provide the same level of energy service. An example would be insulating a home or business to use less heating and cooling energy to achieve the same inside temperature. Another example would be installing fluorescent lighting in place of less efficient halogen or incandescent lights to attain the same level of illumination. Energy efficiency can be achieved through more efficient technologies and/or processes as well as through changes in individual behavior.

3.1.1 GENERAL BENEFITS OF ENERGY EFFICIENCY

There are a number of benefits that accrue to the Commonwealth of Pennsylvania due to energy efficiency programs. These benefits include avoided energy and capacity cost savings, non-electric benefits such as water and fossil fuel savings, environmental benefits, economic stimulus, job creation, risk reduction, and energy security.[16]

Avoided electric energy and capacity costs are based upon the costs an electric utility would incur to construct and operate new electric power plants or to purchase power from another source[17]. These avoided costs of electricity include both fixed and variable costs that can be directly avoided through a reduction in electricity usage. The energy component includes the costs associated with the production of electricity, while the capacity component includes costs associated with the capability to deliver electric energy during peak periods. Capacity costs consist primarily of the costs associated with building peaking generation facilities. The electric avoided costs used in this study were obtained directly from the seven electric distribution companies whose service areas are the focus of this study pursuant to definitions in the 2009 and 2011 TRC Orders.

At the consumer level, energy efficient products often cost more than their standard efficiency counterparts, but this additional cost is balanced by lower energy consumption and lower energy bills. Over time, the money saved from energy efficient products will pay consumers back for their initial investment as well as save them money. Although some energy efficient technologies are complex and expensive, such as installing new high efficiency windows or a high efficiency boiler, many are simple and inexpensive. Installing compact fluorescent lighting or low-flow water devices, for example, can be done by most individuals.

Although the reduction in energy and capacity costs is the primary benefit to be gained from investments in energy efficiency, the utility, its consumers, and society as a whole can also benefit in other ways. Many electric efficiency measures also deliver non-energy benefits. For example, low-flow water devices

[16] For purposes of this study, non-electric benefits were not included in the Pennsylvania TRC test because the savings targets for Act 129 programs are for electric savings only.
[17] Each EDC's forecast of electric energy and capacity avoided costs is provided in the appendices of this report. These forecasts were developed based on the methodology in the Commission's 2009 and 2011 TRC Orders.

and efficient clothes washers also reduce water consumption.[18] Similarly, weatherization measures that improve the building shell not only save on air conditioning costs in the summer, but also can save the customer money on space heating fuels, such as natural gas or propane. Reducing electricity consumption also reduces harmful emissions, such as SO_X, NO_X, CO_2 and particulates into the environment.[19] Exelon (the parent company of PECO) has made a commitment to responsive, low-carbon energy investment to enable the Company to create advantages for stakeholders while reducing the Company's impacts on the environment. In 2003, Exelon committed to a voluntary emissions reduction goal under the EPA Climate Leaders program. When Exelon debuted its *Exelon 2020* in 2008, the Exelon family of companies charted a course to a low-carbon future with an industry-leading plan to abate the Company's carbon footprint by more than 15 million metric tons of greenhouse gas emissions per year by 2020. Now, as Exelon has projected that it hit 75% of its goal by the end of 2011, Exelon states on its web site that the Company continues to focus on being a leading provider of reliable, low-emission energy in the communities they serve and strives to balance the environmental, social and economic aspects of electricity generation and energy distribution.

Energy efficiency programs create both direct and indirect jobs. The manufacture and installation of energy efficiency products involves the manufacturing sector as well as research and development, service, and installation jobs. These are skilled positions that are not easily outsourced to other states and countries. The creation of indirect jobs is more difficult to quantify, but result from households and businesses experiencing increased discretionary income from reduced energy bills. These savings produce multiplier effects, such as increased investment in other goods and services driving job creation in other markets.

Energy efficiency reduces risks associated with fuel price volatility, unanticipated capital cost increases, environmental regulations, supply shortages, and energy security. Aggressive energy efficiency programs can help eliminate or postpone the risk associated with committing to large investments for generation facilities a decade or more before they are needed. Energy efficiency is also not subject to the same supply and transportation constraints that impact fossil fuels. Finally, energy efficiency reduces competition between states and utilities for fuels, and reduces dependence on fuels imported from other states or countries to support electricity production. Energy efficiency can help meet future demand increases and reduce dependence on out-of-state or overseas resources.

PPL Electric also recognizes the benefits of reducing greenhouse gases. The Company's web site provides a carbon footprint calculator for customers to use. The introduction to this calculator states "If we all take a few simple steps to create less greenhouse gases, we can reduce the effects of climate change." First Energy also recognizes the importance of environmental impacts. The First Energy web site states "At FirstEnergy, we are committed to protecting the environment while delivering safe, reliable electricity to six million customers in the Midwest and Mid-Atlantic regions. Using a balanced, long-term approach, we continually look for opportunities to minimize the environmental impact of our operations."

[18] The ENERGY STAR web site (www.energystar.gov) states that "ENERGY STAR qualified clothes washers use about 37% less energy and use over 50% less water than regular washers".

[19] The 2009 ENERGY STAR Annual Report states that "2009 was another banner year for EPA's climate protection partnerships. More than 19,500 organizations across the country have partnered with EPA and achieved outstanding results: (1) Preventing 83 million metric tons (in MMTCE2) of GHGs—equivalent to the emissions from 56 million vehicles (see Figure 4, p. 6)—and net savings to consumers and businesses of about $18 billion in 2009 alone. (2) Preventing more than 1,200 MMTCE of GHGs cumulatively and providing net savings to consumers and businesses of more than $250 billion over the lifetime of their investments." See page 2 of this Annual Report.

3.2 THE PENNSYLVANIA CONTEXT

3.2.1 CONTINUING CUSTOMER GROWTH

The annual kWh sales and electric peak loads for the areas served by the seven Pennsylvania electric distribution companies continues to increase. From 2000 to 2010, the number of residential electric utility customers for these seven electric distribution companies (EDCs) grew at a rate of approximately 0.5% annually.[20] The latest available load forecasts for the seven electric distribution companies as a group indicate that the number of electric consumers in Pennsylvania will continue to increase from 2013 through 2023 (the timeframe for this study) creating further growth in system electricity sales and demand.[21] This report assesses the potential for electric energy efficiency programs to assist Pennsylvania in meeting future electric energy service needs.

3.2.2 ENERGY EFFICIENCY ACTIVITY

Making homes and buildings more energy efficient is seen as a key strategy for addressing energy security, reducing reliance on fossil fuels from other countries, assisting consumers to lower energy bills, and addressing concerns about climate change. Faced with rapidly increasing energy prices, constraints in energy supply and demand, and energy reliability concerns, states are turning to energy efficiency as the most reliable, cost-effective, and quickest resource to deploy.[22] The enactment of Act 129 in 2008 by the Pennsylvania legislature has provided the impetus for the seven EDCs subject to Act 129 to develop and implement cost effective energy efficiency programs.

3.2.3 RECENT ENERGY EFFICIENCY POTENTIAL STUDIES

Table 3-1, below, provides the results from a SWE Team review of recent energy efficiency potential studies conducted throughout the Northeast and US. It is useful to examine the results of these studies to understand if these studies are similar to the latest study for Pennsylvania.

Table 3-1: Results of Recent Energy Efficiency Potential Studies in the Northeast and US

State	Study Year	Author	Study Period	# of Years	Achievable Potential
Connecticut	2009	KEMA	2009-2018	10	20.3%
New Hampshire	2009	GDS	2009-2018	10	20.5%
Rhode Island	2008	KEMA	2009-2018	10	9.0%
Vermont	2011	GDS/Cadmus	2011-2018	10	9.0%
New York	2010	Global Energy Partners	2011-2018	8	9.0%
USA	2009	McKinsey & Company	2011-2020	10	23.0%
Pennsylvania	2012	Statewide Evaluator	2013-2023	10	17.3%

A 2010 report by the American Council for an Energy Efficient Economy (ACEEE) offers information regarding the current savings and spending related to energy efficiency by state.[23] Based on self-reported data, the top states annually spend more than 2% of electric sales revenue on energy efficiency programs.

[20] This is the compound average annual growth rate for residential electric customers for the seven EDCs included in this study.

[21] The Pennsylvania Statewide Evaluation Team (SWE) obtained the latest electric load forecasts directly from the seven Pennsylvania electric distribution companies included in this study.

[22] The December 2008 National Action Plan for Energy Efficiency (NAPEE) "Vision for 2025: A Framework for Change" states that "the long-term aspirational goal for the Action Plan is to achieve all cost-effective energy efficiency by the year 2025. Based on studies, the efficiency resource available may be able to meet 50% or more of the expected load growth over this time frame, similar to meeting 20% of electricity consumption and 10 percent of natural gas consumption. The benefits from achieving this magnitude of energy efficiency nationally can be estimated to be more than $100 billion in lower energy bills in 2025 than would otherwise occur, over $500 billion in net savings, and substantial reductions in greenhouse gas emissions."

[23] American Council for an Energy Efficient Economy, "The 2010 State Energy Efficiency Scorecard", Report #E107, October 2010.

The SWE Team has also examined actual energy efficiency savings data for 2010 from the US Energy Information Administration (EIA) on the top twenty energy efficiency electric utilities. These top twenty utilities saved over 2% of annual kWh sales in 2010 with their energy efficiency programs.

3.3 PURPOSE OF THIS STUDY

This study provides an analysis of the technical, economic, achievable and program potential for electric energy efficiency resources in the service areas of the seven Pennsylvania EDCs included in this study. This study has examined a full array of energy efficiency technologies and building practices that are technically achievable.

3.4 COST-EFFECTIVENESS FINDINGS

Act 129 of 2008 states the following about determining cost effectiveness for subsequent versions of Act 129 programs:

> "By November 30, 2013, and every five years thereafter, the Commission shall evaluate the costs and benefits of the program established under subsection (A) and of approved energy efficiency and conservation plans submitted to the program. The evaluation shall be consistent with a Total Resource Cost test or a cost-benefit analysis determined by the commission. If the Commission determines that the benefits of the program exceed the costs, the Commission shall adopt additional required incremental reductions in consumption."

This study concludes that continuing electric energy efficiency programs in a Phase 2 of Act 129 will continue to be very cost effective for Pennsylvania ratepayers. Table 3-2 and 3-3 show the Total Resource Cost test benefit-cost ratios for the Achievable Potential scenarios #1 and #2 for the three, five, and ten-year implementation periods starting on June 1, 2013. The TRC ratios statewide for Achievable Potential scenario #1 are 1.75, 1.83 and 1.95. The TRC ratios statewide for Achievable Potential scenario #2 are 1.73, 1.85 and 1.97.

Table 3-2: Total Resource Cost Test Benefit-Cost Ratios for Achievable Potential Scenario #1 For 3-Year, 5-Year, and 10-Year Implementation Periods

	TRC Benefits	TRC Costs	TRC Ratio
3-Year Period	$ 4,236,649,800.37	$ 2,415,984,248.08	1.75
5-Year Period	$ 8,349,633,190.47	$ 4,571,820,105.28	1.83
10-Year Period	$ 21,026,641,589.24	$ 10,759,165,841.58	1.95

Table 3-3: Total Resource Cost Test Benefit-Cost Ratios for Achievable Potential Scenario #2 For 3-Year, 5-Year, and 10-Year Implementation Periods

	TRC Benefits	TRC Costs	TRC Ratio
3-Year Period	$ 3,799,475,599.64	$ 2,202,502,753.00	1.73
5-Year Period	$ 4,540,392,369.13	$ 2,450,743,984.66	1.85
10-Year Period	$ 9,455,821,361.87	$ 4,808,941,993.06	1.97

In addition, the Statewide Evaluation Team did calculate a TRC ratio for each energy efficiency measure considered in this study. Only energy efficiency measures that had a TRC ratio greater than or equal to 1.0 were retained in the economic, achievable and program potential savings estimates.

4 CHARACTERIZATION OF SERVICE AREAS OF PENNSYLVANIA EDCS

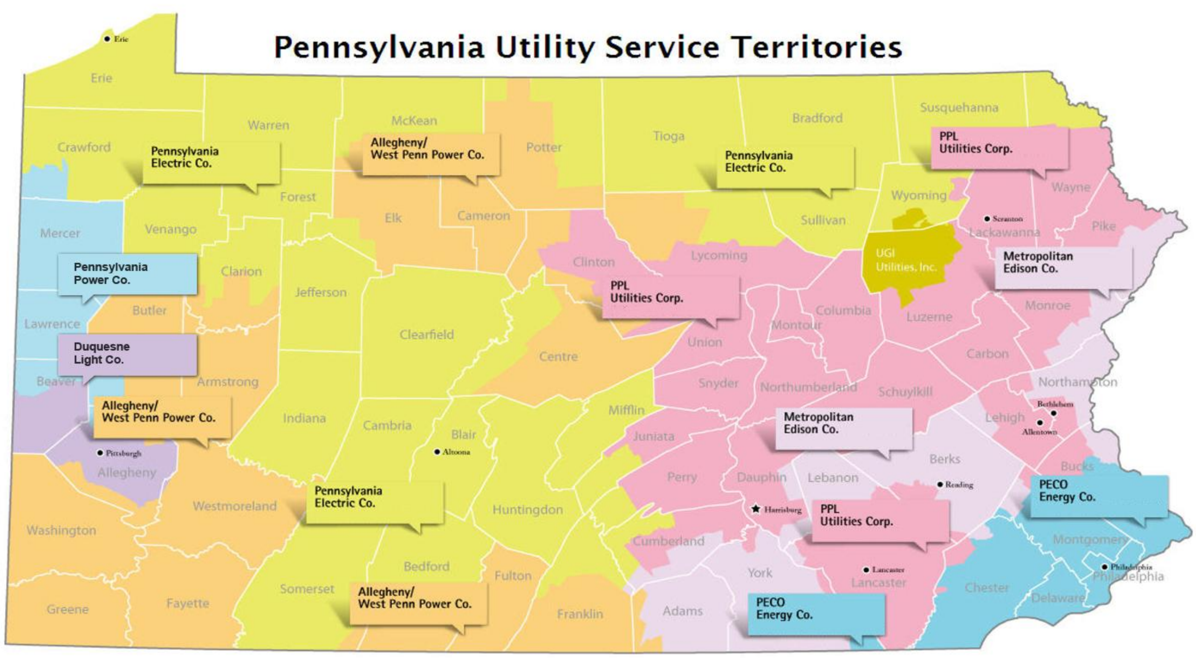
With any potential study it is important to assess and understand the geographic and demographic characteristics of the location being studied. As a result of the Act 129 program in Pennsylvania, a two-part study was initiated to determine: 1) how customers are currently using electricity in their homes and businesses (see Baseline Studies[24]) and 2) the potential for energy savings in the state. The following section provides a brief overview of characteristics specific to Pennsylvania, along with the segmentation findings presented in the C&I Baseline Study.

4.1 EDC AREAS

There are currently eleven electric distribution companies (EDCs) that provide energy to Pennsylvania customers. The focus of this study is on the seven largest EDCs including: Duquesne Light Company, Metropolitan Edison Company, Pennsylvania Electric Company, Pennsylvania Power Company, PPL Electric Utilities Corporation, PECO Energy Company, and West Penn Power Company. Following is a more detailed description of characteristics specific to each EDC.[25]

Figure 4-1 shows the service area for each of the seven EDCs included in this study. Each EDC's territory varies in the size and demographics.

Figure 4-1: Pennsylvania Utility Service Territories



4.1.1 DUQUESNE LIGHT COMPANY

Duquesne Light Company (Duquesne) provides electric service to customers in southwestern Pennsylvania, primarily the city of Pittsburgh and areas of Allegheny and Beaver counties. Duquesne currently serves more than 500,000 electric utility customers.

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[24] The SWE team conducted residential and commercial & industrial base studies in the fall of 2011. See *PA Statewide Residential End Use and Saturation Survey* and the *PA Statewide Commercial and Industrial End Use and Saturation Survey* published in April 2012 for more details.

[25] Reported findings for EDC characteristics in section 4.1 are from the 2010 *Electric Power Outlook for Pennsylvania Report* published by the Pennsylvania Public Utility Commission

4.1.2 FIRSTENERGY CORPORATION

FirstEnergy Corporation is the nation's largest investor-owned electric system providing service to customers in Ohio, Maryland, Pennsylvania, New Jersey, Virginia and West Virginia. FirstEnergy currently serves approximately 6 million customers. There are four subsidiary EDCs serving Pennsylvania customers. These EDCs include the Metropolitan Edison Company, the Pennsylvania Electric Company, the Pennsylvania Power Company and the West Penn Power Company.

4.1.2.1 Metropolitan Edison Company

Metropolitan Edison Company (Met-Ed) provides service to customers in Eastern and South-central Pennsylvania. Met-Ed currently serves 552,594 customers.

4.1.2.2 Pennsylvania Electric Company

Pennsylvania Electric Company (Penelec) provides service to customers located in the Western and Northern parts of Pennsylvania. Penelec currently serves 590,712 electric utility customers.

4.1.2.3 Pennsylvania Power Company

Pennsylvania Power Company (Penn Power) provides service to customers in Western Pennsylvania. Penn Power currently serves 160,116 electric utility customers.

4.1.2.4 West Penn Power Company

West Penn Power Company (West Penn) provides service to customers in Western, North and South Central Pennsylvania. West Penn has approximately 716,115 electric utility customers.

4.1.3 PPL ELECTRIC UTILITIES CORPORATION

PPL Electric Utilities Corporation (PPL) is a subsidiary of PPL Corporation. PPL provides service to electric utility customers in Eastern and Central Pennsylvania. PPL currently serves 1,401,274 customers.

4.1.4 PECO ENERGY COMPANY

PECO Energy Company (PECO), a subsidiary of Exelon Corporation, provides service to customers in the city of Philadelphia as well as Southeastern Pennsylvania. PECO serves 1,566,873 electric utility customers, making it the largest electric utility in Pennsylvania.

4.2 ECONOMIC/DEMOGRAPHIC CHARACTERISTICS

Pennsylvania is the 33rd largest state and is located in the Northeastern and Mid-Atlantic regions of the United States. It is bordered by six states: New York, New Jersey, Delaware, Maryland, West Virginia, and Ohio. The state is 283 miles in length, 170 miles wide, has 51 miles of coastline along Lake Erie and totals 46,055 square miles. It is the 6th most populous state in the US, with a population of approximately 12,702,379.[26]

According to the 2010 Census Bureau, the population density for Pennsylvania is 284 persons per square mile, making it the 9th most densely populated state in the U.S. This population breakdown consists of 5.9% age 5 years and younger, 16.1% age 5-17, and 78.0% age 18 and older. Pennsylvania's population has the 4th highest proportion of people 65 and older in the United States. The estimated number of housing units is 5,518,579 (76.7 percent are single family units) and the total number of households is 4,916,869, of which 3,195,832 are family households.[27]

[26] US Census Bureau, 2010 population estimate for Pennsylvania
[27] Pennsylvania population data obtained from Pennsylvania State Data Center

Table 4-1 summarizes the number of customers by sector in the Pennsylvania areas served by the seven EDCs from 2001 to 2010.

Table 4-1: Number of Customers by Customer Sector[28]

Year	Residential	Non-Residential	Commercial	Industrial
2001	5,021,433	644,204	615,588	28,616
2002	5,048,925	653,077	624,663	28,414
2003	5,082,234	665,610	637,255	28,355
2004	5,121,901	675,131	646,781	28,350
2005	5,154,728	684,043	655,717	28,326
2006	5,190,697	694,035	665,763	28,272
2007	5,207,370	695,276	667,419	27,857
2008	5,231,696	703,877	676,337	27,540
2009	5,235,331	706,627	679,215	27,412
2010	5,244,278	706,067	678,774	27,293

4.3 COMMERCIAL AND INDUSTRIAL SECTOR BASELINE SEGMENTATION FINDINGS

An important first step in calculating C&I energy efficiency potential estimates is to establish baseline energy usage characteristics and disaggregate the market by sector, segment and end use. This section summarizes the segmentation findings from the Pennsylvania C&I Baseline Study. For a full list of baseline findings, the reader should reference the *Pennsylvania Statewide Commercial and Industrial End Use and Saturation* Study, submitted by Nexant, GDS Associates and Mondre Energy in April 2012.

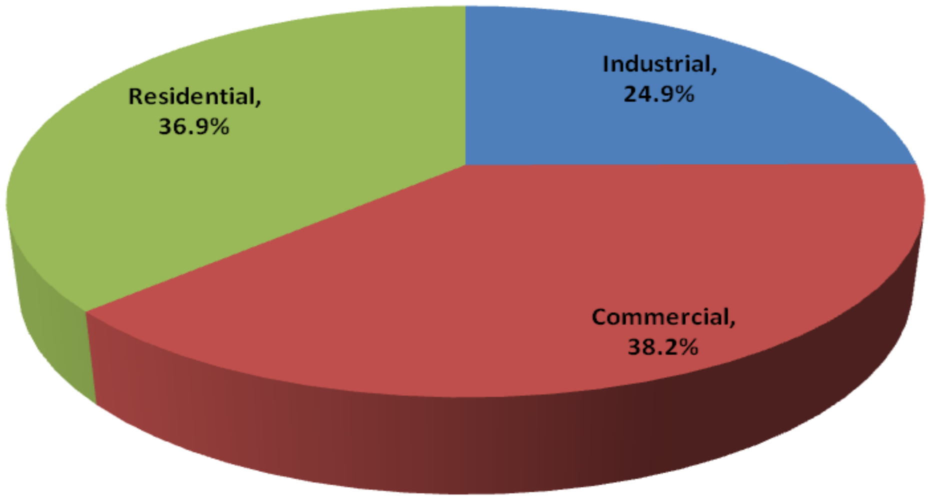
Because our research presents findings on building premises, findings presented below do not include transmission, substation, irrigation or lighting rate classes. Through analysis of EDC customer billing data, on-site surveys, and secondary research, Nexant was able to break out the commercial energy usage by sector, commercial segment and end use. The SWE Team utilized the findings from its own Baseline Studies for inputs into this market potential study, as opposed to what was presented in the Commission's Electric Power Outlook Report.

4.3.1 2010 ELECTRICITY SALES BY SECTOR, BY EDC

Figure 4-2, Table 4-2, and Table 4-3 show the overview of the electric sales and premises by sector for each EDC in Pennsylvania for calendar year 2010.[29] The commercial sector is the largest sector with 38.2% of electricity sales, followed by residential and industrial. PECO is the largest EDC in terms of sales and premises.

[28] EIA (US Energy Information Administration)
[29] PECO figures are for June 2009 to May 2010

Figure 4-2: 2010 Electricity Sales by Sector



Source: "Commercial and Industrial End Use & Saturation Report" performed by Nexant, 2012

Table 4-2: 2010 MWh Sales Breakdown by EDC, and by Sector

EDC	Industrial	Commercial	Residential	Total
Duquesne Light	2,908,498	7,314,744	4,326,339	14,549,581
MetEd	4,148,279	3,771,988	5,666,240	13,586,507
Penelec	5,011,243	4,064,187	4,655,812	13,731,243
Penn Power	1,623,329	1,068,515	1,696,442	4,388,286
PPL	9,618,254	12,041,062	14,205,788	35,865,104
PECO	4,059,704	19,271,928	12,880,403	36,212,035
West Penn Power	6,979,686	5,168,517	7,407,912	19,556,115
Statewide	***34,348,993***	***52,700,941***	***50,838,937***	***137,888,871***

Source: "Commercial and Industrial End Use & Saturation Report" performed by Nexant, 2012
Note: PECO residential customer and sales figures are June 2009 to May 2010

Table 4-3: 2010 Premise[30] Counts by EDC and by Sector

EDC	Industrial	Commercial	Residential	Total
Duquesne Light	1,224	40,348	524,406	565,978
MetEd	6,034	35,780	485,969	527,783
Penelec	7,759	47,321	505,344	560,424
Penn Power	1,964	12,527	140,101	154,592
PPL	10,905	92,112	1,224,602	1,327,619
PECO	7,688	93,873	1,400,000	1,501,561
West Penn Power	6,183	54,024	619,584	679,791
Statewide	***41,756***	***375,986***	***4,900,006***	***5,317,748***

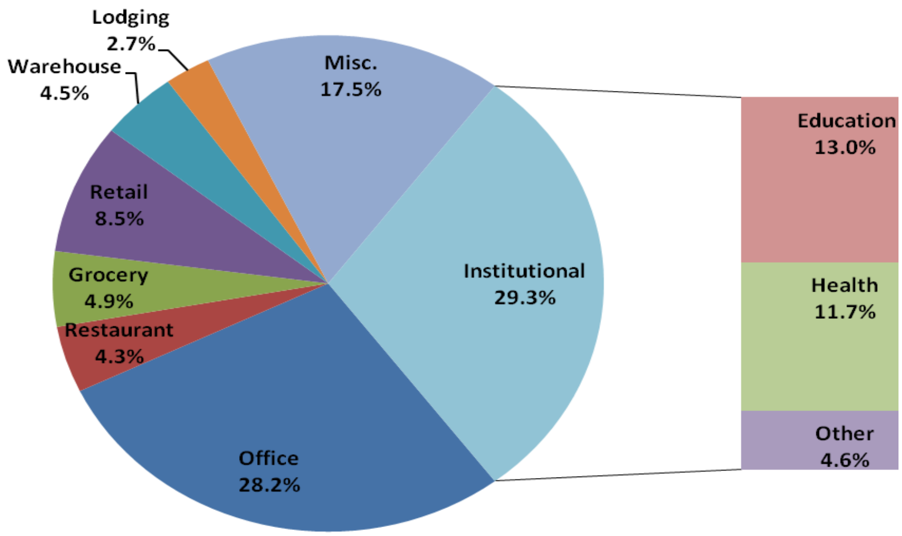
Source: "Commercial and Industrial End Use & Saturation Report" performed by Nexant, 2012
Note: PECO residential customer and sales figures are June 2009 to May 2010

[30] Note: SWE utilized the definition of premise for its study which removes non-building customer accounts such as traffic signals, fire pumps and other miscellaneous loads from its findings. The number of premises, therefore, is less than the number of accounts, or customers, the EDCs serve.

4.3.2 ELECTRICITY CONSUMPTION BY SEGMENT

Figure 4-3 and Table 4-4 show the breakdown of energy consumption and building stock by commercial segment. Figure 4-4 and Table 4-5 show the same breakdown by industrial segment. The institutional segment consumes the largest share of electricity (29.3%) across the state in the commercial sector, followed by the office segment (28.2%). Metal manufacturing facilities consume the largest share of electricity in the industrial sector (29.2%) with a number of steel manufacturers located throughout the state. Other manufacturing (composed of varying manufacturing types such as apparel, furniture, leather, lumber, textile, tobacco, and misc.) comprise 23.9% of the load in the industrial sector.

Figure 4-3: Commercial Energy Consumption by Segment



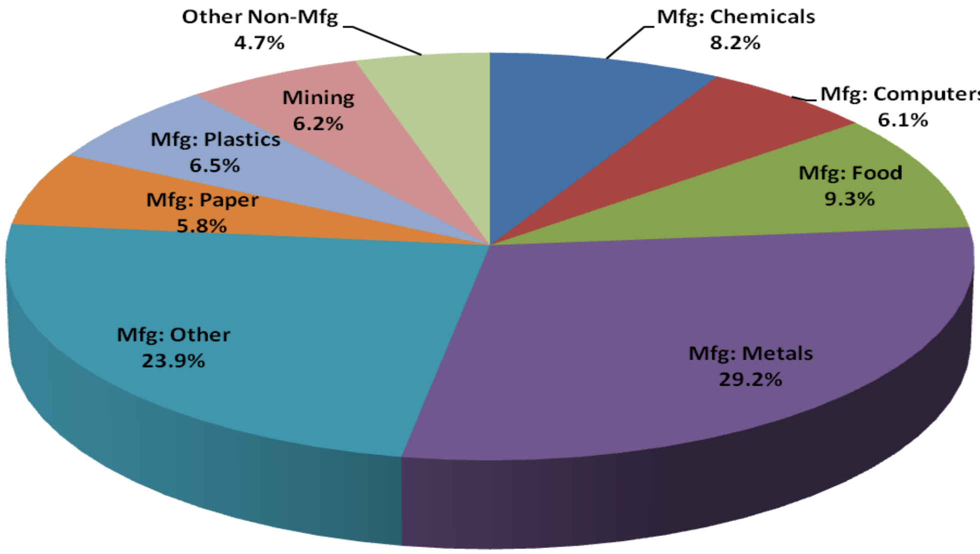
Source: Commercial and Insustrial End-Use & Saturation Report, performed by Nexant, 2012

Table 4-4: Commercial Energy Consumption by Segment

Segment	Consumption (MWh)	Electricity Share
Institutional	15,460,540	29%
Education	6,858,876	13%
Health	6,166,279	12%
Other	2,435,385	5%
Office	14,859,623	28%
Restaurant	2,284,546	4%
Retail	7,050,787	13%
Grocery	2,577,430	5%
Retail	4,473,357	9%
Warehouse	2,390,718	5%
Misc.	10,654,727	20%
Lodging	1,418,697	3%
Other	9,236,030	18%
Total Commercial	***52,700,941***	***100%***

Source: "Commercial and Industrial End Use & Saturation Report" performed by Nexant, 2012

Figure 4-4: Industrial Energy Consumption by Segment



Source: Commercial and Insutrial End-Use & Saturation Report, performed by Nexant , 2012

Table 4-5: Industrial Energy Consumption by Segment

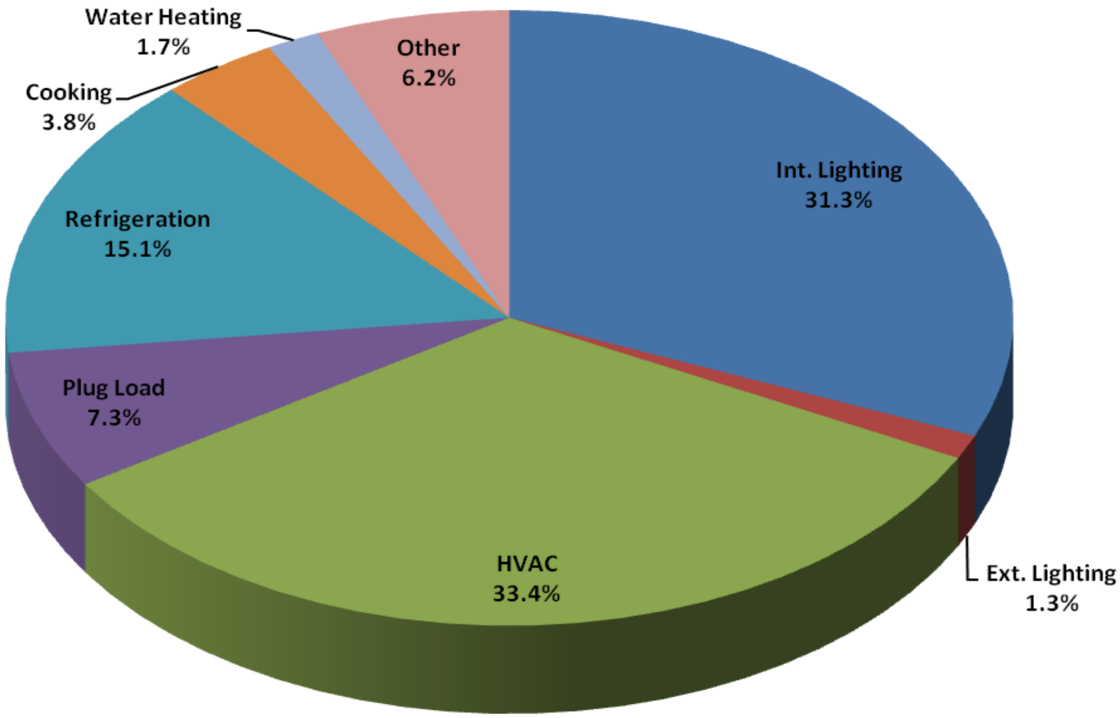
Segment	Consumption (MWh)	Electricity Share
Mfg: Chemicals	2,814,937	8.2%
Mfg: Computers	2,094,323	6.1%
Mfg: Food	3,185,786	9.3%
Mfg: Metals	10,030,211	29.2%
Mfg: Other	8,209,110	23.9%
Mfg: Paper	2,008,114	5.8%
Mfg: Plastics	2,242,259	6.5%
Mining	2,135,127	6.2%
Other Non-Mfg.	1,629,127	4.7%
Total Industrial	***34,348,993***	***100.0%***

Source: "Commercial and Industrial End Use & Saturation Report" performed by Nexant, 2012

4.3.3 ELECTRICITY CONSUMPTION BY END-USE

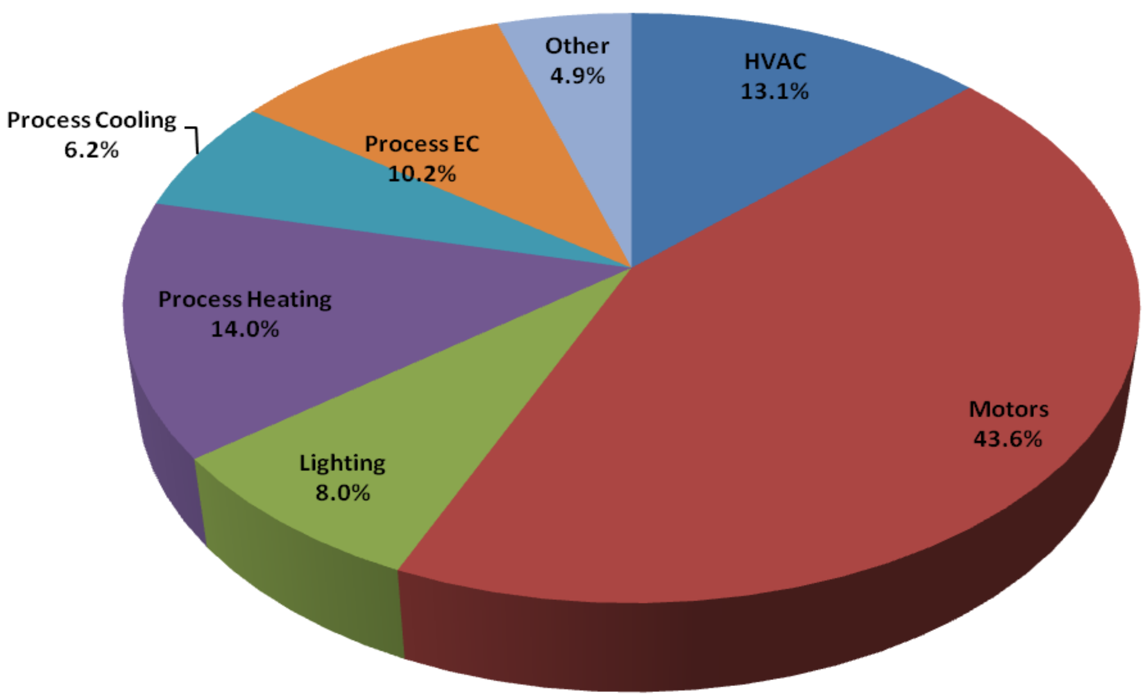
Figure 4-5 and Figure 4-6 show how electricity is consumed by end use in the commercial and industrial sectors. HVAC uses the largest share of electricity at 33.4% in commercial buildings, followed by interior lighting (31.3%) and refrigeration (15.1%). The "Other" end use represents primarily pumps and other miscellaneous loads in buildings. In the industrial sector, motors consume almost half (43.6%) of all the electricity across the state. Process loads (heating, cooling and electro-chemical) make up another 30% of the electricity consumption.

Figure 4-5: Commercial Energy Consumption by End Use



Source: Commercial and Industrial End-Use & Saturation Report, perfomed by Nexant, 2012

Figure 4-6: Industrial Energy Consumption by End Use

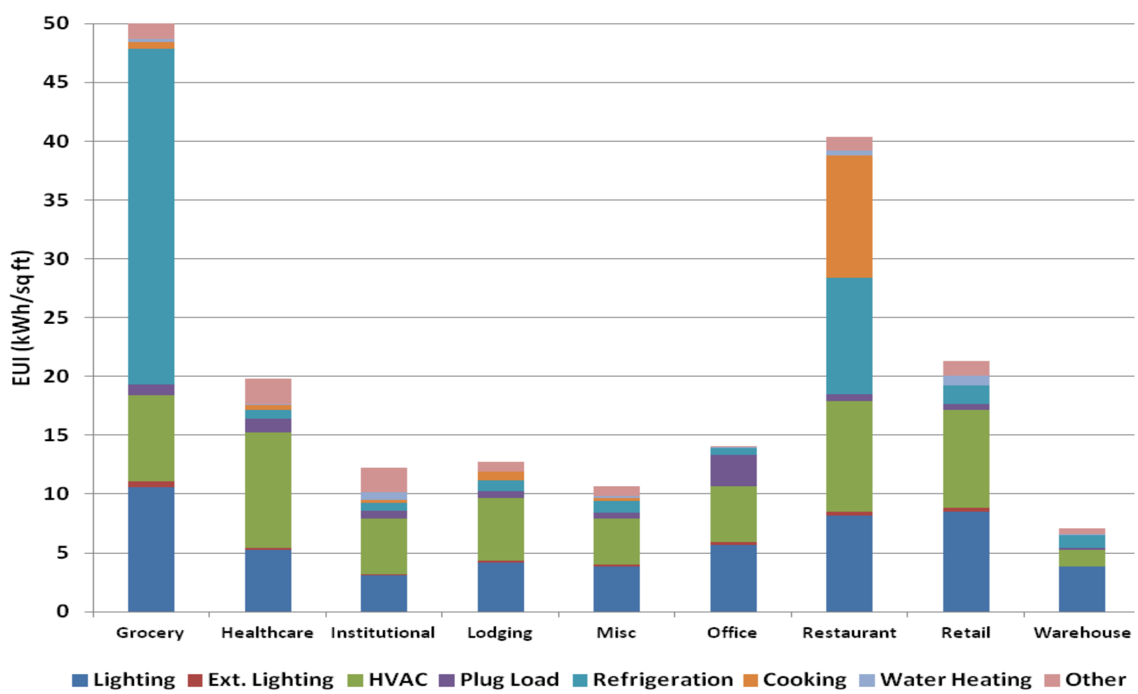


Source: Commercial and Industrial End-Use & Saturation Report, perfomed by Nexant, 2012

4.3.4 ENERGY USE INTENSITY BY END USE, BY COMMERCIAL SEGMENT

Energy use intensity (EUI) is a useful metric to measure how much electricity is consumed per square foot of building space and provides insight into how different building types and end uses consume electricity. The SWE calculated the EUI for each end use at the statewide level. Adjusted EUIs were calculated for each EDC based on differences in space cooling. To come up with EUIs by segment and end use, a variety of data points were utilized. Customer sales data for 2010 (kWh) was paired with the square footages of the buildings surveyed by SWE engineers to come up with average EUIs by segment. End use EUIs were calibrated using a combination of national data, on-site data and with the modeling program eQuest. Figure 4-7 and Table 4-6 below summarize the findings for EUIs for each commercial segment and relevant end use. The grocery segment is the most energy-intensive at 50.1 kWh/ft², due to the large amounts of electricity used to refrigerate foods. Warehouse is the least energy-intensive segment using only 7.1 kWh/ft². HVAC is the most energy-intensive end use consuming an average of 5.7 kWh/ft² across all the segments, followed by lighting which has the highest EUIs in the grocery, retail and restaurant segments.

Figure 4-7: Commercial Energy Use Intensities by Segment



Source: Commercial and Industrial End-Use & Saturation Report, performed by Nexant, 2012

Table 4-6: Commercial Energy Use Intensities by Segment

End Use	Grocery	Healthcare	Institutional	Lodging	Misc.	Office	Restaurant	Retail	Warehouse	Weighted Avg.
Lighting	10.6	5.2	3.1	4.1	3.9	5.7	8.2	8.5	3.8	5.3
Ext. Lighting	0.4	0.2	0.1	0.2	0.2	0.2	0.3	0.4	0.0	0.2
HVAC	7.3	9.8	4.7	5.4	3.9	4.8	9.4	8.3	1.4	5.7
Plug Load	0.9	1.2	0.6	0.5	0.5	2.6	0.6	0.6	0.2	1.2
Refrigeration	28.6	0.7	0.7	0.9	0.9	0.6	9.9	1.5	1.0	2.6
Cooking	0.6	0.4	0.2	0.7	0.3	0.0	10.4	0.0	0.0	0.6
Water Heating	0.2	0.1	0.7	0.0	0.1	0.1	0.4	0.9	0.1	0.3
Other	1.4	2.2	2.0	0.8	0.9	0.1	1.2	1.2	0.6	1.1
Total	**50.1**	**19.8**	**12.2**	**12.7**	**10.7**	**14.0**	**40.4**	**21.3**	**7.1**	**17.0**

Source: "Commercial and Industrial End Use & Saturation Report" performed by Nexant, 2012

4.4 EDC LOAD FORECASTS

Forecasts for total MWh sales in Pennsylvania show a slow growth over the next ten years across all seven EDCs. Table 4-7, below, provides the total projected sales for the seven EDCs included in the study. Sales for the residential sector are forecast to increase at the fastest rate of growth.

Table 4-7: Statewide Sales Forecasts by Sector[31]

Year	Residential (MWh)	Non-Residential (MWh)	Commercial (MWh)	Industrial (MWh)
2012	50,460,301	91,050,329	54,522,737	36,527,592
2013	50,775,309	91,736,200	54,821,297	36,914,902
2014	51,486,411	92,303,164	55,115,274	37,187,890
2015	52,153,427	93,385,380	55,801,767	37,583,613
2016	52,888,710	94,369,561	56,418,135	37,951,426
2017	53,222,501	94,768,150	56,562,383	38,205,767
2018	53,753,081	95,275,882	56,786,296	38,489,586
2019	54,279,753	95,783,209	57,011,327	38,771,882
2020	54,825,855	96,384,486	57,308,148	39,076,338
2021	55,209,850	96,788,849	57,457,577	39,331,272
2022	55,946,661	97,304,613	57,688,542	39,616,071
Avg. Annual Compound Growth Rate (2012 to 2022)	1.0%	0.7%	0.6%	0.8%

4.5 CURRENT PENNSYLVANIA EDC ENERGY EFFICIENCY PROGRAMS

The current iteration of Pennsylvania Act 129 promotes a variety of energy efficiency programs within each EDC. The exact programs vary between the specific EDCs, but cover a general range of program types. The existing programs promote energy efficiency education, energy efficiency audits and the installation of energy efficient equipment across all of the EDCs. This next section summarizes the costs and savings of the programs implemented by the EDCs in Phase 1 of Act 129.

4.5.1 CURRENT ENERGY EFFICIENCY PROGRAM COST AND SAVINGS DATA

In order to properly assess the potential of energy efficiency programs moving forward, an analysis was done of current program energy savings and costs. These cost numbers were used as inputs to the potential models to properly assess the cost of implementing energy efficiency programs[32]. Cost and savings data was taken from the program year two reports that each participating EDC was required to submit to the Pennsylvania Public Utility Commission (PUC). These reports detail program performance through year two (June 2010 - May 2011). All data used represents current program inception to date (CPITD) data, the total expenditure by each EDC, and the verified energy savings through program year two for energy efficiency programs only.

Because the focus of this study was on energy efficiency potential only, demand management programs and other programs not involving energy efficiency were excluded from this analysis of portfolio costs. Only the costs for the applicable energy efficiency programs were captured when rolling up incentive

[31] This data is a roll up of individual EDC forecasts for calendar year energy sales through 2022 provided by the EDCs.

[32] Adjustment factors of 25% were made to the CPITD cost data presented below for the final incentive and administrative cost inputs into the potential models to account for uncertainty about future costs.

and non-incentive costs. Table 4-8 shows the programs for each EDC that were not included in the cost analysis.

Table 4-8: Demand Management or Other Programs Not Included in Cost Analysis

<table>
<tr><th>EDC</th><th colspan="2">Program Name(s)</th></tr>
<tr><td>PPL</td><td colspan="2">Renewable Energy Program</td></tr>
<tr><td>Duquesne</td><td colspan="2">None</td></tr>
<tr><td rowspan="4">West Penn</td><td>Customer Resources DR Program</td><td>Time of Use with Critical Peak Pricing Rate</td></tr>
<tr><td>Hourly Pricing Option Rate</td><td>Distributed Generation Program</td></tr>
<tr><td>Residential Efficiency Rewards Rate</td><td rowspan="2">Pay Ahead Service Rate</td></tr>
<tr><td>Customer Load Response Program</td></tr>
<tr><td>Met-Ed, Penelec, Penn Power</td><td>Demand Reduction</td><td>PJM Demand Response</td></tr>
<tr><td rowspan="2">PECO</td><td>CVR Program</td><td rowspan="2">Residential DLC Program</td></tr>
<tr><td>Commercial DLC Program</td></tr>
</table>

Table 4-9 shows the incentive costs paid to customers, the non-incentive costs, and the costs paid by program participants for the Act 129 programs through year two. The total incentive costs for the programs were $129,681,162 through year two. Non-incentive costs totaled $113,383,586 while participant costs totaled $386,941,909.

Table 4-9: CPITD Cost Data for Energy Efficiency Portfolios[33]

	Incentive Costs ($)	Non-Incentive Costs ($)	Participant Costs ($)
Statewide Residential	$ 60,876,900	$78,063,381	$135,754,844
Statewide Non-Residential	$ 68,804,262	$35,320,205	$251,187,065
Statewide Total	**$129,681,162**	**$113,383,586**	**$386,941,909**

Table 4-10 shows the verified energy savings for each EDC and the percentage of annual sales that those savings represent through the end of program year two. The total verified savings across all sectors totaled 1.7 million MWh or 1.2% of the 2009/2010 sales forecast of 146,661,800 MWh.

Table 4-10: PY2 CPITD Verified Savings for Energy Efficiency Programs by EDC[34]

EDC	Verified Energy Savings (MWh)			% of 2009/2010 Forecast		
	Residential	Non-Residential	Total	Residential	Non-Residential	Total
Duquesne	65,686	101,711	167,397	1.57%	1.03%	1.19%
Met-Ed	97,299	86,713	184,012	1.57%	1.00%	1.24%
PECO	424,483	128,337	552,820	3.03%	0.51%	1.40%
Penelec	93,325	91,534	184,859	1.91%	0.96%	1.28%
Penn Power	34,902	32,263	67,165	1.89%	1.10%	1.41%
PPL	272,631	222,153	494,784	1.80%	0.96%	1.29%
West Penn	63,481	29,364	92,845	0.80%	0.23%	0.44%

[33] All data comes from the program year 2 reports provided by the individual EDCs. Data represents the current program inception to date costs for the applicable programs through May 2011.

[34] Sales data is the 2009/2010 forecast that was used to set EDC savings targets. Forecasted 2009/2010 kWh sales were used to allow the same baseline to establish compliance targets on a cumulative basis from Phase 1 to Phase 2, which also allows adding kWh savings from Phase 1 to Phase 2. Energy savings data is taken from the PY2 final reports submitted by each EDC.

EDC	Verified Energy Savings (MWh)			% of 2009/2010 Forecast		
	Residential	Non-Residential	Total	Residential	Non-Residential	Total
Statewide	1,051,808	692,075	1,743,883	1.95%	0.75%	1.19%

Table 4-11 shows the incremental costs of energy efficiency measures per first-year saved MWh across the state through the end of program year two. The measure incremental costs were used to screen cost effective measures as inputs into the potential model. The residential sector generally has higher non-incentive costs than the non-residential sector, but lower incentive costs. In order to generate a statewide, non-incentive, incremental cost, the verified savings and costs were averaged over the portfolio. The weighted average portfolio non-incentive utility cost for all seven EDCs was calculated to be $65.02 per MWh[35].

Table 4-11: Statewide Acquisition Costs[36]

	Incremental Non-Incentive Costs ($/MWh)		Incremental Incentive Costs ($/MWh)	
	Residential	Non-Residential	Residential	Non-Residential
Statewide	*$74.22*	*$51.04*	*$57.88*	*$99.42*
	Average Portfolio Non-Incentive Cost = $65.02/MWh		*Average Portfolio Incentive Cost = $74.36/MWh*	

Another critical input into the potential model was the relationship between the incentive costs paid by the EDCs and the participant costs paid by customers[37]. This value determines the total incentive costs for the EDCs which affects the total potential savings. Table 4-12 shows the incentive costs as a percentage of participant costs statewide. For the non-residential sector, EDCs incentivized 27.9% of participant costs across the state. For the residential sector, the EDCs incentivized 44.8% of participant costs statewide.

Table 4-12: Incentive Costs as a Percentage of Participant Costs[38]

Statewide Incentive Level (%)	
Residential	**Non-Residential**
44.8%	27.9%

4.5.2 CURRENT DUQUESNE LIGHTING COMPANY EFFICIENCY PROGRAMS

Duquesne Lighting Company (Duquesne) offers several energy efficiency programs for both the residential and non-residential markets.

4.5.2.1 Residential Programs

Residential Energy Efficiency Rebate Program (REEP)

[35] This value was calculated by dividing the non-incentive cost (Costs incurred by the utility that do not include incentives paid to the customer) by the MWh savings for years one and two.
[36] All data comes from the program year 2 reports provided by the individual EDCs. Data represents the current program inception to date costs for the applicable programs through May 2011.
[37] This study assumes that the main programmatic strategy is replace on burnout. Therefore the majority of measure costs refer to incremental costs for the higher efficiency equipment.
[38] All data comes from the program year 2 reports provided by the individual EDCs. Data represents the current program inception to date costs for the applicable programs through May 2011.

Duquesne offers customers an energy efficiency rebate program that aims to encourage them to choose energy efficient options when purchasing household appliances or other equipment. This goal is accomplished through a combination of educational materials and rebates that are provided to customers in conjunction with an online survey. This program also contains an upstream lighting component focused on promoting compact fluorescent lamps at the retail level. This is accomplished through point of purchase discounts for customers and incentives for the participating retail stores. The direct approach is designed to increase participation versus a traditional rebate form.

School Energy Pledge

The School Energy Pledge (SEP) program focuses on teaching students about energy efficiency with the aim of transferring that knowledge to the home. Students receive pledge forms for their families to implement the energy efficient measures that they have learned about through the program. In return for a family's commitment to install energy efficiency measures, the school receives a $25 incentive through the SEP program.

Residential Appliance Recycling Program

The Residential Appliance Recycling Program (RARP) aims to remove working, inefficient refrigerators and freezers from use in an environmentally safe manner. RARP offers $35 incentives to customers to recycle their old appliances through the program instead of simply throwing them away.

4.5.2.2 Low Income Residential Programs

Low Income Energy Efficiency Program

The Low-Income Energy Efficiency Program (LIEEP) assists low-income households to conserve energy and reduce energy costs to the household. The program works in conjunction with REEP and RARP to deliver savings to low-income households. In Q4 of 2010, a portion of the REEP upstream lighting program will be allocated to the low-income sector.

4.5.2.3 Commercial Programs

Duquesne's commercial programs include one commercial umbrella program and five market segment programs. The five market segment programs are designed to fit the specific needs of the markets that they are serving. The five market segments being served are: Small Office, Large Office, Public Agency, Retail, and Healthcare. The umbrella program is designed to fit the needs of customers not directly served by one of the specific market programs.

Each program aims to help commercial customers identify energy efficiency savings potential, and, in some cases implement energy efficiency measures. Approved organizations work with Duquesne's commercial customers to assess energy savings potential, project cost and energy savings, and when appropriate install the chosen measures.

4.5.2.4 Industrial Programs

Duquesne's industrial programs include one industrial umbrella program and three market segment programs. The three market segments that are addressed by Duquesne are Primary Metals, Chemical Products and Mixed Industrials. The industrial umbrella program offers specialized programs focused on technologies or other market segments that are not included in the existing market segment programs.

All of the existing industrial programs are designed to offer customers a comprehensive approach to energy savings and demand reduction. Each of the individual programs provides customers with services ranging from assessments and audits to access to rebates or incentives.

4.5.3 CURRENT FIRSTENERGY EFFICIENCY PROGRAMS – EXCLUDING WEST PENN POWER

Through project year 2 of the Act 129 energy efficiency projects, FirstEnergy offered the same programs through three of their four EDCs (Met-Ed, Penelec, Penn Power). These programs will be referred to as FirstEnergy Programs. West Penn, though a FirstEnergy EDC, offered unique programs through program year two of the Act 129 period and will be discussed separately.

4.5.3.1 Residential Programs

Residential Home Energy Audit Program

FirstEnergy EDCs offer their customers a two stage home audit program designed to help them save energy. The first part of the program involves a self-administered on-line audit looking at a customer's historical energy use. Depending on how the customer responds to certain questions, the survey will provide them with a basic calculation of potential energy savings. The second part of the program is an actual on-site audit by a professional auditor. Auditors will assess energy savings potential, and install low-cost energy savings measures when appropriate. The aim of this program is to identify and install basic energy efficiency measures, and educate customers about other programs being offered.

Residential Appliance Turn-In Program

With this program, customers have the opportunity to turn in old, inefficient, large appliances and receive a cash incentive from the EDC. The program covers the disposal of up to two refrigerators or freezers in a calendar year. The appliances must be in working condition to help meet the programs goals of removing outdated, inefficient appliances from service.

Residential Energy Efficiency HVAC Program

The Residential Energy Efficiency HVAC Program is designed to encourage the installation of ENERGYSTAR® compliant equipment into both existing residential buildings and new construction. Incentives are provided both directly to customers who replace existing HVAC equipment with ENERGYSTAR® systems, and to contractors who promote ENERGYSTAR® compliant systems to their customers at the time of replacement. Through this program, incentives are also available to customers for maintenance on existing equipment, including additional incentives to replace existing HVAC fans with ENERGYSTAR® compliant replacements.

Residential Energy Efficient Products Program

The Residential Energy Efficient Products Program aims to support the adoption of ENERGYSTAR® compliant equipment through customer incentives, and support to retailers selling the equipment. Retailers are involved through promotional support, point-of-sale materials, training materials and assistance with distribution channels for ENERGYSTAR® products. The FirstEnergy EDCs in some cases also provide incentives to retailers, distributors and manufacturers to help drive down the cost of ENERGYSTAR® products at the retail level.

Residential New Construction Program

The Residential New Construction Program provides incentives to builders to build new homes that comply with either ENERGYSTAR® Homes status or the Home Energy Rating System Program. The program incentivizes participants based on the homes construction cost with the ENERGYSTAR® compliant equipment, relative to the cost of building using standard construction practices. The goal is to incentivize the implementation of ENERGYSTAR® or other high efficiency equipment in the areas of building shell, appliances and other energy consuming features of buildings.

Residential Whole Building Comprehensive

The Residential Whole Building Comprehensive program provides customers with direct incentives for participating in diagnostic assessments of their households followed by the installation of selected low-cost energy efficiency measures. Customers are incentivized up to $300 for participating in the two part audit process, and up to $900 in performance based incentives for installing energy saving equipment as a result of the audits.

Residential Multi-Family Program

The Residential Multi-Family Program targets larger, multi-family buildings and attempts to capture energy savings in common lighting areas such as hallways, laundry facilities, exterior lighting and exit signs. The program leverages audits being performed by the Pennsylvania Housing Finance Agency (PHFA) and markets the benefits of the program to participants in the PHFA audits. The program provides energy saving measures for these common areas to owners or property managers based on the findings of the PHFA audits. Tenants of these buildings are also targeted through the distribution of energy conservation kits at no cost to the tenant.

4.5.3.2 Low-Income Residential Programs

Residential Low-Income Program (WARM Programs)

The WARM programs are designed to provide low-income customers with energy savings measures and services. As part of the Act 129 programs the EDCs are offering additional programs that expand upon the existing Low-Income Usage Reduction Program. The WARM Extra Measures Program provides customers with an average of 4 CFL's, LED nightlights and smart power strips. The WARM Plus Program acts to expand the reach of the existing WARM program, supporting a 25% increase in the number of eligible homes for WARM treatments. The Low-Income, Low-Use program is for customers who qualify for the income requirements of WARM, but fall below the minimum annual usage level of 600 kWh/month. Through this program these customers are given CFLs, faucet aerators, LED nightlights, a furnace whistle and materials discussing energy efficiency.

4.5.3.3 Small Commercial and Industrial Programs

Energy Audit, Assessment and Equipment Rebate

Through this program, EDCs provide information to customers about energy efficiency measures, as well as with a list of auditors who can provide detailed audits of energy savings potential. Also through this program, EDCs fund all CFL installations for customers that fall into the Small Commercial and Industrial class. There are also opportunities for customers to receive rebates on other energy efficiency equipment through existing equipment programs covering lighting, HVAC, motors and drives and other specialty equipment.

4.5.3.4 Large Commercial and Industrial Programs

Commercial/Industrial Performance Contracting/Equipment Program

Through this program, customers have the opportunity to hire an Energy Services Company (ESCO) to help them identify opportunities for energy efficiency savings and then install the energy saving equipment. The EDCs provide customers with a qualified list of ESCOs that participate in the program. The savings generated through this program are put back into the program as payment for the ESCO.

Commercial and Industrial Motors and Variable Speed Drives Program

The aim of this program is to incentivize customers to replace existing motors with more efficient NEMA Premium® motors and variable speed drive (VSD) systems. The program is targeted towards customers with a large amount of operating hours and high variability in motor loads. The program sets a minimum operating hour requirement of 3,000 hours per year and offers cash rebates to customers who meet this requirement and upgrade their equipment. The amount of the incentive is based on the size of motor being replaced and starts at $20 for a 1 HP motor. The incentive for the VSD systems is $30 per motor horsepower controlled. All rebates are available on a first come first served basis and are limited to the program budget.

4.5.3.5 Government and Non-Profit Programs

Governmental/Non-Profit Street Lighting Program

The Governmental/Non-Profit Street Lighting Program helps to offset the upfront costs of converting existing street lighting equipment to high pressure sodium units. Incentives are offered to municipalities for these conversions regardless of ownership of the lights. The program also offers the option to upgrade other outdoor lighting and convert other traffic/pedestrian signals to LED units.

Governmental/Non-Profit Program

The Governmental/Non-Profit program is designed to target the small number of customers who fall under non-profit rates. Through this program these customers are eligible for all of the incentive programs that exist for the small or large commercial and industrial classes. There is also an additional opt-in CFL kit offering, providing CFL kits to customers at no cost.

Governmental/Remaining Non-Profit Programs

This program is designed to increase the speed in which governmental buildings and schools adopt energy efficiency measures. Customers are provided with energy audits worth up to $2,000 to help them identify areas of energy efficiency savings potential. There is also a CFL opt-in option with this program which provides CFL kits to these customers free of charge.

4.5.4 CURRENT WEST PENN POWER ENERGY EFFICIENCY PROGRAMS

4.5.4.1 Residential Programs

Compact Fluorescent Lighting Rewards Program

The Compact Fluorescent Lighting Rewards Program is designed to encourage customers to purchase CFL bulbs instead of incandescent bulbs. This is accomplished through both mail-in and retailer point-of-sale rebates for customers to help offset the cost of CFLs. West Penn has also partnered with CFL manufacturers and negotiated buy downs to reduce the cost to customers in the retail stores.

Residential ENERGYSTAR® and High Efficiency Appliance Program

This program is designed to help customers overcome the initial cost barrier of installing ENERGYSTAR® qualifying appliances. The program offers customer rebates that are in most cases equal to approximately 50% of the incremental cost of the appliance for the purchase of new equipment. Rebates are distributed by mail for laundry equipment, dishwashers, refrigerators, freezers, programmable thermostats, and room air conditioners. There are also appliance turn-in rebates available through this program for qualifying refrigerators, freezers and air conditioners.

Residential Home Performance Program

The Residential Home Performance Program is designed to educate customers about opportunities for energy efficiency in their homes. Through this program, customers have the choice of two audit types, one in home and one on-line, to help them identify energy efficiency opportunities. Customers will receive additional incentives to install the measures identified in the audits. Through various parts of the program, customers will also receive information regarding energy efficiency and conservation and are eligible to receive eight CFLs as part of the program.

Residential Whole Home Appliance Efficiency Program

The Residential Whole Home Appliance Efficiency Program encourages the purchase of high efficiency central air conditioners or heat pumps. Incentives are offered to customers to help offset the upfront costs of installation based on the efficiency of the system purchased. To qualify for the program, the system being purchased must exceed the federal energy efficiency standard SEER of 13, be controlled by a programmable thermostat and be installed by a certified contractor.

4.5.4.2 Low-Income Residential Programs

Residential Low Income Home Performance Check-Up Audit & Appliance Replacement Program

This program is designed to ease the entry of energy efficient measures into low-income homes. The program consists of an in-home energy audit and installation of standard low cost measures. All participants in the program receive 6 CFLs free of charge as well as information on energy efficiency. For appropriate customers, installed measures also include faucet aerators and low flow shower heads. Depending on the age and operational effectiveness, a customer's refrigerator or room air conditioning unit may be eligible for replacement with an ENERGYSTAR® qualifying unit.

Residential Low Income Joint Utility Usage Management Program

This program is similar in design to the Residential Low Income Home Performance Check-Up Audit & Appliance Replacement Program. The process and incentives are very similar but for this program, West Penn partners with customers gas utilities to offer the most efficient solutions using both fuel types.

4.5.4.3 Small Commercial and Industrial Programs

Commercial HVAC Efficiency Program

The commercial HVAC Efficiency Program offers customers a $25 rebate per unit incentive towards annual maintenance on existing HVAC equipment.

Commercial Products Efficiency Program

The Commercial Products Efficiency Program offers rebates to customers to upgrade to state-of-the-art energy efficiency lighting technologies. The program covers a wide range of lighting technologies including CFLs, power strips, exit signs and occupancy sensors.

Custom Technology Applications Program

The Custom Technology Applications program is focused on incentivizing customers with specific system needs to update their equipment with more energy efficient options. The program focuses on a wide variety of technology areas including lighting, compressed air, chillers, motors and VSDs, energy management systems, fan and pump systems, renewable energy and combined heat systems that are not previously covered by existing programs. Incentives are available up to 25% of capital costs, and up to $100,000 of project costs to realize the savings.

4.5.4.4 Large Commercial and Industrial Programs

Custom Applications Program

The Custom Applications Program focuses on providing incentives for customers with very specialized processes or applications. Similar to the Custom Technology Applications program, the focus is on lighting, compressed air, chillers, motors and VSDs, energy management systems, fan and pump systems, renewable energy and combined heat systems that are not previously covered by existing programs. Incentives are available up to 50% of capital costs, and up to $500,000 of project costs to realize the savings, awarded on a review of the kWh saved per projects cost.

4.5.4.5 Government and Non-Profit Programs

Both the Custom Technology Applications Program and the Custom Applications Program are available to government and non-profit customers for this EDC.

4.5.5 CURRENT PPL ENERGY EFFICIENCY PROGRAMS

4.5.5.1 Residential Programs

Appliance Recycling Program

This program is designed to prevent the continued operation of older, inefficient appliances. PPL offers incentives and complimentary pick up to customers looking to replace older, operable appliances. By offering recycling services to their customers, PPL can increase the number of energy efficient appliances in the marketplace, and reduce the resale of older, inefficient units back into the market.

Compact Fluorescent Lighting Campaign

PPL's Compact Fluorescent Lighting Campaign consists of both an upstream retail lighting component and a give-away component for customers. The upstream retail component provides CFL manufacturers with upstream incentives which decrease the cost of CFLs at the retail level. These discounted CFLs are available through both retail stores as well as a PPL online marketplace. The give-away component of the program provides CFLs to customer's free-of-charge at PPL sponsored events. The overall goal of the program is to speed up the adoption of CFLs by PPL's customers by making them easier to obtain.

Custom Incentives Program

The Custom Incentives Program is designed to incentivize customers to install energy efficient equipment not covered by any of the other PPL energy efficiency programs. PPL will reimburse customers up to 50% to cover the costs of studying the potential for energy efficiency measures. They may provide additional reimbursement if measures are successfully implemented. Additional incentives are based on avoided or reduced kWh consumption for successfully implemented measures. The aim of the program is to provide customers with assistance in implementing larger, more unique energy efficiency measures. It also helps to identify technologies that should be included in other EE programs.

Efficient Equipment Incentive Program

The Efficient Equipment Incentive Program provides financial incentives to customers for installing energy efficient equipment. The primary areas of focus for this program are electric heating, cooling, lighting, water heating and appliances. Customers are provided with information on the features and benefits of equipment, as well as financial incentives to help offset the upfront costs of installation. The goal of the program is to increase the saturation of energy efficient equipment in the market by increasing customer access to this equipment.

Home Assessment & Weatherization Program

The Home Assessment and Weatherization Program is designed to provide customers with information about their current energy usage and the energy efficiency measures that would be the most effective for them. This program has two tracks to provide customers with information about energy efficiency potential. The first is a customer-paid walk-through energy audit of their homes. The second is a comprehensive energy audit, including diagnostic testing, that is supported by different rebates depending on the type of equipment that is in the home. The goal of this program is to provide customers with the information that they need to save energy in their homes and reduce household energy costs.

Energy Efficiency Behavior & Education Program

The Energy Efficiency Behavior and Education Program focuses on saving energy by encouraging customers to implement free or low-cost measures and adjusting their behavior. PPL partners with OPOWER to provide customers with Home Energy Reports, comparing their energy usage with previous years as well as comparing their energy usage with other households in their area. The report also provides suggestions for low-cost efficiency improvements and tips for reducing peak and overall energy usage. This program is focused on behavior only and does not provide any financial incentives to customers.

4.5.5.2 Low-Income Residential Programs

E-Power Wise Program

The E-Power Wise program works with community based organizations (CBO) to provide training on energy efficiency targeted to low income customers. The idea behind the program is that by training members of the CBOs, they can pass along the education and information through convenient workshops for low-income customers.

Low-Income WRAP Program
The Low-Income WRAP Program provides customers with a free energy audit designed to identify opportunities for energy saving measures. As a result of the audits, outdated or inefficient equipment is replaced with more efficient equipment. The program uses a pre-approved list of cost effective measures to determine what type of equipment is replaced. The program also provides customers with educational materials on ways they can conserve energy.

4.5.5.3 Small Commercial and Industrial Programs

Efficient Equipment Incentive Program
This program is similar to the program described under the residential programs. The focus for this program is commercial and industrial lighting measures.

HVAC Tune-Up Program
The HVAC Tune-Up Program is designed to help customers with existing split system or packaged HVAC rooftop units optimize the performance of their systems to save energy. Through the program, incentives are provided to contractors who diagnose and install energy saving measures. This helps customers save energy on the operating costs of their HVAC units while offsetting the upfront costs of the diagnostic work and equipment.

4.5.5.4 Large Commercial and Industrial Programs

Appliance Recycling Program
This is the same program as described in the Residential section.

Custom Incentives Program
This is the same program as described in the Residential section.

Efficient Equipment Incentive Program
This is the same program as described in the Residential section.

HVAC Tune-Up Program
This is the same program as described in the Small Commercial and Industrial section.

4.5.5.5 Government and Non-Profit Programs

Appliance Recycling Program
This is the same program as described in the Residential section.

Custom Incentives Program
This is the same program as described in the Residential section.

Efficient Equipment Incentive Program
This is the same program as described in the Residential section.

4.5.6 CURRENT PECO ENERGY EFFICIENCY PROGRAMS

4.5.6.1 Residential Programs

Smart Lighting Discounts Program

The Smart Lighting Discounts program is designed to increase the number of CFLs in the market place through education and financial incentives. PECO works with manufacturers and retailers to reduce the cost of CFLs to customers and to educate them about the technology and the discounts that they are receiving. Education is provided through point-of-purchase information, in-store events, and through retailers, all encouraging customers to choose CFLs at the time of purchase.

Smart Appliance Recycling Program

The Smart Appliance Recycling Program focuses on removing older, inefficient appliances from the market. Through the program customers can have these older appliances picked up from the curb and taken to be recycled. PECO is also currently partnering with Sears to inform customers of the program at the time that they are purchasing new appliances. As part of the purchase of a new appliance, the old appliance will be removed and taken away when the new appliance is installed. A portion of the program costs also go to promotional material creation, helping increase customer awareness of the program.

Smart Home Rebates Program

The Smart Home Rebates Program is designed to help customers with the up-front costs of installing energy efficient equipment in their homes. This is accomplished through cash rebates for customers who purchase energy efficient equipment. The program also partners with suppliers and contractors to encourage customers to choose energy efficient options when purchasing or installing new equipment.

4.5.6.2 Low-Income Residential Programs

The Low-Income Energy Efficiency Program (LEEP) is designed to provide low-income customers with educational materials and assistance on how to make their homes more energy efficient. The program is based off of the existing Low-Income Usage Reduction Program (LIURP) with the aim of doubling the number of participants. Through this program, qualifying customers gain access to in-home energy audits and direct installation of energy efficient equipment such as CFLs and in some cases, refrigeration equipment.

4.5.6.3 Commercial and Industrial Programs

Smart Equipment Incentives Program

The Smart Equipment Incentives Program is designed to educate customers about energy saving technologies and to assist them in their ability to install these measures. PECO offers incentives directly to customers for installing energy efficient equipment and also partners with contractors and suppliers to encourage the purchase of energy efficient equipment. The program also has carryover into the government and non-profit sector.

Smart Construction Incentives Program

The Smart Construction Incentives Program focuses on implementing energy efficiency measures into buildings that are being constructed or being completely re-constructed. Through the program, PECO offers training, design assistance and incentives based on kWh savings to facility designers and builders. The information provided is meant to educate designers and builders on how to design energy efficient features into their buildings. Financial incentives are then provided based on how many of the measures are implemented into the buildings and the amount of energy being saved. The program also has carryover into the government and non-profit sector.

4.5.6.4 Government and Non-Profit Programs

Smart Equipment Incentives Program

This is the same program as described in the commercial and industrial sector. This program offers incentives for projects being completed in the government and non-profit sector.

Smart Construction Incentives Program

This is the same program as described in the commercial and industrial sector. This program offers incentives for projects being completed in the government and non-profit sector.

5 POTENTIAL STUDY METHODOLOGY

This section describes the overall methodology that was utilized by the SWE Team to conduct the Pennsylvania statewide electricity energy efficiency potential study. Completion of this study is one of the key tasks included in the recently renewed contract and scope of work for the Statewide Evaluation Team.[39] The main objective of this energy efficiency potential study is to quantify the technical, economic, achievable and program potential for energy efficiency statewide for three and five year periods starting on June 1, 2013, and to provide potential kWh and kW savings estimates for each level (technical, economic, achievable and program potential) of energy efficiency potential. This study has not examined potential savings from demand response programs but reports demand savings associated with different types of energy efficiency potential. This document describes the general steps and methods that were used at each stage of the analytical process necessary to produce the various estimates of energy efficiency potential. The Statewide Evaluation Team has coordinated and provided information to the Pennsylvania Public Utility Commission (PA PUC) Technical Utility Services (TUS) staff and the Act 129 Technical Working Group throughout the development of this study for feedback and comment.

This energy efficiency potential study provides results that are both statewide and specific to each of the seven Pennsylvania investor-owned electric distribution companies (EDC). To accomplish this objective, a unique energy efficiency potential model was created for each EDC for each primary market sector, namely, residential, commercial, and industrial. The study results are being provided to the PA PUC and to each EDC to assist in the establishment of energy efficiency savings goals for Phase 2 of the Pennsylvania Act 129 programs.[40] This analysis of the potential for energy efficiency savings is based on the most recent electricity sales forecasts for Pennsylvania EDCs for a ten-year period starting in the year 2013. Study results are available on a year-by-year basis for the three year period from June 1, 2013 to May 31, 2016, the five year period from June 1, 2013 through May 31, 2018 and an additional five years from June 1, 2018 through May 31, 2023.

Energy efficiency potential studies involve a number of analytical steps to produce estimates of each type of energy efficiency potential: technical, economic, achievable, and program. This study utilizes benefit/cost screening tools for the residential, commercial and industrial sectors. These cost effectiveness screening tools are Excel-based models that integrate technology-specific impacts and costs, customer characteristics, utility avoided cost forecasts and more. Excel was used as the modeling platform to provide transparency to the estimation process and allow for simple customization based on Pennsylvania's unique characteristics and the availability of specific model input data. The major analytical steps are summarized below and specific changes in methodology from one sector to another have been noted throughout this section.

- Measure List Development
- Load Forecast Disaggregation (for the commercial and industrial sectors)
- Potential Savings Overview
- Technical Potential
- Economic Potential
- Measure Cost-Effectiveness Screening
- Achievable Potential
- Program Potential

[39] The Pennsylvania Public Utility Commission officially executed a two year contract renewal with the Pennsylvania Statewide Evaluation team in January 2012.

[40] The nine objectives for this energy efficiency potential study are listed on page 38 of the master contract between the Pennsylvania PUC and GDS Associates, Inc., the prime contractor for the Statewide Evaluation Team.

From the months of November 2011 through April 2012, the SWE team made available key study inputs, such as the measure lists, measure characteristics and baseline study year results to TUS staff, EDCs and their evaluation consultants for their review and comment. Additionally, the SWE and TUS staff held monthly technical working group (TWG) meetings throughout this study development to present study updates and interim findings and to facilitate discussion of study methodology and input data.

5.1 MEASURE LIST DEVELOPMENT

Energy efficiency measure lists include all measures in the Pennsylvania Technical Reference Manual (TRM), as well as other energy efficiency measures based on the SWE team's existing knowledge and current databases of electric end-use technologies and energy efficiency measures. This measure information was supplemented as necessary to include other technology areas of interest to the PA PUC staff and the Pennsylvania utilities. The study scope includes measures and practices that are currently commercially available as well as emerging technologies. The commercially available measures are of the most immediate interest to energy efficiency program planners in Pennsylvania. However, a small number of well documented emerging technologies were considered for each sector. Emerging technology research was focused on measures that are commercially available but may not be widely accepted at the current time. In October 2011 the SWE Team provided the energy efficiency measure lists for each sector to PUC staff and the EDCs for review and comment. These measure lists were then reviewed, discussed and updated at the meetings of the Pennsylvania Technical Working Group in October, November and December 2011.

In addition, this study includes measures that could be relatively easily substituted for or applied to existing technologies on a retrofit or replace-on-burnout basis. Replace-on-burnout applies to equipment replacements that are made normally in the market when a piece of equipment is at the end of its useful life. A retrofit measure is eligible to be replaced at any time in the life of the equipment or building. Replace-on-burnout measures are generally characterized by incremental measure costs and savings (*e.g.* the costs and savings of a high-efficiency versus standard efficiency air conditioner); whereas retrofit measures are generally characterized by full costs and savings (e.g. the full costs and savings associated with adding ceiling insulation into an existing attic). For new construction, energy efficiency measures can be implemented when each new home or building is constructed, thus the rate of availability is a direct function of the rate of new construction.

5.1.1 MEASURE CHARACTERIZATION

A significant amount of data is needed to estimate the KWh and KW savings potential for individual energy efficiency measures or programs across the entire existing residential, commercial and industrial sectors in Pennsylvania. The SWE Team used Pennsylvania specific data wherever it was available and up-to-date. Considerable effort was expended to identify, review, and document all available data sources.[41] This review has allowed the development of reasonable and supportable assumptions regarding measure lives; installed costs (where appropriate); electric savings and saturation for each measure included in the final list of measures in this study.

Costs and savings for new construction and burnout measures are calculated as the incremental difference between the code minimum equipment and the high efficiency energy efficiency measure. This approach is utilized because the consumer must select an efficiency level that is at least the code minimum equipment. The incremental cost is calculated as the difference between the cost of high efficiency and standard (code compliant) equipment. However, for early retirement measures, the

[41] The appendices and supporting databases to this report provide the data sources used by the SWE team to obtain up-to-date data on energy efficiency measure costs, savings, useful lives and saturations.

measure cost and savings were considered to be the "full" cost of the measure, as the baseline scenario assumes the consumer would do nothing.

Savings: Estimates of annual measure savings as a percentage of base equipment usage was developed from a variety of sources, including:

- 2012 Pennsylvania Technical Reference Manual (TRM)
- Existing deemed savings databases
- Building energy simulation software (such as the REM/Rate model) and engineering analyses
- Secondary sources such as the American Council for an Energy-Efficient Economy ("ACEEE"), Department of Energy ("DOE"), Energy Information Administration ("EIA"), ENERGY STAR, and other technical potential studies
- Program evaluations conducted by Pennsylvania EDCs as well as other utilities and program administrators

Measure Costs: Measure costs represent either incremental or full costs, and typically include the incremental cost of measure installation. For purposes of this study, nominal measures costs were held constant over time. This general assumption is being made due to the fact that historically many measure costs (e.g., CFL bulbs, Energy Star appliances, etc.) have declined over time, while some measure costs have increased over time (e.g., fiberglass insulation). Cost estimates were obtained from the following types of data sources:

- Existing deemed savings databases
- Secondary sources such as ACEEE, ENERGY STAR, NREL, Maryland incremental cost study, and other technical potential studies
- Retail store pricing (such as web sites of Home Depot and Lowe's) and industry experts
- EDC program evaluation and market assessment reports
- EDC annual reports to the PA PUC

Measure Life: Represents the number of years that energy-using equipment is expected to operate. Pennsylvania legislative Act 129 caps the measure useful life (when used in the Total Resource Cost Test calculation) at a maximum of 15 years. Useful life estimates have been obtained from the following data sources:

- 2012 Pennsylvania TRM
- Manufacturer data
- Savings calculators and life-cycle cost analyses
- Secondary sources such as ACEEE, ENERGY STAR, and other technical potential studies
- The California Database for Energy Efficient Resources ("DEER") database
- Evaluation reports
- Surveys done by the EDCs
- GDS and other consultant research or technical reports

Baseline and Efficient Technology Saturations: In order to assess the amount of electric energy efficiency savings still available, estimates of the current saturation of baseline equipment and energy efficiency measures are necessary. Up-to-date measure saturation data were primarily obtained from the following recent studies:

- PA PUC residential and commercial/industrial baseline studies (based on site surveys conducted by PECO and the SWE Team)
- Other recently completed home energy and appliance saturation surveys completed in Pennsylvania, including EDC research studies
- 2009 EIA Residential Energy Consumption Survey (RECS)

- 2006 EIA Manufacturing Energy Consumption Survey (MECS)
- 2003 EIA Commercial Building Energy Consumption Survey (CBECS)

Further detail regarding the development of measure assumptions for energy efficiency in the residential, commercial, and industrial sectors are provided in this report in later sections. Additionally, the appendices of the report provide a comprehensive listing of all energy efficiency measure assumptions and sources.

5.2 FORECAST DISAGGREGATION

For the commercial and industrial sectors, each EDCs baseline load forecast was disaggregated by combining inputs compiled in the SWE baseline study for Pennsylvania and each EDCs load forecast to obtain average consumption estimates by customer segment, construction vintage, and end use, and summed up to the sector level. This disaggregation effort was conducted by the SWE Team if this level of detail was not available in the EDC load forecasts provided to the SWE Team. The disaggregated forecast data mainly provides the foundation for the development of energy efficiency potential estimates for the commercial and industrial sectors. The unit energy consumption information was obtained from such sources as the PA TRM, building energy simulation models, EDC load research studies, etc. The baseline year, 2010, end-use segmentations for each EDC were then applied across the study horizon and steps were taken to align with each EDCs fundamental load forecast. It was not necessary to develop a disaggregated residential sales forecast for each EDC because a bottom-up approach was used for the residential sector.

5.2.1 ROLE OF NATURALLY OCCURRING CONSERVATION

Naturally occurring conservation exists through government intervention, improved manufacturing efficiencies, building energy codes, market demand, and increased energy efficient implementation through early fore-runners, who will implement measures without explicit monetary incentives. The impacts of new Federal government mandated energy efficiency standards have already been reflected in the baseline data for equipment unit energy consumption being used for this potential study. The impact of these new government standards, such as the new standards included in the Federal government's December 2007 Energy Independence and Security Act (EISA)[42], have been discussed with the Pennsylvania EDCs at several meetings of the Act 129 Technical Working Group. The EISA impacts on unit energy consumption are discussed in more detail in the Pennsylvania TRM. Government regulation can significantly increase naturally occurring potential through tax incentives, stimulus funding or stricter manufacturing standards. These forces cause certain sector end-use energy consumption values to improve across the baseline forecast. The SWE team has worked with each EDC to understand the types and amount of naturally occurring energy conservation existing in EDC load forecasts. This step is important to ensure the energy efficiency potential is not double-counted, by over-stating the potential that could occur for end-uses where codes and standard are reducing the baseline unit energy consumption included in EDC load forecasts. In addition, the SWE Team has reflected the impacts of new EISA lighting standards that will go into effect in 2020. This specific adjustment reduces energy efficiency potential for 2020 and subsequent years.

5.3 POTENTIAL SAVINGS OVERVIEW

Potential studies often distinguish between several types of energy efficiency potential: technical, economic, achievable, and program. However, because there are often important definitional issues between studies, it is important to understand the definition and scope of each potential estimate as it applies to this analysis.

42 PUBLIC LAW 110–140—DEC. 19, 2007. Energy Independence and Security Act of 2007

Figure 5-1: Types of Energy Efficiency Potential[43]

Not Technically Feasable	Technical Potential			
Not Technically Feasable	Not Cost Effective	Economic Potential		
Not Technically Feasable	Not Cost Effective	Market & Adoption Barriers	Achievable Potential	
Not Technically Feasable	Not Cost Effective	Market & Adoption Barriers	Program Design, Budget, Staffing, & Time Constraints	Program Potential

The first two types of potential, technical and economic, provide a theoretical upper bound for energy savings from energy efficiency measures. Still, even the best designed portfolio of programs is unlikely to capture 100 percent of the technical or economic potential. Therefore, achievable potential and program potential attempt to estimate what may realistically be achieved, when it can be captured, and how much it would cost to do so. Figure 5-1 above illustrates the four most common types of energy efficiency potential.

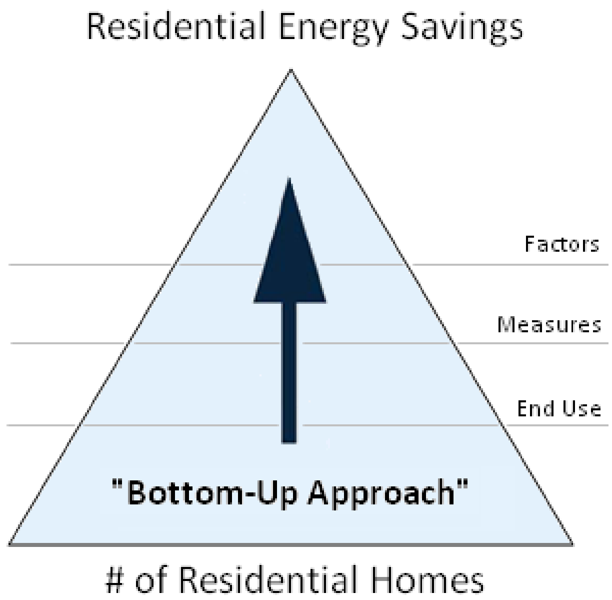
5.4 TECHNICAL POTENTIAL

The Pennsylvania Statewide Evaluation team has used the energy efficiency potential definitions included on page 2-4 of the November 2007 National Action Plan for Energy Efficiency (NAPEE) Guide for Conducting Energy Efficiency Potential Studies. Technical potential is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency measures. It is often estimated as a "snapshot" in time assuming immediate implementation of all technologically feasible energy saving measures, with additional efficiency opportunities assumed as they arise from activities such as new construction.[44]

In general, this study utilizes a "bottom-up" approach in the residential sector to calculate the potential of an energy efficiency measure or set of measures as illustrated in Figure 5-2 below. A bottom-up approach first starts with the savings and costs associated with replacing one piece of equipment with its high efficiency counterpart, and then multiplies these values by the number of measures available to be installed throughout the life of the program. The bottom-up approach is applicable in the residential sector because of the concurrent SWE baseline study, better secondary data availability and greater homogeneity of the building and equipment stock to which measures are applied. However, this methodology was not utilized in the commercial and industrial sectors. For the commercial and industrial sectors, a "top-down" approach was used for developing the technical potential estimates. For the industrial sector, the "top down" approach builds an energy use profile based on estimates of kWh sales by business segment and end use. Savings factors for energy efficiency measures are then applied to applicable end use energy estimates after assumptions are made regarding the fraction of sales that are associated with inefficient equipment and the technical/engineering feasibility of each energy efficiency measure.

[43] Reproduced from "Guide to Resource Planning with Energy Efficiency" November 2007. US EPA. Figure 2-1.
[44] National Action Plan for Energy Efficiency, "Guide for Conducting Energy Efficiency Potential Studies", page 2-4

Figure 5-2: Residential Sector Savings Methodology - Bottom Up Approach



As shown in Figure 5-2, the methodology starts at the bottom based on the number of residential customers (splitting them into single-family and multi-family customers as well as existing vs. new construction). From that point, estimates of the size of the eligible market in Pennsylvania are developed for each energy efficiency measure for each of the seven EDC service areas included in this study. For example, energy efficiency measures that affect electric space heating are only applicable to those homes in Pennsylvania that have electric space heating.

To obtain up-to-date appliance and end-use saturation data, the study made extensive use of the SWE 2011-2012 residential baseline study. The baseline study on-site surveys collected detailed data on the current saturation of electricity consuming equipment in Pennsylvania and the energy efficiency level of HVAC equipment, appliances, and building shell characteristics. Estimates of energy efficient equipment saturations were based on data collected from the 2011-12 residential baseline study on-site surveys in Pennsylvania.

The goal of the approach is to determine how many households that a specific measure applies to (base case factor), then of that group, the fraction of households/buildings which do not have the energy efficient version of the measure being installed (remaining factor). In instances where technical reasons do not permit the installation of the efficient equipment in all eligible households an applicability factor is used to limit the potential. Alternative water heating technologies (efficient water heater tanks and/or heat pump water heaters) are then utilized to meet the remaining market potential. The last factor to be applied is the savings factor, which is the percentage savings achieved from installing the efficient measure over a standard measure.

In developing the overall potential electricity savings, the analysis accounts for the interactive effects of measures designed to impact the same end-use. For instance, if a home were to properly seal all ductwork, the overall space heating and cooling consumption in that home would decrease. As a result, the remaining potential for energy savings derived from a heating/cooling equipment upgrade would be reduced. In instances where there are two (or more) competing technologies for the same electrical end use, such as heat pump water heaters, water heater efficiency measures and high-efficiency electric storage water heaters, an equal percentage of the available population is assigned to each measure using the applicability factor. In the event that one of the competing measures is not found to be cost-effective, the homes/buildings assigned to that measure are transitioned over to the cost effective alternative (if any).

The savings estimates per base unit are determined by comparing the high-efficiency equipment to current installed equipment for existing construction retrofits or to current equipment code standards for replace-on-burnout and new construction scenarios.

5.4.1 CORE EQUATION FOR THE RESIDENTIAL SECTOR

The core equation used in the residential sector energy efficiency technical potential analysis for each individual efficiency measure is shown below in Equation 5-1 below.

Equation 5-1: Core Equation for Residential Sector Technical Potential

$$\text{Technical Potential of Efficient Measure} = \text{Total Number of Households or Buildings} \times \text{Base Case Equipment End Use Intensity [kWh/unit]} \times \text{Saturation Share} \times \text{Applicability Factor} \times \text{Savings Factor}$$

Where:

- Base Case Equipment End Use Intensity = the electricity used per customer per year by each base-case technology in each market segment. This is the consumption of the electrical energy using equipment that the efficient technology replaces or affects.

- Saturation Share = the fraction of the end use electrical energy that is applicable for the efficient technology in a given market segment. For example, for residential water heating, this would be the fraction of all residential electric customers that have electric water heating in their household.

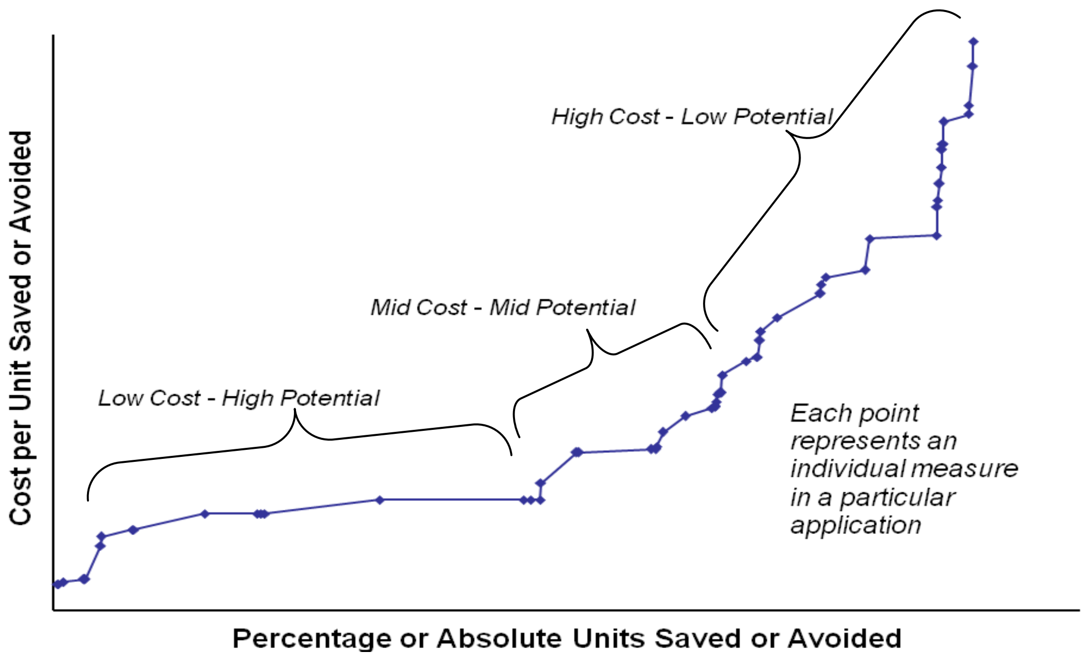
- Applicability Factor = the fraction of the applicable units that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install CFLs in all light sockets in a home because the CFLs may not fit in every socket.)

- Savings Factor = the percentage reduction in electricity consumption resulting from application of the efficient technology.

Technical energy efficiency potential in the residential sector is calculated in two steps. In the first step, all measures are treated *independently*; that is, the savings of each measure are not reduced or otherwise adjusted for overlap between competing or interacting measures. By analyzing measures independently, no assumptions are made about the combinations or order in which they might be installed in customer buildings. However, the cumulative technical potential cannot be estimated by adding the savings from the individual savings estimates because some savings would be double-counted. For example, the savings from a measure that reduces heat loss from a building, such as insulation, are partially dependent on other measures that affect the efficiency of the system being used to heat the building, such as a high-efficiency furnace; the more efficient the furnace, the less energy saved from the installation of the insulation. In the second step, adjustments are made to account for such interactive effects.

Finally, the SWE Team has developed a supply curve to show the amount of energy efficiency savings available at different cost levels. A generic example of a supply curve is shown in Figure 5-3. As shown in the figure, a supply curve typically consists of two axes; one that captures the cost per unit of saving a resource (e.g., dollars per lifetime kWh saved) and another that shows the amount of savings that could be achieved at each level of cost. The curve is typically built up across individual measures that are applied to specific base-case practices or technologies by market segment. Savings measures are sorted based on a metric of cost. Total savings available at various levels of cost are calculated incrementally with respect to measures that precede them. Supply curves typically, but not always, end up reflecting diminishing returns, i.e., costs increase rapidly and savings decrease significantly at the end of the curve.

Figure 5-3: Generic Example of a Supply Curve



As noted above, the cost portion of this energy efficiency supply curve is represented in dollars per unit of lifetime energy savings. Cost are annualized (often referred to as levelized) in supply curves. For example, energy efficiency supply curves usually present levelized costs per kWh saved by multiplying the initial investment in an efficient technology or program by the capital recovery rate (CRR), and then dividing that amount by annual kWh savings:

Therefore,

Levelized Cost per kWh Saved = Initial Cost x CRR/Annual kWh Savings

5.4.2 CORE EQUATION FOR THE COMMERCIAL AND INDUSTRIAL SECTOR

The core equation utilized in the commercial sector technical potential analysis for each individual efficiency measure for each of the Pennsylvania EDCs is shown below in Equation 5-2. The forecast of commercial square footage information for each EDC was developed by the SWE Team. The information used by the SWE Team on the total square footage by business type by EDC is available from the SWE Team upon request.

Equation 5-2: Core Equation for Commercial Sector Technical Potential

$$\text{Technical Potential of Efficient Measure} = \text{Total Stock Square Footage by Business Type by EDC} \times \text{Base Case Equipment End Use Intensity [kWh/sf]} \times \text{Saturation Share} \times \text{Applicability Factor} \times \text{Savings Factor}$$

The core equation utilized in the industrial sector technical potential analysis for each individual efficiency measure for each EDC is shown below in Equation 5-3.

Equation 5-3: Core Equation for Industrial Sector Technical Potential

$$\text{Technical Potential of Efficient Measure} = \sum \text{Total EDC End Use kWh Sales by Industry Type} \times \text{Applicability Factor} \times \text{Savings Factor}$$

Where:

- Total Stock Square Footage by Business Type = the forecasted square footage level for a given commercial business type (e.g., office buildings).
- Base Case Equipment End Use Intensity = the electricity used per square foot per year by each base-case technology in each market segment. This is the consumption of the electrical energy using equipment that the efficient technology replaces or affects. This end-use consumption data was obtained from such sources as the US EIA commercial building energy survey (CBECS), Pennsylvania EDC data, the Pennsylvania TRM, and other sources.
- Total end use kWh sales (by segment) = the forecasted level of electric sales for a given end-use (e.g., space heating) for an EDC in an industrial market segment.
- Saturation Share = the fraction of the EDC end use electrical energy that is applicable for the efficient technology in a given market segment. For example, for boiler heating, this would be the fraction for a specific EDC of all space heating kWh in a given market segment that is associated with electric boilers.
- Applicability Factor = the fraction of the equipment or practice that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install VFDs on all motors in a given market segment).
- Savings Factor = the percentage reduction in electric consumption resulting from application of the efficient technology.

For the commercial and industrial sectors, the development of the energy efficiency technical potential estimate begins with a disaggregated energy sales forecast over the ten year forecast horizon (2013 to 2022). The commercial sales forecast is broken down by building type, then by electric end use. The industrial sales forecast is broken down by industry type, then by electric end use. Then a savings factor is applied to end use electricity sales to determine the potential electricity savings for each end use. The commercial sector, as defined in this analysis, is comprised of the following business segments:

- Warehouse
- Retail

- Grocery
- Office
- Lodging
- Healthcare
- Restaurant
- Institutional, including education
- Other

The industrial sector, as defined in this analysis, is comprised of the following business segments:

- Ag & Pumping
- Construction
- Mfg: Chemicals and Allied Products
- Mfg: Electronic Equipment
- Mfg: Fabricated Metal Products
- Mfg: Food
- Mfg: Ind and Com Machinery
- Mfg: Industrial
- Mfg: Misc
- Mfg: Paper and Allied Products
- Mfg: Primary Metals
- Mfg: Rubber and Mixed Plastics
- Mfg: Stone Clay Glass and Concrete
- Mfg: Transportation Equipment
- Mining & Extraction

Similar to the residential sector, technical electric energy efficiency savings potential in the C&I sectors is calculated in two steps. In the first step, all measures are treated *independently*; that is, the savings of each measure are not reduced or otherwise adjusted for overlap between competing or synergistic measures. By treating measures independently, their relative economics are analyzed without making assumptions about the order or combinations in which they might be implemented in customer buildings. However, the total technical potential across measures cannot be estimated by summing the individual measure potentials directly because some savings would be double-counted. For example, the savings from a weatherization measure, such as low-e ENERGY STAR windows, are partially dependent on other measures that affect the efficiency of the system being used to cool or heat the building, such as high-efficiency space heating equipment or high-efficiency air conditioning systems; the more efficient the space heating equipment or electric air conditioner, the less energy saved from the installation of low-e ENERGY STAR windows. Accordingly, the second step is to rank the measures based on a metric of cost-effectiveness (the measure TRC ratio) and adjust savings for interactive effects so that total savings are calculated incrementally with respect to measures that precede them.

For the residential and commercial sectors, the SWE Team addressed the new construction market as a separate market segment, with measures/programs targeted specifically at the new construction market. In the residential new construction market segment, for example, detailed energy savings estimates for the ENERGY STAR Homes program were used as a basis for determining electric savings for this market segment in Pennsylvania.

5.5 ECONOMIC POTENTIAL

Economic potential refers to the subset of the technical potential that is economically cost-effective (based on screening with the Total Resource Cost) as compared to conventional supply-side energy resources. The SWE Team has calculated the TRC benefit/cost ratios for this study according to the

Pennsylvania PUC's 2009 and 2011 TRC Orders. Both technical and economic potential are theoretical numbers that assume immediate implementation of energy efficiency measures, with no regard for the gradual "ramping up" process of real-life programs. In addition, they ignore market barriers to ensuring actual implementation of energy efficiency. Finally, they only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration, program evaluation, etc.) that would be necessary to capture them.

The SWE team pre-screened possible energy efficiency technologies and practices based on an understanding of which measures were likely to be cost-effective and in an interest in conserving time and effort for other aspects of the analysis. Measure screening removed measures that were not commercially available, were already at current code, or were not applicable to Pennsylvania. All measures that were not found to be cost-effective based on the results of the TRC test were excluded from further analysis. Then allocation factors were readjusted and applied to the remaining measures that were cost effective. The TRC test is defined in greater detail in Section 5.6 below.

5.6 DETERMINING COST-EFFECTIVENESS

The SWE team utilized the 2009 and 2011 Pennsylvania PUC TRC Orders to determine cost-effectiveness for energy efficiency measures in this potential study. The cost effectiveness test that was used is the Total Resource Cost Test (TRC).

5.6.1 THE TOTAL RESOURCE COST TEST

The TRC test measures the net costs of a demand-side management or energy efficiency measure or program as a resource option based on the total costs of the measure/program, including both the participants' and the utility's costs.

The TRC test represents the combination of the effects of a program on both the customers participating and those not participating in a program. In general, the benefits calculated in the TRC test usually include the avoided electric supply costs for the periods when there is an electric load reduction, savings of other resources such as fossil fuels and water, and applicable Federal and State energy efficiency tax credits. For purposes of this study, only the electricity savings were used to calculate the benefit for the PA TRC, as the ACT 129 energy efficiency savings targets include only electric savings. For the estimates of economic and achievable potential, the benefits in the Pennsylvania TRC test were calculated using gross program savings. Net savings, on the other hand, are the savings net of changes in energy use that would have happened in the absence of the program. For the cost effectiveness screening to determine economic potential and achievable and program potential, the net-to-gross ratio for all measures was set at 1.0.[45]

In general, the costs in the TRC test (incremental or full cost depending on whether the measure was replaced on burnout or is an early replacement) are the program costs paid by the utility (or program administrator) and the participants. Thus all equipment costs, installation, operation and maintenance, cost of removal and administration costs, no matter who pays for them, are included in this test. According to the National Action Plan for Energy Efficiency Guide titled "Understanding Cost Effectiveness of Energy Efficiency Programs", any tax credits are considered a benefit for the TRC test. For purposes of this study, administrative costs were not included for the measure cost effectiveness screening conducted to develop the estimates of economic potential. Administrative program costs are included in TRC tests for Achievable and Program potential.

[45] Haeri, Hossein; Khawaja, Sami; "The Trouble with Free-Riders, The Debate About Free-Riders in Energy Efficiency Isn't Wrong, But It is Wrong-Headed", the Cadmus Group, March 2012. This paper notes that over two-thirds of all evaluation studies reviewed in a recent best-practice study had a net-to-gross value of approximately 1.0.

5.6.2 AVOIDED COSTS

The avoided cost forecasts utilized to measure cost-effective screening and for reporting potential benefits were based on the Pennsylvania PUC's 2009 and 2011 TRC Orders and each EDC's avoided cost structure, including energy, transmission, distribution, and capacity avoided costs. The discount rate used in the calculation of the Pennsylvania TRC Test is the utility's weighted average cost of capital. Avoided energy costs are time and seasonally differentiated where possible.

5.7 ACHIEVABLE POTENTIAL

Achievable potential was determined as the amount of energy use that can realistically be saved assuming an aggressive program marketing strategy and with two program incentive scenarios. Achievable potential takes into account barriers that hinder consumer adoption of energy efficiency measures such as financial, political and regulatory barriers, and the capability of programs and administrators to ramp up activity over time. The potential study evaluates two achievable potential scenarios:

- Scenario #1 for achievable potential is based on paying incentives equal to 100% of measure incremental costs
- Scenario #2 for achievable potential scenario is based on EDCs paying incentive levels comparable to those in effect during Program Year 2.

While many different incentive scenarios could be modeled, the number of achievable potential scenarios that could be developed was limited to two scenarios due to the available budget for this potential study. The SWE team analyzed the two selected achievable potential scenarios with different anticipated penetration curves or market acceptance models for each incentive level. In scenario #1, the penetration curve was based on a maximum penetration based on 100% funding of the measure incremental costs. Previous studies and actual program experience have indicated that this curve can reach an asymptote of 85%, as not 100% of customers will accept or adopt energy efficiency measures for various reasons. The second scenario analyzed was the expected market acceptance with current EDC incentive levels increased by 25%. Achievable potential scenario #2 incentives were set at 56% of incremental cost and 34% of incremental cost for the residential and C&I sectors respectively. These two penetration scenarios contain uncertainty based on consumer's willingness to participate.

For new construction, energy efficiency measures can be implemented when each new home or building is constructed, thus the rate of availability is a direct function of the rate of new construction. For existing buildings, determining the annual rate of availability of savings is more complex. Energy efficiency potential in the existing stock of buildings can be captured over time through three principal processes:

1) As equipment replacements are made normally in the market when a piece of equipment is at the end of its effective useful life (referred to as "replace-on-burnout")
2) At any time in the life of the equipment or building (referred to as "retrofit").
3) When a new home or building is constructed.

For the replace-on-burnout measures, existing equipment is assumed to be replaced with high-efficiency equipment at the time a consumer is shopping for a new appliance or other energy consuming equipment, or if the consumer is in the process of building or remodeling. Using this approach, only equipment that needs to be replaced in a given year is eligible to be upgraded to energy efficient equipment. For the retrofit measures, savings can theoretically be captured at any time; however, in practice, it takes many years to retrofit an entire stock of buildings, even with the most aggressive of energy efficiency programs. For new construction, savings are achieved at the time the building is completed.

In the residential base case scenario, achievable potential represents the attainable savings if the market penetration of high-efficiency electric appliances and equipment reaches a certain percentage of the eligible market between 2013 and 2023. The time-frame in which the market penetration target is met, however, differs between replace-on-burnout and retrofit measures. The SWE Team utilized a combination of actual program experience and market penetration models to forecast likely levels of achievable market penetration for energy efficiency measures in Pennsylvania.

1) For replace-on-burnout measures, a fraction of the total eligible market can be achieved annually over the course of the technology's useful life. For example, if a measure has a 20 year useful life, only about half of the existing units would be expected to burnout during a 10 year timeframe; thus only the remaining market would be eligible for replacement during the second ten-year period of the 20 year life.
2) For all retrofit measures the analysis assumes fewer adoption barriers, and the target market penetration for retrofit opportunities can likely be achieved by 2023 for measures with an assumed useful life of 10 years or greater. Retrofit measures with a useful life of less than 10 years would be considered over the specific measure lifetime.
3) For measures installed in new construction, the savings occur as new buildings are constructed and completed.

The methodology for estimating the total energy efficiency measure adoption rates over time (as applied to the core equation 5-4) from 2013-2023 in the residential sector is based on the following core equation:

Equation 5-4: Adoption Rates Over Time – Replace on Burnout

*Program Adoption = [(Population of Homes * Saturation Share * Applicability Factor * Market Penetration Factor) / (Measure Useful Life)] * Program Time Frame*

Where:

- Population = Total number of single family or multi-family homes in Pennsylvania territory.
- Saturation Share = Percent of population with measure (standard or high-efficiency).
- Applicability Factor = Percent of population currently not equipped with energy efficient technology
- Market Penetration Factor = Projected market penetration curve over. In the achievable potential scenarios, this factor ramped up to a maximum asymptote within a given time period based on a market penetration algorithm.
- Measure Useful Life = Useful life of Measure
- Program Time Frame = # of years included in the program analysis

This equation was used to calculate the total adoption of energy efficient measures based on the replace on burnout approach.

5.7.1 ACHIEVABLE POTENTIAL MARKET PENETRATION RATES FOR THE RESIDENTIAL SECTOR

The market penetration factor for replace on burnout measures was developed through two steps. When the total number of measures calculated to turn over (or become eligible for replacement) on an annual basis was determined, one of three annual penetration curves was assigned to each measure for the achievable potential #1 scenario. For measures currently offered as part of an existing energy efficiency and conservation program, measures in the achievable potential #1 scenario were assigned either a "quick" or "slow" annual penetration curve. In general, these curves were assigned based on measure cost and current market acceptance. For example, a measure with a low cost and relatively high market acceptance was assigned a "quick" annual penetration curve, resulting in measures reaching the targeted market penetration scenario by the fifth forecast program year. A measure with a high install cost or low market penetration was assigned the "slow" annual penetration curve, in which measures did not reach the targeted market penetration scenario until the eighth year of analysis. For new measures not currently offered by existing programs, a "new" annual penetration curve was assigned. This annual curve assumes a starting annual penetration well below the existing measures and does not achieve the targeted market penetration until the final year of the analysis period. Although this methodology simplifies what an adoption curve would look like in practice, it succeeds in providing a concise method for estimating achievable savings potential over a specified period of time. For the achievable potential #1 scenario, the market penetration rate started at 40% (for measures currently offered) in year 1 and increased to 85% by year 10. For the achievable potential #2 scenario, the market penetration rate for the residential sector was held constant, reaching a 40% penetration rate of the annual stock turnover. For both of these scenarios, the market penetration rate for new measures started at 5%.

Finally, a select few measures possess a useful life less than the analysis time frame. For example, a measure with a useful measure life of ~7 years might expire in 2019. In this analysis, expiring measures are generally reintroduced the following year. For the residential sector, the SWE Team assumes that if measures are re-introduced, then the incremental costs of the measure also recur. This allows the savings (and costs) to persist throughout the entire 10 year study. For these measures, the SWE Team assumed that an incentive was required again to obtain these savings again.

5.8 PROGRAM POTENTIAL

While the identified achievable potential includes energy efficiency potential available in the marketplace, it was vital to isolate the portion that could be realistically acquired through EDC programs. It is important to recognize that there are program constraints such as available program funding (cost caps), how much time is available to deliver programs or reach a compliance target, net to gross factors consumer willingness to participate in programs or adopt measures, and the possibility of specific "set-asides" for the low-income and institutional sectors.

The SWE team analyzed two basic scenarios for the program potential:

1) Funding levels of 2% of 2006 utility electric revenues (this is the funding cap specified in Act 129 legislation). For example, this program potential estimate for the five year period ending in 2018 was calculated as follows:
    a. Technical potential was calculated first.
    b. Then economic potential was calculated (TRC benefit/cost testing was applied at this step)
    c. Then achievable potential was calculated (penetration rate forecasts were applied to economic potential to arrive at achievable potential). In this step, total TRC costs are developed (utility plus participant costs). The achievable potential estimates are based on forecasts of kWh and kW savings estimates for 2016 and 2018 for all cost effective energy efficiency measures. The achievable potential estimates are provided for each individual energy efficiency measure, and for all measures combined.
    d. Then program potential was calculated based on a target annual utility energy efficiency budget that is 2% of annual utility revenues in the year 2006. Then the kWh and kW achievable potential estimates by measure were scaled up or down across the board with

a single factor until the utility costs for the program potential scenario are equal to 2% of annual utility revenues in 2006. When the budget and the savings are scaled to the 2% utility spending target, then the development of the program potential estimate is complete.

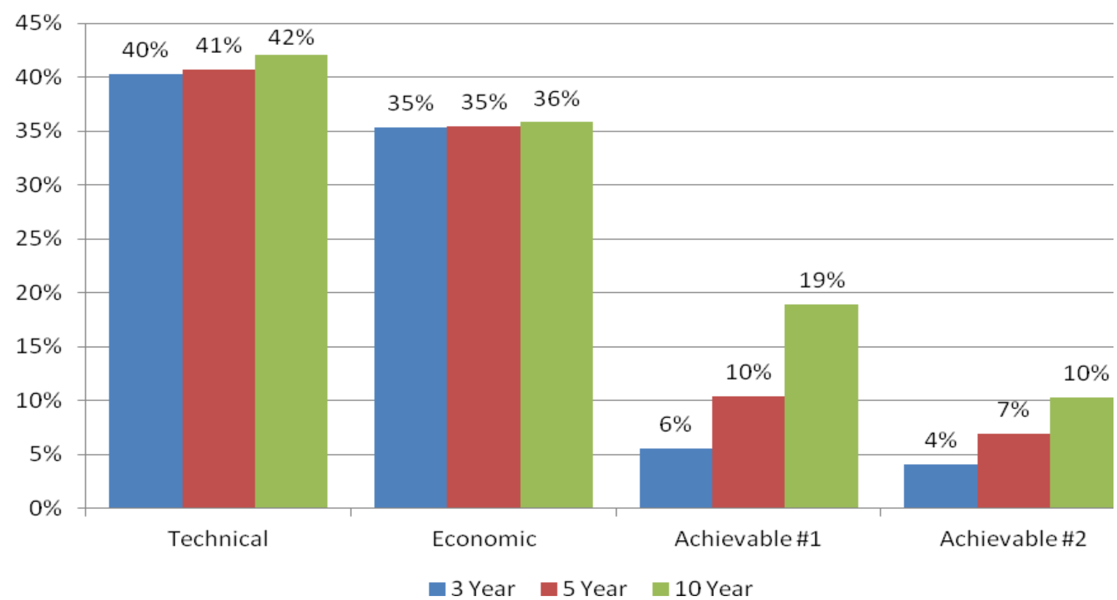
2) Annual savings equal to 1% of aggregate 2011 actual retail kWh sales. For this program potential scenario, the achievable potential kWh savings are scaled until the level of annual kWh savings is equivalent to 1% of aggregate annual kWh sales occurring in the baseline period. For a more detailed explanation of how this scenario was developed, see section 8.

6 RESIDENTIAL ENERGY EFFICIENCY POTENTIAL ESTIMATES

This section of the report presents the estimates of electric technical, economic, achievable and program potential for the Commonwealth of Pennsylvania as well as for each EDC service area.

Figure 6-1 below summarizes the technical, economic, achievable and program savings potential (as a % of forecast sales) for the years 2016, 2018 and 2023. The achievable potential scenario #1 estimates are based on incentives that are set are 100% of measure incremental cost and a long-term market penetration rate of 85%. Achievable potential scenario #2 estimates are based on incentives that are set at 56% of measure incremental cost and a long-term market penetration rate of 40%. If the target market penetration for all remaining eligible cost-effective residential measures can be reached over the next five years, the achievable potential for electric energy efficiency savings in the residential sector is approximately 10.4% of projected residential sales in the year 2010 for achievable potential scenario #1, and 6.9% of projected residential sales in the year 2010 for achievable potential scenario #2.[46]

Figure 6-1: Summary of Residential Energy Efficiency Potential as a % of 2010 Sales Forecasts – Statewide



6.1 ENERGY EFFICIENCY MEASURES EXAMINED

317 residential electric energy efficiency programs or measures were included in the energy savings analysis for the residential sector.[47] Table 6-1 below provides a listing of the various residential energy efficiency measures considered in this study. The list of energy efficiency measures examined was developed based on a review of the measures included in the 2012 Pennsylvania Technical Reference Manual (TRM), measures included in other recent energy efficiency potential studies, and measures suggested by the Pennsylvania electric distribution companies and their consultants.

The Excel models used to develop the energy efficiency potential estimates have a complete list of all of the residential energy efficiency measures included in this study as well as the annual kWh and kW

[46] Forecasted 2009/2010 kWh sales were used to allow the same baseline to establish compliance targets on a cumulative basis from Phase 1 to Phase 2, which also allows adding kWh savings from Phase 1 to Phase 2.

[47] This count of the number of residential energy efficiency measures reflects the number of unique energy efficiency measures as well as the combinations and permutations of measures based on housing type (single-family attached; single-family detached, and multi-family).

savings, useful life, measure cost, and the Total Resource Cost (TRC) benefit-cost ratios for each measure.

Table 6-1: Measures and Programs Included in the Residential Sector Analysis

End Use Type	End-Use Description	Measures/Programs Includes
Appliances	General Home Appliances	* Dehumidifiers * Refrigerators * Freezers * Refrigerator/Freezer Turn-In
Appliances/WH	Kitchen/Laundry	* Clothes Washers * Clothes Dryer * Dishwashers
Electronics	Home Electronics	* Controlled Power Strips * Laptops * Computer Monitors * Televisions (LED, LCD, Plasma) * Energy Star Office Equipment * Misc. Consumer Electronics
HVAC (Envelope)	Building Envelope Upgrades	* Insulation (Attic, Wall, Floor) * Air Sealing *Duct Sealing * Energy Star Windows * Residential New Construction Program
HVAC (Equipment)	Heating/Cooling /Ventilation Equipment	* Efficient Central AC * Efficient Room AC * High Efficiency Air Source Heat Pumps * High Efficiency Fan Motors * Exhaust Fans * Furnace Whistle *Programmable Thermostat * Ductless Mini Splits *Ground Source Heat Pumps *Secondary room AC retirement
Lighting	Indoor/Outdoor Lighting	* Incandescent to CFL * Incandescent to LED * Nightlights * Energy Star Torchieres * Ceiling fan with Energy Star Light Fixture * Energy Star Holiday Lights * Interior & Exterior Fixtures * Lighting Controls
Other	Miscellaneous Efficiency Measures	* 2-speed Pool Pump Motor * Variable Speed Pool Pump Motor *Direct Feedback Devices (In Home Display Units) * Indirect Energy Consumption Feedback (OPower)
Water Heating	Domestic Hot Water	* Efficient Storage Tank WH * Heat Pump WH * Solar WH (w/ Electric Back Up) * Tank Wrap * Pipe Wrap * Low Flow Showerheads * Faucet Aerators

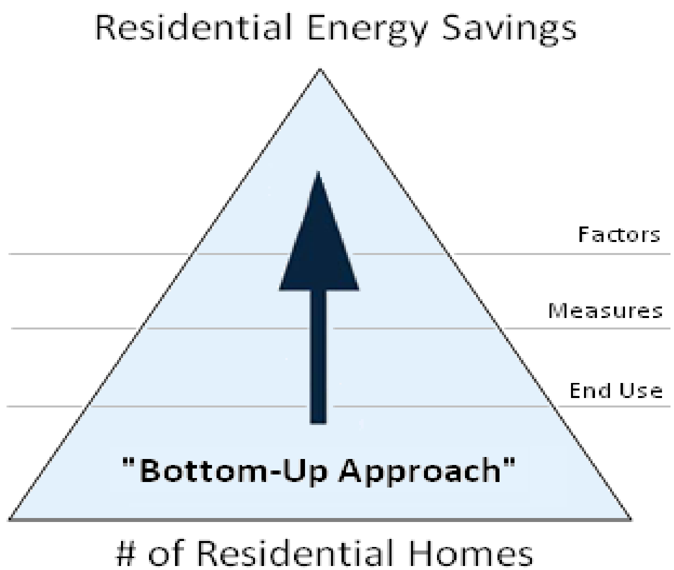
6.2 RESIDENTIAL SECTOR SAVINGS METHODOLOGY OVERVIEW

The portfolio of measures examined in the residential sector includes retrofit, early retirement, and replace-on-burnout programmatic approaches to achieve energy efficiency savings. Replace-on-burnout measures are purchased and installed at the end of the useful life of a measure (when the equipment burns out). A retrofit measure refers to the application of supplemental measures (such as the addition of a low-flow device to a showerhead); early retirement includes the replacement of operational equipment before the end of its remaining useful life.

Existing homes were divided into single family detached units, single-family attached units and multi-family units in order to account for differing equipment saturations, differences in the square footage of living space, and differences in the amount of energy used for space heating and cooling. New homes were also included in the analysis based on a forecast of the number of new customers each year from each EDC. The analysis of the potential for energy efficiency savings is based on the most recent residential electric sales forecasts for each EDC.

The residential sector analysis was modeled using what is considered a "bottom-up approach." The methodology is illustrated in Figure 6-2 below:

Figure 6-2: Residential Sector Savings Methodology - Bottom Up Approach



As shown in this figure, the methodology started at the bottom based on the number of residential customers (splitting them into single-family attached units, single-family detached units, and multi-family units as well as existing vs. new construction). From that point, estimates of the size of the eligible market were developed for each energy efficiency measure. For example, energy efficiency measures that affect electric water heating are only applicable to those homes that have electric water heating.

To obtain up-to-date appliance and end-use saturation data as well as data on the percent of equipment that is already high efficiency, this study made extensive use of the residential baseline data collected by the Statewide Evaluation Team for six of the seven Pennsylvania EDCs and the baseline study conducted independently in 2010 and 2011 by PECO. Up-to-date saturation data for residential appliances, electric water heating, and electric space heating and cooling equipment were obtained from utility appliance saturation surveys. Additional estimates of energy efficient saturation were generated from regional or national data when needed.

The full formula to determine residential sector energy efficiency savings at the measure level is shown below.

Equation 6-1: Core Equation for Residential Sector Technical Potential

Technical Potential of Efficient Measure	=	Total Number of Households or Buildings	X	Base Case Equipment End Use Intensity [kWh/unit]	X	Base Case Factor	X	Remaining Factor	X	Applicability Factor	X	Savings Factor

For measures where deemed kWh savings estimates were available in the Pennsylvania TRM, the base case equipment end-use intensity (kWh/unit) and the savings factor were combined into one number, the deemed estimate of kWh savings per year. The goal of the above formula is to determine how many households that a measure applies to (base case factor), then of that group, the fraction of households which do not have the efficient version of the measure being installed (remaining factor). In instances where technical reasons did not permit the installation of the efficient equipment in all eligible households or competing technologies were eligible for a household, an applicability factor was used that limits the potential. The last factor to be applied was the savings factor, which is the percentage savings achieved from installing the efficient measure over a standard measure.

In developing the overall potential electricity savings, the analysis also took steps to account for the interactive effects of measures designed to impact the same end-use. For instance, if a home were to improve their air leakage rate, the overall space heating and cooling consumption in that home would decrease. As a result, the remaining potential for energy savings derived from additional thermal envelope efficiency measures and efficient heating/cooling equipment would be reduced.

In this analysis, it was assumed that for those measures designed to impact the same end-use, the savings potential for the end use was evenly split across these measures. For example, there are ten energy efficiency measures that can save the electricity used for water heating:

- This study includes three high efficiency water heaters (energy factors of .93, .95, and .97)
- Two different heat pump water heaters
- A solar water heater
- Water heater tank insulation wrap
- Low flow shower heads
- Low flow faucet aerators
- Pipe wrap

This study assumes that one-seventh of the existing electric water heaters are applicable to each of these seven energy efficiency measures. In the event that one of the competing measures was not found to be cost-effective, the homes assigned to that measure were transitioned over to a cost effective alternative (if any).

Fuel-switching for electric space heating and electric water heating was not examined in this study. The residential savings potential also takes into account scheduled federal upgrades to incandescent lighting. Recently enacted federal standards (*Energy Independence and Security Act of 2007*) require incandescent bulbs to be approximately 30% more efficient beginning in 2012.[48] These improvements to incandescent equipment performance result in decreased savings potential for CFL and LED technologies. While these new standards may shift the market even further towards wide-spread acceptance of CFL technologies, they do not necessary signal the end of incandescent bulbs. As a result, this analysis continues to include the potential savings from screw-in CFL bulbs from 2013-2023.

[48] The mandated increase in the efficiency of incandescent bulbs is phased in over a 3-year period: 100-watt bulbs must be 30% more efficient beginning in 2012, 75-watt bulbs in 2013, and 60-watt and 40-watt bulbs in 2014. To facilitate this analysis, GDS took the increased standards for incandescent lighting into account throughout the entire period of study (2012-2031).

6.3 TECHNICAL AND ECONOMIC POTENTIAL SAVINGS

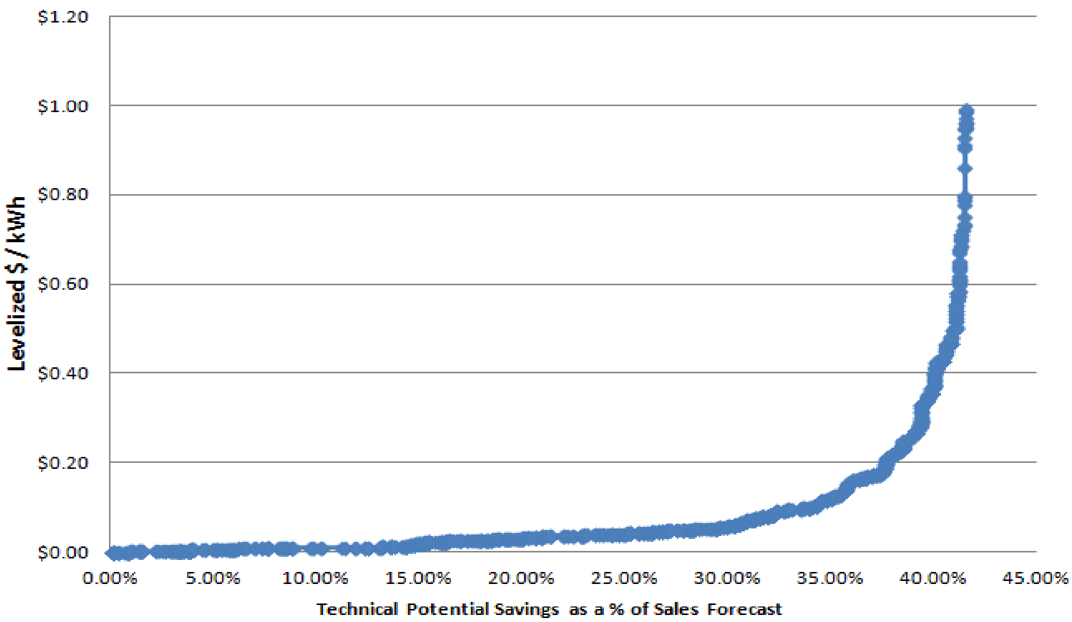
The technical potential represents the savings that could be captured if 100 percent of inefficient electric appliances and equipment were replaced instantaneously (where they are deemed to be technically feasible). As shown below in Table 6-2, total technical potential savings by 2018 for the Pennsylvania residential sector are 22,049,980 MWh, or 41% of forecast residential MWh sales in 2010.

Table 6-2: Statewide Residential Sector Technical Potential kWh Savings By End Use

	Technical Potential, Cumulative Savings (MWh), 2016			Technical Potential, Cumulative Savings (MWh), 2018			Technical Potential, Cumulative Savings (MWh), 2023		
End Use	*MWh*	*Percent of Total*	*MW*	*MWh*	*Percent of Total*	*MW*	*MWh*	*Percent of Total*	*MW*
Water Heating	2,535,551	12%	357	2,535,551	11%	357	2,535,551	11%	357
Lighting	6,288,492	29%	281	6,288,492	29%	281	6,288,492	28%	281
Appliances	2,887,520	13%	756	2,887,520	13%	756	2,887,520	13%	756
Electronics	1,744,855	8%	329	1,744,855	8%	329	1,744,855	8%	329
Pools	227,778	1%	74	227,778	1%	74	227,778	1%	74
HVAC (Envelope)	3,907,700	18%	1,019	3,907,700	18%	1,019	3,907,700	17%	1,019
HVAC (Equipment)	3,338,323	15%	1,291	3,338,323	15%	1,291	3,338,323	15%	1,291
Whole House	752,810	3%	450	752,810	3%	450	752,810	3%	450
New Construction	164,602	1%	26	366,950	2%	59	1,141,735	5%	183
Total	**21,847,632**	**100%**	**4,583**	**22,049,980**	**100%**	**4,616**	**22,824,765**	**100%**	**4,740**
% of Sales	**40.3%**			**40.7%**			**42.1%**		

Figure 6-3 below presents the statewide electric energy efficiency technical potential results for the residential sector in the form of a supply curve. The supply curve presents the technical potential savings (as a % of forecast kWh sales) at varied levelized costs per lifetime kWh saved amounts. For example, roughly 35% savings can be achieved at a cost per lifetime kWh saved of $0.10 or less. To obtain increased electric energy savings from efficiency resources, it is necessary to move to the right on the curve and choose progressively more costly energy efficiency resources. It should be noted that the levelized costs per lifetime kWh saved are based on electric savings and do not factor in associated non-electric benefits, nor do these costs include program administrative costs.

Figure 6-3: Residential Electric Efficiency Supply Curve for Pennsylvania



Note: Only includes measures with a levelized cost between $0.00/kWh and $1.00/kWh

Table 6-3 presents the residential sector economic potential savings by 2016, 2018 and 2023 for Pennsylvania. The economic potential savings by 2018 are 19,215,900 MWh, or 35.5% of forecast residential MWh sales in 2010.

Table 6-3: Statewide Residential Sector Economic Potential kWh Savings By End Use

	Economic Potential, Cumulative Savings (MWh), 2016			Economic Potential, Cumulative Savings (MWh), 2018			Economic Potential, Cumulative Savings (MWh), 2023		
End Use	***MWh***	***Percent of Total***	***MW***	***MWh***	***Percent of Total***	***MW***	***MWh***	***Percent of Total***	***MW***
Water Heating	2,211,118	12%	276	2,211,118	12%	277	2,211,118	11%	277
Lighting	6,262,001	33%	281	6,262,001	33%	281	6,262,001	32%	281
Appliances	2,357,113	12%	611	2,357,113	12%	611	2,357,113	12%	611
Electronics	1,698,313	9%	323	1,698,313	9%	323	1,698,313	9%	323
Pools	173,886	1%	93	173,886	1%	93	173,886	1%	93
HVAC (Envelope)	2,540,140	13%	168	2,540,140	13%	168	2,540,140	13%	168
HVAC (Equipment)	3,261,128	17%	1,201	3,261,128	17%	1,201	3,261,128	17%	1,201
Whole House	619,268	3%	375	619,268	3%	375	619,268	3%	375
New Construction	40,928	0%	5	92,933	0%	10	287,244	1%	32
Total	**19,163,895**	**100%**	**3,333**	**19,215,900**	**100%**	**3,340**	**19,410,211**	**100%**	**3,361**
% of Sales	**35.4%**			**35.5%**			**35.8%**		

The economic potential calculations were made by incorporating the various measure assumptions (savings, cost, and useful life, etc.) into the GDS cost-effectiveness screening tool.[49] Any programmatic

[49] The cost-effectiveness of a measure (used for determining the economic energy efficiency savings potential) is based on each measure's full savings potential, before any adjustments for interactive impacts. After identifying which measures passed screening, we made an additional adjustment for interactive effects in order to finalize estimates of overall economic potential.

costs (e.g., marketing, analysis, and administration) were ignored in the economic potential analysis in order to screen whether energy efficient technologies were cost-effective on their own merit prior to any assistance or marketing endeavors from utilities or other organizations. For the economic potential scenario, the study assumed 100% of all remaining cost-effective measures eligible for installation were installed.

6.4 ACHIEVABLE POTENTIAL SAVINGS IN THE RESIDENTIAL SECTOR

The achievable potential is a subset of the economic potential. The following two achievable potential scenarios were examined in this study:

- Incentives set are 100% of measure incremental cost
- Incentives set at 56% of measure incremental cost

6.4.1 ESTIMATING ACHIEVABLE SAVINGS IN THE RESIDENTIAL SECTOR

In the residential achievable potential scenario #1, achievable potential represents the attainable savings if incentives are set to 100% of measure incremental cost and the long-term market penetration of high efficiency electric appliances and equipment reaches 85%. The 85% target achievable penetration over the long-term was assumed for all residential energy efficiency measures.

Once the total number of measures eligible to be installed over the 10-year analysis time frame was determined, one of four annual penetration curves (upward trending, bell curve, downward trending and flat) was assigned to each measure. In general, these curves were assigned based on the relative level of the measure cost and current market acceptance. For example, a measure with low cost or high market acceptance was assigned the downward trending curve, resulting in higher levels of penetration in early years, followed by a slow decline in incremental annual penetration during latter years. A measure with a high install cost or low market acceptance was assigned the upward trending penetration curve. Early retirement measures and new construction measures were assigned a flat penetration curve. All four curves were tailored to ensure that the full desired market penetration was reached by the end of the analysis time frame (10 years out). For new measures not currently offered by existing programs, a "new" annual penetration curve was assigned. New measures are defined as those for which there is currently no incentive offered, and existing measures do currently have an incentive.

All of these diffusion curves assume a starting annual penetration well below the existing measures and does not achieve the targeted long-term market penetration rate until the final year of the analysis period Although this method simplifies what an adoption curve would look like in practice, it succeeds in providing a concise and practical method for estimating achievable savings potential over a specific period of time.

Finally, some energy efficiency measures possess a useful life less than the ten-year analysis time frame. For example, behavioral energy efficiency programs with a two-year life that are installed in 2013 expire at the end of 2014. In this analysis, expiring measures were reintroduced the year after they expire. This allows the electricity savings (and costs) to persist throughout the entire 10-year study horizon. The authors of this study acknowledge that measures reintroduced in later years may be impacted by future improvements to building or appliance codes and standards yet assumes that future energy and demand savings remain consistent through similar improvements to high efficiency measure standards over time.

6.4.2 RESIDENTIAL ACHIEVABLE SAVINGS POTENTIAL

Tables 6-4, 6-5, and 6-6 present the statewide cumulative annual energy savings by end-use for the residential sector for 2016, 2018 and 2023 for both achievable potential scenarios.

Table 6-4: Statewide Achievable Potential in 2016

	Achievable 1 Potential, Cumulative Savings, 2016			Achievable 2 Potential, Cumulative Savings, 2016		
End Use	***MWh***	***Percent of Total***	***MW***	***MWh***	***Percent of Total***	***MW***
Water Heating	297,078	10%	40	221,819	10%	29
Lighting	1,051,765	35%	47	798,330	36%	36
Appliances	361,681	12%	96	277,387	12%	72
Electronics	156,452	5%	26	89,391	4%	15
Pools	26,741	1%	14	20,870	1%	11
HVAC (Envelope)	376,762	13%	25	294,054	13%	20
HVAC (Equipment)	565,300	19%	295	430,188	19%	219
Whole House	139,976	5%	85	78,659	4%	48
New Construction	21,597	1%	2	16,370	1%	2
Total	**2,997,353**	**100%**	**631**	**2,227,067**	**100%**	**452**
% of Sales	**5.5%**			**4.1%**		

Table 6-5: Statewide Achievable Potential in 2018

	Achievable 1 Potential, Cumulative Savings, 2018			Achievable 2 Potential, Cumulative Savings, 2018		
End Use	***MWh***	***Percent of Total***	***MW***	***MWh***	***Percent of Total***	***MW***
Water Heating	557,807	10%	76	369,698	10%	49
Lighting	1,973,261	35%	89	1,339,673	36%	60
Appliances	673,014	12%	179	462,312	12%	121
Electronics	350,992	6%	57	186,530	5%	30
Pools	49,455	1%	27	34,783	1%	19
HVAC (Envelope)	696,849	12%	46	490,090	13%	33
HVAC (Equipment)	1,027,329	18%	506	693,951	19%	323
Whole House	239,061	4%	145	122,008	3%	74
New Construction	55,681	1%	6	37,169	1%	4
Total	**5,623,449**	**100%**	**1130**	**3,736,214**	**100%**	**713**
% of Sales	**10.4%**			**6.9%**		

Table 6-6: Statewide Achievable Potential in 2023

	Achievable 1 Potential, Cumulative Savings, 2023			Achievable 2 Potential, Cumulative Savings, 2023		
End Use	***MWh***	***Percent of Total***	***MW***	***MWh***	***Percent of Total***	***MW***
Water Heating	1,294,428	13%	175	716,223	13%	95
Lighting	1,891,089	18%	84	1,051,235	19%	47
Appliances	1,405,822	14%	400	751,633	13%	220
Electronics	899,080	9%	151	433,848	8%	73
Pools	120,418	1%	65	69,565	1%	37
HVAC (Envelope)	1,696,855	17%	113	980,181	18%	65
HVAC (Equipment)	2,229,290	22%	886	1,242,362	22%	470
Whole House	486,768	5%	295	230,379	4%	140
New Construction	215,222	2%	24	114,874	2%	13
Total	**10,238,971**	**100%**	**2194**	**5,590,301**	**100%**	**1160**
% of Sales	**18.9%**			**10.3%**		

Figures 6-4 and 6-5 are pie charts that show the Scenario #2 achievable potential energy efficiency savings by end-use and show the shifting flow of measure group share over time. In 2018, lighting is the dominant share (36%) of the total 2018 Scenario #1 achievable potential for the residential sector. By 2023, lighting energy efficiency savings (due to the effects of the EISA lighting provisions proposed to go into effect beginning in 2020 that further increase the baseline efficiency of lighting) have decreased to 19% of the achievable potential savings.

Figure 6-4: Residential Sector 2018 Achievable Potential Savings for Scenario #1 by End Use

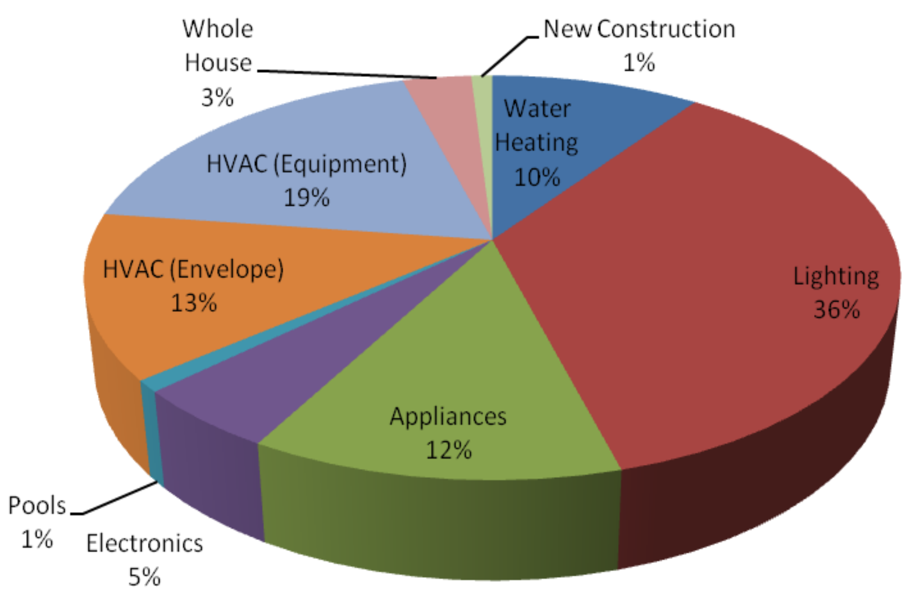


Figure 6-5: Residential Sector 2023 Achievable Potential Savings for Scenario #1 by End Use

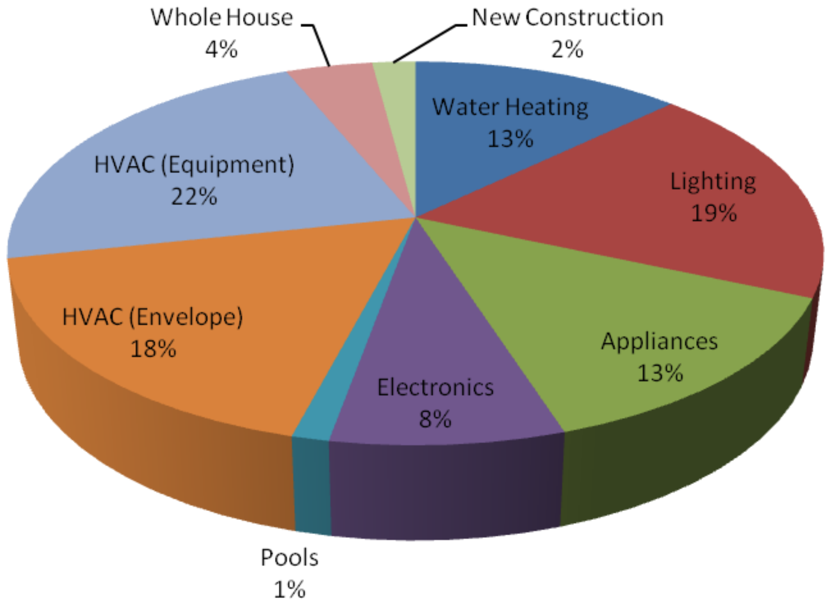


Table 6-7 and Table 6-8 show the breakdown of achievable potential by end use for the residential sector for the years 2013 to 2022 for the Achievable 1 and Achievable 2 potential scenarios.

Table 6-7: Cumulative Annual Residential Energy Savings in Achievable Potential Scenario 1 by End Use for Pennsylvania

End Use	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Water Heating	77,643	166,642	266,991	378,691	501,738	630,725	765,654	905,264	1,044,717	1,161,817
Lighting	274,355	588,251	941,689	1,334,668	1,767,189	2,230,938	2,509,218	2,268,169	1,995,663	1,693,874
Appliances	98,653	210,264	334,829	472,355	622,834	783,852	955,403	1,105,577	1,207,872	1,300,818
Electronics	29,487	77,120	142,901	226,830	320,819	414,056	510,756	611,358	715,858	824,260
Pools	7,717	16,386	26,007	36,576	48,098	60,571	73,994	88,368	102,741	117,115
HVAC (Envelope)	103,930	220,658	350,212	492,566	647,752	815,733	996,489	1,190,103	1,383,717	1,577,332
HVAC (Equipment)	150,713	321,895	513,533	725,634	932,802	1,150,668	1,379,240	1,598,691	1,811,102	2,019,229
Whole House	28,151	73,630	121,895	164,924	207,952	250,982	294,010	337,038	380,066	423,094
New Construction	1,723	5,106	10,307	17,330	26,196	37,099	49,993	64,851	80,516	96,653
Total	***772,374***	***1,679,955***	***2,708,365***	***3,849,575***	***5,075,381***	***6,374,624***	***7,534,758***	***8,169,419***	***8,722,254***	***9,214,192***
% of 2010 Sales	***1.4%***	***3.1%***	***5.0%***	***7.1%***	***9.4%***	***11.8%***	***13.9%***	***15.1%***	***16.1%***	***17.0%***

Table 6-8: Cumulative Annual Residential Energy Savings in Achievable Potential Scenario 2 by End Use for Pennsylvania

End Use	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Water Heating	66,282	132,564	198,846	265,127	331,409	397,691	463,973	529,142	594,311	641,359
Lighting	236,446	474,525	714,236	955,580	1,198,556	1,443,164	1,501,678	1,316,125	1,128,399	940,672
Appliances	85,686	171,373	257,059	342,746	428,432	514,119	599,805	657,511	676,696	695,880
Electronics	19,281	46,501	81,661	124,759	170,510	212,920	256,597	301,980	349,071	397,866
Pools	6,766	13,531	20,297	27,063	33,829	40,594	47,360	54,126	60,892	67,657
HVAC (Envelope)	91,126	182,251	273,377	364,502	455,628	546,753	637,879	729,005	820,130	911,256
HVAC (Equipment)	130,256	260,511	390,767	521,022	629,916	738,809	847,702	939,787	1,031,873	1,123,958
Whole House	18,408	44,396	68,458	87,283	106,108	124,933	143,756	162,582	181,407	200,231
New Construction	1,513	4,149	7,809	12,306	17,514	23,418	29,917	36,903	44,266	51,862
Total	***655,764***	***1,329,802***	***2,012,509***	***2,700,389***	***3,371,902***	***4,042,401***	***4,528,667***	***4,727,161***	***4,887,043***	***5,030,742***
% of 2010 Sales	***1.2%***	***2.5%***	***3.7%***	***5.0%***	***6.2%***	***7.5%***	***8.4%***	***8.7%***	***9.0%***	***9.3%***

Table 6-9 represents the total cost paid by the EDCs to realize 3-year and 5-year achievable savings estimates under the Achievable 2 scenario. For the residential sector, the per-MWh acquisition cost is between $212/MWh to $217/MWh, increasing slightly over the longer time window.

Table 6-9: Residential 3-Year and 5-Year Acquisition Costs Under the Achievable 2 Scenario

EDC	3-yr Acquisition Cost	3-yr Savings	3-yr $/MWh	5-yr Acquisition Cost	5-yr Savings	5-yr $/MWh
Duquesne	$ 46,339,287	209,446	$ 221.25	$ 80,635,783	348,829	$ 231.16
Met-Ed	$ 34,323,422	163,781	$ 209.57	$ 58,658,760	275,134	$ 213.20
Penelec	$ 37,658,610	178,791	$ 210.63	$ 64,223,102	299,700	$ 214.29
PennPower	$ 10,508,091	49,716	$ 211.36	$ 17,891,410	83,214	$ 215.01
PPL	$ 97,084,675	446,283	$ 217.54	$ 166,636,994	746,746	$ 223.15
PECO	$ 101,287,903	492,773	$ 205.55	$ 173,189,394	828,842	$ 208.95
West Penn	$ 49,015,939	232,102	$ 211.18	$ 84,052,544	391,146	$ 214.89
Statewide	**$ 376,217,926**	**1,772,893**	**$ 212.21**	**$ 645,287,988**	**2,973,611**	**$ 217.00**

6.4.3 ACHIEVABLE POTENTIAL BENEFITS & COSTS

For the Scenario #1 achievable potential estimates, it is assumed that EDCs will pay 100% of incremental measure costs. For Scenario #2 the incentive was assumed to be 56% of the incremental measure cost.

In addition, an overall non-incentive or administrative cost per first year kWh saved was assigned to each measure in order to calculate the achievable cost-effectiveness tests. The administrative cost per first year kWh saved used in this study is $.0813 per first year kWh saved. In all subsequent years, the administrative cost per kWh was escalated by the EDCs projection of the annual rate of inflation in the future. Tables 6-10 through 6-12 below provide the present value of benefits, costs and the Total Resource Cost Test ratios for the 3-year, 5-year, and 10-year periods in the Achievable Potential #1 scenario. Tables 6-13 through 6-15 provide the present value of benefits, costs and the Total Resource Cost Test ratios for the 3-year, 5-year, and 10-year periods in the Achievable Potential #2 scenario.

Table 6-10: 3-Year TRC Ratios for Achievable Potential Scenario#1 – Residential Sector Only

	TRC Benefits	TRC Costs	TRC Ratio
PECO	$ 363,430,526.05	$ 224,147,923.23	1.62
PPL	$ 651,009,086.04	$ 296,299,034.29	2.20
WPP	$ 207,648,861.67	$ 101,726,841.16	2.04
ME	$ 179,215,613.91	$ 68,957,588.77	2.60
PE	$ 156,744,345.95	$ 78,157,668.85	2.01
PP	$ 47,721,639.17	$ 22,789,287.62	2.09
Duq.	$ 170,523,210.54	$ 73,873,692.34	2.31
3-Year Period	***$ 1,776,293,283.33***	***$ 865,952,036.24***	***2.05***

Table 6-11: 5-Year TRC Ratios for Achievable Potential Scenario#1 – Residential Sector Only

	TRC Benefits	TRC Costs	TRC Ratio
PECO	$ 670,162,952.07	$ 394,626,947.82	1.70
PPL	$ 1,209,565,384.36	$ 527,381,239.42	2.29
WPP	$ 390,772,959.73	$ 179,606,262.73	2.18
ME	$ 344,660,804.42	$ 128,106,434.06	2.69
PE	$ 299,331,311.69	$ 142,508,344.06	2.10

	TRC Benefits		TRC Costs		TRC Ratio
PP	$	91,396,348.98	$	41,023,621.77	2.23
Duq.	$	305,668,434.05	$	132,892,769.30	2.30
5-Year Period	***$***	***3,311,558,195.30***	***$***	***1,546,145,619.17***	***2.14***

Table 6-12: 10-Year TRC Ratios for Achievable Potential Scenario#1 – Residential Sector Only

	TRC Benefits		TRC Costs		TRC Ratio
PECO	$	1,414,835,983.56	$	763,059,980.53	1.85
PPL	$	2,540,182,528.12	$	1,067,287,225.66	2.38
WPP	$	865,662,059.27	$	344,822,166.33	2.51
ME	$	813,242,024.70	$	279,404,622.50	2.91
PE	$	672,483,135.66	$	291,498,818.47	2.31
PP	$	205,589,891.72	$	81,384,462.48	2.53
Duq.	$	596,578,163.35	$	264,861,749.86	2.25
10-Year Period	***$***	***7,108,573,786.37***	***$***	***3,092,319,025.82***	***2.30***

Table 6-13: 3-Year TRC Ratios for Achievable Potential Scenario#2 – Residential Sector Only

	TRC Benefits		TRC Costs		TRC Ratio
PECO	$	274,010,376.59	$	170,632,179.14	1.61
PPL	$	490,589,466.79	$	223,927,084.60	2.19
WPP	$	155,151,674.74	$	75,698,040.31	2.05
ME	$	135,646,960.83	$	51,270,291.80	2.65
PE	$	118,748,110.90	$	58,502,833.41	2.03
PP	$	36,131,521.39	$	17,075,831.77	2.12
Duq.	$	128,840,971.38	$	55,364,280.12	2.33
3-Year Period	***$***	***1,339,119,082.61***	***$***	***652,470,541.16***	***2.05***

Table 6-14: 5-Year TRC Ratios for Achievable Potential Scenario#2 – Residential Sector Only

	TRC Benefits		TRC Costs		TRC Ratio
Duquesne	$	208,128,079.59	$	89,726,141.92	2.32
MetEd	$	233,333,093.99	$	85,804,449.57	2.72
Penelec	$	202,968,045.26	$	96,267,731.63	2.11
Penn Power	$	61,862,423.67	$	27,736,406.50	2.23
PPL	$	816,036,674.12	$	359,073,882.29	2.27
PECO	$	453,867,223.57	$	271,887,041.08	1.67
West Penn	$	260,687,268.99	$	120,575,839.52	2.16
5-Year Period	**$ 2,236,882,809.19**		**$ 1,051,071,492.51**		**2.13**

Table 6-15: 10-Year TRC Ratios for Achievable Potential Scenario#2 – Residential Sector Only

	TRC Benefits	TRC Costs	TRC Ratio
Duquesne	$ 351,124,843.63	$ 154,427,341.99	2.27
MetEd	$ 462,712,726.92	$ 159,782,853.31	2.90
Penelec	$ 386,268,728.64	$ 169,420,137.36	2.28
Penn Power	$ 117,943,113.89	$ 47,553,443.01	2.48
PPL	$ 1,467,016,032.07	$ 623,270,358.13	2.35
PECO	$ 819,018,364.26	$ 456,229,677.30	1.80
West Penn	$ 492,360,940.36	$ 201,422,581.19	2.44
10-Year Period	**$4,096,444,750**	**$1,812,106,392**	**2.26**

6.5 RESIDENTIAL SAVINGS BY EDC

This next section summarizes each of the savings potential by time-period, by scenario and by EDC. Results are presented as cumulative annual energy (MWh) and demand (MW) savings and the percentage of forecasted 2009/10 sales used in Phase 1 of Act 129.

Table 6-16: 3-Year Potential Savings by Scenario and EDC (2016)

3-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
RESIDENTIAL				
State-wide				
Energy (MWh)	**21,847,632**	**19,163,895**	**2,997,353**	**2,227,067**
% of 2010 MWh Sales	***40.3%***	***35.4%***	***5.5%***	***4.1%***
Summer MW	**4,583.5**	**3,333.1**	**630.6**	**451.5**
Duquesne Territory				
Energy (MWh)	1,951,950	1,738,874	273,619	203,534
% of 2010 MWh Sales	*46.6%*	*41.5%*	*6.5%*	*8.2%*
Summer MW	438.1	281.3	51.2	37.7
Met-Ed Territory				
Energy (MWh)	2,015,625	1,802,165	288,988	214,558
% of 2010 MWh Sales	*32.5%*	*29.5%*	*4.7%*	*3.5%*
Summer MW	391.1	299.9	56.6	40.0
Penelec Territory				
Energy (MWh)	1,780,538	1,618,293	257,169	192,379
% of 2010 MWh Sales	*36.5%*	*33.1%*	*5.3%*	*3.9%*
Summer MW	350.2	300.9	55.3	41.0
Penn Power Territory				
Energy (MWh)	579,802	521,073	81,325	60,683
% of 2010 MWh Sales	*31.4%*	*28.4%*	*4.4%*	*3.3%*
Summer MW	112.9	87.2	15.3	11.1
West Penn Power Territory				
Energy (MWh)	2,584,323	2,302,869	366,589	270,787
% of 2010 MWh Sales	*32.6%*	*29.0%*	*4.6%*	*3.4%*
Summer MW	566.2	511.1	100.9	69.9
PECO Territory				
Energy (MWh)	6,489,928	5,292,925	791,936	588,433
% of 2010 MWh Sales	*46.3%*	*37.8%*	*5.7%*	*4.2%*
Summer MW	1,530.5	897.2	150.7	110.9

3-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
PPL Territory				
Energy (MWh)	6,445,466	5,887,698	937,727	696,694
% of 2010 MWh Sales	*42.6%*	*38.9%*	*6.2%*	*4.6%*
Summer MW	1,194.4	955.5	200.5	140.8
***Achievable Scenario#1: Assumes 100% Incentives *Achievable Scenario#2: Assumes 56% in the residential sector**				

Table 6-17: 5-Year Potential Savings by Scenario and EDC (2018)

5-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
		RESIDENTIAL		
State-wide				
Energy (MWh)	**22,049,980**	**19,215,900**	**5,623,449**	**3,736,214**
% of 2010 MWh Sales	***40.7%***	***35.5%***	***10.4%***	***6.9%***
Summer MW	**4,615.9**	**3,339.6**	**1,130.1**	**712.5**
Duquesne Territory				
Energy (MWh)	1,951,950	1,738,874	512,646	341,480
% of 2010 MWh Sales	*46.6%*	*41.5%*	*12.2%*	*9.8%*
Summer MW	438.1	281.3	91.1	59.6
Met-Ed Territory				
Energy (MWh)	2,063,489	1,829,901	548,069	364,312
% of 2010 MWh Sales	*33.3%*	*29.5%*	*8.8%*	*5.9%*
Summer MW	398.7	302.9	102.9	64.2
Penelec Territory				
Energy (MWh)	1,804,715	1,634,442	485,344	325,182
% of 2010 MWh Sales	*37.0%*	*33.5%*	*9.9%*	*6.7%*
Summer MW	354.2	302.8	99.3	65.3
Penn Power Territory				
Energy (MWh)	582,936	523,129	152,960	102,224
% of 2010 MWh Sales	*31.6%*	*28.4%*	*8.3%*	*5.5%*
Summer MW	113.4	87.4	27.7	18.0
West Penn Power Territory				
Energy (MWh)	2,602,440	2,308,932	688,185	453,677
% of 2010 MWh Sales	*32.8%*	*29.1%*	*8.7%*	*5.7%*
Summer MW	569.5	511.8	183.1	111.6
PECO Territory				
Energy (MWh)	6,543,125	5,292,925	1,488,047	989,465
% of 2010 MWh Sales	*46.7%*	*37.8%*	*10.6%*	*7.1%*
Summer MW	1,540.1	897.9	270.4	177.1
PPL Territory				
Energy (MWh)	6,501,325	5,887,698	1,748,198	1,159,873
% of 2010 MWh Sales	*43.0%*	*38.9%*	*11.5%*	*7.7%*
Summer MW	1,201.9	955.5	355.7	216.8
***Achievable Scenario#1: Assumes 100% Incentives *Achievable Scenario#2: Assumes 56% in the residential sector**				

Table 6-18: 10-Year Potential Savings by Scenario and EDC (2018)

10-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
		RESIDENTIAL		
State-wide				
Energy (MWh)	**22,824,765**	**19,410,211**	**10,238,971**	**5,590,301**

10-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
% of 2010 MWh Sales	***42.1%***	***35.8%***	***18.9%***	***10.3%***
Summer MW	**4,740.3**	**3,361.0**	**2,193.6**	**1,160.4**
Duquesne Territory				
Energy (MWh)	1,951,950	1,738,874	893,495	485,914
% of 2010 MWh Sales	*46.6%*	*41.5%*	*21.3%*	*10.9%*
Summer MW	438.1	281.3	179.5	95.7
Met-Ed Territory				
Energy (MWh)	2,250,555	1,938,297	1,024,779	559,559
% of 2010 MWh Sales	*36.3%*	*31.3%*	*16.5%*	*9.0%*
Summer MW	428.2	314.3	205.5	109.3
Penelec Territory				
Energy (MWh)	1,893,308	1,693,626	846,556	463,659
% of 2010 MWh Sales	*38.8%*	*34.7%*	*17.3%*	*9.5%*
Summer MW	368.9	309.8	201.9	108.6
Penn Power Territory				
Energy (MWh)	594,286	530,556	271,740	148,893
% of 2010 MWh Sales	*32.2%*	*28.8%*	*14.7%*	*8.1%*
Summer MW	115.3	88.2	57.1	30.7
West Penn Power Territory				
Energy (MWh)	2,660,100	2,328,236	1,228,644	666,495
% of 2010 MWh Sales	*33.5%*	*29.4%*	*15.5%*	*8.4%*
Summer MW	579.9	514.0	352.3	182.7
PECO Territory				
Energy (MWh)	6,770,186	5,292,925	2,685,478	1,465,547
% of 2010 MWh Sales	*48.3%*	*37.8%*	*19.2%*	*10.5%*
Summer MW	1,580.7	897.9	552.5	296.4
PPL Territory				
Energy (MWh)	6,704,380	5,887,698	3,288,279	1,800,232
% of 2010 MWh Sales	*44.3%*	*38.9%*	*21.7%*	*11.9%*
Summer MW	1,229.1	955.5	644.7	337.1

***Achievable Scenario#1: Assumes 100% Incentives**
***Achievable Scenario#2: Assumes 56% in the residential sector**

7 COMMERCIAL & INDUSTRIAL ENERGY EFFICIENCY POTENTIAL ESTIMATES

This section provides an overview of findings for the entire non-residential sector in Pennsylvania. The section presents findings for technical, economic, achievable potential energy savings for each sector – non-residential, commercial and industrial. A summary table of findings by time horizon, sector, scenario, and EDC is presented at the end of this section.

7.1 NON-RESIDENTIAL ENERGY EFFICIENCY POTENTIAL

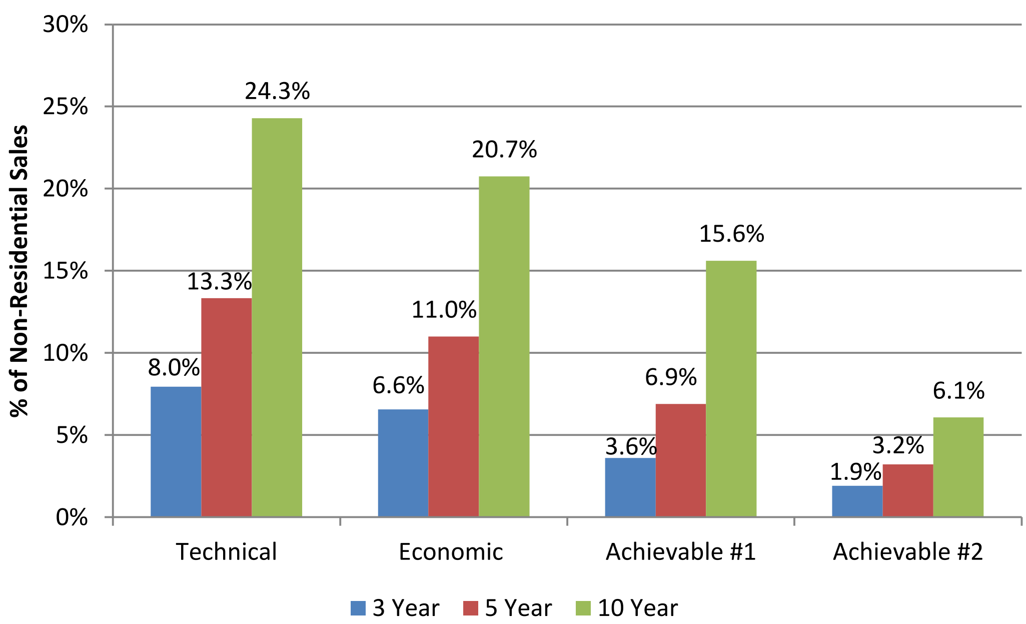
This section presents estimates for technical, economic, and achievable potential for the non-residential sector (commercial and industrial combined). Results are presented at the state level. Each of the tables in the technical, economic and achievable sections present the respective potential for efficiency savings expressed as cumulative savings (MWh), percentage of sales, and demand (MW). Data is provided for a 3, 5, and 10-year horizon for the entire state.

This energy efficiency potential study considers the impacts of the Energy and Independence and Security Act (EISA) as an improving code standard for the non-residential sector. EISA improves the baseline efficiency of compact fluorescent lamps (CFL), general service fluorescent lamps (GSFL), high intensity discharge (HID) lamps and ballasts and motors, all applicable in the non-residential sector. The SWE analyzed the impacts of EISA when benchmarking the results of this study against historical PA ACT 129 program performance, national energy efficiency program performance and contemporary potential studies. The SWE found the result of this potential study in the non-residential sector are approximately 23% lower due to EISA against the expected potentials without EISA.

7.1.1 SUMMARY OF FINDINGS

Figure 7-1 illustrates the estimated savings potential for each of the four scenarios included in this study for all seven EDCs combined (statewide).

Figure 7-1: Summary of Non-Residential Energy Efficiency Potential as a % of 2010 Sales Forecasts – Statewide



Expressed as the cumulative 3-year savings, the theoretical technical savings potential is 8.0% of Act 129 Phase 1 forecasted 2009/10 sector sales[50]. 3-year achievable potential scenario 2 savings is 1.9% of sector sales. The 5-year savings technical savings potential is 13.3% of sector sales. Economic potential is just under 11.0% of sales, achievable potential scenario 1 (100% incentive levels) is 6.9%, while achievable potential scenario 2 is estimated to be 3.2% of sector sales based on an incentive level of just over 34 percent.[51] 10-year technical potential is estimated at 24.3% of 2009/10 forecasted sector sales.

Table 7-1 shows the savings from the Institutional sector as a percentage of total non-residential sales for the four scenarios that were modeled. Institutional savings account for less than 1% of 3-year savings in the technical scenario, and slightly over 1% of 5-year savings.

Table 7-1: Institutional Savings as a Percentage of Non-Residential Sales

Institutional Savings as a Percent of Non-residential Sales					
	Nonres Sales (MWh)	*3 yr. Inst. Savings (MWH)*	*3 yr % of Sales*	*5 yr. Inst. Savings (MWH)*	*5 yr % of Sales*
Technical	92,469,242	615,008	0.7%	1,036,562	1.1%
Economic	92,469,242	473,542	0.5%	797,965	0.9%
Ach 1	92,469,242	271,021	0.3%	513,068	0.6%
Ach 2	92,469,242	138,516	0.1%	233,414	0.3%

7.1.2 TECHNICAL POTENTIAL

Technical potential represents the quantification of savings that can be realized if energy-efficiency measures passing the qualitative screening are applied in all feasible instances, regardless of cost. Table 7-2 shows that it is technically feasible to save nearly 7.5 million MWh in the non-residential sector between 2013 to 2016, and approximately 12.4 million MWh during the 5 year period from 2013 to 2018 across the state, representing just fewer than 8% of 3-year non-residential sales, and 13.3% of 5-year non-residential sales. Lighting represents the majority of the potential at more than 40% of savings, while cooking equipment represents the smallest share with less than 1 percent. Ten-year technical potential is estimated to be just over 22 million MWh (or 24.3% of sector sales) across the state. The Technical scenario also suggests a 3 year reduction in statewide load of 990 MW, a 5 year reduction of 1,662 MW, and 3,099 MW over a 10-year horizon.

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[50] Phase 1 sales represent the 2009/10 forecasted sales number used to benchmark savings targets against. For 2009/2010 this statewide number was 146,661,800 MWh.

[51] The Achievable Potential Scenario 2 represents a situation where the EDCs incentivize programs through a reimbursement of 34.24% of customer costs.

Table 7-2: Statewide Non-Residential Sector Technical Potential kWh Savings By End Use

	Technical Potential, Cumulative Savings (MWh), 2016			Technical Potential, Cumulative Savings (MWh), 2018			Technical Potential, Cumulative Savings (MWh), 2023		
End Use	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Lighting	3,099,448	42.1%	339	5,153,785	41.8%	563	9,050,315	40.3%	993
HVAC	862,549	11.7%	256	1,457,755	11.8%	432	2,981,561	13.3%	884
Plug Load	735,936	10.0%	79	1,266,122	10.3%	135	1,525,471	6.8%	163
Refrigeration	519,088	7.1%	18	869,513	7.0%	30	1,729,217	7.7%	59
Cooking	24,476	0.3%	3	40,848	0.3%	5	80,178	0.4%	9
Water Heating	71,948	1.0%	7	119,933	1.0%	11	236,056	1.1%	22
Motors	1,502,240	20.4%	235	2,520,301	20.4%	394	5,075,709	22.6%	791
Process	381,767	5.2%	36	642,013	5.2%	60	1,230,389	5.5%	114
Other	156,521	2.1%	18	267,069	2.2%	30	560,017	2.5%	63
Total	**7,353,972**	**100%**	**990**	**12,337,338**	**100%**	**1,662**	**22,468,914**	**100%**	**3,099**
% of Sales	**8.0%**			**13.3%**			**24.3%**		

7.1.3 ECONOMIC POTENTIAL

Economic Potential is a subset of technical potential, where only measures that are cost-effective from the Total Resource Cost (TRC) perspective pass the economic screen and are considered when calculating savings potential.

Table 7-3 shows that it is economically feasible to save slightly more than 6 million MWh during the 3 year period from 2013 to 2016, and more than 10 million MWh during the 5 year period from 2013 to 2018, representing 6.6% and 11.0% of non-residential sales respectively. Lighting and motor savings measures again make up a majority of the savings. Ten-year economic potential is estimated at approximately 19 million MWH (or 20.8% of sector sales) across the state. The Economic scenario also suggests a load reduction of between 809 and 2,621 MW, depending on the timeframe

Table 7-3: Statewide Non-Residential Sector Economic Potential kWh Savings By End Use

	Economic Potential, Cumulative Savings (MWh), 2016			Economic Potential, Cumulative Savings (MWh), 2018			Economic Potential, Cumulative Savings (MWh), 2023		
End Use	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Lighting	2,465,635	40.7%	261	4,100,681	40.3%	434	7,521,256	39.2%	814
HVAC	708,095	11.7%	214	1,195,926	11.8%	361	2,443,459	12.7%	738
Plug Load	476,469	7.9%	51	819,779	8.1%	88	1,045,605	5.5%	112
Refrigeration	460,691	7.6%	18	771,791	7.6%	29	1,535,135	8.0%	57
Cooking	11,884	0.2%	1	19,819	0.2%	2	38,947	0.2%	5
Water Heating	41,790	0.7%	4	69,656	0.7%	6	137,073	0.7%	13
Motors	1,430,047	23.6%	214	2,400,095	23.6%	358	4,839,459	25.2%	720
Process	309,474	5.1%	29	520,426	5.1%	49	1,061,486	5.5%	99
Other	156,887	2.6%	18	267,682	2.6%	30	561,262	2.9%	63
Total	**6,060,971**	**100%**	**809**	**10,165,854**	**100%**	**1,359**	**19,183,681**	**100%**	**2,621**
% of Sales	**6.6%**			**11.0%**			**20.7%**		

7.1.4 ACHIEVABLE POTENTIAL

Achievable Potential is an estimate of energy savings that can feasibly be achieved through program and policy interventions. This study estimated theoretically achievable potential for two policy intervention scenarios corresponding to varying incentive levels provided to end-use consumers. Achievable potential scenario 1 (Achievable 1) assumed an incentive level of 100% of incremental costs to C&I customers, where achievable potential scenario 2 (Achievable 2) assumed an incentive level of 34.2% of incremental costs to C&I customers, similar to current program level funding adjusted to account for increasing costs of energy saving measures over time.

Table 7-4 and Table 7-5 show the estimated savings for both achievable scenarios over a 3 and 5 year horizons. Under the Achievable 1 scenario it is feasible to save 3.3 million MWh during the 3 year period from 2013 to 2016 across the state, representing 3.6% of sector sales. Under the Achievable 2 scenario it is feasible to save just under 1.8 million MWh based on the lower incentive level. The Achievable 1 scenario also suggests a 3 year reduction in demand of 429 MW across the state, with the Achievable 2 scenario estimating a demand reduction of 237 MW. The 5-year savings for achievable potential scenario is 6.9% and 3.2% of sector sales for achievable 1 and achievable 2 respectively.

Table 7-4: Non-Residential Achievable Savings Potential in 2016

	Achievable 1 Potential, Cumulative Savings (MWh), 2016			Achievable 2 Potential, Cumulative Savings (MWh), 2016		
End Use	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Lighting	1,329,259	39.8%	142	721,220	40.7%	76
HVAC	457,912	13.7%	107	207,129	11.7%	63
Plug Load	263,770	7.9%	28	139,372	7.9%	15
Refrigeration	230,980	6.9%	13	134,755	7.6%	5
Cooking	4,800	0.1%	1	3,476	0.2%	0
Water Heating	16,868	0.5%	2	12,224	0.7%	1
Motors	787,430	23.6%	111	418,302	23.6%	63
Process	178,779	5.3%	17	90,525	5.1%	9
Other	72,388	2.2%	8	45,890	2.6%	5
Total	**3,342,188**	**100%**	**429**	**1,772,893**	**100%**	**237**
% of Sales		**3.6%**			**1.9%**	

Table 7-5: Non-Residential Achievable Savings Potential in 2018

	Achievable 1 Potential, Cumulative Savings (MWh), 2018			Achievable 2 Potential, Cumulative Savings (MWh), 2018		
End Use	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Lighting	2,528,553	39.7%	270	1,199,486	40.3%	127
HVAC	835,499	13.1%	213	349,827	11.8%	106
Plug Load	517,473	8.1%	55	239,793	8.1%	26
Refrigeration	454,904	7.1%	23	225,754	7.6%	9
Cooking	10,216	0.2%	1	5,797	0.2%	1
Water Heating	35,891	0.6%	3	20,374	0.7%	2
Motors	1,503,216	23.6%	216	702,051	23.6%	105
Process	336,541	5.3%	32	152,230	5.1%	14
Other	150,349	2.4%	17	78,298	2.6%	9
Total	**6,372,642**	**100%**	**831**	**2,973,611**	**100%**	**398**
% of Sales		**6.9%**			**3.2%**	

Table 7-6 shows the estimated savings for both scenarios over a 10-year horizon. Under the Achievable 1 scenario it is feasible to save nearly 14.4 million MWh between 2013 and 2023 which represents 15.6% of sector sales. Assuming a more realistic incentive level, the Achievable 2 scenario estimates a savings of 5.6 million MWh over a 10-year horizon. The Achievable 1 scenario also suggests a 5 year reduction in demand of 1,917 MW across the state, with the Achievable 2 scenario estimating a demand reduction of 767 MW over the 10-year horizon.

Table 7-6: Non-Residential Achievable Savings Potential in 2023

	Achievable 1 Potential, Cumulative Savings (MWh), 2023			Achievable 2 Potential, Cumulative Savings (MWh), 2023		
End Use	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Lighting	5,693,217	39.4%	608	2,200,040	39.2%	238
HVAC	1,895,902	13.1%	530	714,751	12.7%	216
Plug Load	851,994	5.9%	91	305,849	5.5%	33
Refrigeration	1,103,747	7.6%	46	449,037	8.0%	17
Cooking	26,475	0.2%	3	11,392	0.2%	1
Water Heating	93,195	0.6%	9	40,094	0.7%	4
Motors	3,576,676	24.8%	514	1,415,588	25.2%	210
Process	796,443	5.5%	71	310,497	5.5%	29
Other	399,892	2.8%	44	164,171	2.9%	19
Total	**14,437,541**	**100%**	**1,917**	**5,611,418**	**100%**	**767**
% of Sales	**15.6%**			**6.1%**		

Figure 7-2 shows the estimated 5-year cumulative efficiency savings potential broken out by end use across the entire non-residential sector. The lighting end use shows the largest potential for savings by a wide margin at just under 1.2 million MWh, or 40.3% of total savings.

Figure 7-2: Non-Residential Sector 2018 Achievable Potential Savings for Scenario #2 by End Use

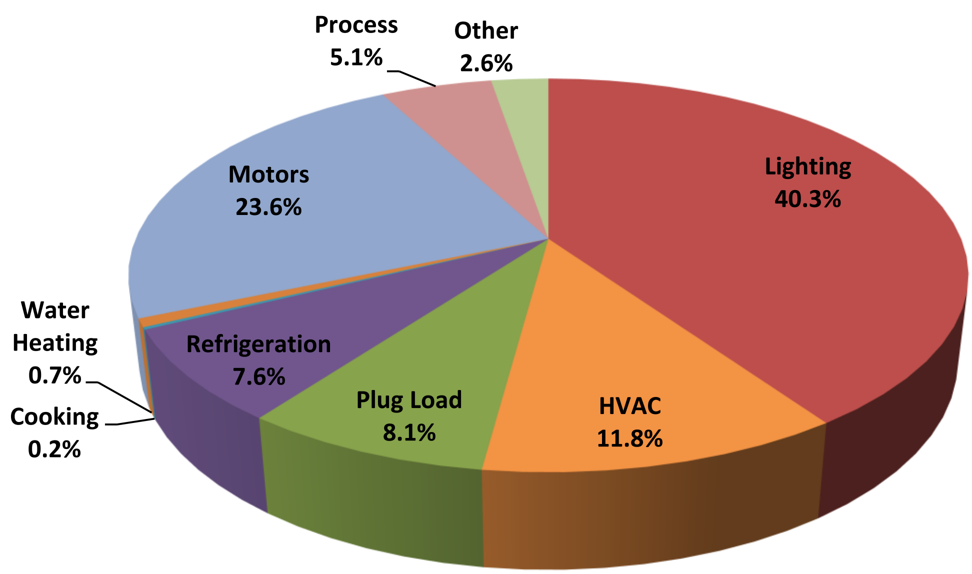


Figure 7-3 shows the breakdown of estimated savings in 2018 by vintage for the Achievable 1 scenario. The vast majority of savings come from existing/turnover measures, meaning energy efficient equipment is installed in replacement of existing equipment that has failed, with less than 2% of savings potential coming from new construction.

Figure 7-3: Non-Residential Achievable 1 Savings in 2018 by Vintage

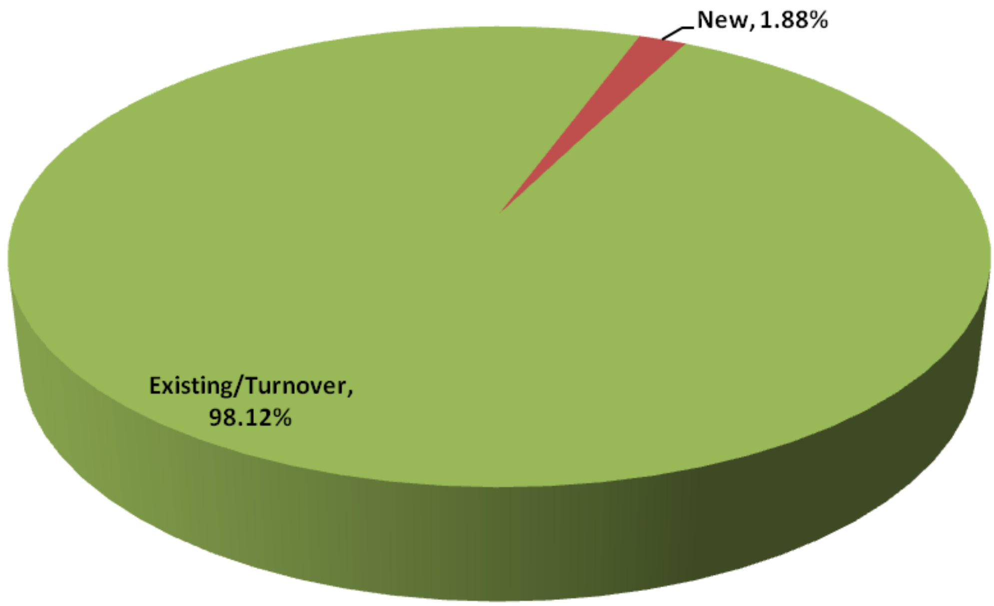


Figure 7-4 shows a breakdown of estimated 2018 savings by vintage for the Achievable 2 scenario. In this scenario, there is slightly more savings potential for new construction.

Figure 7-4: Non-Residential Achievable 2 Savings in 2018 by Vintage

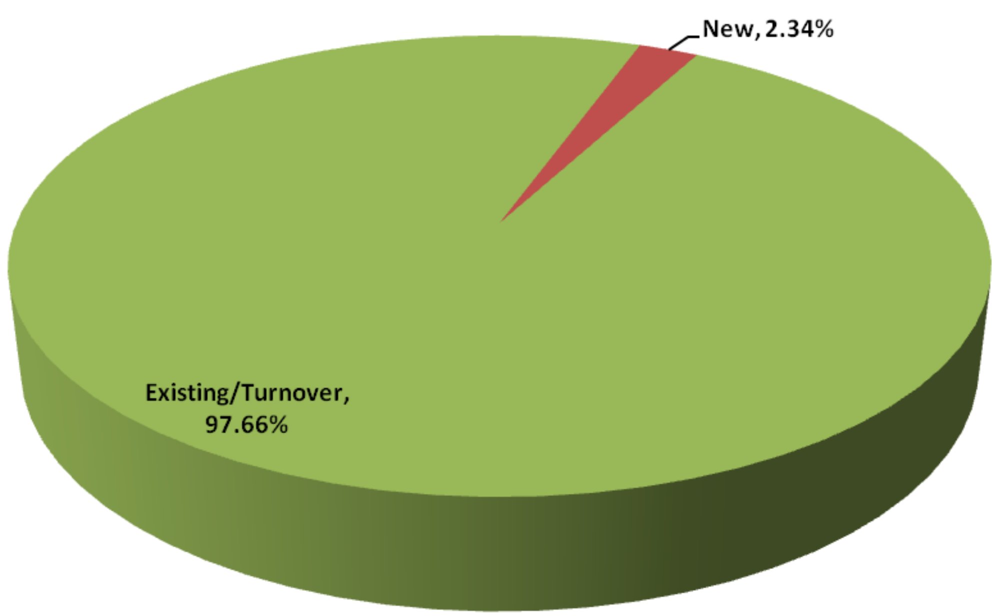


Table 7-7 and Table 7-8 show cumulative energy savings for both achievable scenarios for each year across the 10-year horizon for the study, broken out by end use.

Table 7-7: Cumulative Annual Non-Residential Energy Savings in Achievable Potential Scenario 1 by End Use for Pennsylvania

End Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Lighting	380,861	823,359	1,329,259	1,899,335	2,528,553	3,220,643	3,864,495	4,491,939	5,101,193	5,693,217
HVAC	138,759	291,025	457,912	639,720	835,499	1,044,903	1,255,587	1,467,832	1,681,176	1,895,902
Plug Load	73,808	161,219	263,770	382,505	517,473	601,158	677,340	745,007	803,112	851,994
Refrigeration	63,497	140,586	230,980	336,111	454,904	585,709	715,640	845,379	974,604	1,103,747
Cooking	1,160	2,761	4,800	7,295	10,216	13,531	16,810	20,063	23,281	26,475
Water Heating	4,095	9,721	16,868	25,621	35,891	47,553	59,092	70,554	81,913	93,195
Motors	225,427	487,486	787,430	1,126,520	1,503,216	1,916,375	2,330,036	2,744,918	3,160,284	3,576,676
Process	52,118	111,583	178,779	253,802	336,541	427,167	518,465	610,491	703,126	796,443
Other	18,655	42,721	72,388	108,254	150,349	198,539	247,478	297,363	348,123	399,892
Total	***958,380***	***2,070,461***	***3,342,188***	***4,779,163***	***6,372,642***	***8,055,579***	***9,684,942***	***11,293,546***	***12,876,811***	***14,437,541***

Table 7-8: Cumulative Annual Non-Residential Energy Savings in Achievable Potential Scenario 2 by End Use for Pennsylvania

End Use	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Lighting	241,496	481,526	721,220	961,202	1,199,486	1,437,653	1,627,424	1,818,103	2,008,888	2,200,040
HVAC	68,234	137,159	207,129	278,179	349,827	421,891	494,395	567,436	640,856	714,751
Plug Load	45,227	91,533	139,372	188,895	239,793	252,839	266,160	279,464	292,569	305,849
Refrigeration	44,943	89,921	134,755	180,222	225,754	270,767	315,479	360,126	404,596	449,037
Cooking	1,160	2,319	3,476	4,640	5,797	6,938	8,066	9,185	10,293	11,392
Water Heating	4,095	8,168	12,224	16,307	20,374	24,387	28,358	32,303	36,211	40,094
Motors	138,806	278,085	418,302	559,913	702,051	844,231	986,583	1,129,356	1,272,296	1,415,588
Process	29,945	60,074	90,525	121,275	152,230	183,417	214,836	246,505	278,383	310,497
Other	15,017	30,318	45,890	61,924	78,298	94,881	111,722	128,889	146,356	164,171
Total	***588,922***	***1,179,103***	***1,772,893***	***2,372,556***	***2,973,611***	***3,537,006***	***4,053,024***	***4,571,367***	***5,090,447***	***5,611,418***

Table 7-9 represents the total cost projected to be paid by the EDCs to realize the 3 and 5-year achievable savings under the Achievable 2 scenario. For the non-residential sector the projected statewide cost is approximately $376 and $645 million respectively, or $212/MWh at 3 years and $217/MWh at 5 years.

Table 7-9: Non-Residential 3-Year and 5-Year Acquisition Costs Under the Achievable 2 Scenario

EDC	*3-yr Acquisition Cost*	*3-yr Savings*	*3-yr $/MWh*	*5-yr Acquisition Cost*	*5-yr Savings*	*5-yr $/MWh*
Duquesne	$ 46,339,287	209,446	$ 221.25	$ 80,635,783	348,829	$ 231.16
Met-Ed	$ 34,323,422	163,781	$ 209.57	$ 58,658,760	275,134	$ 213.20
Penelec	$ 37,658,610	178,791	$ 210.63	$ 64,223,102	299,700	$ 214.29
PennPower	$ 10,508,091	49,716	$ 211.36	$ 17,891,410	83,214	$ 215.01
PPL	$ 97,084,675	446,283	$ 217.54	$ 166,636,994	746,746	$ 223.15
PECO	$ 101,287,903	492,773	$ 205.55	$ 173,189,394	828,842	$ 208.95
West Penn	$ 49,015,939	232,102	$ 211.18	$ 84,052,544	391,146	$ 214.89
Statewide	**$ 376,217,926**	**1,772,893**	**$ 212.21**	**$ 645,287,988**	**2,973,611**	**$ 217.00**

7.1.5 ACHIEVABLE POTENTIAL BENEFITS AND COSTS

The total resource cost (TRC) measures the net benefits of the energy efficiency program for a region or service area as a whole. Costs included in the TRC are costs to purchase and install the energy efficiency measure and overhead costs of running the energy efficiency program. The benefits included are the avoided costs of energy and capacity. Tables 7-10 through 7-12 below provide the present value of benefits and costs of the Total Resource Cost Test for the 3-year, 5-year, and 10-year periods in the Achievable Potential #1 scenario. Tables 7-13 through 7-15 provide the present value of benefits and costs of the Total Resource Cost Test for the 3-year, 5-year, and 10-year periods in the Achievable Potential #2 scenario.

Table 7-10: 3-Year TRC Ratios for Achievable Potential Scenario#1 – Non-Residential Sector Only

	TRC Benefits	TRC Costs	TRC Ratio
Duquesne	$274,525,024	$199,460,081	1.38
Met-Ed	$226,148,514	$138,249,695	1.64
Penelec	$257,112,625	$151,888,724	1.69
Penn Power	$68,128,487	$42,604,172	1.60
PPL	$772,031,490	$397,405,588	1.94
PECO	$543,291,228	$420,198,809	1.29
WPP	$319,119,149	$200,225,143	1.59
3-Year Period	***$ 2,460,356,517.03***	***$ 1,550,032,211.84***	***1.59***

Table 7-11: 5-Year TRC Ratios for Achievable Potential Scenario#1 – Non-Residential Sector Only

	TRC Benefits	TRC Costs	TRC Ratio
Duquesne	$555,213,848	$390,802,390	1.42
Met-Ed	$479,367,629	$270,530,609	1.77
Penelec	$542,647,032	$296,736,385	1.83
Penn Power	$143,876,791	$82,919,898	1.74
PPL	$1,548,190,275	$780,419,522	1.98
PECO	$1,091,788,722	$812,314,317	1.34
WPP	$676,990,697	$391,951,364	1.73
5-Year Period	***$ 5,038,074,995.17***	***$ 3,025,674,486.11***	***1.67***

Table 7-12: 10-Year TRC Ratios for Achievable Potential Scenario#1 – Non-Residential Sector Only

	TRC Benefits	TRC Costs	TRC Ratio
Duquesne	$1,571,364,463	$1,047,992,366	1.50
Met-Ed	$1,425,834,957	$684,616,060	2.08
Penelec	$1,584,431,717	$741,142,049	2.14
Penn Power	$428,893,095	$210,158,261	2.04
PPL	$4,087,903,096	$2,015,558,859	2.03
PECO	$2,789,652,316	$1,968,817,033	1.42
WPP	$2,029,988,159	$998,562,189	2.03
10-Year Period	***$13,918,067,802.87***	***$7,666,846,815.75***	***1.82***

Table 7-13: 3-Year TRC Ratios for Achievable Potential Scenario#2 – Non-Residential Sector Only

	TRC Benefits	TRC Costs	TRC Ratio
Duquesne	$141,468,982	$101,210,454	1.40
Met-Ed	$118,992,526	$74,249,438	1.60
Penelec	$134,596,064	$81,613,963	1.65
Penn Power	$35,573,735	$22,799,315	1.56
PPL	$405,141,806	$212,135,256	1.91
PECO	$286,242,111	$217,665,200	1.32
WPP	$163,820,632	$106,314,742	1.54
3-Year Period	***$ 1,285,835,857***	***$ 815,988,367***	***1.58***

Table 7-14: 5-Year TRC Ratios for Achievable Potential Scenario#2 – Non-Residential Sector Only

	TRC Benefits	TRC Costs	TRC Ratio
Duquesne	$251,772,501	$176,076,370	1.43
Met-Ed	$219,224,671	$126,899,896	1.73
Penelec	$247,302,408	$139,193,340	1.78
Penn Power	$65,471,331	$38,820,834	1.69
PPL	$711,803,696	$364,138,937	1.95
PECO	$503,509,412	$372,214,656	1.35
WPP	$304,425,540	$182,328,459	1.67
5-Year Period	***$ 2,303,509,559.93***	***$1,399,672,492.15***	***1.65***

Table 7-15: 10-Year TRC Ratios for Achievable Potential Scenario#2 – Non-Residential Sector Only

	TRC Benefits	TRC Costs	TRC Ratio
Duquesne	$601,460,452	$402,235,625	1.50
Met-Ed	$544,931,402	$269,398,404	2.02
Penelec	$605,811,334	$292,126,088	2.07
Penn Power	$163,553,803	$82,607,181	1.98
PPL	$1,585,793,435	$789,185,792	2.01
PECO	$1,087,793,577	$770,201,740	1.41
WPP	$770,032,609	$391,080,770	1.97
10-Year Period	***$ 5,359,376,612.11***	***$ 2,996,835,600.79***	***1.79***

7.2 COMMERCIAL ENERGY EFFICIENCY POTENTIAL

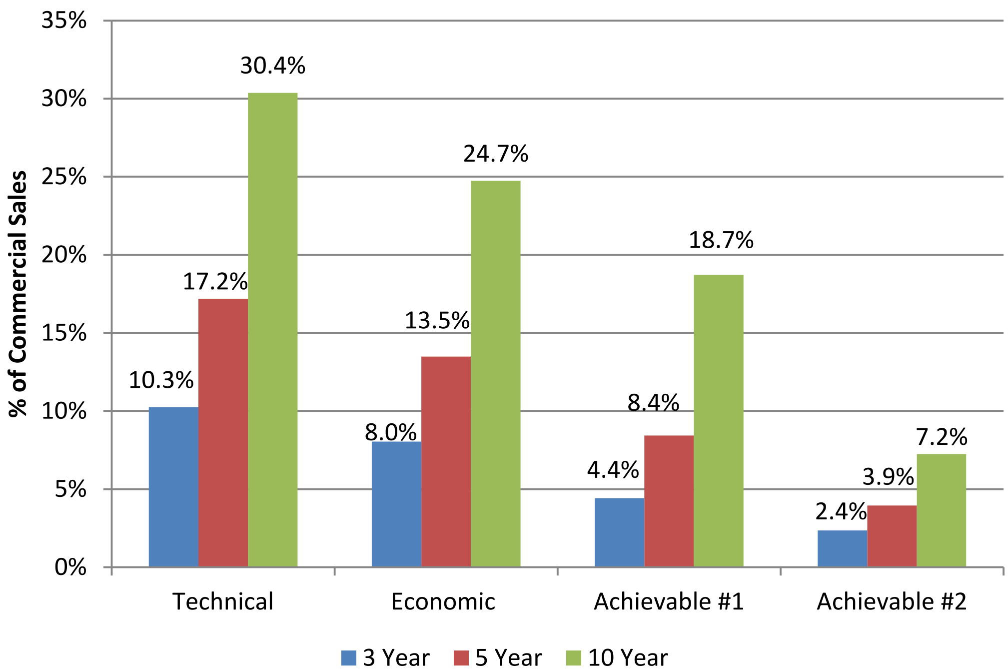
This section presents estimates for technical, economic, and achievable potential for the commercial sector. Results are presented at the state level, with a summary of EDC savings at the end. Each of the tables in the technical, economic and achievable sections present the respective potential for efficiency savings expressed as cumulative sales (MWh), percentage of the forecasted 2009/10 sales used in Phase 1 of Act 129, and demand (MW). Data is provided for a 3-year, 5-year, and 10-year horizons for the entire state.

7.2.1 SUMMARY OF FINDINGS

Figure 7-5 illustrates the estimated commercial energy savings potential for each of the four scenarios included in this study for all seven EDCs combined (i.e. the state). Ten-year technical potential savings are estimated at 30.4% of 2009/10 sector sales. Expressed as the cumulative 5-year savings, the theoretical technical savings potential is 17.2% of Act 129 Phase 1 forecasted 2009/10 commercial sector sales. Economic potential is estimated at 13.5% of sector sales, while achievable 2 savings potential is at 3.9% of sector sales. 3-year achievable 2 savings potential is 2.4% of sector sales.

Achievable potential scenario 1 estimates an 85% long-term target market penetration, and models an aggressive scenario in which consumers would receive a financial incentive equal to 100% of the measure cost. Achievable potential scenario 2 (current incentive levels) assumes that monetary incentives provided to consumers are equal to 34.2% of incremental costs of energy-efficiency improvements.

Figure 7-5: Summary of Commercial Energy Efficiency Potential as a % of 2010 Sales Forecasts – Statewide



7.2.2 TECHNICAL POTENTIAL

Table 7-16 shows that it is technically feasible to save over 5.7 million MWh during the 3 year period from 2013 to 2016, and more than 9.6 million MWh during the 5 year period from 2013 to 2018 across the state. Ten-year technical potential is estimated to be almost 17 million MWh (or 30.4% of sector sales) across the state. This technically feasible scenario also shows a 3-year demand reduction of 802 MW in the commercial sector, a 5-year demand reduction of 1,347 MW, and a reduction of 2,469 MW over a 10-year horizon.

Table 7-16: Statewide Commercial Sector Technical Potential kWh Savings By End Use

	Technical Potential, Cumulative Savings (MWh), 2016			Technical Potential, Cumulative Savings (MWh), 2018			Technical Potential, Cumulative Savings (MWh), 2023		
End Use	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Lighting	2,827,882	49.3%	302	4,696,985	48.8%	501	8,118,651	47.8%	867
HVAC	648,299	11.3%	226	1,097,394	11.4%	382	2,246,723	13.2%	782
Plug Load	735,936	12.8%	79	1,266,122	13.2%	135	1,525,471	9.0%	163
Refrigeration	519,088	9.0%	18	869,513	9.0%	30	1,729,217	10.2%	59
Cooking	24,476	0.4%	3	40,848	0.4%	5	80,178	0.5%	9
Water Heating	71,948	1.3%	7	119,933	1.2%	11	236,056	1.4%	22
Motors	804,454	14.0%	156	1,346,530	14.0%	261	2,681,161	15.8%	522
Other	103,734	1.8%	12	178,278	1.9%	21	378,937	2.2%	44
Total	**5,735,817**	**100%**	**802**	**9,615,602**	**100%**	**1,347**	**16,996,395**	**100%**	**2,469**
% of Sales		**10.3%**			**17.2%**			**30.4%**	

7.2.3 ECONOMIC POTENTIAL

Table 7-17 shows that it is economically feasible to save approximately 4.5 million MWh during the 3 year period from 2013 to 2016, 7.5 million MWh during the 5 year period from 2013 to 2018 across the state. Ten-year economic potential is estimated of 13.8 million MWh (or 24.7% of sector sales) across the state. This economically feasible scenario also shows a 3-year demand reduction of 629 MW, a 5-year demand reduction of 1,055 MW for the Commercial sector and a reduction of 2,006 MW over a 10-year horizon.

Table 7-17: Statewide Commercial Sector Economic Potential kWh Savings By End Use

	Economic Potential, Cumulative Savings (MWh), 2016			Economic Potential, Cumulative Savings (MWh), 2018			Economic Potential, Cumulative Savings (MWh), 2023		
End Use	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Lighting	2,194,084	48.7%	224	3,643,906	48.3%	372	6,589,643	47.6%	688
HVAC	494,165	11.0%	184	836,100	11.1%	311	1,709,712	12.4%	637
Plug Load	476,469	10.6%	51	819,779	10.9%	88	1,045,605	7.6%	112
Refrigeration	460,691	10.2%	18	771,791	10.2%	29	1,535,135	11.1%	57
Cooking	11,884	0.3%	1	19,819	0.3%	2	38,947	0.3%	5
Water Heating	41,790	0.9%	4	69,656	0.9%	6	137,073	1.0%	13
Motors	720,690	16.0%	135	1,206,843	16.0%	226	2,405,230	17.4%	451
Other	103,734	2.3%	12	178,278	2.4%	21	378,937	2.7%	44
Total	**4,503,506**	**100%**	**629**	**7,546,171**	**100%**	**1,055**	**13,840,281**	**100%**	**2,006**
% of Sales		**8.0%**			**13.5%**			**24.7%**	

7.2.4 ACHIEVABLE POTENTIAL

Achievable Potential estimates energy savings that can feasibly be achieved through program and policy interventions. This study estimated theoretically achievable potential for two policy intervention scenarios corresponding to varying incentive levels provided to end-use consumers. Achievable potential scenario 1 (Achievable 1) assumed an incentive level of 100% of incremental costs to C&I customers, where achievable potential scenario 2 (Achievable 2) assumed an incentive level of 34.2% of incremental costs to C&I customers, similar to current program level funding adjusted to account for increasing costs of energy saving measures over time.

Table 7-18 and Table 7-19 show the estimated savings for both scenarios over a 3 and 5-year horizon. Under the Achievable 1 scenario it is feasible to save almost 2.5 million MWh during the 3 year period from 2013 to 2016 in the commercial sector, representing 4.4% of sector sales. Under the Achievable 2 scenario it is feasible to save 1.3 million MWh based on the lower incentive level. Table 7-19 suggests a potential 5 year reduction in demand of 640 MW for the sector, with the Achievable 2 scenario estimating a demand reduction of 309 MW.

Table 7-18: Commercial Achievable Savings Potential in 2016

	Achievable 1 Potential, Cumulative Savings (MWh), 2016			Achievable 2 Potential, Cumulative Savings (MWh), 2016		
End Use	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Lighting	1,198,102	48.3%	124	641,790	48.7%	66
HVAC	336,731	13.6%	90	144,552	11.0%	54
Plug Load	263,770	10.6%	28	139,372	10.6%	15
Refrigeration	230,980	9.3%	13	134,755	10.2%	5
Cooking	4,800	0.2%	1	3,476	0.3%	0
Water Heating	16,868	0.7%	2	12,224	0.9%	1
Motors	384,805	15.5%	67	210,808	16.0%	39
Other	42,083	1.7%	5	30,342	2.3%	4
Total	**2,478,139**	**100%**	**330**	**1,317,319**	**100%**	**184**
% of Sales		**4.4%**			**2.4%**	

Table 7-19: Commercial Achievable Savings Potential in 2018

	Achievable 1 Potential, Cumulative Savings (MWh), 2018			Achievable 2 Potential, Cumulative Savings (MWh), 2018		
End Use	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Lighting	2,265,459	48.0%	234	1,065,877	48.3%	109
HVAC	605,826	12.8%	181	244,575	11.1%	91
Plug Load	517,473	11.0%	55	239,793	10.9%	26
Refrigeration	454,904	9.6%	23	225,754	10.2%	9
Cooking	10,216	0.2%	1	5,797	0.3%	1
Water Heating	35,891	0.8%	3	20,374	0.9%	2
Motors	740,548	15.7%	132	353,012	16.0%	66
Other	93,036	2.0%	11	52,146	2.4%	6
Total	**4,723,354**	**100%**	**640**	**2,207,328**	**100%**	**309**
% of Sales		**8.4%**			**3.9%**	

Table 7-20 shows the estimated savings for both scenarios over a 10-year horizon. Under the Achievable 1 scenario it is feasible to save 10.4 million MWh between 2013 and 2023 in the commercial sector. Assuming a more realistic incentive level, the Achievable 2 scenario estimates a savings of just over 4 million MWh over a 10-year horizon. The Achievable 1 scenario also suggests a 5 year reduction in demand of 1,484 MW for the sector, with the Achievable 2 scenario estimating a demand reduction of 587 MW over the 10-year horizon.

Table 7-20: Commercial Achievable Savings Potential in 2023

	Achievable 1 Potential, Cumulative Savings (MWh), 2023			Achievable 2 Potential, Cumulative Savings (MWh), 2023		
End Use	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Lighting	5,026,511	48.0%	523	1,927,539	47.6%	201
HVAC	1,348,396	12.9%	458	500,122	12.4%	186
Plug Load	851,994	8.1%	91	305,849	7.6%	33
Refrigeration	1,103,747	10.5%	46	449,037	11.1%	17
Cooking	26,475	0.3%	3	11,392	0.3%	1
Water Heating	93,195	0.9%	9	40,094	1.0%	4
Motors	1,759,177	16.8%	323	703,550	17.4%	132
Other	263,596	2.5%	31	110,839	2.7%	13
Total	**10,473,092**	**100%**	**1,484**	**4,048,421**	**100%**	**587**
% of Sales		**18.7%**			**7.2%**	

Figure 7-6 shows a breakdown of the estimated cumulative 5-year efficiency savings potential, broken out by end use. The lighting end use shows the largest potential for savings by a wide margin at more than 1 million MWh, or around 48.3% of all Achievable 2 savings.

Figure 7-6: Commercial Sector 2018 Achievable Potential Savings for Scenario #1 by End Use

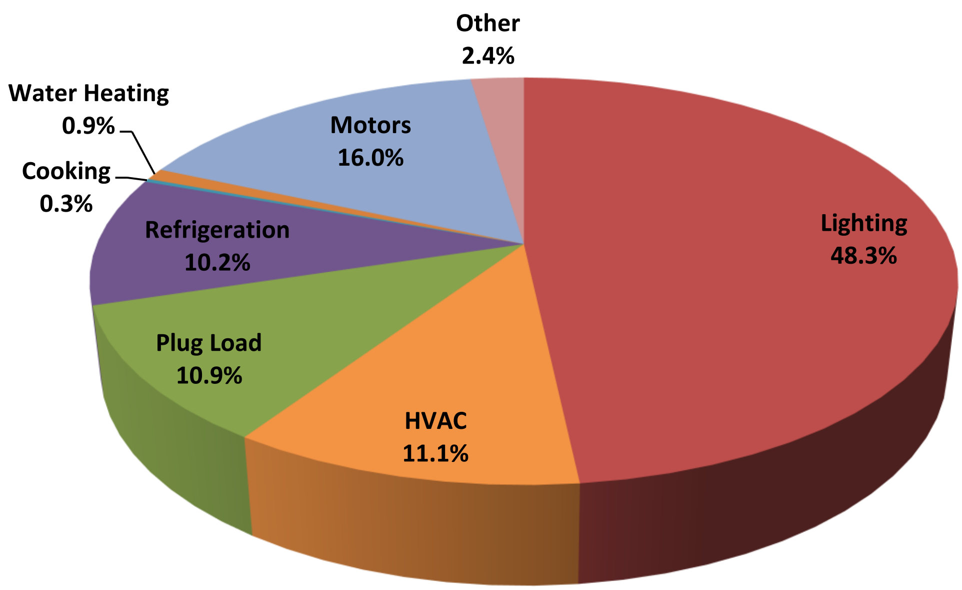


Table 7-21 and Figure 7-7 show a breakdown of the estimated cumulative 3 and 5-year efficiency savings potential, broken out by commercial segment. The office segment shows the most potential for savings, representing around 26.6% of all Achievable 2 savings.

Table 7-21: Commercial Achievable 2 Scenario Savings Potential by Segment

	Achievable 2 - 3 Year Cumulative Savings by Segment			Achievable 2 - 5 Year Cumulative Savings by Segment		
Segment	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Grocery	84,269	6.4%	7	140,738	6.4%	12
Healthcare	100,313	7.6%	15	168,817	7.6%	25
Institutional	138,516	10.5%	25	233,414	10.6%	42
Lodging	40,817	3.1%	7	68,381	3.1%	11
Misc	288,033	21.9%	40	481,486	21.8%	68
Office	349,980	26.6%	49	587,073	26.6%	82
Restaurant	79,611	6.0%	10	133,308	6.0%	17
Retail	144,428	11.0%	20	240,809	10.9%	33
Warehouse	91,352	6.9%	11	153,303	6.9%	18
Total	**1,317,319**	**100.0%**	**184**	**2,207,328**	**100.0%**	**309**

Figure 7-7: 5-Year Commercial Achievable 2 Cumulative Savings Distribution by Segment (2018)

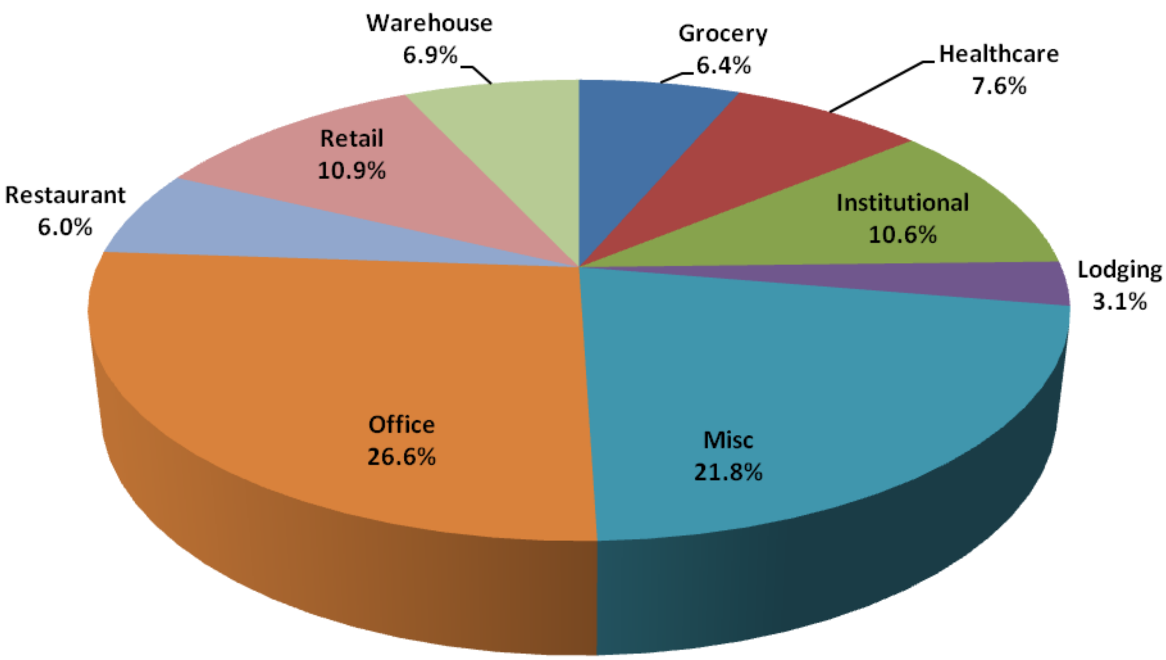


Table 7-22 represents the total cost paid by the EDCs to realize 3-year and 5-year achievable savings estimates under the Achievable 2 scenario. For the commercial sector, the per-MWh acquisition cost is between $212/MWh to $217/MWh, increasing slightly over the longer time window.

Table 7-22: Commercial 3-Year and 5-Year Acquisition Costs Under the Achievable 2 Scenario

EDC	3-yr Acquisition Cost	3-yr Savings	3-yr $/MWh	5-yr Acquisition Cost	5-yr Savings	5-yr $/MWh
Duquesne	$ 39,386,251	177,330	$ 222.11	$ 68,504,587	295,239	$ 232.03
Met-Ed	$ 21,748,075	103,364	$ 210.40	$ 37,167,490	173,622	$ 214.07
Penelec	$ 91,185,145	444,053	$ 205.35	$ 155,876,073	746,694	$ 208.76
PennPower	$ 22,677,947	107,859	$ 210.26	$ 38,628,933	180,559	$ 213.94
PPL	$ 6,036,983	28,582	$ 211.21	$ 10,264,647	47,771	$ 214.87
PECO	$ 68,910,339	314,310	$ 219.24	$ 118,041,698	524,824	$ 224.92
West Penn	$ 30,144,879	141,821	$ 212.56	$ 51,619,535	238,619	$ 216.33
Statewide	**$ 280,089,620**	**1,317,319**	**$ 212.62**	**$ 480,102,962**	**2,207,328**	**$ 217.50**

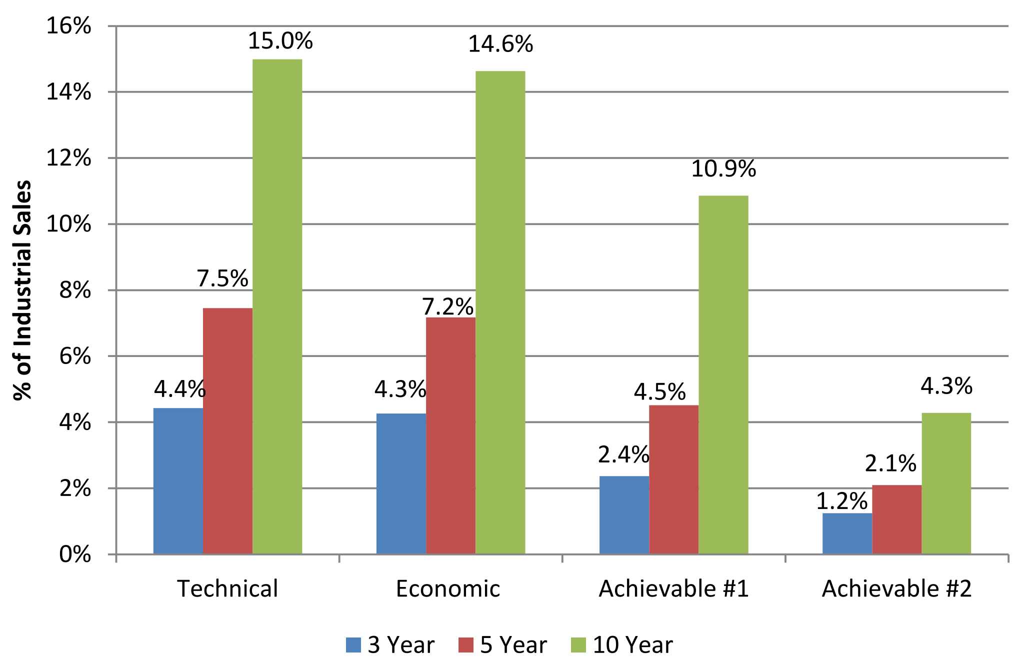
7.3 INDUSTRIAL ENERGY EFFICIENCY POTENTIAL

This section presents estimates for technical, economic, and achievable potential for the industrial sector. Results are presented at the state level, with a summary of EDC savings at the end. Each of the tables in the technical, economic and achievable sections present the respective potential for efficiency savings expressed as cumulative sales (MWh), percentage of the forecasted 2009/10 sales used in Phase 1 of Act 129, and demand (MW). Data is provided for a 3, 5 and 10-year horizon for the entire state.

7.3.1 SUMMARY OF FINDINGS

Figure 7-8 illustrates the estimated savings potential for each of the four scenarios included in this study for all seven EDCs combine (i.e. the state). Expressed as the cumulative 3-year, 5-year, and 10-year savings, the theoretical technical savings potential is between 4.3% and 15.0% of forecasted 2009/10 sector sales used in Act 129 Phase 1 targets. Five-year Achievable 2 savings potential is estimated to be 2.1% of sector sales.

Figure 7-8: Summary of Industrial Energy Efficiency Potential as a % of 2010 Sales Forecasts – Statewide



7.3.2 TECHNICAL POTENTIAL

Table 7-23 shows that it is technically feasible to save just over 1.6 million MWh for the 3-year period from 2013 to 2016, and slightly more than 2.7 million MWh during the 5 year period from 2013 to 2018 across the state, representing 7.5% of non-residential sales. The 10-year technical potential is estimated to be just under 5.5 million MWh (or 15.0% of sector sales) across the state. The technical scenario estimates demand reductions between 187 and 630 MW, depending on the timeframe.

Table 7-23: Statewide Industrial Sector Technical Potential kWh Savings By End Use

	Technical Potential, Cumulative Savings (MWh), 2016			Technical Potential, Cumulative Savings (MWh), 2018			Technical Potential, Cumulative Savings (MWh), 2023		
End Use	*MWh*	*% of Total*	*MW*	*MWh*	*% of Total*	*MW*	*MWh*	*% of Total*	*MW*
Lighting	271,566	16.8%	37	456,800	16.8%	62	931,664	17.0%	126
HVAC	214,250	13.2%	30	360,361	13.2%	50	734,838	13.4%	102
Motors	697,786	43.1%	79	1,173,771	43.1%	133	2,394,548	43.8%	269
Process	381,767	23.6%	36	642,013	23.6%	60	1,230,389	22.5%	114
Other	52,787	3.3%	5	88,792	3.3%	9	181,080	3.3%	18
Total	**1,618,155**	**100%**	**187**	**2,721,736**	**100%**	**315**	**5,472,519**	**100%**	**630**
% of Sales		**4.4%**			**7.5%**			**15.0%**	

7.3.3 ECONOMIC POTENTIAL

Table 7-24 shows that it is economically feasible to save just over 1.5 million MWh and 2.6 million MWh during the 3 and 5 year periods respectively, representing 4.3% and 7.2% of sector sales respectively. The 10-year economic potential is estimated of 5.3 million MWh (or 14.6% of sector sales) across the state. The estimated demand reduction over 5 years is 304 MW, while the 10-year horizon estimates a reduction of 615 MW in energy demand.

Table 7-24: Statewide Industrial Sector Economic Potential kWh Savings By End Use

	Economic Potential, Cumulative Savings (MWh), 2016			Economic Potential, Cumulative Savings (MWh), 2018			Economic Potential, Cumulative Savings (MWh), 2023		
End Use	*MWh*	*% of Total*	*MW*	*MWh*	*% of Total*	*MW*	*MWh*	*% of Total*	*MW*
Lighting	271,551	17.4%	37	456,775	17.4%	62	931,613	17.4%	126
HVAC	213,930	13.7%	30	359,825	13.7%	50	733,747	13.7%	102
Motors	709,357	45.5%	79	1,193,252	45.5%	133	2,434,229	45.6%	269
Process	309,474	19.9%	29	520,426	19.9%	49	1,061,486	19.9%	99
Other	53,153	3.4%	6	89,405	3.4%	9	182,325	3.4%	19
Total	**1,557,465**	**100%**	**180**	**2,619,682**	**100%**	**304**	**5,343,401**	**100%**	**615**
% of Sales		**4.3%**			**7.2%**			**14.6%**	

7.3.4 ACHIEVABLE POTENTIAL

Achievable Potential estimates energy savings that can feasibly be achieved through program and policy interventions. This study estimated theoretically achievable potential for two policy intervention scenarios corresponding to varying incentive levels provided to end-use consumers. Achievable potential scenario 1 (Achievable 1) assumed an incentive level of 100% of incremental costs to C&I customers, where achievable potential scenario 2 (Achievable 2) assumed an incentive level of 34.2% of incremental costs to C&I customers, similar to current program level funding adjusted to account for increasing costs of energy saving measures over time.

Table 7-25 and Table 7-26 show the estimated savings for both scenarios over 3-year and 5-year horizons. The 3-year achievable 2 savings potential is 1.3% of sector sales. Under the Achievable 1 scenario it is feasible to save almost 1.7 million MWh during the 5 year period from 2013 to 2018 in the industrial sector, representing 4.5% of sector sales. Under the Achievable 2 scenario it is feasible to save 766,283 MWh based on the lower incentive level. The Achievable 1 scenario also suggests a 5 year reduction in demand of 190 MW for the sector, with the Achievable 2 scenario estimating a demand reduction of 89 MW.

Table 7-25: Industrial Achievable Savings Potential in 2016

	Achievable 1 Potential, Cumulative Savings (MWh), 2016			Achievable 2 Potential, Cumulative Savings (MWh), 2016		
End Use	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Lighting	131,158	8.4%	18	79,430	5.1%	11
HVAC	121,182	7.8%	17	62,577	4.0%	9
Motors	402,625	25.9%	45	207,495	13.3%	23
Process	178,779	11.5%	17	90,525	5.8%	9
Other	30,305	1.9%	3	15,548	1.0%	2
Total	**864,048**	**55%**	**100**	**455,574**	**29%**	**53**
% of Sales		**2.4%**			**1.2%**	

Table 7-26: Industrial Achievable Savings Potential in 2018

	Achievable 1 Potential, Cumulative Savings (MWh), 2018			Achievable 2 Potential, Cumulative Savings (MWh), 2018		
End Use	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Lighting	263,094	10.0%	36	133,609	5.1%	18
HVAC	229,672	8.8%	32	105,253	4.0%	15
Motors	762,668	29.1%	85	349,039	13.3%	39
Process	336,541	12.8%	32	152,230	5.8%	14
Other	57,313	2.2%	6	26,152	1.0%	3
Total	**1,649,289**	**63%**	**190**	**766,283**	**29%**	**89**
% of Sales		**4.5%**			**2.1%**	

Table 7-27 shows the estimated savings for both scenarios over a 10-year horizon. Under the Achievable 1 scenario it is feasible to save just under 4 million MWh between 2013 and 2023 in the industrial sector. Assuming a more realistic incentive level, the Achievable 2 scenario estimates a savings of just over 1.5 million MWh over a 10-year horizon. The Achievable 1 scenario also suggests a 10 year reduction in demand of 433 MW for the sector, with the Achievable 2 scenario estimating a demand reduction of 180 MW over the 10-year horizon.

Table 7-27: Industrial Achievable Savings Potential in 2023

	Achievable 1 Potential, Cumulative Savings (MWh), 2023			Achievable 2 Potential, Cumulative Savings (MWh), 2023		
End Use	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Lighting	666,706	12.5%	84	272,501	5.1%	37
HVAC	547,506	10.2%	72	214,629	4.0%	30
Motors	1,817,499	34.0%	191	712,038	13.3%	79
Process	796,443	14.9%	71	310,497	5.8%	29
Other	136,295	2.6%	14	53,332	1.0%	6
Total	**3,964,449**	**74%**	**433**	**1,562,997**	**29%**	**180**
% of Sales		**10.9%**			**4.3%**	

Figure 7-9 shows the estimated cumulative efficiency savings potential broken out by industrial end use. Motor measures make up the majority of the savings, representing nearly half of the savings potential in the industrial sector.

Figure 7-9: Industrial Sector 2018 Achievable Potential Savings for Scenario #2 by End Use

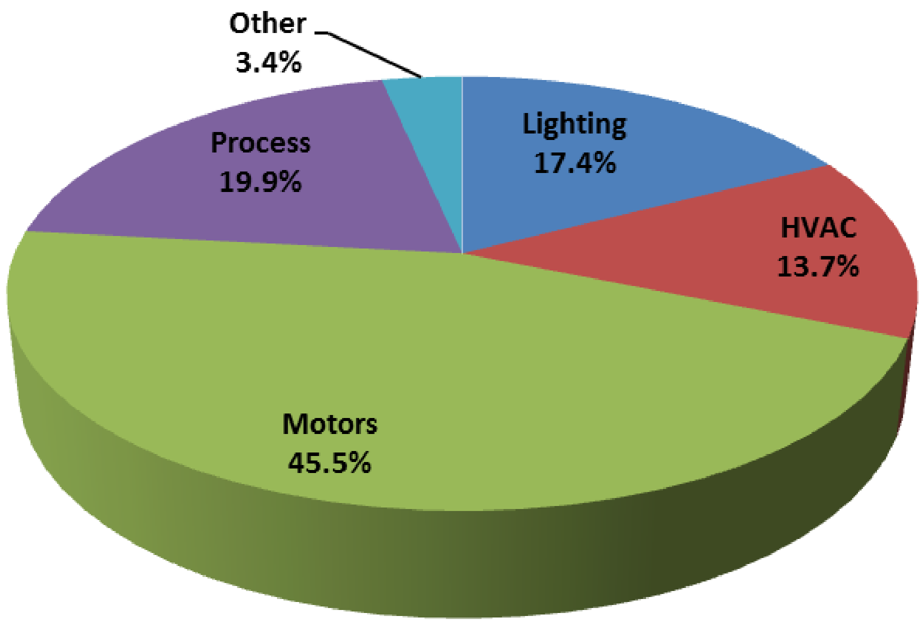


Table 7-28 and Figure 7-10 show the estimated cumulative 3-year and 5-year efficiency savings potential broken out by industrial segment. The metal and paper manufacturing segments show the most potential for savings, representing just over 50% of the savings potential in the industrial sector.

Table 7-28: Industrial Achievable Potential Scenario 2 Savings by Segment

	Achievable 2 - 3 Year Cumulative Savings by Segment			Achievable 2 - 5 Year Cumulative Savings by Segment		
Segment	***MWh***	***% of Total***	***MW***	***MWh***	***% of Total***	***MW***
Mfg: Chemicals	29,736	6.5%	4	49,974	6.5%	6
Mfg: Computers	35,015	7.7%	4	58,919	7.7%	7
Mfg: Food	47,978	10.5%	6	80,675	10.5%	10
Mfg: Metals	115,137	25.3%	12	193,618	25.3%	20
Mfg: Paper	119,384	26.2%	14	200,821	26.2%	23
Mfg: Plastics	27,085	5.9%	3	45,571	5.9%	5
Mfg: Other	37,612	8.3%	5	63,248	8.3%	8
Mining	19,033	4.2%	2	32,095	4.2%	3
Other: Non-Mfg	24,594	5.4%	3	41,363	5.4%	5
Total	**455,574**	**100.0%**	**53**	**766,283**	**100.0%**	**89**

Figure 7-10: Industrial Achievable 2, 5-Year Cumulative Savings Distribution by Segment

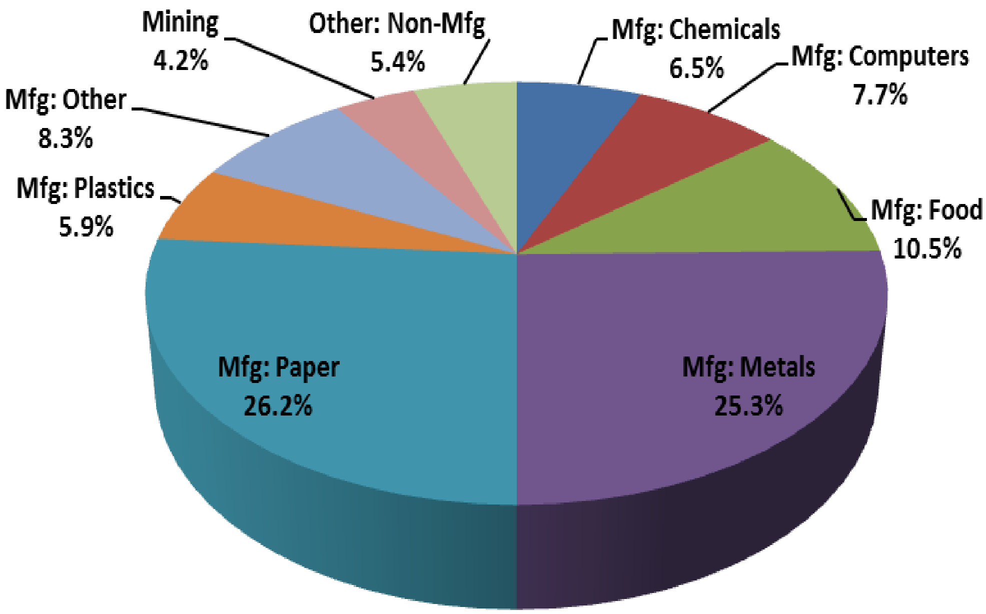


Table 7-29 represents the total cost paid by the utilities to achieve the potential 3 and 5-year savings under the Achievable 2 scenario. For the industrial sector the cost per MWh is between $211 and $215/MWh depending on period.

Table 7-29: Industrial 5-Year Acquisition Costs Under The Achievable 2 Scenario by EDC

EDC	*3-yr Acquisition Cost*	*3-yr Savings*	*3-yr $/MWh*	*5-yr Acquisition Cost*	*5-yr Savings*	*5-yr $/MWh*
Duquesne	$ 6,953,035	32,117	$ 216.49	$ 12,131,196	53,590	$ 226.37
Met-Ed	$ 12,575,347	60,418	$ 208.14	$ 21,491,271	101,512	$ 211.71
Penelec	$ 10,102,758	48,720	$ 207.37	$ 17,313,321	82,148	$ 210.76
PennPower	$ 14,980,663	70,932	$ 211.20	$ 25,594,169	119,141	$ 214.82
PPL	$ 4,471,108	21,134	$ 211.56	$ 7,626,763	35,443	$ 215.19
PECO	$ 28,174,335	131,973	$ 213.49	$ 48,595,296	221,923	$ 218.97
West Penn	$ 18,871,060	90,281	$ 209.03	$ 32,433,009	152,527	$ 212.64
Statewide	**$ 96,128,306**	**455,574**	**$ 211.00**	**$ 165,185,025**	**766,283**	**$ 215.57**

7.4 ENERGY EFFICIENCY MEASURES EXAMINED

For the non-residential sector, there were 262 total measure included in the potential energy savings analysis. Of these 262 measures, 95 were considered in the industrial model and 167 were included in the commercial model. The 262 is a count of the individual measures included, many measures had overlap between different segments and were counted as one measure[52].

Table 7-30 provides a brief description of the types of measures included for each end use in the commercial model. Table 7-31 provides a brief description of the types of measures included for each end use in the industrial model. The list of measures was developed based on a review of the Pennsylvania TRM and measures found in other non-residential potential studies. Measure data includes incremental costs, energy and demand savings, and measure life with persistence discounting.

[52] The total number of measures across all segments was 2062, 424 in the industrial sector and 1638 in the commercial sector. This accounted for measures that were applicable to multiple segments within the model.

Table 7-30: Measures and Programs Included in the Commercial Sector Analysis

End Use Type	End Use Description	Measures/Programs Included
Chiller	Chiller Improvements	Duct Improvements Re-commissioning Energy Management System Efficient Chiller Equipment Insulation Upgrades Economizers
Cooking	Cooking Equipment Improvements	Efficient Cooking Equipment
Fluorescent	Fluorescent Lighting Improvements	High Efficiency Fixtures Lighting Controls Ballast Replacement Premium Efficiency T8 LED Retrofit Tubes
Heating	Heating System Improvements	Thermostat Upgrades Insulation Upgrades Heating Equipment Upgrades Re-commissioning
HID	High Intensity Lighting Improvements	High Efficiency Fixtures Fixture Retrofits Lighting Controls
Incandescent	Incandescent Lighting Improvements	LED Retrofits CFL Retrofits Lighting Controls High Efficiency Fixtures
Large Appliances	Appliance Upgrades	High Efficiency Equipment
Motors	Motor Improvements	Ultra-PE Motors Variable Frequency Drives Motor Rewinds Air Compressor System Improvements Motor Downsizing
Office Equipment	Office Equipment Upgrades	High Efficiency Equipment
Other	Miscellaneous Equipment Upgrades	Transformers Industrial Motor Improvement
Packaged DX	Cooling System Upgrades	Cooling Equipment Upgrades Improved Controls Building Shell Upgrades Economizers Re-Commissioning
Refrigeration	Refrigeration Improvements	Anti-Sweat Heat Controls Upgrades Motors High Efficiency Equipment Variable Frequency Drives on Motors Efficient Lighting
Signage	Signage Improvements	Improved Street Lighting LED Signs
Water Heating	Water Heating Improvements	High Efficiency Equipment Low Flow Equipment Heat Recovery Units Solar Water Heaters

Table 7-31: Measures and Programs Included in the Industrial Sector Analysis

End Use Type	End Use Description	Measures/Programs Included
HVAC	Heating/Cooling/Ventilation Equipment	Dehumidifiers Equipment Upgrades Heat Reclaimers Heat Recovery Ventilators Improved Controls Infrared Films Prog. Ventilation Controllers Recommissioning Scroll Compressors
Lighting	Indoor/Outdoor Lighting Equipment	Efficient Lighting Equipment High Bay Lighting Equipment Lighting Controls
Motors	Motor Equipment and System Upgrades	Air Compressor Improvements Efficient Pump Systems Fan System Improvements Improved Fan Controls Motor Controllers Motor Re-Winds Pump System Controls Ultra-PE Motors Variable Frequency Drives
Other	Miscellaneous System Upgrades	Agricultural Equipment Building Improvements Energy Management Systems Manufacturing Equipment Transformers
Process Cooling	Cooling and Refrigeration Upgrades	Chiller Improvements Cooling System Tune-ups Improved Controls Refrigeration Equipment Improvements
Process EC	Electro Chemical Upgrades	Electro-Chemical Equipment Upgrades
Process Heating	Heating System Upgrades	Efficient Heating Equipment Improved Heating Controls Heating System Maintenance

7.5 NON-RESIDENTIAL SAVINGS BY EDC

This next section summarizes each of the savings potential by time-period, by sector, by scenario and by EDC. Results are presented as cumulative annual energy (MWh) and demand (MW) savings and the percentage of forecasted 2009/10 sales used in Phase 1 of Act 129.

Table 7-32: 3-Year Potential Savings by Sector, Scenario, and EDC (2016)

3-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
NON-RESIDENTIAL				
State-wide				
Energy (MWh)	7,353,972	6,060,971	3,342,188	1,772,893
% of 2010 MWh Sales	*8.0%*	*6.6%*	*3.6%*	*1.9%*
Summer MW	1,444.7	1,248.1	788.3	365.1
Duquesne Territory				

3-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
Energy (MWh)	902,102	716,031	400,184	209,446
% of 2010 MWh Sales	9.1%	7.2%	4.0%	2.1%
Summer MW	157.1	128.4	75.1	37.6
Met-Ed Territory				
Energy (MWh)	667,505	559,918	306,278	163,781
% of 2010 MWh Sales	7.7%	6.5%	3.5%	1.9%
Summer MW	134.0	118.4	78.4	34.6
Penelec Territory				
Energy (MWh)	718,396	611,230	336,198	178,791
% of 2010 MWh Sales	7.5%	6.4%	3.5%	1.9%
Summer MW	147.9	133.0	88.9	38.9
Penn Power Territory				
Energy (MWh)	202,800	169,964	94,125	49,716
% of 2010 MWh Sales	6.9%	5.8%	3.2%	1.7%
Summer MW	48.2	42.7	29.0	12.5
West Penn Power Territory				
Energy (MWh)	940,858	793,484	443,723	232,102
% of 2010 MWh Sales	7.2%	6.1%	3.4%	1.8%
Summer MW	218.1	184.5	120.5	54.0
PECO Territory				
Energy (MWh)	2,095,252	1,684,639	922,585	492,773
% of 2010 MWh Sales	8.3%	6.6%	3.6%	1.9%
Summer MW	301.0	249.1	145.4	72.9
PPL Territory				
Energy (MWh)	1,827,059	1,525,704	839,096	446,283
% of 2010 MWh Sales	7.9%	6.6%	3.6%	1.9%
Summer MW	438.4	391.9	251.0	114.6
COMMERCIAL SECTOR				
State-wide				
Energy (MWh)	**5,735,817**	**4,503,506**	**2,478,139**	**1,317,319**
% of 2010 MWh Sales	***10.3%***	***8.0%***	***4.4%***	***2.4%***
Summer MW	**802.5**	**628.9**	**329.6**	**183.9**
Duquesne Territory				
Energy (MWh)	785,363	606,234	339,250	177,330
% of 2010 MWh Sales	11.1%	8.6%	4.8%	2.5%
Summer MW	117.4	90.7	47.1	26.5
Met-Ed Territory				
Energy (MWh)	450,583	353,369	192,168	103,364
% of 2010 MWh Sales	10.9%	8.6%	4.7%	2.5%
Summer MW	55.9	43.7	23.2	12.8
Penelec Territory				
Energy (MWh)	469,825	368,737	200,756	107,859
% of 2010 MWh Sales	11.0%	8.7%	4.7%	2.5%
Summer MW	58.6	45.9	24.3	13.4
Penn Power Territory				
Energy (MWh)	125,979	97,714	54,023	28,582
% of 2010 MWh Sales	10.8%	8.4%	4.6%	2.5%
Summer MW	16.6	12.9	6.8	3.8
West Penn Power Territory				

3-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
Energy (MWh)	618,459	484,842	271,609	141,821
% of 2010 MWh Sales	11.2%	8.8%	4.9%	2.6%
Summer MW	100.6	73.7	38.2	21.6
PECO Territory				
Energy (MWh)	1,922,907	1,518,082	830,318	444,053
% of 2010 MWh Sales	9.2%	7.2%	4.0%	2.1%
Summer MW	241.2	191.3	102.7	55.9
PPL Territory				
Energy (MWh)	1,362,702	1,074,528	590,013	314,310
% of 2010 MWh Sales	10.6%	8.4%	4.6%	2.4%
Summer MW	212.1	170.7	87.3	49.9
INDUSTRIAL SECTOR				
State-wide				
Energy (MWh)	**1,618,155**	**1,557,465**	**864,048**	**455,574**
% of 2010 MWh Sales	***4.4%***	***4.3%***	***2.4%***	***1.2%***
Summer MW	**642.2**	**619.2**	**458.7**	**181.1**
Duquesne Territory				
Energy (MWh)	116,739	109,797	60,933	32,117
% of 2010 MWh Sales	4.1%	3.9%	2.2%	1.1%
Summer MW	39.7	37.8	28.0	11.0
Met-Ed Territory				
Energy (MWh)	216,922	206,549	114,109	60,418
% of 2010 MWh Sales	4.8%	4.6%	2.5%	1.3%
Summer MW	78.1	74.7	55.2	21.8
Penelec Territory				
Energy (MWh)	248,572	242,494	135,441	70,932
% of 2010 MWh Sales	4.7%	4.6%	2.6%	1.3%
Summer MW	89.3	87.1	64.6	25.5
Penn Power Territory				
Energy (MWh)	76,821	72,250	40,102	21,134
% of 2010 MWh Sales	4.4%	4.1%	2.3%	1.2%
Summer MW	31.6	29.9	22.2	8.7
West Penn Power Territory				
Energy (MWh)	322,399	308,642	172,114	90,281
% of 2010 MWh Sales	4.3%	4.1%	2.3%	1.2%
Summer MW	117.5	110.8	82.3	32.4
PECO Territory				
Energy (MWh)	172,345	166,557	92,266	48,720
% of 2010 MWh Sales	3.9%	3.8%	2.1%	1.1%
Summer MW	59.7	57.9	42.7	16.9
PPL Territory				
Energy (MWh)	464,356	451,176	249,082	131,973
% of 2010 MWh Sales	4.5%	4.4%	2.4%	1.3%
Summer MW	226.3	221.2	163.7	64.7

***Achievable Scenario#1: Assumes 100% Incentives**
***Achievable Scenario#2: Assumes 34% in the commercial sector**

Table 7-33: 5-Year Potential Savings by Sector, Scenario, and EDC (2018)

5-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
NON-RESIDENTIAL				
State-wide				
Energy (MWh)	**12,337,338**	**10,165,854**	**6,372,642**	**2,973,611**
% of 2010 MWh Sales	***13.3%***	***11.0%***	***6.9%***	***3.2%***
Summer MW	**1,661.8**	**1,358.9**	**830.5**	**397.5**
Duquesne Territory				
Energy (MWh)	1,503,313	1,192,536	753,534	348,829
% of 2010 MWh Sales	15.2%	12.0%	7.6%	3.5%
Summer MW	215.2	169.6	102.6	49.6
Met-Ed Territory				
Energy (MWh)	1,121,659	940,600	586,513	275,134
% of 2010 MWh Sales	12.9%	10.9%	6.8%	3.2%
Summer MW	132.4	110.3	67.9	32.3
Penelec Territory				
Energy (MWh)	1,204,393	1,024,581	641,366	299,700
% of 2010 MWh Sales	12.7%	10.8%	6.7%	3.1%
Summer MW	142.1	119.8	74.0	35.0
Penn Power Territory				
Energy (MWh)	339,530	284,482	178,765	83,214
% of 2010 MWh Sales	11.6%	9.7%	6.1%	2.8%
Summer MW	43.3	36.2	22.4	10.6
West Penn Power Territory				
Energy (MWh)	1,585,778	1,337,204	846,740	391,146
% of 2010 MWh Sales	12.2%	10.3%	6.5%	3.0%
Summer MW	226.7	178.0	108.8	52.1
PECO Territory				
Energy (MWh)	3,525,202	2,833,556	1,768,406	828,842
% of 2010 MWh Sales	13.9%	11.2%	7.0%	3.3%
Summer MW	436.3	351.3	216.8	102.8
PPL Territory				
Energy (MWh)	3,057,462	2,552,894	1,597,319	746,746
% of 2010 MWh Sales	13.2%	11.1%	6.9%	3.2%
Summer MW	465.6	393.8	238.1	115.2
COMMERCIAL SECTOR				
State-wide				
Energy (MWh)	**9,615,602**	**7,546,171**	**4,723,354**	**2,207,328**
% of 2010 MWh Sales	***17.2%***	***13.5%***	***8.4%***	***3.9%***
Summer MW	**1,347.0**	**1,055.4**	**640.1**	**308.7**
Duquesne Territory				
Energy (MWh)	1,308,524	1,009,330	638,287	295,239
% of 2010 MWh Sales	18.5%	14.3%	9.0%	4.2%
Summer MW	195.8	151.2	91.0	44.2
Met-Ed Territory				
Energy (MWh)	757,192	593,561	368,672	173,622
% of 2010 MWh Sales	18.3%	14.4%	8.9%	4.2%
Summer MW	94.1	73.6	45.0	21.5
Penelec Territory				

5-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
Energy (MWh)	786,878	617,275	383,848	180,559
% of 2010 MWh Sales	18.5%	14.5%	9.0%	4.2%
Summer MW	98.4	77.1	47.1	22.5
Penn Power Territory				
Energy (MWh)	210,696	163,314	102,493	47,771
% of 2010 MWh Sales	18.1%	14.1%	8.8%	4.1%
Summer MW	27.8	21.6	13.2	6.3
West Penn Power Territory				
Energy (MWh)	1,041,095	815,763	517,089	238,619
% of 2010 MWh Sales	18.8%	14.7%	9.3%	4.3%
Summer MW	169.7	124.3	74.9	36.3
PECO Territory				
Energy (MWh)	3,234,604	2,552,718	1,591,743	746,694
% of 2010 MWh Sales	15.4%	12.2%	7.6%	3.6%
Summer MW	406.4	322.3	198.6	94.3
PPL Territory				
Energy (MWh)	2,276,613	1,794,210	1,121,222	524,824
% of 2010 MWh Sales	17.7%	14.0%	8.7%	4.1%
Summer MW	354.7	285.4	170.2	83.5
INDUSTRIAL SECTOR				
State-wide				
Energy (MWh)	**2,721,736**	**2,619,682**	**1,649,289**	**766,283**
% of 2010 MWh Sales	***7.5%***	***7.2%***	***4.5%***	***2.1%***
Summer MW	**314.8**	**303.6**	**190.4**	**88.8**
Duquesne Territory				
Energy (MWh)	194,789	183,206	115,247	53,590
% of 2010 MWh Sales	6.9%	6.5%	4.1%	1.9%
Summer MW	19.4	18.5	11.6	5.4
Met-Ed Territory				
Energy (MWh)	364,467	347,039	217,841	101,512
% of 2010 MWh Sales	8.0%	7.6%	4.8%	2.2%
Summer MW	38.3	36.6	22.9	10.7
Penelec Territory				
Energy (MWh)	417,515	407,306	257,518	119,141
% of 2010 MWh Sales	7.9%	7.8%	4.9%	2.3%
Summer MW	43.8	42.7	26.9	12.5
Penn Power Territory				
Energy (MWh)	128,834	121,168	76,273	35,443
% of 2010 MWh Sales	7.3%	6.9%	4.3%	2.0%
Summer MW	15.5	14.6	9.2	4.3
West Penn Power Territory				
Energy (MWh)	544,683	521,441	329,651	152,527
% of 2010 MWh Sales	7.3%	7.0%	4.4%	2.0%
Summer MW	57.0	53.7	33.8	15.7
PECO Territory				
Energy (MWh)	290,598	280,838	176,663	82,148
% of 2010 MWh Sales	6.6%	6.4%	4.0%	1.9%
Summer MW	29.9	29.0	18.2	8.5
PPL Territory				

5-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
Energy (MWh)	780,849	758,685	476,097	221,923
% of 2010 MWh Sales	7.6%	7.4%	4.6%	2.2%
Summer MW	110.9	108.4	67.8	31.7
*Achievable Scenario#1: Assumes 100% Incentives *Achievable Scenario#2: Assumes 34% in the commercial sector				

Table 7-34: 10-Year Potential Savings by Sector, Scenario, and EDC (2023)

10-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
NON-RESIDENTIAL				
State-wide				
Energy (MWh)	**22,468,914**	**19,183,681**	**14,437,541**	**5,611,418**
% of 2010 MWh Sales	***24.3%***	***20.7%***	***15.6%***	***6.1%***
Summer MW	**2,689.8**	**2,244.5**	**1,586.0**	**656.5**
Duquesne Territory				
Energy (MWh)	2,689,697	2,206,139	1,676,096	645,319
% of 2010 MWh Sales	*27.2%*	*22.3%*	*16.9%*	*6.5%*
Summer MW	336.5	270.0	190.5	79.0
Met-Ed Territory				
Energy (MWh)	2,082,099	1,808,021	1,354,216	528,863
% of 2010 MWh Sales	*24.0%*	*20.9%*	*15.6%*	*6.1%*
Summer MW	220.3	188.0	133.2	55.0
Penelec Territory				
Energy (MWh)	2,211,584	1,952,978	1,462,099	571,266
% of 2010 MWh Sales	*23.2%*	*20.5%*	*15.4%*	*6.0%*
Summer MW	235.4	203.7	144.2	59.6
Penn Power Territory				
Energy (MWh)	637,581	549,551	412,775	160,749
% of 2010 MWh Sales	*21.8%*	*18.8%*	*14.1%*	*5.5%*
Summer MW	73.7	63.1	44.7	18.4
West Penn Power Territory				
Energy (MWh)	3,005,909	2,611,817	1,969,711	763,984
% of 2010 MWh Sales	*23.1%*	*20.1%*	*15.1%*	*5.9%*
Summer MW	380.8	304.9	215.2	89.2
PECO Territory				
Energy (MWh)	6,215,997	5,190,793	3,905,390	1,518,358
% of 2010 MWh Sales	*24.5%*	*20.5%*	*15.4%*	*6.0%*
Summer MW	674.1	551.5	392.9	161.3
PPL Territory				
Energy (MWh)	5,626,047	4,864,383	3,657,254	1,422,880
% of 2010 MWh Sales	*24.4%*	*21.1%*	*15.8%*	*6.2%*
Summer MW	768.9	663.4	465.4	194.0
COMMERCIAL SECTOR				
State-wide				
Energy (MWh)	**16,996,395**	**13,840,281**	**10,473,092**	**4,048,421**
% of 2010 MWh Sales	***30.4%***	***24.7%***	***18.7%***	***7.2%***
Summer MW	**2,059.7**	**1,629.7**	**1,153.3**	**476.7**
Duquesne Territory				
Energy (MWh)	2,294,971	1,832,001	1,398,558	535,880

10-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
% of 2010 MWh Sales	*32.4%*	*25.9%*	*19.7%*	*7.6%*
Summer MW	297.3	232.4	164.1	68.0
Met-Ed Territory				
Energy (MWh)	1,352,072	1,101,050	830,432	322,067
% of 2010 MWh Sales	*32.8%*	*26.7%*	*20.1%*	*7.8%*
Summer MW	143.8	113.8	81.1	33.3
Penelec Territory				
Energy (MWh)	1,374,988	1,122,162	844,598	328,244
% of 2010 MWh Sales	*32.3%*	*26.3%*	*19.8%*	*7.7%*
Summer MW	148.0	117.3	83.3	34.3
Penn Power Territory				
Energy (MWh)	375,741	302,001	229,078	88,338
% of 2010 MWh Sales	*32.3%*	*26.0%*	*19.7%*	*7.6%*
Summer MW	42.5	33.4	23.8	9.8
West Penn Power Territory				
Energy (MWh)	1,894,314	1,536,703	1,169,438	449,502
% of 2010 MWh Sales	*34.2%*	*27.8%*	*21.1%*	*8.1%*
Summer MW	265.5	195.3	137.8	57.1
PECO Territory				
Energy (MWh)	5,643,460	4,630,154	3,490,896	1,354,365
% of 2010 MWh Sales	*26.9%*	*22.1%*	*16.7%*	*6.5%*
Summer MW	615.1	493.7	352.3	144.4
PPL Territory				
Energy (MWh)	4,060,848	3,316,209	2,510,091	970,025
% of 2010 MWh Sales	*31.7%*	*25.8%*	*19.6%*	*7.6%*
Summer MW	547.5	443.7	311.0	129.8
INDUSTRIAL SECTOR				
State-wide				
Energy (MWh)	**5,472,519**	**5,343,401**	**3,964,449**	**1,562,997**
% of 2010 MWh Sales	***15.0%***	***14.7%***	***10.9%***	***4.3%***
Summer MW	**630.1**	**614.8**	**432.7**	**179.8**
Duquesne Territory				
Energy (MWh)	394,726	374,137	277,538	109,439
% of 2010 MWh Sales	*14.0%*	*14.0%*	*9.9%*	*3.9%*
Summer MW	39.2	37.6	26.4	11.0
Met-Ed Territory				
Energy (MWh)	730,027	706,971	523,783	206,796
% of 2010 MWh Sales	*16.1%*	*15.6%*	*11.5%*	*4.6%*
Summer MW	76.5	74.1	52.1	21.7
Penelec Territory				
Energy (MWh)	836,595	830,815	617,501	243,022
% of 2010 MWh Sales	*15.9%*	*15.8%*	*11.8%*	*4.6%*
Summer MW	87.4	86.4	61.0	25.3
Penn Power Territory				
Energy (MWh)	261,840	247,550	183,698	72,411
% of 2010 MWh Sales	*14.8%*	*14.0%*	*10.4%*	*4.1%*
Summer MW	31.2	29.6	20.9	8.7
West Penn Power Territory				
Energy (MWh)	1,111,595	1,075,114	800,272	314,482

10-Year Savings	Technical Potential	Economic Potential	Achievable Potential Scenario#1	Achievable Potential Scenario#2
% of 2010 MWh Sales	*14.9%*	*14.4%*	*10.7%*	*4.2%*
Summer MW	115.3	109.5	77.4	32.0
PECO Territory				
Energy (MWh)	572,538	560,639	414,494	163,992
% of 2010 MWh Sales	*13.0%*	*12.7%*	*9.4%*	*3.7%*
Summer MW	59.0	57.8	40.5	16.9
PPL Territory				
Energy (MWh)	1,565,199	1,548,173	1,147,163	452,856
% of 2010 MWh Sales	*15.3%*	*15.1%*	*11.2%*	*4.4%*
Summer MW	221.5	219.7	154.4	64.3

*Achievable Scenario#1: Assumes 100% Incentives
*Achievable Scenario#2: Assumes 34% in the commercial sector

8 PROGRAM ENERGY EFFICIENCY POTENTIAL ESTIMATES

This section of the report presents the estimates of electric program potential for the state of Pennsylvania as well as for each EDC service area. Program Potential estimates energy savings that can feasibly be achieved through programs within a specific planning constraint. This study estimated program potential for a scenario where annual program spending is capped at 2% of 2006 EDC revenues. Program potential is only determined within this section for the first three and five years of the study horizon, as the purpose of this analysis is to inform decision making on the next implementation of PA Act 129, expected to be either the period from June 1, 2013 and extending for three years, or the period from June 1, 2013 and extending for five years.

8.1 ESTIMATION OF PROGRAM POTENTIAL SCENARIO #1

Program potential estimation considered an annual spending ceiling that limits the program spending to 2% of 2006 annual revenue. This program spending constraint is the same as currently implemented within Phase 1 of PA Act 129 (energy years 2009-2012). The ceiling was determined for each EDC and is summed to the state level, as each EDC has a unique rate and customer structure. The 2006 spending for each EDC was obtained from the PA PUC.[53] Table 8-1 summarizes the annual spending ceiling and spending ceiling for a three and five-year implementation phase.

Table 8-1: One-Year, Three-Year and Five-Year Program Potential Budgets

EDC	Single Year Spending Ceiling (total portfolio)	3 Year Spending Ceiling (total portfolio)	5 Year Spending Ceiling (total portfolio)
Duquesne	$19,545,952	$58,637,855	$97,729,758
Met-Ed	$24,866,892	$74,600,676	$124,334,460
Penelec	$22,974,744	$68,924,232	$114,873,720
Penn Power	$6,659,784	$19,979,352	$33,298,920
PPL	$61,501,376	$184,504,128	$307,506,880
PECO	$85,395,159	$256,185,476	$426,975,793
West Penn	$23,562,468	$70,687,404	$117,812,340
Statewide	***$244,506,374***	***$733,519,122***	***$1,222,531,870***

8.1.1 PHASE 1 BUDGETS AND SAVINGS GOALS

The current implementation of energy-efficiency programs in PA Act 129 is a four-year cycle (energy years 2009-2012). The four-year maximum spending budget is established by the sum of the four annual budget ceilings (2% of 2006 revenues). The energy-efficiency cumulative savings goal established for Phase 1 is 3% of 2009 energy year (June 1, 2009 – May 31, 2010) consumption forecasts established in the 2009 implementation order of PA Act 129. The Phase 1 implementation order also sets forth an intermediate savings goal of 1% of 2009 energy year consumption forecasts after the first two years of program implementation. Table 8-2 summarizes these budget and savings goals targets.

Table 8-2: Budgets and Savings Targets for Phase 1 of Act 129

EDC	Spending Ceiling (total portfolio)	Savings Goals (total portfolio) (MWh)	Max. Acquisition Costs ($/MWh)
Duquesne	$78,183,806	422,565	$185.02
Met-Ed	$99,467,568	445,951	$223.05
Penelec	$91,898,976	431,979	$212.74
Penn Power	$26,639,136	143,188	$186.04
PPL	$246,005,504	1,146,431	$214.58

[53] PA PUC calculated 2% spending cap based on data available in the *Electric Power Outlook* Report, Table 3. Pg 18.

EDC	Spending Ceiling (total portfolio)	Savings Goals (total portfolio) (MWh)	Max. Acquisition Costs ($/MWh)
PECO	$341,580,634	1,181,580	$289.09
West Penn	$94,249,872	628,160	$150.04
Statewide	***$978,025,496***	***4,399,854***	***$222.29***

Table 8-2 also displays the maximum acquisition cost metric for each EDC and for the state. Acquisition costs are defined within this report as program expense dollars spent to acquire first-year energy savings. Program expense dollars include all program costs such as rebates, incentives, administrative costs, marketing, outreach, and evaluation expenditures. Discussion of acquisition cost is useful because of its simplicity (costs divided by first year savings). However, this metric does have important limitations, because it does not reflect the value of the energy savings as a resource. Additional savings parameters would need to be included, specifically measure lifetime, to determine the value of the savings resource.

The acquisition costs summarized in Table 8-2 also illustrate an important disparity in the available budget for each EDC. There is nearly a two-to-one ratio between the acquisition cost budgets for PECO and West Penn. The PA state acquisition cost for Phase 1 of Act 129 is $222.29 per first year MWh savings. Additionally, it should be noted that the acquisition budget for the final two years of Phase 1 only allows for an acquisition cost budget of $167.71 per first year MWh savings. This final two year metric is determined by the cumulative EDC's annual maximum expenditures divided by the sum of the savings goals in the same period (program years 3 and 4). Finally, these Phase 1 budgets are not necessarily indicative of the actual costs necessary to acquire energy savings. Summarized in section 4 (Table 4-11) of this report, the weighted acquisition cost average for the state during the first two years of Phase 1 was $139.38 per first year MWh savings.

8.1.2 USE OF ACHIEVABLE POTENTIAL RESULTS

Estimation of program potential for Phase 2 of Act 129 (expected to be energy years 2013-2016 or 2013-2018) utilizes both residential and non-residential potential savings. Because achievable potential scenario 2 is based on Phase 1 performance, this achievable scenario was utilized for the determination of program potential. In calculating expected program costs, incentive and non-incentive, the SWE team utilized economic and performance metrics from the Phase 1 implementation of PA EDC programs, as described in Section 4 of this report. Because the SWE team acknowledges that the existing EDC program savings have large shares of "low hanging fruit" and very cost-effective measures, Phase 1 non-incentive program cost estimates have been increased by an additional 25%. Additionally, program incentive funding estimates have been increased by an additional 25% to address uncertainties in future adoption rates, market pricing, and EDCs adopting more comprehensive and less cost-effective measures. The SWE team notes that the 25% increase in the percentage of measure costs paid by the EDC does not impact the TRC test results, because the TRC ratio calculation uses the total measure costs paid by the utility and the participant. Furthermore, the 25% increase in non-incentive costs per first year kWh saved also does not impact the TRC test significantly because this cost increase is approximately $.016 per first year kWh saved, which is a very small percentage of the total resource acquisition cost for the program potential portfolio of approximately $.22 per first year kWh saved.

The first step in the program potential calculation uses the cumulative annual three-year (2013-2016) and five-year (2013-2018) residential and non-residential sector estimated savings and costs. These figures are summarized in Table 8-3 and Table 8-4.

Table 8-3: Summary of 2013-2016 Cumulative Annual Achievable Scenario 2 Costs and Savings

EDC	3 yr Residential Ach 2 Savings (MWh)	3 yr Residential Ach 2 Costs ($)	3 yr Non-residential Ach 2 Savings (MWh)	3 yr Non-residential Ach 2 Costs ($)	3 yr Portfolio Ach 2 Savings (MWh)	3 yr Portfolio Ach 2 Costs ($)
Duquesne	203,534	$41,172,067	209,446	$46,339,287	412,981	$87,511,354
Met-Ed	214,558	$49,241,560	163,781	$34,323,422	378,339	$83,564,982
PECO	588,433	$124,057,990	492,773	$101,287,903	1,081,205	$225,345,894
Penelec	192,379	$42,584,437	178,791	$37,658,610	371,169	$80,243,047
Penn Power	60,683	$12,587,705	49,716	$10,508,091	110,399	$23,095,796
PPL	696,694	$159,754,945	446,283	$97,084,675	1,142,977	$256,839,620
West Penn	270,787	$56,300,955	232,102	$49,015,939	502,889	$105,316,894
Statewide	***2,227,067***	***$485,699,660***	***1,772,893***	***$376,217,926***	***3,999,960***	***$861,917,587***

Table 8-4: Summary of 2013-2018 Cumulative Annual Achievable Scenario 2 Costs and Savings

EDC	5 yr Residential Ach 2 Savings (MWh)	5 yr Residential Ach 2 Costs ($)	5 yr Non-residential Ach 2 Savings (MWh)	5 yr Non-residential Ach 2 Costs ($)	5 yr Portfolio Ach 2 Savings (MWh)	5 yr Portfolio Ach 2 Costs ($)
Duquesne	341,480	$71,841,433	348,829	$80,635,783	**690,309**	**$152,477,216**
Met-Ed	364,312	$88,515,778	275,134	$58,658,760	**639,446**	**$147,174,539**
PECO	989,465	$212,828,467	828,842	$173,189,394	**1,818,307**	**$386,017,861**
Penelec	325,182	$75,613,392	299,700	$64,223,102	**624,882**	**$139,836,494**
Penn Power	102,224	$22,075,533	83,214	$17,891,410	**185,438**	**$39,966,943**
PPL	1,159,873	$273,526,849	746,746	$166,636,994	**1,906,619**	**$440,163,844**
West Penn	453,677	$97,794,117	391,146	$84,052,544	**844,823**	**$181,846,661**
Statewide	***3,736,214***	***$842,195,569***	***2,973,611***	***$645,287,988***	***6,709,824***	***$1,487,483,557***

The next step in the program potential calculation compares the sum of the residential and non-residential sector program costs to the three-year and five-year budget ceilings at the EDC and state levels in Table 8-5 and Table 8-6.

Table 8-5: Comparison of 2013-2016 Cumulative Annual Achievable 2 Costs and Program Budget

EDC	Three Year Spending Ceiling (total portfolio)	Three Year Ach 2 Costs (total portfolio)	Ach 2 Exceeds Spending Ceiling	Achievable 2 Potential Savings (MWh)
Duquesne	$ 58,637,855	$ 87,511,354	YES	412,981
Met-Ed	$ 74,600,676	$ 83,564,982	YES	378,339
Penelec	$ 68,924,232	$ 80,243,047	YES	371,169
Penn Power	$ 19,979,352	$ 23,095,796	YES	110,399
PPL	$ 184,504,128	$ 256,839,620	YES	1,142,977
PECO	$ 256,185,476	$ 225,345,894	NO	1,081,205
West Penn	$ 70,687,404	$ 105,316,894	YES	502,889
Statewide	***$ 733,519,122***	***$ 861,917,587***	***YES***	***3,999,960***

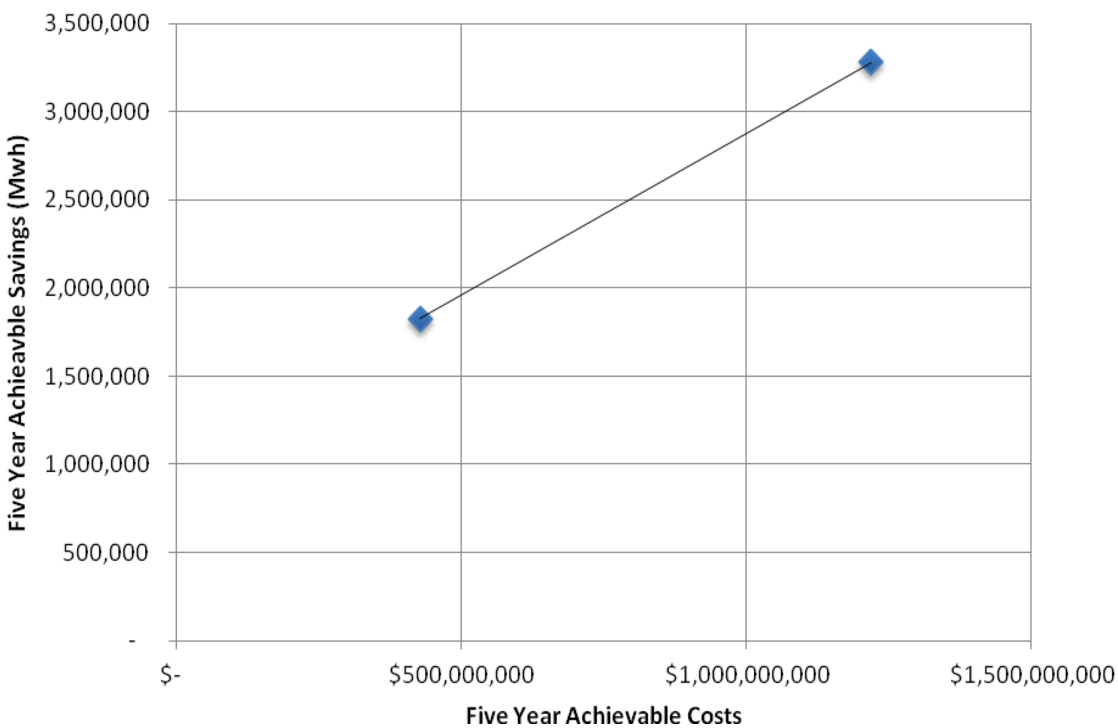
Table 8-6: Comparison of 2013-2018 Cumulative Annual Achievable 2 Costs and Program Budget

EDC	Five Year Spending Ceiling (total portfolio)	Five Year Ach 2 Costs (total portfolio)	Ach 2 Exceeds Spending Ceiling	Achievable 2 Potential Savings (MWh)
Duquesne	$ 97,729,758	$ 152,477,216	YES	690,309
Met-Ed	$ 124,334,460	$ 147,174,539	YES	639,446
Penelec	$ 114,873,720	$ 139,836,494	YES	624,882
Penn Power	$ 33,298,920	$ 39,966,943	YES	185,438

EDC	Five Year Spending Ceiling (total portfolio)	Five Year Ach 2 Costs (total portfolio)	Ach 2 Exceeds Spending Ceiling	Achievable 2 Potential Savings (MWh)
PPL	$ 307,506,880	$ 440,163,844	YES	1,906,619
PECO	$ 426,975,793	$ 386,017,861	NO	1,818,307
West Penn	$ 117,812,340	$ 181,846,661	YES	844,823
Statewide	***$ 1,222,531,870***	***$ 1,487,483,557***	***YES***	***6,709,824***

The final step to calculate program potential is to scale the respective EDC achievable scenario 2 energy savings down to the three and five-year spending ceiling value while holding the acquisition cost constant. The one exception is PECO; Table 8-6 illustrates that PECO's program cost for achievable 2 are less than the spending ceiling (spending ceiling of $427 million with achievable 2 costs $386 million). This reveals that it is unlikely that additional savings are achievable at this incentive level. Thus, program acquisition cost spending must increase for PECO to spend up to the program budget ceiling. In order to calculate the increase in savings achievable by PECO from the achievable 2 scenario, a linear model was created using achievable potential scenarios 1 (100% incremental funding) and 2 (current funding levels).This model is shown in Figure 8-1.

Figure 8-1: PECO Scaling Model



8.1.3 PROGRAM POTENTIAL RESULTS

The final three-year and five-year program potential energy savings and budget values are found in Table 8-7 and Table 8-8 for each EDC and the state of the Pennsylvania.

Table 8-7: Program Potential Scenario 1 2013-2016 Cumulative Savings and Budget

EDC	3 Year Spending Ceiling (total portfolio)	3 Year Program Potential Savings (MWh)	3 Year Program Acquisition Cost ($/MWh)	3 Year % of 2009/10 Forecast	Probable Range of 2009/10 Forecast
Duquesne	$58,637,855	276,722	$211.90	2.0%	1.7% - 2.5%
Met-Ed	$74,600,676	337,753	$220.87	2.3%	2.0% - 2.7%
Penelec	$68,924,232	318,813	$216.19	2.2%	1.9% - 2.7%
Penn Power	$19,979,352	95,502	$209.20	2.0%	1.7% - 2.5%
PPL	$184,504,128	821,072	$224.71	2.1%	1.9% - 2.7%
PECO	$256,185,476	1,125,851	$227.55	2.9%	2.6% - 3.1%
West Penn	$70,687,404	337,533	$209.42	1.6%	1.4% - 2.1%
Statewide	$733,519,122	3,313,247	$221.39	***2.3%***	***2.0% - 2.7%***

Table 8-8: Program Potential Scenario 1 2013-2018 Cumulative Savings and Budget

EDC	5 Year Spending Ceiling (total portfolio)	5 Year Program Potential Savings (MWh)	5 Year Program Acquisition Cost ($/MWh)	5 Year % of 2009/10 Forecast	Probable Range of 2009/10 Forecast
Duquesne	$97,729,758	442,451	$220.88	3.1%	2.8% - 4.2%
Met-Ed	$124,334,460	540,210	$230.16	3.6%	3.4% - 4.5%
Penelec	$114,873,720	513,332	$223.78	3.6%	3.2% - 4.4%
Penn Power	$33,298,920	154,500	$215.53	3.2%	2.8% - 4.1%
PPL	$307,506,880	1,332,001	$230.86	3.5%	3.2% - 4.5%
PECO	$426,975,793	1,884,517	$226.57	4.8%	4.3% - 5.2%
West Penn	$117,812,340	547,332	$215.25	2.6%	2.3% - 3.5%
Statewide	***$1,222,531,870***	***5,414,343***	***$225.80***	***3.7%***	***3.3% - 4.5%***

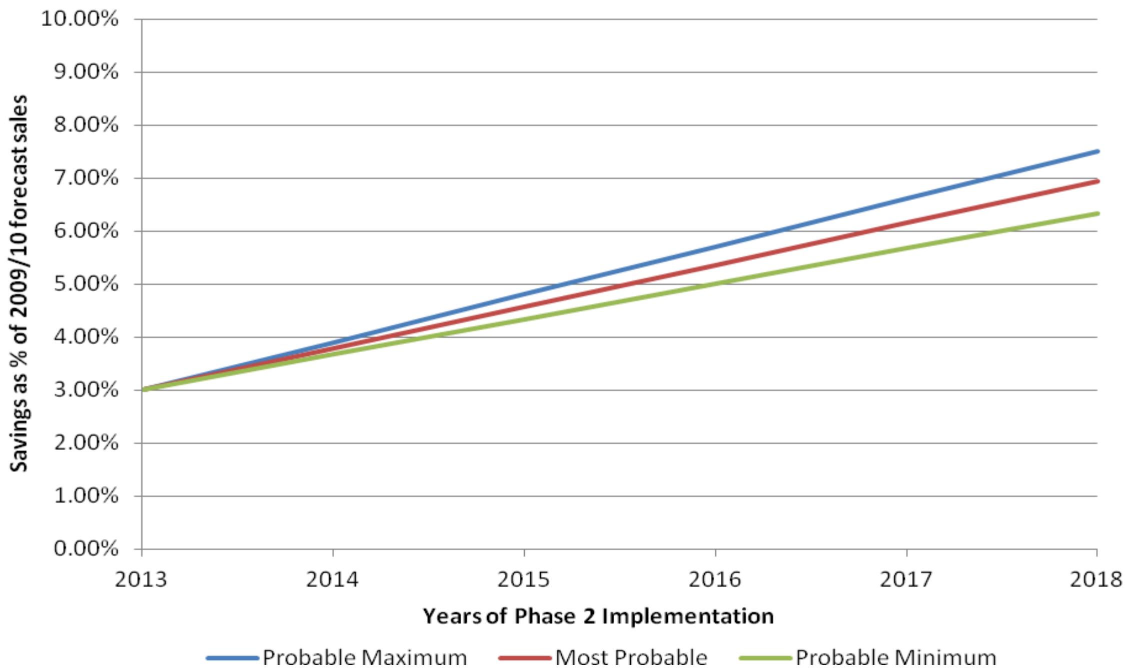
The uncertainty ranges presented are largely based outcomes of this study supplemented with research of other regional (non-Pennsylvania) utilities' program forecasts, and SWE's industry experience. There are several key observations to be noted within these program potential savings and budgets:

- For the three year period (2013-2016), program potential scenario 1 estimated MWh savings are 2.3% of forecast sales. Over the five year period (2013-2018) program potential scenario 1 estimated MWh savings are 3.7% of forecast sales.
- Program potential savings are less than currently expected with Phase 1 implementation. This is largely due to the impacts of federal legislation, changing baseline conditions and increasing saturation of energy efficient equipment.
- Expected program costs are considerably higher than current Phase 1 implementation. Statewide estimated acquisition costs for 2013-2018 acquisition costs are 62% higher than current acquisition costs.

8.1.3.1 Program Potential Uncertainty

Due to the uncertainty in forecasting, marketplace technologies and costs, and expected program adoption, program potential may be best considered as a range of probable outcomes. Based largely on analysis within this study, SWE's experience and research of other utilities the most likely statewide program potential annual savings for years 2013-2018 ranges between 0.7% to 0.9% of 2009/2010 forecasted sales. Consequently, the expected probable acquisition cost may range from $170 to $250 per first year MWh savings. Figure 8-2 illustrates this range from 2013-2018 along with the most probable outcomes summarized in Table 8-8.

Figure 8-2: Program Potential Range 2013-2018[54]



Some of this uncertainty has been addressed through the adoption of safety margins to the program costs. However, it also needs to be stated that these forecasts of program potential are based on many assumptions, including EDC forecasted sales, avoided costs, measure costs and expected savings, SWE's experience, and industry knowledge, among others. A significant change to these assumptions—for instance, due to a large change in economic conditions— can affect the applicability of these values.

Finally, this analysis does not consider the impacts of program "carve-outs" or "set-asides" for specific sectors or target markets. Current Phase 1 of Act 129 has two such set-asides for residential low-income and governmental/non-profit sectors. Addition of set-asides could change this analysis, likely with the effect of reducing program potential. For instance, residential low-income programs often utilize 100% incremental measure cost incentives. Higher budgets for set-aside programs would have the consequence of reducing the overall budget for the broader portfolio, leading to reduced program potential savings.

8.2 ESTIMATION OF PROGRAM POTENTIAL SCENARIO #2

The second program potential scenario considered a fixed annual savings target of 1% of 2009/2010 forecast energy sales and determined what the estimated costs would be to achieve these savings. This scenario provides an understanding of what the acquisition costs would be to acquire the current Phase 1 savings goals for Phase 2 of Act 129.

Based on the findings for Program Potential 1, and as can be seen in Table 8-7 and Table 8-8, no EDC achieves this goal of 1% annual incremental savings and thus all expenditures must be scaled upward from achievable 2 cumulative costs using a model similar to the one described for PECO in program potential scenario 1. The results for Program Potential 2 can be found in Table 8-9 and Table 8-10

[54] Note: future savings potentials illustrated in this graph assume that the EDCs achieve exactly 3% of 2009/10 sales at the end of phase 1.

Table 8-9: Program Potential Scenario 2 2013-2016 Estimated Program Costs

EDC	3 Year Spending Ceiling (total portfolio)	3 Year Program Potential Savings (MWh)	3 Year Program Acquisition Cost ($/MWh)	3 Year % of 2009/10 Forecast
Duquesne	$94,543,076	422,565	$223.74	3.00%
Met-Ed	$131,640,852	445,951	$295.19	3.00%
Penelec	$123,114,709	431,979	$285.00	3.00%
Penn Power	$45,409,402	143,188	$317.13	3.00%
PPL	$259,331,715	1,146,431	$226.21	3.00%
PECO	$294,681,687	1,181,580	$249.40	3.00%
West Penn	$189,508,954	628,160	$301.69	3.00%
Statewide	***$1,138,230,395***	***4,399,854***	***$258.70***	***3.00%***

Table 8-10: Program Potential Scenario 2 2013-2018 Estimated Program Costs

EDC	5 Year Spending Ceiling (total portfolio)	5 Year Program Potential Savings (MWh)	5 Year Program Acquisition Cost ($/MWh)	5 Year % of 2009/10 Forecast
Duquesne	$161,993,612	704,275	$230.01	5.00%
Met-Ed	$215,195,164	743,252	$289.53	5.00%
Penelec	$201,619,549	719,965	$280.04	5.00%
Penn Power	$73,270,746	238,647	$307.03	5.00%
PPL	$442,854,308	1,910,718	$231.77	5.00%
PECO	$479,423,225	1,969,300	$243.45	5.00%
West Penn	$307,017,920	1,046,933	$293.25	5.00%
Statewide	***$1,881,374,524***	***7,333,090***	***$256.56***	***5.00%***

This analysis demonstrates that considerable increase in program spending would be required to achieve savings similar to Phase 1 goals during the Phase 2 period. Spending across the five-year horizon (2013-2018) would need to increase by over $650,000,000 to achieve these goals.

9 CONCLUSIONS

In summary, the remaining potential for electric energy efficiency in the service areas of the seven electric distribution companies (included in this study) is significant. The statewide estimated achievable potential electricity savings for Scenario #1 amounts to 6,339,540 MWh on a cumulative annual basis by 2013 (a 4.3% reduction in projected 2010 baseline MWh sales) and 11,996,092 MWh on a cumulative annual basis by 2018 (an 8.2% reduction in projected 2010 baseline MWh sales).

The TRC ratios statewide for Achievable Potential scenario #1 are 1.75 (3-year timeframe), 1.83 (5-year timeframe) and 1.95 (10-year timeframe). The TRC ratios statewide for Achievable Potential scenario #2 are 1.73 (three-year), 1.85 (five-year) and 1.97 (10-year).

After taking into account the Act 129 program spending limits, the SWE recommends that the savings targets for Phase 2 be based on the program potential 1 scenario presented in Table 1-3 and Table 1-4 . The three-year program potential savings is 3,313,247 MWh with a corresponding three-year statewide reduction target of 2.3%. The five-year program potential savings is 5,414,343 MWh with a five-year statewide reduction target of 3.7%.

The results of this study demonstrate that cost effective electric energy efficiency resources can play an important role in Pennsylvania's energy resource mix during the next three-year or five-year period.

9.1 IMPORTANT CONSIDERATIONS ABOUT THIS ENERGY EFFICIENCY POTENTIAL STUDY

There are several important facts about the data and assumptions used in this electric energy efficiency potential study, as follows:

- This study includes a comprehensive list of energy efficiency measures for the residential, commercial and industrial sectors. For example, consumer electronics are treated as a comprehensive end use in the residential sector in this analysis. Savings from consumer electronics were not always examined in studies conducted in the past. Second, all of the energy efficiency measures included in the 2012 Pennsylvania Technical Reference manual are included in this study.
- Emerging, commercially available technologies have been included in this analysis along with behavioral based energy efficiency measures.
- This study has used the latest available forecasts of electric avoided costs provided by the seven electric distribution companies. Many of these avoided cost forecasts are higher than those used by the companies in the development of their 2009 Energy Efficiency and Conservation Plans.
- The main programmatic strategy used in this study is a replace on burnout strategy, where measures are implemented when equipment reaches the end of its useful life.
- Achievable potential scenario #1 assumes an incentive level for energy efficiency measures of 100% of measure incremental cost, and a long-term market penetration rate of eighty-five percent. Achievable potential scenario #2 assumes an incentive level for energy efficiency measures of 56% of measure incremental cost for the residential sector, and 34% for the commercial and industrial sectors.

9.2 CONCLUDING THOUGHTS

It is clear that electric energy efficiency programs could save residents of Pennsylvania a substantial amount of electricity by 2018. The electric energy efficiency potential estimates and the TRC Test savings provided in this report are based upon the latest load forecasts and avoided cost forecasts provided by the seven electric distribution companies. These distribution companies also provided appliance saturation data, data on energy efficiency measure costs and savings, and measure lives available at the time of this study. Over time, additional technologies are likely to become available in the market that may serve to increase the potential for energy and demand savings and warrant additional attention. Finally, actual energy and demand savings will depend upon the level and degree of Pennsylvania residences and business participation in the EE programs offered by the EDCs.