Maryland Benefits: Examining the Results of EmPOWER Maryland through 2015

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Executive Summary

The end of 2015 marked the conclusion of the first phase of the EmPOWER Maryland energy efficiency programs. The first phase of this effort began in 2008 following the passage of the EmPOWER Maryland Energy Efficiency Act. This act established energy efficiency savings goals for the five largest electric distribution companies in the state and the Maryland Energy Administration. This report reviews the costs and benefits of the first phase from 2008 through 2015.

Our review of the costs and benefits of programs implemented thus far show these programs produced substantial benefits to the state of Maryland. These benefits included reduced utility system costs, lower customer bills, and diminished emissions of harmful pollutants. The programs also increased net jobs in Maryland and boosted the state's gross domestic product (GDP). The cost of saved energy for these programs was also lower than the market price for electricity, reducing Maryland's dependence on costly electricity imports from other states.

The programs produced the following results:

- Total lifetime energy savings of over 51 million MWh, equivalent to the electricity used by 850,000 residential customers in five years
- Savings at a levelized cost of 3.4 cents per kWh
- Total demand savings of more than 2,000 MW in 2015, equivalent to the output of four large power plants
- Benefits of $2.4 billion at a cost of $1.3 billion, a cost–benefit ratio of 1.81
- More than $4 billion in total customer bill savings over the life of the measures
- Installation of more than 26 million energy efficiency measures
- Avoided emissions of nearly 19 million metric tons of carbon dioxide, more than 34 million pounds of nitrogen oxides, and nearly 78 million pounds of sulfur dioxide over the lifetime of the programs
- Nearly $392 million in wholesale market revenues from participation in regional generating capacity auctions, which reduce the ratepayer costs of the programs
- A 9.5 million therm reduction in natural gas consumption, equivalent to the annual usage of 11,600 residential customers
- More than 2,000 new jobs and an $80 million increase in state GDP in 2011 alone

ENERGY AND DEMAND SAVINGS

The 2008 act required utilities to reduce per capita electricity consumption from 2007 levels by 10% by 2015. The act also required utilities to reduce per capita electric demand by 15% during this time. The Maryland Public Service Commission (PSC), in its annual report to the legislature in 2015, stated that the utilities achieved 99% of the per capita consumption goal and 100% of the per capita demand reduction goal.[1] ACEEE used utility evaluation and

[1] This does not include the portion of the savings goal allocated to the Maryland Energy Administration.

semiannual reports to determine annual savings. Figure ES1 shows the cumulative annual gross wholesale electricity and demand savings achievements.

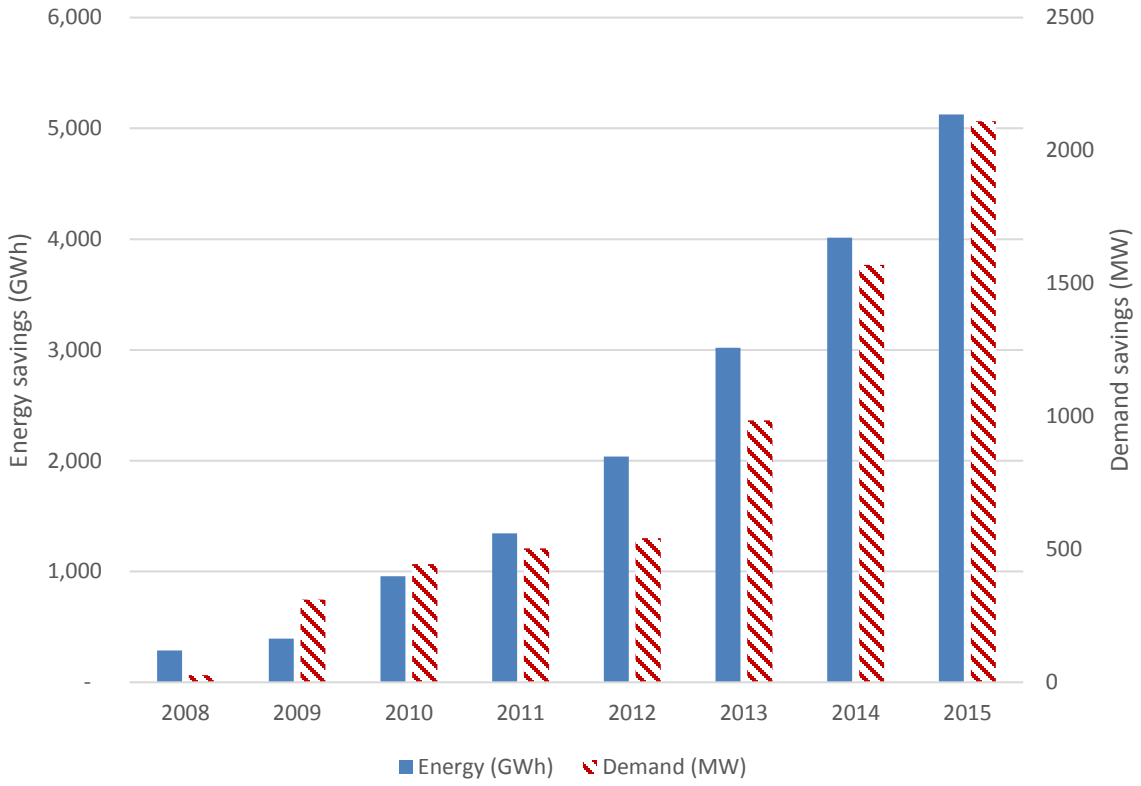

Figure ES1. Cumulative annual gross wholesale energy and demand savings 2008–2015

The energy and demand savings highlighted in figure ES1 produced many significant benefits for Maryland. These benefits accrue over several different time periods. While the program implementation costs are recovered from Maryland electric customers over a 5-year period, it is important to remember the energy savings from these programs continue for an average of 10 years after installation. To better understand the benefits realized from these programs, we focus on three distinct time periods: the calendar year 2015, the period 2008 through 2015, and the total lifetime of energy savings.

BENEFITS OVER THE LIFETIME OF THE PROGRAMS

The programs will produce gross electric savings of more than 51 million megawatt-hours (MWh). These are the savings from all measures for the useful life of those measures, some of which can exceed 20 years. These energy savings reduce the need for power plants and other utility infrastructure, and avoid emissions of nearly 19 million metric tons of carbon dioxide, more than 34 million pounds of nitrogen oxide, and more than 78 million metric tons of sulfur dioxide.[2] The reduction of harmful pollutants will provide health benefits to residents in Maryland and the surrounding states for many years to come. The health

[2] Net wholesale savings were used to determine power plant emission reduction benefits.

benefits of reducing sulfur dioxide and nitrogen dioxide include reduced respiratory hospital admissions, less chronic bronchitis, and fewer asthma cases (Yang et al. 2005).

Program participants will save more than $4 billion on their electric bills over the lifetime of program measures installed through 2015.[3] Those who do not directly participate in programs also greatly benefit. For example, the programs have generated more than $392 million in revenue from participation in PJM capacity auctions. These dollars directly offset the cost of the programs. Also, the inclusion of energy efficiency and demand response reduces wholesale prices for generating capacity. For the 2015 auction (delivery year 2018–2019), the total cost of generating capacity would have been 29.4% higher if energy efficiency and demand response had not participated (Monitoring Analytics 2016).[4] Finally, our analysis of economic benefits from measures installed in 2011 shows that more than 2,000 net jobs were created from these programs and that the state gross domestic product (GDP) increased by more than $80 million.

COST EFFECTIVENESS RESULTS

The vast majority of energy savings included in the EmPOWER Maryland goals undergo rigorous annual evaluation. The cost effectiveness of the programs is reviewed as part of this evaluation effort. Table ES1 shows the cost effectiveness results of the evaluated programs since 2009 using the total resource cost test.[5] Programs were cost effective every year since 2010 and showed an increase in cost effectiveness in the final three years. The results show that every dollar invested in the EmPOWER programs produced $1.81 in benefits.

Table ES1. Total resource test cost effectiveness results for 2010–2015

Year	Present-value costs	Present-value benefits	Benefit–cost ratio
2015	$270,042,144	$535,572,744	1.98
2014	$374,402,170	$681,215,825	1.82
2013	$256,311,488	$463,337,561	1.81
2012	$184,790,351	$316,799,939	1.71
2011	$151,493,608	$210,500,575	1.39
2009/2010	$100,166,096	$211,454,879	2.11
Total	$1,337,205,857	$2,418,881,523	1.81

2010 includes costs and benefits from the 2009 programs. The 2008 programs were not evaluated and are not included in this table.

[3] Gross wholesale energy savings were used to determine participant benefits.

[4] This considers energy efficiency and demand response in all of PJM, not just the EmPOWER programs.

[5] The total resource cost test measures cost effectiveness from the perspective of the total utility system, including all utility and participant costs and all utility-system benefits.

COST OF SAVED ENERGY

Our analysis shows the levelized cost of saved energy (LCSE) for EmPOWER programs implemented between 2009 and 2015 was 3.4 cents per kilowatt-hour (kWh) based on gross savings achievements. The residential, commercial, and industrial sectors showed similar results, with the commercial and industrial sectors achieving a lower LCSE than the residential sector. The LCSE considers the total utility-related costs of the program over the lifetime of the energy savings to determine a per-unit cost of saved electricity.

CONCLUSION

The benefits of Maryland's energy efficiency programs are far-reaching and accrue to all residents and businesses in the state, including those who do not directly participate in programs. EmPOWER energy efficiency programs have provided enough energy savings to be the state's third-largest electricity resource, behind only coal and nuclear. The demand savings are also a critical resource that met 15% of peak power needs in 2015.

We find that the EmPOWER programs were successful in providing Maryland electric customers with the least-cost electricity resource. The programs have provided many other benefits to the state as well. These benefits include lower wholesale power prices, reduced power plant–related emissions and the associated improvement in public health, avoided utility costs such as new generating and distribution system capacity, increased state GDP, a net gain in jobs, and substantial bill savings.

Introduction

On April 24, 2008 Maryland Governor Martin O'Malley signed into law the EmPOWER Maryland Energy Efficiency Act. The bill passed both the Senate (33–13) and House (101—33) by supermajorities. This act established the first energy efficiency resource standard in Maryland, requiring that the five largest utilities in the state reduce per capita consumption of electricity by 10% of 2007 levels by 2015, and per capita demand by 15%. The total energy savings goal was 15%, but 5% of this goal was allocated to the Maryland Energy Administration. In the act, the Maryland legislature declared that energy efficiency is among the least expensive ways to meet growing electricity demand and that the energy efficiency targets provide affordable, reliable, and clean energy for consumers in Maryland (EmPOWER Maryland 2008).

Following passage of the act, the five largest electric companies in Maryland established a successful energy efficiency implementation network that includes hundreds of Maryland businesses, including lighting contractors; heating, ventilation, and air conditioning (HVAC) contractors; home performance contractors; retail stores; home builders; and other trade allies. The utilities have spent considerable time and effort to increase customer awareness of programs and general education of the benefits of energy efficiency. Through these efforts and the strong support of the Maryland Public Service Commission (MD PSC), the state has emerged as a leader in energy efficiency performance. Since 2008, Maryland has climbed in the ACEEE *State Scorecard* rankings, from 12th position in 2008 (earning 5.5 out of 20 possible points for utility performance) to 9th place in 2016 (earning 9.5 out of 20 points) (Berg et al. 2016).

In its annual report to the legislature in 2015, the MD PSC declared that the utilities achieved 99% of the per capita consumption reduction goal and 100% of the per capita demand reduction goal. According to PSC staff, the EmPOWER programs implemented between 2008 and 2015 will save customers more than 38 billion kWh over the lifetimes of the measures, equating to approximately $4.39 billion in electric bill savings. The PSC also determined the cost of saved energy to be 3.2 cents per kWh—a much lower cost than current electric supply rates in Maryland (MD PSC 2016).[6]

In this report we examine the benefits and relative costs for the EmPOWER Maryland programs from 2008 to 2015. The programs continue in 2016, with a second phase requiring utilities to ramp up annual savings targets to 2% of retail sales by 2020. This report reviews only the first phase of EmPOWER, which concluded at the end of 2015.

Methodology

The intent of this research is to review the performance, benefits, and costs of the EmPOWER energy efficiency programs administered from 2008 through 2015.

[6] The cost of saved energy is the total utility costs of efficiency program implementation by year for the lifetime of the programs, per energy unit (usually kWh).

DATA SOURCES

The data and information presented in this report were compiled from publicly available regulatory filings before the Maryland PSC.[7] These filings include semiannual reports, evaluations, and cost effectiveness reports. We also relied on the U.S. Energy Information Administration (EIA) and other sources to obtain other publicly available data on sales, revenues, customer counts, electricity prices, and state economic indicators. These data sources are cited throughout the report.

PROGRAM CATEGORIES AND DATA LIMITATIONS

There are four distinct categories of energy and demand savings programs under EmPOWER, summarized in table 1. These program categories include energy efficiency; limited income; demand response; and "other programs," such as street lighting, conservation voltage reduction (CVR), dynamic pricing, energy-efficient transformers, and other smart grid investments. While utilities report energy and demand savings for the "other programs" category, they do not report expenditures for these efforts as part of EmPOWER Maryland. Therefore energy savings from these programs are excluded from some analyses, including levelized cost of saved energy and cost effectiveness of the rest of the EmPOWER investments. The energy savings from other programs are included in environmental and bill savings benefits. To avoid confusion, we refer to the residential, commercial, and industrial programs as the energy efficiency programs. The limited-income program is referred to separately because this program is implemented by a third-party state agency and is reported separately from the other energy efficiency programs.

Table 1. EmPOWER Maryland program categories

Category of program	Third-party evaluation of savings	Funds collected in EmPOWER surcharge	Programs included
Energy efficiency	Yes	Yes	Residential, commercial, and industrial energy efficiency programs
Limited income	Yes[1]	Yes	Limited-income energy efficiency program (LIEEP) and Multifamily Energy Efficiency and Housing Affordability Program (MEEHA)
Demand response	Yes[2]	No	Residential and commercial demand response programs
Other programs	No[3]	No	Street lights, high-efficiency transformers, conservation voltage reduction, smart meters

[1] DHCD did complete one year of evaluation in 2014 and is currently in the process of evaluating prior savings years. [2] These savings were assessed as part of PJM evaluations but not reviewed for this report. [3] Some of these programs, such as CVR, are evaluated but are not included in EmPOWER filings and thus not reviewed for this report.

[7] See Case Nos. 9153-9156 in the matter of Baltimore Gas and Electric, Delmarva Power and Light, Potomac Edison (previously Alleghany Power), PEPCO, and Southern Maryland Electric Cooperative energy efficiency, conservation, and demand response programs pursuant to the EmPOWER Maryland Energy Efficiency Act of 2008.

DETERMINING BENEFITS

Throughout this report we provide data on specific benefits from the EmPOWER programs. These benefits include air emissions reductions, participant bill savings, wholesale market cost savings, nonenergy benefits, and utility system benefits. Specific methodologies for determining these benefits are discussed in greater detail in those respective sections.

ENERGY SAVINGS ASSUMPTIONS

In this report we present both net and gross energy savings. Net savings are energy savings attributable to the EmPOWER energy efficiency programs. These changes may implicitly or explicitly include the effects of factors such as free ridership, participant and nonparticipant spillover, and induced market effects.[8] Gross energy savings are changes in energy consumption that result directly from program-related actions taken by participants in an energy efficiency program, regardless of why they participated. We report both net and gross savings because they are used for different purposes in Maryland. For example, the statewide energy and demand savings goals are gross, but the cost effectiveness tests rely on net savings.

The energy savings data presented in this report were collected primarily from semiannual utility filings and evaluation reports. Within these, utilities report lifetime energy savings for all programs. The lifetime savings values were used to determine cumulative annual savings from EmPOWER programs. Cumulative annual savings are incremental annual savings combined with energy savings from prior years' activities that are still saving energy. The cumulative annual savings figures presented in this report rely on the weighted average measure life for reported programs.[9] We assumed savings degradation was already included in the lifetime savings estimates and therefore did not apply degradation factors to savings results.

Savings estimates are also presented at the wholesale or generator level. The wholesale-level savings include transmission and distribution system energy losses, also known as line losses. The avoided line losses are direct energy savings from the programs. We relied on estimates presented in the *Avoided Energy Costs in Maryland* 2014 study (Exeter Associates 2014).

It is important to note that our analysis approach did yield results slightly different from the savings reported by PSC staff. This is due to a couple of factors. The evaluation of savings in 2009 and 2010 were combined in the evaluation reports. To determine what the evaluated savings were for these years separately, we took the ratio of reported savings for each year and then applied this ratio to the total evaluated savings for 2009/2010. Our analysis also

[8] Free ridership refers to program participants who would have implemented the program measure or practice even in the absence of the program. Spillover is a reduction in energy consumption and/or demand caused by the presence of an energy efficiency program, beyond the program-related gross savings of participants and without financial or technical assistance from the program. Induced market effects are changes in the structure or functioning of a market, or the behavior of participants in a market, that result from one or more program efforts (NEEP 2011).

[9] The assumptions for measure life by year can be found in Appendix A. These values were based on lifetime savings estimates gathered from semiannual reports filed in Case Nos. 9153–9157.

uses evaluated instead of reported savings for 2015. The 2015 evaluation covered only the first half of the year. To determine the evaluated savings for the entire calendar year, we applied the realization rate to the calendar-year reported values. Differences in lifetime savings estimates may be attributed to differences in assumed weighted average measure lives for the portfolio-level savings.

Table 2 shows the percentage of savings from each program type and is organized by year. The majority of energy savings have come from the energy efficiency programs.

Table 2. Gross energy savings as a percentage of total savings by program, 2008–2015

	2008	2009	2010	2011	2012	2013	2014	2015
Energy efficiency	100%	99%	88%	88%	96%	93%	92%	87%
Other programs	0%	0%	0%	0%	2%	3%	5%	11%
Demand response	0.0%	1.3%	11.3%	10.5%	0.6%	2.6%	1.7%	0.9%
Limited income	0.0%	0.1%	0.6%	1.3%	1.3%	1.5%	1.6%	1.4%

Electricity and Demand Savings

The EmPOWER Maryland programs have produced significant benefits for the state since 2008. These benefits are far-reaching and accrue to all residents and businesses in the state, including those who do not directly participate in programs. The drivers of these benefits are the energy (GWh) and demand (MW) savings produced by the programs. Figure 1 shows the cumulative annual energy net and gross savings produced by these programs since 2008.[10] The energy savings in figure 1 include all four program categories outlined in table 1.

[10] Cumulative annual savings are incremental annual savings combined with energy savings from prior years' activities that are still saving energy and have not yet reached the end of their useful lifetime. Lifetime savings are a forward-looking measurement of savings, while cumulative annual (or total annual) savings look back at savings achieved from past measures that still remain in 2015.

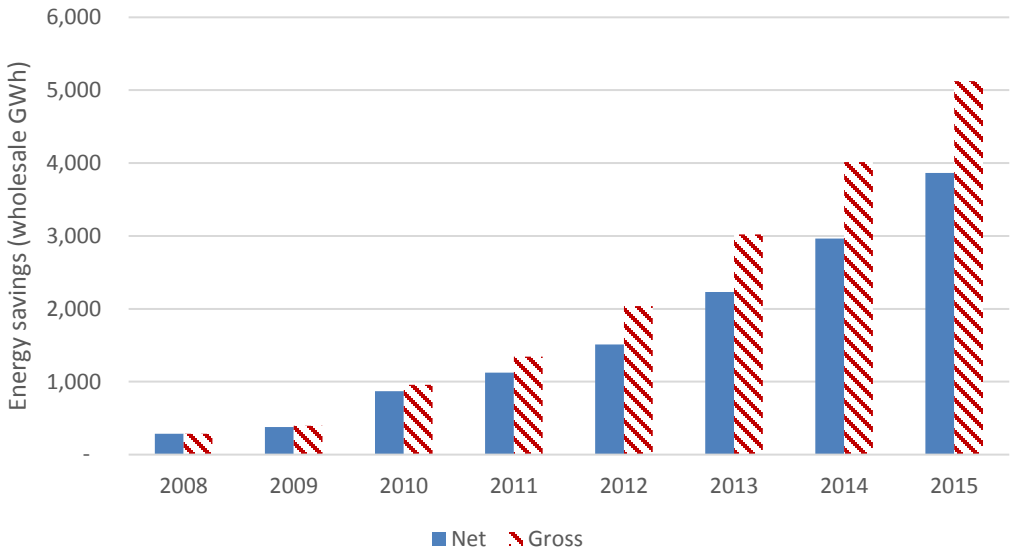

Figure 1. Cumulative annual net and gross electric savings, 2008–2015

Our results, presented in figure 1, indicate a consistent increase in cumulative annual energy savings. First-year incremental energy savings show a similar trend, with a slight decline in 2015. Utilities were able to ramp up energy savings at an average rate of 0.22% of total electric sales over the 2008–2015 period. Incremental savings are not shown in figure 1. By 2015, cumulative annual gross energy savings reached approximately 5,105 GWh, roughly equivalent to the output of two 500 MW power plants.[11] Energy efficiency savings amounted to approximately 8% of total electric sales in 2015.

Figure 2 presents the cumulative annual net and gross demand reductions produced by the programs. The figure shows a slow start then a dramatic increase in demand savings after 2012. By 2015 the programs were producing cumulative annual gross demand reductions of approximately 2,110 MW.

[11] This value assumes a 64% capacity factor.

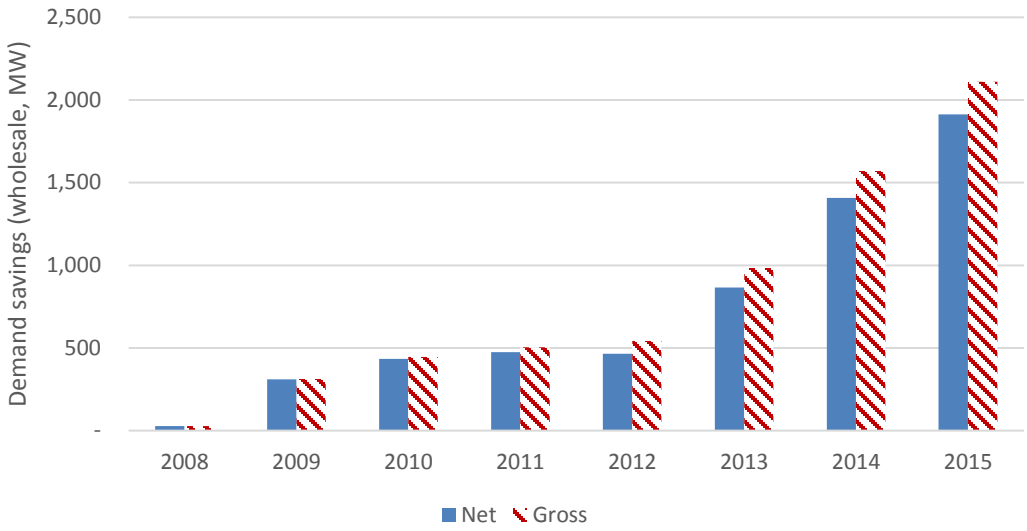

Figure 2. Cumulative annual net and gross demand savings, 2008–2015

The 2015 peak demand reduction achieved through the EmPOWER programs represents 15% of the total summer peak in Maryland (MD PSC 2015). Not only does the peak reduction avoid the need to construct new peaking power plants, but it also reduces the need for new transmission and distribution infrastructure throughout the state, ultimately saving all customers money through reduced utility system costs.

Energy Efficiency as a Resource in Maryland

Energy efficiency has become one of the largest in-state electricity resources in Maryland in terms of total production. In 2015, the 5,105 GWh of gross energy savings represented 14.5% of total in-state generation.[12] Table 3 compares energy efficiency with other Maryland resources in 2015. It shows that energy efficiency savings from EmPOWER programs is the state's third-largest electricity resource.

[12] If net savings were considered instead of gross, the 3,852 GWh of net energy savings would represent 11%.

Table 3. Maryland in state energy resources in 2015

Source	Production (GWh)
Nuclear	14,643
Coal	14,316
Energy efficiency (gross)	5,105
Gas	2,894
Water	1,597
Oil	799
Biomass	651
Wind	433
Solar	37

Source: All data except for energy efficiency are from the SNL Financial Power Plant Briefing Book. Energy efficiency figures are from ACEEE analysis.

Emissions Reduction Benefits

QUANTIFYING AIR EMISSIONS REDUCTIONS

Reductions in air emissions from power plants are a significant benefit of energy efficiency programs. In July 2015, the Maryland PSC approved the inclusion of air emissions reductions as a benefit in assessing the cost effectiveness of programs (MD PSC 2015). For the air emissions reductions presented in this section, we relied on the methodology used by Itron, the commission's consultant.[13] This methodology uses publicly available PJM data to determine the fuel mix for the year in question; then other sources are used to determine the associated air emissions per unit of energy. Employing the commission-approved methodology, we find that EmPOWER programs substantially reduced harmful power plant emissions in Maryland. Table 4 shows the emissions reductions annually for the three pollutants we examined: carbon dioxide, nitrogen oxide, and sulfur dioxide.

Table 4. Cumulative air emission reductions by pollutant by year

Year	Cumulative annual net savings (GWh)	Carbon dioxide (million metric tons)	Nitrogen oxide (million pounds)	Sulfur dioxide (million pounds)
2008	287	0.14	0.26	0.60
2009	380	0.19	0.35	0.79
2010	869	0.43	0.79	1.81
2011	1,124	0.56	1.02	2.34
2012	1,511	0.76	1.38	3.14

[13] A memo outlining this methodology can be found at webapp.psc.state.md.us/newIntranet/Casenum/NewIndex3_VOpenFile.cfm?filepath=C:%5CCasenum%5C9100-9199%5C9153%5CItem_597%5C%5C9153-57-NonEnergyBenefitsReport-Itron-022415.pdf.

Year	Cumulative annual net savings (GWh)	Carbon dioxide (million metric tons)	Nitrogen oxide (million pounds)	Sulfur dioxide (million pounds)
2013	2,233	1.12	2.03	4.64
2014	2,950	1.48	2.68	6.14
2015	3,852	1.93	3.51	8.01
Lifetime	37,586	18.79	34.20	78.18

Savings are net wholesale.

According to our analysis, the air emissions reductions from the EmPOWER programs in 2015 are comparable to the annual emissions of a 500 MW power plant. The emissions reductions also will continue for several years after 2015. The estimated lifetime savings are nearly 19 million metric tons of CO_2, 34.2 million pounds of NOx, and 78.2 million pounds of SO_2. These reductions will provide health benefits to those living in Maryland and the surrounding states over the next decades.

ENVIRONMENTAL DAMAGES

Power plant air pollution imposes costs on society, including health costs. These health-related costs are more commonly known as damages. Table 5 shows the present value of avoided damages for the 2013 programs and several different assumptions on the proportion of damages to apply to Maryland.[14] While PSC staff presented a range of potential values, the commission approved the low carbon value scenario, which ascribes 10% of the estimated avoided damages to the state of Maryland. The low, medium, and high scenarios represent different potential carbon prices. Low is $5.58/MWh, medium is $22.74/MWh, and high is $34.85/MWh. The avoided damages for NO_x and SO_2 were the same in all scenarios.

Table 5. Sensitivity estimates of present value of avoided damages for 2013 EmPOWER energy savings, in thousands of dollars

% of emissions damages applied to Maryland	Low	Medium	High
10%	$8,239	$15,877	$21,266
50%	$41,193	$79,383	$106,330
100%	$82,386	$158,767	$212,659

Commission staff also estimated the value of avoided damages on the per kWh benefit of saved electricity. Table 6 shows the range of cost savings for nine specific scenarios. The nine scenarios were based on the percentage of externality costs that were avoided in Maryland (as opposed to nearby states) and three alternate damage estimates representing a

[14] The PV avoided damages presented in table 5 include only the evaluated energy efficiency savings and do not include electric savings from "other programs," demand response, or the limited-income program. The methodological approach for these estimates can be found in Loper and Scheidler 2015.

range from recent studies. The commission-approved use of the low, 10% scenario for use in cost effectiveness testing resulted in an adder of 0.11 cents per kWh.

Table 6. Adder for environmental damages avoided for 2013 EmPOWER MD programs (cents per kWh)

% of emission damages applied to Maryland	Low	Medium	High
10%	0.11	0.21	0.28
50%	0.55	1.06	1.42
100%	1.10	2.11	2.83

Wholesale Market Benefits

WHOLESALE AUCTION REVENUES

There are two primary wholesale market economic benefits from EmPOWER Maryland programs. The first is the direct revenues the programs generate from participating in the specific wholesale markets facilitated by PJM, a federally regulated regional transmission organization. This forward-capacity auction compensates energy resources able to provide power during a given year of operations. Several programs from EmPOWER participate in this market, including energy efficiency, demand response, and dynamic pricing. Table 7 shows the resulting cleared capacity and revenue from each program since the 2009 auction (for the 2012–2013 delivery year). As the table indicates, revenues from EmPOWER-related programs came to nearly $400 million through 2015. Energy efficiency capacity totaled nearly $66 million for auctions held between 2009 and 2015. These dollars are used to offset the cost of the programs.

Table 7. PJM capacity auction revenues from EmPOWER programs, 2009–2015

	Energy efficiency		Demand response		Dynamic pricing		Total	
Delivery year	Cleared capacity (MW)	Revenue (millions)	Cleared capacity (MW)	Revenue (millions)	Cleared capacity (MW)	Revenue (millions)	Cleared capacity (MW)	Revenue (millions)
2012–2013	168	$8.2	953	$46.5			1,121	$54.7
2013–2014	107	$8.7	803	$67.7			910	$76.4
2014–2015	179	$8.3	772	$33.9	267	$12.2	1,218	$54.4
2015–2016	175	$10.2	625	$36.0	426	$23.3	1,226	$69.5
2016–2017	226	$9.5	554	$24.1	461	$20.0	1,241	$53.6
2017–2018	243	$10.8	536	$23.5	387	$17.0	1,166	$51.3
2018–2019	172	$10.1	522	$11.5	378	$10.0	1,072	$31.6
Total	1,270	$65.8	4,765	$243.2	1,919	$82.5	7,954	$391.5

Source: MD PSC 2016

MARKET PRICE IMPACTS

The second primary wholesale market benefit is price suppression, also known as demand reduction induced price effect (DRIPE). As demand is reduced through the adoption of energy efficiency, wholesale energy market prices decline. This benefit of energy efficiency has been explored in several recent publications and is well understood (Taylor, Hedman, and Goldberg 2015; Chernick and Neme 2015; Baatz 2015, Exeter Associates 2014; Hornby et al. 2015). Market price suppression can also occur in energy, generating capacity, and natural gas markets. The value of this benefit can be substantial. For example, a 2013 ACEEE study for Ohio showed potential energy market price suppression benefits of $880 million and capacity market price suppression benefits of $1.3 billion through 2020 (Neubauer et al. 2013). Such benefits are forecast in future years to more accurately depict estimated benefits of energy efficiency investments.

Energy efficiency and demand response drive down wholesale prices in capacity auctions in PJM. Following its annual capacity auction, PJM's independent market monitor (Monitoring Analytics) releases an evaluation of the market prices across varying scenarios. One scenario is the total market cost for generating capacity without energy efficiency and demand response. According to the most recent evaluation following the 2015 auction (procuring for delivery year 2018–2019), the total cost of generating capacity would have been 29.4% higher if energy efficiency and demand response had not participated (Monitoring Analytics 2016). The substantial impact of these resources lowers costs for all customers in the PJM region and is a significant benefit of energy efficiency and demand response programs. Maryland's contribution to total PJM market-cleared energy efficiency was approximately 14%. For demand response, this value was 5%.

Cost Effectiveness and Cost of Saved Energy

TOTAL RESOURCE COST TEST

Utilities and the Maryland PSC review the cost effectiveness of the EmPOWER energy efficiency programs annually. The analysis is based on the evaluated net savings and includes the residential, commercial, and industrial programs. This analysis does not include other programs, demand response, or limited-income program savings. Traditionally, the MD PSC has relied on the total resource cost (TRC) test to measure cost effectiveness.[15] The benefit/cost (B/C) ratio has exceeded 1.0 each year during program administration, meaning programs are cost effective. Table 8 shows the results of the TRC test since 2010.

[15] In a July 2015 order, the PSC changed the primary cost effectiveness test from the TRC to the societal cost test (SCT). This change was not in place for any of the programs evaluated in this report.

Table 8. Total resource cost test results for 2010–2015

Year	Present-value cost	Present-value benefits	TRC B/C ratio
2015	$270,042,144	$535,572,744	1.98
2014	$374,402,170	$681,215,825	1.82
2013	$256,311,488	$463,337,561	1.81
2012	$184,790,351	$316,799,939	1.71
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2009/2010	$100,166,096	$211,454,879	2.11
Total	$1,337,205,857	$2,418,881,523	1.81

2010 includes costs and benefits from the 2009 programs. The 2008 programs were not evaluated and are not included in this table.

The cost effectiveness analysis demonstrates significant benefits to all residents and businesses in Maryland from these programs. For every dollar spent on EmPOWER energy efficiency programs, the state will see $1.81 in benefits. The TRC test in Maryland has evolved over time. The test now includes several benefits that were previously excluded, such as increased participant comfort from home improvements, reduced operations and maintenance costs for business customers, market price suppression (or DRIPE), water usage reductions, and lower consumption of other fuels, such as propane. Therefore the TRC results from earlier years may have undercounted some participant and wholesale market benefits while including all costs. To ensure proper evaluation of energy efficiency resources, it is critical to include all relevant costs and benefits of programs.

Statewide, the residential and commercial and industrial (C&I) programs have all been cost effective at the sector level since the inception of the programs, as shown in figure 3.

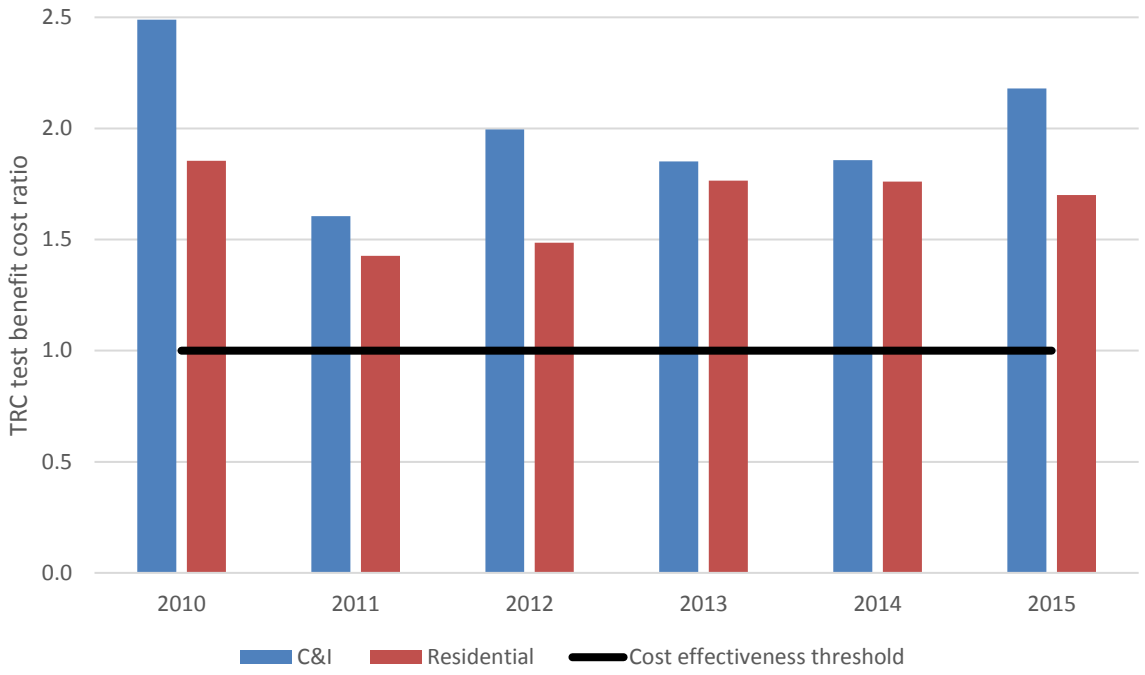

Figure 3. TRC test benefit cost ratios at sector level

LEVELIZED COST OF SAVED ENERGY

Levelized cost of electricity is a common method used to compare the cost of electricity from various energy resources. It may also be applied to energy efficiency by estimating the lifetime cost of energy savings for a given investment. The method relies on determining the utility or program administrator cost per kWh produced using the up-front capital and cost of operation (including fuel) over the lifetime of an asset. Previous ACEEE studies have used this approach (Molina 2014).

Our analysis shows the LCSE for EmPOWER savings between 2009 and 2015 is 4.9 cents per kWh based on net savings and 3.4 cents based on gross savings. The residential, commercial, and industrial sectors shared similar results, with the C&I sector achieving a lower LCSE than the residential sector.

Participant Bill Savings

Over the lifetime of the measures installed since 2008, participant bill savings will exceed $4.1 billion.[16] While all Marylanders benefit from the EmPOWER programs through reduced utility system costs, lower harmful air emissions, and increased economic activity, program participants earn additional benefits through immediate reductions in electricity bills. Customers can participate by paying for a portion of the up-front costs of energy efficiency equipment and upgrades. When considering all of the programs, including demand response, limited-income, and other programs, Maryland residents and businesses saved an estimated $413 million on their electric bills in 2015. These saved dollars increase disposable

[16] Figures for participant bill savings are based on gross savings.

incomes for residents and improve bottom lines for businesses in the state. Figure 4 shows annual bill savings from programs beginning in 2008. The bill savings will continue beyond 2015, because savings last for 10 years on average after installation.

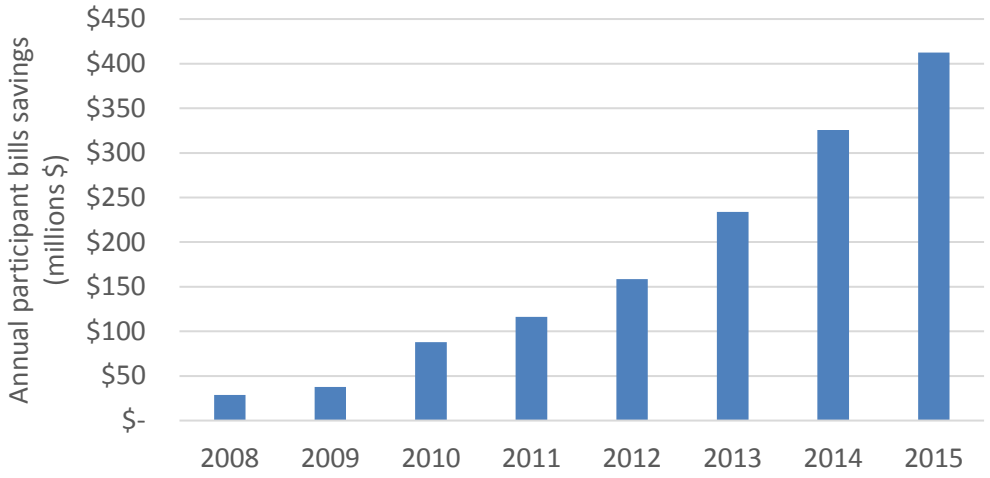

Figure 4. Annual participant bill savings for programs, 2008–2015. Energy savings are gross wholesale.

In estimating participant bill savings, our analysis may be considered conservative. We used the Maryland average annual electricity price for 2008 through 2014. For 2015, we used an average of the residential standard offer service (SOS) rate, and we assumed this rate held constant after 2015. We also used this rate for all customer classes. Finally, for commercial and industrial customers, we did not include bill savings resulting from lower peak demand. Thus these results, while significant, present a conservative view of participant bill savings.

Natural Gas Savings

Maryland electric utilities also report natural gas savings for EmPOWER programs. Although the reduction of natural gas consumption is not a primary goal of the programs, utilities reported significant gas savings at the conclusion of 2015. In total, program-to-date natural gas savings reported in 2015 was nearly 9.5 million therms, equivalent to the annual consumption of more than 11,600 residential customers.[17]

Economic Benefits

To provide an example of the economic benefits of energy efficiency in Maryland, we used ACEEE's DEEPER economic modeling framework to produce estimates of the employment and state-level GDP created from a single year's worth of energy efficiency investments. We chose 2011 as an illustrative year, using data on utility expenditures on energy efficiency by customer class and the lifetime savings they generate. In that year, utility spending on energy efficiency was roughly $104 million, generating more than three million MWh of saved electricity at a value of almost $290 million, based on 2011 electricity prices.

[17] Assumes an average monthly consumption of 67.42 therms. We relied on EIA natural gas consumption data for Maryland (EIA 2016b).

In calculating the economic impacts of the efficiency investments, our modeling accounts for the net impacts of the investments themselves (i.e., work required to implement efficiency upgrades) as well as the impacts of reduced energy expenditures by consumers. We account for both the positive and the negative impacts. Efficiency investments create jobs and economic activity by increasing demand for the products and labor that go into efficiency upgrades, but those jobs and materials must be paid for somehow. Similarly, once they are in place, the investments generate cost savings that energy customers spend on other goods and services, but those savings also mean reduced revenues for energy producers. We perform a comprehensive accounting that includes all the various costs and benefits to determine whether the net impact is positive or negative.

The net result of these impacts is the creation of more than 2,000 jobs in the state and an increase in state GDP of more than $80 million.[18] This is due in part to the fact that Maryland imports a substantial share of its electricity, so reducing electricity consumption reduces imports, keeping more money in the state economy. Another major factor, contributing to the positive employment impacts, is that the electricity industry tends to employ fewer people per sales dollar than do other industries providing goods and services; when consumers reduce their electricity purchases and spend that money elsewhere, it typically goes to industries that employ more people per dollar of revenue. More detail on the model used for these estimates can be found in Appendix B.

Nonparticipant Benefits

EmPOWER programs provide many benefits to nonparticipants as well. A primary benefit for nonparticipants is the reduction in future utility system costs. Energy efficiency programs reduce the need for new power plants and new transmission and distribution infrastructure. Other utility system benefits include avoided cost of renewable portfolio standard compliance; reduced credit and collection costs associated with limited-income customers; market price suppression of energy, natural gas, and capacity costs; and avoided line losses. Energy efficiency also reduces risk exposure to utility customers because of the lessened reliance on volatile fossil fuel prices and reduced exposure to potential cost overruns associated with new generating, distribution, and transmission capacity. These utility system benefits are substantial and provide significant cost savings to all customers in the utility system.

Utility customers who do not participate in programs benefit in other ways as well. Utility sector energy efficiency programs provide benefits to the state through increased jobs and state GDP, as discussed above. Finally, nonparticipants benefit through improved environmental outcomes, such as reduced air emissions and improved health.

Limited-Income Program

A program targeted to limited-income residential customers has been part of EmPOWER since 2009. This program was initially offered by the utilities, but administration was transferred to the Maryland Department of Housing and Community Development

[18] The jobs figure is the number of job years created over the life of the 2011 EmPOWER investments.

(DHCD) in April 2012. Figure 5 shows the total annual spending and incremental first-year electric savings from the limited-income program since its inception.[19] The figure includes spending and savings data from both the utilities and DHCD. The figure shows a decline in performance on energy savings in 2012 during the transfer of administration and in 2015.

The limited-income program comprises two separate programs, the Limited Income Energy Efficiency Program (LIEEP) and the Multifamily Energy Efficiency and Housing Affordability Program (MEEHA).

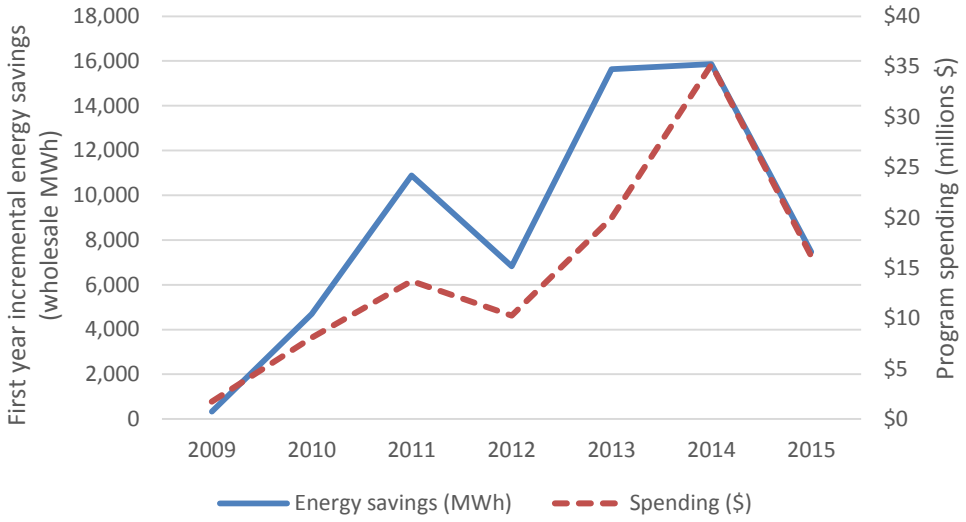

Figure 5. Limited-income program spending and first-year savings, 2009–2015

The figure shows only the first-year incremental savings of the program, but electric savings continue for years. Many of the measures installed as part of this program have longer lives, giving this program an average measure life of 17 years. Total lifetime savings to date exceed 1.1 million MWh, and the cumulative annual demand savings are more than 17 MW.

Since inception the limited-income program has reached 22,759 participants. A participant in this context refers to a residential home or apartment unit, depending on the program. The average spending per participant is approximately $4,000. The monthly energy savings per participant average 246 kWh and will continue for the estimated 17-year lifetime of the measures. Figure 6 shows participation levels by year.

[19] The energy savings data are presented at the generator or wholesale level, meaning line losses are included. Net savings are assumed to be the same as gross savings. The limited-income programs are not regularly evaluated, and savings data presented here are reported.

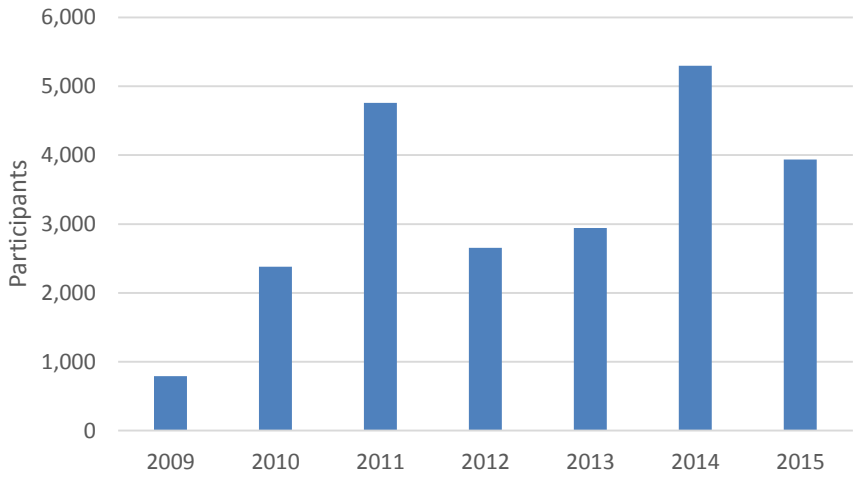

Figure 6. Reported participation in limited-income programs from utilities and DHCD, 2009–2015

Conclusions

In this report, we have reviewed the costs and benefits of EmPOWER Maryland from 2008 through 2015. We find that the programs have produced many significant benefits. These benefits are far-reaching, accrue to all ratepayers in the state of Maryland, and will continue for many years. The benefits to all electric customers in Maryland include reduced utility system costs and decreased air pollution through lowered demand for power plants. The programs also boosted economic activity in the state, increasing state GDP and creating jobs. Further, the energy savings drove down wholesale energy and capacity prices in the region, saving all customers money.

Cost effectiveness analysis relying on the total resource cost test and a review of the cost of saved energy demonstrate that the programs are highly cost effective while delivering electricity at a lower cost than available to the average customer. The statewide evaluation of the program shows benefits of $2.4 billion at a cost of $1.3 billion, a benefit–cost ratio of 1.81. The reduction in utility system costs, coupled with the numerous other benefits provided by these programs, illustrates the value of energy efficiency in Maryland.

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Appendix A. Data Tables

Table A1. Total program spending ($)

Year	BGE	DPL	PE	PEPCO	SMECO	Statewide
2009	24,066,110	697,987	1,113,032	1,885,274	609,681	28,372,084
2010	55,420,291	2,068,000	5,264,384	8,912,979	4,588,398	76,254,052
2011	67,180,000	4,434,598	11,501,241	14,376,171	6,904,777	104,396,787
2012	87,970,217	9,740,216	17,320,534	37,104,377	9,345,597	161,480,941
2013	101,518,443	18,746,559	23,013,182	65,934,277	10,163,656	219,376,117
2014	108,695,611	47,369,470	29,273,763	121,560,756	12,364,077	319,263,677
2015	112,413,247	33,263,522	19,936,611	98,533,553	12,609,625	276,756,558

Includes residential, C&I, and limited income. Does not include demand response or other programs.

Table A2. Residential program spending by year ($)

Year	BGE	DPL	PE	PEPCO	SMECO	Statewide
2008	5,449,235	405,863	6,508,977	1,866,655		14,230,730
2009	12,928,191	468,008	845,637	1,429,473	441,281	16,112,590
2010	25,126,159	1,048,830	3,329,864	3,154,018	3,620,324	36,279,195
2011	28,383,464	1,522,519	6,960,463	6,190,467	4,050,357	47,107,270
2012	42,464,330	5,065,045	13,523,090	19,564,796	6,563,426	87,180,687
2013	44,055,431	5,902,968	14,439,279	26,442,582	6,750,793	97,591,053
2014	45,886,065	7,243,340	14,101,717	30,879,459	7,755,773	105,866,354
2015	45,364,228	7,668,165	11,838,759	24,578,696	8,160,755	97,610,603

2008 includes only Fast Track programs.

Table A3. C&I program spending by year ($)

Year	BGE	DPL	PE	PEPCO	SMECO	Statewide
2009	9,650,441	187,401	207,748	368,243	126,735	10,540,568
2010	24,523,598	833,834	899,908	5,288,368	701,044	32,246,752
2011	30,524,901	1,646,439	3,260,239	6,398,743	1,752,322	43,582,644
2012	40,318,150	3,437,726	2,493,947	15,882,160	2,211,223	64,343,206
2013	46,915,828	10,171,170	5,172,121	37,529,660	2,110,420	101,899,199
2014	43,435,181	34,046,276	10,874,835	87,000,200	3,064,240	178,420,732
2015	58,428,390	22,971,853	5,574,042	72,495,012	3,526,349	162,995,646

Table A4. Limited-income program spending ($)

Year	BGE	DPL	PE	PEPCO	SMECO	Statewide
2009	1,487,478	42,578	59,647	87,558	41,665	1,718,926
2010	5,770,534	185,336	1,034,612	470,593	267,030	7,728,105
2011	8,271,635	1,265,640	1,280,539	1,786,961	1,102,098	13,706,873
2012	5,187,737	1,237,445	1,303,497	1,657,421	570,948	9,957,048
2013	10,547,184	2,672,421	3,401,782	1,962,035	1,302,443	19,885,865
2014	19,374,365	6,079,854	4,297,211	3,681,097	1,544,064	34,976,591
2015	8,620,629	2,623,504	2,523,810	1,459,845	922,521	16,150,309

2012 includes both utility and DHCD spending. Post-2012 spending is all reported by DHCD.

Table A5. Energy efficiency program energy savings (first-year gross wholesale MWh)

Year	BGE	DPL	PE	PEPCO	SMECO	Statewide
2009	86,309	6,837	6,592	485	300	100,522
2010	312,422	9,493	7,863	106,057	22,123	457,958
2011	198,812	22,982	23,654	78,701	15,349	339,498
2012	439,099	31,678	73,402	180,313	41,682	766,175
2013	403,957	60,246	79,959	270,491	40,933	855,585
2014	352,591	96,299	93,475	318,697	18,229	879,290
2015	330,672	64,066	65,158	275,448	39,539	774,883

Table A6. Other programs energy savings (first-year gross wholesale MWh)

Year	BGE	DPL	PE	PEPCO	SMECO	Statewide
2010		133	660	57		850
2011		379	4,219	731		5,328
2012	9,966	851	24,626	5,637		41,082
2013	6,067	870	28,251	5,961	7,754	48,903
2014	81,496	948	153	2,580		85,177
2015	152,016	44,755	161	153,495		350,427

Table A7. Demand response energy savings (first-year gross wholesale MWh)

Year	BGE	DPL	PEPCO	Statewide
2009		2,356	4,152	6,508
2010		13,344	91,742	105,085
2011		16,290	120,750	137,040
2012	1,919	4,428	5,726	12,073
2013	2,927	9,440	61,781	74,148
2014	1,710	2,745	60,843	65,299
2015	2,375	5,663	36,299	44,337

Table A8. Limited-income program energy savings (first-year gross wholesale MWh)

Year	BGE	DPL	PE	PEPCO	SMECO	Statewide
2009	354					354
2010	3,925	30	822	155	48	4,980
2011	5,932	1,336	2,183	1,233	826	11,510
2012	2,991	1,193	2,765	1,932	625	9,506
2013	9,502	1,868	2,110	2,145	919	16,544
2014	7,460	3,561	2,003	2,323	1,426	16,773
2015	3,079	1,373	377	2,738	330	7,897

Table A9. Total energy savings (first-year gross wholesale MWh)

Year	BGE	DPL	PE	PEPCO	SMECO	Statewide
2008	105,466		91,576	90,002		287,044
2009	86,662	9,193	6,592	4,636	300	107,383
2010	316,347	22,999	9,346	198,011	22,171	568,873
2011	204,744	40,986	30,056	201,415	16,175	493,376
2012	453,975	38,151	100,794	193,608	42,307	828,835
2013	422,452	72,425	110,319	340,378	49,606	995,180
2014	443,257	103,553	95,631	384,443	19,654	1,046,539
2015	488,141	115,857	65,696	467,980	39,869	1,177,543

Table A10. Energy efficiency program demand savings (first-year gross wholesale kW)

Year	BGE	DPL	PE	PEPCO	SMECO	Statewide
2009	12,080	390	476	118	293	13,357
2010	46,914	1,627	2,905	13,888	2,650	67,984
2011	33,116	2,212	3,628	10,394	2,717	52,067
2012	71,768	5,123	10,439	28,735	5,979	122,045
2013	59,955	9,885	10,967	45,467	6,208	132,482
2014	52,532	15,427	14,976	57,357	6,413	146,706
2015	56,036	11,206	11,020	47,907	8,813	134,982

Table A11. Other programs demand savings (first-year gross wholesale kW)

Year	BGE	DPL	PE	PEPCO	Statewide
2011			1,359		1,359
2012	1,849	178	3,135	6,456	11,619
2013	896	220	4,788	325,936	331,840
2014	223,223	249	18	132,288	355,778
2015	142,955	59,043	15	190,141	392,154

Table A12. Demand response demand savings (first-year gross wholesale kW)

Year	BGE	DPL	PEPCO	SMECO	Statewide
2009		3,165	6,300	1,296	10,761
2010		14,475	52,129	8,400	75,004
2011	10,125		46,434	22,428	78,987
2012	(26,229)			7,518	(18,711)
2013	(88,260)	8,041	31,413	3,623	(45,183)
2014	(5,522)	920	34,890	1,360	31,648
2015	372	5,232	32,909	4,183	42,696

Table A13. Limited-income program energy savings (first-year gross wholesale kW)

Year	BGE	DPL	PE	PEPCO	SMECO	Statewide
2009	96					96
2010	985	3	65		21	1,074
2011	1,070	200	267	115	162	1,814
2012	697	245	289	537	127	1,894
2013	2,703	710	321	965	285	4,983
2014	2,450	1,855	389	983	538	6,213
2015	546	427	60	1,122	60	2,215

Table A14. Total energy savings (first-year gross wholesale kW)

	BGE	DPL	PE	PEPCO	SMECO	Statewide
2008	11,875		8,912	6,395		27,181
2009	12,176	3,555	476	6,418	1,588	24,213
2010	47,899	16,105	2,970	66,017	11,071	144,063
2011	44,311	2,413	5,253	56,943	25,307	134,227
2012	48,085	5,546	13,864	35,728	13,624	116,847
2013	(24,706)	18,857	16,076	403,780	10,115	424,123
2014	272,683	18,451	15,383	225,519	8,311	540,346
2015	199,909	75,908	11,094	272,080	13,056	572,048

Table A15. Residential program measure life (years)

	2009	2010	2011	2012	2013	2014	2015
BGE	10.29	10.35	7.67	6.89	7.33	7.62	11.16
DPL	8.99	9.31	7.54	6.80	6.04	6.31	6.69
PEPCO	9.18	9.48	7.75	6.56	6.78	5.81	7.22
PE	8.94	11.52	6.85	5.69	5.28	5.40	4.82
SMECO	9.07	8.98	7.65	7.53	6.60	6.58	6.73
Median	9.07	9.48	7.65	6.80	6.60	6.31	6.73
Average	9.30	9.93	7.49	6.70	6.40	6.35	7.33

Table A16. C&I program measure life (years)

	2009	2010	2011	2012	2013	2014	2015
BGE	11.00	11.62	12.07	11.81	12.08	12.24	11.88
DPL		14.74	12.26	16.46	15.49	13.65	14.89
PEPCO	11.03	15.35	16.07	14.69	15.09	13.36	14.71
PE		7.14	4.67	7.56	11.16	9.89	12.78
SMECO		11.23	16.60	11.61	11.98	11.15	11.13
Median	11.01	11.62	12.26	11.81	12.08	12.24	12.78
Average	11.01	11.95	12.32	12.32	12.98	12.09	13.03

Table A17. Other program measure life (years)

	2010	2011	2012	2013	2014	2015
BGE		10.99	30.00	30.00	2.23	1.44
DPL	11.00	10.00	23.22	25.75	26.22	1.69
PE	10.00	11.01	14.67	14.96	10.03	1.00
PEPCO	11.09		22.93	23.71	26.74	1.28
SMECO				15.00		

Table A18. Weighted measure life calculation

Year	Ratio of savings from residential	Ratio of savings from C&I	C&I EUL	Res EUL	Weighted average
2015	0.43	0.57	13.03	7.33	9.79
2014	0.44	0.56	12.09	6.35	8.88
2013	0.60	0.40	12.98	6.40	10.34
2012	0.68	0.32	12.32	6.70	10.52
2011	0.61	0.39	12.32	7.49	10.46
2010	0.65	0.35	11.95	9.93	11.25
2009	0.65	0.35	11.01	9.30	10.42

EUL is effective useful life.

Table A19. Total EE energy net-to-gross ratios

	2009	2010	2011	2012	2013	2014	2015
BGE	0.85	0.85	0.61	0.60	0.70	0.69	0.69
DPL	0.80	0.80	0.63	0.60	0.72	0.74	0.80
PE	0.93	0.93	0.64	0.67	0.69	0.70	0.71
Pepco	0.82	0.82	0.60	0.60	0.69	0.73	0.77
SMECO	0.75	0.75	0.57	0.56	0.66	0.67	0.67
Statewide	0.84	0.84	0.61	0.60	0.69	0.71	0.73

Table A20. C&I program energy net-to-gross ratios

	2009	2010	2011	2012	2013	2014	2015
BGE	0.90	0.90	0.73	0.71	0.69	0.71	0.76
DPL	0.80	0.80	0.72	0.71	0.73	0.75	0.87
PE	0.92	0.92	0.72	0.72	0.71	0.72	0.76
Pepco	0.80	0.80	0.72	0.70	0.73	0.76	0.86
SMECO	0.90	0.90	0.72	0.72	0.72	0.72	0.78
Statewide	0.88	0.88	0.73	0.71	0.70	0.74	0.82

Table A21. Residential program energy net-to-gross ratios

	2009	2010	2011	2012	2013	2014	2015
BGE	0.81	0.81	0.53	0.53	0.75	0.67	0.61
DPL	0.80	0.80	0.54	0.56	0.71	0.72	0.63
PE	0.92	0.92	0.56	0.65	0.68	0.69	0.63
Pepco	0.80	0.80	0.53	0.55	0.65	0.66	0.62
SMECO	0.72	0.72	0.55	0.53	0.65	0.66	0.62
Statewide	0.80	0.80	0.53	0.55	0.68	0.68	0.62

Table A22. Total EE demand net-to-gross ratios

	2009	2010	2011	2012	2013	2014	2015
BGE	0.88	0.88	0.63	0.61	0.68	0.68	0.69
DPL	0.81	0.81	0.64	0.61	0.71	0.73	0.81
PE	0.96	0.96	0.68	0.70	0.67	0.69	0.71
Pepco	0.87	0.87	0.63	0.61	0.68	0.72	0.79
SMECO	0.81	0.81	0.60	0.58	0.65	0.66	0.68
Statewide	0.88	0.88	0.63	0.61	0.68	0.70	0.74

Table A23. C&I program demand net-to-gross ratios

	2009	2010	2011	2012	2013	2014	2015
BGE	0.90	0.90	0.74	0.67	0.71	0.71	0.76
DPL	0.80	0.80	0.74	0.66	0.72	0.75	0.88
PE	0.91	0.91	0.74	0.71	0.69	0.72	0.77
Pepco	0.80	0.80	0.74	0.66	0.73	0.76	0.88
SMECO	0.90	0.90	0.74	0.71	0.73	0.72	0.78
Statewide	0.88	0.88	0.74	0.67	0.72	0.74	0.83

Table A24. Residential program demand net-to-gross ratios

	2009	2010	2011	2012	2013	2014	2015
BGE	0.82	0.82	0.54	0.55	0.66	0.65	0.62
DPL	0.80	0.80	0.53	0.57	0.69	0.70	0.62
PE	0.92	0.92	0.63	0.70	0.66	0.66	0.64
Pepco	0.80	0.80	0.53	0.56	0.64	0.64	0.62
SMECO	0.76	0.76	0.58	0.56	0.64	0.64	0.63
Statewide	0.82	0.82	0.55	0.57	0.65	0.66	0.63

Table A25. Energy-only rates in Maryland, 2008–2014 (cents per kWh)

Year	Residential	Commercial	Industrial	Total
2014	10.15	7.76	7.04	8.16
2013	9.25	7.50	6.49	7.74
2012	9.00	7.70	6.57	7.77
2011	9.45	8.70	7.38	8.61
2010	10.45	9.20	8.47	9.18
2009	12.17	9.51	8.92	9.50
2008	12.30	9.98	9.41	9.95

Average SOS rates were used for 2015. *Source:* EIA 2016a.

Appendix B. How DEEPER Evaluates Policy Alternatives

ACEEE's DEEPER modeling framework uses principles of input–output (I/O) modeling to evaluate the economic impacts of various policy alternatives. This appendix gives additional detail on how it handles data and produces results.

The core of the DEEPER model is the A-matrix or "Direct Requirements" matrix. This relates industries to one another, detailing how much input from one industry is required to make a dollar's worth of output from another industry. The L-matrix (or Leonteif inverse) multiplied by a final demand vector will return the amount of output from each industry that is required to support that level of final demand, where final demand is the use of goods and services by end users, as opposed to inputs to other production processes. For any given increase in final demand of goods and services, it is conceptually straightforward to determine how much additional output each industry would have to create to meet this increase.

A second critical component of DEEPER is a set of multipliers that convert the resulting increases in output into the amount of employment needed to generate that increase in output, how much income that would generate for workers, and how much GDP (or value added, the state-level equivalent of GDP) that would create. DEEPER uses data from the IMPLAN Group for its national- and state-level A-matrices and multipliers.

We calculate changes in final demand using data on expenditures on energy efficiency, the lifetime energy savings they generate, and the associated avoided energy costs. We account for the cost of the efficiency investments as well as the lost revenues to utilities that result from reduced energy consumption. We account for interstate and international trade by using Regional Purchase Coefficients that indicate how much of each type of good and service consumed in Maryland is also produced there. The model allocates changes in final demand among in-state and out-of-state producers accordingly, so that only changes in Maryland-based producers contribute to state employment and value added.

We aggregate all of these state-level impacts to calculate the net change in Maryland final demand across 14 economic sectors. The DEEPER model translates these net changes into changes in output and calculates the changes in employment and value added associated with it. It includes employment and value added associated with the changes in demand, changes in production along the supply chain required to meet that demand, and the increased economic activity generated by workers spending their increased income. The model accounts for this both for the energy efficiency investments themselves and for the shifts in economic activity associated with the energy savings they generate.