Final Report

Assessment of Energy Efficiency and Load Management Potential (2011–2016)

Prepared for:
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Executive Summary

The Cadmus Group, Inc. was retained by Commonwealth Edison (ComEd) to conduct an assessment of residential, commercial, and industrial energy-efficiency and load management potentials in ComEd's Illinois service territory. ComEd identified five primary goals associated with the three core activities. The primary goals included:

- Identify fuel use statistics and gather electric energy use and building envelope characteristics from a representative sample of each of the ComEd customers.
- Collect building occupancy demographics and energy usage profiles for pertinent customer segments.
- Estimate recent, current, and potential end-use penetrations of specific efficient technologies.
- Estimate the hourly impacts of energy-efficiency measures and load management strategies.
- Identify the program potential of energy-efficient products and services for each of the residential, commercial and industrial markets.

This study addressed each of these goals. Cadmus conducted a substantial primary data collection effort, including over 1,250 telephone surveys and site visits with ComEd end-use customers and trade allies to meet the goals of the first two core activities. In addition, the study includes a comprehensive set of electric energy-efficiency measures applicable to the climate and customer characteristics of ComEd's service territory based on 239 *discrete* electric energy-efficiency measures, representing over 3,800 measures when considering all permutations of across customer sectors and segments. The data collection effort then served as the foundation for estimating the technical, economic, and realistically achievable potentials to address the goals of the third core activity.

Estimates of Resource Potentials

Consistent with accepted industry standards, this study's approach distinguishes among four definitions of resource potential widely used in utility resource planning:

- ***Naturally occurring conservation*** refers to reductions in energy use that occur due to normal market forces, such as technological change, energy prices, market transformation efforts, and improved energy codes and standards.
- ***Technical potential*** assumes that all available DSM measures and supplemental resource options may be implemented, regardless of their costs, or market barriers.
- ***Economic potential*** represents a subset of technical potential consisting of only measures that meet the cost-effectiveness criterion based on the ComEd avoided energy and capacity costs.

- ***Achievable potential*** is defined as the portion of economic potential that might be assumed to be reasonably achievable in the course of the planning horizon, given market barriers that may impede customer participation in utility programs.

General Approach to Estimating Resource Potentials

The general methodology utilized in this report is best described as a hybrid “top-down/bottom-up” approach. The top-down methodology component begins with the most current utility load forecasts, then decomposes them into their constituent customer sector, customer segment, and end-use components. The bottom-up component considers the potential technical impacts of various demand-side and supplemental resource technologies, measures, and practices on each end use, which are then estimated based on engineering calculations taking into account fuel shares, current market saturations, technical feasibility and costs.

Technical and Economic Energy-Efficiency Potentials

Table 1 shows the baseline electric sales and potential by sector forecast for the year 2016, the end of the 6-year study horizon. As shown, the results of this study indicate 22,117 GWh of technically feasible electric energy-efficiency potential will be available by 2016. This technical potential translates to an economic potential of 13,617 GWh. Were all of this potential cost-effective and realizable, it would amount to a 14% reduction in 2016 forecast retail sales. In addition, ComEd would experience a 10% reduction of load growth from 2011 to 2016 (Figure 1). The commercial sector has the largest economic potential (7,489 GWh), followed by the residential sector (4,564 GWh), and the industrial sector (1,564 GWh).

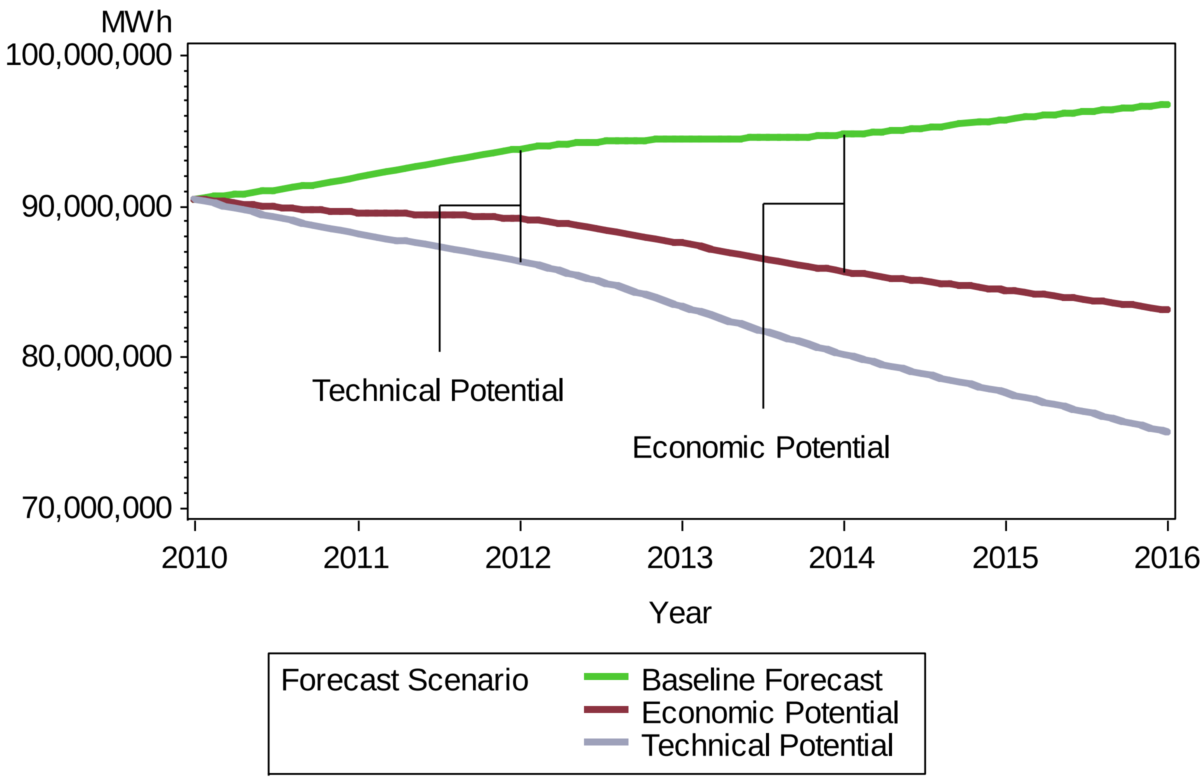
While the effects of EISA have been incorporated into the potential estimate, an alternative EISA scenario was modeled that considered the impact of CFLs as the new baseline, rather than the base scenario of approximately 30% improvement in baseline incandescent lighting efficiency. In this alternative scenario, residential economic potential in 2016 results in 3,665 GWh, representing a 20% decrease from the assumed EISA scenario (or a drop in economic potential, across all sectors, from 14% to 13% of baseline sales).

Table 1. Summary Technical and Economic Electric Energy-Efficiency Potential (MWh in 2016) by Sector

Sector	Baseline Sales	Technical Potential	Technical Potential as % of Baseline	Economic Potential	Economic Potential as % of Baseline	Economic Potential (MW)	Average Levelized Cost ($/kWh)
Residential	31,583,697	8,514,175	27%	4,564,469	14%	1,107	$0.04
Commercial	49,285,486	12,039,102	24%	7,488,711	15%	1,426	$0.05
Industrial	15,816,115	1,563,982[A]	10%	1,563,982	10%	217	$0.01
Total	**96,685,298**	**22,117,259**	**23%**	**13,617,162**	**14%**	**2,750**	**$0.04**

[A] Because the industrial sector uses a “top-down” approach based on cost-effective measures, the estimates of technical and economic potential are identical.

Figure 1. Sales Forecast with Energy-Efficiency Potential Scenarios



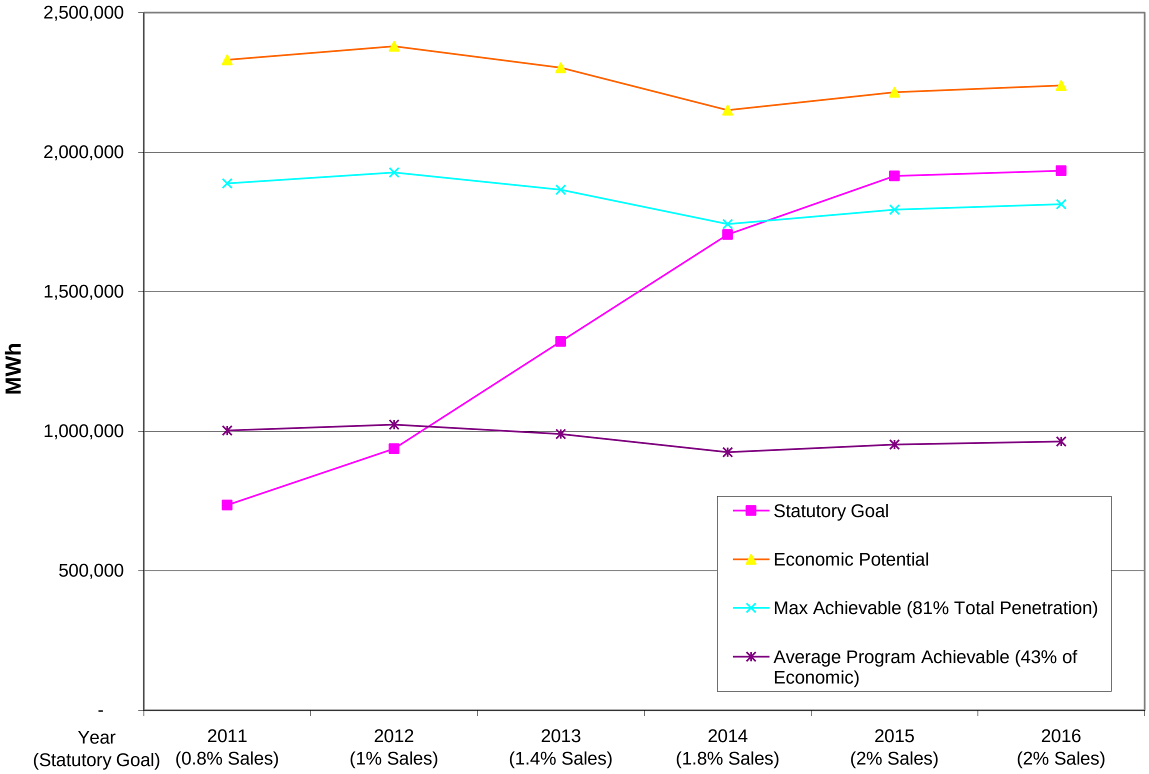
Achievable Energy-Efficiency Potential

Projections of achievable potential pose significant analytic challenges as they are inherently based on assumptions regarding market acceptance of energy-efficiency measures and programs offered by utilities. Levels of cost-effective, energy-efficiency potential realistically achievable depends on several factors, including customers' willingness to participate in energy-efficiency programs (which is only partially a function of incentive levels), retail energy rates, and a host of market barriers that have historically impeded the adoption of energy-efficiency measures and practices by consumers.

The most reliable way to estimate achievable potential is to examine actual achieved savings (i.e., historical program savings accomplishments) as a function of program delivery mechanisms, incentives, and marketing expenditures. However, because ComEd is only in its second year of recent program activity, limited historical data are available for this purpose. Alternatively, many studies examine achievable potential as a subset of economic potential. This report examined over 20 studies, and found that Program Achievable Potential typically is estimated at about 43% of economic potential (with a wide variance), with Maximum Achievable Potential at approximately 81% of economic potential.

As shown in Figure 2, the EISA lighting standards have a downward effect on economic potential, particularly in 2013 and 2014. Statutory goals, however, continue to rise (quite aggressively in 2015). As shown in the figure, ComEd will need to exceed the estimated maximum achievable percentage in 2015-2016 to meet the program goals.

Figure 2. Estimates of Achievable Potential (2011-2016)



Demand Response Potential

The demand response (DR) potential study examined four types of programs. The residential programs included a direct load control (DLC) program, currently offered to ComEd customers as the Smart Ideas Central Air Conditioning Cycling Program, which allows the utility to cycle the power to residential customers' central air conditioning units during peak times, plus a real-time pricing (RTP) program which encourages customers to reduce their load during peak times by billing them the real-time electricity prices. The non-residential programs included an interruptible tariffs load response (ILR) program, currently offered by ComEd as Capacity Based Load Response (CLR), which contractually obligates medium and large customers to reduce load when a DR event is called. The second non-residential program was a demand buy-back (DBB) program which encourages commercial and industrial customers to reduce load during an event by offering real-time voluntary incentives.

The residential programs showed some potential growth increases over the forecast period, while the non-residential programs were determined to be fairly saturated based on their current levels of participation. All programs are assumed to grow at least at the rate of overall peak capacity. Sector peaks were determined by the 2016 peak load forecast and hourly load shapes for each sector and end use. Technical potential was determined by the peak load of participants and end uses that qualify for each DR program (i.e., assuming 100% participation). Achievable, or market potential was determined by the Cadmus forecast of each programs future growth and event participation rates. Table 2 shows a summary of these results.

Table 2. Demand Response Technical and Achievable Technical Potential (MW in 2016)

Sector	Sector Peak	Technical Potential	Achievable Technical Potential	Achievable Technical Potential As Percent of Sector Peak
Residential	10,988	9,886	342	3%
Commercial	11,444	3,422	563	5%
Industrial	2,678	1,609	274	10%
Total	**25,110**	**14,917**	**940**	**4%**

Note: Individual results may not sum to total due to rounding.
Note: Interactions between programs have not been taken into account.

1. Introduction

The Cadmus Group, Inc. was retained by Commonwealth Edison (ComEd) to conduct an assessment of residential, commercial, and industrial energy-efficiency and load management potentials in ComEd's Illinois service territory.

Overview

Studies of demand-side management (DSM) potentials are important tools for policy analysis, utility resource planning, and program design. As such, reasonably accurate projections of actual DSM potentials, as well as reliable estimates of their associated costs, are critical in guiding utilities as they design their resource acquisition programs. DSM objectives may be met through a broad range of technology- and activity-based measures, behavior modification, or legislative action such as the institution of energy-efficiency codes and standards. Demand-side resource potential also varies depending on a utility's load characteristics, customer mix, local market conditions, and climate.

ComEd identified five primary goals associated with the three core activities. The primary goals of the residential/commercial/industrial energy use survey were to:

- Identify fuel use statistics and gather electric energy use and building envelope characteristics from a representative sample of each of the ComEd residential, commercial, and industrial customer segments.
- Collect building occupancy demographics and energy usage profiles for pertinent customer segments (e.g., single-family homes, multi-family homes, office, and retail).

The primary goal of the market penetration study was to estimate recent, current, and potential end-use penetrations of specific efficient technologies.

The primary goals of the program potential assessment study were to:

- Estimate the hourly impacts of energy-efficiency measures and load management strategies.
- Identify the program potential of energy-efficient products and services for each of the residential, commercial and industrial markets, reflecting specific program designs and escalating annual funding, and corresponding energy savings targets of ComEd's programs.

This study addressed each of these goals. Cadmus conducted a substantial primary data collection effort, including over 1,250 telephone surveys and site visits with ComEd end-use customers and trade allies to meet the goals of the first two core activities. The data collection effort then served as the foundation for estimating the technical, economic, and realistically achievable potentials to address the goals of the third core activity.

Definition of Resource Potentials

Estimates of technical and economic potential in this study are based on best-practice research methods and analytic techniques that are standard in the utility. Consistent with accepted industry standards, this study's approach distinguishes among four definitions of resource potential widely used in utility resource planning.

Naturally occurring conservation refers to reductions in energy use that occur due to normal market forces, such as technological change, energy prices, market transformation efforts, and improved energy codes and standards. In this analysis, naturally occurring conservation is accounted for in several ways. First, the potential associated with certain energy-efficiency measures assumes a natural rate of adoption. For example, the savings associated with ENERGY STAR® appliances account for current trends in customer adoption. Second, current codes and standards are applied in the consumption characteristics of new construction. Finally, the assessment accounts for the gradual increase in efficiency as older equipment in existing buildings is retired and replaced by units meeting current standards. However, this assessment does not forecast changes to codes and standards; rather, it treats them as "frozen" at a given efficiency level.

Technical potential assumes that all available DSM measures and supplemental resource options may be implemented, regardless of their costs, or market barriers. For energy-efficiency resources, technical potential further falls into two classes: retrofit (discretionary) and equipment (phased-in or lost-opportunity resources). It is important to recognize that the notion of technical potential is less relevant to resources such as capacity-focused programs and distributed generation since most end-use loads may be subject to interruption through load curtailment or displacement by on-site generation from a strictly "technical" point of view.

Economic potential represents a subset of technical potential consisting of only measures that meet the cost-effectiveness criterion based on the ComEd avoided energy and capacity costs. For each energy-efficiency measure, the benefit-cost test is structured as the ratio of the net present values of the measure's benefits and costs. Only measures that have a benefit-to-cost ratio of 1.0 or greater are deemed cost-effective. The methodology for cost-effectiveness calculations and relevant benefit and cost elements is described in detail in Volume II, Appendix E.

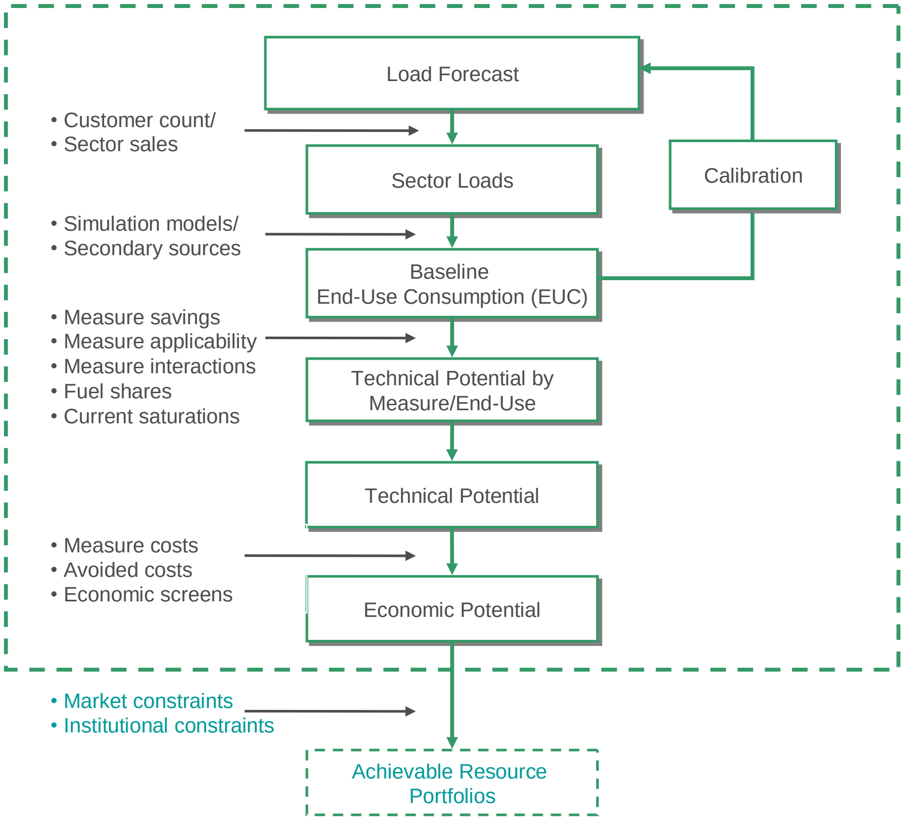
Achievable potential is defined as the portion of economic potential that might be assumed to be reasonably achievable in the course of the planning horizon, given market barriers that may impede customer participation in utility programs. Achievable potential can vary sharply based on program incentive structures, marketing efforts, energy costs, customer socio-economic characteristics, and other factors. This study analyzed achievable potential in the context of the goals and budgets as legislated by the Illinois Power Agency Act.

General Approach to Estimating Resource Potentials

Resources analyzed in this study differ with respect to several salient attributes, such as the type of load impact (energy or capacity), availability, reliability, and applicability to various customer classes and customer segments (business, dwelling, or facility types). They also require fundamentally different approaches in program design, incentive structures and delivery mechanisms for their deployment. Therefore, analysis of the potential for these resources requires methods tailored to address the unique technical and market characteristics of each resource. These methods, however, generally spring from a common conceptual framework, and their applications to various resources rely on similar analytic methodologies.

This general methodology is best described as a hybrid "top-down/bottom-up" approach. As illustrated in Figure 3, the top-down methodology component begins with the most current utility load forecasts, then decomposes them into their constituent customer sector, customer segment, and end-use components. The bottom-up component considers the potential technical impacts of various demand-side and supplemental resource technologies, measures, and practices on each end use, which are then estimated based on engineering calculations taking into account fuel shares, current market saturations, technical feasibility and costs. These individual impacts are aggregated to produce estimates of resource potential at the sector, segment, and end-use levels. In many ways, the approach is analogous to generating two alternative load forecasts at the end-use level (one with and one without DSM and supplemental resources) and calculating resource potential as the difference between the two forecasts.

Figure 3. General Methodology for Assessment of Demand-Side Resource Potentials



Effects of the Energy Independence and Security Act of 2007

While this analysis does not attempt to predict how energy codes and standards may change in the future, it does capture legislation that has already been enacted, even if it will not go into effect for several years. The most notable of these is the Energy Independence and Security Act (EISA) of 2007, which sets new standards for general service lighting, motors, and other end-use equipment. Because of the large role residential lighting plays in ComEd's energy-efficiency programs, it was particularly important to capture the effects of this legislation.

Most notably, EISA mandates higher energy-efficiency levels in light bulbs sold in or imported into the United States beginning in 2012. As shown in Table 3, EISA's performance standards correspond to approximately 30% improvements in efficiencies (measured in lumens-per-watt) over current incandescent technology. It is important to note that EISA is a performance-based standard; thus, the standards are "blind" to technology and do not ban incandescent bulbs.

Table 3. EISA Requirements for General Service Incandescent Lamps

Lumen Output	Typical Wattage: Current Incandescent Technology	EISA Requirements		
		Maximum Wattage	Minimum Lifetime (hours)	Effective Date
1490–2600	100	72	1,000	1/1/2012
1050–1489	75	53	1,000	1/1/2013
750–1049	60	43	1,000	1/1/2014
310–749	40	29	1,000	1/1/2014

A number of lighting scenarios may develop in response to EISA, including the following:

- ***EISA Scenario***. While EISA will preclude current incandescent technology, advanced incandescent (particularly halogen bulbs) may meet EISA's minimum standards. Advanced incandescent bulbs use a variety of approaches to increase efficacy, and there are already a number of incandescent products (e.g., some bulbs from the Philips Halogena series) that meet the requirements. These bulbs, however, currently cost $4 to $8 each (substantially more than the cost of a comparable CFL), and it is unknown how much the price might drop in the next few years.[1] So even though more products become available, they may cost more than CFLs, making CFLs both a lower cost and more efficient technology.
- ***CFL Baseline Scenario***. There is also evidence that CFLs may become the new baseline technology. Advanced incandescents not only may cost more than CFLs, some manufacturers, such as General Electric, have abandoned efforts to develop an advanced incandescent and instead are focusing on improved CFLs and Light Emitting Diodes (LEDs).[2] Current CFL limitations regarding color rendering, dimmability, and warm-up period have limited consumer acceptance, so improvements in performance are needed to increase sales. Even with technological improvements, however, consumer concerns about the use of mercury could prove to be a significant deterrent.
- ***LED Scenario***. There has been a significant interest in LED technology, which offers the bulbs that have longest lifetime and promises to offer very high efficacy (lumens per watt) bulbs in future bulb generations. While LED technology is not new (the first LEDs were produced in the 1960s), it is relatively new to mass-market applications and can still

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1 http://www.amazon.com/Philips-70-Watt-Halogena-Energy-2-Pack/dp/B001FA07UW and http://www.lutronstore.com/lutronproductsdetails.aspx?productid=151

2 http://greeninc.blogs.nytimes.com/2009/05/29/can-incandescent-bulbs-be-made-efficient/?pagemode=print

be considered an immature technology. Despite significant price drops, LED first costs are still extremely high, with incandescent equivalents selling for $20 to $30 per bulb.

The selection of a scenario is quite important in terms of the baseline forecast and efficiency potential. For example, our analysis estimates that residential lighting accounts for 6% of total electricity sales. Even under the EISA scenario, with a 30% improvement in efficiency, baseline sales could drop 1% to 2%, depending on assumptions regarding naturally occurring adoption and use in the commercial and industrial sectors. The CFL scenario would even be more dramatic: assuming 75% efficiency (compared to current incandescent bulbs), the drop in sales could be in the range of 4% to 5%.

Because the potential estimates are calculated to ComEd sales forecasts, we chose to be consistent with the current load forecasting assumptions, which assume that baseline lighting will meet, yet not exceed, the EISA requirements (i.e., the EISA scenario). This approach assumes that a cost-effective intermediate technology between CFLs and current incandescents will be developed during the next two years. However, because of the uncertainty around this assumption, we also developed an alternative scenario that assumes this technology, even if it exists, may be more costly than CFLs and so not be cost-effective, making CFLs the less expensive, *de facto* baseline. For both of these scenarios we assumed that all sockets—even if prolonged by an incandescent stocking (or "hoarding") effect—would be eligible for replacement to the new baseline by 2016.

Organization of the Report

This report is organized in two volumes. The present document, Volume I, presents the methodology and findings and includes the following chapters:

- Chapter 2, ""Data Development," provides an overview of the methods and findings from the comprehensive data collection and analysis efforts.
- Chapter 3, "Technical and Economic Energy-Efficiency Potentials," presents the technical and economic potential available from energy-efficiency resources.
- Chapter 4, "Achievable Energy-Efficiency Potentials," describes the realistically achievable energy efficiency resources.
- Chapter 5, "Demand Response," presents the technical and economic potential available from demand response programs

Supplemental technical information, assumptions, data, and other relevant details are presented in Volume II as appendices. They are:

- Appendix A: Data Collection Instruments
- Appendix B: Summary of Findings from Primary Data Collection
- Appendix C: Detailed Frequencies from Primary Data Collection
- Appendix D: Measure Database

- Appendix E: Supplemental Material – Energy Efficiency, including Data & Assumptions and Detailed Results
- Appendix F: Supplemental Material – Demand Response
- Appendix G: Bibliography for Achievable Potential

2. Data Development

Assessment of energy-efficiency and load management potentials requires compiling a large and complex database of customer and equipment market data (e.g., structural characteristics, fuel shares, equipment saturations, and efficiency penetration), measure characteristics (technical specifications, life, savings, costs), and utility data (loads and sales forecasts). The approach for assembling these data is presented below.

Primary Data Collection

The 2009 Assessment of Energy and Capacity Savings Potential data collection efforts included a combined total of over 1,250 telephone and on-site surveys of residential and non-residential customers, trade allies, and contractors (Table 4 and Table 5).

This approach represented a concerted effort to ensure an accurate representation of the ComEd territory market for use in modeling the energy and capacity savings potential. To maximize the value of the data collection efforts, measures that represent disproportionately large savings potentials were given highest priority in the surveys. For these measures, the comprehensive survey effort collected three metrics critical to estimating efficiency potential:

- ***Equipment saturation***: The percentage of customers that own specific equipment that is energy-efficient or of standard efficiency (e.g., the percentage of single-family homes that have air-conditioning);
- ***Efficiency penetration:*** The percentage of the installed equipment stock considered efficient (e.g., the percentage of installed central air conditioners that exceed SEER 13); and
- ***Market share:*** The percentage of current sales of equipment that is considered efficient (e.g., the percentage of central air conditioners sold in the past 12 months that exceeded SEER 13).

Primary data collection findings were validated through comparisons to available state and regional secondary data. The findings of the data collection efforts were also presented to the Illinois Stakeholder Advisory Group.

The following tables present each of the residential and non-residential data collection efforts that were undertaken, the measures investigated, the sources of the samples, stratification methods, and the number of completed surveys. The data collection instruments, a summary of the findings, and the detailed tabulations of the results for each of these efforts are presented in Volume II, Appendix A, Appendix B, and Appendix C.

In addition, the data can be accessed via the Internet as part of an the online data analysis tool.[3] The Cadmus Online Data Analysis Tool serves two functions: an analysis environment for the primary data collected; and a repository of primary data collection instruments, data files, analysis, reporting and presentations. The online tool provides a single point of access to all information pertinent to primary data collection. Users may access standard reports and summary presentations, exporting in MS Excel, Word, or PDF formats. Data sets area also available for download through the website. The website includes a data dictionary and a copy of the survey instruments available for the all users to reference. Any additional documentation regarding the data collection activities may also be included.

Table 4. Residential Primary Data Collection Efforts

Data Collection Effort	Method	Measures	Sources	Stratification	Number of Surveys/ Visits
Residential Appliance Saturation Survey (RASS)	Telephone Survey	Residential Appliances and Household Characteristics—primarily saturations and fuel shares	ComEd Single-Family Homeowners and Residents of Multi-Family Buildings Identified from Utility Customers Database	By Building Type	521
Residential On-Site Validation Effort	In-Person On-Site Audits	Residential Appliances and Household Characteristics—efficiency ratings and quantities of equipment	Participants in RASS Agreeing to Site Visits. Some site visits were recruited without the full survey.	By Building Type	140
Residential HVAC Trade Ally Survey	Telephone Survey	Residential Central Air Conditioners, Air and Ground Source Heat Pumps, Electric Furnaces Gas Furnaces, Boilers	Residential HVAC dealers and installers identified through Yellow Page searches and lists of participating trade allies from ComEd.	N/A	30
Retailer Survey	Telephone Survey	Thermostats, Water Heaters (Gas, Electric, Storage and Tankless), Clothes Washers and, Refrigerators, Freezers, Dishwashers, CFLs, Room ACs, Dehumidifiers, Lighting fixtures, Televisions, DVD Players, Windows	Retail Stores Installers Identified Through Yellow Page Searches.	By Measure Type	70
Residential Home Builder	Telephone Survey	Cooling Equipment, Heating Equipment, Ducts, Windows, Lighting, Siding, Framing, Barriers, Insulation	Builders Identified Through Yellow Page Searches, Lists of Participating Builders from ComEd.	N/A	26
Total Residential Surveys					**787**

[3] http://comedsurveytool.cadmusweb.com

Table 5. Non-Residential Primary Data Collection Efforts

Data Collection Effort	Method	Measures	Sources	Stratification	Number of Surveys/ Visits
Commercial End User	In-Person On-Site Audits	Heating and Cooling Systems, Controls, Refrigeration, Water Heating, Commercial Kitchen Equipment, Lighting and Lighting Controls	Utility-Provided Samples of Non-Residential Customers	Customer Segment/Building Type	316
Industrial End User	In-Person On-Site Audits	Heating and Cooling Systems, Controls, Refrigeration, Water Heating, Commercial Kitchen Equipment, Motors	Utility-Provided Samples of Non-Residential Customers	Customer Segment/Building Type	35
Non-Residential Builders	Telephone Survey	Lighting and HVAC Controls, Sensors, Insulation Cool Roofs, Ducts, Lighting, Windows, Lighting Equipment	Yellow Page searches and lists of participating trade allies from ComEd	N/A	25
Non-Residential Architects & Engineering Firms	Telephone Survey	Lighting and HVAC Controls, Sensors, Insulation Cool Roofs, Ducts, Lighting, Windows, Lighting Equipment	Yellow Page Searches and lists of participating trade allies from ComEd	N/A	21
Non-Residential Lighting Vendors	Telephone Survey	Lighting Equipment and Controls	Yellow Page Searches and lists of participating trade allies from ComEd	N/A	16
Compressed Air Vendors	Telephone Survey	Compressed Air Equipment, and control strategies	Yellow Page Searches and lists of participating trade allies from ComEd	N/A	15
Mechanical Contractors	Telephone Survey	Heating and Cooling Equipment, Controls, Motors and Drives	Yellow Page Searches and lists of participating trade allies from ComEd	N/A	16
Refrigeration Specialists	Telephone Survey	Refrigeration Equipment, Motors, Drives, Lighting, Insulation Measures, and Controls	Yellow Page Searches and lists of participating trade allies from ComEd	N/A	15
Electric Motor Dealers	Telephone Survey	Motors, controls,	Yellow Page Searches and lists of participating trade allies from ComEd	N/A	13
Total Non-Residential Surveys					**472**

Summary of Data Collection for High Priority Measures

The data sources for each of the high-priority measures are summarized in Table 6 and Table 7. The customer surveys provided the majority of the saturation data, and the site visits provided much of the penetration data, while the trade ally and other "upstream" market actor surveys provided the market share information.

Table 6. Summary of Data Sources for Residential Sector Measures

Measure Type	End-use Customer Telephone Surveys	Customer Site Visits	HVAC Trade Ally Surveys	Appliance Retailer Survey	Home Builder Survey
Residential Central AC	✓	✓	✓		✓
Geothermal/Air Source Heat Pumps	✓	✓	✓		✓
Programmable Thermostats	✓	✓	✓	✓	✓
Clothes Washers	✓	✓		✓	
Water Heating	✓	✓		✓	✓
Clothes Dryers	✓	✓		✓	
Dishwashers	✓	✓		✓	
Windows		✓			✓
Insulation		✓			✓
Refrigerators	✓	✓		✓	
Electronic Equipment Plug Load	✓			✓	
CFLs	✓	✓		✓	✓

Table 7. Summary of Data Sources for Non-Residential Sector Measures

Measure Type	Builders / A&E Firm Surveys	HVAC Contractors Survey	Mechanical Contractors Survey	Motor Vendors Survey	Lighting Vendors Survey	Compressed Air Vendors Survey	Refrigeration Vendors Survey
Central Air Conditioning	✓	✓	✓				
Furnaces	✓	✓					
Geothermal/Air Source/Add on Heat Pump	✓	✓	✓				
Boilers		✓					
Programmable Thermostats	✓	✓	✓				
Building Energy Management Systems	✓		✓				
Occupancy Sensors	✓				✓		
Heat Recovery from Exhaust Air to Water Heating	✓		✓				
Water Heating	✓	✓					
Windows	✓						
Insulation	✓						
Motors/ASDs	✓			✓			
Refrigeration	✓						✓
CFLs/T8 Lighting/High Bay Lighting/LED Exit/Pulse Start Metal Halide	✓				✓		
Compressed Air Systems and controls						✓	

Data Collection Stratification

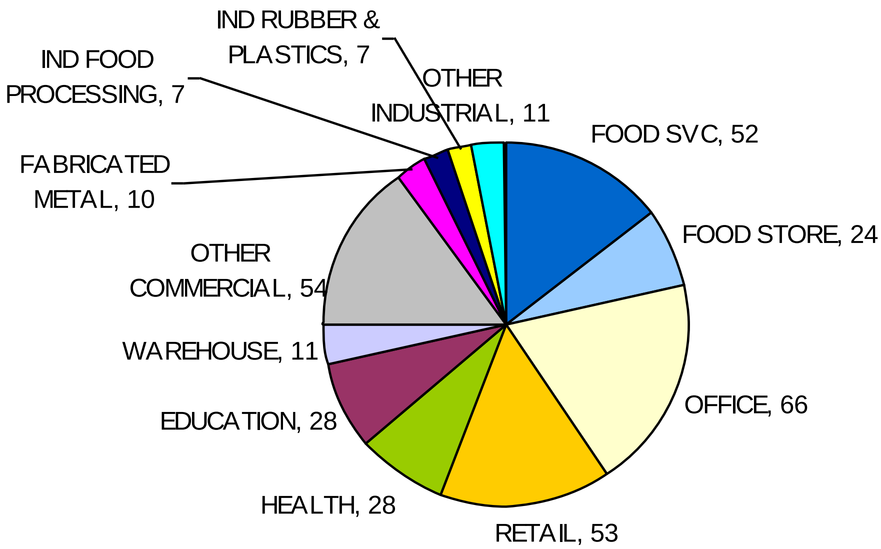
As noted above, the telephone and on-site audits of the residential sector were stratified by single-family and multifamily housing types. Of the 521 telephone surveys conducted, 431 were conducted with single-family customers and 90 with multifamily customers. For the on-site audits, 73 were conducted with single-family and 67 with multifamily customers.

For the non-residential data collection, the SIC codes of industry types that made up the highest level of energy sales were analyzed to determine the primary segments. For commercial customers, primary segments were education, food service (restaurants), food stores (grocery & convenience), health care, office, retail, warehouse, and an "other" category (Figure 4).

Industrial segments included fabricated metals, food processing, rubber & plastics industries, and an "other" category.

The distribution of surveys across segments was controlled by setting quotas during the recruitment process. Priority was given to segments with the highest kWh in the population, including offices and restaurants, and the remaining segments were distributed proportionally. Further, Cadmus conducted statistical analyses on the total kWh of respondents to confirm that the survey respondent segments were representative of each segment's population. The overall energy use of the sample showed no significant difference from the overall energy use of similar segments of the customer population.

Figure 4. Stratification for Non-residential On-site Audits



Measure Database

The study includes a comprehensive set of electric energy-efficiency measures applicable to the climate and customer characteristics of ComEd's service territory. The analysis began by assessing the technical potential of 239 *discrete* electric energy-efficiency measures (Table 8). Considering all permutations of these measures across all customer sectors and segments, customized data had to be compiled and analyzed for over 3,800 measures.

Table 8. Energy-Efficiency Measure Counts

Sector	Electric Measure Counts
Residential	106 unique, 875 permutations across segments
Commercial	154 unique, 2,446 permutations across segments
Industrial	15 unique process improvements, 89 permutations across segments

Additional Utility Data for Potential Analysis

Extensive data sets were also provided by ComEd as key inputs into the study. These data, provided by sector where applicable, covered:

- Customer counts
- Electric sales (consumption)
- System hourly load shapes
- Peak demand history
- Sales and demand forecasts
- Historical demand and efficiency achievements
- Avoided costs
- Line losses

3. Technical and Economic Energy-Efficiency Potentials

Scope of Analysis

The primary objective of this assessment was to develop reasonable estimates of available energy-efficiency potential, essential for ComEd program planning efforts. To support these efforts, Cadmus performed an in-depth assessment of technical, economic, and achievable potential for electric resources in the residential, commercial, and industrial sectors.

Within each sector, the study distinguished between customer segments or facility types and their respective applicable end uses. Four residential segments (existing and new construction for single-family and multifamily homes), 16 commercial segments (existing and new construction for 8 building types), and 4 industrial segments (3 specific facility types and a miscellaneous segment) were analyzed.

The remainder of this section is divided into three parts: a brief description of the methodology for estimating technical and economic potential, a summary of resource potentials, and detailed sector-level results.

Methodology

The basic methodology for estimating energy-efficiency potential is consistent for all three sectors:

- **Develop baseline forecast:** A baseline forecast is created based on end-use consumption estimates, calibrated to ComEd's base year sales and official forecast. This provides accurate estimates of consumption by sector, customer segment, end use, and year.

- **Compile measure lists:** All measures applicable to ComEd's climate and customers were analyzed to accurately depict the energy-efficiency potential over the 6-year planning horizon. When expanded by customer segment, end use, and vintage (existing vs. new construction), this list totaled over 3,800 measures (as discussed above).

- **Estimate technical potential:** An alternate forecast was created where all technically feasible measures were assumed to be installed. The difference between this forecast and the baseline represents the technical potential in each year.

- **Estimate economic potential:** A second alternate forecast was created where all technically feasible and cost-effective measures were assumed to be installed. The difference between this forecast and the baseline represents the economic potential in each year.

- **Estimate achievable potential:** A subset of the economic potential was taken to reflect the maximum that could be achieved after accounting for market barriers, assuming ComEd was willing to pay up to 100% of incremental cost in incentives. A more detailed discussion of the methodology and results of achievable potential can be found in the subsequent chapter.

A detailed discussion of the methodology for estimating energy-efficiency potential is presented in Volume II, Appendix E.

Summary of Resource Potential

Table 9 shows the baseline electric sales and potential by sector forecast for the year 2016, the end of the 6-year study horizon. As shown, the results of this study indicate 22,117 GWh of technically feasible electric energy-efficiency potential will be available by 2016. This technical potential translates to an economic potential of 13,617 GWh. Were all of this potential cost-effective and realizable, it would amount to a 14% reduction in 2016 forecast retail sales. In addition, instead of a 5% increase in sales from 2011 to 2016, as forecasted, ComEd would experience 10% reduction of load growth from 2011 to 2016 (Figure 5).

The commercial sector has the largest economic potential (7,489 GWh), followed by the residential sector (4,564 GWh), and the industrial sector (1,564 GWh).

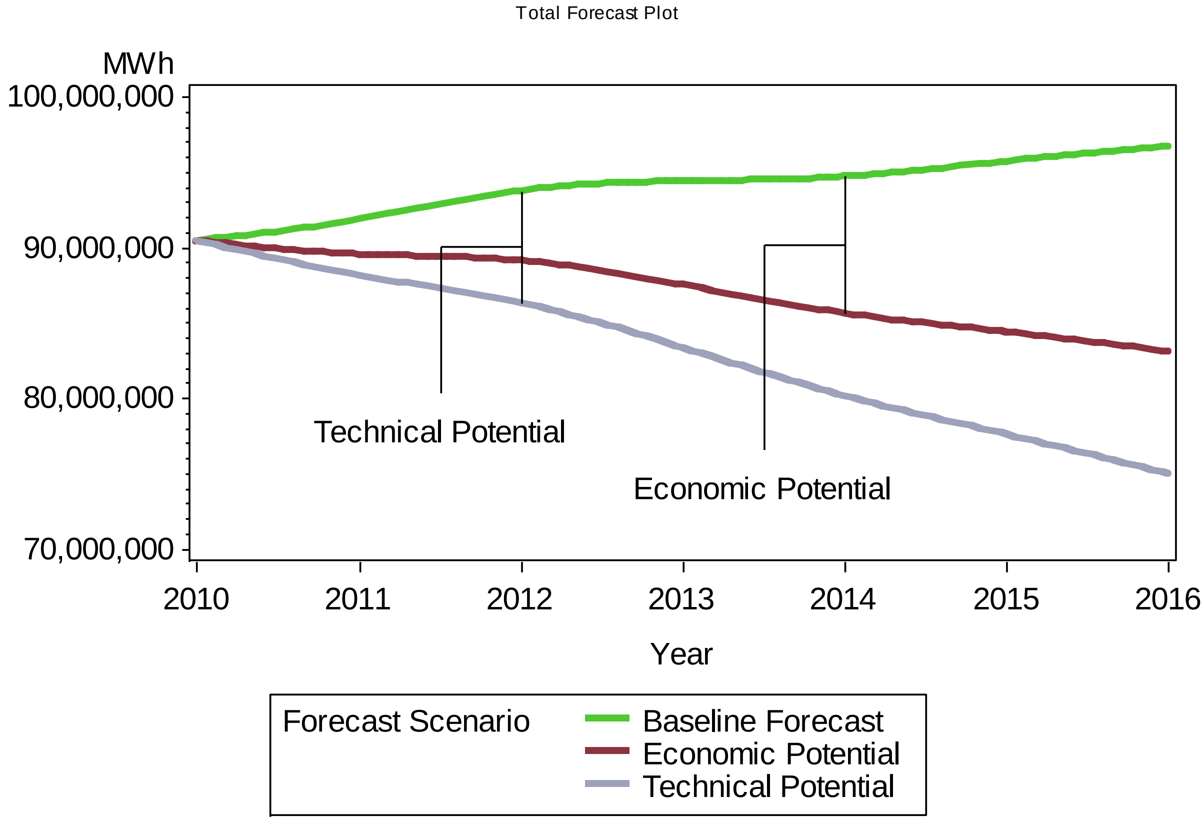
These savings are based on forecasts of future consumption absent any utility program activities. The estimated potential, therefore, is inclusive of—not in addition to—current or forecast program savings.

Table 9. Summary Technical and Economic Electric Energy-Efficiency Potential (MWh in 2016) by Sector

Sector	Baseline Sales	Technical Potential	Technical Potential as % of Baseline	Economic Potential	Economic Potential as % of Baseline	Economic Potential (MW)	Average Levelized Cost ($/kWh)
Residential	31,583,697	8,514,175	27%	4,564,469	14%	1,107	$0.04
Commercial	49,285,486	12,039,102	24%	7,488,711	15%	1,426	$0.05
Industrial	15,816,115	1,563,982[A]	10%	1,563,982	10%	217	$0.01
Total	**96,685,298**	**22,117,259**	**23%**	**13,617,162**	**14%**	**2,750**	**$0.04**

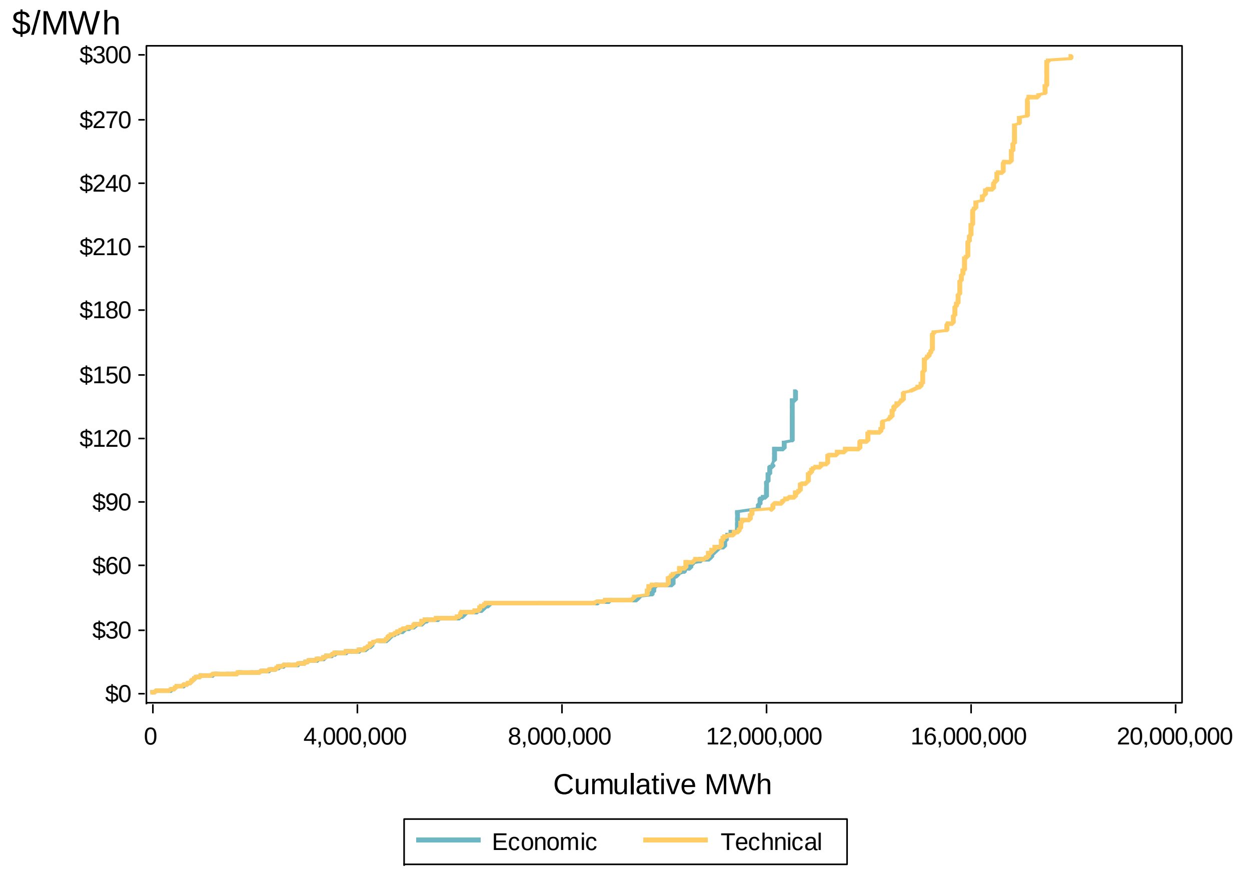
[A] Because the industrial sector uses a "top-down" approach based on cost-effective measures, the estimates of technical and economic potential are identical.

Figure 5. Sales Forecast with Energy-Efficiency Potential Scenarios



A diagram of the efficiency supply curve is presented in Figure 6. The economic potential is capped at approximately $142/MWh (or $0.142/kWh).

Figure 6. Energy-Efficiency Supply Curve



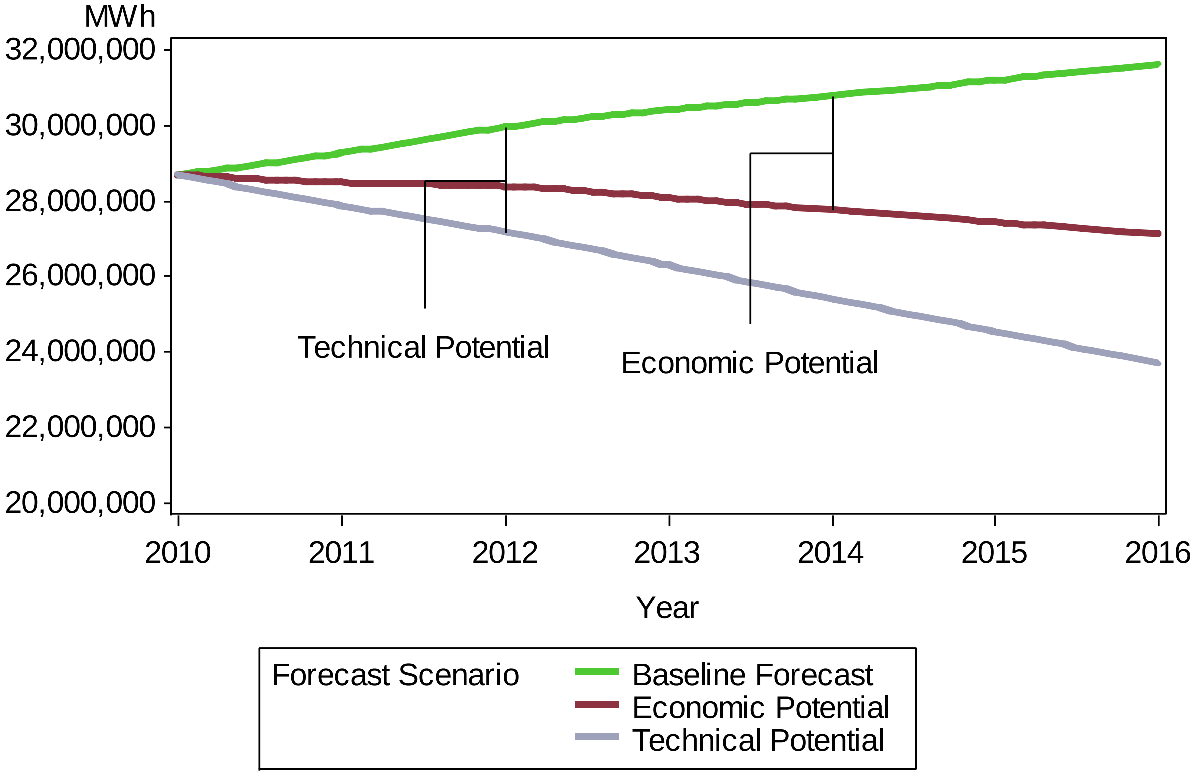
Detailed Resource Potential

Residential Sector

The 3.4 million residential customers in ComEd's service territory accounted for approximately 31% of baseline retail electricity sales in 2008. The single-family and multifamily dwellings that compose this sector present a variety of potential savings sources, including equipment efficiency upgrades (e.g., air conditioning, refrigerators), improvements to building shells (e.g., insulation, windows, air sealing), and increases in lighting efficiency (e.g., CFLs, LED interior lighting).

Electric economic potential in the residential sector is expected to be 4,564 GWh during the 6-year time horizon, corresponding to a 14% reduction of forecast 2016 residential consumption at an average levelized cost of $0.04/kWh (Table 9). Total economic potential, if all realized, would amount to an 8% load reduction from 2011 to 2016 (Figure 7).

Figure 7. Residential Sales Forecast with Energy-Efficiency Potential Scenarios



As shown in Figure 8, single-family homes represent 83% of the total economic residential potential and multifamily homes account for the remaining 17%. The main driver of these results is each home type's proportion of baseline sales, which is 78% for single-family and 22% for multifamily homes, but other factors, such as the presence of cooling or the current CFL saturation, also play a role in determining potential. A comprehensive list of the specific factors affecting the results is included in the segment-specific data in Volume II, Appendix E.

Figure 8. Residential Sector Economic Potential by Segment

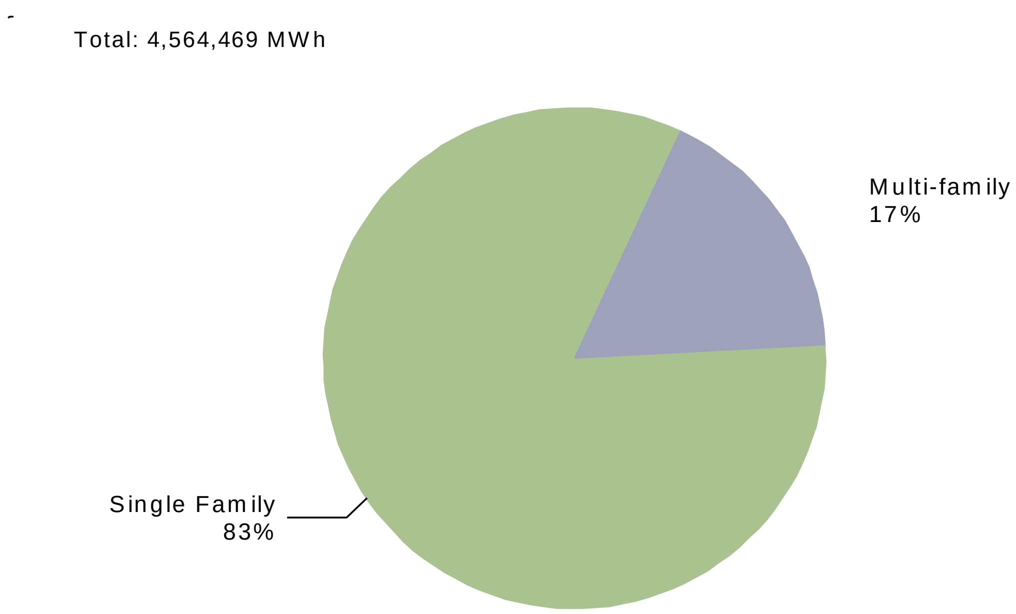


Figure 9 shows the total economic potential by end-use group. Lighting represents the largest portion (50%) of residential sector economic potential, followed by cooling savings (16%), appliances (refrigerators, freezers, dryers, etc., 14%), and HVAC auxiliary (e.g., fans and motors for heating and cooling equipment, 9%). Detailed sales and potentials by end use are presented in Table 10.

Figure 9. Residential Sector Economic Potential by End Use

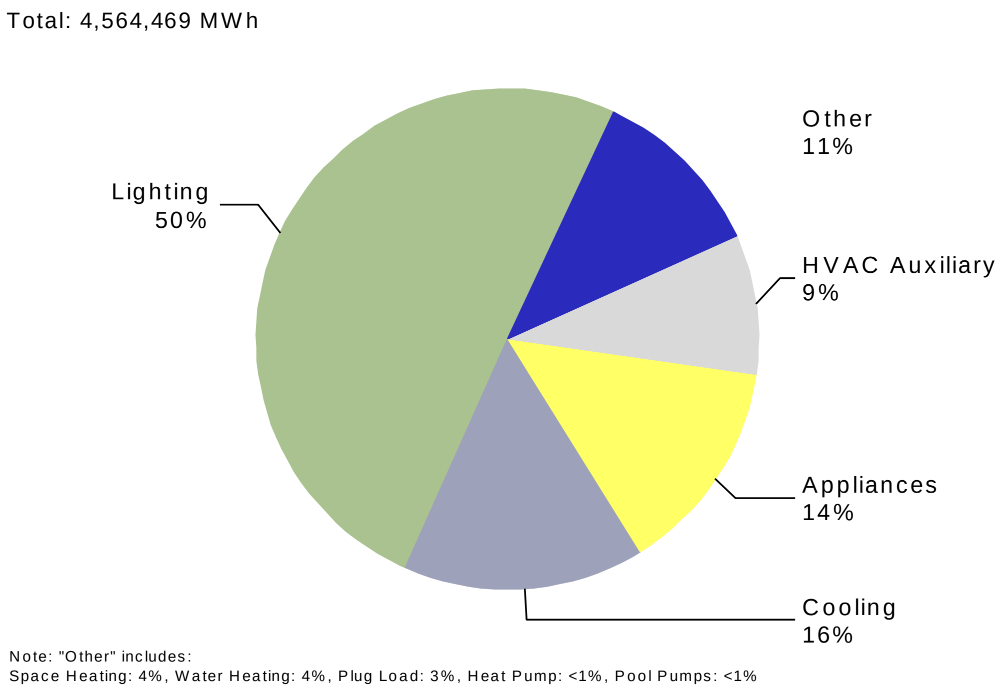


Table 10. Residential Sector Energy-Efficiency Potential by End Use (GWh in 2016)

End Use	Baseline Sales	Technical Potential	Economic Potential
Central AC	5,088	2,756	681
Cooking	886	15	-
Dryer	727	17	17
Freezer	783	293	272
HVAC Auxiliary	2,274	572	411
Heat Pump	79	26	9
Lighting	6,502	2,833	2,296
Other	1,927	-	-
Plug Loads	7,606	633	152
Pool Pump	188	7	2
Refrigerator	2,380	483	344
Room AC	583	164	28
Space Heating	1,921	457	187
Water Heat	685	259	167
Total	**31,584**	**8,514**	**4,564**

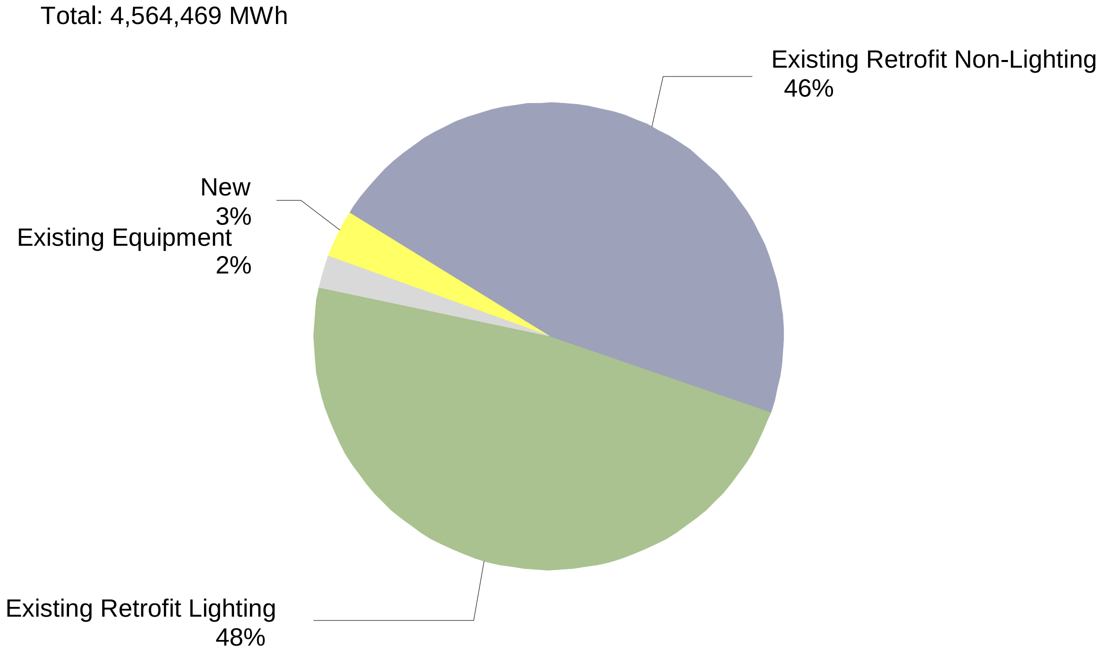
Figure 10 shows economic potential by vintage (existing buildings vs. new construction) and resource type (equipment or retrofit measures). About 3% of the residential economic potential is in new construction, representing both the depressed housing market and the fact that new construction already tends to be quite efficient (i.e., the incremental savings for new construction if typically far less than for existing homes).

In existing homes, potential is divided among retrofit (discretionary) and equipment (phased-in) measures. Discretionary measures are opportunities existing in current building stock (retrofit opportunities in existing construction), while phased-in measures rely on equipment burnout. Lighting, which for residential typically resembles an equipment (replace upon failure) measure, is also shown separately.[4] Lighting retrofit in existing construction accounts for the majority (48%) of the economic potential, followed by non-lighting retrofit measures (46%). Equipment measures represent only 2% of economic potential. It is important to note that the existing retrofit savings have been modeled to occur within the study's 6-year time horizon. For this reason, these discretionary resources will represent a slightly larger percentage of resource savings than if they occurred over a 10-year or 20-year period (i.e., more equipment would burn out and need to be replaced over a longer time horizon, thus providing additional opportunities for replacement with higher efficiency equipment).

The distinction between discretionary and phased-in measures becomes important in the context of timing of resource availability and acquisition planning. Phased-in resources are timing-driven: when a piece of equipment fails, there is an opportunity to install a high-efficiency model in its place. If standard equipment is installed in the absence of early replacement, the high-efficiency equipment could not be installed until the new equipment reaches the end of its normal life cycle. The same is true for new construction; resource acquisition opportunities become available only when a home or building is built. On the other hand, discretionary resources are not subject to the same timing constraints. Though program planning is outside the scope of this study, these considerations are vital for setting accurate annual program and portfolio goals.

4 While the majority of fixtures are medium and small screw based sockets, which can be readily retrofitted with CFLs upon bulb failure, pin-based fixtures may require fixture retrofits to allow more efficient lighting. In addition, barriers resulting from performance issues (e.g., limited dimming capabilities of CFLs) are addressed separately under the estimates of achievable potential.

Figure 10. Residential Sector Economic Potential by Vintage and Resource Category



Effect of EISA 2007 Lighting Requirements

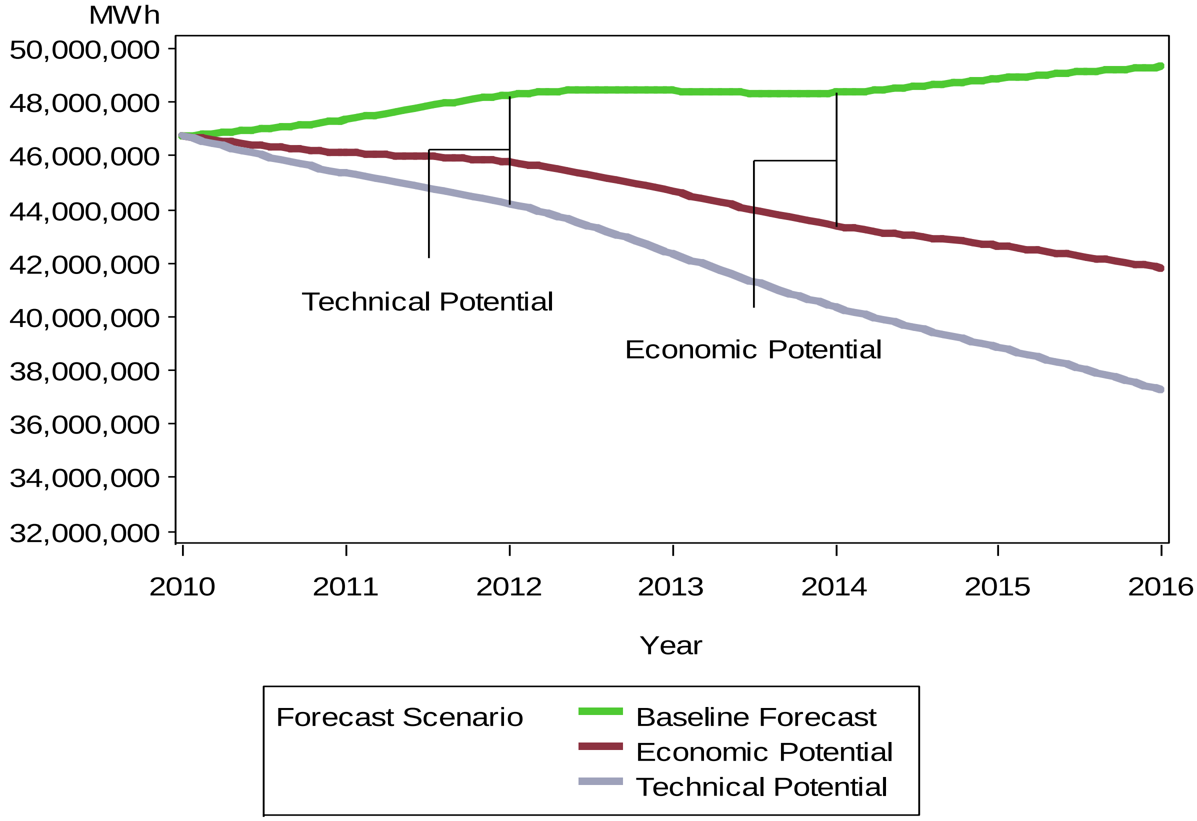
As noted above, the expected impacts of new lighting standards created in EISA 2007 have been accounted for in both the sales forecast and the potential estimate presented in this section.

While the effects of EISA have been incorporated into the potential estimate, an alternative EISA scenario was modeled that considered the impact of CFLs as the new baseline, rather than the base scenario of approximately 30% improvement in baseline incandescent lighting efficiency. Since the base EISA scenario is calibrated to the ComEd sales forecast, it is only appropriate to consider this alternative scenario relative to the potential estimate under the base scenario and not the baseline forecast. In this alternative scenario, residential economic potential in 2016 results in 3,665,467 MWh, representing a 20% decrease from the assumed EISA scenario. In other words, if EISA requirements are assumed to result in CFLs as the new lighting baseline, the residential economic potential would be 20% lower than the estimate currently presented in this report.

Commercial Sector

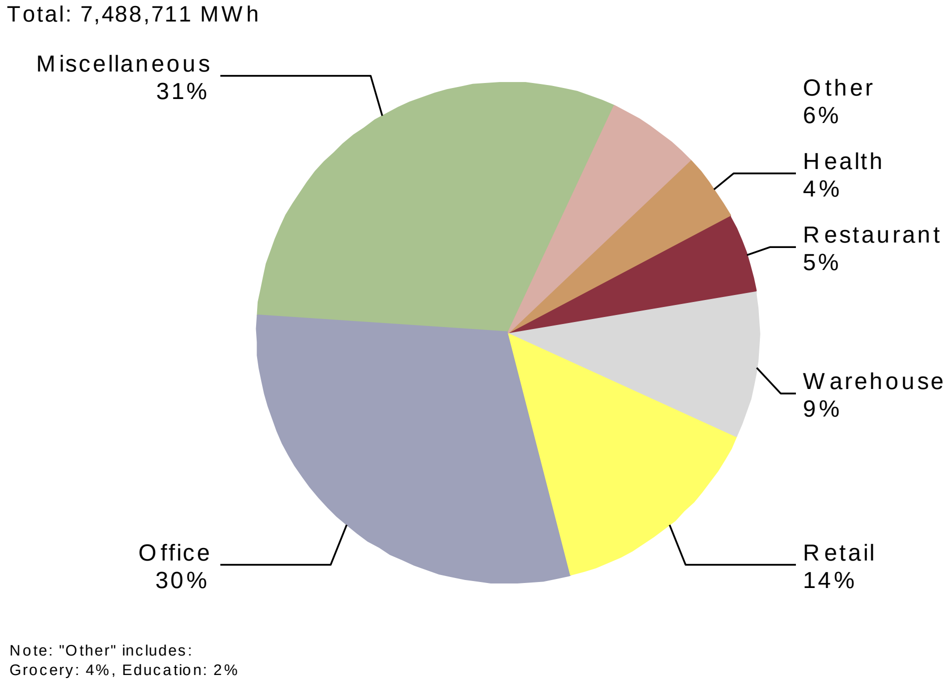
The 330,944 commercial customers in ComEd's service territory accounted for just over half (52%) of baseline electricity retail sales in 2008. Electric economic potential in the commercial sector is expected to be 7,489 GWh during the 6-year time horizon, corresponding to a 15% reduction of forecast commercial consumption in 2016 at an average levelized cost of $0.05/kWh (Table 9). Total economic potential, if entirely realized, would amount to a 12% load reduction from 2011 to 2016 (Figure 11).

Figure 11. Commercial Sales Forecast with Energy-Efficiency Potential Scenarios



The composition of the commercial sector varies more than the residential sector in terms of percentage of customers and sales by segment, which partially accounts for the difference in technical and economic potential as a percentage of 2016 sales. As shown in Figure 12, offices and miscellaneous buildings represent the largest shares (30% and 31%, respectively) of economic potential in the commercial sector. The miscellaneous segment is a combination of customers that do not fit into one of the other categories (e.g., agriculture) and those that would, but for which there was not enough information to classify them. Considerable savings opportunities are also expected in the commercial sector's retail (14%) and warehouse (9%) segments. Moderate savings are expected to be available in restaurants, education, health, grocery, and street lighting.

Figure 12. Commercial Sector Economic Potential by Segment



Lighting efficiency represents by far the largest portion of economic potential in the commercial sector (80%), followed by cooling (8%), and refrigeration (5%), as shown in Table 11 and Figure 13. The large lighting potential includes bringing existing buildings to code and exceeding code in new and existing structures.

Table 11. Commercial Sector Electric Energy-Efficiency Potential by End Use (GWh in 2018)

End Use	Baseline Sales	Technical Potential	Economic Potential
Cooking	104	2	1
Cooling Chillers	727	336	162
Cooling DX	2,817	1,590	401
HVAC Aux	6,945	705	84
Heat Pump	144	65	39
Lighting	24,380	7,968	6,021
Other	1,686	2	0
Plug Load	7,775	340	262
Refrigeration	2,092	400	322
Space Heat	1,461	460	168
Street Lighting	739	94	0
Water Heat	416	77	29
Total	49,285	12,039	7,489

Figure 13. Commercial Sector Economic Potential by End Use

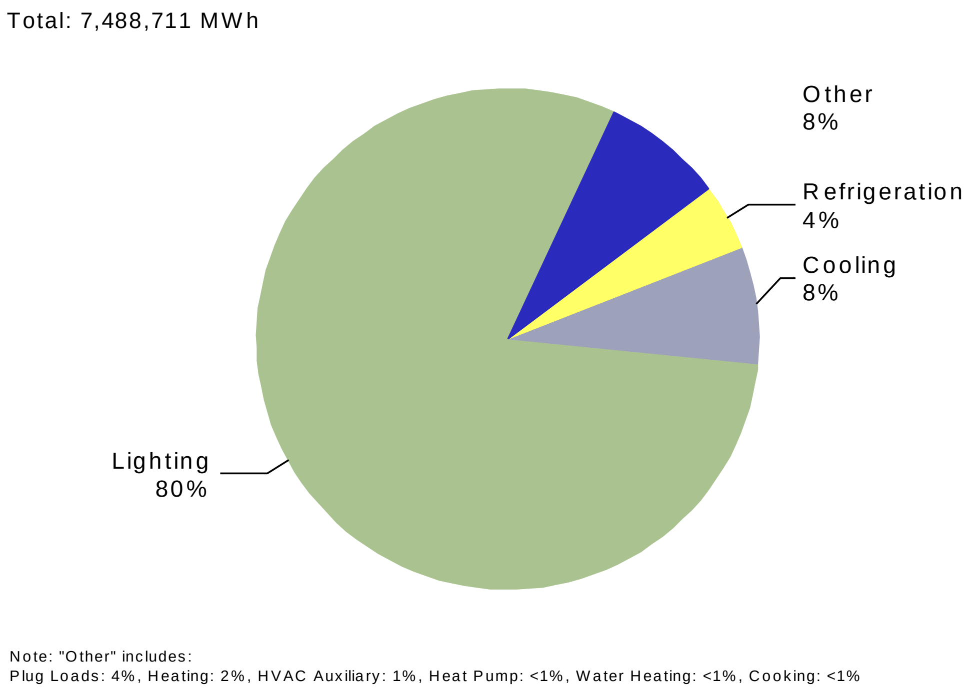
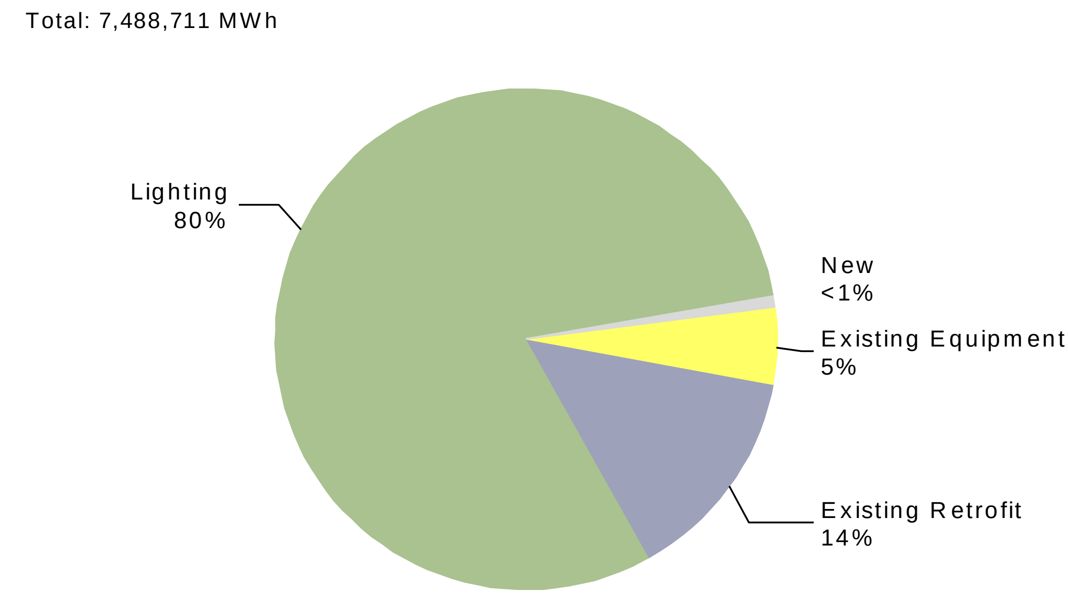


Figure 14 shows economic potential by vintage (existing buildings vs. new construction) and resource type (equipment or retrofit measures). Lighting, which for the commercial sector represents a cross between equipment and retrofit, is once again broken out as a separate category.[5] Retrofit in existing construction accounts for the majority (58%) of the economic potential, followed by lighting measures (38%). Like the residential sector, a relatively small percentage of the economic potential is represented by equipment measures (5%) and new construction (less than 1%).

5 The majority of lighting opportunities in the commercial sector are represented by retrofitting fluorescent T-12 lighting. While the bulbs do fail, and thus resemble an equipment measure, the replacement of the fixture itself requires a discretionary retrofit decision.

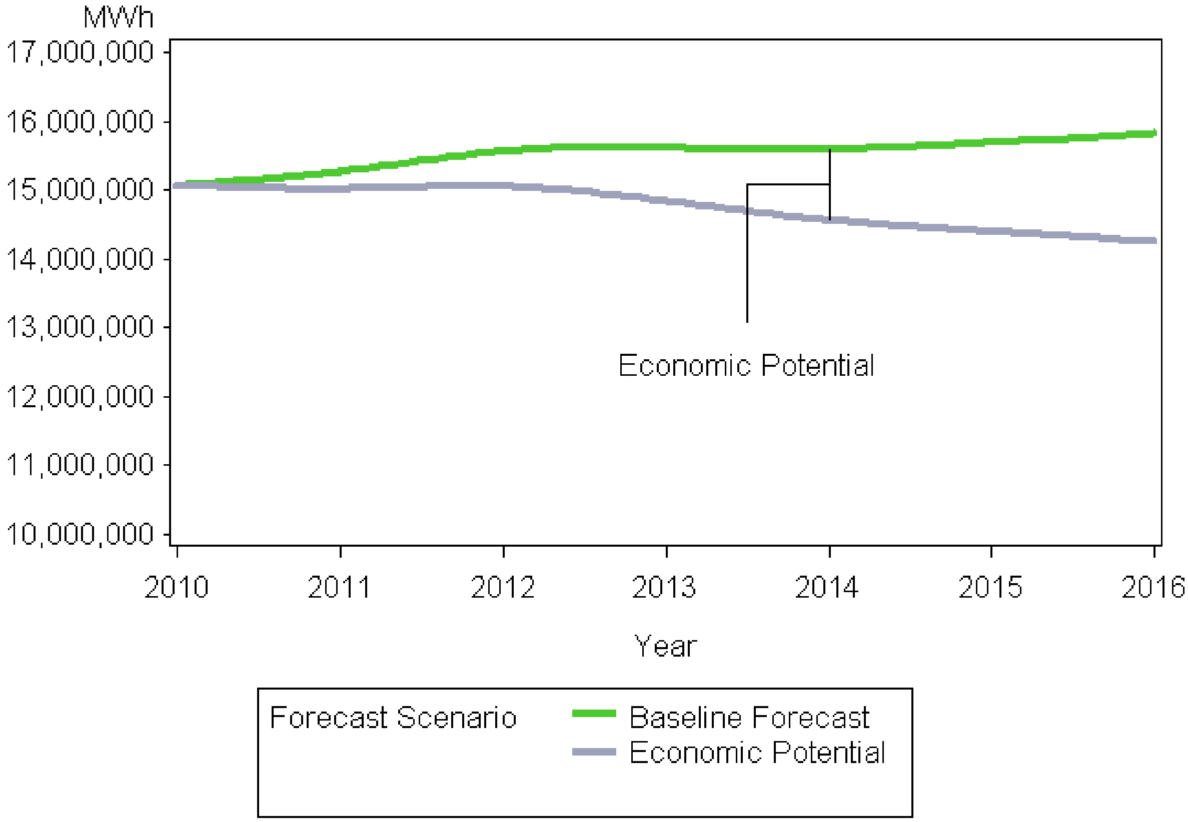
Figure 14. Commercial Sector Economic Potential by Vintage and Resource Category



Industrial Sector

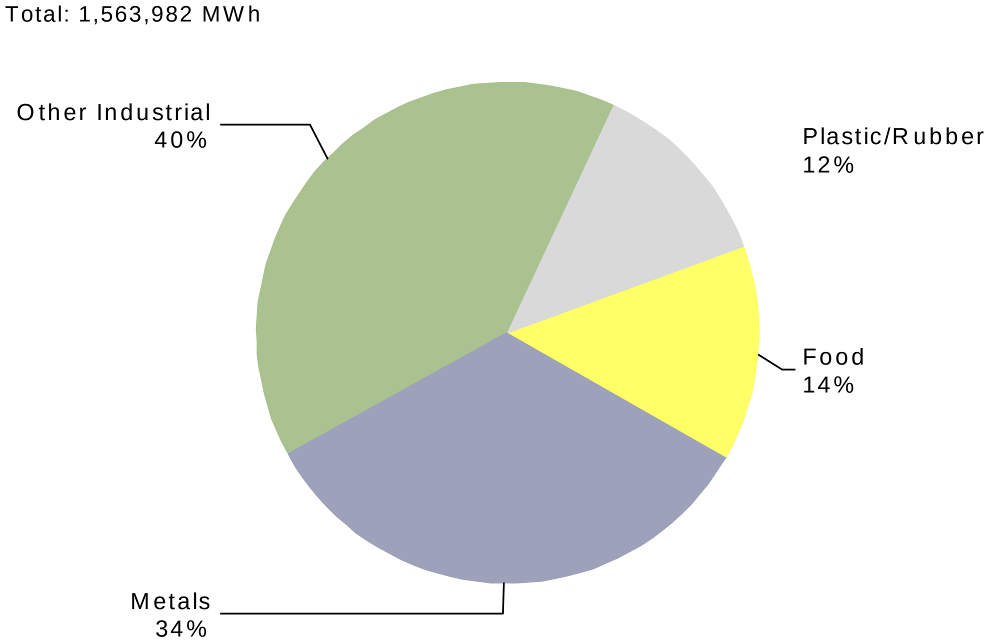
The 27,077 industrial customers in ComEd's service territory accounted for approximately 17% of baseline retail electricity sales in 2008. Electric economic potential in the industrial sector is expected to be 1,564 GWh during the 6-year time horizon, corresponding to a 10% reduction of forecast 2016 commercial consumption at an average levelized cost of $0.01/kWh (Table 9). Total economic potential, if entirely realized, would amount to a 7% load reduction from 2011 to 2016 (Figure 15).

Figure 15. Industrial Sales Forecast with Energy-Efficiency Potential Scenarios



Technical and economic energy-efficiency potentials were estimated for major end uses in four major industrial sectors. Current projected electricity usage in 2016 is 15,816 GWh for the industrial sector. Across all industries, annual economic potential totals approximately 1,563 GWh, corresponding to a 10% reduction of industrial consumption forecast for 2016. Figure 15 shows the breakout of the economic potential by segment, with metals representing the largest area for savings with 34%.

Figure 16. Industrial Sector Electric Economic Potential by Segment



The majority of electric economic potentials in the industrial sector (65%) is attributable to gains in process efficiency (heating, cooling, compressed air, etc.), followed by HVAC improvements (19%). Motors and lighting account for another 7% and 6% of economic potential, respectively. Figure 17 shows the allocation of the economic potential by end use. Table 12 presents the baseline energy usage by end use in GWh and the corresponding technical and economic potential for each end use type.

Note that all of the estimated technical potential in the industrial sector is considered economic. Because of the sector's tight cost margins, available measure data focus on technologies that are currently cost-effective. As such, the universe of available measures examined is smaller than those of the other sectors, possibly influencing the technical potential downward. Furthermore, the industrial potential estimates relied largely on energy audits that primarily examined individual measures and not on a systems approach; thus the actual economic potential may be slightly higher than that presented in this report. For a more complete description of the methodology used, please see Volume II, Appendix E.

Figure 17. Industrial Sector Electric Economic Potential by End Use

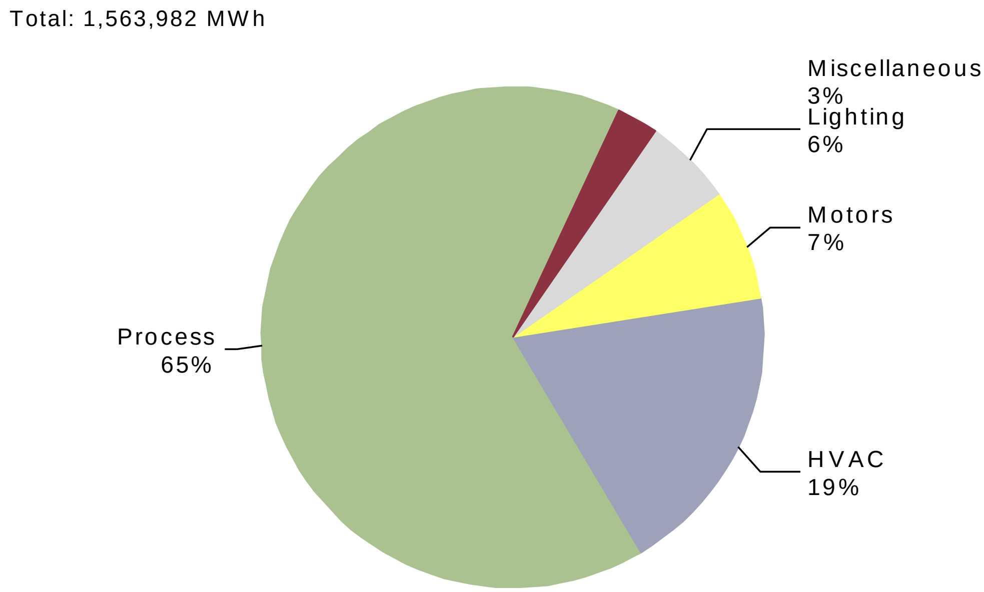


Table 12. Industrial Sector Electric Energy-Efficiency Potential by End Use

End Use	Baseline Sales (GWh)	Economic Potential (GWh)
Fans	939	48
HVAC	2,715	297
Indirect Boiler	2	0
Lighting	2,052	89
Motors Other	3,537	169
Other	879	42
Process AirComp	945	193
Process Cool	1,330	161
Process Electro Chemical	41	0
Process Heat	1,894	418
Process Other	70	8
Process Refrig	418	75
Pumps	994	64
Total	15,816	1,564

4. Achievable Energy-Efficiency Potentials

The previous chapter provided estimates of the technical and economic energy-efficiency potentials in the residential, commercial, and industrial sectors. This chapter expands on the analysis, estimating the subset of technical and economic potential that can actually be achieved through program activity.

Definitions of Achievable Potential

Achievable potential typically is defined in two ways:[6]

- ***Maximum Achievable Potential (MAP)*** 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). MAP accounts for real-world barriers to convincing end users to adopt efficiency measures, recognizing that even if the full incremental cost of measures were to be paid for by utilities, some customers would still refuse to install efficient equipment. For example, some customers may reject CFLs, even if they are given away for free, because they do not like the light quality. Similarly, industrial customers may have been using fixed-speed motor systems for many years, and may be risk-averse to upgrade for variable frequency drives, even at no incremental cost.

- ***Program Achievable Potential (PAP)*** is the amount of energy use the ComEd efficiency programs realistically can be expected to displace from 2011 through 2016.[7] PAP reflects the market, financial, political, and regulatory barriers likely to limit the amount of savings that might be achieved through program activity. For example, new programs require a ramp-up period to educate customers and trade allies about program activity; the recent recession and housing crises also limit customer spending and interest in programs; and Illinois legislation requires a 2% annual spending rate cap. In addition, the six-year time horizon for this study means much of the discretionary measures (e.g., replacement of insulation or other shell measures) that do not require replacement from 2001–2016 will likely not be achieved, particularly since customers will not be in the market to replace such measures (i.e., the adoption of such measures will be substantially longer than that of a replacement measure, where a utility can devise a program-intervention strategy to educate customers and trade allies during the natural replacement cycle).

Projection of MAP and PAP pose significant analytic challenges as they are inherently based on assumptions regarding market acceptance of energy-efficiency measures and programs offered by utilities. Surely, levels of cost-effective, energy-efficiency potential realistically achievable

6 These definitions are consistent with the National Action Plan for Energy Efficiency (NAPEE) *Guide for Conducting Energy Efficiency Potential Studies*, November 2007.

7 Program Achievable Potential is also referred to as Realistically Achievable Potential.

depends on several factors, including customers' willingness to participate in energy-efficiency programs (which is only partially a function of incentive levels), retail energy rates, and a host of market barriers that have historically impeded the adoption of energy-efficiency measures and practices by consumers.[8] These barriers tend to vary depending on the customer sector, local energy market conditions, and other, hard-to-quantify factors.

Estimating Achievable Potential

The most reliable way to estimate achievable potential is to examine actual achieved savings (i.e., historical program savings accomplishments) as a function of program delivery mechanisms, incentives, and marketing expenditures. However, because ComEd is only in its second year of recent program activity, limited historical data are available for this purpose.

Alternatively, many studies examine achievable potential as a subset of economic potential. These estimates implicitly assume the measure savings estimates, incremental costs, and other assumptions going into deriving economic potential are fixed during the time horizon of interest, and that a portion of economic potential can be achieved.

For example, a review of recent conservation potential assessment studies in North America indicates a wide range for achievable potentials, from 30% (New Jersey) to 75% (New England) of economic potentials across all sectors.[9] The available data indicate, on the whole, an estimated average PAP of approximately 47% across all sectors. A 2004 "meta-analysis" of potential found, on average, achievable potential was about 41% of economic potential.[10]

Due to differences in methodology, however, underlying assumptions (e.g., the length of the planning horizon), variations in local market conditions (e.g., customer mix, electric rates, and historical conservation efforts), and the calculated "average" or "typical" reported here should be interpreted in light of these limitations and be considered only as "indicative" measures of what might be achievable. For example, some studies calculate only achievable potential and not economic potential, making it difficult to compare the two estimates. Other studies, such as recent California estimates of efficiency potential, only include measures that need to be replaced in the next 10 years (i.e., discretionary or retrofit measures are not included).

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8 Consumers' apparent unwillingness to invest in energy efficiency has been attributed to certain market barriers for energy efficiency. A rich literature exists concerning what has become known as the "market barriers to energy efficiency" debate. Market barriers identified in the energy-efficiency literature fall into five broad classes of market imperfections thought to inhibit energy efficiency investments: (1) misplaced or split incentives; (2) high front costs and lack of access to financing; (3) lack of information and uncertainty concerning benefits, costs, and risks of energy-efficiency investments; (4) investment decisions guided by convention and custom; and (5) time and "hassle" factors. For an ample discussion of these barriers, see William H. Golove and Joseph H. Eto, "Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy," Lawrence Berkeley National Laboratory, University of California, Berkeley, California, LBL-38059, March 1996.

9 A full bibliography of studies used to inform achievable potentials estimates is included in Appendix G.

10 Nadel, Steven, et. al. "The Technical, Economic, and Achievable Potential for Energy-Efficiency in the U.S.—A Meta-Analysis of Recent Studies." 2004 ACEEE Summer Study on Energy Efficiency in Buildings.

The Power and Conservation Council in the Pacific Northwest, a region with a history of conservation planning beginning in the late 1970s, has historically assumed 85% of economic potential is likely to be achievable. Recent data from the Council indicates that while the region has indeed achieved significant portions of the expected economic potential since the early 1980s, a large portion of these savings have been achieved through implementation of energy codes and standards, particularly in Oregon and Washington.[11]

Several utilities have made more rigorous attempts to develop realistic estimates of achievable potentials. For example, a survey of about 30 national energy-efficiency experts (conducted for Tacoma Power in 2006) found between 30% to 48% of economic potentials are likely to be achievable across all sectors for existing buildings, assuming a 50% incentive and a 10-year planning horizon.

Another recent study by the Electric Power Research Institute (EPRI) examined the impacts of energy-efficiency programs around the country, combined with expert judgment, to estimate MAP and PAP through two adjustment factors:[12]

- ***Market Acceptance Ratios*** (MARs) are used to derive the MAP by recognizing some consumers will not select the most efficient equipment, even if programs offer perfect information and cover the full incremental cost of that equipment. As noted, many customers consider aesthetics, performance, and a myriad of additional product attributes as far higher priorities than energy efficiency. The MARs were developed based on current market data where available, such as ENERGY STAR sales figures, and have been augmented through an expert review process. In addition, the MARs generally increase through the forecast horizon, reflecting energy efficiency's growing acceptance.

- ***Program Implementation Factors*** (PIFs) account for recent utility experience and reported savings to estimate the percentage of the MAP that likely (realistically) can be acquired as PAP. The PIFs account for the many other factors that limit program accomplishments, including: a requisite ramp-up period to educate customers and trade allies about program activity; limited (and, in the case of Illinois, capped) resources for incentive and marketing budgets; and other market barriers, such as split incentives.

The values from the EPRI study, however, appear quite conservative in terms of identifying the percentage of economic potential that is considered achievable. For example, the MAR for residential central AC is only 25% in 2010, increasing to 50% in 2015. Extrapolating this to the 2011–2016 potential horizon, the maximum achievable potential for residential central AC would only be approximately 38%. The PIFs for the same measure would increase from 30% in 2010 to 40% in 2015. Once again, extrapolating to the 2011–2016 potential horizon, the

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[11] "Achievable Savings: A Retrospective Look at the Northwest Power and Conservation Planning Assumptions," Council Document, 2007-7, Northwest Power and Conservation Council, May 2007.

[12] Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S.: (2010–2030). EPRI, Palo Alto, CA: 2009. 1016987.

program-achievable potential for this measure would only be approximately 14%.[13] Similarly low estimates have been projected for most measures; thus, this technique was not applied as part of this study.

Finally, Cadmus conducted an independent review of 60 potential studies covering 40 states, plus four national studies.[14] As shown in Table 13, the achievable potential as a percent of economic potential ranges from an average of 38% at the low end to 81% on the high end (maximum achievable), with typical realistically achievable potential averaging about 43% of economic potential. Note the average number of years was 15 year, with an implied annual achievable of about 0.8% of baseline sales.

Table 13. Summary of Potential Study Research

Parameter	Number of Studies	Average Potential as Percent of Baseline Sales*	Average Potential as Percent of Economic*
Technical Potential	30	27%	NA
Economic Potential	33	21%	NA
Minimum Achievable Potential	14	8%	38%
Program Achievable Potential	11	9%	43%
Maximum Achievable Potential	38	17%	81%

* Cumulative % of End Year Sales

Figure 18 presents annual estimates of MAP and PAP compared against estimated economic potential as well as statutory Illinois' savings goals, which require energy savings of 0.2% of sales beginning in 2008, and ramping up to 2% of sales for 2015 and 2016. The PAP (43% of economic potential) and the MAP (81% of economic potential) are based upon the literature review above.

Note that the application of the PAP to the entire estimate of the economic potential, including the retrofit measures (e.g., insulation and other discretionary measures), assumes that in six years (the time horizon for the current study) that 43% of the potential can be achieved. Because most potential studies cover a longer time horizon (average of 15 years), most studies assume this same potential would be achieved over a much longer time horizon. If retrofit measures are assumed to need a longer time horizon to achieve the program potential, the PAP for retrofit measures would be reduced. For example, if a ten-year phase-in is assumed for retrofit measures, the PAP for these measures would be:

*Retrofit PAP = (Study Horizon/Phase-in) * 43%*

*Retrofit PAP = (6/10) * 43% = 25.8%*

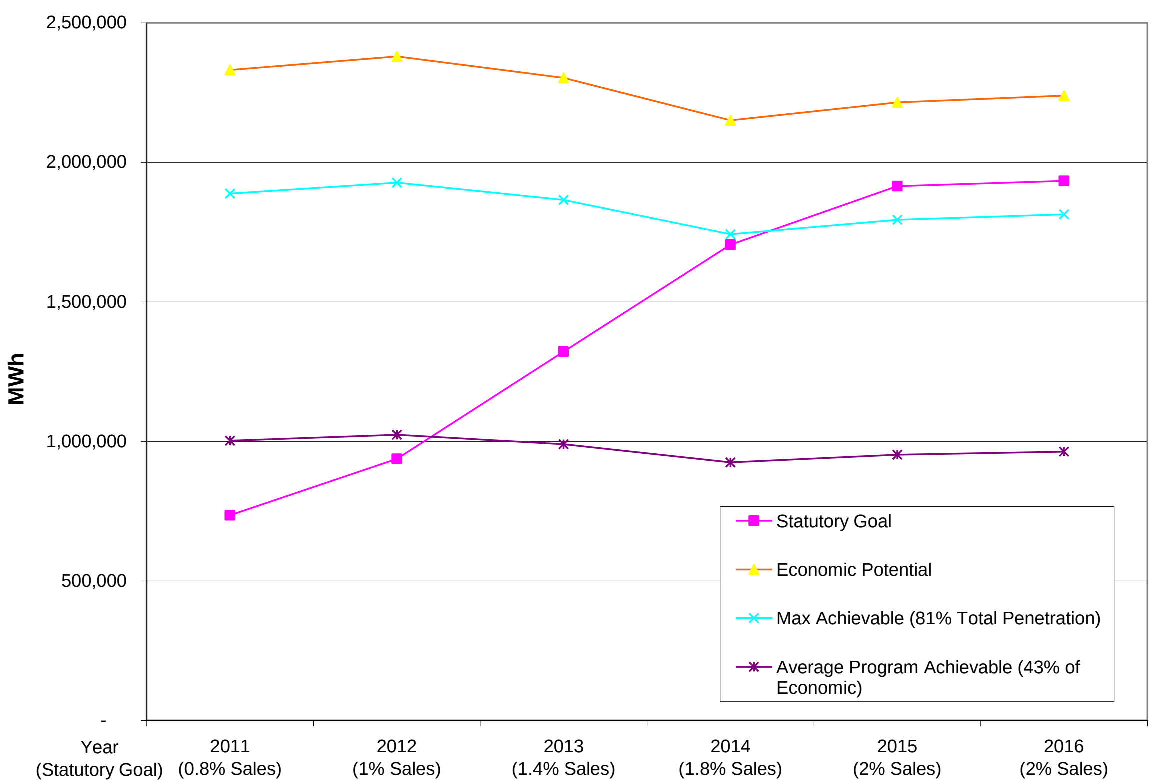
13 The program achievable percent is a subset of the maximum achievable potential; so PIFs are applied to the maximum achievable percent. As an example for central AC units, if the MAR is 25% and the PIF is 30%, the estimated achievable percent is the product of 25% and 30% (or 7.5% of economic potential).

14 The full bibliography of studies is included in Appendix G.

The overall effect of this assumption would be reduce the total estimated PAP from 43% to about 35%.

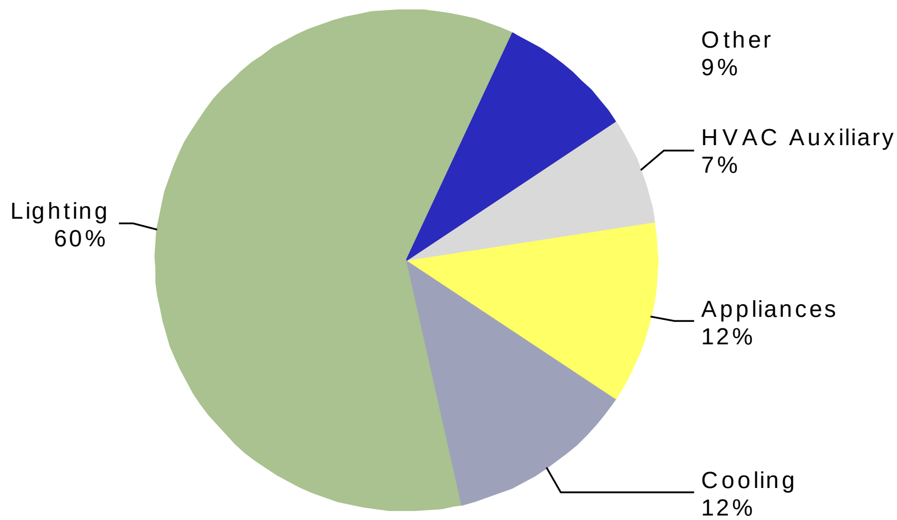
As shown in Figure 18, the EISA lighting standards have a downward effect on economic potential, particularly in 2013 and 2014. Statutory goals, however, continue to rise (quite aggressively in 2015). As shown in the figure, the EISA lighting standards have a downward effect on economic potential, particularly in 2013 and 2014. Statutory goals, however, continue to rise (quite aggressively in 2015). As shown in the figure, ComEd will need to exceed the estimated maximum achievable percentage in 2015-2016 to meet the program goals.

Figure 18. Estimates of Achievable Potential (2011-2016)



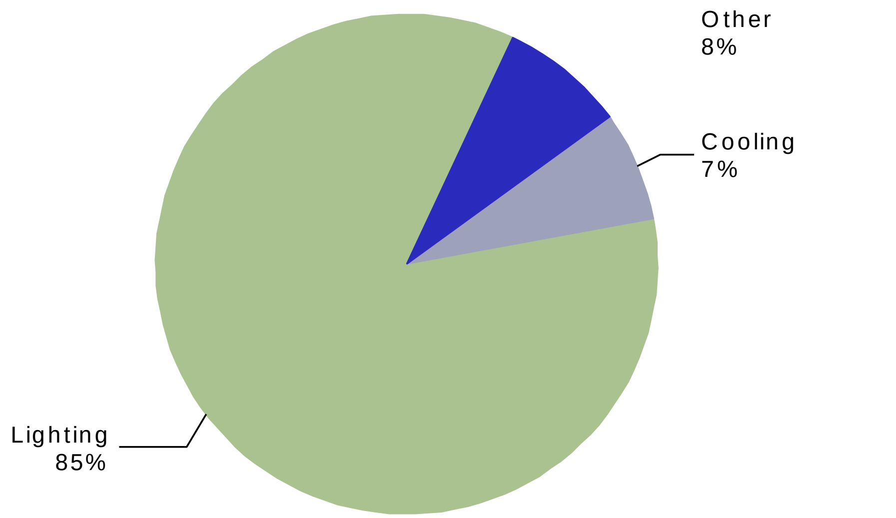
As shown in Figure 19 and Figure 20, lighting still remains an important end use for achievable potential for residential (45%), and is still the dominant end-use for commercial (85%). In addition, process improvements are still the primary sources for industrial potential (Figure 21).

Figure 19. Residential Sector Electric Achievable Potential by End Use (2016)



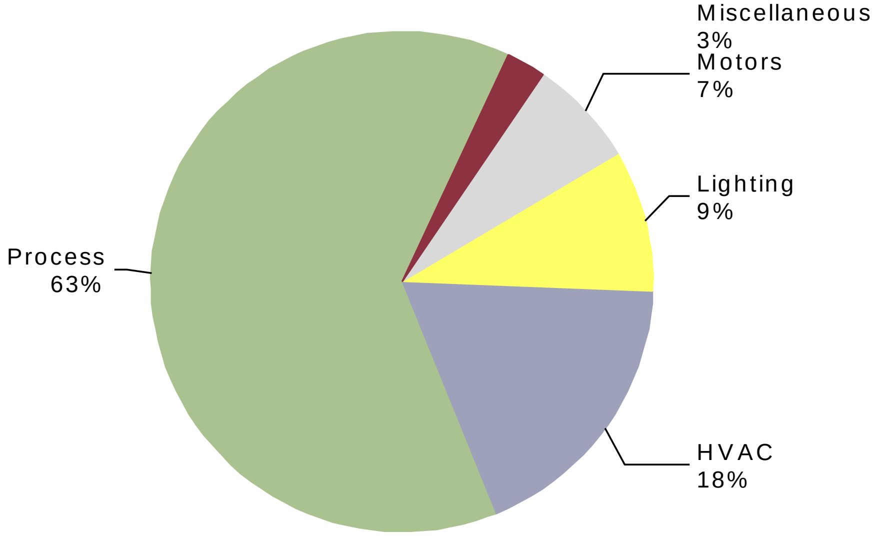
Note: "Other" includes:
Space Heating: 3%, Water Heating: 3%, Plug Load: 3%, Heat Pump: <1%, Pool Pumps: <1%

Figure 20. Commercial Sector Electric Achievable Potential by End Use (2016)



Note: "Other" includes:
Refrigeration: 3%, Plug Loads: 2%, Heating: 1%, HVAC Auxiliary: <1%, Heat Pump: <1%, Water Heating: <1%, Cooking: <1%

Figure 21. Industrial Sector Electric Achievable Potential by End Use (2016)



Comparison of Program Savings to Potential Estimates

As noted above, actual program achievements provide important insight into achievable potential estimates. ComEd, however, has only recently completed one year of DSM program activity, and is planning more aggressive program activity during the next few years. To help highlight areas where ComEd should focus on achieving program savings, Cadmus developed a series of pie charts to compare the percentage of economic potential by sector, segment, and end-use with the percentage of Program Year 1 (PY1) achieved savings by the same categories.[15] "Slices" of the pie charts that are larger on the economic potential estimates compared to the PY1 achieved estimates represent areas that ComEd should consider targeting for future DSM program activities.

Comparison of Potential vs. Achieved Savings by Sector

As shown in Figure 22, in PY1 ComEd achieved savings in a mixture of residential (45%), commercial (43%), and industrial (12%) sectors. The percent of achieved savings was slightly lower in the commercial sector (43%) than the percent of commercial economic potential (55%), but in general the PY1 achievements represent a mix of savings for all sectors.

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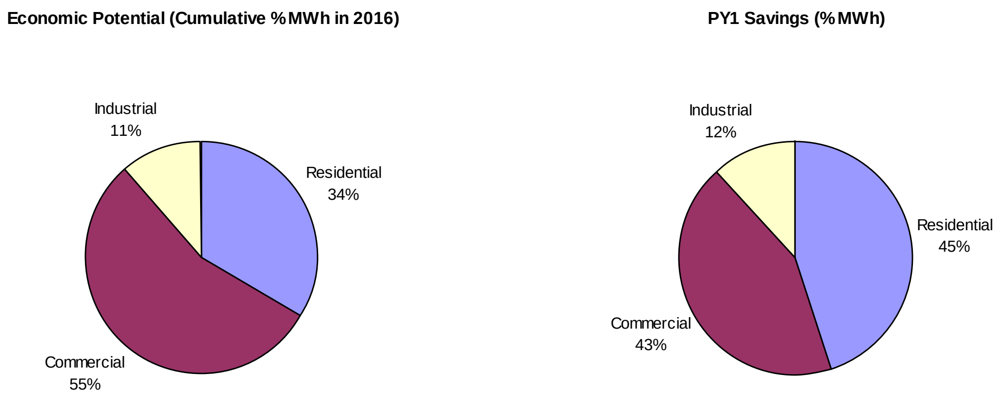
[15] Note that the PY1 valuation did not include the full resolution needed to conduct this analysis using the final net savings estimates, so the analysis supplemented these sources with gross savings estimates from the program tracking database, generated in October 2009. These data, therefore, may be considered illustrative, rather than conclusive, of PY1 results.

Figure 22. Economic Potential vs. PY1 Savings by Sector

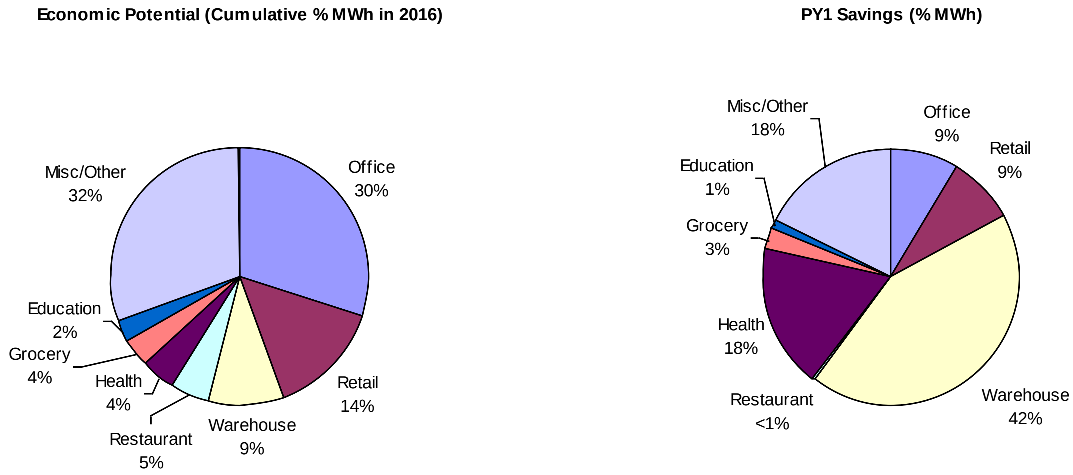


Comparison of Potential vs. Achieved Savings by Segment

Because a significant portion of the savings from the residential sector were generated by CFL buy downs, and the "upstream" incented CFLs cannot be tracked to single family vs. multifamily homes, savings by residential segment were not available. For the commercial sector, a significantly higher percentage of savings were achieved in the warehouse segment (42%) compared to the percentage of economic potential in that segment (9%) (Figure 23). Analysis of the site visit data revealed that many of the warehouses visited had retrofitted their lights to more efficient lighting, possibly reflecting the achievements of the program.[16] Offices, which represent 30% of the economic potential but only 9% of the PY1 savings, may offer additional program opportunities.

[16] The survey collected information on saturations, not purchases, so did not determine the timing for the retrofits or program attribution.

Figure 23. Economic Potential vs. PY1 Savings by Commercial Segments



Comparison of Potential vs. Achieved Savings by End-Use

As shown in Figure 24, the residential savings in PY1 was dominated by lighting (82%). Although lighting represented the largest potential end-use in the residential sector (50%), the study found additional economic potential (and thus program opportunities) for cooling, HVAC auxiliary, space heating, and water heating measures. In the commercial sector, the PY1 savings were also dominated by lighting (84%), which also closely mirrored the findings from the potential study (Figure 25).

Figure 24. Economic Potential vs. PY1 Savings by Residential End-Use

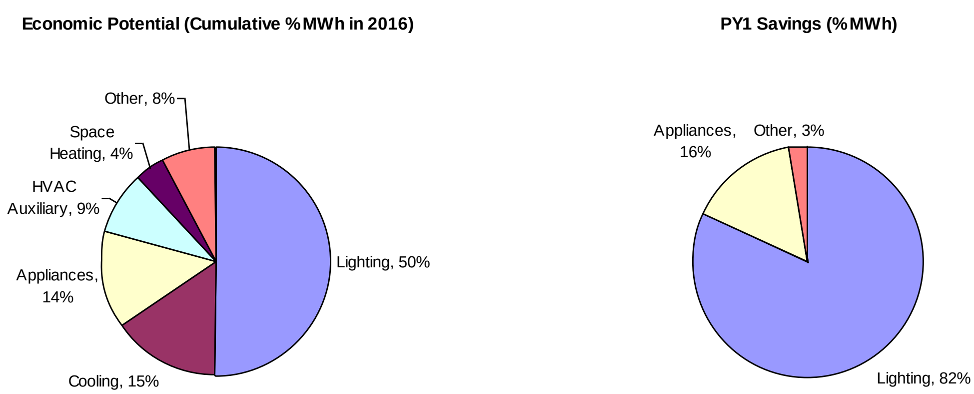
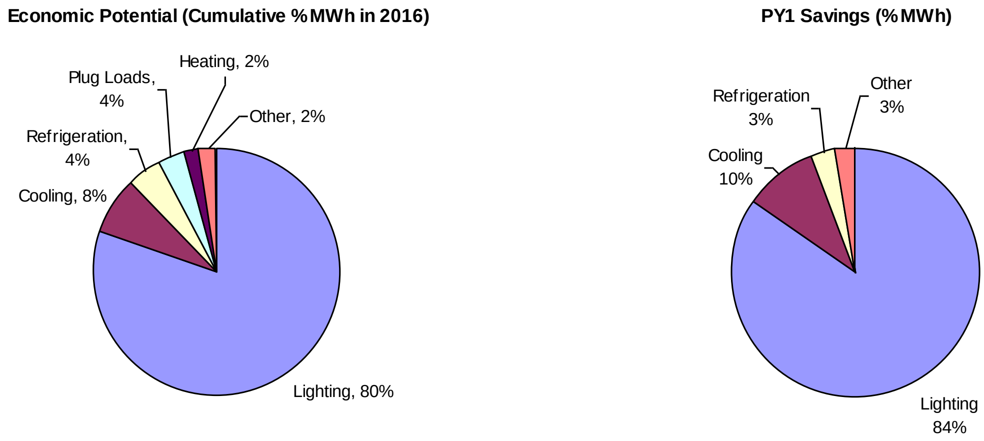


Figure 25. Economic Potential vs. PY1 Savings by Commercial End-Use



5. Demand Response Potential

Scope of Analysis

Demand response (DR) or load reduction programs, focused on reducing a utility's capacity needs, are comprised of flexible, price-responsive loads, which may be curtailed or interrupted during system emergencies or when wholesale market prices exceed the utility's supply cost. These programs are designed to help reduce peak demand, promote improved system reliability, and, in some cases, may lead to the deferment of investments in delivery and generation infrastructure. DR objectives may be met through a broad range of price-based (e.g., time-varying rates and interruptible tariffs) or incentive-based (e.g., direct load control) strategies. In this assessment, the following demand-response strategies were analyzed:

1. ***Direct Load Control*** (DLC) programs allow a utility to remotely interrupt or cycle electrical equipment and appliances at a customer's facility or home. In this study, assessment of DLC program potential is analyzed for ComEd's existing residential central AC program. Within the program are two options for customers: a 50% cycling option and a 100% cycling option. The program analysis examines potential for summer peak demand reduction in customer-owned homes with central AC (including heat pumps).

2. ***Real-Time Pricing*** (RTP) is a tariff structure for customers to pay electric rates tied to market prices. The prices are posted by the utility, ISO, or program contractor based on day-ahead hourly prices, but are not guaranteed to match the day-of hourly prices that customers must pay. RTP price structures are suitable for large C&I customers with flexible schedules, and for residential customers interested in lowering their electricity bill by raising the cost of electricity during peak times. This analysis examines demand reduction under ComEd's existing Residential RTP (RRTP) program, which is open to all residential customers in ComEd's service territory.

3. ***Interruptible Tariffs*** (Capacity Based Load Response (CLR)) refer to contractual arrangements between the utility and its customers, who agree to curtail or interrupt their loads in whole or part for a predetermined period when requested. In most cases, mandatory participation is required once the customer enrolls in the program; however, these programs may include provisions for customers to exercise an economic buy-through of a curtailment event. Incentives are paid regardless of the quantity of events called each year (less any penalties associated with an event buy-through). This analysis evaluates ComEd's existing contractual Capacity-Based Load Response program (Rider CLR7) available to nonresidential customers who can provide 100 kW or greater of load reduction.

4. ***Demand-Bidding or Demand Buy-Back*** (Voluntary Load Response (VLR)) programs offer payments to customers for voluntarily reducing their demand at the utility's request. The buyback amount generally depends on market prices published by the utility in advance of the event, coupled with the customer's ability to curtail use during the hours load curtailment is requested. The reduction level achieved is verified using an agreed-upon baseline usage level specific to the participating customer. This analysis examines

ComEd's existing Voluntary Load Response (Rider VLR7) program available to nonresidential customers who can reduce their load 10 kW or more.

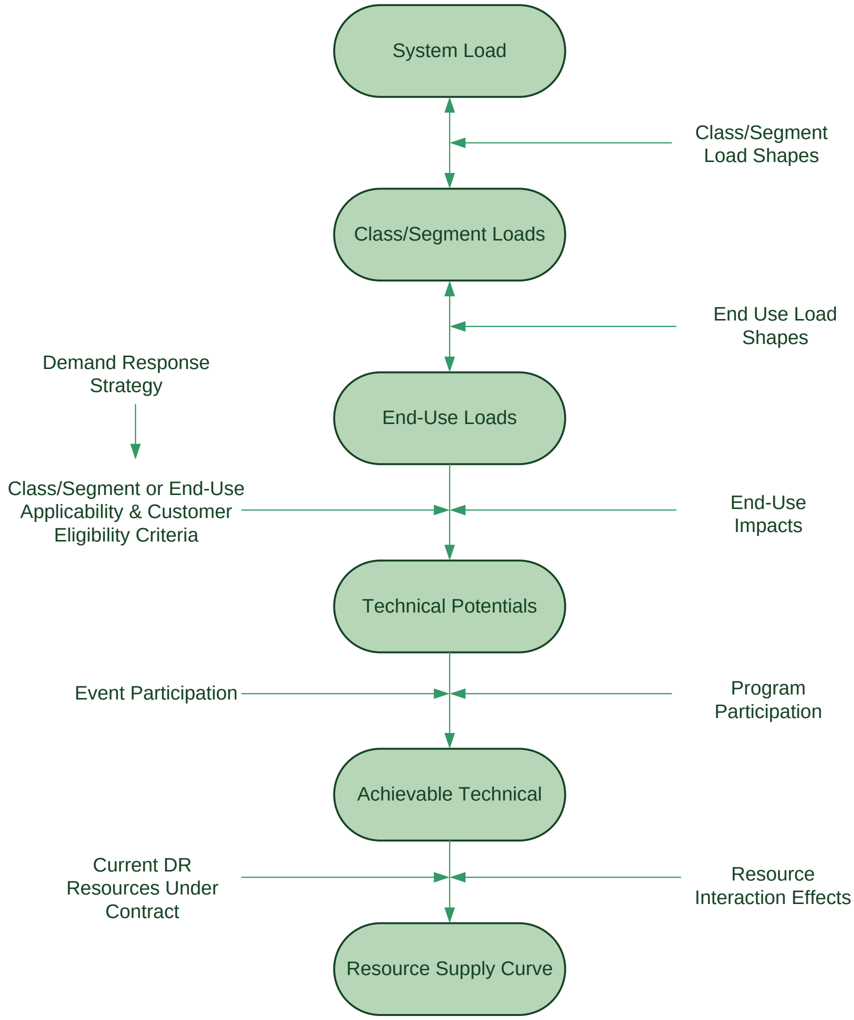
Program options listed above are based primarily on ComEd's existing vetted programs as well as thorough review of literature on DR strategies offered by utilities and regional transmission organizations across the country. For each program offering, data were collected on the offering's main features, such as objectives, program periods, eligibility criteria, curtailment event triggers, incentive structures, and technology requirements. These program options are described in more detail later in this section.

Methodology

The methodology for estimating DR potential was based on a combined "top-down"/"bottom-up" approach. Cadmus's DRPro® Model provided the basic framework for this analysis. As shown schematically in Figure 26, the approach begins with utility system loads, disaggregating them into sector, segment, and applicable end uses. For each DR program (or program component), potential technical impacts are calculated for all applicable end uses. The end-use load impacts are aggregated to obtain estimates of technical potentials. Ranges are assigned to probabilities of program and event participation around expected participation levels with lower and upper bounds based on market knowledge and other utilities' reported results. These market factor ranges are applied to the technical potentials and run through multiple Monte Carlo simulations to obtain the most likely and ranged probability estimates of achievable technical potentials. The methodology for calculating technical and achievable technical potentials is described in detail below.[17]

[17] Note the study does not examine changes in energy use that may occur from demand response programs. Some programs are expected to reduce energy use, while others may primarily lead to load shifting.

Figure 26. Schematic Overview of Demand Response Assessment Methodology



Estimating Technical Potential

DR technical potentials are first estimated at the end-use level, and then are aggregated to market segment, sector, and system levels. This approach was implemented in the following four steps.

1. **Define customer sectors, market segments and applicable end uses**. The first step in the process involved defining appropriate sectors, market segments, and end uses within each segment in accordance with ComEd's requirements. We used the following classification scheme for demand response:

   Customer classes/sectors: residential, commercial, and industrial.

   Market segments:

   1. Residential: single-family and multi-family.
   2. Commercial: education, food service, food stores, health services, office building, retail, warehouse, street lighting, and other commercial.

3. Industrial: fabricated metal products, food manufacturing, plastics and rubber products, and miscellaneous manufacturing.

End uses: central AC, central heat, cooking, cooking oven, cooking range, cooling chillers, direct expansion (DX) cooling, dryers, freezers, heat pumps, auxiliary HVAC, lighting, plug load, pool pump, commercial refrigeration, residential refrigerators, room AC, room heat, commercial space heat, street lighting, water heaters, industrial processes, and other.

2. **Screen customer segments and end uses for eligibility**. This step involved screening end uses for applicability of specific DR strategies. For example, hot water loads in hospitals were excluded (if no backup generation was available).

3. **Compile ComEd-specific sector/end-use loads**. Reliable estimates of DR potential depend on the correct characterization of sector, segment, and end-use loads. Load profiles were developed for each end use. Contributions to system peak for each end use were estimated based on end-use load shapes.

4. **Estimate technical potential**. Technical potential for each DR program is assumed to be a function of customer eligibility in each class, affected end uses in that class, and the expected impact of the strategy on the targeted end uses. Analytically, technical potential (*TP*) for a demand-response program *(s)* is calculated as the sum of impacts at the end-use level (*e*), generated in customer class (*c*), by the program; that is:

$$TP_s = \sum TP_{sce}$$

and

$$TP_{sce} = LE_{cs} \times EUS_{cs} \times LI_{se}$$

where,

- LE_{cs} (load eligibility) represents the percent of customer class loads that are eligible for strategy *s*,
- EUS_{cse} represents the share of end use *e* in customer class *c* eligible for DR strategy *s, and*
- LI_{se} (load impact) is percent reduction in end-use load *e* resulting from program *s*.

Load eligibility thresholds were established by calculating the percent of load by customer class and market segment that met minimum (or maximum) load criteria for each program, based on program filings.

Estimate Achievable Technical Potential

Estimates of expected load impacts resulting from various DR programs (LI_{se}) are based on a comprehensive review and assessment of DR program impacts offered by ComEd and other utilities throughout the United States. Program participation indicates the percent of participating customers, while event participation summarizes the percent of program participation that will participate in any one event.

Develop Supply Curves

Achievable technical potentials for each DR program strategy were combined with per-unit resource costs to produce "cumulative" resource supply curves. The supply curves show price/quantity relationships at the aggregate level. Interactive program impacts were not taken into consideration.

Program implementation costs were researched and documented by our engineering staff. All categories of costs were considered, generally falling into two categories:

1. Fixed program expenses, such as program infrastructure, administration, maintenance, and communication.

2. Variable costs, such as incentive payments to participants, customer-site hardware, customer-specific marketing/recruiting, and metering.

Summary of Resource Potential

Table 14 presents estimated resource potentials for all DR resources for the residential, commercial, and industrial sectors at peak capacity loads. Sector peak represents the average MW capacity over the time of the modeled load basis for each program. Technical potential is the sector peak times the percent of technically eligible load for each program. The achievable technical potential shows the estimate of load reduction over the load basis time period for each program at forecasted program and event participation rates. Achievable technical potential as a percent of sector load peak gives the expected capacity reductions as a result of all DR programs for ComEd.

Technical potential is highest in the residential sector due to the central AC direct load control (DLC) program. However, it has a relatively low achievable potential due to low participation in the program. In the summary table, the moderate participation scenario (10%) for residential DLC is included in the residential subtotal. Cadmus believes this higher than business-as-usual scenario is highly feasible. The residential sector also includes capacity reductions from the real time pricing program. Commercial and Industrial demand response programs include Rider VLR and Rider CLR, which continue to be successful programs for ComEd. Commercial business is the largest load sector for ComEd and has the highest achievable potential with the current programs. The industrial sector has a substantially smaller load than the residential and commercial sectors, yet has the achievable potential as a percent of sector load (10%). This is due to the success of the VLR and CLR Rider programs and the ability for industrial users to cut the most capacity use of all users. As noted previously, the analysis does not account for program interactions and overlap; thus, the actual total would be less than the sum of the individual programs.

Table 14. Technical and Achievable Technical Potential (MW in 2016)

Sector	Sector Peak	Technical Potential	Achievable Technical Potential	Achievable Technical Potential As Percent of Sector Peak
Residential	10,988	9,886	342	3%
Commercial	11,444	3,422	563	5%
Industrial	2,678	1,609	274	10%
Total	**25,110**	**14,917**	**940**	**4%**

Note: Individual results may not sum to total due to rounding.
Note: Interactions between programs have not been taken into account.

Resource Costs and Supply Curves

Utility costs for DR program options can vary significantly. Where possible, cost estimates were developed for each program option based on data available from ComEd and comparable programs across the region and nation. In certain cases, this level of specificity was difficult to establish as many utilities do not track or report program costs in sufficient detail. For example, development of a new DR program can be a significant effort for a utility, requiring enrollment, call centers, program management, load research, development of evaluation protocols, changes to billing systems, and marketing. Adding to the uncertainty is a growing number of independent contractors bidding against each other for a slice of the utilities' installation and administration budget. Background research on utilities across the nation indicated large variations in direct program costs.

In developing estimates of per-unit costs, program expenses were allocated annually over the expected program life cycle (10 years), then were discounted by ComEd's weighted average cost of capital to estimate the total discounted cost. The ratio of this value and the average annual kW reduction produced the levelized per-kW cost for each resource. Additionally, attrition rates were used to account for program turnover due to changes in electric service (i.e., housing stock turnover) and program drop-outs. The basic assumption for this analysis was an attrition rate of 3% for the residential sector and 2% for the commercial sector, based on averaged values experienced by ComEd and other utilities. Attrition requires reinvestment of new customer costs, including technology, installation, and marketing. In addition, the analysis assumed a measure life for the installed technology.

Table 15 displays the per-unit ($/kW-year) costs for the estimated achievable technical potential. Startup costs were not associated with these DR programs, as the infrastructure for them already existed.

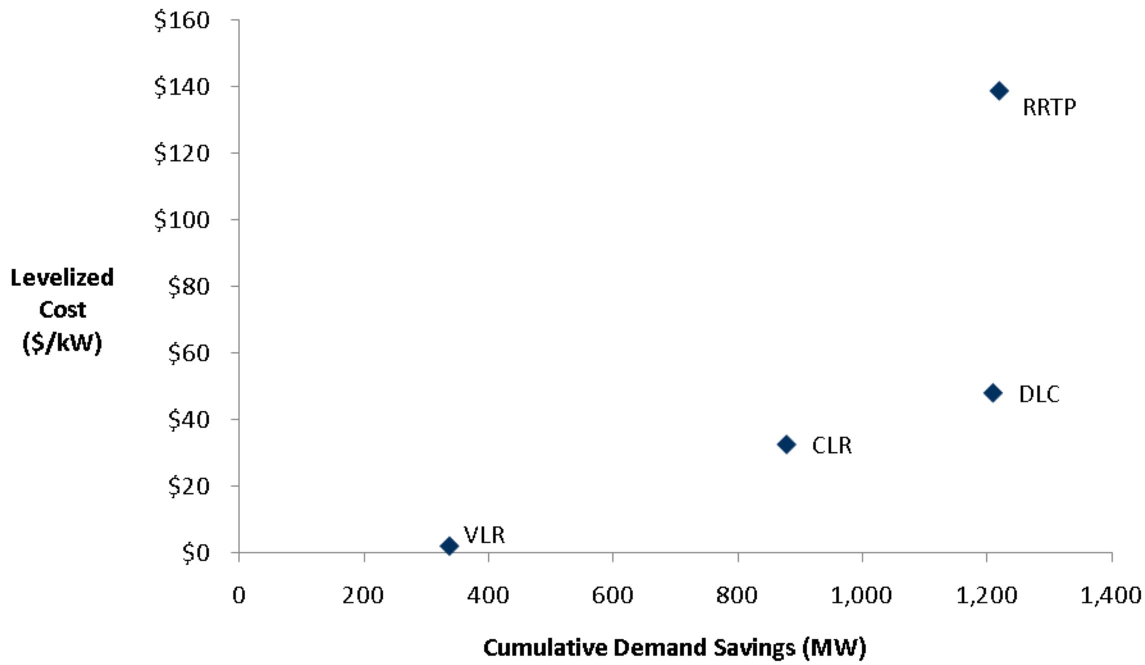
Table 15. Levelized Costs and Achievable Technical Potential (MW in 2016)

Strategy	Technical Potential (MW)	Achievable Technical Potential (MW)	Levelized Cost ($/kW)
Residential Direct Load Control	7,780	332	$48
Residential RTP	2,106	10	$139
C&I Interruptible Tarifs (CLR)	2,817	542	$33
C&I Demand Buyback (VLR)	2,212	336	$2

Note: Individual results may not sum to total due to rounding.
Note: Interactions between programs has not been taken into account.

Supply curves were constructed from quantities of estimated market resource potential and per-unit costs of each resource option. The capacity-focused supply curves, shown in Figure 27 and represent the quantity of each resource (cumulative achievable technical MW) that can be achieved at or below a given cost. Program interactions were not accounted for in this study.

Figure 27. Demand Response Supply Curve (Cumulative MW in 2016)



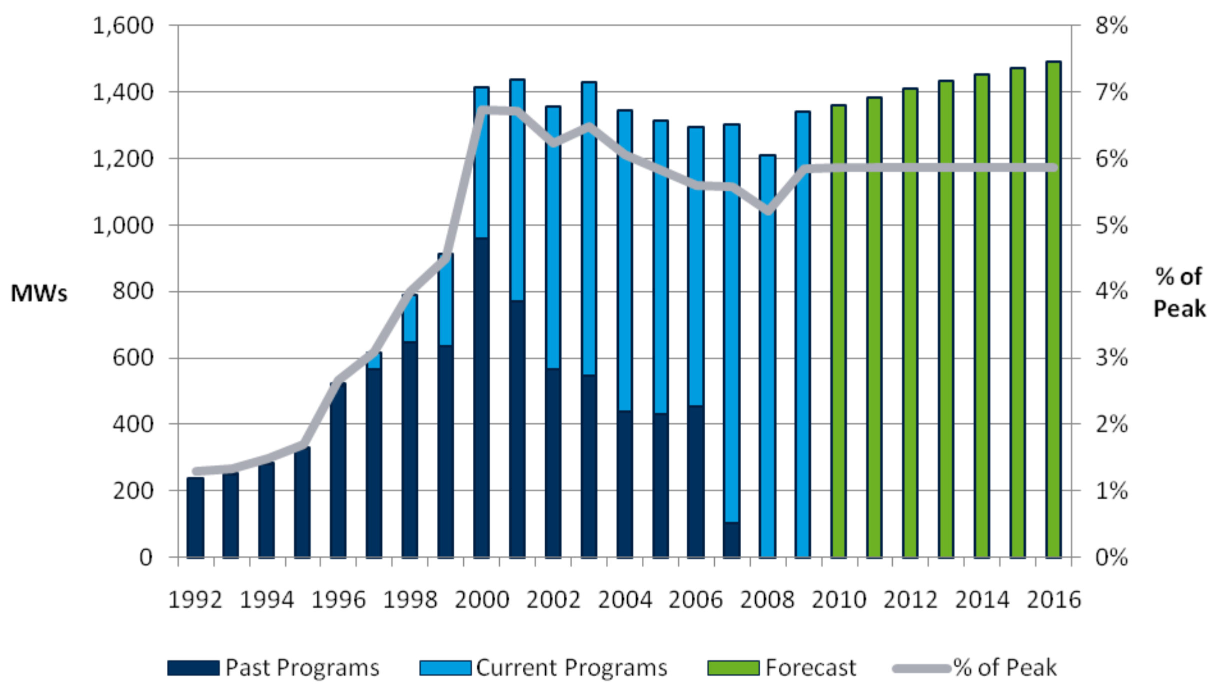
Resource Acquisition Schedule

Each program option has an associated ramping with the general logic that it requires 10 years to grow a new program from inception to full potential. The first three years have relatively slow growth; as more customers become aware of the DR programs, the participation rate will increase; finally, years nine and ten have a slow rate of increase due to the program reaching the maximum number of participating customers. After Year 10, the program levels increase at the rate of forecasted capacity growth only.

All of ComEd's programs, except for Residential RTP, have reached the 10-year saturation point and thus have assumed business-as-usual (BAU) growth matching only the sector capacity growth. The ComEd Residential RTP program, after a four-year pilot, was brought online in 2007 as a four-year program. It is assumed to have a high growth potential through 2010 with a goal of 13,000 customers. After this time, the program's marketing efforts will be reduced while a scheduled review of the program is conducted by the Illinois Commerce Commission. Due to the uncertainty in how the program will continue after the review, it is assumed by Cadmus to have small growth for the remainder of the forecast period. Due to its small relative size as a DR program, the 2010 growth in RRTP savings represents less than 1% of the total forecasted capacity reductions from DR. The bars in Figure 28 show the historical growth of all DR programs (including discontinued programs) as well as the forecasted growth of existing DR programs in megawatts of capacity. The figure also includes a line showing the percent of peak capacity that these DR programs represent. After 2009, the percentage does not increase over the forecast period due to the assumed complete saturation of enrollment in ComEd's DR programs.

Note that this business-as-usual (BAU) scenario assumes the status quo for the program offerings, the current marketing levels, and the regulatory statutes. As discussed for each program, there is still additional growth potential for many programs outside of the business-as-usual scenario. The BAU growth rate scenario is simply used as the baseline for percent penetration and capacity of ComEd's current DR programs. Upper and lower penetration scenarios that include smaller and larger program participation are discussed within each program's section.

Figure 28. DR Capacity Available for Curtailment



Detailed Resource Potentials

Direct Load Control

DLC programs are designed to interrupt specific end-use loads at customer facilities or homes through utility-directed control. When deemed necessary, the utility is authorized to cycle or shut off participating appliances or equipment for a limited number of hours on a limited number of occasions. Customers do not have to pay for the equipment or installation of control systems and are given incentives that are paid through monthly credits on their utility bills. For this type of program, receiver systems are installed on the customer's equipment to enable communications from the utility and to execute controls. Event participation is required once the participant enrolls and the receiver is installed, although malfunctioning equipment can lead to unintended non-participation.

DLC of air-conditioning has emerged as the most common load management program type. This analysis covers ComEd's existing residential AC cycling program, formerly known as Nature First and now known as Smart Ideas Central Air Conditioning Cycling. Values used in modeling have been standardized based on specific operating conditions and parameters provided by ComEd as well as general DR program research.

For the residential DLC program, two options are available to customers who choose to participate:

1. The 50% Option allows cycling off the AC unit for 15 minutes every half hour for no more than 6 hours. An incentive of $5 per month is applied to the customer's energy bill.

2. The 100% Option allows shutting off the AC unit for a continuous block of time lasting no more than 3 hours. An incentive of $10 per month is applied to the customer's energy bill.

Both options allow curtailment events on weekdays, 11am to 8pm, between June and September. Incentives are paid monthly only during the four months available for curtailment and are paid regardless of an event. All participants of the 100% option are available for curtailment at the 50% option level. For both options, receiver equipment switches are attached to the appliance, at no cost to the customer, allowing the machine to cycle or shut-off. A summary of program qualifications are presented in Table 16.

Table 16. Program Qualifications for Residential DLC Air-Conditioning Potential

Program Concept	Qualifications
Customer Sectors Eligible	Multifamily and Single Family Home Owners
End Uses Eligible for Program	Central AC (or Heat Pump)
Customer Size Requirements	N/A
Number of Events	Up to 20 Events per Year

The current program uses two types of meter equipment for communicating with the appliances. Most installed meters consist of only a one-way receiver that triggers the cycling event. A small percentage of customers have two-way communication meters installed that allow event triggering and collection of usage data from the appliance.

The first type of meter is primarily chosen by most utilities, though there is one major drawback. The utility does not receive confirmation that the appliance has actually shut off (i.e., with a one-way communication receiver no signal can be sent back to the utility to confirm the proper load control). This is, however, the least expensive approach.

The second type of meter involves additional charges: a more expensive communication receiver and a data storage charge. Although using these meters is more expensive than the one-way meter approach, two major advantages include improved reliability and future expense savings:

- Notification the equipment has shut off. Utilities have performed evaluation studies and determined not all receivers attached to appliances work properly. Using more switches with two-way communication capabilities would allow ComEd to confirm the appliance shuts off and would allow them to replace any nonfunctional receivers without having to field-test the units.

- As the two-way meter is capable of producing interval data, an evaluation study would be significantly less expensive than initiating a separate end-use load metering study, and far more reliable than relying on secondary data.

Business as Usual

Table 17 shows the estimated future technical and achievable technical potentials by customer class for ComEd's existing 50% option AC cycling program. All customers participating in the 100% option are eligible to be called on for a 50% option event and are also included in this part of the analysis. Achievable technical potential includes an 80% event participation rate based on previous reports of equipment failure rates.

Table 17. Baseline Residential DLC Air-conditioning 50% Option: Technical and Achievable Technical Potential (MW in 2016)

	Sector Peak Load Basis	Technical Potential	Achievable Technical Potential	Achievable Technical Potential as % of 2016 Sector Peak
Multifamily	1,043.6	208.7	1.9	0.2%
Single Family	5,600.7	2,380.3	21.3	0.4%
Total	**6,644.4**	**2,589.0**	**23.2**	**0.3%**

Table 18 shows the estimated future technical and achievable technical potentials by customer class for ComEd's existing 100% option AC cycling program. About 60% of AC cycling participants are enrolled in the 100% option.

Table 18. Baseline Residential DLC Air-conditioning 100% Option: Technical and Achievable Technical Potential (MW in 2016)

	Sector Peak Load Basis	Technical Potential	Achievable Technical Potential	Achievable Technical Potential as % of 2016 Sector Peak
Multifamily	1,046.2	418.5	5.6	0.5%
Single Family	5,614.6	4,772.4	64.1	1.1%
Total	**6,660.7**	**5,190.9**	**69.8**	**1.0%**

Additional Residential DLC Potential

ComEd's current participation rates for the residential DLC program appear low when compared to other utilities. For example, a number of utilities with mature residential DLC programs have up 20 to 30% of the eligible population in their programs, with some utilities reporting up to 50% of the eligible population. ComEd, on the other hand, currently only has about 3% of the eligible population in the program.[18]

Two additional scenarios, therefore, were run in order to examine the potential if program market penetration were increased. A program enrollment of a typical DLC program would be closer to 10% and a higher end successful program can reach 25% of market potential. If marketing efforts were increased and these market penetration percentages were achieved, ComEd's potential savings could be closer to those shown in Table 19. The table combines both multifamily and single family with the same participation rates. The number of customers enrolled in the program must increase over time to meet the same MW reductions due to the increasing efficiency standards of air conditioning units. Based on forecasted federal averages, the savings from each AC unit will have likely decreased by 20 percent in 2016. Note that participation percentages are measured in percent of eligible megawatts, not number of eligible participants.

18 ComEd currently serves about 3.3 million residential customers. Based on the RASS, approximately 54% of customers (1.8 million) own their home and have a central AC or heat pump that only serves their unit, and thus qualify for the program. The current program, however, only has about 60,300 participants.

Table 19. Potential Residential DLC Air-conditioning: Technical and Achievable Technical Potential (MW in 2016)

	Program Participation	Thousands of Customers	Achievable Technical Potential	Achievable Technical Potential as % of 2016 Sector Peak
Baseline	2.8%	80	93	1.4%
Medium	10%	285	332	5.0%
High	25%	713	830	12.5%

Program Cost

Annual levelized program costs to achieve the baseline savings of 93 MW in 2016 (23.2 MW from 50% Option and 69.8 MW from 100% Option) are $4.7 million dollars. This equates to $48 per kilowatt savings over the forecast period. This includes replacing customers who drop out and growing the customer base to meet forecasted reduction goals. A detailed list of cost and program assumptions is shown in Appendix F.

Real-Time Pricing (RTP)

Generally, under RTP programs, electricity prices vary each hour according to the expected marginal cost of supply and are typically established one day ahead of the time the prices are in effect. RTP programs utilize electricity wholesale prices, which change throughout the day. Programs can vary in how they notify customers of expected prices and can utilize day-ahead or hour-ahead price forecasts. Notification of the forecasted price schedule can occur via the Internet, text (SMS) messages, phone, or special technology-enabled devices (Internet- or radio-based devices).

ComEd's Residential RTP program uses a website to post day-ahead prices and real time hourly prices from the PJM ISO. Customers have the option to be notified via email, text (SMS) message, or automated phone call when day-ahead or real-time prices reach a threshold value selected by the customer (10 or 14 cents per kWh). While day-ahead prices can be used to plan the next day's energy use in the home, customers must pay the real time day-of hourly price which may differ.

A commonly cited reason for utilities introducing RTP is to build customer satisfaction and loyalty by providing an opportunity for customers to realize bill savings. Some programs incorporate a two-part rate, where only the difference in actual versus expected usage is subject to real-time prices. Additionally, programs can include price protection that enables RTP customers to manage their exposure to volatile prices. Many newer programs have unbundled the electricity commodity from transmission and distribution services, and the electricity component is priced according to hourly energy prices.

At this point, residential RTP is not widely implemented by utilities. In 2006, the state of Illinois was the first to pass legislation requiring large investor-owned utilities to offer residential RTP to all customers. After a four year pilot program, ComEd launched their first full-scale program in the spring of 2007. One important thing to note in RTP programs is, while a few programs have been very successful, it can be difficult to attract participants. Unfamiliar billing, a 12 month contract, the requirement to micro-manage energy use, an extra metering fee, and no guarantee of bill savings can dissuade residential customers from enrolling. ComEd's program is open to all individually metered residential customers, but only 8,244 are enrolled and 7,653 were actively participating at the end of the 2009 year (about 0.2% of households).

An interesting component of the ComEd RTP program is the option for customers to link their AC cycling with real time electricity prices. Customers who are enrolled in both the ComEd Residential DLC program and ComEd Residential RTP can combine the two to potentially increase savings even further. Called the Load Guard Automated Price Response Service, customers choose an hourly price (10 or 14 cents per kWh) for which their AC units cycle off and on. The AC unit will cycle every fifteen minutes for a two-hour period when the price trigger notifies the AC switch. While very few customers (around 670) have enrolled in this combo option, it has the greatest potential for reducing load with the least amount of customer micro-management. Since the same incentives are paid to DLC AC cycling customers as customers with Load Guard, no additional incentive costs are incurred by the utility but the capacity load is reduced much more significantly than with DLC AC cycling events alone. For comparison, the DLC AC cycling program has averaged 1.1 events per summer, while the Load Guard program has averaged over 137 events per summer for the 10 cent option and 42 events for the 14 cent option. Because of the program's greater ability to give more measurable results, the potential reductions for this specific Load Guard program is included below.

A summary of program qualifications for the Residential RTP Program with and without Load Guard are presented in Table 20 and Table 21.

Table 20. Program Qualifications for Residential RTP

Program Concept	Qualification
Customer Sectors Eligible	All Residential Customers
End Uses Eligible for Program	Total Load of All End Uses
Customer Size Requirements	None
Number of Events	N/A

Table 21. Program Qualifications for Residential RTP with Load Guard

Program Concept	Qualification
Customer Sectors Eligible	Multifamily and Single Family Home Owners
End Uses Eligible for Program	Central AC (or Heat Pump)
Customer Size Requirements	None
Number of Events	Up to 120 Hours per Year

Currently, 5.0 MW of potential capacity are enrolled in ComEd's Residential RTP program. About 9% of this load is enrolled in the Load Guard program, or 0.45 MW. At our assumed capacity growth rate for this program (as described in the Resource Acquisition Schedule section of this report), a potential of 8.6 MW Residential RTP capacity and 0.9 kW Load Guard capacity is achievable by 2016. Using the same efficiency gain assumptions as described for the DLC program, this equals about 1,180 customers enrolled in Load Guard and 14,440 enrolled overall.

Table 22 shows there is 3,003.6 MW of technical potential for ComEd's RRTP program, with 9.5 MW of market potential.

Table 22. Residential RTP Load Guard: Technical and Market Potential (MW in 2016)

	Sector Peak Load Basis	Technical Potential	Achievable Technical Potential	Achievable Technical Potential as % of 2016 Sector Peak
Load Guard	5,404.0	2,105.7	0.9	<0.1%
RRTP w/o Load Guard	5,404.0	3,003.6	8.6	0.2%
Total	**5,404.0**	**3,003.6**	**9.5**	0.2%

Program Cost

High administration, marketing and contractor costs, coupled with low growth assumptions for the program, have caused a high levelized cost. The annual levelized cost was calculated at a rate of $139/kW for ComEd's Residential RTP program. This includes the Load Guard customers as well as regular RRTP participants without Load Guard. A detailed list of cost and program assumptions is shown in Appendix F.

Interruptible Loads (Capacity-Based Load Response)

Interruptible load response (ILR) programs refer to contractual arrangements between the utility and its customers, typically nonresidential customers who agree to curtail or interrupt their operations, in whole or part, for a predetermined period when requested by the utility. In most cases, mandatory participation or liquidated damage agreements are required once the customer enrolls in the program; however, the number of curtailment requests, both in total and on a daily basis, is limited by the terms of the contracts. ComEd's program is known as Rider CLR7 or Capacity-Based Load Response (CLR). Any commercial or industrial customer who can commit 100 kW or more of load reduction at the time of an event is eligible for the program. While this program has historically had many incarnations, going forward it will fall under the PJM ISO guidelines of a PJM Capacity-Based Load Response program.

Customers who choose to enroll are paid for their participation in individual events at the rate of their load reduction from their typical operating conditions multiplied by the market price of the avoided capacity. These rates can vary per depending on the market and the customer's specific CLR contract. Contracts require customers to curtail their connected load by a set wattage (e.g., reduce total load by 100 kW) or a predetermined level (e.g., reduce load to 900 kW), depending on the contract. Additional reductions beyond the contracted value will not receive compensation. Customers who fail to reduce their load when an event is called are responsible for any penalties or other economic consequences assessed by PJM or ComEd.

In this study, it is assumed nonresidential customers with a monthly demand of at least 200 kW for industrial users and 400 kW for commercial users would be technically eligible for such a program. General program qualifications for CLR program eligibility are shown in Table 23.

Table 23. Program Qualifications for Interruptible Nonresidential Potential (CLR)

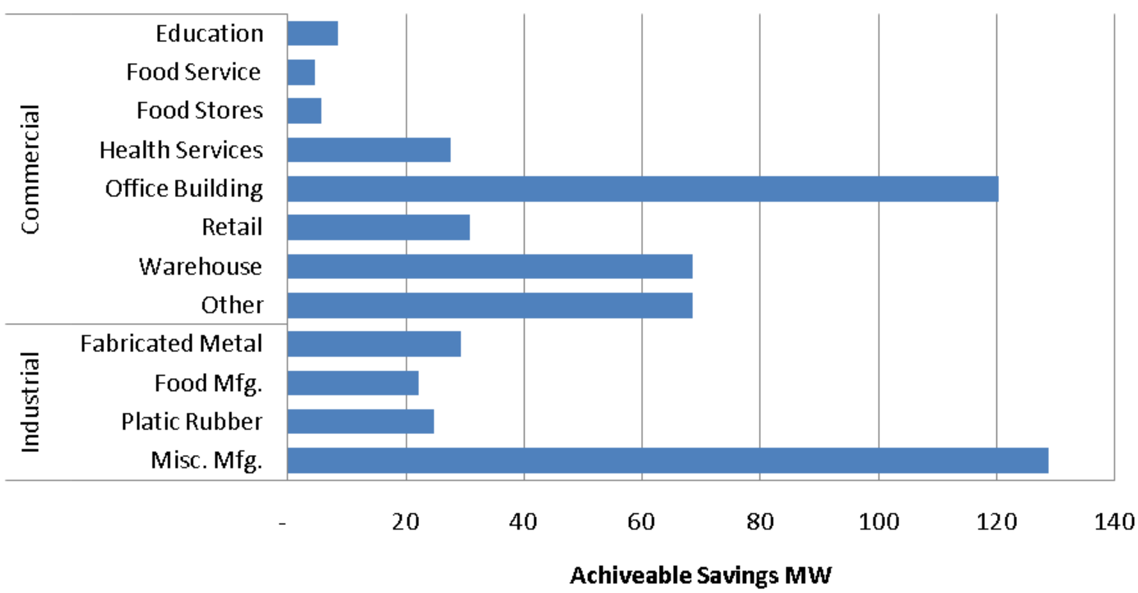
Program Name	Assumptions
Customer Sectors Eligible	Nonresidential
End Uses Eligible for Program	Total Load of All End Uses
Customer Size Requirements	Ability to reduce 100 kW or more
Event Timing	Up to 15 Events per Year (10 PJM + 5 ComEd)

In 2009, ComEd reported a total of 433 MW of available capacity in the CLR Program. Assuming program growth will follow forecasted nonresidential load growth, in 2016 there will be an estimated 2,817 MW of technical potential and 542 MW of achievable technical potential in 2016, totaling 4.7% of ComEd's 2016 nonresidential peak load (Table 24). This potential is largely in office buildings (120 MW) and manufacturing facilities (129 MW) (Figure 29). This is based on a one time, two hour event (much like a performance test audit event).

Table 24. CLR Technical and Achievable Technical Potential (MW in 2016)

	Sector Peak Load Basis	Technical Potential	Achievable Technical Potential	Achievable Technical Potential as % of 2016 Sector Peak
Commercial	6,863	1,718	336	3.0%
Industrial	2,203	1,101	206	7.6%
Total	**9,066**	**2,817**	**542**	**4.7%**

Figure 29. CLR Achievable Technical Potential by Sector (MW in 2016)



Uncertainty Regarding CLR Potential

It is important to know that in addition to ComEd, private curtailment service providers (CSPs) also offer incentives for ILR programs. In September 2009, there were a number of CSPs (including ComEd) serving the ComEd service territory with a reported 1,553 MW of unique available capacity.

ComEd's ILR program incentives are based on the PJM Base Residual Auction (BRA) capacity market. A PJM system-wide auction is held annually in which additional load capacity is submitted and chosen by PJM. The bidders, which include utilities and private CSPs, can place capacity on the market out three years, with the most recent auctions going out to 2012/2013. For a number of reasons, including the variety and volume of capacity providers, as well as the shift of old ILR programs into the market, the clearing price of this capacity can change through the auction period and will be unknown past that period. The latest auction included a much higher supply to the market than previous years due partly to new capacity from DR and EE resources coupled with the elimination of the old ILR alternative. This increased supply and decreased demand from preliminary peak load forecasts caused a dramatic drop in the BRA price, from $93.54/MW-day for 2011/2012 to $16.64/MW-day for 2012/2013. Cadmus believes this price will recover in future years as supply comes in line with demand.

This makes incentive levels for ComEd's customer variable over the forecast period, and Cadmus has done its best to use reasonable target numbers for future incentive pricing. The result of the auctions will determine future participation and returns of the program across PJM, ComEd's territory, and the number of customers who use ComEd as their curtailment service provider. It is possible that as incentives decrease (as seen in the 2012/2013 auction) privately-held CSPs will find less profit in managing ILR programs, and customers will select ComEd as their curtailment service provider. Forecasting future PJM prices, and the impacts of this price elasticity, are outside the scope of this project, and ComEd participation is assumed to follow forecasted load growth for nonresidential customers going forward.

Program Cost

The nominal levelized per year of continuing this program over the forecast period is expected to be about $15.9 million for a savings of 542 MW. This equates to approximately $33 per kilowatt peak load reduction. A detailed list of cost and program assumptions is shown in Appendix F.

Demand Buyback (Voluntary Load Response)

Under demand buyback (DBB) or demand bidding arrangements, the utility offers payments to customers for reducing demand when requested by the utility. Under these programs, customers remain on a standard rate, but they are presented with options to bid or propose load reductions in response to utility requests. The buyback amount generally depends on market prices published by the utility ahead of the curtailment event, and the reduction level is verified against an agreed-upon baseline usage level. At ComEd, the Rider VLR7, or Voluntary Load Response, most closely resembles a DBB program.

DBB is a mechanism enabling consumers to actively participate in electricity trading by offering to undertake changes in their normal consumption patterns. Participation requires the flexibility to make changes to their normal electricity demand profile, install the necessary control and monitoring technology to execute the bids, and demonstrate bid delivery. One of several Internet-based programs is generally used to disseminate information on buyback rates to potential customers, who can then take the appropriate actions to manage their peak loads during requested events. The ComEd program option in this analysis targets a wide range of small to large commercial and industrial customers. As a broad cut-off, Cadmus uses a minimum of 50 kW peak capacity per customer to use in the model.

Unlike curtailment programs, customers have the option to curtail power requirements on an event-by-event basis. Incentives are paid to participants for energy reduced during each event, based primarily on the difference between market prices and utility rates. In many ways, ComEd's VLR program is much like its CLR program but with less stringent requirements and load response contracts.

Compared with most other utilities, ComEd has a low minimum load reduction criterion of 10 kW. Consequently perhaps, program participation has been much higher than in other areas of the country. Their VLR program participants account for about 3.5% of its peak demand, while most other utilities are estimated to be less than one percent. Of course, participation in these programs is highly effected by market energy prices and can fluctuate from year to year. General program qualifications for eligibility are shown in Table 25.

Table 25. Program Qualifications for DBB (VLR) Potential

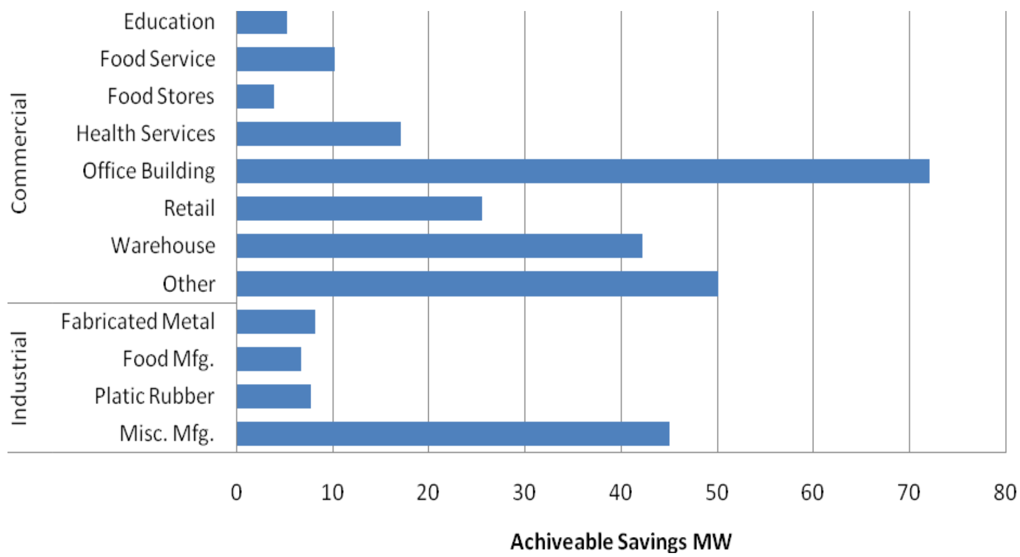
Program Name	Assumptions
Customer Sectors Eligible	All Non-Residential Market Segments
End Uses Eligible for Program	Total Load of All End Uses
Customer Size Requirements	Ability to reduce 10 kW or more
Number of Events	Unlimited Number of Events (1 to 8 hours each)

Table 26 shows that at peak demand, about 294 MW of achievable technical potential can be expected during a six-hour event call in 2016. This assumes a participation rate of 38% based on the most recent event call in 2006. It is assumed that close to 800 MW of capacity is on the enrollment sheets but most will not participate in the event.

Table 26. Demand Buyback (VLR): Technical and Achievable Technical Potential (MW in 2016)

	Sector Peak Load Basis	Technical Potential	Achievable Technical Potential	Achievable Technical as % of 2016 Peak
Commercial	10,802	1,704	227	2.1%
Industrial	2,730	508	68	2.5%
Total	**13,532**	**2,212**	**294**	**2.2%**

Figure 30. Demand Buyback (VLR): Achievable Technical Potential by Sector (MW in 2016)



Program Cost

Because participants are paid based on market energy rates and minimal administration costs are incurred, this program's total cost is lower than most DR programs. At an estimated levelized cost of $2/kW-year, this is ComEd's most cost effective program. New customer costs include hardware, marketing and program administration and all are relatively low. New participant costs must be reinvested due to a 2% annual attrition rates and a hardware life of 10 years. Incentives are paid based on real time electricity pricing and can vary greatly throughout the year and the forecast period. A detailed list of cost and program assumptions is shown in Appendix F.