Hometown People. Hometown Power.

Demand-Side Management Potential Study

FINAL REPORT- MAY 7, 2020

prepared for

LANSING BOARD OF WATER & LIGHT

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prepared by

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1 Executive Summary

1.1 BACKGROUND

Lansing Board of Water and Light (BWL) and GDS Associates, Inc. (GDS) coordinated to complete this assessment of demand-side management (DSM) potential in the BWL service area. This study presents the future potential for electric energy efficiency and demand response programs, combined heat and power (CHP) equipment, distributed solar generation and electric vehicles (EV) in the BWL service area. The results of this study have been used as inputs to BWL's 2020 Integrated Resource Plan (IRP).

In addition to technical and economic potential estimates, the development of achievable potential estimates for a range of feasible DSM measures is useful for program planning and modification purposes. Unlike achievable potential estimates, technical and economic potential estimates do not include customer acceptance considerations for DSM measures, which are often among the most important factors when estimating the likely customer response to new programs. For this study, GDS produced the following estimates of potential for energy efficiency and demand response measures:

- ***Technical Potential***
- ***Economic Potential***
- ***Achievable Potential***

Definitions of the types of energy efficiency potential[1] are provided below.

TECHNICAL POTENTIAL is the theoretical maximum amount of energy use that could be displaced by DSM measures, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency or demand response measures.

ECONOMIC POTENTIAL refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources. Both technical and economic potential ignore market barriers to ensuring actual implementation of efficiency. Finally, they only consider the costs of efficiency measures themselves, ignoring any programmatic costs (e.g., marketing, analysis, administration) that would be necessary to capture them. Cost effectiveness screening was based upon the results of the Total Resource Cost (TRC) Test. Measure level cost effectiveness screening included measure incremental costs and excluded program management and administrative costs.

ACHIEVABLE POTENTIAL is the amount of energy use that cost-effective DSM measures can realistically be expected to displace assuming different market penetration scenarios for DSM measures. An aggressive scenario, for example, could provide program participants with payments for the entire incremental cost of energy efficient equipment. This is often referred to as "maximum achievable potential." Achievable potential considers real-world barriers to convincing end-users to adopt cost effective DSM measures, the non-measure costs of delivering programs (for administration, marketing, tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time. Achievable savings potential savings is a subset of economic potential. This study assessed three

[1] These definitions are from the November 2007 National Action Plan for Energy Efficiency "Guide for Conducting Energy Efficiency Potential Studies"

achievable potential scenarios for the energy efficiency analysis. The parameters of these scenarios are described below.

***Scenario No. 1 – 100% TRC*.** For the first scenario, achievable potential represents the amount of energy use that efficiency can realistically be expected to displace assuming incentives equal to 100% of the incremental measure cost. Cost effectiveness of measures was determined with the TRC test.

***Scenario No. 2 – 50% TRC*.** For the second scenario, achievable potential represents the amount of energy use that efficiency can realistically be expected to displace assuming incentives equal to 50% of the incremental measure cost. Cost effectiveness of measures was determined with the TRC test.

***Scenario No. 3 – PB TRC*.** For the third scenario, achievable potential represents the amount of energy use that efficiency can realistically be expected to displace assuming incentives set based on BWL buying down payback levels to 5 years in the residential sector and to 2 years in the commercial and industrial (C&I) sectors. Cost effectiveness of measures was determined with the TRC test.

1.2 SCOPE

The study examines the potential to change electric consumption patterns and peak demand through the implementation of energy efficiency, demand response, distributed solar photovoltaic (PV) generation, CHP equipment and EV technologies by residential, commercial, and industrial electric customers in the BWL service area. This study assesses DSM potential in this area over a twenty-year period, from 2021 through 2040.

The main objective of this study was to evaluate the DSM technical, economic and achievable potential for BWL, based upon cost effectiveness screening with the TRC benefit/cost test. Figure 1-1 below provides a graphical representation of the relationship of the various definitions of DSM potential.

FIGURE 1-1 TYPES OF DSM POTENTIAL[2]

Not Technically Feasible	TECHNICAL POTENTIAL		
Not Technically Feasible	Not Cost-Effective	ECONOMIC POTENTIAL	
Not Technically Feasible	Not Cost-Effective	Market & Adoption Barriers	ACHIEVABLE POTENTIAL

1.2.1 Limitations to the scope of study

As with any assessment of DSM potential, this study necessarily builds on a large number of assumptions and data sources, including the following:

- DSM measure lives, measure savings and measure costs. The data sources for these assumptions are provided in the appendices of this report. The key data source for these assumptions was the Michigan Energy Measures Database (MEMD).
- The discount rate for determining the net present value (NPV) of future savings (4.66%)

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

- Projected penetration rates for DSM measures
- Projections of BWL specific electric avoided costs for generation, transmission and distribution (T&D)
- Future changes to current energy efficiency codes and standards for buildings and equipment

While the GDS Team has sought to use the best and most current available data, there are many assumptions where there may be reasonable alternative assumptions that would yield somewhat different results. Furthermore, while the lists of DSM measures examined in this study are lengthy and represent most commercially available measures, these measure lists are not exhaustive.

With respect to non-energy benefits of DSM programs, GDS did not place a value on reductions in power plant emissions of carbon dioxide (CO_2) or other emissions reductions resulting from the implementation of DSM programs.

Finally, no dollar value was placed on difficult to quantify benefits arising from installation of some DSM measures, such as increased comfort or increased safety, which may in turn support some personal choices to implement particular measures that may otherwise not be cost-effective or only marginally so.

The DSM potential estimates for energy efficiency, demand response, CHP, distributed solar generation and EVs are summarized below.

1.3 RESULTS--ENERGY EFFICIENCY

This electric energy efficiency potential study provides a foundation for the continuation of utility-administered programs in the BWL service area and provides estimates of the remaining opportunities for cost effective electricity savings for the BWL service area. This report presents results of the technical, economic and achievable potential for electric energy efficiency measures in the BWL service area for two-time periods:

- The ten-year period from January 1, 2021 through December 31, 2030
- The twenty-year period from January 1, 2021 through December 31, 2040

This study examined several hundred electric energy efficiency measures in the residential, C&I sectors combined.

Figure 1-2 shows that Technical Potential approaches 43% over the next 20 years, while Economic Potential exceeds 24%. The Achievable Potential ranges from 13% to 19% over the next 20 years. It is important to note that these estimates of energy efficiency potential do not include energy efficiency savings from measures installed in the past through BWL's programs.[3]

[3] BWL data indicates that the impacts of past BWL energy efficiency programs have reduced annual BWL retail MWh sales by approximately ten percent.

FIGURE 1-2 ENERGY EFFICIENCY POTENTIAL SAVINGS SUMMARY

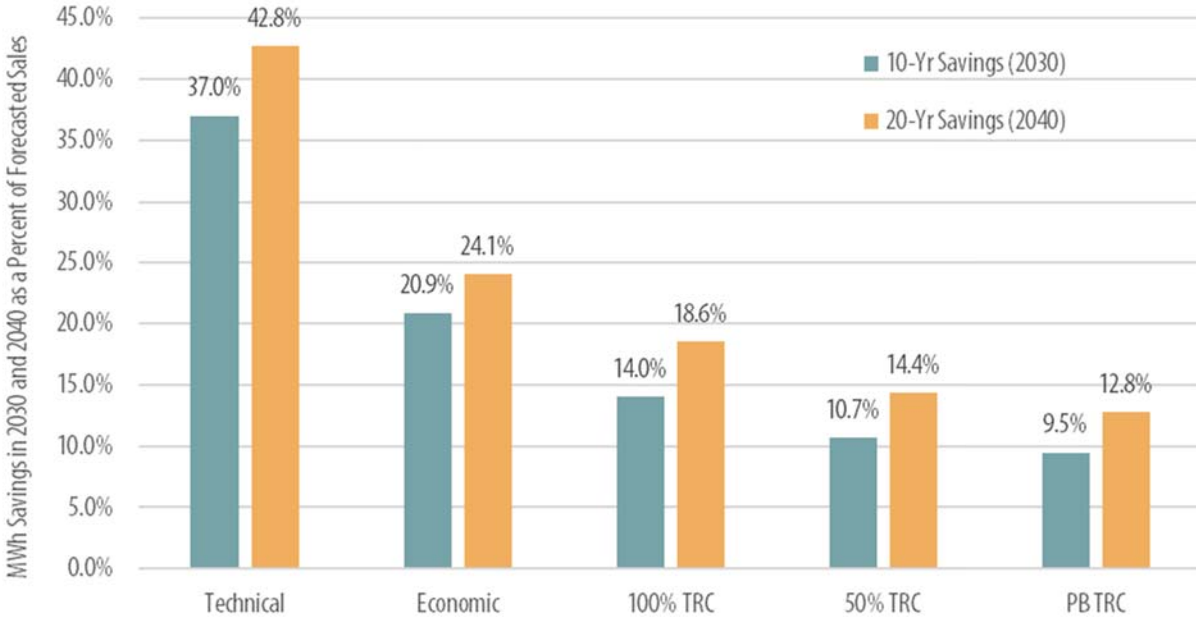


Table 1-1 and Table 1-2 present additional detail on the energy efficiency savings potential for all scenarios over a period of and 10 and 20 years, respectively. The cumulative annual Achievable Potential ranges from 212,000 to 314,000 MWh over the next 10 years in all three scenarios, and ranges from 291,000 to 424,000 MWh over 20 years.

TABLE 1-1 10 YEAR ENERGY EFFICIENCY POTENTIAL SUMMARY – ENERGY AND DEMAND

	Technical	Economic	100% TRC	50% TRC	PB TRC
Electric MWh Savings as % of Sales Forecast					
Savings % - Residential	33.8%	20.6%	11.3%	8.3%	10.2%
Savings % - Commercial	40.5%	21.5%	15.3%	12.0%	9.1%
Savings % - Industrial	30.3%	19.3%	14.1%	10.3%	9.6%
Savings % - Total	37.0%	20.9%	14.0%	10.7%	9.5%
Electric MWh Savings					
Savings MWh - Residential	207,131	126,057	69,362	50,945	62,563
Savings MWh - Commercial	513,773	272,824	194,260	151,663	115,365
Savings MWh - Industrial	108,704	69,442	50,615	36,910	34,466
Savings MWh - Total	829,607	468,323	314,237	239,517	212,394
Electric Summer Peak Savings					
Savings MW - Residential	44	19	11	8	9
Savings MW - Commercial	104	45	31	21	18
Savings MW - Industrial	20	13	9	7	6
Savings MW - Total	168	77	51	36	34

TABLE 1-2 20 YEAR ENERGY EFFICIENCY POTENTIAL SUMMARY – ENERGY AND DEMAND

	Technical	Economic	100% TRC	50% TRC	PB TRC
Electric MWh Savings as % of Sales Forecast					
Savings % - Residential	34.7%	18.5%	14.4%	10.1%	12.6%
Savings % - Commercial	48.8%	27.4%	21.3%	16.8%	12.9%
Savings % - Industrial	34.9%	21.7%	16.1%	13.2%	12.4%
Savings % - Total	42.8%	24.1%	18.6%	14.4%	12.8%
Electric MWh Savings					
Savings MWh - Residential	220,078	117,119	91,364	63,822	80,167
Savings MWh - Commercial	632,186	355,291	275,642	217,873	167,216
Savings MWh - Industrial	124,338	77,147	57,191	46,919	44,012
Savings MWh - Total	976,602	549,557	424,198	328,614	291,395
Electric Summer Peak Savings					
Savings MW - Residential	55	20	16	12	13
Savings MW - Commercial	128	59	45	32	26
Savings MW - Industrial	23	14	10	9	8
Savings MW - Total	206	93	72	52	47

Section 4 of this report provides sector specific details about the electric energy efficiency savings potential in the BWL service area by 2040.

1.4 RESULTS--DEMAND RESPONSE

The demand response ("demand response" or "DR") potential analysis provides a roadmap for the BWL as it develops additional strategies and programs for reducing the forecast of peak summer electric demand in the BWL service area. This demand response analysis examined a comprehensive set of demand response program options and presents the cost, benefits and potential summer peak demand reductions associated with each demand response program option. Demand Response is defined as changes in electric usage by retail customers from their normal consumption patterns in response to changes in the price of electricity over various time periods, or in response to incentive payments designed to induce lower electricity use at times of peak electric demand[4]. GDS used a systematic, bottom-up approach (at the customer segment and end use level) to develop estimates of demand response potential for both the residential and non-residential (C&I) sectors. This study provides annual estimates of demand response potential for the period 2021-2040.

The key objectives of this study include:

1. Conduct a 20-year bottom-up demand response potential study to determine the technical, economic and achievable potential of specific demand response program options to reduce summer peak demand for electricity in the BWL service area.
2. Identify the costs and benefits of all cost-effective demand response programs.
3. Identify the total and incremental annual demand response program budget that would be required to acquire all achievable cost-effective demand response potential.

[4] Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them. A Report to the US Congress Pursuant to Section 1252 of the Energy Policy Act of 2005. Feb 2006.

Table 1-3 shows a high-level summary of the demand response potential that GDS identified. Cumulative annual demand response potential for years 5, 10, 15 and 20 of the analysis are shown. The only demand response program determined to be achievable and cost effective according to the TRC Test is the non-residential Critical Peak Pricing Program with enabling technology.[5]

TABLE 1-3 TECHNICAL, ECONOMIC, AND ACHIEVABLE POTENTIAL FOR DEMAND RESPONSE

	2025 Potential (MW)	2030 Potential (MW)	2035 Potential (MW)	2040 Potential (MW)
Technical	136	137	138	138
Economic	48	48	48	49
Achievable	11	12	12	12

1.5 RESULTS--DISTRIBUTED ENERGY RESOURCES

Siemens (a subcontractor to GDS for this study) projected the distributed solar (DS) penetration using a bass-diffusion model. The Siemens model can incorporate multiple inputs including federal and state tax credits, incentive payments, tax savings on loan interest, retail electricity prices, debt/value ratio, financing parameters, marginal tax rates, and forecasted DS capital costs. Three scenarios were developed:

- A Reference Case that was based on historical market penetration and other local documented market conditions.
- A High Penetration Case, where Siemens developed paybacks with low future installation cost scenarios.
- A Low Penetration Case, where Siemens developed paybacks with high future installation cost scenarios.

Section 6.2 presents detailed payback values by sub-period for the Low, Reference and High Penetration Case Scenarios. The High Penetration Case shows a trend where the payback period decreases over time. The other two cases do not show this trend due to the impact of the Investment Tax Credit (ITC) with respect to relatively higher installation cost scenarios.

The paybacks are longer for the residential market than for the commercial market, reflecting the historically lower average system size installed under the BWL program, and the higher assumed installation costs. In the Low Penetration Case, estimated payback values exceed the expected useful life of 25 years in all periods except the 2031 to 2040 period, where it is estimated at 9 years. For the Reference Case, estimated payback values are below the expected useful life in the current period (2015-2019) at 21 years, dropping to 9 years in the 2031 to 2040 period. In the High Penetration case, estimated payback values begin at the same level as in the reference case in the current period but decrease at a higher rate to 3.5 years in the 2031-2040 period.

The MPSC is also considering an alternative tariff to net metering based on inflow and outflow. In the Inflow/Outflow scenario, the PV owner would benefit from offset consumption at avoided retail rates but sell excess generation at the equivalent of the utility's avoided costs. Because avoided costs are lower than retail rates, this would make a PV project's economics less favorable than the current net metering tariff. Siemens modeled three Inflow/Outflow scenarios at the current installation cost incentive ($500

[5] GDS defined enabling technology as a smart controllable thermostat for this analysis.

per kilowatt up to $2,000), at zero incentive, and at a high incentive ($1000 per kilowatt up to $4000). The estimated market penetrations from these alternative program designs, however, were mixed and generally less favorable than the current program.

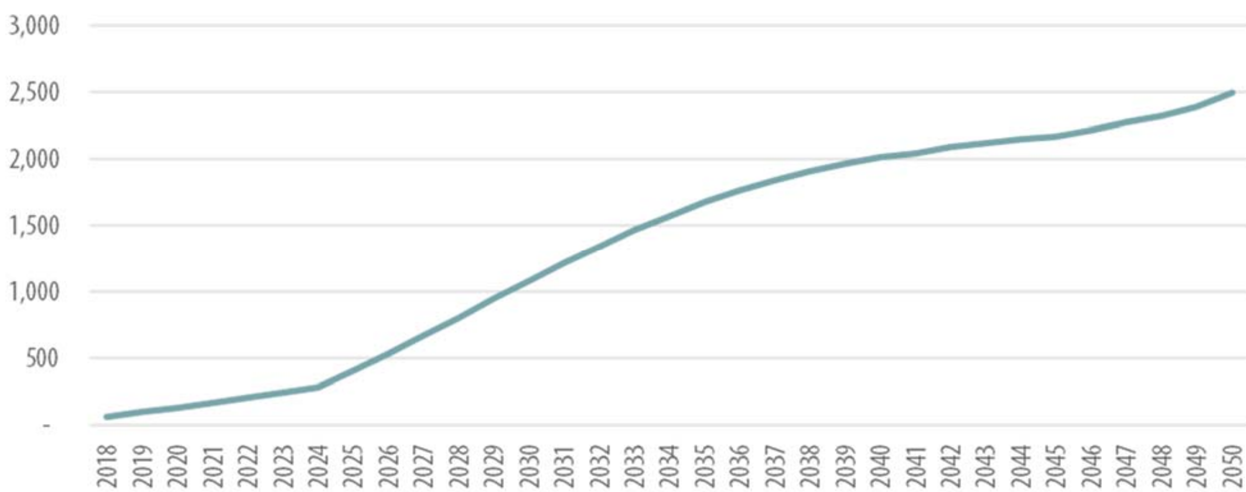
1.6 RESULTS--ELECTRIC VEHICLES

Siemens forecasted the energy and load impacts of increased EV adoption within the service territory of the BWL throughout the forecast period. Using deterministic methods to develop the forecasted estimates, Siemens estimated penetration forecasts for three EV adoption cases defined as:

1. The reference case (Siemens)
2. A high case (Bloomberg New Energy Finance (BNEF)), and
3. A low case (Energy Information Administration (EIA)).

Siemens also estimated the EV load impacts for each associated forecast for integration into BWL's core electric load forecast. Annual adoption rates of EVs, including plug-in electric (PEV) light-duty vehicles (LDVs), commercial trucks, transit buses, school buses and other buses in the BWL territory are presented in Figure 1-3 below. The adoption of EVs is expected to accelerate the fastest for LDVs as the reference case forecast of annual PEV sales. More results can be found in Section 7.

FIGURE 1-3 BWL REFERENCE CASE LDV PEV SALES, NUMBER OF VEHICLES



1.7 RESULTS--COMBINED HEAT AND POWER

GDS completed a literature search of existing CHP potential studies for Michigan. GDS found two recent CHP potential studies for Michigan, one completed by the U.S. Department of Energy (DOE) in March 2016 and one completed by the Michigan Energy Office in February 2018. The amount of statewide CHP technical potential in Michigan reported in these two studies ranged from 722 MW to 4,291 MW.[6] GDS also examined the current cost effectiveness of new CHP equipment in the BWL service area given BWL's most recent forecast of its avoided costs of electricity. GDS determined that the most common types of CHP equipment are not cost effective at this time in the BWL service area given BWL's very low avoided costs of electricity. ***At this time, none of the 78 CHP equipment types fueled by natural gas, biomass, biogas, hydrogen, propane or diesel are cost effective in the BWL service area according to screening***

[6] Note that estimates of technical potential do not consider cost effectiveness.

with the TRC test. This situation could change in the future if forecasts of the avoided costs of electricity increase significantly or if capital and operating costs of CHP equipment decrease significantly, or both. The main reason that new CHP equipment is not cost effective in the BWL service area at this time is due to the relatively low BWL electric avoided costs of capacity and energy.

In 2018, BWL retail electricity sales totaled 2,119,742 MWh. Total state of Michigan MWh sales to electricity consumers totaled 101,899,093 MWh in 2017. Thus, BWL's annual electricity sales are approximately 2.1 percent of statewide electricity sales. If BWL's share of statewide CHP potential follows its share of annual MWh sales, BWL's CHP technical potential ranges from 15.2 to 90.1 MW.

Chapter 9 presents GDS' program recommendations along with projections of the potential cumulative annual MWh savings, utility costs and MWh acquisition costs for each recommended program. Chapter 10 describes how the energy efficiency measures were grouped together in Bins based upon cost effectiveness criteria. These energy efficiency Bins were then analyzed by BWL's integrated resource planning model. The data tables in Chapter 10 present projections of the cumulative annual MWh savings potential for each Bin for the period 2021 to 2040. Chapter 10 also discusses the amount of energy efficiency potential added in Bin 5 for measures that pass the Utility Cost Test assuming that incentives paid to program participants are set at 50% of incremental measure cost.

2 Potential Study Methodology

2.1 OVERVIEW OF APPROACH

As noted in the Executive Summary, this study assessed the DSM potential for electric energy efficiency and demand response measures, CHP equipment, distributed solar generation and EVs. This section of the report presents the technical methodology used by the GDS Team to develop estimates of DSM potential for each of these DSM options.

2.2 ENERGY EFFICIENCY

This section describes the overall methodology GDS utilized to develop the electric energy efficiency potential study. The main objective of this energy efficiency potential study is to quantify the technical, economic and achievable potential for electric energy efficiency savings in the BWL electric service area. This report provides estimates of the potential MWh and MW electric savings for each level (technical, economic and achievable potential) of energy efficiency potential. This section of the report describes the general steps and methods that were used at each stage of the analytical process necessary to produce the various estimates of energy efficiency potential.

2.3 OVERVIEW OF APPROACH

GDS used a bottom-up approach to estimate energy efficiency potential in the residential sector. Bottom-up approaches begin with characterizing the eligible equipment stock, estimating savings and screening for cost-effectiveness first at the measure level, then summing savings at the end-use and service area levels. In the C&I sectors, the GDS team utilized a top-down modeling approach to first estimate measure-level savings and costs as well as cost-effectiveness, and then applied cost-effective measure savings to all applicable shares of electric energy load. Further details of the market research and modeling techniques utilized in this assessment are provided in the following sections.

2.3.1 Forecast Disaggregation for the Residential Sectors

For the residential sector, GDS created a forecast end-use disaggregation through a process of developing building energy simulation models calibrated to the characteristics of the housing stock in the BWL service territory. GDS used BEopt™ to build the energy simulation models. These models were refined in order to create estimates of annual energy consumption equal to the average per home consumption estimated for BWL customers in 2021. Once the average annual estimated consumption was calibrated, a simulation of the models was run to develop estimates of hourly and annual consumption for the space heating, space cooling, lighting, water heating, appliances, and other end-uses. This yielded estimates of the proportion of annual consumption attributable to each of these end-uses. GDS then used these proportions to disaggregate the sales forecasts for the 2021-2040 timeframe.

2.3.2 Forecast Disaggregation for the Commercial & Industrial Sectors

For the commercial sector, the baseline electric energy forecasts for the BWL service area were disaggregated by combining (1) sales breakdowns by business type provided by BWL and (2) regional energy estimates by business type available from the U.S. EIA. The forecasts were then further disaggregated by end use based on end use consumption estimates from the Commercial Building Energy Consumption Survey (CBECS). The disaggregated forecast provided the foundation for the development of energy efficiency potential estimates for the commercial sector. The commercial sector, as defined in this analysis, is comprised of the following business segments:

- ***Warehouse***
- ***Retail***
- ***Grocery***
- ***Office***
- ***Lodging***
- ***Healthcare***
- ***Restaurant***
- ***Education***
- ***Assembly***
- ***Other***

For the industrial sector, the baseline electric forecast was disaggregated by industry type and then by end use. The industry type breakdowns are based on BWL electric sales by market segment data. Further disaggregation by end use is based on data from the EIA's 2014 Manufacturing Energy Consumption Survey (MECS). The disaggregated forecast data provides the foundation for the development of energy efficiency potential estimates for the industrial sector.

End use electric energy consumption estimates were calculated for the following end use categories for specific manufacturing segments:

- ***Direct Uses - Process***
  - Process heating (e.g., kilns, furnaces, ovens, strip heaters)
  - Process cooling & refrigeration
  - Machine drive
  - Electro-chemical processes
  - Other direct process uses
- ***Direct Uses – Non-Process***
  - Facility heating, ventilation and air conditioning
  - Facility lighting
  - Other facility support (e.g., cooking, water heating, office equipment)
- ***Other Non-Process Use***
- ***Indirect Uses – Boilers***
  - Conventional boiler use

Commercial and industrial baseline energy consumption data were advanced to 2021 and future years based upon the observed historical trend in the BWL nonresidential electricity consumption and the forecast of electric sales for BWL's C&I sectors.

2.3.3 Measure List Analysis

Measure List Development

Energy efficiency measures considered in the study include measures in the 2019 Michigan Energy Measure Database (MEMD), as well as other energy efficiency measures based on GDS' knowledge and current databases of electric end-use technologies and energy efficiency measures in other jurisdictions. The study includes measures and practices that are currently commercially available as well as emerging technologies. Emerging technology research was focused on measures that are either commercially available but currently not widely accepted or are not currently available but expected to be commercialized over the analysis timeframe.[7]

In total, GDS analyzed 547 energy efficiency measure types. Many measures required multiple permutations for different applications, such as different building types, efficiency levels, and

[7] For example, an ENERGY STAR criterion was recently established for clothes dryers. High efficiency clothes dryers were included as an emerging technology (these measures are also in the MEMD), even though the commercialization of high efficiency clothes dryers has not become widespread.

replacement decision types. GDS developed a total of 4,171 measure permutations for this study and tested all measures for cost-effectiveness using the TRC Test. The parameters for cost-effectiveness calculations under the TRC are discussed in detail later in this section of the report. Approximately 56% of the measures had a measure TRC benefit-cost ratio of 1.0 or higher.

TABLE 2-1 NUMBER OF MEASURES EVALUATED

	# of Measures	Total # of Measure Permutations	# with TRC ≥ 1
By Sector			
Residential	131	572	239
Commercial	229	2,290	1,080
Industrial	187	1,309	1,021
Total	***547***	***4,171***	***2,340***

A complete listing of the energy efficiency measures included in this study is provided in the Appendices of this report.

Measure Characterization

GDS used BWL or Michigan-specific data wherever it was available and reflective of recent updates. Costs and savings for new construction and replace-on-burnout measures are calculated as the incremental difference between the code minimum equipment and the energy efficiency measure. This approach is utilized because the consumer must select an efficiency level that is at least the code minimum equipment when purchasing new equipment. The incremental cost is calculated as the difference between the cost of high efficiency and standard efficiency (code compliant) equipment. However, for retrofit or direct install measures, the measure cost was considered to be the "full" cost of the measure, as the baseline scenario assumes the consumer would not make energy efficiency improvements in the absence of a program. Savings for retrofit measures are calculated as the difference between the energy use of the removed equipment and the energy use of the new high efficiency equipment (until the removed equipment would have reached the end of its useful life).

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

- 2019 MEMD
- Secondary sources such as the American Council for an Energy-Efficient Economy (ACEEE), DOE, EIA, ENERGY STAR savings calculators, Air Conditioning Contractors of America (ACCA) and other technical potential studies and Technical Reference Manuals (TRMs)
- Recent program evaluations conducted for BWL Energy Efficiency Programs

Measure Costs. Measure costs represent either incremental or full costs, and typically also include the incremental cost of measure installation. For purposes of this study, nominal measures costs were held constant over time. This general assumption is being made because historically many measure costs (e.g., LED and CFL bulbs, ENERG STAR appliances, etc.) have declined over time, while some measure costs have increased over time (e.g., fiberglass insulation).

When available, GDS obtained measure cost estimates from the MEMD. For measures not in the database, GDS referenced the following data sources:

- Secondary sources such as ACEEE, ENERGY STAR and other technical potential studies and TRMs
- Retail store pricing (such as web sites of Home Depot and Lowe's) and industry experts

- BWL program evaluation reports

Measure Life. Represents the number of years that energy-using equipment is expected to operate. Useful life estimates have been obtained from the following data sources:

- 2019 MEMD
- Manufacturer data
- Savings calculators and life-cycle cost analyses
- Secondary sources such as ACEEE, ENERGY STAR and other technical potential studies
- The California Database for Energy Efficient Resources ("DEER") database
- Evaluation reports
- GDS and other consultant research or technical reports

Baseline & Efficient Technology Saturations. In order to assess the amount of electric energy efficiency savings still available, estimates of the current saturation of baseline equipment and energy efficiency measures, or for the non-residential sector the amount of energy use that is associated with a specific end use (such as HVAC) and percent of that energy use that is associated with energy efficient equipment are necessary. Up-to-date measure saturation data were primarily obtained from the following recent studies:

- 2017 Michigan Lower Peninsula Energy Efficiency Potential Study , August 2017
- 2016 Consumer's Energy 2016 Non-Residential Baseline Study completed by EMI Consulting, January 2016[8]
- 2014 Consumers Energy residential appliance saturation and home characteristics study [9]
- 2014 EIA MECS
- 2012 EIA CBECS
- 2011 Michigan Residential Baseline Study conducted by the Michigan Public Service Commission (MPSC)
- 2009 EIA Residential Energy Consumption Survey
- 2007 American Housing Survey

Further detail regarding the development of measure assumptions for energy efficiency in the residential and non-residential sectors are provided in this report in later sections. Additionally, as noted above, the appendices of the report provide a comprehensive listing of all energy efficiency measure assumptions and data sources.

2.3.4 Potential Savings Overview

Potential studies often distinguish between several types of energy efficiency potential: technical, economic, and achievable. Figure 2-1 provides an illustration of these levels of energy efficiency potential.

[8] Consumer's Energy 2016 Non-Residential Baseline Study completed by EMI Consulting, January 2016. Consumers Energy granted GDS permission to utilize data from this study to develop saturation estimates

[9] Consumers Energy granted GDS permission to utilize data from this study to develop saturation estimates.

FIGURE 2-1 TYPES OF ENERGY EFFICIENCY POTENTIAL[10]

Not Technically Feasible	TECHNICAL POTENTIAL		
Not Technically Feasible	Not Cost-Effective	ECONOMIC POTENTIAL	
Not Technically Feasible	Not Cost-Effective	Market & Adoption Barriers	ACHIEVABLE POTENTIAL

It is important to understand the definition and scope of each potential estimate as it applies to this analysis. Technical and economic potential provide a theoretical upper bound for energy savings from energy efficiency measures. Even optimally designed portfolios of programs are unlikely to capture 100 percent of the technical or economic potential. Therefore, achievable potential attempts to estimate what may realistically be achieved over a given timeframe and what the utility would need to spend to achieve those estimated results.

2.3.5 Technical Potential

Technical potential is the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end users to adopt the efficiency measures. Technical potential is only constrained by factors such as technical feasibility and applicability of measures. Under technical potential, GDS assumed that 100% of new construction and burnout measures are adopted as those opportunities become available (e.g., as new buildings are constructed they immediately adopt efficiency measures), while retrofit opportunities are replaced incrementally (10% per year) until 100% of homes (residential) and stock (C&I) are converted to the efficient measures over a period of 10 years.[11]

In instances where technical reasons do not permit the installation of the efficient equipment in all eligible households or nonresidential facilities an applicability factor is used to limit the potential. The alternative technologies are then utilized to meet the remaining market potential. The applicability factor was also used to delineate between two (or more) competing technologies for the same electrical end use. In the technical potential estimate, priority was given to measures that produced the most savings.[12]

In developing the overall potential electricity savings, the analysis also accounts for the interactive effects of measures designed to impact the same end-use. For instance, if a home or business were to install energy efficient heating and cooling equipment, the overall space heating and cooling consumption in that home would decrease. As a result, the remaining potential for energy savings derived from duct sealing or other building shell equipment would be reduced.

Core Equation for the Residential Sector

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

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

[11] Low-income direct install measures were assumed to occur at a rate of 5% annually over a 20-year timeframe.

[12] For estimates of economic and achievable potential, priority was generally assigned to measures that were found to be most cost-effective.

EQUATION 2-1 CORE EQUATION FOR RESIDENTIAL SECTOR TECHNICAL POTENTIAL

TECHNICAL POTENTIAL OF EFFICIENT MEASURES = *total number of households* X *base case equipment energy use intensity (kWh/unit)* X *saturation Share* X *remaining Factor* X *applicability factor* X *savings factor*

Where

- **Total Number of Households** = the number of households in the market segment (e.g. the number of residential single and multi-family buildings)
- **Base Case Equipment End-use Intensity** = the electricity used per customer per year by each base-case technology in each market segment. In other words, the base case equipment end-use energy intensity is the consumption of the electrical energy using equipment that the efficient technology replaces or affects.
- **Saturation Share** = the fraction of the end-use electrical energy that is applicable for the efficient technology in each market segment. For example, for residential water heating, the saturation share would be the fraction of all residential electric customers that have electric water heating in their household.
- **Remaining Factor** = the fraction of equipment that is not considered to already be energy efficient. To extend the example above, the fraction of electric water heaters that is not already energy efficient.
- **Applicability Factor** = the fraction of the applicable units that is technically feasible for conversion to the most efficient available technology from an engineering perspective (e.g., it may not be possible to install LEDs in all light sockets in a home because the LEDs may not fit in every socket).[13]
- **Savings Factor** = the percentage reduction in electricity consumption resulting from the application of the efficient technology.

Core Equation for the Non-Residential Sectors

The core equation utilized in the non-residential sectors to estimate technical potential for each individual efficiency measure is shown below.

EQUATION 2-2 CORE EQUATION FOR NON-RESIDENTIAL SECTOR TECHNICAL POTENTIAL

TECHNICAL POTENTIAL OF C&I EFFICIENT MEASURES = *total end use MWh sales by building/ industry type* X *base case factor* X *applicability factor* X *remaining Factor* X *savings factor*

[13] In instances where there are two (or more) competing technologies for the same electrical end use, such as heat pump water heaters, water heater efficiency measures, high-efficiency electric storage water heaters and solar water heating systems, an applicability factor aids in determining the proportion of the available population assigned to each measure. In estimating the technical potential, measures with the most savings are given priority for installation. For all other types of potential, measures with the greatest TRC ratio are assigned installation priority.

Where

- **Total End-Use MWh Sales by Building/Industry Type** = the forecasted non-residential MWh sales for a given building type or market segment (e.g., office buildings in the commercial sector, or machinery in the industrial sector).
- **Base Case Factor** = the fraction of end-use energy applicable for the efficient technology in a given commercial sector type. For example, with fluorescent lighting, this would be the fraction of all lighting kWh in a given commercial building type that is associated with fluorescent fixtures.
- **Applicability Factor** = the fraction of the equipment or practice that is technically feasible for conversion to the efficient technology from an engineering perspective (e.g., it may not be possible to install variable-frequency drives (VFDs) on all motors.
- **Remaining Factor** = the fraction of applicable kWh sales associated with equipment not yet converted to the electric energy efficiency measure; that is, one minus the fraction with energy efficiency measures already installed.
- **Savings Factor** = the fraction of electric consumption reduced by application of the efficient technology.

Estimating energy efficiency potential for the industrial sector can be more challenging than it is for the residential and commercial sectors because of the significant differences in the way energy is used across manufacturing industries (or market segments). The auto industry uses energy in a very different manner than does a plastics manufacturer. Further, even within a particular industrial segment, energy use is influenced by the particular processes utilized, past investments in energy efficiency, the age of the facility, and the corporate operating philosophy.

Recognizing the variability of energy use across industry types and the significance of process energy use in the industrial sector, GDS employed a top-down approach that constructed an energy profile based on local economic data, national energy consumption surveys and any available Michigan studies related to industrial energy consumption.

2.3.6 Economic Potential

Economic potential refers to the subset of the technical potential that is cost-effective as compared to conventional supply-side energy resources. For this study the standard of cost-effectiveness used was the TRC Test. All measures that were not found to be cost-effective based on the results of the measure-level cost effectiveness screening were excluded from further analysis in this potential study report. (See Section 10 of this report for a discussion of an additional analysis to determine how energy efficiency potential would change if measures passing the Utility Cost Test were included in the potential estimates.) GDS has calculated the benefit/cost ratios for this study according to the cost effectiveness test definitions provided in the National Action Plan for Energy Efficiency (NAPEE) guide titled "*Understanding Cost Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods and Emerging Issues for Policy Makers*".[14] Economic potential ignores market barriers to the adoption of energy efficiency measures.

Total Resource Cost Test

The TRC examines the costs and benefits of an energy efficiency program from the combined perspective of the entity implementing the program (utility, government agency, nonprofit, or other third party) as well as program participants. The Total Resource benefits include the savings from avoided costs of

[14] https://www.epa.gov/sites/production/files/2015-08/documents/cost-effectiveness.pdf

generation, T&D as well as any other quantifiable benefits accruing to the utility or program participants. TRC costs include incremental measure costs and the utility's costs for administering an energy efficiency program. Table 2-2 shows the benefit and cost components included in the TRC Test.

TABLE 2-2 BENEFIT AND COST COMPONENTS OF THE TRC TEST

Benefits	Costs
Avoided energy costs	Incremental measure costs
Avoided capacity and T&D costs	Program installation costs
Non-electric savings	Program management, administrative, data tracking and reporting, evaluation costs
Non-energy benefits / tax credits	

When conducting screening at the measure level, GDS only included energy efficiency measure costs and did not include utility administrative and program management costs. These costs are included in the evaluation of the achievable potential benefits and costs.

2.3.7 Achievable Potential

Achievable potential considers barriers that hinder consumer adoption of energy efficiency measures such as financial, political and regulatory barriers, and the capability of programs and administrators to ramp up activity over time. Achievable potential estimates attempt to identify the amount of energy and demand that can realistically be saved assuming an aggressive program marketing strategy. The energy efficiency part of this study evaluated three achievable potential scenarios, according to varied incentive levels. The parameters of these scenarios are described below.

Scenario No. 1 – 100% TRC. For the first scenario, achievable potential represents the amount of energy use that efficiency can realistically be expected to displace assuming incentives equal to 100% of the incremental measure cost. Cost effectiveness of measures was determined with the TRC test.

Scenario No. 2 – 50% TRC. For the second scenario, achievable potential represents the amount of energy use that efficiency can realistically be expected to displace assuming incentives equal to 50% of the incremental measure cost. Cost effectiveness of measures was determined with the TRC test.

Scenario No. 3 – PB TRC. For the third scenario, achievable potential represents the amount of energy use that efficiency can realistically be expected to displace assuming incentives set based on BWL buying down payback levels to 5 years in the residential sector and to 2 years in the C&I sectors. Cost effectiveness of measures was determined with the TRC test.

Market Penetration Methodology

GDS assessed achievable potential on a measure-by-measure basis. In addition to accounting for the natural replacement cycle of equipment in the achievable potential scenario, GDS estimated measure specific maximum adoption rates that reflect the presence of possible market barriers and associated difficulties in achieving the 100% market adoption assumed in the technical and economic scenarios. The methodology utilized to forecast participation within each customer sector is described below.

Residential. The initial step in the market penetration methodology was to assess the long-term market adoption potential for residential energy efficiency technologies. Due to the wide variety of measures across multiple end-uses, GDS employed varied measure and end-use-specific ultimate adoption rates versus a singular universal market adoption curve. These long-term market adoption estimates were based on willingness to participate (WTP) market research or publicly available DSM research including market adoption rate surveys and other utility program benchmarking. These surveys included questions to residential homeowners and nonresidential facility managers regarding their perceived willingness to purchase and install energy efficient technologies across various end uses and incentive levels. GDS also acknowledges that estimating future market adoption of energy efficient technologies is a difficult and uncertain practice, and that reliance on additional studies and alternate methods could produce different estimates of achievable potential.

Once the long-term market adoption rate was determined, GDS estimated initial year adoption rates by calibrating the estimates to recent historical levels achieved by BWL's Energy Waste Reduction portfolio. GDS then assumed a linear ramp rate over 10 years from the initial year market adoption rate to the various long-term market adoption rates for each specific end-use. Table 2-3 below provides the maximum market adoption rates used for the residential sector in the achievable potential scenarios.

TABLE 2-3 MARKET ADOPTION RATES BY END USE – RESIDENTIAL SECTOR

End Use	Initial Year Adoption Rate	Ultimate Adoption Rate – AP 100%	Ultimate Adoption Rate – AP 50%	Ultimate Adoption Rate – AP 100%
Lighting	13%	88%	70%	59%-88%
Appliances	29%	86%	65%	48%-86%
Electronics	1%	80%	55%	36%-80%
Water Heating	1%	79%	60%	41%-79%
HVAC Shell	11%	77%	53%	52%-77%
HVAC Equipment	17%	79%	51%	50%-79%
Miscellaneous	0%	80%	55%	36%-80%
Cross-Cutting	11%	80%	55%	36%-80%
Low Income	17%	80%	55%	36%-80%

One caveat to this approach is that the ultimate long-term adoption rate is generally a simple function of incentive levels and payback. There are many other possible elements that may influence a customer's willingness to purchase an energy efficiency measure. For example, increased marketing and education programs can have a critical impact on the success of energy efficiency programs. Additionally, other perceived measure benefits, such as increased comfort or safety as well as reduced maintenance costs could also factor into a customer's decision to purchase and install energy efficiency measures. Although these additional elements are not explicitly accounted for under this incentive/payback analysis, the estimated adoption rates and penetration curves provide a concise method for estimating achievable savings potential over a specified period.

Non-Residential. The non-residential approach for estimating market adoption rates is very similar to the residential sector approach. GDS employed varied, measure-specific maximum adoption rates versus the simple payback of measure benefits compared to cost. The long-term market adoption estimates were based on the willingness to participate payback survey data, see Table 2-4 below, from a study conducted for Ameren-Missouri's 2017 IRP.[15] The following assumptions were used to determine market adoption rates:

1. Simple Payback = measure cost / (kWh measure savings x retail rate per kWh)
2. Incentive levels were assigned by end-use based upon the following willing to participate payback survey data from Ameren-Missouri.

TABLE 2-4 NON-RESIDENTIAL SECTOR ADOPTION FACTORS BY END-USE AND PAYBACK

Sector	End Use	0 Year Payback	Less than 2-year Payback	2-4 Year Payback	Over 4-Years Payback
Commercial	Appliances	64.0%	42.0%	35.4%	28.9%
Commercial	Central AC	79.7%	52.3%	44.1%	36.0%
Commercial	Lighting	80.8%	53.0%	44.8%	36.5%
Commercial	Other	80.8%	53.0%	44.8%	36.5%
Commercial	Refrigeration	90.0%	59.0%	49.8%	40.6%
Commercial	Space Heating	77.8%	51.0%	43.1%	35.1%
Commercial	Ventilation	80.0%	52.5%	44.3%	36.1%
Commercial	Weatherization	79.8%	52.3%	44.2%	36.0%

GDS used the data shown above to estimate long term market penetration for C&I (process) measures based on the assumed incentive level stated as a percent of incremental cost.

The non-residential market penetration methodology uses the relationship between payback and market adoption as a concise quantitative method for estimating achievable savings potential over a specified period. While there are many other elements that may influence a business customer's willingness to install an energy efficiency measure, such as access to capital, corporate policy or reduced maintenance costs, these factors are difficult to quantify and fit into a forecasting approach.

2.4 DEMAND RESPONSE

2.4.1 Characterization of Peak Demand Consumption

Customer Segmentation

The first step in the demand response potential analysis was to divide the market into customer segments that are relevant for analyzing demand response potential, given available data. The first level of segmentation was by sector: Residential and Non-Residential (or C&I) customers. GDS further segmented the market by the saturation of end uses that are typically targeted in demand response programs such as central air conditioning (CAC) and electric water heating.

Table 2-5 presents the total number of customers in each BWL customer segment in 2021, the coincident peak summer demand for each customer segment and the average coincident demand per customer. Coincident demand is the average customer kW demand at the time of the system summer peak. The breakdown of customers by segment was provided by BWL. The segment and per customer coincident peak demands were estimated by applying load factors developed by GDS for the 2016 BWL Energy Efficiency Potential Study and applying these factors to the latest available BWL peak demand forecast.

[15] https://www.ameren.com/-/media/missouri-site/files/environment/2017-irp/chapter-8-appendix-a.pdf?la=en-us-mo&hash=D8BA272701DB1E43BF154F8F8B41994CF9E58ACA

TABLE 2-5 NUMBER OF BWL CUSTOMERS AND COINCIDENT PEAK SUMMER DEMAND BY CLASS

Customer Segment	Number of BWL Customers	Segment Peak (Summer MW)[16]	Per Customer Peak Demand (kW)
Residential	84,716	207.7	2.45
Small Non-Residential (<= 1000 kW)	12,038	176.1	14.63
Large Non-Residential (> 1000 kW)	176	63.9	363.95
Total	**96,930**	**447.8**	**4.62**

The end use saturations used to further characterize the market for potential demand response programs were obtained from the 2014 Consumers Energy Residential Appliance Saturation Survey, the 2015 Consumers Commercial Market Assessment, the 2010 Michigan Commercial Baseline Study and the 2010 and 2013 DTE Energy Commercial Baseline Studies.[17]

Customer Forecast

BWL provided GDS with a reference forecast of the number of residential and non-residential customers for the period 2021 through 2040. BWL also provided the number of non-residential customers in each size range (small being 0-1000 kW and large being 1000+ kW). GDS used the historical percentages of small and large non-residential customers and applied them to the non-residential customer forecast to develop the forecast for the number of small and large non-residential customers. This customer forecast along with participation rates were used to estimate the number of program participants in each segment. See Section 2.4.5 to see the explanation of how the participation rates were developed. The customer forecasts for selected forecast years are presented below in Table 2-6.

TABLE 2-6 BWL CUSTOMER FORECAST BY SEGMENT

	2021	2025	2030	2035	2040
Residential	84,716	85,141	85,502	85,682	85,868
Small Non-Residential (<=1000 kW)	12,038	12,175	12,342	12,487	12,583
Large Non-Residential (>1000 kW)	176	178	180	182	184

2.4.2 Demand Response Program Options

This analysis examined a comprehensive set of demand response programs that fall into two main categories, Direct Load Control and Rate Programs. Table 2-7 provides a brief description of these demand response programs and identifies the eligible customer segment for each program.

After discussion with BWL, GDS decided on two achievable potential scenarios. The Air Conditioner (AC) load switch scenario includes rate programs and all direct load control programs that use load control switches. The Smart Thermostat scenario includes rate programs, load control switches for all direct load control programs except for air conditioning, and controllable thermostats for direct control of air conditioning.

[16] Coincident with the system peak

[17] GDS obtained permission from Consumers Energy and DTE Energy to use this information.

TABLE 2-7 DEMAND RESPONSE PROGRAM OPTIONS AND ELIGIBLE MARKETS

Demand Response Programs	Brief Description	Eligible Customer Segments
Direct Load Control		
Direct Load Control of CAC with Load Switch	The compressor of the air conditioner is remotely shut off (cycled) by the system operator for periods that may range from 7 ½ to 15 minutes during every 30-minute period (i.e., 25%-50% duty cycle)	Residential Small Non-Residential
Direct Load Control of Window Air Conditioners	The air conditioner is remotely shut off (cycled) by the system operator for periods that may range from 7 ½ to 15 minutes during every 30-minute period (i.e., 25%-50% duty cycle)	Residential
Direct Load Control of Water Heaters	The water heater is remotely shut off by the system operator for periods normally ranging from 2 to 8 hours. Can also be used for energy storage.	Residential Small Non-Residential
Direct Load Control of Swimming Pool Pumps	The swimming pool pump is remotely shut off by the system operator for periods normally ranging from 2 to 4 hrs.	Residential
Direct Load Control of Lighting	The lighting load is remotely or dimmed partially shut off by the system operator for periods normally ranging from 2 to 4 hours	Small Non-Residential
Direct Load Control of CAC with Smart Controllable Thermostats	The system operator can remotely raise the AC's thermostat set point during peak load conditions, lowering AC and/or heating load.	Residential Small Non-Residential
Auto Demand Response of Air Conditioning	Building automation system that can receive Auto Demand Response signal and control energy air conditioning equipment. Control equipment must be installed at the customer site.	Large Non-Residential
Auto Demand Response of Lighting	Building automation system that can receive Auto Demand Response signal and control energy lighting equipment. Control equipment must be installed at the customer site.	Large Non-Residential
Rate Programs		
Interruptible Rate	A discounted rate is offered to the customer for agreeing to interrupt or curtail load during peak period. The interruption is mandatory. No buy-through options are available.	Large Non-Residential
Critical Peak Pricing Rate	A retail rate in which an extra-high price for electricity is provided during a limited number of critical periods (e.g. 100 hours) of the year. Market-based prices are typically provided on a	Residential Small & Large Non-Residential

Demand Response Programs	Brief Description	Eligible Customer Segments
	day-ahead basis, or an hour-ahead basis. Includes enabling technology that connects technologies within building.	
Time of Use Rate	A retail rate with different prices for usage during different blocks of time. Daily pricing blocks could include on-peak, mid-peak, and off-peak periods. Pricing is pre-defined, and once established do not vary with actual cost conditions.	Residential Small Non-Residential
Electric Thermal Storage Rate	Special rate service for the use of a cold storage medium such as ice, chilled water, or other liquids. Off-peak energy is used to produce chilled water or ice for use in cooling during peak hours. The cool storage process is limited to off-peak periods	Small & Large Non-Residential
Plug-In EV TOU Charging Rate	Special rate service for EVs that charge off-peak. Includes Level 1 chargers, where only an additional TOU meter would have to be installed and Level 2 chargers, where the Level 2 charger would have to be installed, which has built in metering capabilities.	Residential

2.4.3 Demand Response Potential Assessment Approach

The demand response analysis was conducted using the GDS Demand Response Potential Model (DR Model). The GDS DR Model is an Excel spreadsheet tool that allows the user to determine the achievable potential for a demand response program based on one of two basic equations that can be chosen by the model user.

If the model user chooses to base the estimated potential demand reduction on a percent of the total per participant coincident peak (CP) load, then the following equation is used:

ACHIEVABLE DR POTENTIAL = *per customer CP load for eligible customer segment* X *potentially eligible customers* X *eligible customer participation rate* X *percent CP load reduction per participant*

If the model user chooses to base the estimated potential demand reduction on a per customer CP load reduction value, then the following equation is used:

ACHIEVABLE DR POTENTIAL = *potentially eligible customers* X *eligible customer participation rate* X *percent CP load reduction per participant*

The GDS DR Model produces estimates of technical, economic and achievable potential. These are defined as follows:

Technical Potential. All technically feasible demand reductions are incorporated to provide a measure of the theoretical maximum demand response potential. This assumes 100% of eligible customers will participate in all programs regardless of cost-effectiveness.

Economic Potential. Only cost-effective demand response programs are included in the economic potential. The cost-effectiveness of each demand response measure is determined within the model for the Utility Cost Test (UCT) and the TRC test. Benefits are based on avoided kW demand, energy (including load shifting) and T&D costs. Costs include incremental costs (such as load control switches), fixed costs (such as a central computer controller), program administrative and marketing costs, O&M and program incentives. Incremental equipment costs are included for both new and replacement units to account for units that are replaced at the end of their useful life. The user also has the option to amortize incremental program equipment costs.

In accordance with guidance provided by BWL all demand response program utility capital costs, such as the cost of load control switches, associated with demand response program delivery are amortized over the assumed useful life of the equipment.

Cost-Effectiveness Framework. The framework for assessing the cost-effectiveness of demand response programs is based *on A Framework for Evaluating the Cost-Effectiveness of Demand Response, Prepared for the National Forum on the National Action Plan on Demand Response*.[18]

For the purposes of this study, the TRC and the UCT tests were used to assess the benefits and costs associated with the demand response programs, as prescribed by the State of Michigan. The TRC test examines benefits and costs from the combined perspective of the utility and program participants. The UCT test measures benefits and costs from the perspective of the utility. The benefits accounted for in the UCT are those attributable to avoided capacity, energy (including energy shifted to off-peak hours) and T&D. The UCT costs include any customer incentives, utility equipment (costs) associated with the purchase and installation of enabling technologies amortization of equipment costs and program implementation, administrative and marketing costs incurred by the utility. While the economic and achievable demand response potential shown in this report are based on the TRC test, BWL requested that GDS also determine the cost-effectiveness of demand response programs using the UCT. (See Section 10 of this report for a discussion of an additional analysis conducted by GDS to determine how demand response potential would change if measures passing the UCT were included in the potential estimates.)

[18] Study was prepared by Synapse Energy Economics and the Regulatory Assistance Project, February 2013.

The cost-effectiveness analysis was conducted for each demand response program included in the study. The GDS DR model was the used to conduct the cost-effectiveness assessment.

Achievable Potential is the cost-effective demand response potential that can practically be attained in a real-world program delivery scenario, assuming that a certain level of market penetration can be attained. Achievable potential takes into account real-world barriers to convincing customers to participate in cost effective demand response programs. Achievable savings potential savings is a subset of economic potential.

2.4.4 Avoided Costs and Other Economic Assumptions Used in Demand Response Analysis

The avoided costs used to determine utility benefits were provided by BWL. They can be found in Appendix D. Avoided electric generation capacity refers to the benefit resulting from demand response programs achieved by a reduction in the need for new peaking generation capacity. Demand response can also produce energy related benefits. If the demand response is considered “load shifting”, such as electric water heating, the consumption of energy is shifted from the control period to the period immediately following the period of control. GDS assumes that the energy is shifted with no loss of energy. For power suppliers, this shift in the timing of energy can produce benefits from either the production of energy from lower cost resources or the purchase of energy at a lower rate during off-peak hours. If the demand response program is not considered to be “load shifting”, such as when lighting levels are dimmed, the measure is turned off during peak control hours, and the energy is saved altogether.

The discount rate used in this study is 4.66%. A peak demand line loss factor of 4.02%, and reserve margin of 7.83% (for firm load reduction such as direct load control) were also applied to demand reductions at the customer meter. All of these values were provided by BWL.

The maximum number of annual control hours for all DLC programs was assumed to be 80. Time-of-use (TOU) control hours are assumed to be 8 hours per day for 5 days per week[19], or 2,080 annual hours. For the Thermal Electric Storage Rate, control hours are assumed to be 6 hours a day for 5 days per week in the summer, or 520 annual hours.

Useful Lives of Load Control Devices and AMI Meters

GDS assumed a useful life of load control switches to be 10 years[20]. This life was used for all direct load control measures in this study. AMI meters used for rate programs in this study are also assumed to have a useful life of 20 years[21].

2.4.5 Demand Response Customer Participation

The assumed customer participations rates for each demand response program are a key driver of achievable demand response potential estimates. Customer participation rates reflect the total number of eligible customers that are likely to participate in a demand response program. An eligible customer is defined as a customer that has the option to participate in a demand response program. For DLC programs, eligibility is determined by whether or not a customer has the end use equipment that will be controlled. For rate programs eligibility can be limited by the size and type of customer.

[19] DTE Energy Rate Schedule, Final Order Case No. U-17767, approved by BWL.

[20] Freeman, Sullivan & Co Cost Effectiveness of CECONY Demand Response Programs 2013; PA Act 129 Order 2013

[21] Ameren Illinois AMI Cost/Benefit Analysis, 2012

Existing Demand Response Programs

BWL currently does not have any existing demand response programs.

Demand Response Eligible Market Size

Table 2-8 and Table 2-9 provide information on the size of the eligible markets for residential and non-residential demand response programs, respectively. For direct load control, the size of the eligible market was determined by multiplying BWL's forecast of customers by the saturation of the end use (such as air conditioning or electric water heating) obtained from the sources listed in the tables below. This determination of the size of the eligible market was done for each year from 2021 through 2040.

Double-counting savings from demand response programs that affect the same end uses is a common issue that must be addressed when calculating the demand response savings potential. For example, a customer cannot elect to participate in both DLC programs and rate programs and claim savings from both programs for curtailing the same end use. One cannot save a kW of load in a specific hour more than once. In general, the hierarchy of demand response programs is accounted for by subtracting the number participants in a higher priority program from the eligible market for a lower priority program. Since there was only one cost-effective program in the achievable potential, the hierarchy adjustments were not necessary to incorporate for this analysis.

TABLE 2-8 ELIGIBLE RESIDENTIAL CUSTOMERS FOR ACHIEVABLE POTENTIAL IN EACH DEMAND RESPONSE PROGRAM

Demand Response Program Option	Saturation	Source / Description
DLC AC (Switch)	67.1% of residential customers	Consumers Energy 2014 Appliance Saturation Study
DLC AC (Thermostat)	67.1% of residential customers with central AC * 76% of customers with Wi-Fi = 51%	Consumers 2014 Appliance Saturation Study; https://www.securitysales.com/research/majority-broadband-households-wifi-connection/
DLC Pool Pumps	5.8% of residential customers	Consumers 2014 Appliance Saturation Study
DLC Water Heaters	15.9% of residential customers	Consumers 2014 Appliance Saturation Study
DLC Room AC	26.5% of residential customers	Consumers 2014 Appliance Saturation Study
Critical Peak Pricing with Enabling Technology	67.1% of residential customers	Consumers 2014 Appliance Saturation Study
Critical Peak Pricing without Enabling Technology	100% of residential customers	GDS Assumption
Time of Use with Enabling Technology	67.1% of residential customers	Consumers 2014 Appliance Saturation Study

Demand Response Program Option	Saturation	Source / Description
Time of Use without Enabling Technology	100% of residential customers	GDS Assumption
Plug In EVs	100% of residential customers with EVs	EV Forecast provided by Siemens

TABLE 2-9 ELIGIBLE NON-RESIDENTIAL CUSTOMERS FOR ACHIEVABLE POTENTIAL IN EACH DEMAND RESPONSE PROGRAM

Demand Response Program Option	Saturation	Source / Description
DLC AC (Switch)	79.8% of small non-residential customers	2015 Consumers Commercial Market Assessment
DLC AC (Thermostat)	79.8% of small non-residential customers	2015 Consumers Commercial Market Assessment
DLC Water Heaters	79.8% of small non-residential customers	2015 Consumers Commercial Market Assessment
Critical Peak Pricing with Enabling Technology	79.8% of non-residential customers	2015 Consumers Commercial Market Assessment
Critical Peak Pricing without Enabling Technology	100% of non-residential customers	GDS Assumption
Time of Use with Enabling Technology	79.8% of small non-residential customers	2015 Consumers Commercial Market Assessment
Time of Use without Enabling Technology	100% of small non-residential customers	GDS Assumption
Thermal Electric Storage	3.27% of non-residential customers	EIA CBECS table B40
DLC Lighting	24.8% of small non-residential customers	2010 U.S. Lighting Market Characterization. US DOE. Jan 2012. (% of lighting that is T12)
Interruptible Rate	100% of large non-residential customers	GDS Assumption
Auto Demand Response - AC	79.8% of large non-residential customers	2015 Consumers Commercial Market Assessment
Auto Demand Response - Lighting	24.8% of large non-residential customers	2010 U.S. Lighting Market Characterization. US DOE. Jan 2012. (% of lighting that is T12)

Demand Response Participation Rates

The assumed maximum long-term customer participation rates used in this potential study and the sources upon which each assumption is based are shown in Table 2-10 for residential and non-residential customers, respectively. The maximum long-term participation rate represents the maximum percent of eligible customers that will participate over the long term. Maximum participation rates are expressed as a percentage of eligible customers. Program participation and impacts (demand reductions) are assumed to begin in 2020. The main sources of participation rates are several studies completed by the Brattle Group. Additional detail about participation rates and sources are shown in Table 2-10.

TABLE 2-10 STEADY STATE PARTICIPATION RATES FOR DEMAND RESPONSE PROGRAM OPTIONS

Demand Response Program Options	Maximum Participation Rate In the Long Term	Source
Residential		
DLC AC (Switch)	25%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.
DLC AC (Thermostat)	25%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.
DLC Pool Pumps	19%	Pool Pump Demand Response Potential, Design & Engineering Services Customer Service Business Unit Southern California Edison, June 200
DLC Water Heaters	23%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.
DLC Room AC	20%	Ameren Missouri Demand Side Management Market Potential Study, Volume 4, Demand Response Analysis, EnerNOC, December 20, 2013.
Critical Peak Pricing with Enabling Technology	22%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.
Critical Peak Pricing without Enabling Technology	17%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.
Time of Use with Enabling Technology	36%	Applied ratio of take rates for CPP with and without enabling technology.
Time of Use without Enabling Technology	28%	(1) A Review of Alternative Rate Designs, Rocky Mountain Institute, May 2016. (2) Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.

Demand Response Program Options	Maximum Participation Rate In the Long Term	Source
Plug in EV TOU Rate - Level 1 Charger	3%	Participation rate: Plug-in EV and Infrastructure Analysis September 2015, Prepared for the U.S. DOE's Office of Energy Efficiency and Renewable Energy by Idaho National Lab.; Saturation of level 1/2 chargers: Siemens' data on charging infrastructure within 20-mile radius of Lansing
Plug in EV TOU Rate - Level 2 Charger	54%	Participation rate: Plug-in EV and Infrastructure Analysis September 2015, Prepared for the U.S. DOE's Office of Energy Efficiency and Renewable Energy by Idaho National Lab.; Saturation of level 1/2 chargers: Siemens' data on charging infrastructure within 20-mile radius of Lansing
Non-Residential		
DLC AC (Switch)	8%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.
DLC AC (Thermostat)	8%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.
DLC Water Heaters	7%	FERC 2012 Demand Response Survey Data (50th/75th percentile). Other Demand Response potential studies (1) reviewed by GDS showed take rates ranging from 2% - 15% with an average of 7.6%.
DLC Lighting	3%	FERC 2012 Demand Response survey data
Critical Peak Pricing with Enabling Technology	20%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.
Critical Peak Pricing without Enabling Technology	18%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.
Time of Use with Enabling Technology	16%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016
Time of Use without Enabling Technology	13%	Applied ratio of take rates for CPP with and without enabling technology.

Demand Response Program Options	Maximum Participation Rate In the Long Term	Source
Interruptible Rate	3%	FERC 2012 Demand Response Survey Data
Auto Demand Response	15%	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016. (avg of small, medium, large C&I)

2.4.6 Demand Response Load Reduction Assumptions

Table 2-11 presents the per participant load reductions for each proposed demand response program. Where there are no existing BWL demand response programs, load reduction impacts are based on the FERC 2012 Survey on Demand Response and Advanced Metering or engineering calculations.

TABLE 2-11 DEMAND RESPONSE LOAD REDUCTION ASSUMPTIONS

Demand Response Program Options	Per Participant Diversified CP Demand Reduction[22]	Source
Residential		
DLC AC (Switch)	0.7 kW	DTE - SmartCurrents Report 2016
DLC AC (Thermostat)	0.61 kW	DTE - SmartCurrents Report 2016
DLC Pool Pumps	1.36 kW	Southern California Edison Pool Pump Demand Response Potential Report, 2008.
DLC Water Heaters	0.41 kW	Average of Brattle Study (0.4 kW), Cadmus PSE potential study (0.57 kW with 94% effective rate applied), and Cadmus evaluation for Kootenai (0.26 kW)
DLC Room AC	0.504 kW	GDS Calculations using saturations, UECs, and peak factors. Net Fraction of Load Available for Spinning Reserves from US DOE report on Use of Residential Smart Appliances for Peak-Load Shifting and Spinning Reserves, 2010.
Critical Peak Pricing with Enabling Technology	31% of coincident peak load	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.
Critical Peak Pricing without Enabling Technology	11.7% of coincident peak load	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.
TOU with Enabling Technology	5.2% of coincident peak load	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016.

[22] The per unit load impacts are diversified load reductions at the time of the system peak, and are based on either impact evaluation results, engineering calculations, recent DR potential studies completed by other utilities or the 2012 FERC survey of Demand Response and Advanced Metering Programs. The per unit load impacts listed in this table take into account appliance duty cycles as well as cycling strategies used for load management of air conditioners and electric water heaters.

Demand Response Program Options	Per Participant Diversified CP Demand Reduction[22]	Source
TOU without Enabling Technology	3.2% of coincident peak load	The Potential Impact of Demand-Side Rates for Ameren Missouri, The Brattle Group, Stakeholder Webinar, May 24, 2013
Plug In EV TOU Rate	1.62 kW	DTE Energy Plug-In EVs and Infrastructure, Presentation by Hawk Asgeirsson, P.E. Manager -Power Systems Technologies DTE Energy
Non-Residential		
DLC AC (Switch)	2.5 kW[23]	DTE - SmartCurrents Report
DLC AC (Thermostat)	2.19 kW	DTE - SmartCurrents Report
DLC Water Heaters	0.9 kW	2012 FERC Demand Response Survey Data (Reported realized savings data for 6 utility programs)
DLC Lighting	20% of coincident peak load	Demand Response Potential in Bonneville Power Administration's PUC Service Area, March 2018
Critical Peak Pricing with Enabling Technology	21.5% of coincident peak load	Dynamic Pricing: Transitioning from Experiments to Full Scale Deployments, Michigan Retreat on Peak Shaving to Reduce Wasted Energy, The Brattle Group, August 06, 2014.
Critical Peak Pricing without Enabling Technology	4.2% of coincident peak load	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016. (avg of small, med, lrg C&I)
TOU with enabling tech	4% of coincident peak load	Dynamic Pricing: Transitioning from Experiments to Full Scale Deployments, Michigan Retreat on Peak Shaving to Reduce Wasted Energy, The Brattle Group, August 06, 2014.
TOU without enabling tech	2% of coincident peak load	Demand Response Market Research: Portland General Electric, 2016 to 2035, The Brattle Group, January 2016. (average of small, medium, large C&I)
Thermal Electric Storage Rate	10.3 kW	Michigan Commercial Baseline Study, Prepared for the MPSC by Cadmus and Opinion Dynamics, July 2011
Interruptible Rate	41.3 KW (customers larger than 200 kw)	MISO Demand Response, EE, DG Potential Study: Supplemental Program Slides, July 31, 2015. Value for Local Resource Zone 5

[23] The per unit kW demand impacts for direct load control of air conditioners in the non-residential sector are larger than the residential sector because the non-residential AC equipment has higher connected load per unit.

2.4.7 Demand Response Program Costs

One-time program development costs of $400,000 were included in the first year of the analysis for new programs[24]. Table 2-12 for how development costs were split between similar programs. Table 2-13 shows the program equipment costs that were assumed for each demand response program. Each program includes a $50,000/year evaluation cost. It was assumed to cost $50 per new participant for marketing[25]. This does not include existing customers or customers that were participating in the program the previous year. All program costs were escalated each year by the general rate of inflation assumed for this study[26].

GDS assumed that an outside consultant or contractor would run the demand response programs, with one senior project manager overseeing each of the residential and non-residential sectors, one associate engineer, and one engineering assistant working on all the direct load control programs for each sector. All outside consultants are assumed to work part-time on the demand response projects, working 10 hours per week. These consultants are billed at GDS rates.

For our analysis, expenditures on direct load control computer equipment and load control switches were amortized over the life of the measure, using a weighted average cost of capital of 4.66%[27]. GDS assumed that the customer would own the thermostat, and BWL would provide a rebate of $50 to the customer. BWL will be able to provide a list of thermostats that would qualify for this rebate. Rate programs were assumed to have no equipment cost, because AMI meters will be fully deployed by 2021.

An initial central controller computer (one computer) costing $25,000 will be needed at the start of BWL's demand response program implementation and is assumed to be replaced after 10 years, with an additional $5,000 per year for software updates. This computer equipment is only for direct load control programs (including control of thermostats), not rate programs.

TABLE 2-12 DEMAND RESPONSE PROGRAM DEVELOPMENT COSTS

	Program	Program Development Cost	Notes
Residential	DLC Central AC Switch	$100,000	$400,000 split between four DLC AC programs
	DLC Room AC	$133,333	$400,000 split between DLC Room AC, DLC PP, DLC Res WH
	DLC Pool Pumps	$133,333	$400,000 split between DLC Room AC, DLC PP, DLC Res WH
	DLC Water Heating	$133,333	$400,000 split between DLC Room AC, DLC PP, DLC Res WH
	DLC Central AC Thermostat	$100,000	$400,000 split between four DLC AC programs

[24] TVA Potential Study Volume III: Demand Response Potential, Global Energy Partners, December 2011; $400,000 split between similar programs. The program development cost estimate is also based on communications with planners of demand response programs at other electric utilities.
[25] TVA Potential Study Volume III: Demand Response Potential, Global Energy Partners, December 2011.
[26] The general rate of inflation used for this study was 2.5%. This was provided by BWL.
[27] Provided by BWL

	Program	Program Development Cost	Notes
	EV Charging Rate	$400,000	$200,000 for each type of EV charging (Level 1 and Level 2)
	Time of Use with Enabling Tech	$50,000	$400,000 split between TOU and CPP programs
	Time of Use without Enabling Tech	$50,000	$400,000 split between TOU and CPP programs
	Critical Peak Pricing with Enabling Tech	$50,000	$400,000 split between TOU and CPP programs
	Critical Peak Pricing without Enabling Tech	$50,000	$400,000 split between TOU and CPP programs
Non-Residential	DLC Central AC Switch	$100,000	$400,000 split between four DLC AC programs
	DLC Central AC Thermostat	$100,000	$400,000 split between four DLC AC programs
	Interruptible Rate	$200,000	$400,000 split between Interruptible Rate and TES Rate
	DLC Water Heating	$200,000	$400,000 split between DLC Non-Res WH, DLC Lighting
	Thermal Electric Storage Cooling Rate	$200,000	$400,000 split between Interruptible Rate and TES Rate
	DLC Lighting	$200,000	$400,000 split between DLC Non-Res WH, DLC Lighting
	Auto Demand Response - AC	$200,000	$400,000 split between Auto Demand Response programs
	Auto Demand Response - Lighting	$200,000	$400,000 split between Auto Demand Response programs
	Time of Use with Enabling Tech	$50,000	$400,000 split between TOU and CPP programs
	Time of Use without Enabling Tech	$50,000	$400,000 split between TOU and CPP programs
	Critical Peak Pricing with Enabling Tech	$50,000	$400,000 split between TOU and CPP programs
	Critical Peak Pricing without Enabling Tech	$50,000	$400,000 split between TOU and CPP programs

TABLE 2-13 DEMAND RESPONSE PROGRAM EQUIPMENT COST ASSUMPTIONS

Device	Cost	Applicable Demand Response Programs	Source
One-way communicating load control switch	$70 for switch + $200 for installation	DLC programs controlled by switches (except pool pumps and lighting)	Comverge - Angel Sustaeta
Smart controllable thermostat (such as Nest or Ecobee)	$249	DLC AC Thermostat	Nest / Ecobee
TOU meter for EV level 1 charger	$245 for meter + $100 installation	EV Charging - Level 1	Landis & Gyr S4X meter
EV level 2 charger	$1,300	EV Charging - Level 2	Demand Response Advanced Controls Framework and Assessment of Enabling Tech Costs, LBNL August 2017
Non-residential lighting control system	$1,900	Non-Residential DLC Lighting	Demonstration and Evaluation of lighting technologies and Applications, Lighting Research Center, Field Test Issue 6, October 2011
Swimming pool pump control switch + installation	$146	Residential DLC Pool Pumps	Demand Response Advanced Controls Framework and Assessment of Enabling Tech Costs, LBNL August 2017
Auto Demand Response control system	$4,000	Auto Demand Response	SCE Demand Response Program

2.5 DISTRIBUTED ENERGY RESOURCES

2.5.1 Approach

For the BWL net-metering program participants who have installed solar PV panels, the net benefits from distributed solar generation come in two forms: value from offset energy consumption and value from selling excess generation back to the electrical grid. To estimate offset energy consumed and excess generation, Siemens (subcontractor to GDS) applied the average solar PV system size for commercial and residential customers to local conditions and participant history within the PV Watts[28] model and developed generation load shapes to subtract from the average net load shapes for those commercial and

[28] https://pvwatts.nrel.gov/

residential participants. To estimate net benefit dollar streams of both the offsetting energy consumption and the sale of excess generation, Siemens then applied the prevailing retail rate for energy during the time energy is produced or consumed from the distributed solar generation unit. Historical and current energy rates are published on BWL's web site for 2014 to 2020. For the purpose of modeling future penetration, and Siemens assumed no change in energy rates over the future period of analysis as small changes in rates would likely not alter the payback calculations compared to other factors such as declining installation costs or program subsidy levels.

The Reference Case model was based on historical market penetration and other local documented market conditions. Historical market penetration from BWL's solar program since the program began in 2008 is low, at 48 total residential installations and seven commercial installations through August of 2019. The lack of overall program activity and data limited Siemens' ability to incorporate more detailed market conditions into the model.

Rather than make additional assumptions that add to the uncertainty and calibrate the model outputs to fit relatively low historical market penetration, Siemens placed greater emphasis on developing the data inputs, leveraging actual participation data where available. This in turn assumes that actual market penetration will sync with modeled values in the future. Consequently, Siemens developed average inputs for 18 residential and four commercial net metering participants based on available net load shape data from July 2018 to June 2019. For modeling purposes, we assumed that future participants will be net metering participants, mirroring the program design in place at the time of this study. This assumption also simplifies the modeling based on limited available data. Participants who interconnected directly are few and unique. Therefore, Siemens applied participation data inputs on offset consumption, excess generation and average system size for those subsets of net metering customers only. For modeling installation costs, however, Siemens incorporated data from average installation costs in 2019 from all available participant data in one scenario.

Additional assumptions were necessary to complete the modeling inputs for the Reference Case. The federal ITC was applied historically and into the future according to the tax credit schedule in all scenarios. Although we know anecdotally a small number of past projects have included financing, loans for participation are assumed to be zero as installation cost trends decline[29] because the priority is to simulate future market conditions rather than the past. The BWL installation cost subsidy is assumed, however, during the entire period of analysis at $500 per kilowatt, and capped at $2,000 per installation.

Finally, Siemens modeled estimated paybacks and the associated adoption rates from 2020 to 2040 for the Reference Case scenario, given the market and policy conditions of BWL's net metering program participants. The period of analysis, however, began in 2010 and was broken into several sub-periods for estimating average paybacks:

- ***2010-2014:*** Early program trends characterized by scant participation and rapid reduction in average installation costs.
- ***2015-2019:*** Current program trends characterized by steady but limited program activity and continued rapid reduction in average installation costs.
- ***2020:*** Reduction of ITC to 26%.
- ***2021:*** Reduction of ITC to 22%.
- ***2022-2030:*** Market maturation, relative stability of declining installation cost trends, and reduction of ITC to 20% for commercial installations but 0% for residential installations.

[29] LBWL experience estimated at 5-10%.

- ***2031-2040:*** Distant future market conditions based on low, stable installation costs and continued ITC and BWL policy support.

While average installation costs declined during the period of analysis, they decreased at a decreasing rate with the first decade showing the greatest rate of decline. To model this trend, Siemens selected the median installation cost input value during the sub-periods that covered multiple years. Siemens then developed a composite market penetration estimate for the period of analysis by estimating the penetration for each individual year corresponding with the payback period in which that year is associated.

To develop high and low penetration cases, Siemens developed paybacks with low and high future installation cost scenarios based largely on differences in varying installation cost data from National Renewable Energy Laboratory (NREL). Adoption rates are lower for longer payback periods and higher for shorter payback periods.

The MPSC is also considering an alternative tariff to net metering based on inflow and outflow. In the Inflow/Outflow scenario, the PV owner would benefit from offset consumption at avoided retail rates but sell excess generation at the equivalent of the utility's avoided costs. Because avoided costs are lower than retail rates, this would make a PV project's economics less favorable than the current net metering tariff. Siemens modeled three Inflow/Outflow scenarios at the current installation cost incentive ($500 per kilowatt up to $2,000), at zero incentive, and at a high incentive ($1000 per kilowatt up to $4000).

2.5.2 Data Sources & Assumptions

Key assumptions incorporated into the model are listed in Table 2-14 below.

TABLE 2-14 KEY ASSUMPTIONS

Data Input	Value or Description	Source	Notes
Energy rates for residential and commercial customers		https://www.lbwl.com/sites/default/files/2019-04/2019_Electric_Residential%20%281%29.pdf	
PV System Cost Curve 2017-2051		https://atb.nrel.gov/electricity/data.html	Includes modeled low, middle and constant cost stream forecasts
PV System Cost Curve 2010-2018		https://www.nrel.gov/docs/fy19osti/72133.pdf	Includes modeled historic costs from 2010-2018
Average residential installation costs 2019	$3.35 per watt	BWL Participation Data	Average from five residential customers as of August 2019.
Solar PV Capacity Factor, Output and Generation Shape	14.7%	Assumptions based on solar resource information from PVWatts (https://pvwatts.nrel.gov/pvwatts.php) and BWL Solar Customer Generation Data for Lansing, MI	
Solar System Size	Residential: 5.55 kw Commercial: 20 kw	Assumptions made based on the historic data of PV installed size as in BWL Solar Customer Data	
Solar ITC	2010-2019: 30% 2020: 26% 2021: 22% 2022: 0% (residential) 10% (commercial)	https://www.seia.org/initiatives/solar-investment-tax-credit-itc	
Solar Penetration Model		NREL dGen Model & SolarDS: https://www.nrel.gov/analysis/dgen/ https://www.nrel.gov/docs/fy10osti/45832.pdf	

Data Input	Value or Description	Source	Notes
Solar Rebate	$500/kw installed	https://www.lbwl.com/customers/save-money-energy/install-my-own-solar	
Diffusion Penetration Function	Residential: p=7.1E-06 q=0.239 Commercial: p=4.4E-05 q=0.200	Calculate new adoption fraction in time t (A_t) using the classic Bass diffusion: $A_t = \frac{1 - e^{-(p+q)*t+2}}{1 + (\frac{q}{p})e^{-(p+q)*t+2}}$ Then calculate the maximum Market Fraction: $M_t = e^{-Payback\ Sensitivity*Payback\ Years}$ Finally, calculate the market share rate (S) as: $S_t = M_t * A_t$	Used default values in NREL documentation for Michigan

The installation cost data was a significant input to the modeling process and developed from three different data sources. After reviewing the participant data, we averaged the 2019 installation cost data available from five of 24 residential participants through August of that year. We also leveraged two different data streams from NREL, including a study covering 2010 to 2018, and a modeled forecast from 2017 to 2051 that included a low, middle and constant (or high) cost streams. Siemens joined the middle and low NREL cost streams with the historical cost stream through interpolation. For the high cost stream, since the point value from average partial participant data in 2019 was the highest across the data sets, we rejected the NREL constant cost stream as an input and estimated a high installation cost stream from 2019 forward that was proportionate to the NREL middle cost forecast, and backwards from the NREL historical data.

2.6 ELECTRIC VEHICLES

2.6.1 Approach

Typically, publicly reported EV forecasts focus at a national level on light duty passenger vehicles (LDV) only. They generally do not provide state, regional, or local projections, and ignore commercial vehicle classes and ownership. These forecasts frequently predict EV sales to the mass market, but not the cumulative number, or stock, of EVs, and they typically stop with vehicle adoption and do not estimate electric energy and load impacts. To address this need, Siemens developed a proprietary approach and toolset to provide our clients seeking additional forecast detail to support infrastructure planning efforts.

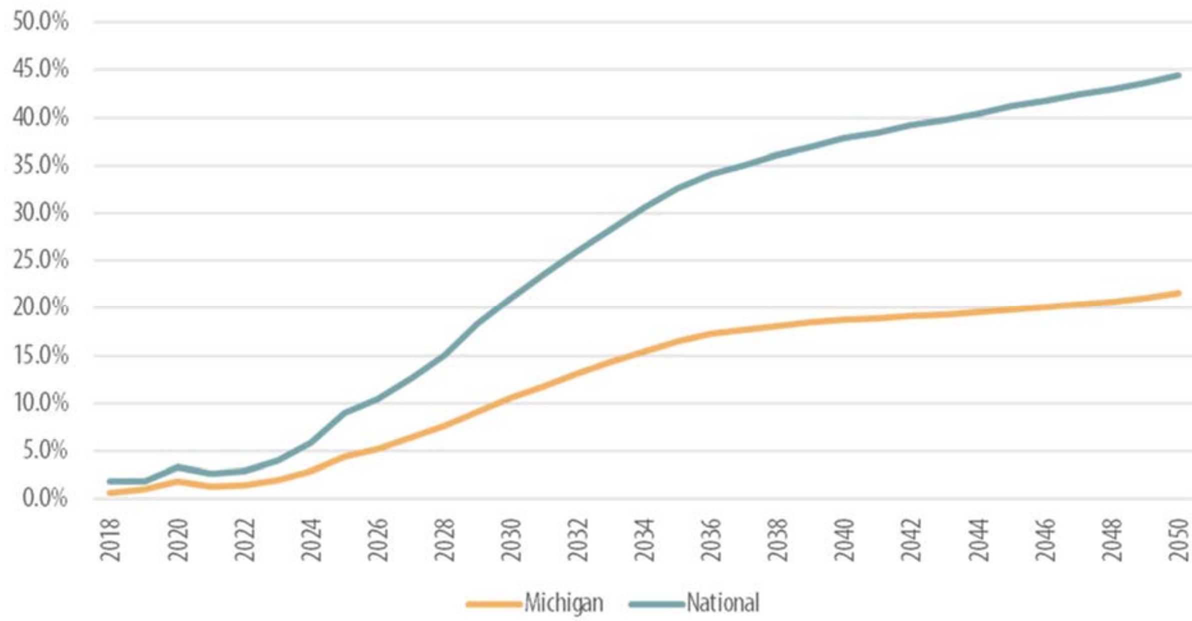
Siemens applied our proprietary EV forecasting approach, which employs our market view, a leading LDV adoption tool, and our proprietary analytical models to project commercial and bus adoption and load calculations, to estimate the potential for EV adoption in BWL's territory. We use this approach and combination of expertise and tools to provide our clients with national, state and local incremental load forecasts for LDV, commercial vehicles and buses.

The Siemens' reference case LDV adoption forecast leverages proprietary inputs and adjustments to the latest version of the best-in-class customer choice model (MA^{3}T Model[30]) developed by Oak Ridge National Labs (ORNL). Forecasted EV LDV adoption rates for the nation and Michigan are presented in Figure 2-2 below. This model generates state forecasts for both battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) by state, and Siemens allocated the Michigan forecast derived from this model using our proprietary inputs to BWL's service territory using available vehicle and household counts provided by the American Community Survey (ACS) conducted annually by the U.S. Census Bureau. Specifically, we estimated the number of available vehicles within BWL's service territory by summing the number reported in the City of Lansing and our estimate of the number of vehicles operating within the territory, but outside the city proper. This estimate was developed based on the number of BWL's residential customers and the ratio of vehicles to households developed from the ACS data for the three counties that comprise/ surround the city of Lansing. This estimate of vehicles operating within the BWL territory was divided by the total number of available vehicles operating in Michigan, as reported in the ACS, to understand the portion of the state forecast attributable to the LWBL territory.

This study does not include a traffic analysis to determine the degree to which commuting traffic would increase vehicle charging requirements.

[30] https://www.ornl.gov/content/ma3t-model

FIGURE 2-2 COMPARISON OF FORECASTED NATIONAL VERSUS MICHIGAN EVLDV EVADOPTION, % OF LIGHT DUTY VEHICLE SALES



The commercial vehicle and bus forecasts were developed from third party sources. The reference case commercial vehicle forecast was derived from the DOE's Annual Energy Outlook PEV adoption forecast, which we applied to the commercial vehicles operating in BWL's service territory. We leveraged several public and private forecasts to develop the reference case bus forecast.

To establish high and low boundaries for developing BNEF and EIA forecast estimates, Siemens' research identified alternative EV adoption forecasts[31] for each vehicle class. The highest and lowest adoption forecasts were used to establish the widest range of potential outcomes. BNEF provided the most rapid case for EV adoption, largely driven by their view that EV costs will decline below those of traditional vehicles by the early 2020s. Conversely, the EIA takes a more conservative view of EV price declines which provided the low case. These forecasts were then applied against local vehicle fleets and expected procurement within the service territory to establish the widest range of potential annual EV sales within BWL's territory. Siemens then adjusted annual sales for the low, reference and high adoption scenarios for vehicle expected survivorship to develop a cumulative vehicle forecast by vehicle type. By applying vehicle energy requirements to typical driving patterns, Siemens determined incremental vehicle energy requirements.[32] These energy requirements were then shaped to typical 24-hour periods for both weekdays and weekends by applying charging patterns that resulted in peak load and coincident peak impact estimates from EV charging.

2.6.2 Data Sources and Assumptions

Key assumptions incorporated into the model are listed in Table 2-15 below.

[31] Sources included: EIA AEO 2019, BNEF, Mass Transit Magazine

[32] Siemens had insufficient data on local traffic patterns to determine the degree to which commuting traffic would increase vehicle charging requirements, so that analysis was not conducted for this assignment.

TABLE 2-15 KEY ASSUMPTIONS

Data Input	Value or Description	Source
LDV EV Adoption Model	State level LDV customer choice model	ORNL MA^3T Model
High National PEV Adoption Forecast		BNEF
Low National PEV Adoption Forecast		EIA Annual Energy Outlook, 2019
Available Vehicles	State, County, MSA	ACS, 2017
Recent E-Bus Activities		Mass Transit Magazine
Vehicle Survival Rates	Portion of vehicles surviving to next year	U.S. Environmental Protection Agency (EPA) Moves Model
LDV Load Shapes	Hourly charging profile	California Public Utility Commission Filings, Charging Infrastructure

2.7 COMBINED HEAT AND POWER

This section describes the methodology and data sources generally used by GDS to determine the potential for cost effective CHP in the BWL service area.

2.7.1 CHP Potential Methodology

GDS completed a literature search of existing CHP potential studies for Michigan. GDS found two recent CHP potential studies for Michigan, one completed by the U.S. DOE in March 2016 and one completed by the Michigan Energy Office in February 2018. The amount of statewide CHP technical potential in Michigan reported in these two studies ranged from 722 MW to 4,291 MW. In 2018, BWL retail electricity sales totaled 2,119,742 MWh. Total state of Michigan MWh sales to electricity consumers totaled 101,899,093 MWh in 2017. Thus, BWL's annual electricity sales are approximately 2.1 percent of statewide electricity sales. If BWL's share of statewide CHP potential follows its share of annual MWh sales, BWL's CHP technical potential ranges from 15.2 to 90.1 MW.

GDS also examined the current cost effectiveness of new CHP equipment in the BWL service area given BWL's most recent forecast of its avoided costs of electricity. GDS determined that the most common types of CHP equipment are not cost effective at this time in the BWL service area given BWL's very low avoided costs of electricity. ***At this time, none of the 78 CHP equipment types fueled by natural gas, biomass, biogas, hydrogen, propane or diesel are cost effective in the BWL service area according to screening with the TRC test. Electric avoided costs would need to increase on the order of 132% to over 600% for any of these 78 CHP equipment types to pass the TRC cost effectiveness test.***

GDS did not develop more detailed estimates of CHP technical, economic, achievable or program potential because, as noted above, GDS did not find any of the CHP equipment to be cost effective according to the TRC test screening. If GDS had found any of the CHP equipment configurations to be cost effective according to the TRC test, GDS would then have proceeded to follow the steps listed below to develop estimates of CHP technical, economic, achievable and program potential. The step by step analytical process and relevant data sources ordinarily used by GDS to develop technical, economic, achievable and program potential estimates are the following:

1 ***Technical Potential:*** GDS ordinarily follows the CHP potential estimation methodology used by the U.S. DOE as described in its latest National CHP Potential Study. [33] In general, that approach consists of the following elements:
   - Identify target markets where CHP provides a reasonable fit to the electric and thermal needs of the user. Using North American Industry Classification System (NAICS) market segment codes, GDS could identify the BWL C&I accounts where CHP is suitable (where there is a thermal load). Target applications can be identified based on reviewing the electric and thermal energy consumption data for various building types and industrial facilities. GDS would need to collect monthly billing kWh and kW usage data for the latest twelve months for BWL's C&I customers that are in NAICS industry classifications deemed compatible with CHP equipment.
   - Estimate CHP potential in terms of MW of electric capacity. CHP potential is derived based on the thermal and electric load for each site. Total CHP potential for each target market is then calculated by the amount of CHP potential in each size category. For this step in the process, GDS would obtain equipment and facility power to heat ratios from the U.S. DOE National CHP Potential Study referenced above. GDS would use this data to calculate CHP kW and kWh potential for each C&I customer where CHP is suitable and develop a total CHP technical potential estimate.
   - GDS would then subtract existing CHP generation capacity from the sites identified to be suitable for CHP installation to determine the remaining technical potential.

2 ***Economic Potential:*** Conduct measure cost effectiveness screening to identify the percentage of CHP equipment that is cost-effective based on measure level cost-effectiveness screening for various types and sizes of CHP equipment. The CHP technical potential is then multiplied by this percentage factor to get an estimate of economic potential. This is an initial factor that can be adjusted once an electric utility gains more experience with a CHP program. It is important to note that the benefit/cost analysis of CHP equipment considers the higher efficiency of CHP systems in addition to the avoided costs of electric generation capacity, generation energy and T&D avoided costs. Thus, the benefit/cost analysis for CHP equipment is different than the analysis for energy efficiency or demand response resources.

3 ***Maximum Achievable Potential (MAP):*** Based on program participation data gathered through a literature search, GDS would apply an adjustment to CHP economic potential to reflect the percent of eligible economic projects that are implemented.

4 ***Realistically Achievable Potential (RAP):*** RAP is assumed to be a specific percentage lower than the measure level MAP in each year of the study period. The percentage factor adjustment for RAP is usually based on an analysis of regional and national CHP evaluations, such as the ComEd CHP Potential Study completed in 2016. This ComEd study showed 427 MW of MAP and 380 MW of RAP for the ComEd service area.[34]

5 ***Program Potential – MAP (Program MAP):*** Because the market analysis for CHP equipment is different than for energy efficiency or demand response measures, GDS has developed a unique modeling approach for CHP program potential. It is assumed that 85% of the measure level MAP can be achieved through

[33] U.S. Department of Energy, CHP Technical Potential in the United States, Appendix A, March 2016, p. A-1.

[34] ICF International, Assessment of the Technical and Economic Potential for CHP in Commonwealth Edison's Service Territory, May 2016, pp. 15, 18.

a CHP Program (if any of the CHP equipment is found to be cost effective). This allows for the exclusion of large projects 5 MW's and over as these projects are likely to be free-riders.[35]

6 ***Program Potential – RAP (Program RAP):*** Program-RAP represents a reduction from Program-MAP based on allocating the expected program budget to smaller kW projects.

2.7.2 Economic Analysis Assumptions

The electric avoided costs for generation and T&D used to determine TRC Test benefits were provided by BWL. Electric avoided costs for CHP projects refer to the reduction in the needs for future generation, T&D infrastructure and production resulting from the energy and capacity provided by a CHP project installation. CHP installations can potentially delay the construction of new T&D lines and facilities, which are reflected in avoided T&D costs.

GDS also included as a benefit (in the TRC test) the savings that accrue to the participant from not having to operate a natural gas-fired boiler once the CHP equipment is installed. These savings were calculated over the useful life of the CHP equipment.

The discount rate used in this study is 4.66%. The general rate of inflation used in this study is 2.5% per year. The overall line loss factor is 4.02% for the residential, C&I sectors. The reserve margin used for long-term planning is based upon the latest forecast from the Midwest Independent System Operator (MISO) for the Planning Reserve Margin Unforced Capacity (PRM UCAP) and is 7.8 percent based on forecast data for the period 2021 to 2028.[36] These values (discount rate, inflation rate, line loss factors, planning reserve margin) were provided by BWL in response to GDS data requests.

Table 2-16 shows the cost, useful life and operating assumptions used to determine the cost-effectiveness of various types of CHP equipment.

TABLE 2-16 USEFUL LIFE AND OPERATING ASSUMPTIONS

Measure Type	Life	Size (kW)	Total Installed Cost	O&M Fixed Cost ($/Yr/kW)	O&M Variable Cost ($/kWh)	Capacity Factor	Fuel Type
Reciprocating Engine	20 Years	100	$290,000	$ -	$0.0240	80%	Diesel, Natural Gas, Biogas (For 1000 kW engine operating on biogas, added equipment & install cost is
		633	$1,795,821	$ -	$0.0210		
		1121	$2,652,286	$ -	$0.0190		
		3325	$5,990,126	$ -	$0.0160		

[35] ICF International, Assessment of the Technical and Economic Potential for CHP in Commonwealth Edison's Service Territory, May 2016, p. 15.
[36] MISO System, "Planning Year 2019 – 2020 Loss of Load Expectation Study Report", prepared by Loss of Load Expectation Working Group, Table 5-4, page 24.

Measure Type	Life	Size (kW)	Total Installed Cost	O&M Fixed Cost ($/Yr/kW)	O&M Variable Cost ($/kWh)	Capacity Factor	Fuel Type
		9341	$13,385,653	$ -	$0.0085		$600/kW), Hydrogen, Propane.
Combustion Turbine	20 Years	3304	$10,840,424	$ -	$0.0126	80-95%	Natural Gas, Hydrogen, Propane.
		7038	$14,639,040	$ -	$0.0123		
		9950	$19,661,200	$ -	$0.0120		
		20336	$30,870,048	$ -	$0.0093		
		44488	$55,521,024	$ -	$0.0092		
Steam Turbine	20 Years	500	$568,000	$ 0.0100	Typically below $.01/kWh	85-95%	Natural Gas, Biomass, Hydrogen, Propane.
		3000	$2,046,000	$ 0.0090			
		15000	$9,990,000	$ 0.0060			
Microturbines	20 Years	30	$129,000	$ -	$0.0200	85-90%	Natural Gas, Biogas, Hydrogen, Propane.
		65	$209,300	$ -	$0.0130		
		200	$630,000	$ -	$0.0160		
		250	$687,500	$ 9.1200	$ 0.0100		
		333	$859,140	$ 6.8470	$0.0070		
		1000	$2,500,000	$ -	$0.0120		
Fuel Cells	20 Years	0.7	$15,400	$ -	$0.0600	80-98%	Natural Gas, Biogas, Hydrogen, Propane.
		1.5	$34,500	$ -	$ 0.0550		

Measure Type	Life	Size (kW)	Total Installed Cost	O&M Fixed Cost ($/Yr/kW)	O&M Variable Cost ($/kWh)	Capacity Factor	Fuel Type
		300	$3,000,000	$ -	$0.0450		
		400	$2,800,000	$ -	$0.0360		
		1400	$6,440,000	$ -	$0.0400		
Organic Rankine Cycle	15 years	500	$1,800,000.00	$ -	$0.9940	80%	Waste heat (steam)

The data source for the CHP equipment data shown in the Table above is the U.S. DOE, Energy Efficiency and Renewable Energy Division, CHP Technology Fact Sheets. These fact sheets are available on the U.S. DOE website.

3 BWL Service Territory Characterization

This chapter provides historical and forecast information on electricity consumption and the number of electric customers in the BWL service territory. This chapter also provides an overview of the number of households and housing units in this service area. Developing this information is a fundamental part of any energy efficiency potential study. It is necessary to understand how energy is consumed in a utility service area or region before one can assess the energy efficiency savings potential that remains to be tapped.

3.1 MICHIGAN ELECTRIC UTILITIES

There are multiple utilities that provide electricity to Michigan customers. According to data from the MPSC and the American Public Power Association, Michigan has eight investor-owned electric utilities, 40 municipal electric utilities and 11 rural electric distribution cooperatives. The two largest electric utilities are DTE Energy and Consumers Energy. These two utilities provide approximately 92% of electric energy sales in the State. BWL is the third largest electric utility in the state, and the largest municipally owned utility in Michigan.

Figure 3-1 shows the service areas for electric distribution utilities in Michigan, with the largest two companies, DTE Energy and Consumers Energy taking up much of the geographic region of the state. Note that the size of utility service areas varies greatly. BWL represents one of the 40 municipal electric utilities in Michigan and its service territory is not highlighted on the map. Figure 3-2 shows the service territory specifically for the BWL.

FIGURE 3-1 MICHIGAN ELECTRIC UTILITY SERVICE TERRITORIES

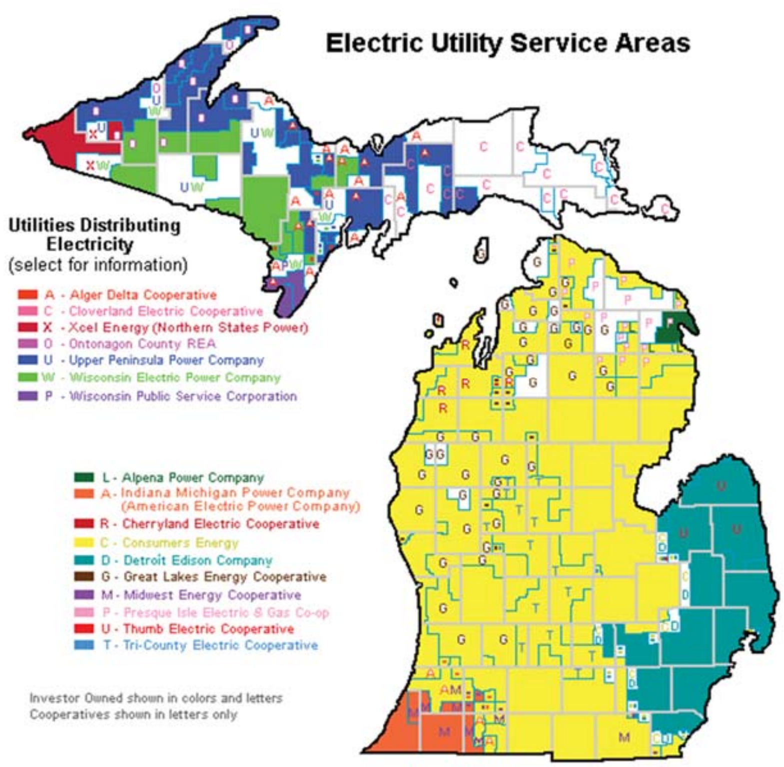
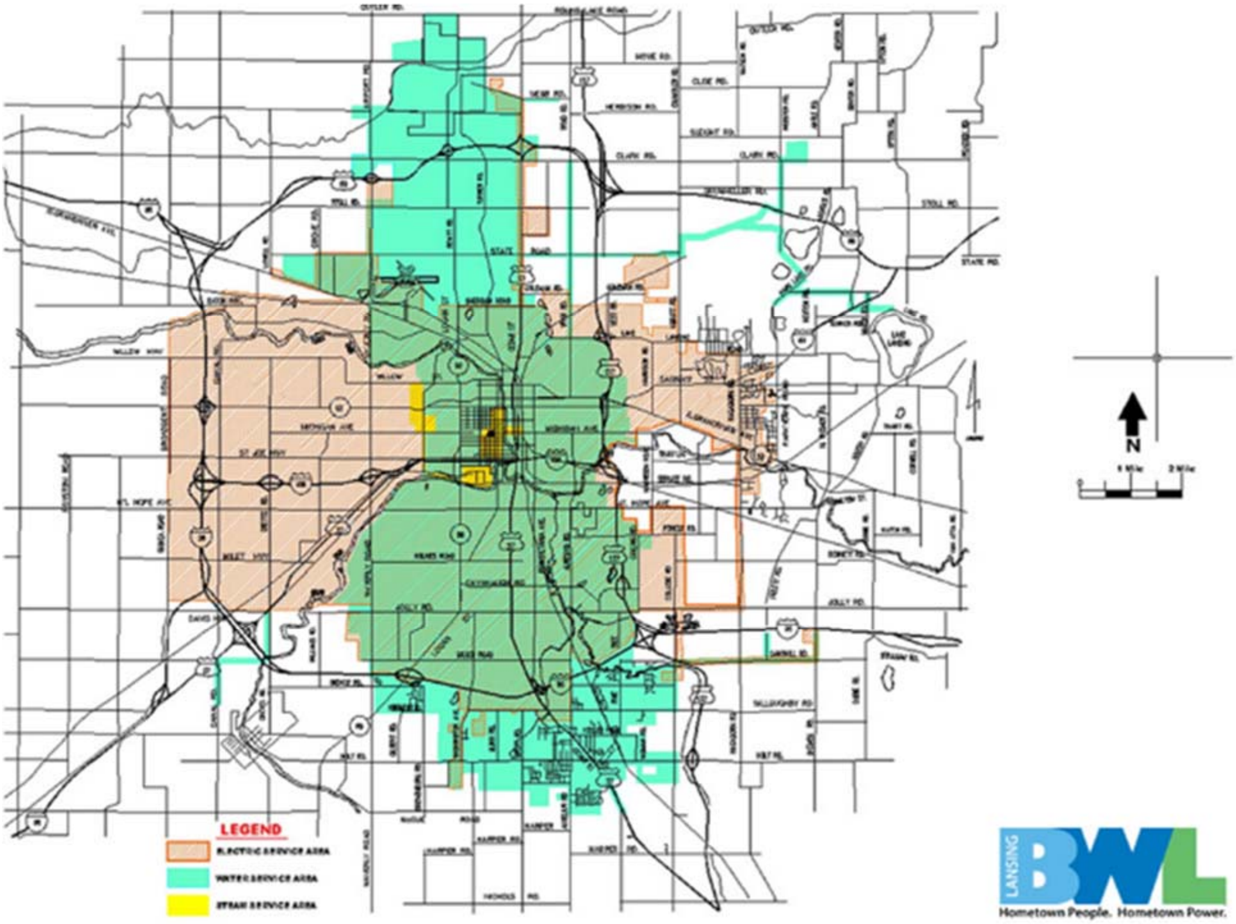


FIGURE 3-2 BWL SERVICE TERRITORY



3.2 LANSING BOARD OF WATER AND LIGHT SYSTEM LOAD

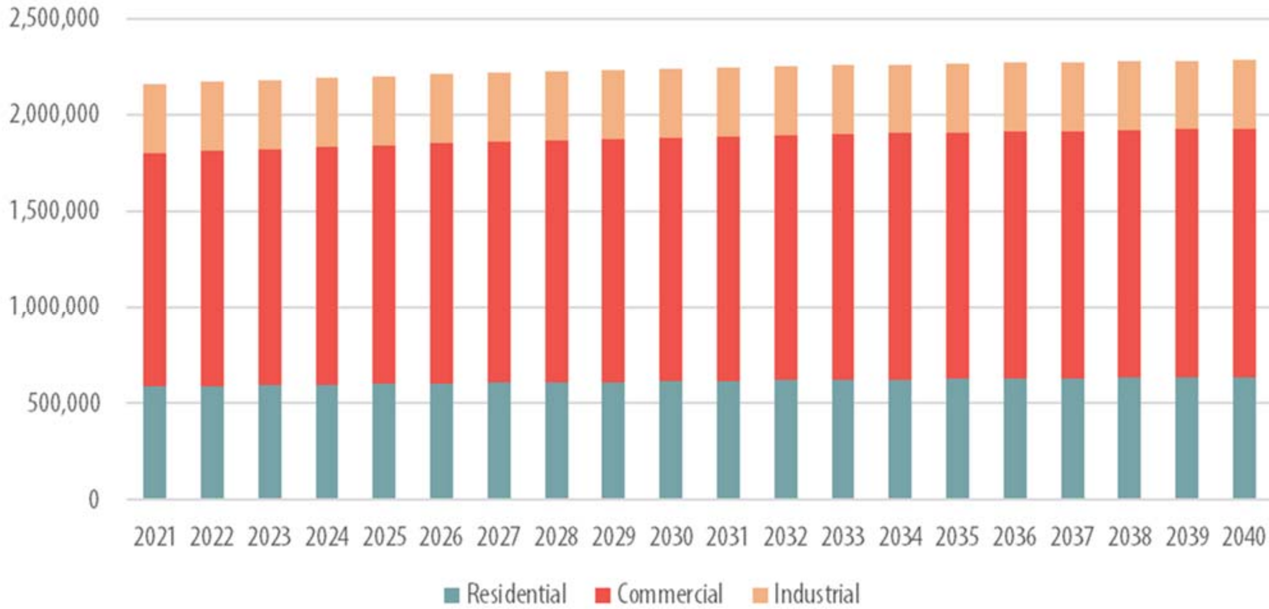
BWL has an electric generating capacity of 396 megawatts from the Erickson (150 MW), Eckert (160 MW) and REO (86 MW)power stations. BWL receives an additional 146 MW of electricity from the Belle River Plan through membership in the Michigan Public Power Agency.[37] The Eckert station, a 1950s-era coal-fired power plant that provides approximately one-third of the energy in the BWL's service territory, is scheduled to be retired by the end of 2020.

3.3 SALES FORECAST BY SECTOR

Figure 3-3 and Table 3-1 show forecast electricity sales by sector (in MWh) for the BWL service area for the period 2021 to 2040. The energy forecast does not include the impact of future DSM efforts. The forecast of annual electric sales for the BWL service area shown below does reflect the impacts of past BWL energy efficiency programs.

[37] These MW capacity number were provided by BWL staff to GDS in an email dated February 19, 2020.

FIGURE 3-3 FORECAST OF ANNUAL ELECTRIC SALES BY SECTOR, 2021-2040 (MWH)



The BWL forecast of electricity sales shown in Figure 3-3 above highlights that the Company expects future MWh sales to have minimal underlying growth for the next two decades, 0.3% per year. The commercial sector is forecasted to have the largest share of annual MWh sales, followed by the residential and industrial sectors.

TABLE 3-1 PROJECTED ELECTRIC MWH SALES BY SECTOR FOR 2021 TO 2040

Year	Residential Electric Sales (MWh)	Commercial & Other[38] Electric Sales (MWh)	Industrial Electric Sales (MWh)	Total Electric Sales (MWh)
2021	584,461	1,215,458	360,904	2,160,822
2022	588,057	1,223,764	360,254	2,172,074
2023	591,616	1,231,024	359,939	2,182,579
2024	595,070	1,237,705	359,532	2,192,307
2025	598,418	1,243,834	359,591	2,201,843
2026	601,676	1,249,702	359,782	2,211,160
2027	604,827	1,255,220	359,630	2,219,677
2028	607,845	1,260,402	359,485	2,227,732
2029	610,945	1,264,937	359,361	2,235,243
2030	613,606	1,269,009	359,235	2,241,851
2031	616,363	1,272,661	359,095	2,248,119
2032	618,913	1,275,699	358,849	2,253,462
2033	621,270	1,278,258	358,626	2,258,153

[38] The "Other" sales category includes streetlighting, traffic signals and other electricity using equipment.

Year	Residential Electric Sales (MWh)	Commercial & Other[38] Electric Sales (MWh)	Industrial Electric Sales (MWh)	Total Electric Sales (MWh)
2034	623,461	1,280,553	358,356	2,262,370
2035	625,885	1,282,333	358,078	2,266,296
2036	627,795	1,283,821	357,771	2,269,387
2037	629,626	1,285,730	357,379	2,272,736
2038	631,404	1,288,082	356,940	2,276,427
2039	633,625	1,290,912	356,483	2,281,020
2040	635,342	1,294,374	356,002	2,285,718

3.4 DEMAND FORECAST

Table 3-2 shows the forecast of total BWL electric system peak demand (in MW) for the BWL service area for the period 2021 to 2040. GDS developed a sector level (e.g., residential, commercial, industrial) forecast of peak demand using load factor data developed by GDS for the 2016 BWL energy efficiency potential study. GDS created this sector level peak demand forecast as such a sector level forecast was not available from BWL.

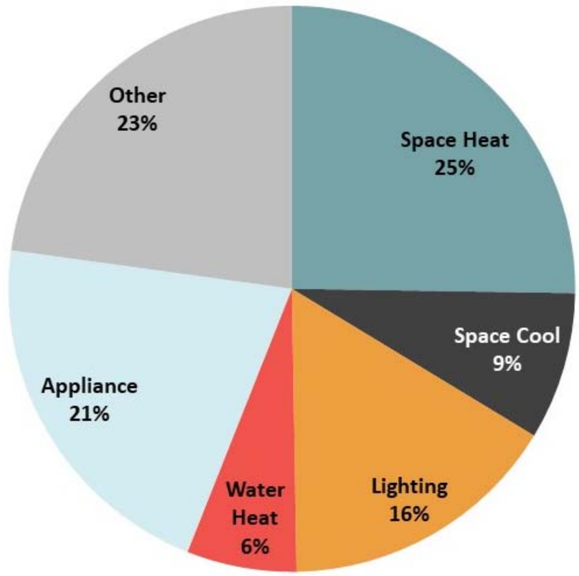
TABLE 3-2 PROJECTED SYSTEM ELECTRIC MW PEAK FOR 2021 TO 2040

Year	System Peak Forecast (MW)	Year	System Peak Forecast (MW)
2021	448	2031	464
2022	450	2032	464
2023	452	2033	466
2024	453	2034	467
2025	456	2035	468
2026	458	2036	467
2027	459	2037	469
2028	459	2038	469
2029	462	2039	470
2030	463	2040	470

3.5 RESIDENTIAL MARKET SEGMENTATION AND END USE BREAKDOWN

Figure 3-4 and Table 3-3 show the breakdown prepared by GDS of expected BWL residential sector annual electricity consumption in 2021 by end use for the BWL residential sector. Space heating and appliances account for nearly half of the consumption. Space cooling, lighting, and water heating account for nearly a third of the consumption. Other consumption is mostly household electronics.

FIGURE 3-4 2021 BWL RESIDENTIAL ELECTRICITY CONSUMPTION (MWH) BY END USE



The percentage breakdown of residential MWh sales by end use are provided in Table 3-3.

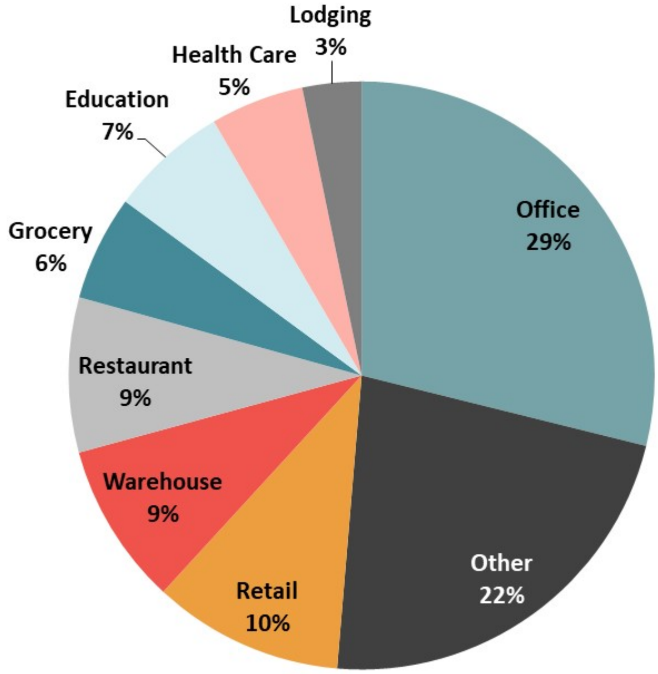
TABLE 3-3 2021 BWL RESIDENTIAL SECTOR ELECTRIC ENERGY CONSUMPTION BY END USE

End Use	Residential Electricity Consumption (MWh)	Percent of Total Residential Sector Sales
Space Heat	147,529	25.2%
Space Cool	49,316	8.4%
Lighting	93,761	16.0%
Water Heat	36,667	6.3%
Appliance	123,694	21.2%
Other	133,382	22.8%
Total	**584,350**	**100%**

3.6 NON-RESIDENTIAL MARKET SEGMENTATION AND END USE BREAKDOWN

Figure 3-5 and Table 3-4 show the breakdown prepared by GDS of expected BWL 2021 commercial sector annual electricity consumption by building type for the BWL commercial sector. The Office market sector (29%) contributes the largest share of commercial electricity consumption, followed by the Other (18%) category and Retail buildings (11%).

FIGURE 3-5 2021 BWL COMMERCIAL ELECTRICITY CONSUMPTION (MWH) BY BUSINESS TYPE



The percentage breakdown of commercial sector electricity consumption by business type shown in Figure 3-5 was developed from actual utility data and from the EIA CBECS data and applied to all years in the study period.

TABLE 3-4 2021 BWL COMMERCIAL SECTOR ELECTRIC ENERGY CONSUMPTION BY BUSINESS TYPE

Business Type	BWL Commercial Electricity Consumption (MWh)	Percent of Total Commercial Sector Sales
Office	373,492	28.9%
Other	290,998	22.5%
Retail	135,972	10.5%
Warehouse	115,662	8.9%
Food Service	110,203	8.5%
Food Sales	74,899	5.8%
Education	84,255	6.5%
Health Care	66,765	5.2%
Lodging	42,128	3.3%
Total	**1,294,374**	**100.0%**

The breakdown of BWL 2021 industrial sector MWh sales prepared by GDS is presented in Figure 3-6 and Table 3-5, Transportation Equipment (38% of annual industrial electricity sales) is the largest sector, followed by Primary Metals (19%) and Fabricated Metal at (6%). Reviewing and understanding information on BWL sales of electricity by C&I market segments is an important step in the development of the estimates of future energy efficiency savings potential. Figure 3-6 along with Table 3-4 and Table 3-5 provide the actual market segment percentage breakdown for the BWL's C&I electricity sales. Industrial segmentation by industry type was the same as was estimated for the 2016 study based on information provided by BWL on number of customers in each industry type category along with assumed size of facility based on the industry type.

FIGURE 3-6 BWL 2021 INDUSTRIAL ELECTRICITY CONSUMPTION (MWH) BY INDUSTRY TYPE

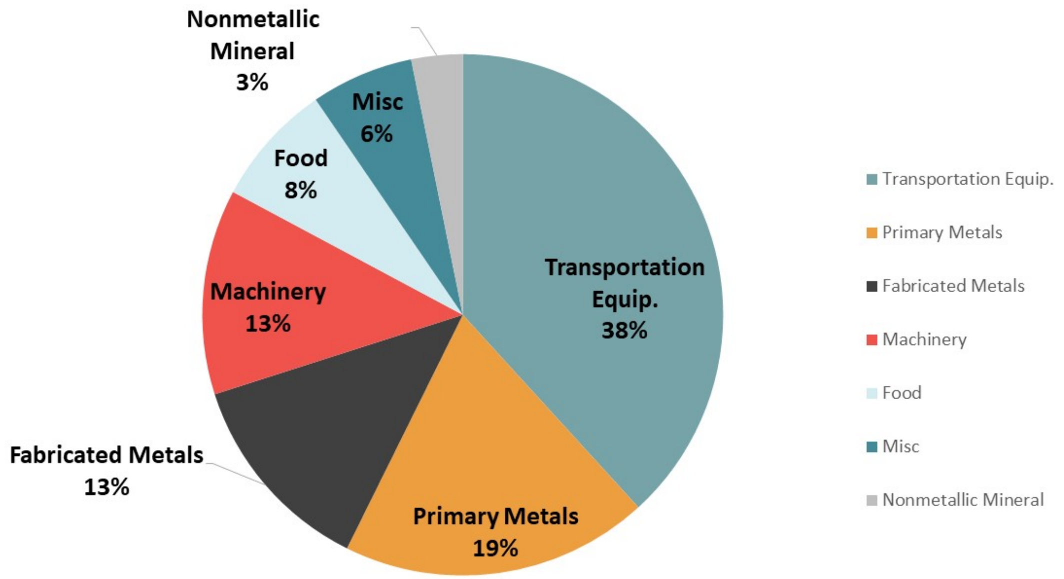


TABLE 3-5 BWL INDUSTRIAL ENERGY CONSUMPTION BY INDUSTRY TYPE

Industry Type	BWL Industrial Electricity Consumption (MWh)	Electricity Share
Transportation Equip.	136,064	38.2%
Primary Metals	68,032	19.1%
Fabricated Metals	45,355	12.7%
Machinery	45,355	12.7%
Food	27,199	7.6%
Misc.	22,677	6.4%
Nonmetallic Mineral	11,321	3.2%
Total	**356,002**	**100%**

Table 3-6 shows the breakdown of BWL expected 2021 electric energy consumption prepared by GDS by commercial building type and end use. The EIA CBECS 2012[39] results released in May 2016 (CBECS) were used to allocate energy consumption results to different end-uses for the Study.

Table 3-7 shows the end-use energy breakdown for BWL annual industrial sector MWh sales by market segment. Machine drives represent the largest end use, followed by facility HVAC and process heating.

[39] http://www.eia.gov/consumption/commercial/

TABLE 3-6 BWL COMMERCIAL ELECTRICITY SALES BY BUILDING TYPE AND END-USE

	Food Sales	Education	Food Service	Health Care	Lodging	Retail	Office	Warehouse	Other
Miscellaneous	8%	11%	21%	14%	14%	15%	14%	9%	0%
Lighting	26%	34%	21%	48%	59%	47%	44%	61%	57%
Ventilation	4%	25%	12%	18%	7%	10%	10%	9%	22%
Cooling	4%	12%	8%	8%	6%	9%	8%	3%	9%
Refrigeration	51%	4%	28%	2%	4%	6%	4%	12%	6%
Office Equipment	3%	9%	2%	6%	3%	2%	15%	3%	2%
Space Heating	3%	3%	4%	2%	5%	7%	4%	1%	3%
Water Heating	1%	2%	3%	1%	3%	4%	1%	1%	0%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

TABLE 3-7 BWL INDUSTRIAL ENERGY CONSUMPTION BY INDUSTRY TYPE AND END USE

	Food	Textile Mill Products	Wood	Printing	Petroleum	Chemicals	Plastics & Rubber
Conventional Boiler Use	3%	1%	0%	1%	2%	1%	1%
Process Heating	5%	9%	5%	6%	3%	4%	0%
Process Cooling and Refrigeration	28%	6%	2%	1%	1%	5%	5%
Machine Drive	43%	47%	51%	72%	75%	46%	83%
Electro-Chemical Processes	0%	1%	0%	1%	1%	1%	0%
Other Process Use	1%	1%	2%	1%	4%	1%	2%
Facility HVAC (g)	8%	16%	22%	6%	4%	24%	4%
Facility Lighting	8%	15%	13%	8%	4%	9%	3%
Other Facility Support	2%	3%	2%	2%	1%	3%	1%
Onsite Transportation	0%	0%	0%	0%	0%	0%	0%
Other Non-Process Use	0%	0%	0%	1%	0%	1%	0%
End Use Not Reported	2%	1%	1%	2%	4%	4%	2%

	Food	Textile Mill Products	Wood	Printing	Petroleum	Chemicals	Plastics & Rubber
Total Industrial	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

4 Energy Efficiency Potential Estimates

4.1 RESIDENTIAL SECTOR

This section provides electric energy efficiency potential estimates for the residential sector in BWL's service area. Estimates of technical, economic and achievable potential are provided.

4.1.1 Residential Energy Efficiency Measures Examined

For the residential sector, there were 572 total electric savings measures included in the analysis.[40] Table 4-1 provides a brief description of the types of energy efficiency measures included for each end use in the residential sector. The list of measures was developed based on a review of the MEMD and energy efficiency measures found in other residential potential studies and TRMs from the Midwest. Measure data includes incremental costs, electric energy and demand savings, natural gas savings, and measure lives.

TABLE 4-1 MEASURES AND PROGRAMS INCLUDED IN THE ELECTRIC RESIDENTIAL SECTOR ANALYSIS

End Use Type	End Use Description	Measures Included
HVAC Envelope	Building envelope upgrades	– Air/duct sealing – Duct insulation and duct sealing – Improved insulation – Efficient windows – Window film – Cool roofs
HVAC Equipment	Heating/cooling/ventilation equipment	– Existing central AC tune-up – Efficient air-source heat pump – Dual fuel heat pumps – Geothermal heat pumps – Ductless mini-split systems – Efficient central AC systems – Programmable thermostats – Efficient room air conditioners – Room air conditioner recycling – Efficient chillers – Chiller controls – Efficient furnace fans
Water Heating	Domestic hot water	– Heat pump water heater – Solar water heater – Low flow showerhead/faucet aerator – Gravity film heat exchangers – Pipe wrap – Restriction valves (ShowerStart / TubSpout)
Lighting	Interior/exterior lighting	– Standard LED bulbs – Specialty LED bulbs

[40] This total represents the number of unique electric energy efficiency measures and all permutations of these unique measures. For example, there are 16 permutations of the ENERGY STAR Clothes Washer measure to account for the various housing types, water heating type and presence and fuel type of dryers.

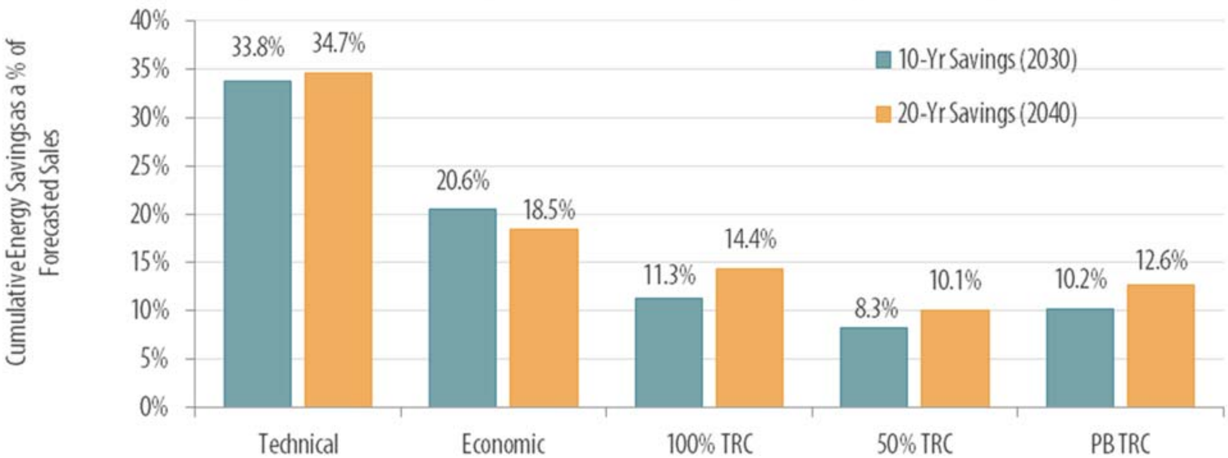
End Use Type	End Use Description	Measures Included
		– Efficient fluorescent tube lighting – LED night lights – Occupancy sensors – CFLs
Appliances	High-efficiency appliances / retirement of inefficient appliances	– ENERGY STAR clothes washers – ENERGY STAR refrigerator – ENERGY STAR freezers – ENERGY STAR dishwashers – ENERGY STAR dehumidifiers – ENERGY STAR dryers – Secondary refrigerator/freezer recycling – Dehumidifier recycling – ENERGY STAR Air Purifier
Electronics	High efficiency consumer electronics	– Controlled power strips – Efficient set-top boxes – ENERGY STAR desktops – Efficient laptops – Efficient televisions – LCD Monitors
Behavioral	Consumer response to feedback from utility and smartphone applications	– Home energy reports – Mobile applications
Other	Efficient pool equipment	– Efficient pool pump motors

4.1.2 Results Summary

This section presents estimates for electric technical, economic, and achievable potential for the residential sector. Each of the tables in the technical, economic and achievable sections present the respective potential for energy efficiency savings expressed as cumulative annual energy savings (MWh), percentage of savings by end use, and savings as a percentage of forecast MWh sales. Data is provided on a 10-year and 20-year time horizon.

Figure 4-1 illustrates the estimated savings potential for each of the scenarios included in this study.

FIGURE 4-1 RESIDENTIAL ENERGY EFFICIENCY POTENTIAL AS A % OF FORECASTED SALES



The potential estimates are expressed as cumulative annual 10-year and 20-year savings, as percentages of the respective 2030 and 2040 sector sales forecast. The technical potential is 33.8% in 2030 and 34.7% in 2040. The 10-year and 20-year economic potential is 20.6% and 18.5% based on the TRC screening results.[41] For the achievable potential scenarios, the 10-year and 20-year 100% TRC achievable potential savings are 11.3% and 14.4%; the 10-year and 20-year 50% TRC achievable potential savings are 8.3% and 10.1%; and the 10-year and 20-year PB TRC achievable potential savings are 10.2% and 12.6%.

4.1.3 Technical Potential

Technical potential represents the quantification of savings that can be realized if all technologically available energy-efficiency measures are adopted in all feasible instances, regardless of cost. Table 4-2 shows that it is technically feasible to save more than 200,000 MWh in the residential sector across the 10-yr and 20-yr timeframes, representing 33.8% of 10-year residential sales, and 34.7% of 20-year residential sales. The HVAC Equipment end-use is the greatest contributor to the technical potential, with Appliances, Electronics, Water Heating, HVAC Shell, and Lighting each accounting for between 9% and 12% of 20-yr potential. Table 4-3 shows the peak demand savings potential in 2030 and 2040. The 10-yr and 20-yr summer peak demand savings technical potential is 44 MW and 55 MW, respectively.

TABLE 4-2 RESIDENTIAL SECTOR TECHNICAL POTENTIAL ENERGY SAVINGS BY END USE

End Use	2030 Energy (MWh)	% of 2030 Savings	2040 Energy (MWh)	% of 2040 Savings
Lighting	18,133	8.8%	19,900	9.0%
Appliances	38,513	18.6%	25,985	11.8%
Electronics	26,543	12.8%	26,812	12.2%
Water Heating	21,282	10.3%	25,391	11.5%
HVAC Shell	17,523	8.5%	22,096	10.0%
HVAC Equipment	74,896	36.2%	89,714	40.8%

[41] The 20 year economic potential is less than the 10-year economic potential because the opportunities for MWh savings from refrigerator recycling are exhausted in between the 10-year and 20-year timeframe, and, as a result, the MWh savings after 20 years are less than the savings after 10 years. This decline in MWh savings due to the decline in refrigerator recycling savings opportunities appear in the Economic Potential for the Residential Sector in Figure 4-1 and appear in the Appliances end use category in Table 4-2.

End Use	2030 Energy (MWh)	% of 2030 Savings	2040 Energy (MWh)	% of 2040 Savings
Miscellaneous	3,042	1.5%	3,053	1.4%
Cross-Cutting	7,198	3.5%	7,126	3.2%
Total	**207,131**	**100.0%**	**220,078**	**100.0%**
% of Annual Sales Forecast	***33.8%***		***34.7%***	

TABLE 4-3 RESIDENTIAL SECTOR TECHNICAL POTENTIAL DEMAND SAVINGS

	2030 Demand Savings (MW)	% of 2030 Forecast Peak	2040 Demand Savings (MW)	% of 2040 Forecast Peak*
Total System	44	25.1%	55	30.5%

**The forecast of BWL residential sector peak demand was estimated by GDS and is not a forecast provided by BWL.*

4.1.4 Economic Potential

Economic potential is a subset of technical potential, which only accounts for measures that are cost-effective based on the TRC Test. 40% of all residential energy efficiency measures that were included in the electric potential analysis passed the TRC screening.

Table 4-4 indicates that the economic potential is more than 126,000 MWh (on a cumulative annual basis) during the 10-year period from 2021 to 2030, and the economic potential is 117,000 MWh during the 20-year period from 2021 to 2040. This represents 20.6% and 18.5% of residential sales across the respective 10-year and 20-year timeframes. HVAC Equipment is the leading end use for energy efficiency savings, followed by Appliances, Lighting, HVAC Shell and Electronics.

Table 4-5 shows the demand savings potential in 2030 and 2040. The 10-yr and 20-yr summer peak demand savings potential is 19 MW and 20 MW, respectively.

TABLE 4-4 RESIDENTIAL ECONOMIC POTENTIAL ENERGY SAVINGS BY END USE

End Use	2030 Energy (MWh)	% of 2030 Savings	2040 Energy (MWh)	% of 2040 Savings
Lighting	14,097	11.2%	15,856	13.5%
Appliances	33,209	26.3%	18,130	15.5%
Electronics	14,154	11.2%	14,356	12.3%
Water Heating	7,788	6.2%	8,003	6.8%
HVAC Shell	11,858	9.4%	14,576	12.4%
HVAC Equipment	34,897	27.7%	35,923	30.7%
Miscellaneous	3,042	2.4%	3,053	2.6%
Cross-Cutting	7,013	5.6%	7,222	6.2%
Total	**126,057**	**100.0%**	**117,119**	**100.0%**
% of Annual Sales Forecast	***20.6%***		***18.5%***	

TABLE 4-5 RESIDENTIAL ECONOMIC POTENTIAL DEMAND SAVINGS

	2030 Demand Savings (MW)	% of 2030 Forecast Peak	2040 Demand Savings (MW)	% of 2040 Forecast Peak*
Total System	19	10.9%	20	11.4%

**The forecast of residential sector peak demand was developed by GDS and is not a forecast provided by BWL.*

4.1.5 Achievable Potential – 100% TRC

The Achievable Potential – 100% TRC scenario provides an estimate of energy efficiency savings that can feasibly be achieved given market barriers and equipment replacement cycles with incentives equal to 100% of the incremental measure cost. Unlike the economic potential, the residential achievable potential considers the estimated market adoption of energy efficiency measures based on the incentive level and the natural replacement cycle of equipment.

Table 4-6 shows the estimated cumulative annual savings for the Achievable Potential – 100% TRC scenario over 10-yr and 20-yr time horizons. Table 4-7 shows the peak demand savings in 2030 and 2040, respectively.

TABLE 4-6 RESIDENTIAL ACHIEVABLE POTENTIAL – 100% TRC ENERGY SAVINGS BY END USE

End Use	2030 Energy (MWh)	% of 2030 Savings	2040 Energy (MWh)	% of 2040 Savings
Lighting	7,759	11.2%	13,023	14.3%
Appliances	20,997	30.3%	18,558	20.3%
Electronics	9,167	13.2%	11,470	12.6%
Water Heating	3,545	5.1%	6,337	6.9%
HVAC Shell	5,878	8.5%	10,862	11.9%
HVAC Equipment	14,441	20.8%	22,634	24.8%
Miscellaneous	1,338	1.9%	2,439	2.7%
Cross-Cutting	6,237	9.0%	6,041	6.6%
Total	69,362	100.0%	91,364	100.0%
% of Annual Sales Forecast	***11.3%***		***14.4%***	

TABLE 4-7 RESIDENTIAL ACHIEVABLE POTENTIAL – 100% TRC DEMAND SAVINGS

	2030 Demand Savings (MW)	% of 2030 Forecast Peak	2040 Demand Savings (MW)	% of 2040 Forecast Peak*
Total System	10.9	6.2%	16.2	9.0%

* *The forecast of residential sector peak demand was developed by GDS and is not a forecast provided by BWL.*

4.1.6 Achievable Potential – 50% TRC

The Achievable Potential – 50% TRC scenario provides an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles with incentives equal to 50% of the incremental measure cost.

Table 4-8 shows the estimated cumulative annual savings for the Achievable Potential – 50% TRC scenario over 10-year and 20-year time horizons. Table 4-9 shows the peak demand savings 2030 and 2040, respectively.

TABLE 4-8 RESIDENTIAL ACHIEVABLE – 50% TRC ENERGY SAVINGS BY END USE

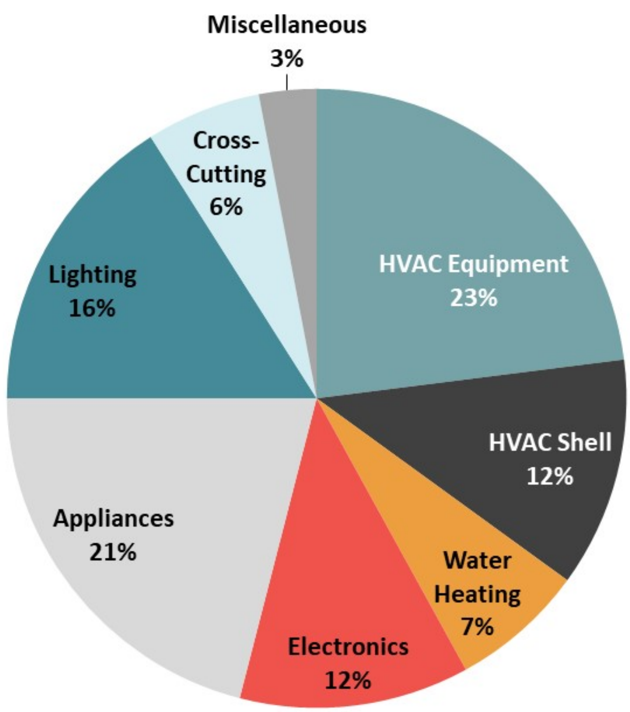
End Use	2030 Energy (MWh)	% of 2030 Savings	2040 Energy (MWh)	% of 2040 Savings
Lighting	6,053	11.9%	10,066	15.8%
Appliances	16,462	32.3%	13,285	20.8%
Electronics	6,283	12.3%	7,854	12.3%
Water Heating	2,653	5.2%	4,668	7.3%
HVAC Shell	4,230	8.3%	7,477	11.7%
HVAC Equipment	10,048	19.7%	14,636	22.9%
Miscellaneous	922	1.8%	1,679	2.6%
Cross-Cutting	4,294	8.4%	4,158	6.5%
Total	50,945	100.0%	63,822	100.0%
% of Annual Sales Forecast	***8.3%***		***10.1%***	

TABLE 4-9 RESIDENTIAL ACHIEVABLE POTENTIAL – 50% TRC DEMAND SAVINGS

	2030 Demand Savings (MW)	% of 2030 Forecast Peak	2040 Demand Savings (MW)	% of 2040 Forecast Peak
Total System	8.2	4.7%	11.6	6.4%

Figure 4-2 shows the percentage of electric savings by each end use for the Achievable Potential – 50% TRC scenario. HVAC Equipment represents 23% of the total electric savings. Appliances, HVAC Shell, Electronics, and Lighting contribute at least 12% each of the total electric savings.

FIGURE 4-2 RESIDENTIAL ACHIEVABLE – 50% TRC ENERGY SAVINGS BY END USE



4.1.7 Achievable Potential – PB TRC

The Achievable Potential – PB TRC scenario provides an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles with incentives set to yield a customer payback of no more than 5 years.

Table 4-10 shows the estimated cumulative annual savings for the Achievable Potential – PB TRC scenario over 10-yr and 20-yr time horizons. Table 4-11 shows the peak demand savings in 2030 and 2040, respectively.

TABLE 4-10 RESIDENTIAL ACHIEVABLE POTENTIAL – PB TRC ENERGY SAVINGS BY END USE

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Lighting	7,753	12.4%	13,516	16.9%
Refrigeration	19,690	31.5%	16,793	20.9%
Ventilation	8,696	13.9%	10,874	13.6%
Space Cooling	3,376	5.4%	6,027	7.5%
Miscellaneous	4,720	7.5%	8,452	10.5%
Office Equipment	11,602	18.5%	17,425	21.7%
Space Heating	668	1.1%	1,214	1.5%
Behavioral	6,057	9.7%	5,866	7.3%
Water Heating	62,563	122.8%	80,167	125.6%
Total	7,753	12.4%	13,516	16.9%
% of Annual Sales Forecast	***10.2%***		***12.6%***	

TABLE 4-11 RESIDENTIAL ACHIEVABLE POTENTIAL – PB TRC DEMAND SAVINGS

End Use	2030 Demand Savings (MW)	% of 2030 Forecast Peak	2040 Demand Savings (MW)	% of 2040 Forecast Peak*
Total System	9.1	5.2%	12.8	7.1%

* *The forecast of residential sector peak demand was developed by GDS and is not a forecast provided by BWL.*

4.1.8 Achievable Potential Benefits & Costs

Table 4-12 below provide the NPV benefits and costs in the residential sector for all three achievable potential scenarios across the 10-year and 20-year time periods. The Achievable Potential 50% TRC scenario provides the greatest net benefits of the three scenarios and the benefit-cost ratios exceed 1.0 across the next 10-yr and 20-yr periods.[42]

TABLE 4-12 RESIDENTIAL ACHIEVABLE POTENTIAL BENEFIT-COST RATIOS

	NPV Benefits	NPV Costs	B/C Ratio	Net Benefits
10-yr				
Achievable 100% TRC	$19,757,422	$19,720,497	1.00	$36,925
Achievable 50% TRC	$14,989,616	$14,665,412	1.02	$324,203
Achievable PB TRC	$15,354,412	$17,282,663	0.89	-$1,928,251

[42] It is important to note that the initial economic screening of individual energy efficiency measures included only incremental measure costs and did not include any "other" utility costs for program administration and management, data tracking and reporting, marketing and program evaluation. The economic screening for program portfolios for each sector does include these "other" utility costs. This explains why some of the benefit/cost ratios for program portfolios are less than 1.0.

	NPV Benefits	NPV Costs	B/C Ratio	Net Benefits
20-yr				
Achievable 100% TRC	$34,236,362	$36,791,466	0.93	-$2,555,104
Achievable 50% TRC	$25,151,937	$23,442,313	1.07	$1,709,624
Achievable PB TRC	$25,794,616	$28,166,283	0.92	-$2,371,667

Year by year budgets for all three scenarios, broken out by incentive and administrative costs are depicted in Table 4-13. The Achievable Potential 50% TRC budgets range from $0.7 million to $1.9 million over the next 20 years.

TABLE 4-13 RESIDENTIAL SECTOR ACHIEVABLE POTENTIAL ANNUAL BUDGETS ($, IN MILLIONS)

	Achievable 100% TRC	Achievable 50% TRC	Achievable PB TRC
2021	$1.2	$0.7	$0.8
2022	$1.5	$0.9	$1.0
2023	$1.8	$1.0	$1.1
2024	$2.0	$1.1	$1.2
2025	$2.3	$1.2	$1.4
2026	$2.6	$1.3	$1.6
2027	$3.0	$1.5	$1.8
2028	$3.3	$1.6	$2.0
2029	$3.6	$1.8	$2.2
2030	$3.9	$1.9	$2.4
2031	$3.5	$1.7	$2.1
2032	$3.4	$1.7	$2.1
2033	$3.3	$1.6	$2.0
2034	$3.2	$1.6	$2.0
2035	$3.1	$1.6	$2.0
2036	$3.3	$1.7	$2.1
2037	$3.3	$1.7	$2.1
2038	$3.3	$1.7	$2.1
2039	$3.3	$1.8	$2.2
2040	$3.3	$1.8	$2.2

4.2 COMMERCIAL SECTOR

This section provides electric energy efficiency potential estimates for the commercial sector in BWL's service area. Estimates of technical, economic and achievable potential are provided.

4.2.1 Electric Energy Efficiency Measures Examined

For the commercial sector, there were 229 unique energy efficiency measures included in the analysis.[43] Table 4-14 provides a brief description of the types of energy efficiency measures included for each end use in the commercial sector. The list of measures was developed based on a review of the latest MEMD, measures found in other TRMs, and measures included in other commercial sector energy efficiency potential studies. Measure data includes incremental costs, electric energy and demand savings, natural gas savings, and measure life. Data Center energy efficiency measures are included in the office equipment end-use category for the C&I sectors. Office equipment measures include energy efficient computers, Energy Star uninterruptible power supplies (UPS) and smart strip plug outlets which benefit all office environments, including data centers. Besides general office energy efficiency measures, the potential study includes six specific data center related measures, including high efficiency CRAC units, VFDs for CRAC units, ECM plug fans, computer room hot aisle/cold aisle configurations, computer room air side economizers and computer room air-side heat exchangers.

TABLE 4-14 COMMERCIAL SECTOR ELECTRIC ENERGY EFFICIENCY MEASURES

End Use Type / Description	Measures Included	
Office Equipment	– Appliances – High Efficiency Office Equipment – Smart Power Strips	– Computer Energy Management Controls – Computer Room Upgrades
Compressed Air	– Efficient Air Compressors – Automatic Drains – Cycling and High Efficiency Dryers – Low Pressure Drop-Filters	– Air-Entraining Air Nozzles – Receiver Capacity Addition – Compressed Air Audits, Leak Repair, and Flow Control
Cooking	– Efficient Cooking Equipment	
Envelope	– Building Envelope Improvements – Cool Roofing	– Integrated Building Design
HVAC Controls	– Smart Thermostats – EMS Installation/Optimization	– Hotel Guest Room Occupancy Control System – Retrocommissioning & Commissioning
Lighting	– Efficient Lighting Equipment – Fixture Retrofits – High Bay Lighting Equipment – LED Bulbs and Fixtures	– Light Tube – Lighting Controls – Efficient Design for New Construction – LED Traffic Signals and Street Lighting
Other	– Efficient Transformers – Optimized Snow and Ice Melt Controls	– Engine Block Heater Timer – Efficient Machine Belt on Motors
Pools	– Efficient Equipment and Controls	– Heat Pump Pool Heaters

[43] This total represents the number of unique electric energy efficiency measures and all permutations of these unique measures. For example, there are 16 permutations of the ENERGY STAR Clothes Washer measure to account for the various housing types, water heating type and presence and fuel type of dryers.

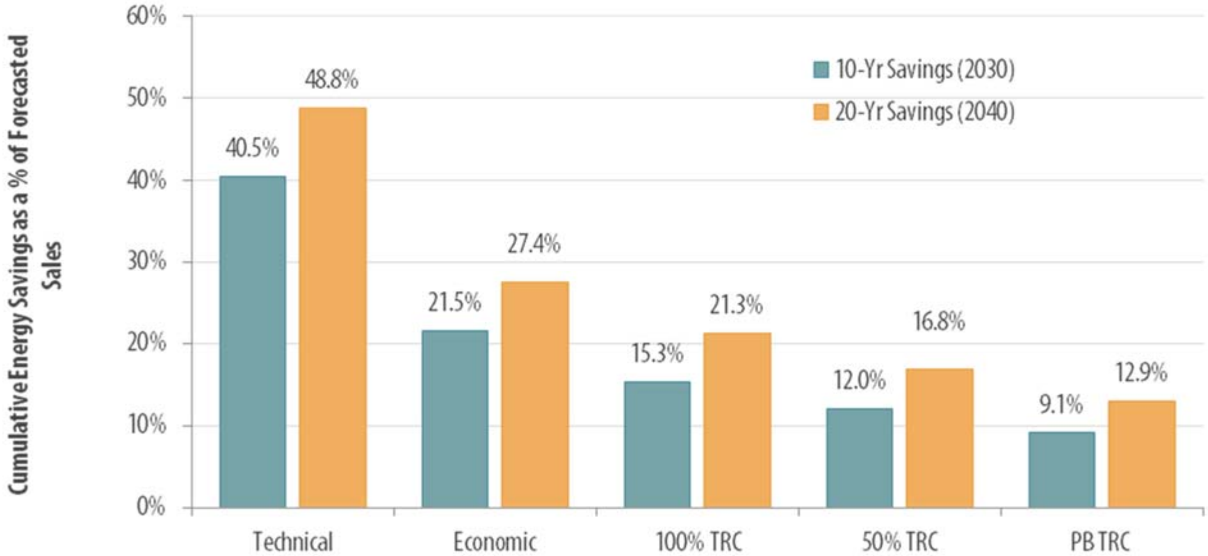
End Use Type / Description	Measures Included	
Refrigeration	– Vending Misers – Refrigerated Case Covers – Economizers – Efficient Refrigeration – Upgrades Motors and Controls	– Door Heater Controls – Efficient Compressors and Controls – Door Gaskets and Door Retrofits – Refrigerant Charging Correction – Ice-Makers
Space Cooling	– Efficient Chillers – Efficient Cooling Equipment – Ground/Water Source Heat Pump	– Chiller Tune-up/Diagnostics – High Efficiency Pumps
Space Heating	– Efficient Heating Equipment – Ground/Water Source Heat Pump	– Efficient Heating Pumps, Motors, and Controls
Ventilation	– Enthalpy Economizer – Variable Speed Drive Controls	– Destratification Fans – Demand Controlled Ventilation
Water Heating	– Efficient Equipment – High Efficiency HW Appliances – Low Flow Equipment	– Pipe and Tank Insulation – Heat Recovery Systems – Efficient HW Pump and Controls
Behavioral	– Strategic Energy Management (SEM) – Commercial Energy Report	– Whole-Building Modeling – In-Home Energy Use Displays

4.2.2 Results Summary

This section presents estimates for electric technical, economic, and achievable potential for the commercial sector. Each of the tables in the technical, economic and achievable sections present the respective potential for efficiency savings expressed as cumulative annual energy savings (MWh), percentage of savings by end use, and savings as a percentage of forecast MWh sales. Data is provided for 10-year and 20-year time horizons.

Figure 4-3 illustrates the estimated energy efficiency savings potential in the BWL service area for each of the scenarios included in this study.

FIGURE 4-3 COMMERCIAL ENERGY EFFICIENCY POTENTIAL AS A % OF FORECASTED SALES



The potential estimates are expressed as cumulative 10-year and 20-year savings, as percentages of the respective 2030 and 2040 sector sales. The technical potential is 40.5% in 2030 and 48.8% in 2040. The 10-year and 20-year economic potential is 21.5% and 27.4% based on the TRC screening results. For the achievable potential scenarios, the 10-year and 20-year 100% TRC achievable potential savings are 15.3% and 21.3%; the 10-year and 20-year 50% TRC achievable potential savings are 12.0% and 16.8%; and the 10-year and 20-year PB TRC achievable potential savings are 9.1% and 12.9%.

4.2.3 Technical Potential

Technical potential represents the quantification of savings that can be realized if energy-efficiency measures passing the qualitative screening are applied in all feasible instances, regardless of cost effectiveness. Table 4-15 shows that it is technically feasible to save approximately 514,000 MWh on a cumulative annual basis in the commercial sector by 2030, and approximately 632,000 MWh annually by 2040 across the BWL territory, representing 40.5% of the commercial sales forecast in 2030, and 48.8% of the commercial sales forecast in 2040. Lighting represents most of the technical energy efficiency savings potential at 42% of 20-Year savings followed by Ventilation at 13% and Space Cooling at 11%. Table 4-16 shows the peak demand technical potential savings in 2030 and 2040. The 10-yr and 20-yr summer peak demand savings technical potential is 104 MW and 128 MW, respectively.

TABLE 4-15 COMMERCIAL SECTOR TECHNICAL POTENTIAL ENERGY SAVINGS BY END USE

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Lighting	197,985	39%	266,629	42%
Ventilation	76,937	15%	82,164	13%
Space Cooling	58,043	11%	70,361	11%
Refrigeration	56,169	11%	65,549	10%
Behavioral	36,922	7%	43,549	7%
Miscellaneous	27,577	5%	34,751	5%
Office Equipment	28,718	6%	31,430	5%

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Space Heating	22,462	4%	28,105	4%
Water Heating	8,960	2%	9,649	2%
Total	**513,773**	**100%**	**632,186**	**100%**
% of Annual Sales Forecast	***40.5%***		***48.8%***	

TABLE 4-16 COMMERCIAL SECTOR TECHNICAL POTENTIAL DEMAND SAVINGS

End Use	2030 Demand Savings (MW)	% of 2030 Forecast Peak	2040 Demand Savings (MW)	% of 2040 Forecast Peak*
Total System	104	46.7%	128	57.2%

** The forecast of commercial sector peak demand was developed by GDS and is not a forecast provided by BWL.*

4.2.4 Economic Potential

Economic potential is a subset of technical potential, which only accounts for measures that are cost-effective based on the TRC Test. 47% of all measures that were included in the commercial sector electric potential analysis passed the TRC screening.

Table 4-17 indicates that the economic potential based on the TRC screen is approximately 272,824 MWh on a cumulative annual basis by 2030 and 355,291 MWh by 2040. This represents 21.5% and 27.4% of forecast BWL commercial MWh sales in 2030 and 2040, respectively. Lighting, refrigeration and ventilation energy efficiency measures make up most of the economic potential savings. Table 4-18 shows the peak demand savings economic potential in 2030 and 2040. The ten and twenty-year summer peak demand savings economic potential is 45 MW and 59 MW.

TABLE 4-17 COMMERCIAL SECTOR ECONOMIC POTENTIAL ENERGY SAVINGS BY END USE

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Lighting	120,312	44%	179,702	51%
Refrigeration	38,973	14%	44,999	13%
Ventilation	33,284	12%	35,744	10%
Space Cooling	23,781	9%	28,195	8%
Miscellaneous	15,535	6%	20,566	6%
Office Equipment	15,751	6%	17,180	5%
Space Heating	9,577	4%	11,271	3%
Water Heating	8,148	3%	8,830	2%
Behavioral	7,464	3%	8,803	2%
Total	**272,824**	**100%**	**355,291**	**100%**
% of Annual Sales Forecast	***21.5%***		***27.4%***	

TABLE 4-18 COMMERCIAL ECONOMIC POTENTIAL DEMAND SAVINGS

End Use	2030 Demand Savings (MW)	% of 2030 Forecast Peak	2040 Demand Savings (MW)	% of 2040 Forecast Peak*
Total Commercial Sector	45	20.2%	59	26.4%

** The forecast of commercial sector peak demand was developed by GDS and is not a forecast provided by BWL.*

4.2.5 Achievable Potential – 100% TRC

The Achievable Potential – 100% TRC scenario provides an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles with incentives equal to 100% of the incremental measure cost. Unlike the economic potential, the commercial achievable potential considers the estimated market adoption of energy efficiency measures based on the incentive level and the natural replacement cycle of equipment.

Table 4-19 shows the estimated cumulative annual savings for the Achievable Potential – 100% TRC scenario over 10-yr and 20-yr time horizons. Table 4-20 shows the peak demand savings in 2030 and 2040, respectively.

TABLE 4-19 COMMERCIAL ACHIEVABLE POTENTIAL – 100% TRC ENERGY SAVINGS BY END USE

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Lighting	86,171	44%	140,001	51%
Refrigeration	33,126	17%	40,217	15%
Ventilation	25,149	13%	27,091	10%
Space Cooling	16,201	8%	20,607	7%
Miscellaneous	8,030	4%	15,636	6%
Office Equipment	7,856	4%	10,664	4%
Space Heating	6,517	3%	7,466	3%
Behavioral	6,006	3%	7,084	3%
Water Heating	5,202	3%	6,876	2%
Total	**194,260**	**100%**	**275,642**	**100%**
% of Annual Sales Forecast	***15.3%***		***21.3%***	

TABLE 4-20 COMMERCIAL ACHIEVABLE POTENTIAL – 100% TRC DEMAND SAVINGS

End Use	2030 Demand Savings (MW)	% of 2030 Forecast Peak	2040 Demand Savings (MW)	% of 2040 Forecast Peak*
Total System	31	14.1%	45	20.0%

* *The forecast of commercial sector peak demand was developed by GDS and is not a forecast provided by BWL.*

4.2.6 Achievable Potential – 50% TRC

The Achievable Potential – 50% TRC scenario provides an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles with incentives equal to 50% of the incremental measure cost.

Table 4-21 shows the estimated cumulative annual savings for the Achievable Potential – 50% TRC scenario over 10-year and 20-year time horizons. Table 4-22 shows the peak demand savings 2030 and 2040, respectively.

TABLE 4-21 COMMERCIAL ACHIEVABLE POTENTIAL – 50% TRC ENERGY SAVINGS BY END USE

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Lighting	70,182	46%	113,386	52%
Refrigeration	27,856	18%	33,462	15%
Space Cooling	12,237	8%	16,251	7%
Miscellaneous	7,369	5%	14,112	6%
Ventilation	10,941	7%	12,070	6%
Office Equipment	7,029	5%	9,286	4%
Behavioral	6,006	4%	7,084	3%
Water Heating	5,033	3%	6,471	3%
Space Heating	5,011	3%	5,751	3%
Total	**151,663**	**100%**	**217,873**	**100%**
% of Annual Sales Forecast	***12.0%***		***16.8%***	

TABLE 4-22 COMMERCIAL ACHIEVABLE POTENTIAL – 50% TRC DEMAND SAVINGS

End Use	2030 Demand Savings (MW)	% of 2030 Forecast Peak	2040 Demand Savings (MW)	% of 2040 Forecast Peak
Total System	21	9.4%	32	14.1%

* *The forecast of commercial sector peak demand was developed by GDS and is not a forecast provided by BWL.*

Figure 4-4 shows the estimated commercial sector 20-Year cumulative annual energy efficiency savings potential broken out by end use across the entire commercial sector for the Achievable Potential – 50% TRC scenario. The lighting and refrigeration end-uses together account for 67% of the energy efficiency savings in this scenario.

FIGURE 4-4 2040 COMMERCIAL ACHIEVABLE POTENTIAL – 50% TRC ENERGY SAVINGS BY END USE

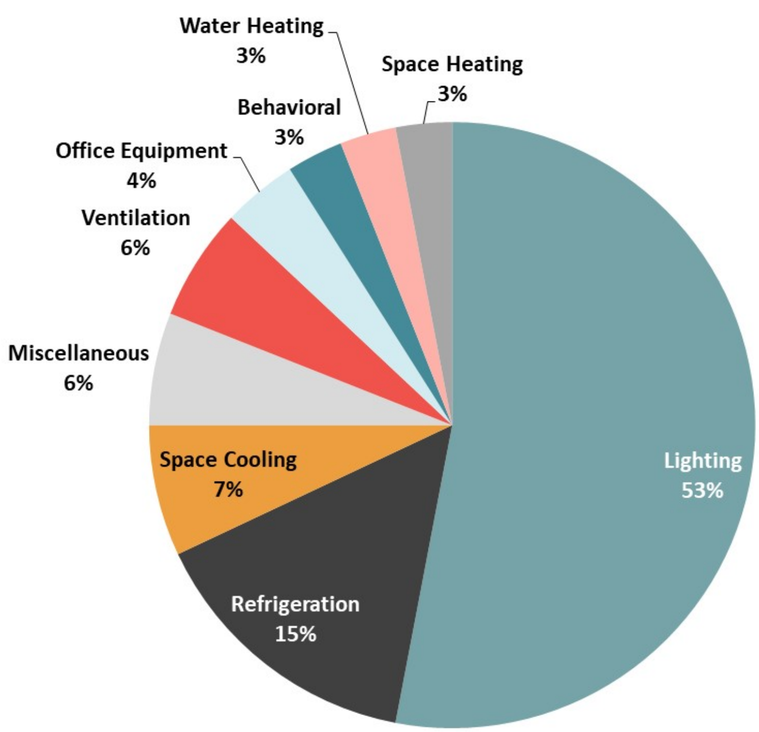
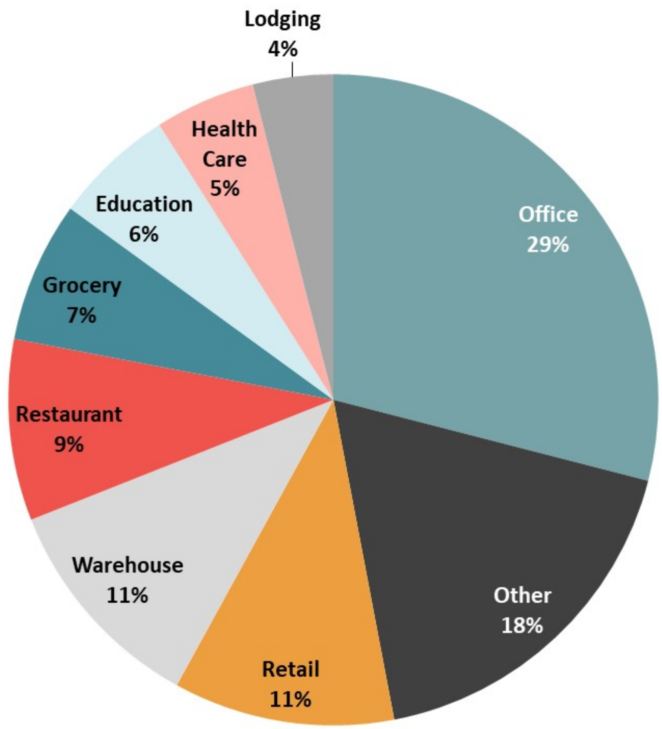


Figure 4-5 shows the breakdown of estimated savings in 2040 by building type for the Realistically Achievable Potential – 50% TRC scenario. Approximately 29% of the potential savings are found in Offices, followed by 18% in Other building types and 11% in Retail establishments.

FIGURE 4-5 2040 COMMERCIAL ACHIEVABLE POTENTIAL – 50% TRC ENERGY SAVINGS BY BUILDING TYPE



4.2.7 Achievable Potential – PB TRC

The Achievable Potential – PB TRC scenario provides an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles with incentives set to yield a customer payback of no more than 2 years.

Table 4-23 shows the estimated cumulative annual savings for the Achievable Potential – PB TRC scenario over 10-yr and 20-yr time horizons. Table 4-24 shows the peak demand savings in 2030 and 2040, respectively.

TABLE 4-23 COMMERCIAL ACHIEVABLE POTENTIAL – PB TRC ENERGY SAVINGS BY END USE

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Lighting	51,421	45%	85,335	51%
Ventilation	13,953	12%	15,182	9%
Space Cooling	8,724	8%	11,596	7%
Refrigeration	21,288	18%	25,892	15%
Behavioral	3,939	3%	4,646	3%
Miscellaneous	5,389	5%	10,407	6%
Office Equipment	4,178	4%	6,066	4%
Space Heating	3,484	3%	3,990	2%

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Water Heating	2,988	3%	4,103	2%
Total	**115,365**	**100%**	**167,216**	**100%**
% of Annual Sales Forecast	***9.1%***		***12.9%***	

TABLE 4-24 COMMERCIAL ACHIEVABLE POTENTIAL – PB TRC DEMAND SAVINGS

End Use	2030 Demand Savings (MW)	% of 2030 Forecast Peak	2040 Demand Savings (MW)	% of 2040 Forecast Peak
Total System	18	8.2%	26	11.4%

** The forecast of commercial sector peak demand was developed by GDS and is not a forecast provided by BWL.*

4.2.8 Achievable Potential Benefits & Costs

Table 4-25 and below provide the NPV benefits and costs in the commercial sector for all three achievable potential scenarios across the 10-year and 20-year time periods. The Achievable Potential 50% TRC scenario provides the greatest net benefits of the three scenarios and the benefit-cost ratios exceed 1.3 across the next 10-yr and 20-yr periods.

TABLE 4-25 COMMERCIAL ACHIEVABLE POTENTIAL BENEFIT-COST RATIOS

	NPV Benefits	NPV Costs	B/C Ratio	Net Benefits
10-yr				
Achievable 100% TRC	$49,487,764	$53,192,381	0.93	($3,704,617)
Achievable 50% TRC	$36,727,382	$26,455,966	1.39	$10,271,416
Achievable PB TRC	$28,200,204	$25,843,444	1.09	$2,356,759
20-yr				
Achievable 100% TRC	$83,004,038	$81,374,696	1.02	$1,629,342
Achievable 50% TRC	$63,989,717	$49,213,990	1.30	$14,775,727
Achievable PB TRC	$49,214,697	$44,626,225	1.10	$4,588,472

Annual budgets for the three achievable potential scenarios are presented in Table 4-26. The Achievable Potential 50% TRC annual budgets range from $1.3 million to $3.6 million over the next 20 years.

TABLE 4-26 COMMERCIAL SECTOR ACHIEVABLE POTENTIAL ANNUAL BUDGETS ($, IN MILLIONS)

	Achievable 100% TRC	Achievable 50% TRC	Achievable PB TRC
2021	$6.33	$1.25	$1.67
2022	$6.68	$1.49	$1.84
2023	$6.69	$1.73	$1.96
2024	$6.48	$1.95	$2.02
2025	$6.29	$2.22	$2.11
2026	$6.11	$2.47	$2.18
2027	$5.85	$2.62	$2.20
2028	$5.62	$2.71	$2.19
2029	$5.50	$2.79	$2.19
2030	$4.87	$2.76	$2.06
2031	$5.55	$3.13	$2.31

	Achievable 100% TRC	Achievable 50% TRC	Achievable PB TRC
2032	$5.54	$3.16	$2.32
2033	$5.63	$3.26	$2.37
2034	$5.64	$3.28	$2.39
2035	$5.66	$3.33	$2.42
2036	$6.56	$3.49	$2.71
2037	$6.63	$3.56	$2.77
2038	$6.54	$3.56	$2.77
2039	$6.41	$3.57	$2.76
2040	$6.19	$3.53	$2.71

4.3 INDUSTRIAL SECTOR

This section provides electric energy efficiency potential estimates for the industrial sector in BWL's service area. Estimates of technical, economic and achievable potential are provided.

4.3.1 Electric Energy Efficiency Measures Examined

For the industrial sector, there were 187 energy efficiency measures included in the energy savings potential analysis. Table 4-27 provides a brief description of the types of measures included for each end use in the industrial sector. The list of measures was developed based on a review of the latest MEMD, measures found in other TRMs, and measures included in other industrial sector energy efficiency potential studies. Measure data includes incremental costs, electric energy and demand savings, natural gas savings, and measure lives.

TABLE 4-27 INDUSTRIAL SECTOR ELECTRIC ENERGY EFFICIENCY MEASURES

End Use Type	Measures Included	
Computers & Office Equipment	– Energy Star office equipment including computers, monitors, copiers, multi-function machines. – PC Network Energy Management Controls replacing no central control – Energy Efficient "Smart" Power Strip for PC/Monitor/Printer	– Energy Star UPS – Energy Star compliant single door refrigerator – High Efficiency CRAC unit
Water Heating	– Low Flow Faucet Aerator – Tank Insulation (electric) – Process Cooling Condenser Heat Recovery – HVAC Condenser Heater Recovery Water Heating – Heat Pump Water Heater	– Efficient Hot Water Pump – Hot Water (DHW) Pipe Insulation – Drain Water Heat Recovery Water Heater – ECM Circulator Pump – Electric Tankless Water Heater
Ventilation	– EMS for manufacturing HVAC fan – VFD Supply Fan – VFD Return Fan – Strategic Energy Management (SEM)	– Destratification Fan (HVLS) – High Volume Low Speed Fans – Economizer – High Speed Fans
Space Cooling – Chillers	– EMS Pump Scheduling – Wall Insulation – EMS install – Strategic Energy Management (SEM)	– Motor Belt Replacement – VAV System Conversion – Air-Cooled Recip Chiller – Air-Cooled Screw Chiller

End Use Type	Measures Included	
	– Web Enabled EMS – Efficient Chilled Water Pump – Chilled Hot Water Reset – EMS Optimization – Water Side Economizer – Chiller Tune Up – VFD Chilled Water Pump – Water-Cooled Centrifugal Chiller > 300 ton – Integrated Building Design – Retrocommissioning	– High Efficiency Pumps – Ceiling Insulation – HVAC Occupancy Sensors – Programmable Thermostats – Economizer – Energy Efficient Windows – Roof Insulation – Improved Duct Sealing – Window Improvements – Cool Roofing – VFD Tower Fans
Space Cooling – Unitary and Split AC	– EMS Pump Scheduling – Wall Insulation – EMS install – Strategic Energy Management (SEM) – Web Enabled EMS – EMS Optimization – Integrated Building Design – Retrocommissioning – Advanced Rooftop Controls – Ground Source Heat Pump - Cooling – Water Loop Heat Pump (WLHP) - Cooling – Ceiling Insulation	– DX Condenser Coil Cleaning – HVAC Occupancy Sensors – Economizer – Programmable Thermostats – Air Source Heat Pump - Cooling – Energy Efficient Windows – DX Packaged System – Roof Insulation – Improved Duct Sealing – Window Improvements – Split System < 65,000 Btuh – Cool Roofing – C&I CO2 Heat Pump
Lighting	– Lighting Power Density - Parking Garage – Lighting Power Density- Exterior – Lighting Power Density - Interior – LED Downlight – LED Exit Sign – LED Screw In Replacing Incandescent – LED Specialty replacing incandescent – Stairwell Bi-Level Control – LED Grow Light – Daylight Sensor Controls – Central Lighting Control – Occupancy Sensor & Daylight Sensor – Occupancy Sensor	– LED Tube Lighting – LED High Bay Lighting – Switching Controls for Multilevel Lighting (Non-HID) – Garage Bi-level Controls – LED Specialty replacing CFL – Interior Non-Highbay/Lowbay LED Fixtures – LED Low Bay Lighting – Exterior Bi-level Controls – Light Tube – Exterior HID replaced with LED – LED Troffer – Advanced Lighting Controls – Strategic Energy Management (SEM)
Space Heating	– EMS Pump Scheduling – Wall Insulation – EMS install – Setback with Electric Heat – Web Enabled EMS – EMS Optimization – VFD Pump – Integrated Building Design – Retrocommissioning – Ground Source Heat Pump - Heating – Ceiling Insulation	– Destratification Fan (HVLS) – HVAC Occupancy Sensors – Programmable Thermostats – Economizer – ECM motors on furnaces – Air Source Heat Pump - Heating – Energy Efficient Windows – Roof Insulation – Improved Duct Sealing – Window Improvements – Ductless (mini split) - Heating – Cool Roofing

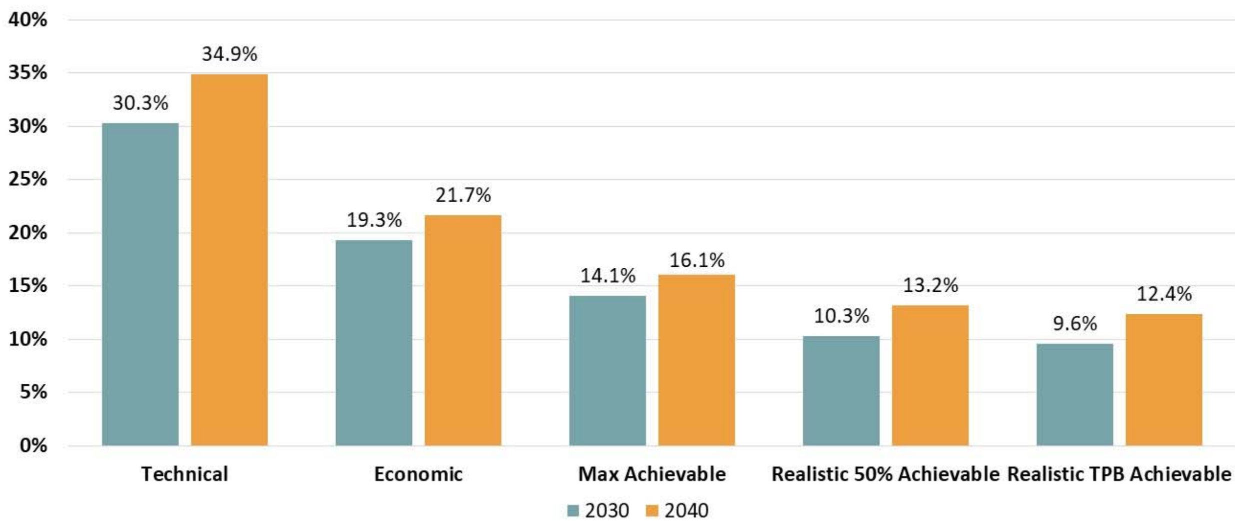
End Use Type	Measures Included	
	– Water Loop Heat Pump (WLHP) - Heating	– Strategic Energy Management (SEM)
Other	– Engine Block Heater Timer – Parking Garage Exhaust Fan CO Control – High Efficiency Transformer, three-phase – NEMA Premium Transformer, three-phase	– High Efficiency Transformer, single-phase – NEMA Premium Transformer, single-phase – Optimized Snow and Ice Melt Controls
Machine Drive	– Compressed Air Low Pressure Drop Filters – Efficient Air Compressors – Compressed Air Pressure Flow Controller – Compressed Air replacement with air blowers – Compressed Air Audits and Leak Repair – Compressed Air Storage Tank – VFD for Process Fans – Compressed Air Automatic Drains – VFD for Process Pumps – Pump System Efficiency Improvements	– Motor System Optimization (Including ASD) – Electric Supply System Improvements – Sensors & Controls – Industrial Motor Management – Fan System Improvements – High Efficiency Pumps – Advanced Efficient Motors – Compressed Air High Efficiency Dryers – Compressed Air Outdoor Air Intake – Strategic Energy Management (SEM)
Process Cooling & Refrigeration	– Improved Refrigeration – Electric Supply System Improvements	– Sensors & Controls – Energy Information System – Strategic Energy Management (SEM)
Process Heating	– Electric Supply System Improvements – Sensors & Controls	– Energy Information System – Decrease Oven Exhaust Flow – Strategic Energy Management (SEM)
Industrial Other	– Barrel Insulation - Inj. Molding (plastics) – High Efficiency Welders – Pellet Dryer Insulation (plastics) – Dewpoint sensor control for desiccant plastic dryer	– 3 Phase High Eff Battery Charger – Injection Molding Machine - efficient (plastics) – Fiber Laser Replacing CO_2 laser (auto industry)
Agriculture	– Fan Thermostat Controller – VFD for Process Fans - Agriculture – Milk Pre-Cooler Heat Exchanger – VFD for Process Pumps - Agriculture – Low Pressure Sprinkler Nozzles – Long Daylighting Dairy – VFD for Process Pumps – Irrigation – LED Poultry Lights	– Variable Speed Drives for Dairy Vacuum Pumps – Other Industrial -Low-Energy Livestock Waterer – Other Industrial -Dairy Refrigerator Tune-Up – Grain Storage Temperature and Moisture Management Controller – Greenhouse Environmental Controls – Variable Speed Drive with Heat Exchanger, Milk – Scroll Compressor with Heat Exchanger for Dairy Refrigeration

4.3.2 Results Summary

This section presents estimates for electric technical, economic, and achievable potential for the industrial sector. Each of the tables in the technical, economic and achievable sections present the respective potential for efficiency savings expressed as cumulative annual energy savings (MWh), percentage of savings by end use, and savings as a percentage of forecast sales. Data is provided on a 10-year and 20-year time horizon.

Figure 4-6 illustrates the estimated energy efficiency savings potential in the BWL service area for each of the scenarios included in this study.

FIGURE 4-6 INDUSTRIAL ENERGY EFFICIENCY POTENTIAL AS A % OF FORECASTED SALES



The potential estimates are expressed as cumulative 10-year and 20-year savings, as percentages of the respective 2030 and 2040 sector sales. The technical potential is 30.3% in 2030 and 34.9% in 2040. The 10-year and 20-year economic potential is 19.3% and 21.7% based on the TRC screening results. For the achievable potential scenarios, the 10-year and 20-year 100% TRC achievable potential savings are 14.1% and 16.1%; the 10-year and 20-year 50% TRC achievable potential savings are 10.3% and 13.2%; and the 10-year and 20-year PB TRC achievable potential savings are 9.6% and 12.4%.

4.3.3 Technical Potential

Technical potential represents the quantification of savings that can be realized if energy-efficiency measures passing the qualitative screening are applied in all feasible instances, regardless of cost effectiveness. Table 4-28 shows that it is technically feasible to save approximately 109,000 MWh on a cumulative annual basis in the industrial sector by 2030, and approximately 124,000 MWh annually by 2040 across the BWL territory, representing 30.3% of the industrial sales forecast in 2030, and 34.9% of the commercial sales forecast in 2040. Machine Drive, Space Cooling, Lighting, and Process Heating and Cooling account for approximately 90% of the industrial potential. Table 4-29 shows the peak demand technical potential savings in 2030 and 2040. The 10-yr and 20-yr summer peak demand savings technical potential is 20 MW and 23 MW, respectively.

TABLE 4-28 INDUSTRIAL SECTOR TECHNICAL POTENTIAL SAVINGS BY END USE

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Machine Drive	32,149	29.6%	35,450	28.5%
Space Cooling	29,533	27.2%	33,273	26.8%

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Lighting	19,482	17.9%	24,933	20.1%
Process Heating and Cooling	16,081	14.8%	16,910	13.6%
Ventilation	5,244	4.8%	5,899	4.7%
Space Heating	3,971	3.7%	5,151	4.1%
Agriculture	1,187	1.1%	1,339	1.1%
Other	422	0.4%	659	0.5%
Water Heating	356	0.3%	433	0.3%
Computers & Office Equipment	278	0.3%	292	0.2%
Total	**108,704**	**100.0%**	**124,338**	**100.0%**
% of Annual Sales Forecast	***30.3%***		***34.9%***	

TABLE 4-29 INDUSTRIAL SECTOR TECHNICAL POTENTIAL DEMAND SAVINGS

	2030 Demand Savings (MW)	% of 2030 Forecast Peak*	2040 Demand Savings (MW)	% of 2040 Forecast Peak*
Total System	19.8	32.5%	22.6	37.5%

* *The forecast of industrial sector peak demand was developed by GDS and is not a forecast provided by BWL.*

4.3.4 Economic Potential

Economic potential is a subset of technical potential and only includes measures that are cost-effective based on the TRC Test. 78% of all measures that were included in the industrial sector electric potential analysis passed the TRC screening.

Table 4-30 indicates that the economic potential based on the TRC screen is 69,442 MWh on a cumulative annual basis by 2030 and 77,147 MWh by 2040. This represents 19.3% and 21.7% of forecast BWL commercial MWh sales in 2030 and 2040, respectively. Machine drive, lighting, space cooling, and process end uses make up a majority of the savings. Table 4-31 shows the peak demand savings economic potential in 2030 and 2040. The ten and twenty-year summer peak demand savings economic potential is 13 MW and 14 MW.

TABLE 4-30 INDUSTRIAL ECONOMIC POTENTIAL ENERGY SAVINGS BY END USE

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Machine Drive	31,528	45.4%	34,293	44.5%
Lighting	13,914	20.0%	14,742	19.1%
Space Cooling	10,594	15.3%	11,551	15.0%
Process Heating and Cooling	7,506	10.8%	9,580	12.4%
Ventilation	3,001	4.3%	3,341	4.3%
Space Heating	1,111	1.6%	1,440	1.9%
Other	844	1.2%	956	1.2%
Agriculture	354	0.5%	578	0.7%
Water Heating	353	0.5%	427	0.6%
Computers & Office Equipment	237	0.3%	239	0.3%

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Total	**69,442**	**100.0%**	**77,147**	**100.0%**
% of Annual Sales Forecast	***19.3%***		***21.7%***	

TABLE 4-31 INDUSTRIAL ECONOMIC POTENTIAL DEMAND SAVINGS

	2030 Demand Savings (MW)	% of 2030 Forecast Peak*	2040 Demand Savings (MW)	% of 2040 Forecast Peak*
Total Industrial Sector	12.6	20.8%	14.0	23.3%

* *The forecast of industrial sector peak demand was developed by GDS and is not a forecast provided by BWL.*

4.3.5 Achievable Potential – 100% TRC

The Achievable Potential – 100% TRC scenario provides an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles with incentives equal to 100% of the incremental measure cost. Unlike the economic potential, the commercial achievable potential considers the estimated market adoption of energy efficiency measures based on the incentive level and the natural replacement cycle of equipment.

Table 4-32 shows the estimated cumulative annual savings for the Achievable Potential – 100% TRC scenario over 10-yr and 20-yr time horizons. Table 4-33 shows the peak demand savings in 2030 and 2040, respectively.

TABLE 4-32 INDUSTRIAL ACHIEVABLE POTENTIAL – 100% TRC ENERGY SAVINGS BY END USE

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Machine Drive	23,434	46.3%	25,805	45.1%
Lighting	9,211	18.2%	10,141	17.7%
Space Cooling	8,419	16.6%	9,135	16.0%
Process Heating and Cooling	5,370	10.6%	7,073	12.4%
Ventilation	2,260	4.5%	2,526	4.4%
Space Heating	690	1.4%	964	1.7%
Other	634	1.3%	657	1.1%
Agriculture	244	0.5%	421	0.7%
Water Heating	181	0.4%	281	0.5%
Computers & Office Equipment	171	0.3%	186	0.3%
Total	**50,615**	**100.0%**	**57,191**	**100.0%**
% of Annual Sales Forecast	***14.1%***		***16.1%***	

TABLE 4-33 INDUSTRIAL ECONOMIC POTENTIAL DEMAND SAVINGS

	2030 Demand Savings (MW)	% of 2030 Forecast Peak*	2040 Demand Savings (MW)	% of 2040 Forecast Peak*
Total Industrial	9.2	15.2%	10.4	17.3%

* *The forecast of industrial sector peak demand was developed by GDS and is not a forecast provided by BWL.*

4.3.6 Achievable Potential – 50% TRC

The Achievable Potential – 50% TRC scenario provides an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles with incentives equal to 50% of the incremental measure cost.

Table 4-34 shows the estimated cumulative annual savings for the Achievable Potential – 50% TRC scenario over 10-year and 20-year time horizons. Table 4-35 shows the peak demand savings 2030 and 2040, respectively.

TABLE 4-34 INDUSTRIAL ACHIEVABLE POTENTIAL – 50% TRC ENERGY SAVINGS BY END USE

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Machine Drive	18,489	50.1%	23,645	50.4%
Lighting	7,650	20.7%	9,141	19.5%
Space Cooling	4,828	13.1%	5,387	11.5%
Ventilation	3,137	8.5%	4,903	10.4%
Process Heating and Cooling	1,524	4.1%	1,977	4.2%
Space Heating	418	1.1%	613	1.3%
Other	427	1.2%	524	1.1%
Agriculture	159	0.4%	307	0.7%
Water Heating	130	0.4%	239	0.5%
Computers & Office Equipment	148	0.4%	184	0.4%
Total	**36,910**	**100.0%**	**46,919**	**100.0%**
% of Annual Sales Forecast	***10.3%***		***13.2%***	

TABLE 4-35 INDUSTRIAL ACHIEVABLE 50% TRC POTENTIAL DEMAND SAVINGS

	2030 Demand Savings (MW)	% of 2030 Forecast Peak*	2040 Demand Savings (MW)	% of 2040 Forecast Peak*
Total System	6.7	11.0%	8.5	14.2%

* *The forecast of industrial sector peak demand was developed by GDS and is not a forecast provided by BWL.*

Figure 4-7 shows the estimated 20-year cumulative annual efficiency savings potential broken out by end use across the entire industrial sector for Achievable Potential – 50% TRC scenario. The Machine Drive end use shows the largest potential for savings at 50% of total savings. Lighting is second at 20% of total savings.

FIGURE 4-7 INDUSTRIAL ACHIEVABLE POTENTIAL – 50% TRC ENERGY SAVINGS BY END USE

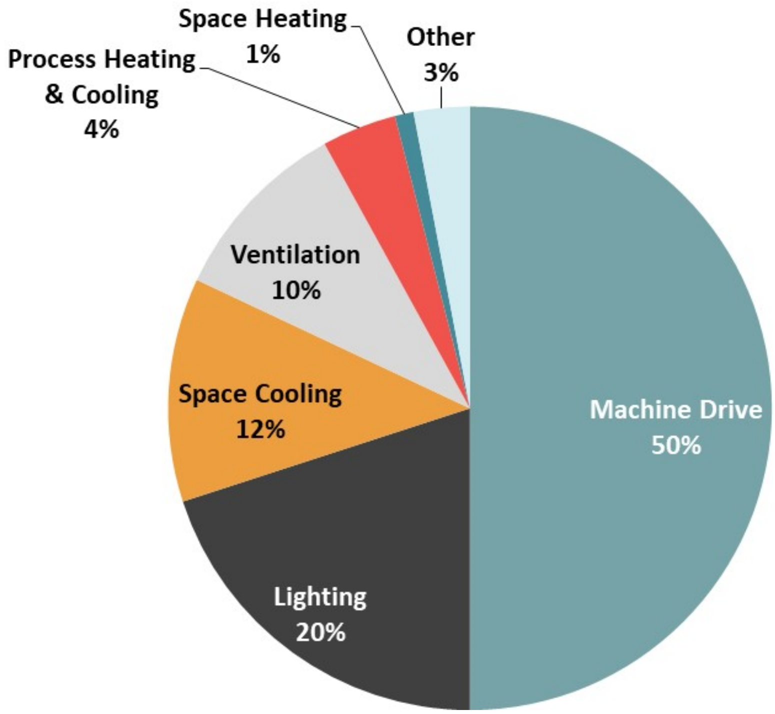
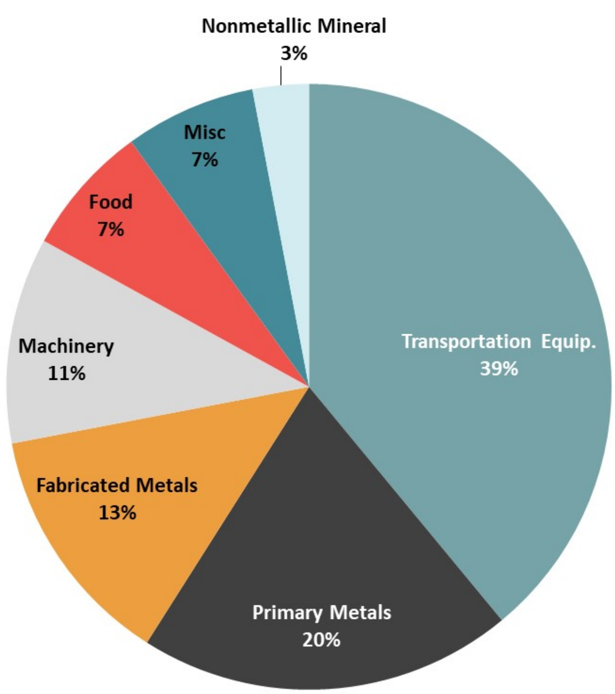


Figure 4-8 shows the breakdown of estimated savings in 2040 by industry type for the Achievable Potential 50% TRC scenario. The vast majority of savings come from the transportation equipment, plastics primary metals, fabricated metals, machinery, and food industries; with the other NAICS codes accounting for less than 10% of total savings.

FIGURE 4-8 2040 INDUSTRIAL ACHIEVABLE POTENTIAL – 50% TRC ENERGY SAVINGS BY INDUSTRY



4.3.7 Achievable Potential – PB TRC

The Achievable Potential – PB TRC scenario provides an estimate of energy savings that can feasibly be achieved given market barriers and equipment replacement cycles with incentives set to yield a customer payback of no more than 2 years.

Table 4-36 shows the estimated cumulative annual savings for the Achievable Potential – PB TRC scenario over 10-yr and 20-yr time horizons. Table 4-37 shows the peak demand savings in 2030 and 2040, respectively.

TABLE 4-36 INDUSTRIAL ACHIEVABLE POTENTIAL – PB TRC ENERGY SAVINGS BY END USE

End Use	2030 Energy Savings (MWh)	% of 2030 Total	2040 Energy Savings (MWh)	% of 2040 Total
Machine Drive	17,359	50.4%	22,170	50.4%
Lighting	7,638	22.2%	9,123	20.7%
Space Cooling	4,443	12.9%	5,054	11.5%
Ventilation	2,832	8.2%	4,595	10.4%
Process Heating and Cooling	1,114	3.2%	1,443	3.3%
Space Heating	356	1.0%	550	1.2%
Other	338	1.0%	417	0.9%
Agriculture	141	0.4%	279	0.6%
Water Heating	129	0.4%	236	0.5%
Computers & Office Equipment	116	0.3%	144	0.3%
Total	**34,466**	**100.0%**	**44,012**	**100.0%**
% of Annual Sales Forecast	***9.6%***		***12.4%***	

TABLE 4-37 INDUSTRIAL ACHIEVABLE POTENTIAL – PB TRC DEMAND SAVINGS

	2030 Demand Savings (MW)	% of 2030 Forecast Peak*	2040 Demand Savings (MW)	% of 2040 Forecast Peak*
Total System	6.3	10.3%	8.0	13.3%

* *The forecast of industrial sector peak demand was developed by GDS and is not a forecast provided by BWL.*

4.3.8 Achievable Potential Benefits & Costs

Table 4-38 provides the NPV benefits and costs in the industrial sector for all three achievable potential scenarios across the 10-year and 20-year time periods. The Achievable Potential 50% TRC scenario provides the greatest net benefits of the three scenarios and the TRC benefit-cost ratios are 2.0 and 2.4 across the next 10-yr and 20-yr periods.

TABLE 4-38 INDUSTRIAL ACHIEVABLE POTENTIAL BENEFIT COST RATIOS

	NPV Benefits	NPV Costs	B/C Ratio	Net Benefits
10-yr				
Achievable 100% TRC	$16,273,257	$9,671,983	1.68	$6,601,273
Achievable 50% TRC	$9,905,830	$4,996,524	1.98	$4,909,306
Achievable PB TRC	$9,477,633	$5,468,629	1.73	$4,009,005
20-yr				
Achievable 100% TRC	$24,203,761	$15,636,066	1.55	$8,567,695
Achievable 50% TRC	$19,014,811	$8,003,693	2.38	$11,011,118

	NPV Benefits	NPV Costs	B/C Ratio	Net Benefits
Achievable PB TRC	$18,928,051	$10,006,424	1.89	$8,921,627

Annual budgets for the three achievable potential scenarios are presented in Table 4-39. The Achievable Potential 50% TRC annual budgets range from $0.3 million to $0.9 million over the next 20 years.

TABLE 4-39 INDUSTRIAL SECTOR ACHIEVABLE POTENTIAL ANNUAL BUDGETS ($, IN MILLIONS)

	Achievable 100% TRC	Achievable 50% TRC	Achievable PB TRC
2021	$0.9	$0.3	$0.2
2022	$1.0	$0.4	$0.3
2023	$1.1	$0.4	$0.3
2024	$1.2	$0.4	$0.3
2025	$1.2	$0.5	$0.3
2026	$1.1	$0.5	$0.4
2027	$1.0	$0.5	$0.4
2028	$1.0	$0.5	$0.4
2029	$0.9	$0.5	$0.4
2030	$0.8	$0.5	$0.4
2031	$0.9	$0.6	$0.4
2032	$0.9	$0.6	$0.4
2033	$1.0	$0.6	$0.4
2034	$1.0	$0.6	$0.4
2035	$1.0	$0.6	$0.5
2036	$1.3	$0.8	$0.6
2037	$1.5	$0.8	$0.7
2038	$1.4	$0.8	$0.7
2039	$1.4	$0.9	$0.7
2040	$1.4	$0.9	$0.7

5 Demand Response Potential Estimates

5.1 COST-EFFECTIVENESS RESULTS

Cost-effectiveness of demand response measures was determined based on screening with the TRC and UCT tests. Table 5-1 shows the residential and non-residential TRC, UCT, participant cost test (PCT), and ratepayer impact measure (RIM) ratios for each program. The TRC test was the primary cost-effectiveness test used for screening purposes. Only one demand response program was determined to be cost effective according to the TRC Test: the non-residential critical peak pricing program with enabling technology.

TABLE 5-1 TRC RATIOS, UCT RATIOS, PCT RATIOS, AND RIM RATIOS FOR EACH DEMAND RESPONSE PROGRAM

	Program	TRC Ratio	UCT Ratio	PCT Ratio	RIM Ratio
Residential	DLC Central AC Switch	0.12	0.12	N/A	0.12
	DLC Room AC	0.07	0.07	N/A	0.07
	DLC Pool Pumps	0.10	0.10	N/A	0.10
	DLC Water Heating	0.05	0.05	N/A	0.05
	DLC Central AC Thermostat	0.10	0.15	1.07	0.15
	EV Charging Rate	0.12	0.31	0.00	0.15
	Time of Use with Enabling Technology	0.15	0.15	N/A	0.06
	Time of Use without Enabling Technology	0.53	0.53	N/A	0.22
	Critical Peak Pricing with Enabling Technology	0.25	0.25	N/A	0.25
	Critical Peak Pricing without Enabling Technology	0.67	0.67	N/A	0.64
Non-Residential	DLC Central AC Switch	0.13	0.13	N/A	0.13
	DLC Central AC Thermostat	0.12	0.13	1.89	0.13
	Interruptible Rate	0.03	0.03	N/A	0.03
	DLC Water Heating	0.04	0.04	N/A	0.04
	Thermal Electric Storage Cooling Rate	0.03	0.12	0.02	0.09

	Program	TRC Ratio	UCT Ratio	PCT Ratio	RIM Ratio
	DLC Lighting	0.01	0.01	N/A	0.01
	Auto Demand Response - AC	0.11	0.13	0.00	0.12
	Auto Demand Response - Lighting	0.05	0.05	0.21	0.05
	Time of Use with Enabling Technology	0.21	0.21	N/A	0.08
	Time of Use without Enabling Technology	0.19	0.19	N/A	0.08
	Critical Peak Pricing with Enabling Technology	1.04	1.04	N/A	1.01
	Critical Peak Pricing without Enabling Technology	0.55	0.55	N/A	0.52

5.2 RESIDENTIAL SECTOR

Table 5-2 shows the residential technical, economic, and achievable demand response potential. Technical potential assumes 100% of eligible customers will participate in all programs starting in year 1, regardless of cost effectiveness. Economic potential includes all programs that are considered cost-effective based on screening with the TRC test. Economic potential, like technical potential, assumes that 100% of eligible customers will participate in programs starting in year 1. Achievable potential includes all cost-effective programs. However, achievable potential includes a participation rate to estimate the percent of customers that are realistically expected to participate, and the electric load they will reduce. These demand reduction values are present at the customer meter level of the BWL grid. Since no residential demand response programs passed the TRC Test, there is no economic or achievable potential in the residential sector.

TABLE 5-2 SUMMARY OF RESIDENTIAL TECHNICAL, ECONOMIC, AND ACHIEVABLE PROGRAM POTENTIAL

	2025 Potential (MW)	2030 Potential (MW)	2035 Potential (MW)	2040 Potential (MW)
Technical	68	68	68	68
Economic	0	0	0	0
Achievable	0	0	0	0

5.3 NON-RESIDENTIAL SECTOR

Table 5-3 shows the non-residential technical, economic, and achievable potential. There is only one cost-effective program in the non-residential sector: the non-residential Critical Peak Pricing Rate with Enabling Technology. This is the only program included in the estimates of economic and achievable demand response potential in the BWL service area.

TABLE 5-3 SUMMARY OF NON-RESIDENTIAL TECHNICAL, ECONOMIC, AND ACHIEVABLE POTENTIAL

	2025 Potential (MW)	2030 Potential (MW)	2035 Potential (MW)	2040 Potential (MW)
Technical	68	69	70	70
Economic	48	48	48	49
Achievable	11	12	12	12

5.4 TOTAL DEMAND RESPONSE

Table 5-4 shows the total technical, economic, and achievable potential for both the residential and non-residential sectors.

TABLE 5-4 TOTAL TECHNICAL, ECONOMIC, AND ACHIEVABLE POTENTIAL

	2025 Potential (MW)	2030 Potential (MW)	2035 Potential (MW)	2040 Potential (MW)
Technical	136	137	138	138
Economic	48	48	48	49
Achievable	11	12	12	12

5.5 COST OF ACQUIRING DEMAND RESPONSE ACHIEVABLE POTENTIAL

Table 5-5 shows the annual achievable program costs. Since there is only one cost-effective program, the cost of achievable program potential is the cost of the Non-Residential Critical Peak Pricing Program with Enabling Technology program.

TABLE 5-5 SUMMARY OF ACHIEVABLE POTENTIAL ANNUAL BUDGET REQUIREMENTS FOR CRITICAL PEAK PRICING RATE WITH ENABLING TECHNOLOGY

Year	Achievable Potential Cost
2021	$110,391
2022	$94,091
2023	$140,496
2024	$150,230
2025	$143,092
2026	$140,324
2027	$140,626
2028	$141,834
2029	$143,297
2030	$144,874
2031	$148,156
2032	$153,800
2033	$161,920
2034	$167,801
2035	$171,001
2036	$173,119
2037	$174,969

Year	Achievable Potential Cost
2038	$176,793
2039	$178,603
2040	$180,430

6 Distributed Solar Market Penetration Potential

6.1 INTRODUCTION

To project the future penetration of distributed solar (DS) from an economic standpoint, Siemens used a bass-diffusion model. Siemens has developed a proprietary DS penetration model based on the methodology described in NREL SolarDS[44] and DGen[45] model documentation. The Siemens model can incorporate multiple inputs including federal and state tax credits, incentive payments, tax savings on loan interest, retail electricity prices, debt/value ratio, financing parameters, marginal tax rates, and forecasted DS capital costs. The adoption rates and the maximum market penetration are a function of the payback period using an empirical formulation that has been thoroughly vetted in the industry. The payback period is based on the down-payment (equity portion), federal tax credits in the form of the ITC through 2022[46], and the net benefits accruing to the business or homeowner.

6.2 DETAILED RESULTS

This section presents key findings from the Reference Case, the Low Penetration Case, and the High Penetration Case.

6.2.1 Payback Estimates by Penetration Case

Table 6-1 presents payback values by sub-period for the residential Low, Reference and High Penetration Case Scenarios. While the payback period should decrease over time across all scenarios with declining installation costs, only the high penetration case shows that trend based on the overwhelming influence of low scenario installation costs. The other two cases show the impact of the ITC with the respect to relatively higher installation cost scenarios. For the low penetration scenario, the payback for the Early Program period (2010-2014) could not be estimated and exceeds 25 years, which is the generally accepted expected useful life of solar panel technologies.[47]

Table 6-1 shows that the paybacks for the residential market are longer than for the commercial market, reflecting the historically lower average system size installed under the BWL program, and the higher assumed installation costs. In the Low Penetration Case, estimated payback values exceed the expected useful life of 25 years in all periods except the 2031 to 2040 period, where it is estimated at 9 years. For the Reference Case, estimated payback values are below the expected useful life in the current period (2015-2019) at 21 years, dropping to 9 years in the 2031 to 2040 period. In the High Penetration case, estimated payback values begin at the same level as in the reference case in the current period but decrease at a higher rate to 3.5 years in the 2031-2040 period.

[44] https://www.nrel.gov/docs/fy10osti/45832.pdf
[45] https://www.nrel.gov/analysis/dgen/
[46] https://www.irs.gov/pub/irs-drop/n-18-59.pdf
[47] https://www.nrel.gov/docs/fy12osti/51664.pdf

TABLE 6-1 COMMERCIAL SECTOR PAYBACK AND INSTALLATION COSTS

Program Period Modeled	Description	Low Penetration Case Payback (Years)	Low Penetration Case Installation Costs ($/kW)	Reference Penetration Case Payback (Years)	Reference Penetration Case Installation Costs ($/kW)	High Penetration Case Payback (Years)	High Penetration Case Installation Costs ($/kW)
2010-2014	Early Program	>25.00	$5,709	18.74	$4,389	12.23	$3,470
2015-2019	Current Program	7.60	$2,323	5.39	$1,786	5.55	$1,832
2020	ITC Reduction to 26%	8.17	$2,053	5.96	$1,578	4.51	$1,231
2021	ITC Reduction to 22%	8.41	$2,006	6.11	$1,542	4.20	$1,108
2022-2030	Market Maturation; ITC Reduction to 10% for Commercial Owners and 0% for Residential Owners	8.38	$1,768	6.04	$1,359	3.84	$920
2031-2040	Distant Future Market Conditions	5.08	$1,174	5.08	$1,174	2.69	$666

TABLE 6-2 RESIDENTIAL SECTOR PAYBACK AND INSTALLATION COSTS

Program Period Modeled	Description	Low Penetration Case Payback (Years)	Low Penetration Case Installation Costs ($/kW)	Reference Penetration Case Payback (Years)	Reference Penetration Case Installation Costs ($/kW)	High Penetration Case Payback (Years)	High Penetration Case Installation Costs ($/kW)
2010-2014	Early Program	>25.00	$7,849	>25.00	$6,034	>25.00	$4,550
2015-2019	Current Program	>25.00	$3,603	20.99	$2,770	20.99	$2,770
2020	ITC Reduction to 26%	>25.00	$3,266	18.65	$2,511	14.90	$2,217
2021	ITC Reduction to 22%	>25.00	$3,123	18.65	$2,401	14.36	$2,076
2022-2030	Market Maturation; ITC Reduction to 10% for Commercial Owners and 0% for Residential Owners	>25.00	$2,406	16.79	$1,849	10.00	$1,369
2031-2040	Distant Future Market Conditions	8.80	$1,261	8.80	$1,261	3.52	$696

6.2.2 Penetration Rates by Case

Table 6-3 summarizes historical participation in the BWL Net Metering Program compared to each of the modeled composite penetration scenarios. The composite penetration values are the combined estimated penetration across the various sub-periods and associated payback values. While the modeled values in the commercial market are generally in line with the actual program history, the model does not demonstrate any “lift” in the residential market until 2028 in the high penetration scenario. Cumulative participation is low in both the commercial and residential markets at four (4) and forty-four (44) as of August 2019, respectively, with the residential market showing some acceleration in incremental participation beginning in 2016. At such low participation numbers, however, comparisons between modeled and actual values are a reach. Furthermore, federal policy to reduce the ITC could be introducing variability into the market. The ITC is clearly distorting the modeled paybacks in the commercial market; and the complete sunset of the ITC tax advantages in the residential market could be temporarily accelerating demand.

TABLE 6-3 BWL INCREMENTAL NET METERING PROGRAM PARTICIPATION

	Commercial				Residential			
Year	Program	Low	Ref.	High	Program	Low	Ref.	High
2010	0	0	0	0	2	0	0	0
2011	0	0	0	0	2	0	0	0
2012	0	0	0	0	3	0	0	0
2013	0	0	0	0	4	0	0	0
2014	0	0	0	0	5	0	0	0
2015	1	1	2	2	7	0	0	0
2016	2	1	2	2	11	0	0	0
2017	2	2	3	3	14	0	0	0
2018	0	2	3	3	23	0	0	0
2019	4	2	4	4	44	0	0	0
2020	-	2	5	7	-	0	1	3
2021	-	3	5	9	-	0	1	3
2022	-	3	6	15	-	0	2	13
2023	-	4	8	19	-	0	3	16
2024	-	5	9	23	-	0	3	20
2025	-	6	12	28	-	0	4	25
2026	-	8	14	35	-	0	5	30
2027	-	10	17	43	-	0	6	37
2028	-	12	21	52	-	0	7	45
2029	-	14	26	64	-	0	9	55
2030	-	18	32	79	-	0	11	67
2031	-	53	53	129	-	149	149	669
2032	-	64	64	158	-	182	182	814
2033	-	78	78	192	-	220	220	988
2034	-	95	95	233	-	267	267	1198

Year	Program	Commercial Low	Commercial Ref.	Commercial High	Program	Residential Low	Residential Ref.	Residential High
2035	-	115	115	283	-	323	323	1449
2036	-	139	139	342	-	390	390	1749
2037	-	168	168	413	-	470	470	2106
2038	-	202	202	497	-	564	564	2528
2039	-	242	242	595	-	675	675	3024
2040	-	288	288	709	-	804	804	3603

For the residential market, Siemens notes that actual residential penetration in 2019 is approaching 50 since program inception in contrast to modeling results that indicate much lower penetration in all scenarios. While the overall penetration compared to the market is still small, the disparity is noteworthy. Based on informal feedback from the BWL Solar Program Manager, customers are more motivated by environmental concerns than payback economics. Moreover, solar installers are marketing the opportunity to capture the ITC tax advantage before it expires, possibly shifting participation forward for a small segment of the market.

Figure 6-1 and Figure 6-2 illustrates the residential and commercial penetration curves for the individual payback functions compared to actual program history for the high penetration scenario. To the extent comparisons can be made given the limited actual participation, the commercial market penetration is tracking below the five-year payback period curve. As installation costs decline, coupled with the continued support of the ITC, we expect the payback periods to decline over time. With improved payback periods, we also expect average project size to increase which will only further improve project economics. Like the commercial market, decreasing installation costs over time will improve payback periods; however, unlike the commercial market, the ITC for the residential market will phase out completely by 2022, increasing the payback period.

FIGURE 6-1 COMMERCIAL PENETRATION CURVES COMPARISON

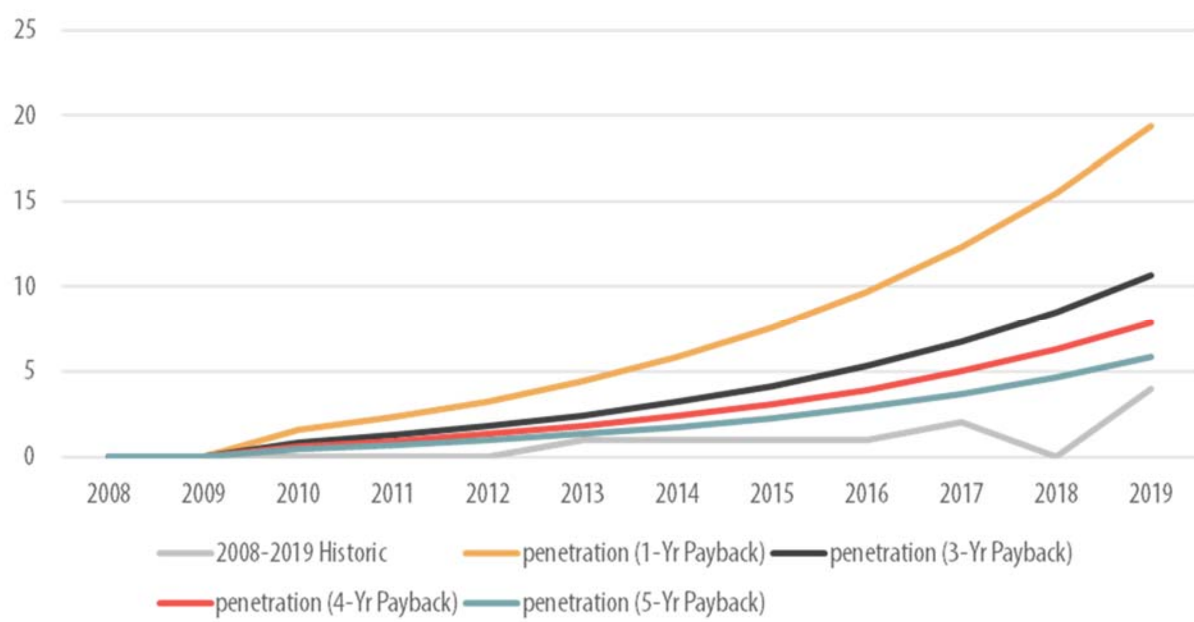
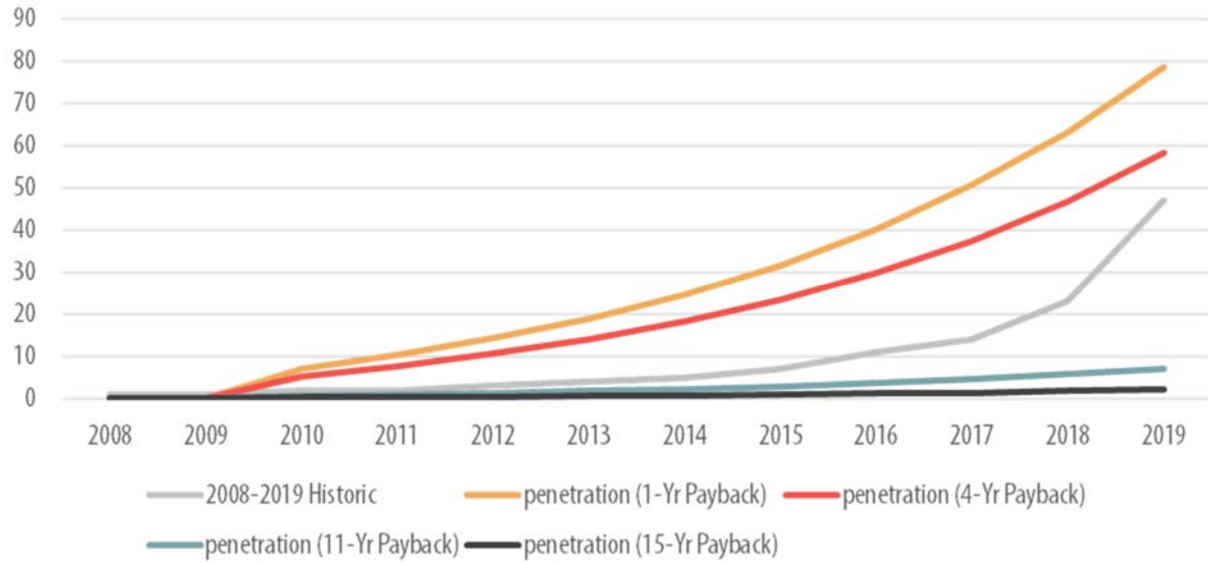


FIGURE 6-2 RESIDENTIAL PENETRATION CURVES COMPARISON



6.2.3 Alternative Market and Policy Scenarios

Several market and policy drivers could affect project economics and program participation in the future. Two House Bills (4069 and 4465) in the Michigan Legislature would provide property and personal tax relief to Michigan residents having solar panel systems. As of the time of this report, however, those bills have not yet been passed by the Michigan Senate.

The MPSC is also considering an alternative tariff to net metering based on inflow and outflow. In the Inflow/Outflow scenario, the PV owner would benefit from offset consumption at avoided retail rates but sell excess generation at the equivalent of the utility's avoided costs. Because avoided costs are lower than retail rates, this would make a PV project's economics less favorable than the current net metering tariff. Siemens modeled three Inflow/Outflow scenarios at the current installation cost incentive ($500 per kilowatt up to $2,000), at zero incentive, and at a high incentive ($1000 per kilowatt up to $4000). The results showed market penetrations for both customer segments at the Zero Incentive Inflow/Outflow scenario profiling below the High Cost/Low Penetration scenario for the current net metering policy above, and the High Incentive Inflow/Outflow scenario profiling between the Reference and Low Cost/High Penetration scenarios for the current net metering policy.

6.2.4 Conclusion

Based on the model, the primary driver on adoption rates are the installation costs, followed by the incentive levels, and finally the electricity rates. Siemens developed an installation cost scenario from available installation data on a partial set of residential participants and scaled the cost curve based on secondary sources. This data stream developed from actual program data turned out to be the highest installation cost scenario, however, when compared to secondary sources. Given this transition phase of federal policy support for the ITC, the uncertainty of the partial installation cost data set for which the values probably exceed actual market conditions, and the historically low adoption rates that exceed the Reference Case, Siemens recommends using the High Penetration Case because the modeled values best represent the market at this time. We note however, that this conclusion is based on several other key static factors such as system size, BWL installation cost rebates, and the current net metering rider, all of which could change over time. For the Inflow/Outflow scenarios where excess onsite generation is sold back to the grid at the avoided cost level instead of the full retail value, the lost sell back benefit had a diminishing effect on payback and associated penetration rates compared to similar, and even higher, incentives to the Reference Case scenario under the current net metering tariff.

7 Electric Vehicle Penetration Potential

7.1 INTRODUCTION

Siemens forecasted the energy and load impacts of increased EV adoption within the service territory of BWL through the forecast period. Using deterministic methods to develop the forecasted estimates, Siemens estimated penetration forecasts for three EV adoption cases defined as: the reference case (Siemens), and two other cases to account for uncertainty in the reference case: a high case (BNEF), and a low case (EIA). Siemens also estimated the EV load impacts for each associated forecast for integration into BWL's core electric load forecast.

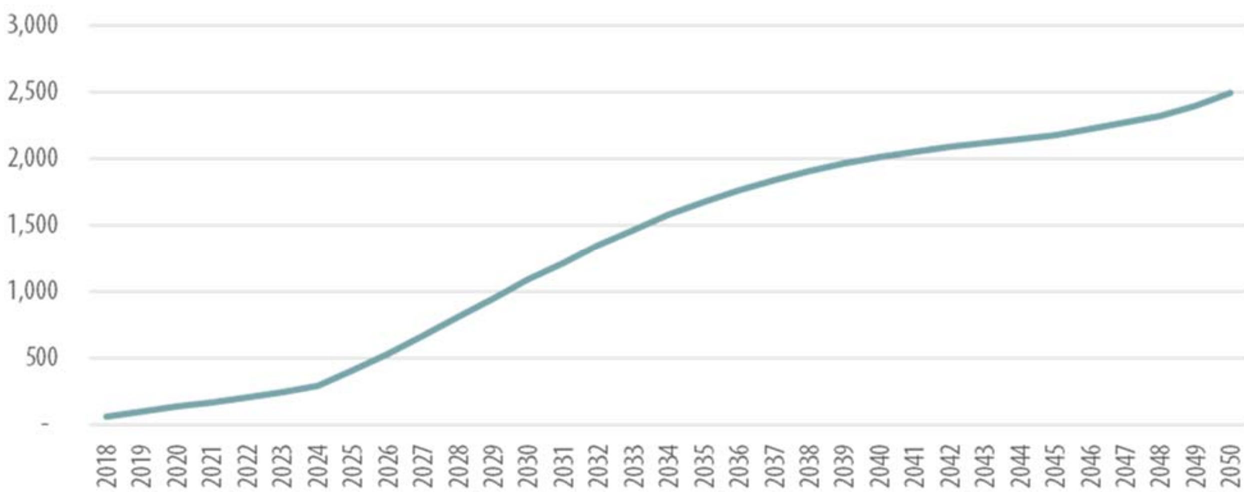
The following sections describe the key findings of the EV penetration and associated load impact forecasts. The findings are illustrated graphically, and the actual forecasted values are provided separately in an accompanying data file.

7.2 DETAILED RESULTS

This section presents key findings from the Siemens (Reference) Case, the EIA (Low Penetration) Case, and the BNEF (High Penetration) case.

Annual adoption of EVs, including PEV LDVs (light duty vehicle), commercial trucks, transit buses, school buses, and other buses in the BWL territory, is presented in Figure 7-1 below. The adoption of EVs is expected to accelerate the fastest for LDVs as the reference case forecast of annual PEV sales.

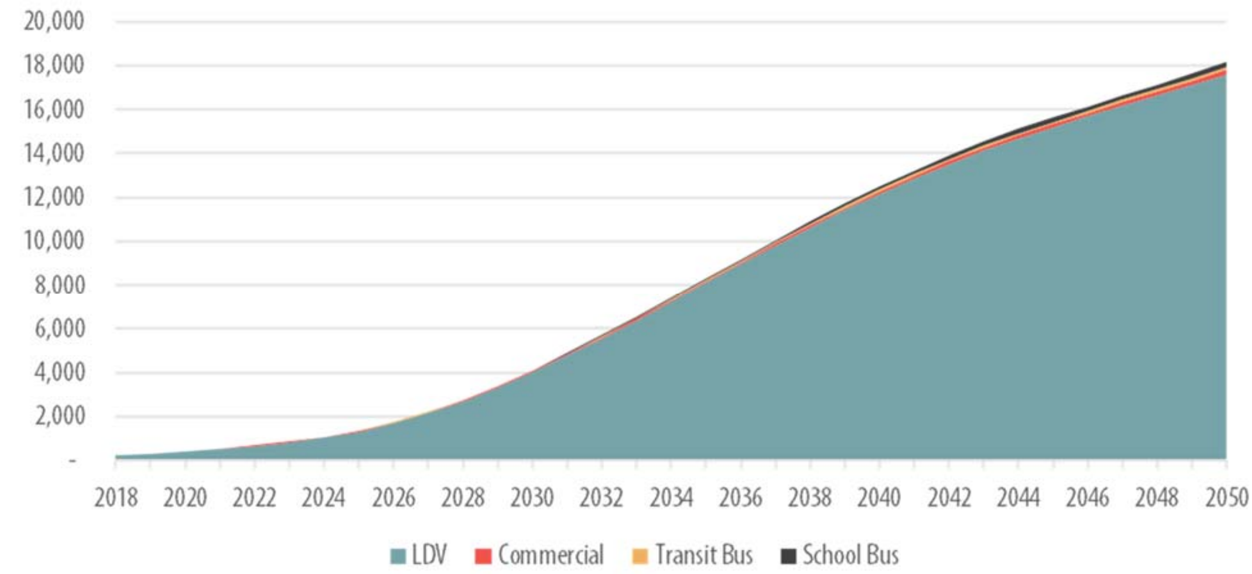
FIGURE 7-1 LBWL REFERENCE CASE LDV PEV SALES, NUMBER OF VEHICLES



While the typical life for a passenger car may, for example, be 10 years, not all will remain in operation that long. Catastrophic equipment failures or uneconomically repairable accidents prevent a portion of vehicles, regardless of type, from continuing in operation from one year to the next. Siemens applied these survivor rates[48], which vary by vehicle type and age, to determine how many vehicles of each type would be operating and therefore require electricity in each year. The cumulative PEV forecast, or the overall reference case for BWL, is provided in Figure 7-2 below.

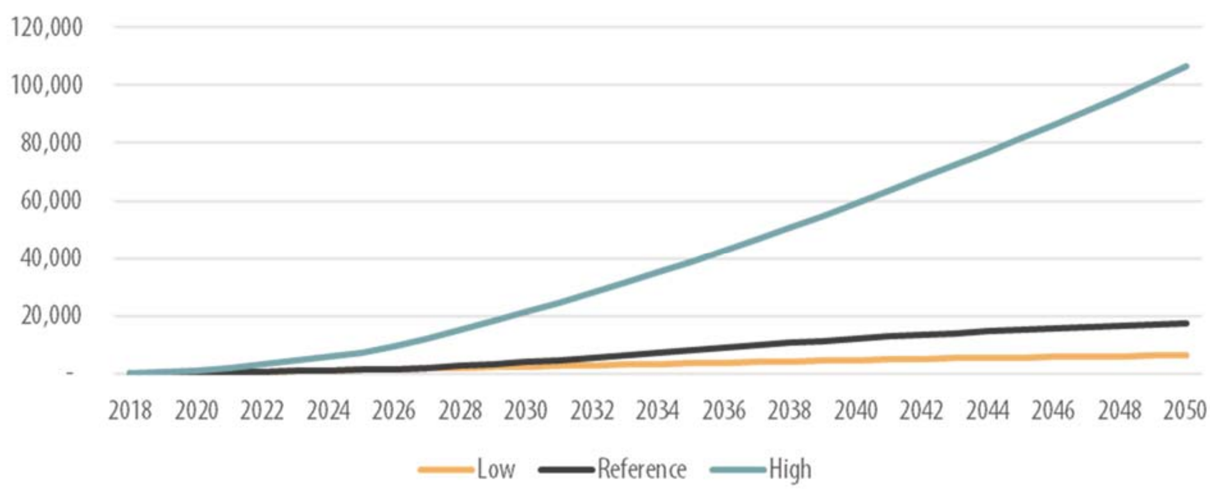
[48] US EPA Moves Model https://www.epa.gov/moves

FIGURE 7-2 LBWL REFERENCE CASE PEV STOCK PROJECTIONS BY VEHICLE TYPE, NUMBER OF VEHICLES



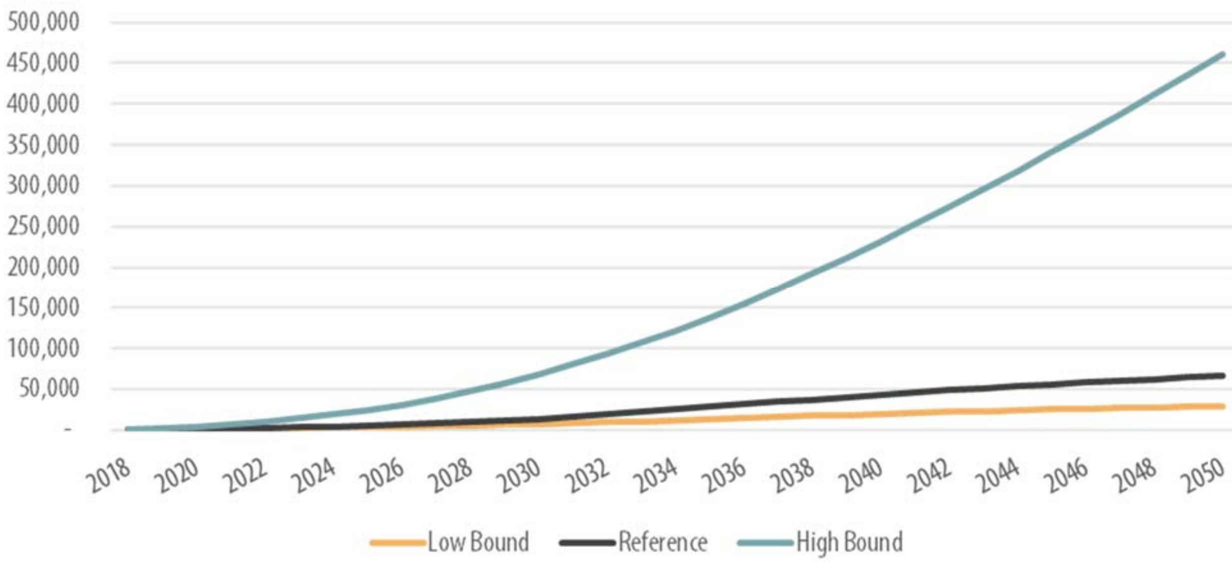
As mentioned earlier, Siemens developed two additional EV adoption cases for each vehicle type: a high case (BNEF) and a low case (EIA), which were based on our reference forecast, and between the low EIA forecast and the high BNEF forecast. A sample of the light duty EV adoption cases which represents the vast majority of EVs in the marketplace are provided in Figure 7-3 below.

FIGURE 7-3 CUMULATIVE LDV PEV STOCK, ALTERNATIVE CASES, NUMBER OF VEHICLES



Since the operating patterns for vehicle types differ, Siemens calculated the energy and load impacts resulting from cumulative PEV (both BEVs and PHEVs) adoption for each vehicle class and each adoption case and summed the results to estimate the cumulative impacts of PEV adoption. For each vehicle type, annual mileage, energy consumption rates, and daily charging patterns were applied to determine the energy requirements and convert those requirements to peak and coincident peak impacts. Inputs used to convert vehicle counts to energy consumption and load impacts include but are not limited to: Federal Highway Administration state driving estimates, California Energy Commission vehicle technology papers, DOE Alternative Fuel Data Center, Battery University, and vehicle manufacturers product specifications. The cumulative energy impacts for each case are presented in Figure 7-4 below.

FIGURE 7-4 CUMULATIVE PEV ENERGY REQUIRED, MWH



BWL reported system load of 2,096,596 MWh in 2018 with a summer system peak of 426 MWs and winter peak of 320 MWs. According to 2018 hourly system load data, BWL has a load factor of 56%. Figure 7-5 displays the average hourly load shape for BWL in 2018.

FIGURE 7-5 LBWL AVERAGE HOURLY LOAD SHAPE FOR 2018, MWS

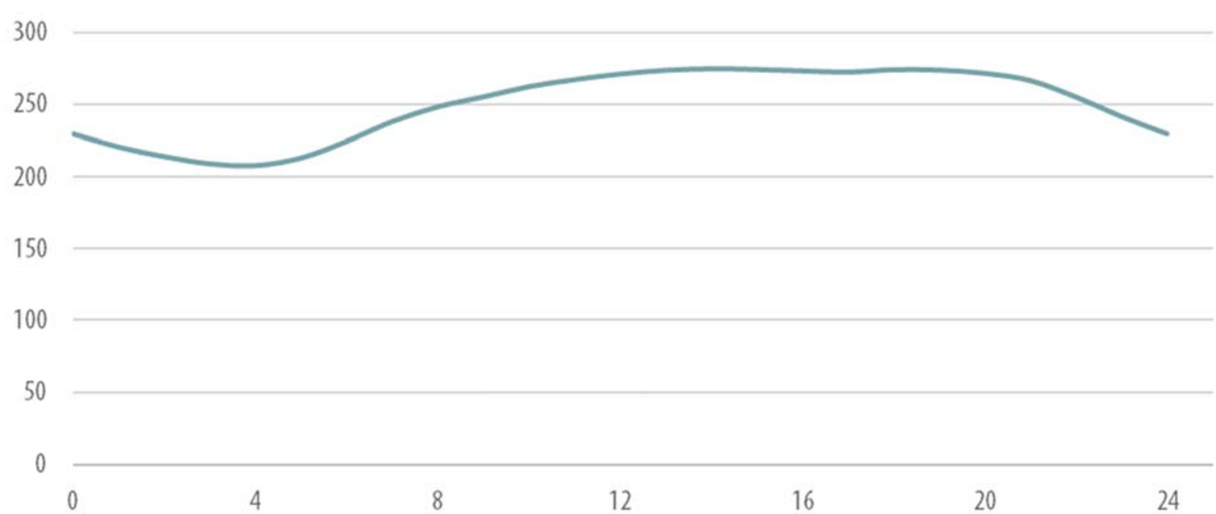
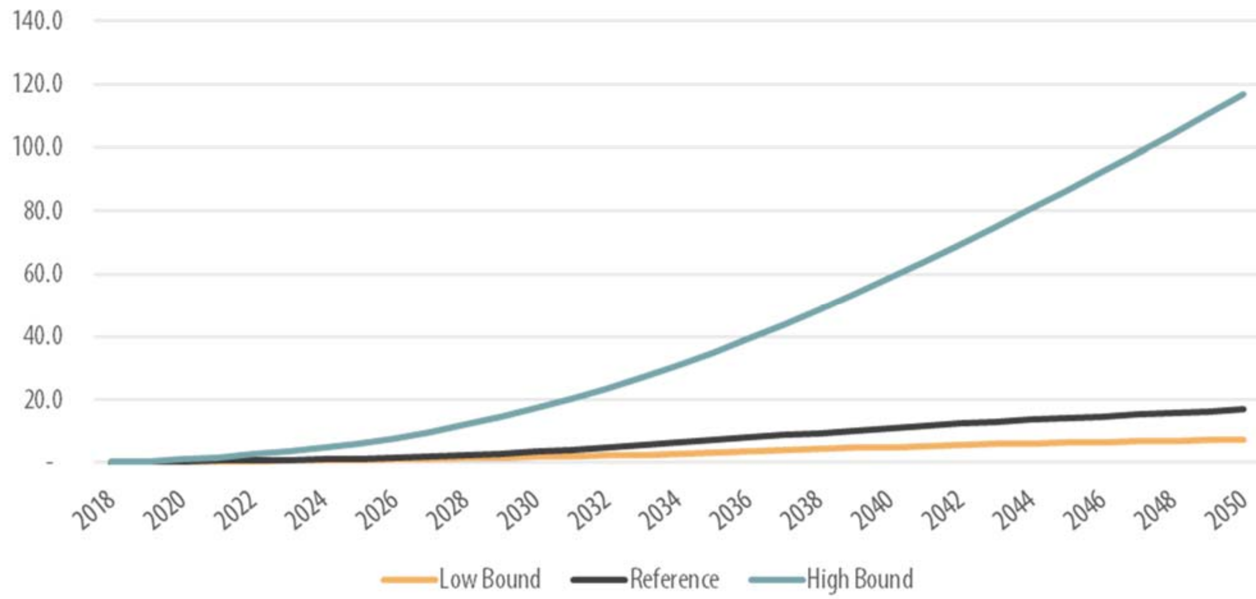


FIGURE 7-6 CUMULATIVE PEV PEAK LOAD AT 8PM, MW



Based on the average hourly load shape, BWL typically reaches over 95% of daily peak load between the hours of 10:00 am and 9:00 pm. By 2050, total incremental PEV induced load is expected to range between 38,254 and 468,203 MWh with a reference value of 38,846 MWh. At the same time, the impact at 8:00 pm, the expected peak charging time, is expected to range between 9.70 and 118.71 MWs with a reference value of 12.47 MW. The wide range in potential energy required to meet EV load is driven by the different adoption forecasts, while the peak load impacts are driven by expected driver charging behavior. By 2050, during BWL's typical peak of 2:00 pm and 6:00 pm, the total incremental PEV peak load is expected to range between 7.74 and 94.68 MWs with a reference value of 9.94 MWs. This impact could be partially mitigated by implementing time of use charging rates to incentivize charging at other times which would impact the 17.2% of charging that occurs between those peak hours of 2:00 to 6:00 PM.

7.3 CONCLUSION

While the adoption of PEV vehicles began in earnest several years ago, widespread use remains elusive for all but the earliest adopters. Siemens believes the reference case forecast provides the most likely adoption scenario based on the information known to date. However, as the broad forecast range indicates, there remains significant uncertainly regarding the pace of EV adoption. While experts disagree as to the timing of rapidly accelerated EV purchases, most agree that by the early to mid-2020s that the combination of extensive EV model availability (including pick-up trucks), lower EV prices (driven by battery cost declines), increased vehicle range, and more numerous charging ports/infrastructure will accelerate mass market EV adoption.

8 Combined Heat & Power Potential

8.1 INTRODUCTION

This high-level analysis of Combined Heat & Power (CHP) provides information on the costs, benefits and potential for cost effective CHP equipment in the BWL service area. This section of the report also provides a discussion of the characteristics and fuel sources of CHP equipment that could be installed in the future in the BWL service area. CHP systems generate electric power and useful thermal energy in a single, integrated system.[49] Heat that is normally wasted in conventional power generation is recovered as useful thermal energy.[50] Due to the integration of both power and thermal generation, CHP systems are more efficient than separate sources for electric power generation and thermal energy production.[51] This provides environmental, economic and energy system infrastructure benefits.

For this study, GDS completed a literature search of existing CHP potential studies for Michigan. GDS found two recent CHP potential studies for Michigan, one completed by the U.S. DOE in March 2016 and one completed by the Michigan Energy Office in February 2018. The amount of CHP technical potential in Michigan ranged from 722 MW to 4,291 MW. GDS also examined the current cost effectiveness of new CHP equipment in the BWL service area given BWL's most recent forecast of avoided costs of electricity. GDS has determined that the most common types of CHP equipment are not cost effective at this time in the BWL service area given BWL's very low avoided costs of electricity. ***At this time, none of the 78 CHP equipment types fueled by natural gas, biomass, biogas, hydrogen, propane or diesel are cost effective in the BWL service area according to the TRC test benefit/cost ratio.*** This situation could change in the future if forecasts of the avoided costs of electricity increase significantly or if capital and operating costs of CHP equipment decrease significantly, or both. The main reason that new CHP equipment is not cost effective in the BWL service area at this time is due to the relatively low BWL electric avoided costs of capacity and energy.

In 2018, BWL retail electricity sales totaled 2,119,742mWh. Total state of Michigan mWh sales to electricity consumers totaled 101,899,093 mWh in 2017. Thus BWL's annual electricity sales are approximately 2.1 percent of statewide electricity sales. Assuming that BWL's share of statewide CHP potential follows its share of annual mWh sales, BWL's CHP technical potential ranges from 15.2 to 90.1 MW.

Table 8-1 below summarizes the costs and benefits that GDS included in the TRC cost effectiveness analysis of CHP equipment for the BWL service area:

TABLE 8-1 BENEFITS AND COSTS INCLUDED IN THE TRC TEST FOR CHP EQUIPMENT

Item Description	TRC Cost	TRC Benefit
Capital cost of CHP equipment	X	
Fuel cost of CHP equipment over useful life	X	
O&M expense of CHP equipment over useful life	X	

[49] CHP Roadmap for Michigan, February 2018, page 8.
[50] Id.
[51] Id.

Item Description	TRC Cost	TRC Benefit
Fuel savings from not having to operate a natural gas boiler		X
Avoided costs of generation capacity		X
Avoided electric energy costs		X
Avoided T&D costs		X

Other direct benefits of CHP for facility operators can be:

- Reduced Energy Related Costs – providing direct cost savings for electric utility customers located in utility service areas with higher than average electric avoided costs and retail electric rates.[52] It is important to note that electric avoided costs are used to calculate the value of avoiding utility costs relating to generation capacity and energy production. On the other hand, retail electric rates are used to value any electricity savings that accrue to electric customers who install CHP.
- Increased Reliability and Decreased Risk of Power Outages due to the addition of a separate power supply.
- Increased Economic Competitiveness due to lower cost of operations (in service areas with higher than average electric avoided costs and retail electric rates).

In addition to these direct benefits, the electric industry, electricity customers, and society in general can derive benefits from CHP deployment, including:

- Increased Energy Efficiency – The overall efficiency of energy production of a CHP system is more efficient than central station power generation.
- Economic Development Value – allowing an option for businesses to be more economically competitive in a global market thereby maintaining local employment and economic health.
- Reduction in Emissions that Contribute to Global Warming – increased efficiency of energy production allows facilities to achieve the same levels of output or business activity with lower levels of fuels, resulting in reduced emissions of CO_2, nitrogen oxides, and sulfur dioxide, especially when state-of-the-art CHP equipment replaces outdated and inefficient boilers at a site.
- Increased Reliability and Grid Support for the utility system and customers as a whole.
- Resource Adequacy – reduced need for regional power plant and T&D infrastructure construction.

The potential for additional installations of cost-effective CHP equipment in the BWL service area is highly dependent on a comparison of the capital and operating costs of CHP equipment as compared to the forecast of the BWL avoided costs for generation, T&D over the life of the CHP equipment. BWL provided GDS with its latest forecast of electric avoided costs. BWL forecasts that avoided costs for generation capacity will remain very low over the next two decades, in the range of $6 to $12 per kW-year. BWL's avoided cost of energy are expected to be very low, in the range of $.03 per kWh of generation over the next 20 years. Based on screening with the TRC test, installation of new CHP equipment in the BWL service area is not projected to be cost effective at this time at any customer sites because BWL's forecast of electric avoided costs is relatively low. It is possible, however, that some combinations of CHP equipment and fuel sources might be cost effective in certain unique situations not examined in this study. For example, if a business is already planning on replacing an existing boiler, the incremental cost of CHP

[52] Note, these direct cost savings will not necessarily occur in regions of the U.S. where electric avoided costs are relatively low.

equipment may be much lower than the CHP costs used in this study, and as such a CHP project may be cost effective under these specific conditions.

8.1.1 Study Scope

The GDS examination of CHP potential in the BWL service area over the 20-year study period (2021 to 2040) considered both traditional "topping cycle" and "bottoming cycle" or waste heat to power CHP. This is consistent with that March 2016 U.S. DOE's Report on CHP Potential in the United States. Topping cycle CHP systems are the most common CHP systems currently in use.[53] In a topping cycle system, fuel is first combusted to generate electricity. A portion of the heat left over from the electricity generation process is then converted into useful thermal energy (e.g. heating, hot water, or steam for industrial processes). A bottoming-cycle CHP system uses the reverse process. Fuel is first combusted to provide thermal input to industrial process equipment like a kiln or furnace, and the heat rejected from the process is then captured and used for power production. [54] CHP technologies include:

- Reciprocating Engines
- Combustion Turbines
- Boiler/Steam Turbines
- Combined Cycle CHP Equipment

CHP systems can range in size from 5 kilowatts (kW; the demand of a typical single-family home) to several hundred MW (the demand of a very large industrial plant).[55] In general, the more efficiently the thermal energy can be utilized, the greater the net overall efficiency of the CHP system. Because fuel costs are the primary expenses for operational CHP systems, the more efficient the system is, the less fuel it consumes, and in turn, the less money the end-user likely spends on energy. For more detailed information on the types of CHP equipment suitable for utilization in Michigan, see "CHP Roadmap for Michigan" published in February 2018 by the Michigan Energy Office.[56]

Applications with steady demand for electricity and thermal energy are potentially good economic targets for CHP deployment. Industrial applications, particularly in industries with continuous processing and high steam requirements, are very economic and represent a large share of existing CHP capacity in the U.S. today. Commercial applications such as hospitals, nursing homes, laundries and hotels with large hot water needs are well suited for CHP. Institutional applications such as colleges and schools, prisons, and residential and recreational facilities are also excellent prospects for CHP equipment.

The various levels of CHP potential are defined below. The March 2016 U.S. DOE CHP Technical Potential Study estimates that there is 4,291 MW of on-site CHP technical potential remaining in Michigan.[57] The February 2018 CHP Roadmap for Michigan estimates there is an optimal level of 722 to 1,014 MW of new CHP that can be deployed in Michigan.[58]

[53] U.S. Department of Energy, CHP Technical Potential in the United States, March 2016, p. ii.
[54] Id., p. ii.
[55] Cuttica, J. J. and Haefke C. May 14, 2009. U.S. DOE Industrial Technologies Program. *Combined Heat and Power: Is It Right For Your Facility?* Webcast Series. https://energy.gov/sites/prod/files/2013/11/f4/webcast_2009-0514_chp_in_facilities_2.pdf.
[56] Michigan Energy Office, "CHP Roadmap for Michigan", February 2018, Section 2.
[57] It is important to note that the calculation of technical potential does not involve any cost effectiveness screening.
[58] Michigan Energy Office, "CHP Roadmap for Michigan", February 2018, page 7. On September 17, 2019 GDS sent an email to David Baker and Graeme Miller at the University of Illinois Energy Resource Center in Chicago to determine the benefit/cost test used in the STEER model used in this CHP Roadmap for Michigan study to determine the cost effectiveness of CHP equipment. GDS is waiting for a response to this email question.

Listed below are the definitions of various types of CHP potential:

Technical Potential. The U.S. DOE defines CHP technical potential as an estimation of market size constrained only by technological limits — the ability of CHP technologies to fit customer energy needs without regard to economic or market factors.[59]

Economic Potential. All CHP options included in technical potential are screened for cost-effectiveness by comparing the anticipated benefits and costs as defined by the TRC Test. Only cost-effective CHP options would be included in the economic potential estimate. As noted above, none of the 78 CHP equipment types examined for this study were cost effective according to the TRC Test.

Maximum Achievable Potential (MAP). This is the maximum cost-effective CHP potential that can practically be attained in a real-world program delivery scenario, assuming that incentives and take rates are at the high end of actual utility program offerings and results.

Realistically Achievable Potential (RAP). This represents an estimate of the amount of CHP potential that can realistically be achieved given typical industry experience with similar CHP program offerings.

Maximum Achievable Program Potential (MAPP). This is the maximum cost-effective CHP potential that can practically be attained, with adjustments for potential free riders or utility budgets that may be less than what is necessary to achieve the full maximum potential.

Realistically Achievable Program Potential (RAPP). This represents an estimate of the amount of cost-effective CHP program potential that can realistically be achieved with program budgets that are representative of expected utility funding levels or the targeting at smaller CHP systems.

8.2 CHARACTERIZATION OF CHP IN THE BWL SERVICE AREA

There are two existing operable CHP installations within the BWL service area, representing a total installed capacity of 101.8 MW.[60] CHP is generally dependent on natural gas availability, including pipeline capacity availability, and customer steam usage. This CHP potential study assumes that almost all BWL electric customers also have access to natural gas either via the distribution system or the wholesale pipeline system.

[59] U.S. Department of Energy, CHP Technical Potential in the United States, March 2016, p. iii.

[60] U.S. DOE CHP Installation Database and discussions with Ameren Missouri. Note that the LBWL REO plant produces steam to sell to customers. The steam production creates electricity to sell to customers. LBWL sells steam to General Motors, who uses the steam for their "CHP unit". General Motors is not using their own waste steam but buying LBWL's waste steam.

TABLE 8-2 CHP INSTALLATIONS IN BWL SERVICE AREA AS OF AUGUST 2019

City	Organization	Facility Name	Application	SIC Code	NAICS Code	First Operation Year	Latest Install Year	Capacity (kW)	Prime Mover	Fuel Class/ Primary Fuel	Last Verified
Lansing	Lansing Board of Water and Light	REO Town Plant	Utilities	4939	221112	2013	2013	100,000	CC	NG-Natural Gas	2017
Lansing	General Motors	GM Lansing	Transportation Equip.	3711	336111	2002	2002	1,800	BPST	Waste - Steam	2005
Total								101,800			

Source: U.S. DOE, CHP Installations Database

8.3 TECHNICAL, ECONOMIC, ACHIEVABLE, PROGRAM POTENTIAL RESULTS

As noted in the Methodology chapter (Section 2) of this report, GDS examined the current cost effectiveness of new CHP equipment in the BWL service area given CHP equipment capital and operating costs, BWL's most recent forecast of avoided costs of electricity and forecasts of prices of other fuels (natural gas, propane, biomass, biogas and hydrogen). GDS has determined that the most common types of CHP equipment are not cost effective at this time in the BWL service area given BWL's very low avoided costs of electricity. ***At this time, none of the CHP equipment fueled by natural gas, biomass, biogas, hydrogen, diesel or propane is cost effective in the BWL service area according to the TRC test benefit/cost ratio.*** This situation could change in the future if forecasts of the avoided costs of electricity increase significantly or if capital and operating costs of CHP equipment decrease significantly, or both.

9 Energy Efficiency Program Recommendations

9.1 INTRODUCTION

This chapter of the report presents GDS' recommendations for programs that BWL should offer starting in 2022. BWL plans to continue its current program offerings through the end of 2021. These recommendations are based upon the GDS potential study results for the achievable potential scenario Path #3. The Path 3 scenario is (1) based on incentives to program participants set at 50% of the incremental measure cost, (2) includes all energy efficiency measures that pass the Total Resource Cost (TRC) Test or energy efficiency measures that do not pass the TRC test but pass the Utility Cost Test and meet a participant test payback requirement of 1 year or less and (3) includes all energy efficiency measures that pass the TRC test assuming higher electric avoided costs. More details on the Path 3 scenario assumptions are provided in chapter 10 of this report.

Table 9-1 below provides summary information for actual program participation, kWh and kW savings and BWL costs for 2019. Table 9-2 at the end of section 9.2 presents summary information for 2021 to 2030 on the Path 3 achievable potential scenario for projected program participation, MWh savings, MW savings, program budgets and acquisition costs per first year kWh saved. The data in Table 9-2 is presented for all recommended residential programs and for the overall portfolio of residential programs. Section 9.2 presents GDS' program recommendations for the residential sector. Section 9.3 presents GDS' program recommendations for the non-residential sector. Table 9-3 at the end of section 9.3 presents summary information for 2021 to 2030 on the Path 3 achievable potential scenario for projected nonresidential program participation, MWh savings, MW savings, program budgets and acquisition costs per first year kWh saved.

TABLE 9-1 SUMMARY OF 2019 BWL ENERGY WASTE REDUCTION PROGRAM ACTUAL KWH AND KW SAVINGS AND PROGRAM EXPENDITURES

Program	kWh	kW	Incentive $	Admin $	Total Program Expenditures $
Residential Programs					
Low Income Total	***669,295***	***604***	***$148,235***	***$98,824***	***$247,059***
Appliance Recycling	***725,309***	***0.39***	***$97,235***	***$39,331***	***$136,567***
Lighting, Appliances & HVAC	***4,402,629***	***575.65***	***$426,146***	***$160,517***	***$586,663***
Lighting	3,665,758	411.50	$195,633	$0	***$195,633***
Appliances	136,600	46.25	$77,000	$0	***$77,000***
HVAC	600,271	117.91	$153,513	$0	***$153,513***
Multi-family	***235,862***	***30.55***	***$31,581***	***$8,739***	***$40,320***
Residential Education Service	465,444			$93,013	***$93,013***
Residential Pilot	320,055			$64,011	***$64,011***
Residential Totals	***5,363,800***	***607***	***$554,963***	***$208,587***	***$763,550***
Residential & Low Income Totals	***6,818,594***	***1,211***	***$703,198***	***$464,435***	***$1,167,633***
Business Programs					
Comprehensive Business	***16,894,650***	***2,400***	***$1,368,247***	***$695,509***	***$2,063,756***
Small Business Direct Install	314,862	43	$30,010	$6,499	***$36,509***
Prescriptive	14,365,643	1,877	$1,009,745	$397,745	***$1,407,491***
Custom	2,214,145	481	$328,492	$291,264	***$619,756***
Business Education Services	54,075			$10,815	***$10,815***
Business Pilot	633,699			$126,239	***$126,239***
Business Totals	***17,582,424***	***2,400***	***$1,368,247***	***$832,563***	***$2,200,810***
Evaluation				***$182,771***	***$182,771***

Program	kWh	kW	Incentive $	Admin $	Total Program Expenditures $
BWL Admin				***$190,305***	***$190,305***
PORTFOLIO TOTALS	**24,401,018**	**3,611**	**$2,071,446**	**$1,479,769**	**$3,551,214**

9.2 RECOMMENDATIONS FOR RESIDENTIAL PROGRAMS

Low Income Services: GDS recommends that BWL continue to offer the residential Low Income Services program. Energy efficiency measures offered by this program include ENERGY STAR labeled smart thermostats, regular and specialty LED's, LED nightlights, refrigerators, dehumidifiers, room air conditioners, electric water heater energy efficiency measures, roof insulation, wall insulation, basement wall insulation, high efficiency HVAC equipment, HVAC duct insulation and air sealing. Other eligible measures include recycling of secondary refrigerators, freezers, dehumidifiers and room air conditioners and the installation of other efficient appliances and HVAC measures as applicable. GDS recommends that the eligible measures for the low income program be expanded to include window repair and replacement (where deemed necessary).

Behavioral Program: GDS recommends that BWL consider offering a Behavior program is to encourage residential customers to be more energy efficient. The program strategy is delivered by means of social competition and social norming. Encouragement is provided by way of printed and electronic Home Energy Reports (HERs) that display the customer's energy usage in comparison with average energy usage of approximately 100 nearby similar homes and a second comparison with the customer's most efficient nearby similar homes (the top 20 percent). The Home Energy Report also contains the customer's individual ranking within the group of 100 homes, energy-savings tips and promotions for other energy-efficiency programs. The customer is sent a Home Energy Report via the USPS, and an abbreviated email version of the Home Energy Report is sent to customers with an available email address. Additionally, encouragement can also be provided through active engagement via a mobile app where the customer is presented with electric usage data of their home. Customers that choose to receive the mobile application treatment would download the mobile application to their smart device to receive a standard treatment. This treatment includes displaying hourly household electric consumption data. Other treatments include the ability to set an energy saving target and monitor progress towards it and various interactive feedback tools. Additionally, customers may request an additional piece of hardware that is connected to the home internet. This hardware would enable an enhanced treatment by displaying one-minute household energy consumption history and displaying the real-time household electric energy consumption.

Weatherization (Building Shell Measures) Program: The objective of this program will be to motivate residential non-low income customers by offering rebates for the installation of eligible weatherization measures in their homes. Following is a summary of the components of this recommended program:

- Home Performance (HP): would offer customers incentives for insulation, windows and air sealing measures. HP customers would be required to have a comprehensive energy assessment (CEA) performed by a qualifying contractor listed on BWL's website.
- The Insulation and Windows (INWIN) component of the program would offer customers who do not wish to perform a CEA to still receive rebates for insulation and window improvements.

Residential High Efficiency Lighting: GDS recommends that BWL continue to offer a residential high efficiency lighting program. BWL's current residential lighting program leverages the nationally-recognized ENERGY STAR brand to promote LED lighting products that can reduce electric energy use. LED lighting products can save electricity when they replace incandescent, halogen or CFL bulbs, without sacrificing features, style or comfort. GDS recommends that this program include the full range of specialty LED bulbs that are included in the Path 3 achievable potential scenario. This program should continue to focus primarily on upstream retail sales and direct marketing of ENERGY STAR lighting products. GDS recommends that standard (non-specialty) LED bulbs be excluded from this program after 2021 as many or most consumers already purchase standard LED bulbs when replacing standard incandescent, halogen or CFL bulbs in their homes.

Residential High Efficiency Appliances: GDS recommends that BWL continue to offer the High-Efficient Appliances program. Going forward, this program should provide financial incentives to residential customers to encourage them to replace their older, inefficient refrigerators and freezers, clothes washers and dryers, dishwashers, dehumidifiers, room air-conditioners, smart power strips and air purifiers with high-efficiency units. In the future, other high efficiency appliances can be added if they are found to be cost effective. GDS recommends that Energy Star televisions be excluded from this program going forward as most televisions sold today are already Energy Star rated.

Residential Appliance Turn-In and Recycling: GDS recommends that BWL continue to offer the Appliance Turn-In and Recycling Program. This program offers incentives to customers to replace currently operating older, inefficient refrigerators, freezers, dehumidifiers and/or room air conditioners as secondary units.

Residential High-Efficiency HVAC: GDS recommend that BWL continue the High Efficiency HVAC program. This program will provide incentives to customers for the following contractor installed measures

- Replacement of electrically commutated motors (ECMs) that are part of a natural gas or oil-fired heating system.
- Furnace tune-ups
- Ductless mini-split heat pumps
- Smart and programmable thermostats
- High efficiency central air-conditioning equipment. The program will provide incentives for high-efficiency central air-conditioners with a SEER rating ≥ 15. Incentives for central air-conditioning tune-ups will also be promoted.
- ENERGY STAR heat pump water heaters

GDS recommends that high efficiency pool pumps be removed from this program. The Federal energy efficiency standard for pool pumps is changing soon and this measure will no longer be needed as part of a program.

Residential Multi-Family In-Unit Efficiency: GDS recommends that BWL continue this existing program. Eligible measures for the direct install component currently include high-efficiency LED lighting products. Eligible measures for the new construction/remodeling component currently include replacing incandescent or CFL light bulbs with energy-efficient LED lighting and coordinating with other programs for the installation of efficient heating and cooling equipment, choosing new ENERGY STAR® appliances and recycling old appliances. GDS recommends that the measures offered through this program be expanded to include the following measures:

- High efficiency water heater measures
- High efficiency appliances
- Roof and wall insulation
- Air sealing

- High efficiency HVAC equipment

9.3 RECOMMENDATIONS FOR NON-RESIDENTIAL PROGRAMS

Prescriptive Program: GDS recommends that BWL continues its non-residential Prescriptive energy efficiency program. The objective of the C&I Prescriptive program is to provide pre-determined measures and incentives to C&I customers for the installation of high efficiency equipment. The incentives will continue to be designed to encourage C&I business customers to install energy-efficient measures in existing facilities in an effort to reduce overall energy consumption and save money on their energy bills. C&I Prescriptive categories of energy-efficient equipment can include numerous applications, such as the following: LED lighting and fixtures, control systems, HVAC, food service and refrigeration equipment. Incentives apply to qualified equipment commonly installed in a retrofit or equipment-replacement project and are paid based on the quantity, size, and efficiency of the technology installed. Prescriptive incentives take the form of rebates paid after the installation of eligible measures. The C&I Prescriptive program could include several hundred prescriptive measures. Typical measures implemented in the past have included lighting fixtures, lamps, LED lighting systems and controls, motors and variable-speed drives, food service and refrigeration equipment, air conditioning and ventilation equipment and other common non-residential energy-efficient equipment. Additionally, the savings and spend for commercial common areas of the Multifamily program and the ENERGY STAR® retail lighting program are included as C&I Prescriptive components. Property owners can be encouraged and provided with incentives to install energy-efficient equipment in the common areas (e.g., hallways, stairwells, and parking lots) of their building(s). Examples of common-area measures implemented in the past include interior lighting replacement, parking lot lighting, LED exit signs, and controls.

Custom Program: GDS recommends that BWL continues its non-residential Custom energy efficiency program. The C&I Non-Prescriptive program promotes the installation of energy-efficient technologies among BWL's commercial and industrial customers. This program provides incentives to nonresidential customers for eligible measures installed in qualifying projects that are less common or more complex than the projects where Prescriptive measures are installed. As with Prescriptive incentives, custom incentive payments occur after equipment is installed and operational at the customer's location. Examples of custom measures include energy management system controls on condenser and chilled water pumps, cooling tower replacement with energy efficient motors and variable frequency drives, demand control ventilation (DCV) mechanical systems, and custom lighting projects with extended hours of use. GDS also recommends that BWL consider using this program to promote the installation of emerging energy-efficient technologies that have recently been commercialized.

TABLE 9-2 FORECAST OF PARTICIPANTS, ANNUAL MWH SAVINGS, ANNUAL BWL UTILITY COSTS

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Low Income										
Incremental annual participants	17,813	23,325	28,838	34,350	39,862	45,375	50,887	56,399	61,912	67,424
Cumulative annual participants	17,813	41,138	69,967	104,326	144,188	189,563	240,450	296,849	358,650	425,934
Incremental annual MWh savings	828	1,080	902	594	685	778	871	966	1,061	1,157
Cumulative annual MWh savings	828	1,915	2,211	1,847	2,541	3,331	4,218	5,204	6,163	7,191
Incremental annual BWL utility costs	$106,241	$128,067	$129,287	$120,496	$137,917	$155,086	$172,020	$188,697	$205,211	$221,546
Cumulative annual BWL utility costs	$106,241	$234,308	$363,595	$484,091	$622,008	$777,094	$949,114	$1,137,811	$1,343,022	$1,564,568
Incremental annual program acquisition costs	$0.13	$0.12	$0.14	$0.20	$0.20	$0.20	$0.20	$0.20	$0.19	$0.19
Residential High Efficiency Lighting										
Incremental annual participants	24,634	33,308	41,880	50,452	59,009	67,571	76,136	84,669	93,136	77,712
Cumulative annual participants	24,634	57,941	99,822	150,274	209,283	276,853	352,990	437,659	530,795	608,507
Incremental annual MWh savings	886	1,209	858	308	366	425	486	549	612	522
Cumulative annual MWh savings	886	2,104	2,046	916	1,296	1,741	2,254	2,836	3,490	4,062
Incremental annual BWL utility costs	$94,754	$113,024	$98,064	$55,718	$63,310	$70,365	$76,851	$82,844	$88,377	$72,081
Cumulative annual BWL utility costs	$94,754	$207,778	$305,842	$361,560	$424,870	$495,235	$572,087	$654,930	$743,307	$815,388
Incremental annual program acquisition costs	$0.11	$0.09	$0.11	$0.18	$0.17	$0.17	$0.16	$0.15	$0.14	$0.14
Residential High Efficient Appliances										
Incremental annual participants	3,160	3,501	3,834	4,168	4,503	4,838	5,174	5,509	5,840	6,177

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cumulative annual participants	3,160	6,661	10,495	14,663	19,165	24,003	29,177	34,686	40,526	46,505
Incremental annual MWh savings	281	321	361	400	439	479	518	558	597	638
Cumulative annual MWh savings	281	603	963	1,363	1,803	2,281	2,799	3,357	3,954	4,514
Incremental annual BWL utility costs	$80,436	$90,099	$99,731	$109,541	$119,498	$129,632	$139,941	$150,379	$160,914	$171,954
Cumulative annual BWL utility costs	$80,436	$170,535	$270,266	$379,807	$499,305	$628,937	$768,878	$919,257	$1,080,171	$1,252,125
Incremental annual program acquisition costs	$0.29	$0.28	$0.28	$0.27	$0.27	$0.27	$0.27	$0.27	$0.27	$0.27
Residential Appliance Recycling										
Incremental annual participants	678	778	877	977	1,076	1,176	1,275	1,375	1,475	1,574
Cumulative annual participants	678	1,455	2,333	3,309	4,386	5,561	6,837	8,212	9,009	9,806
Incremental annual MWh savings	499	576	653	730	807	883	960	1,037	1,114	1,191
Cumulative annual MWh savings	499	1,075	1,728	2,458	3,265	4,148	5,108	6,145	6,760	7,375
Incremental annual BWL utility costs	$54,871	$64,118	$73,633	$83,427	$93,510	$103,892	$114,584	$125,597	$136,943	$148,634
Cumulative annual BWL utility costs	$54,871	$118,988	$192,622	$276,049	$369,559	$473,451	$588,035	$713,633	$850,576	$999,210
Incremental annual program acquisition costs	$0.11	$0.11	$0.11	$0.11	$0.12	$0.12	$0.12	$0.12	$0.12	$0.12
Residential High Efficiency HVAC										
Incremental annual participants	1,855	2,314	2,772	3,230	3,687	4,145	4,603	5,061	5,519	5,976
Cumulative annual participants	1,855	2,837	3,923	5,111	6,402	7,795	9,292	10,891	12,592	14,395
Incremental annual MWh savings	728	888	1,048	1,208	1,367	1,527	1,687	1,847	2,006	2,166

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cumulative annual MWh savings	728	1,439	2,263	3,199	4,247	5,408	6,682	8,068	9,566	11,177
Incremental annual BWL utility costs	$156,293	$190,246	$224,733	$259,787	$295,428	$331,679	$368,563	$406,096	$444,300	$483,204
Cumulative annual BWL utility costs	$156,293	$346,539	$571,271	$831,059	$1,126,487	$1,458,166	$1,826,729	$2,232,825	$2,677,126	$3,160,330
Incremental annual program acquisition costs	$0.21	$0.21	$0.21	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22
Residential HVAC Shell										
Incremental annual participants	404	518	631	744	856	969	1,082	1,195	1,307	1,418
Cumulative annual participants	404	922	1,553	2,297	3,153	4,122	5,205	6,399	7,706	9,125
Incremental annual MWh savings	105	139	173	206	240	273	306	339	371	403
Cumulative annual MWh savings	105	244	416	622	860	1,131	1,434	1,768	2,132	2,527
Incremental annual BWL utility costs	$29,686	$38,871	$48,138	$57,515	$67,000	$76,599	$86,315	$96,140	$106,070	$116,117
Cumulative annual BWL utility costs	$29,686	$68,556	$116,694	$174,209	$241,209	$317,808	$404,123	$500,263	$606,333	$722,450
Incremental annual program acquisition costs	$0.28	$0.28	$0.28	$0.28	$0.28	$0.28	$0.28	$0.28	$0.29	$0.29
Residential Water Heating										
Incremental annual participants	137	263	388	512	635	759	883	1,006	1,127	1,248
Cumulative annual participants	137	400	788	1,300	1,936	2,695	3,577	4,583	5,710	6,958
Incremental annual MWh savings	36	70	103	136	168	201	233	266	298	329
Cumulative annual MWh savings	36	106	209	344	512	713	947	1,212	1,510	1,839
Incremental annual BWL utility costs	$3,892	$7,583	$11,331	$15,179	$19,127	$23,194	$27,385	$31,678	$36,052	$40,545

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cumulative annual BWL utility costs	$3,892	$11,475	$22,806	$37,985	$57,112	$80,306	$107,691	$139,368	$175,421	$215,965
Incremental annual program acquisition costs	$0.11	$0.11	$0.11	$0.11	$0.11	$0.12	$0.12	$0.12	$0.12	$0.12
Residential Multi-Family In-Unit Efficiency										
Incremental annual participants	6,786	9,088	11,334	13,581	15,862	18,111	20,423	22,659	24,926	23,290
Cumulative annual participants	6,786	15,874	27,208	40,789	56,233	73,544	92,609	113,369	135,510	155,337
Incremental annual MWh savings	671	883	981	1,046	1,216	1,381	1,557	1,722	1,893	2,032
Cumulative annual MWh savings	671	1,556	2,386	3,195	4,360	5,643	7,028	8,509	9,861	11,212
Incremental annual BWL utility costs	$111,327	$138,365	$159,790	$177,310	$204,026	$230,845	$259,231	$286,994	$315,751	$341,008
Cumulative annual BWL utility costs	$111,327	$249,692	$409,482	$586,792	$790,818	$1,021,663	$1,280,895	$1,567,889	$1,883,640	$2,224,648
Incremental annual program acquisition costs	$0.17	$0.16	$0.16	$0.17	$0.17	$0.17	$0.17	$0.17	$0.17	$0.17
Behavioral										
Incremental annual participants	7,305	10,135	12,971	15,811	18,655	21,504	24,356	27,212	30,069	32,927
Cumulative annual participants	7,305	10,135	12,971	15,811	18,655	21,504	24,356	27,212	30,069	32,927
Incremental annual MWh savings	1,487	2,043	2,597	3,150	3,677	4,188	4,681	5,154	5,614	6,057
Cumulative annual MWh savings	1,487	2,043	2,597	3,150	3,677	4,188	4,681	5,154	5,614	6,057
Incremental annual BWL utility costs	$111,838	$157,206	$204,339	$253,486	$302,936	$353,363	$404,674	$456,735	$510,055	$564,319
Cumulative annual BWL utility costs	$111,838	$269,044	$473,383	$726,868	$1,029,804	$1,383,168	$1,787,841	$2,244,576	$2,754,631	$3,318,950
Incremental annual program acquisition costs	$0.08	$0.08	$0.08	$0.08	$0.08	$0.08	$0.09	$0.09	$0.09	$0.09
Other										

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Incremental annual participants	1,319	2,522	3,719	4,915	6,151	7,352	8,616	9,816	11,078	12,270
Cumulative annual participants	1,319	3,841	7,561	12,475	17,708	23,302	28,936	34,582	40,262	45,943
Incremental annual MWh savings	183	350	516	682	853	1,020	1,196	1,363	1,538	1,703
Cumulative annual MWh savings	183	532	1,048	1,730	2,468	3,267	4,083	4,912	5,755	6,609
Incremental annual BWL utility costs	$19,784	$38,531	$57,719	$77,449	$98,268	$119,264	$141,924	$164,239	$187,990	$211,529
Cumulative annual BWL utility costs	$19,784	$58,315	$116,034	$193,483	$291,751	$411,015	$552,940	$717,179	$905,168	$1,116,697
Incremental annual program acquisition costs	$0.11	$0.11	$0.11	$0.11	$0.12	$0.12	$0.12	$0.12	$0.12	$0.12
Total Residential										
Incremental annual participants	64,092	85,751	107,243	128,739	150,297	171,800	193,437	214,901	236,388	230,017
Cumulative annual participants	64,092	141,206	236,619	350,355	481,108	628,943	793,430	974,442	1,170,829	1,355,436
Incremental annual MWh savings	5,705	7,560	8,190	8,459	9,819	11,155	12,496	13,799	15,104	16,198
Cumulative annual MWh savings	5,705	11,617	15,867	18,824	25,029	31,852	39,234	47,165	54,806	62,564
Incremental annual BWL utility costs	$769,123	$966,109	$1,106,764	$1,209,908	$1,401,020	$1,593,920	$1,791,488	$1,989,399	$2,191,663	$2,370,938
Cumulative annual BWL utility costs	$769,123	$1,735,232	$2,841,996	$4,051,904	$5,452,923	$7,046,844	$8,838,332	$10,827,731	$13,019,394	$15,390,332
Incremental annual program acquisition costs	$0.13	$0.13	$0.14	$0.14	$0.14	$0.14	$0.14	$0.14	$0.15	$0.15

Note: incremental annual program acquisition costs are expressed in $ per first-year kWh saved

TABLE 9-3 FORECAST OF PARTICIPANTS, ANNUAL MWH SAVINGS, ANNUAL BWL UTILITY COSTS FOR NON RESIDENTIAL PROGRAMS

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Incremental annual units	414,228	506,806	601,445	693,003	790,553	875,152	923,285	1,001,287	995,484	968,628
Cumulative annual units	414,228	921,034	1,522,479	2,215,482	3,006,035	3,881,187	4,804,472	5,805,760	6,801,244	7,769,872
Incremental annual MWh savings	10,936	13,053	15,297	17,416	20,311	23,090	24,777	25,898	26,929	26,763
Cumulative annual MWh savings	10,936	23,617	37,979	53,850	71,089	89,241	106,592	123,181	138,441	151,663
Incremental annual BWL utility costs	$1,252,805	$1,488,753	$1,727,280	$1,952,174	$2,224,640	$2,474,439	$2,620,613	$2,711,459	$2,788,994	$2,757,153
Cumulative annual BWL utility costs	$1,252,805	$2,741,557	$4,468,838	$6,421,012	$8,645,652	$11,120,091	$13,740,704	$16,452,163	$19,241,157	$21,998,309
Incremental annual program acquisition costs	$0.11455	$0.11405	$0.11292	$0.11209	$0.10953	$0.10716	$0.10577	$0.10470	$0.10357	$0.10302

Note: incremental annual program acquisition costs are expressed in $ per first-year kWh saved

10 Demand-Side Management Inputs to the BWL Integrated Resource Planning Model

10.1 INTRODUCTION

Once the GDS Team completed the analyses of the future potential for energy efficiency and demand response resources, electric vehicles, distributed solar generation and CHP, GDS worked with BWL staff to aggregate the data for hundreds of individual measures into a dozen or so bins that could be input to BWL's integrated resource planning model. Each bin represents the aggregated electric load impacts and associated costs for only the measures eligible to be included in that bin based on cost effectiveness criteria defined for that bin. Each bin is exclusive and does not include measures from other bins. This section of the report describes the bins created for the DSM and other resources analyzed in this report.

10.2 BINS FOR ENERGY EFFICIENCY MEASURES

For each sector (residential, commercial and industrial added together), energy efficiency measures were grouped into five bins. In total, therefore, there are two sets of five bins. Bin 1 included measures with a TRC benefit/cost ratio greater than 2.0. Bin 2 included measures with a TRC benefit/cost ratio greater than or equal to 1.0 and less than 2.0. Bin 3 included measures with a TRC benefit/cost ratio greater than or equal to 0.8 and if the UCT benefit/cost ratio using the targeted payback incentive was greater than or equal to 1.0. Bin 4 included additional measures than had a TRC benefit/cost ratio greater than 1.0 under the high avoided cost scenario. The high avoided costs for Bin 4 increased avoided energy costs each by 10%, avoided capacity costs were increased by 1000% (10 times higher) and avoided T&D costs were increased by 200 percent (2 times higher). Bin 5 included additional measures that had a UCT benefit/cost ratio greater than or equal to 1.0 with incentives set (1) at either 50% of measure incremental cost or (2) at the targeted payback incentive level (if not included in any of the previous bins). To summarize, GDS used the following criteria to sort energy efficiency measures into the five bins:

- Bin 1 – TRC > 2.0
- Bin 2 - TRC >=1.0 and < 2.0
- Bin 3 - TRC >=.8 and < 1 or UCT Payback scenario >= 1.0
- Bin 4 - TRC >= 1, High Avoided Cost[61]
- Bin 5 – UCT > 1 at 50% incentive level

10.3 BINS FOR DEMAND RESPONSE MEASURES

The GDS demand response potential study determined that only one demand response program was cost-effective based on the avoided costs of electricity provided to GDS by BWL staff. Based on discussions with BWL staff, GDS examined a scenario to determine which additional demand response programs would become cost-effective if avoided energy costs were 10 percent higher, avoided capacity costs increased by 1000%, and avoided transmission and distribution costs increased by 200%. The demand response programs that had a TRC ratio greater than or equal to 1.0 with these higher avoided costs were considered to be cost-effective for this demand response scenario and included the following programs in the IRP modeling:

- Residential Critical Peak Pricing with Enabling Technology
- Residential Critical Peak Pricing without Enabling Technology
- Residential Time of Use without Enabling Technology

[61] The high avoided costs for Bin 4 increased avoided energy costs each by 10%, avoided capacity costs were increased by 1000% (10 times higher) and avoided T&D costs were increased by 200 percent (2 times higher).

- Non-Residential Critical Peak Pricing with Enabling Technology[62]
- Non-Residential Critical Peak Pricing without Enabling Technology

10.4 BIN FOR COMBINED HEAT AND POWER

A single bin was developed for CHP. This hourly load impact and cost characteristics for this bin are based upon a 633 kW CHP Reciprocating Engine fueled with natural gas. The total potential CHP MW load impacts for this CHP bin are based upon the CHP potential identified in Chapter 8 of this report. Although none of the CHP technologies were found to be cost effective in the CHP potential study, BWL included CHP resources in the IRP modeling as a resource with a flat dispatch (not dispatched by BWL but dispatched by the customer).

10.5 BINS FOR DISTRIBUTED SOLAR PHOTOVOLTAIC (PV) GENERATION

The GDS team developed forecasts of the potential generation from distributed solar photovoltaic generation for reference, high and low cases. For each of these three cases, the GDS Team provided BWL with projections of (1) hourly solar PV generation and (2) annual operation and maintenance costs for the years 2021 to 2040. The forecasts of solar PV generation for the reference, high and low cases are provided in Chapter 6 of this report. In the BWL IRP modeling effort, BWL used revised versions of the distributed solar generation base, high and low cases, and varying levels of incentives paid to program participants (no incentive, $500 per kW and $1,000 per kW).

10.6 BINS FOR ELECTRIC VEHICLES

The GDS team developed reference, high and low case forecasts of the potential number of light-duty electric passenger vehicles (LDV's) connected to the BWL electric grid and the hourly load impacts of these electric vehicles for the period 2021 to 2040. For each of these three cases, the GDS Team provided BWL with projections of the hourly load impacts of these electric vehicles for the years 2021 to 2040. The forecasts of the number of electric vehicles on the BWL grid for the reference, high and low cases are provided in Chapter 7 of this report.

10.7 ENERGY EFFICIENCY SCENARIO PATHS

BWL staff developed three different proposed paths for energy waste reduction in the BWL service area. Listed below are the explanations of the energy efficiency Bins include in each of the three paths.

PATH 1:

- C&I Bin 1 50% Incentive

PATH 2:

- C&I Bin 1 50% Incentive
- C&I Bin 2 50% Incentive
- C&I Bin 3 TPB Incentive
- RES Bin 1 50% Incentive
- RES Bin 3 50% Incentive
- RES Bin 5 50% Incentive

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[62] The non-residential critical peak pricing program was cost effective under the base case scenario, without higher avoided costs. However, the BWL IRP model did not select any demand response programs until the year 2030.

PATH 3:

- C&I Bin 1 50% Incentive
- C&I Bin 2 50% Incentive
- C&I Bin 3 TPB Incentive
- C&I Bin 4 50% Incentive
- C&I Bin 5 50% Incentive
- RES Bin 1 50% Incentive
- RES Bin 2 50% Incentive
- RES Bin 3 50% Incentive
- RES Bin 4 50% Incentive
- RES Bin 5 50% Incentive

Tables 10-1 to 10-4 below present information on the cumulative annual MWH savings potential by sector (e.g., residential, commercial, industrial, total) for the Path 3 scenario that includes all Bins and assumes incentives paid to program participants are set at 50% of measure incremental cost.

TABLE 10-1 BWL RESIDENTIAL SECTOR CUMULATIVE ANNUAL ACHIEVABLE MWH SAVINGS POTENTIAL WITH INCENTIVES SET AT 50% OF MEASURE INCREMENTAL COST

YEAR	RESIDENTIAL BIN 1 TRC > 2.0	RESIDENTIAL BIN 2 TRC < 2.0 & >= 1.0	RESIDENTIAL BIN 3 TRC < 1, TRC >0.8, UCTBP >= 1.0	RESIDENTIAL BIN 4 TRC > 1, High Avoided Cost	RESIDENTIAL BIN 5 UCT > 1 at 50% incentive level	TOTAL - ALL RESIDENTIAL BINS
2021	2,901	2,159	552	210	0	7,843
2022	6,768	3,423	1,218	350	0	13,781
2023	8,676	4,848	1,995	513	0	18,055
2024	8,994	6,435	2,885	700	0	21,038
2025	12,330	8,116	3,886	910	0	27,268
2026	16,042	9,904	5,000	1,144	0	34,116
2027	20,112	11,758	6,225	1,400	0	41,523
2028	24,537	13,671	7,562	1,640	0	49,438
2029	28,517	15,646	9,010	1,896	0	57,099
2030	32,536	17,571	10,569	2,076	0	64,782
2031	35,421	18,763	11,600	2,231	0	70,046
2032	37,702	19,835	12,523	2,362	0	74,453
2033	39,199	20,652	13,337	2,468	0	77,690
2034	40,090	21,336	14,044	2,551	0	80,054
2035	40,524	21,911	14,642	2,608	0	81,720
2036	40,415	22,375	15,117	2,641	0	82,584
2037	39,860	22,780	15,481	2,650	0	82,808
2038	38,864	23,131	15,735	2,681	0	82,448
2039	38,424	23,416	15,879	2,699	0	82,456
2040	37,910	23,659	15,912	2,699	0	82,220
BIN Cumulative Annual MWH Savings As A Percent of MWH Savings for All Residential BINS						
2021	37%	28%	7%	3%	0%	100%
2022	49%	25%	9%	3%	0%	100%
2023	48%	27%	11%	3%	0%	100%
2024	43%	31%	14%	3%	0%	100%
2025	45%	30%	14%	3%	0%	100%

YEAR	RESIDENTIAL BIN 1 TRC > 2.0	RESIDENTIAL BIN 2 TRC < 2.0 & >= 1.0	RESIDENTIAL BIN 3 TRC < 1, TRC >0.8, UCTBP >= 1.0	RESIDENTIAL BIN 4 TRC > 1, High Avoided Cost	RESIDENTIAL BIN 5 UCT > 1 at 50% incentive level	TOTAL - ALL RESIDENTIAL BINS
2026	47%	29%	15%	3%	0%	100%
2027	48%	28%	15%	3%	0%	100%
2028	50%	28%	15%	3%	0%	100%
2029	50%	27%	16%	3%	0%	100%
2030	50%	27%	16%	3%	0%	100%
2031	51%	27%	17%	3%	0%	100%
2032	51%	27%	17%	3%	0%	100%
2033	50%	27%	17%	3%	0%	100%
2034	50%	27%	18%	3%	0%	100%
2035	50%	27%	18%	3%	0%	100%
2036	49%	27%	18%	3%	0%	100%
2037	48%	28%	19%	3%	0%	100%
2038	47%	28%	19%	3%	0%	100%
2039	47%	28%	19%	3%	0%	100%
2040	46%	29%	19%	3%	0%	100%

TABLE 10-2 BWL COMMERCIAL SECTOR CUMULATIVE ANNUAL ACHIEVABLE MWH SAVINGS POTENTIAL WITH INCENTIVES SET AT 50% OF MEASURE INCREMENTAL COST

YEAR	Commercial BIN 1 (MWH) TRC > 2.0	Commercial BIN 2 (MWH) TRC < 2.0 & >= 1.0	Commercial BIN 3 (MWH) TRC < 1, TRC >0.8, UCTBP >= 1.0	Commercial BIN 4 (MWH) TRC > 1, High Avoided Cost	Commercial BIN 5 (MWH) UCT > 1 at 50% incentive level	TOTAL - ALL Commercial BINS
2021	7,703	3,233	898	1,154	3,393	16,382
2022	16,601	7,016	1,897	1,319	6,628	33,461
2023	26,675	11,304	2,995	1,471	9,422	51,868
2024	37,821	16,029	4,170	1,590	11,652	71,262
2025	50,017	21,071	5,376	1,639	13,342	91,445
2026	63,005	26,236	6,544	1,635	14,595	112,016
2027	75,291	31,302	7,603	1,575	15,531	131,302

YEAR	Commercial BIN 1 (MWH) TRC > 2.0	Commercial BIN 2 (MWH) TRC < 2.0 & >= 1.0	Commercial BIN 3 (MWH) TRC < 1, TRC >0.8, UCTBP >= 1.0	Commercial BIN 4 (MWH) TRC > 1, High Avoided Cost	Commercial BIN 5 (MWH) UCT > 1 at 50% incentive level	TOTAL - ALL Commercial BINS
2028	87,075	36,106	8,507	1,474	16,296	149,457
2029	97,859	40,583	9,248	1,327	17,029	166,046
2030	107,437	44,226	9,784	1,148	17,333	179,928
2031	115,898	47,286	10,195	1,275	17,649	192,303
2032	123,384	50,017	10,517	1,181	17,974	203,073
2033	130,053	52,485	10,794	1,486	18,291	213,109
2034	136,262	54,724	10,957	1,448	18,598	221,988
2035	142,257	56,782	11,114	1,397	18,892	230,442
2036	145,504	58,664	11,223	1,662	19,162	236,215
2037	148,489	60,479	11,327	1,506	19,405	241,206
2038	151,258	62,226	11,425	1,506	19,617	246,031
2039	152,850	63,117	11,516	1,472	19,796	248,751
2040	154,081	63,792	11,599	1,399	19,943	250,815
BIN Cumulative Annual MWH Savings As A Percent of MWH Savings for All Commercial BINS						
2021	47%	20%	5%	7%	21%	100%
2022	50%	21%	6%	4%	20%	100%
2023	51%	22%	6%	3%	18%	100%
2024	53%	22%	6%	2%	16%	100%
2025	55%	23%	6%	2%	15%	100%
2026	56%	23%	6%	1%	13%	100%
2027	57%	24%	6%	1%	12%	100%
2028	58%	24%	6%	1%	11%	100%
2029	59%	24%	6%	1%	10%	100%
2030	60%	25%	5%	1%	10%	100%
2031	60%	25%	5%	1%	9%	100%
2032	61%	25%	5%	1%	9%	100%

YEAR	Commercial BIN 1 (MWH) TRC > 2.0	Commercial BIN 2 (MWH) TRC < 2.0 & >= 1.0	Commercial BIN 3 (MWH) TRC < 1, TRC >0.8, UCTBP >= 1.0	Commercial BIN 4 (MWH) TRC > 1, High Avoided Cost	Commercial BIN 5 (MWH) UCT > 1 at 50% incentive level	TOTAL - ALL Commercial BINS
2033	61%	25%	5%	1%	9%	100%
2034	61%	25%	5%	1%	8%	100%
2035	62%	25%	5%	1%	8%	100%
2036	62%	25%	5%	1%	8%	100%
2037	62%	25%	5%	1%	8%	100%
2038	61%	25%	5%	1%	8%	100%
2039	61%	25%	5%	1%	8%	100%
2040	61%	25%	5%	1%	8%	100%

TABLE 10-3 BWL INDUSTRIAL SECTOR CUMULATIVE ANNUAL ACHIEVABLE MWH SAVINGS POTENTIAL WITH INCENTIVES SET AT 50% OF MEASURE INCREMENTAL COST

YEAR	Industrial BIN 1 (MWH) TRC > 2.0	Industrial BIN 2 (MWH) TRC < 2.0 & >= 1.0	Industrial BIN 3 (MWH) TRC < 1, TRC >0.8, UCTBP >= 1.0	Industrial BIN 4 (MWH) TRC > 1, High Avoided Cost	Industrial BIN 5 (MWH) UCT > 1 at 50% incentive level	TOTAL - ALL Industrial BINS
2021	3,165	706	612	0	0	4,484
2022	6,439	1,459	1,258	0	0	9,156
2023	9,767	2,245	1,933	0	0	13,945
2024	13,086	3,046	2,621	0	0	18,754
2025	16,338	3,850	3,303	0	0	23,492
2026	19,455	4,641	3,971	0	0	28,068
2027	22,393	5,402	4,614	0	0	32,409
2028	25,108	6,114	5,229	0	0	36,451
2029	27,463	6,761	5,793	0	0	40,018
2030	29,576	7,334	6,307	0	0	43,217
2031	31,351	7,775	6,755	0	0	45,881
2032	32,861	8,149	7,153	0	0	48,163
2033	34,122	8,449	7,480	0	0	50,051

YEAR	Industrial BIN 1 (MWH) TRC > 2.0	Industrial BIN 2 (MWH) TRC < 2.0 & >= 1.0	Industrial BIN 3 (MWH) TRC < 1, TRC >0.8, UCTBP >= 1.0	Industrial BIN 4 (MWH) TRC > 1, High Avoided Cost	Industrial BIN 5 (MWH) UCT > 1 at 50% incentive level	TOTAL - ALL Industrial BINS
2034	35,134	8,690	7,763	0	0	51,587
2035	35,984	8,873	8,009	0	0	52,867
2036	36,537	9,012	8,221	0	0	53,770
2037	36,952	9,101	8,402	0	0	54,454
2038	37,286	9,174	8,575	0	0	55,035
2039	37,494	9,201	8,748	0	0	55,443
2040	37,688	9,231	8,930	0	0	55,849
BIN Cumulative Annual MWH Savings As A Percent of MWH Savings for All Industrial BINS						
2021	71%	16%	14%	0%	0%	100%
2022	70%	16%	14%	0%	0%	100%
2023	70%	16%	14%	0%	0%	100%
2024	70%	16%	14%	0%	0%	100%
2025	70%	16%	14%	0%	0%	100%
2026	69%	17%	14%	0%	0%	100%
2027	69%	17%	14%	0%	0%	100%
2028	69%	17%	14%	0%	0%	100%
2029	69%	17%	14%	0%	0%	100%
2030	68%	17%	15%	0%	0%	100%
2031	68%	17%	15%	0%	0%	100%
2032	68%	17%	15%	0%	0%	100%
2033	68%	17%	15%	0%	0%	100%
2034	68%	17%	15%	0%	0%	100%
2035	68%	17%	15%	0%	0%	100%
2036	68%	17%	15%	0%	0%	100%
2037	68%	17%	15%	0%	0%	100%
2038	68%	17%	16%	0%	0%	100%
2039	68%	17%	16%	0%	0%	100%

YEAR	Industrial BIN 1 (MWH) TRC > 2.0	Industrial BIN 2 (MWH) TRC < 2.0 & >= 1.0	Industrial BIN 3 (MWH) TRC < 1, TRC >0.8, UCTBP >= 1.0	Industrial BIN 4 (MWH) TRC > 1, High Avoided Cost	Industrial BIN 5 (MWH) UCT > 1 at 50% incentive level	TOTAL - ALL Industrial BINS
2040	67%	17%	16%	0%	0%	100%

TABLE 10-4 TOTAL RESIDENTIAL, COMMERCIAL, AND INDUSTRIAL CUMULATIVE ANNUAL ACHIEVABLE MWH SAVINGS POTENTIAL WITH INCENTIVES SET AT 50% OF MEASURE INCREMENTAL COST

YEAR	RES & C&I BIN 1 TRC > 2.0	RES & C&I BIN 2 TRC < 2.0 & >= 1.0	RES & C&I BIN 3 TRC < 1, TRC >0.8, UCTBP >= 1.0	RES & C&I BIN 4 TRC > 1, High Avoided Cost	RES & C&I BIN 5 UCT > 1 at 50% incentive level	TOTAL - ALL RES & C&I BINS
2021	13,770	6,099	2,063	1,364	3,393	26,688
2022	29,807	11,898	4,374	1,668	6,628	54,376
2023	45,118	18,397	6,924	1,984	9,422	81,845
2024	59,901	25,510	9,676	2,290	11,652	109,029
2025	78,686	33,038	12,565	2,549	13,342	140,180
2026	98,502	40,781	15,516	2,779	14,595	172,173
2027	117,796	48,462	18,442	2,976	15,531	203,207
2028	136,721	55,891	21,298	3,113	16,296	233,319
2029	153,839	62,991	24,051	3,223	17,029	261,133
2030	169,548	69,131	26,660	3,224	17,333	285,896
2031	182,670	73,824	28,549	3,506	17,649	306,199
2032	193,946	78,001	30,193	3,543	17,974	323,657
2033	203,374	81,586	31,611	3,954	18,291	338,816
2034	211,485	84,749	32,763	3,998	18,598	351,594
2035	218,765	87,566	33,765	4,005	18,892	362,994
2036	222,456	90,051	34,561	4,302	19,162	370,532
2037	225,301	92,360	35,210	4,156	19,405	376,432
2038	227,407	94,530	35,736	4,187	19,617	381,477
2039	228,768	95,734	36,144	4,170	19,796	384,612
2040	229,679	96,681	36,441	4,098	19,943	386,843
BIN Cumulative Annual MWH Savings As A Percent of MWH Savings for All BINS for All Sectors Combined						
2021	52%	23%	8%	5%	13%	100%

YEAR	RES & C&I BIN 1 TRC > 2.0	RES & C&I BIN 2 TRC < 2.0 & >= 1.0	RES & C&I BIN 3 TRC < 1, TRC >0.8, UCTBP >= 1.0	RES & C&I BIN 4 TRC > 1, High Avoided Cost	RES & C&I BIN 5 UCT > 1 at 50% incentive level	TOTAL - ALL RES & C&I BINS
2022	55%	22%	8%	3%	12%	100%
2023	55%	22%	8%	2%	12%	100%
2024	55%	23%	9%	2%	11%	100%
2025	56%	24%	9%	2%	10%	100%
2026	57%	24%	9%	2%	8%	100%
2027	58%	24%	9%	1%	8%	100%
2028	59%	24%	9%	1%	7%	100%
2029	59%	24%	9%	1%	7%	100%
2030	59%	24%	9%	1%	6%	100%
2031	60%	24%	9%	1%	6%	100%
2032	60%	24%	9%	1%	6%	100%
2033	60%	24%	9%	1%	5%	100%
2034	60%	24%	9%	1%	5%	100%
2035	60%	24%	9%	1%	5%	100%
2036	60%	24%	9%	1%	5%	100%
2037	60%	25%	9%	1%	5%	100%
2038	60%	25%	9%	1%	5%	100%
2039	59%	25%	9%	1%	5%	100%
2040	59%	25%	9%	1%	5%	100%

10.8 IMPACT ON ENERGY EFFICIENCY POTENTIAL OF ADDING MEASURES THAT PASS THE UCT ASSUMING INCENTIVES SET AT 50% OF INCREMENTAL MEASURE COST

As discussed above, BWL included five different bins for each sector (e.g., residential, non-residential) of energy efficiency MWh savings in the development of the Path 3 energy efficiency potential scenario. Bins 1 to 4 include only measures that pass the TRC test. Bin 5 included additional measures that passed the Utility Cost Test (UCT) when incentives paid to program participants are set at 50% of measure incremental costs. Table 10-5 below presents cumulative annual MWh savings added to the energy efficiency potential savings from Bin 5 measures for the period 2021 to 2040. As one can see from this Table, the addition of Bin 5 increased cumulative annual MWh savings from 5 to 15 percent depending on the year examined. On average over the forecast period Bin 5 measures added 8 percent to cumulative annual MWh savings potential for Path 3.

TABLE 10-5 CUMULATIVE ANNUAL MWH SAVINGS FROM BIN 5 MEASURES FOR THE PERIOD 2021 TO 2040

Year	PATH 3 BINS 1 TO 4 CUMULATIVE ANNUAL MWH SAVINGS	PATH 3 BIN 5 CUMULATIVE ANNUAL MWH SAVINGS	BIN 5 AS A PERCENT OF BINS 1 TO 4 CUMULATIVE ANNUAL MWH SAVINGS
2021	23,295	3,393	15%
2022	47,748	6,628	14%
2023	72,423	9,422	13%
2024	97,377	11,652	12%
2025	126,838	13,342	11%
2026	157,578	14,595	9%
2027	187,676	15,531	8%
2028	217,023	16,296	8%
2029	244,104	17,029	7%
2030	268,563	17,333	6%
2031	288,550	17,649	6%
2032	305,683	17,974	6%
2033	320,525	18,291	6%
2034	332,996	18,598	6%
2035	344,102	18,892	5%
2036	351,370	19,162	5%
2037	357,027	19,405	5%
2038	361,860	19,617	5%
2039	364,816	19,796	5%
2040	366,900	19,943	5%

APPENDIX A Residential Measure Detail

LBWL — **Measure Assumption Tab - Residential**

Measure #	End-Use	Measure Name	Program	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Base Fuel Use	% Fuel Savings	Per unit Fuel Saving	Per Unit Water Savings	RC EUL	EE EUL	Measure Cost	O&M Benefits	O&M Costs	Tax Credits	TRC	UCT 50%	UCT 100%	UCT PB
1001	Lighting	Standard CFL (Replacing EISA Bulb)	Lighting	SF	NLI	ROB	36.08	67%	24.34	0.032	0.032	-	-	-0.043	0	2	9	$0.01	$0.00	$0.00	$0.00	632.78	7.05	7.01	7.00
1002	Lighting	Specialty CFL (Replacing Specialty Incandescent)	Lighting	SF	NLI	ROB	50.35	77%	38.60	0.050	0.050	-	-	-0.068	0	2	9	$0.99	$0.88	$0.00	$0.00	11.03	5.26	4.18	5.22
1003	Lighting	Standard LED (Replacing EISA Bulb)	Lighting	SF	NLI	ROB	36.08	85%	30.55	0.040	0.040	-	-	-0.054	0	2	15	$1.92	$2.71	$0.00	$0.00	7.41	4.17	3.10	4.14
1004	Lighting	Specialty LED (Replacing Specialty Incandescent)	Lighting	SF	NLI	ROB	50.35	89%	44.81	0.058	0.058	-	-	-0.079	0	2	15	$4.20	$3.25	$0.00	$0.00	4.79	3.56	2.48	3.54
1005	Lighting	Standard CFL (Replacing CFL)	Lighting	SF	NLI	ROB	36.08	67%	24.34	0.032	0.032	-	-	-0.043	0	9	9	$0.01	$0.00	$0.00	$0.00	632.78	7.05	7.01	7.00
1006	Lighting	Specialty CFL (Replacing Specialty CFL)	Lighting	SF	NLI	ROB	50.35	77%	38.60	0.050	0.050	-	-	-0.068	0	9	9	$0.99	$0.88	$0.00	$0.00	11.03	5.26	4.18	5.22
1007	Lighting	Standard LED (Replacing CFL)	Lighting	SF	NLI	ROB	36.08	85%	30.55	0.040	0.040	-	-	-0.054	0	9	15	$1.92	$2.71	$0.00	$0.00	7.41	4.17	3.10	4.14
1008	Lighting	Specialty LED (Replacing Specialty CFL)	Lighting	SF	NLI	ROB	50.35	89%	44.81	0.058	0.058	-	-	-0.079	0	9	15	$4.20	$3.25	$0.00	$0.00	4.79	3.56	2.48	3.54
1009	Lighting	Reflector CFL (Replacing EISA Bulb)	Lighting	SF	NLI	ROB	54.55	77%	41.96	0.054	0.054	-	-	-0.074	0	2	9	$2.04	$2.89	$0.00	$0.00	6.77	4.28	3.06	4.25
1010	Lighting	Reflector LED (Replacing EISA Bulb)	Lighting	SF	NLI	ROB	54.55	87%	47.50	0.062	0.062	-	-	-0.084	0	2	15	$6.93	$8.43	$0.00	$0.00	3.80	2.86	1.85	2.84
1011	Lighting	Reflector CFL (Replacing CFL)	Lighting	SF	NLI	ROB	54.55	77%	41.96	0.054	0.054	-	-	-0.074	0	9	9	$2.04	$2.89	$0.00	$0.00	6.77	4.28	3.06	4.25
1012	Lighting	Reflector LED (Replacing CFL Bulb)	Lighting	SF	NLI	ROB	54.55	87%	47.50	0.062	0.062	-	-	-0.084	0	9	15	$6.93	$8.43	$0.00	$0.00	3.80	2.86	1.85	2.84
1013	Lighting	T8 Replacing T12 Linear Fluorescent Bulb	Lighting	SF	NLI	RETRO	70.10	29%	20.57	0.025	0.025	-	-	0.000	0	8	8	$60.00	$0.00	$0.00	$0.00	0.08	0.16	0.08	0.10
1014	Lighting	Residential Occupancy Sensors	Lighting	SF	NLI	RETRO	53.27	30%	15.98	0.044	0.044	-	-	0.000	0	10	10	$30.00	$0.00	$0.00	$0.00	0.16	0.33	0.16	0.25
1015	Lighting	LED Nightlights	Lighting	SF	NLI	RETRO	25.55	86%	21.90	0.006	0.006	-	-	0.000	0	12	12	$3.00	$0.00	$0.00	$0.00	2.21	4.46	2.23	4.42
1016	Lighting	DI Standard CFL (Replacing EISA Bulb)	Lighting	SF	LI	DI	36.08	67%	24.34	0.032	0.032	-	-	-0.043	0	2	9	$2.00	$0.00	$0.00	$0.00	3.16	2.20	2.20	3.33
1017	Lighting	DI Specialty CFL (Replacing Specialty Incandescent)	Lighting	SF	LI	DI	50.35	77%	38.60	0.050	0.050	-	-	-0.068	0	2	9	$1.99	$0.88	$0.00	$0.00	5.49	2.96	2.96	4.15
1018	Lighting	DI Standard LED (Replacing EISA Bulb)	Lighting	SF	LI	DI	36.08	85%	30.55	0.040	0.040	-	-	-0.054	0	2	15	$3.91	$2.71	$0.00	$0.00	3.64	2.02	2.02	3.05
1019	Lighting	DI Specialty LED (Replacing Specialty Incandescent)	Lighting	SF	LI	DI	50.35	89%	44.81	0.058	0.058	-	-	-0.079	0	2	15	$5.20	$3.25	$0.00	$0.00	3.87	2.16	2.16	3.20
1020	Lighting	DI Standard CFL (Replacing CFL)	Lighting	SF	LI	DI	36.08	67%	24.34	0.032	0.032	-	-	-0.043	0	9	9	$2.00	$0.00	$0.00	$0.00	3.16	2.20	2.20	3.33
1021	Lighting	DI Specialty CFL (Replacing Specialty CFL)	Lighting	SF	LI	DI	50.35	77%	38.60	0.050	0.050	-	-	-0.068	0	9	9	$1.99	$0.88	$0.00	$0.00	5.49	2.96	2.96	4.15
1022	Lighting	DI Standard LED (Replacing CFL)	Lighting	SF	LI	DI	36.08	85%	30.55	0.040	0.040	-	-	-0.054	0	9	15	$3.91	$2.71	$0.00	$0.00	3.64	2.02	2.02	3.05
1023	Lighting	DI Specialty LED (Replacing Specialty CFL)	Lighting	SF	LI	DI	50.35	89%	44.81	0.058	0.058	-	-	-0.079	0	9	15	$5.20	$3.25	$0.00	$0.00	3.87	2.16	2.16	3.20
1024	Lighting	DI Reflector CFL (Replacing EISA Bulb)	Lighting	SF	LI	DI	54.55	77%	41.96	0.054	0.054	-	-	-0.074	0	2	9	$5.35	$2.89	$0.00	$0.00	2.58	1.59	1.59	2.58
1025	Lighting	DI Reflector LED (Replacing EISA Bulb)	Lighting	SF	LI	DI	54.55	87%	47.50	0.062	0.062	-	-	-0.084	0	2	15	$10.24	$8.43	$0.00	$0.00	2.57	1.38	1.38	2.25
1026	Lighting	DI Reflector CFL (Replacing CFL Bulb)	Lighting	SF	LI	DI	54.55	77%	41.96	0.054	0.054	-	-	-0.074	0	9	9	$5.35	$2.89	$0.00	$0.00	2.58	1.59	1.59	2.58
1027	Lighting	DI Reflector LED (Replacing CFL Bulb)	Lighting	SF	LI	DI	54.55	87%	47.50	0.062	0.062	-	-	-0.084	0	9	15	$10.24	$8.43	$0.00	$0.00	2.57	1.38	1.38	2.25
1028	Lighting	DI T8 Replacing T12 Linear Fluorescent Bulb	Lighting	SF	LI	DI	70.10	29%	20.57	0.025	0.025	-	-	0.000	0	8	8	$60.00	$0.00	$0.00	$0.00	0.08	0.08	0.08	0.10
1029	Lighting	DI LED Nightlights	Lighting	SF	LI	DI	25.55	86%	21.90	0.006	0.006	-	-	0.000	0	12	12	$3.00	$0.00	$0.00	$0.00	2.21	2.23	2.23	4.42
1030	Lighting	Standard CFL (Replacing EISA Bulb)	Lighting	SF	ALL	NC	36.08	67%	24.34	0.032	0.032	-	-	-0.043	0	2	9	$0.01	$0.00	$0.00	$0.00	632.78	7.05	7.01	7.00
1031	Lighting	Specialty CFL (Replacing Specialty Incandescent)	Lighting	SF	ALL	NC	50.35	77%	38.60	0.050	0.050	-	-	-0.068	0	2	9	$0.99	$0.88	$0.00	$0.00	11.03	5.26	4.18	5.22
1032	Lighting	Standard LED (Replacing EISA Bulb)	Lighting	SF	ALL	NC	36.08	85%	30.55	0.040	0.040	-	-	-0.054	0	2	15	$1.92	$2.71	$0.00	$0.00	7.41	4.17	3.10	4.14
1033	Lighting	Specialty LED (Replacing Specialty Incandescent)	Lighting	SF	ALL	NC	50.35	89%	44.81	0.058	0.058	-	-	-0.079	0	2	15	$4.20	$3.25	$0.00	$0.00	4.79	3.56	2.48	3.54
1034	Lighting	Standard CFL (Replacing CFL)	Lighting	SF	ALL	NC	36.08	67%	24.34	0.032	0.032	-	-	-0.043	0	9	9	$0.01	$0.00	$0.00	$0.00	632.78	7.05	7.01	7.00
1035	Lighting	Specialty CFL (Replacing Specialty CFL)	Lighting	SF	ALL	NC	50.35	77%	38.60	0.050	0.050	-	-	-0.068	0	9	9	$0.99	$0.88	$0.00	$0.00	11.03	5.26	4.18	5.22
1036	Lighting	Standard LED (Replacing CFL)	Lighting	SF	ALL	NC	36.08	85%	30.55	0.040	0.040	-	-	-0.054	0	9	15	$1.92	$2.71	$0.00	$0.00	7.41	4.17	3.10	4.14
1037	Lighting	Specialty LED (Replacing Specialty CFL)	Lighting	SF	ALL	NC	50.35	89%	44.81	0.058	0.058	-	-	-0.079	0	9	15	$4.20	$3.25	$0.00	$0.00	4.79	3.56	2.48	3.54
1038	Lighting	Reflector CFL (Replacing EISA Bulb)	Lighting	SF	ALL	NC	54.55	77%	41.96	0.054	0.054	-	-	-0.074	0	2	9	$2.04	$2.89	$0.00	$0.00	6.77	4.28	3.06	4.25
1039	Lighting	Reflector LED (Replacing EISA Bulb)	Lighting	SF	ALL	NC	54.55	87%	47.50	0.062	0.062	-	-	-0.084	0	2	15	$6.93	$8.43	$0.00	$0.00	3.80	2.86	1.85	2.84
1040	Lighting	Reflector CFL (Replacing CFL)	Lighting	SF	ALL	NC	54.55	77%	41.96	0.054	0.054	-	-	-0.074	0	9	9	$2.04	$2.89	$0.00	$0.00	6.77	4.28	3.06	4.25
1041	Lighting	Reflector LED (Replacing CFL Bulb)	Lighting	SF	ALL	NC	54.55	87%	47.50	0.062	0.062	-	-	-0.084	0	9	15	$6.93	$8.43	$0.00	$0.00	3.80	2.86	1.85	2.84
1042	Lighting	Residential Occupancy Sensors	Lighting	SF	ALL	NC	53.27	30%	15.98	0.044	0.044	-	-	0.000	0	10	10	$30.00	$0.00	$0.00	$0.00	0.16	0.33	0.16	0.25
1043	Lighting	Standard CFL (Replacing EISA Bulb)	Lighting	MF	NLI	ROB	36.08	67%	24.34	0.032	0.032	-	-	-0.043	0	2	9	$0.01	$0.00	$0.00	$0.00	632.78	7.05	7.01	7.00
1044	Lighting	Specialty CFL (Replacing Specialty Incandescent)	Lighting	MF	NLI	ROB	50.35	77%	38.60	0.050	0.050	-	-	-0.068	0	2	9	$0.99	$0.88	$0.00	$0.00	11.03	5.26	4.18	5.22
1045	Lighting	Standard LED (Replacing EISA Bulb)	Lighting	MF	NLI	ROB	36.08	85%	30.55	0.040	0.040	-	-	-0.054	0	2	15	$1.92	$2.71	$0.00	$0.00	7.41	4.17	3.10	4.14
1046	Lighting	Specialty LED (Replacing Specialty Incandescent)	Lighting	MF	NLI	ROB	50.35	89%	44.81	0.058	0.058	-	-	-0.079	0	2	15	$4.20	$3.25	$0.00	$0.00	4.79	3.56	2.48	3.54
1047	Lighting	Standard CFL (Replacing CFL)	Lighting	MF	NLI	ROB	36.08	67%	24.34	0.032	0.032	-	-	-0.043	0	9	9	$0.01	$0.00	$0.00	$0.00	632.78	7.05	7.01	7.00
1048	Lighting	Specialty CFL (Replacing Specialty CFL)	Lighting	MF	NLI	ROB	50.35	77%	38.60	0.050	0.050	-	-	-0.068	0	9	9	$0.99	$0.88	$0.00	$0.00	11.03	5.26	4.18	5.22
1049	Lighting	Standard LED (Replacing CFL)	Lighting	MF	NLI	ROB	36.08	85%	30.55	0.040	0.040	-	-	-0.054	0	9	15	$1.92	$2.71	$0.00	$0.00	7.41	4.17	3.10	4.14
1050	Lighting	Specialty LED (Replacing Specialty CFL)	Lighting	MF	NLI	ROB	50.35	89%	44.81	0.058	0.058	-	-	-0.079	0	9	15	$4.20	$3.25	$0.00	$0.00	4.79	3.56	2.48	3.54
1051	Lighting	Reflector CFL (Replacing EISA Bulb)	Lighting	MF	NLI	ROB	54.55	77%	41.96	0.054	0.054	-	-	-0.074	0	2	9	$2.04	$2.89	$0.00	$0.00	6.77	4.28	3.06	4.25
1052	Lighting	Reflector LED (Replacing EISA Bulb)	Lighting	MF	NLI	ROB	54.55	87%	47.50	0.062	0.062	-	-	-0.084	0	2	15	$6.93	$8.43	$0.00	$0.00	3.80	2.86	1.85	2.84
1053	Lighting	Reflector CFL (Replacing CFL)	Lighting	MF	NLI	ROB	54.55	77%	41.96	0.054	0.054	-	-	-0.074	0	9	9	$2.04	$2.89	$0.00	$0.00	6.77	4.28	3.06	4.25
1054	Lighting	Reflector LED (Replacing CFL Bulb)	Lighting	MF	NLI	ROB	54.55	87%	47.50	0.062	0.062	-	-	-0.084	0	9	15	$6.93	$8.43	$0.00	$0.00	3.80	2.86	1.85	2.84
1055	Lighting	T8 Replacing T12 Linear Fluorescent Bulb	Lighting	MF	NLI	RETRO	70.10	29%	20.57	0.025	0.025	-	-	0.000	0	8	8	$60.00	$0.00	$0.00	$0.00	0.08	0.16	0.08	0.10
1056	Lighting	Residential Occupancy Sensors	Lighting	MF	NLI	RETRO	53.27	30%	15.98	0.044	0.044	-	-	0.000	0	10	10	$30.00	$0.00	$0.00	$0.00	0.16	0.33	0.16	0.25
1057	Lighting	LED Nightlights	Lighting	MF	NLI	RETRO	25.55	86%	21.90	0.006	0.006	-	-	0.000	0	12	12	$3.00	$0.00	$0.00	$0.00	2.21	4.46	2.23	4.42
1058	Lighting	DI Standard CFL (Replacing EISA Bulb)	Lighting	MF	LI	DI	36.08	67%	24.34	0.032	0.032	-	-	-0.043	0	2	9	$2.00	$0.00	$0.00	$0.00	3.16	2.20	2.20	3.33
1059	Lighting	DI Specialty CFL (Replacing Specialty Incandescent)	Lighting	MF	LI	DI	50.35	77%	38.60	0.050	0.050	-	-	-0.068	0	2	9	$1.99	$0.88	$0.00	$0.00	5.49	2.96	2.96	4.15
1060	Lighting	DI Standard LED (Replacing EISA Bulb)	Lighting	MF	LI	DI	36.08	85%	30.55	0.040	0.040	-	-	-0.054	0	2	15	$3.91	$2.71	$0.00	$0.00	3.64	2.02	2.02	3.05
1061	Lighting	DI Specialty LED (Replacing Specialty Incandescent)	Lighting	MF	LI	DI	50.35	89%	44.81	0.058	0.058	-	-	-0.079	0	2	15	$5.20	$3.25	$0.00	$0.00	3.87	2.16	2.16	3.20
1062	Lighting	DI Standard CFL (Replacing CFL)	Lighting	MF	LI	DI	36.08	67%	24.34	0.032	0.032	-	-	-0.043	0	9	9	$2.00	$0.00	$0.00	$0.00	3.16	2.20	2.20	3.33
1063	Lighting	DI Specialty CFL (Replacing Specialty CFL)	Lighting	MF	LI	DI	50.35	77%	38.60	0.050	0.050	-	-	-0.068	0	9	9	$1.99	$0.88	$0.00	$0.00	5.49	2.96	2.96	4.15
1064	Lighting	DI Standard LED (Replacing CFL)	Lighting	MF	LI	DI	36.08	85%	30.55	0.040	0.040	-	-	-0.054	0	9	15	$3.91	$2.71	$0.00	$0.00	3.64	2.02	2.02	3.05
1065	Lighting	DI Specialty LED (Replacing Specialty CFL)	Lighting	MF	LI	DI	50.35	89%	44.81	0.058	0.058	-	-	-0.079	0	9	15	$5.20	$3.25	$0.00	$0.00	3.87	2.16	2.16	3.20
1066	Lighting	DI Reflector CFL (Replacing EISA Bulb)	Lighting	MF	LI	DI	54.55	77%	41.96	0.054	0.054	-	-	-0.074	0	2	9	$5.35	$2.89	$0.00	$0.00	2.58	1.59	1.59	2.58
1067	Lighting	DI Reflector LED (Replacing EISA Bulb)	Lighting	MF	LI	DI	54.55	87%	47.50	0.062	0.062	-	-	-0.084	0	2	15	$10.24	$8.43	$0.00	$0.00	2.57	1.38	1.38	2.25
1068	Lighting	DI Reflector CFL (Replacing CFL Bulb)	Lighting	MF	LI	DI	54.55	77%	41.96	0.054	0.054	-	-	-0.074	0	9	9	$5.35	$2.89	$0.00	$0.00	2.58	1.59	1.59	2.58
1069	Lighting	DI Reflector LED (Replacing CFL Bulb)	Lighting	MF	LI	DI	54.55	87%	47.50	0.062	0.062	-	-	-0.084	0	9	15	$10.24	$8.43	$0.00	$0.00	2.57	1.38	1.38	2.25
1070	Lighting	DI T8 Replacing T12 Linear Fluorescent Bulb	Lighting	MF	LI	DI	70.10	29%	20.57	0.025	0.025	-	-	0.000	0	8	8	$60.00	$0.00	$0.00	$0.00	0.08	0.08	0.08	0.10
1071	Lighting	DI LED Nightlights	Lighting	MF	LI	DI	25.55	86%	21.90	0.006	0.006	-	-	0.000	0	12	12	$3.00	$0.00	$0.00	$0.00	2.21	2.23	2.23	4.42
1072	Lighting	Standard CFL (Replacing EISA Bulb)	Lighting	MF	ALL	NC	36.08	67%	24.34	0.032	0.032	-	-	-0.043	0	2	9	$0.01	$0.00	$0.00	$0.00	632.78	7.05	7.01	7.00
1073	Lighting	Specialty CFL (Replacing Specialty Incandescent)	Lighting	MF	ALL	NC	50.35	77%	38.60	0.050	0.050	-	-	-0.068	0	2	9	$0.99	$0.88	$0.00	$0.00	11.03	5.26	4.18	5.22
1074	Lighting	Standard LED (Replacing EISA Bulb)	Lighting	MF	ALL	NC	36.08	85%	30.55	0.040	0.040	-	-	-0.054	0	2	15	$1.92	$2.71	$0.00	$0.00	7.41	4.17	3.10	4.14
1075	Lighting	Specialty LED (Replacing Specialty Incandescent)	Lighting	MF	ALL	NC	50.35	89%	44.81	0.058	0.058	-	-	-0.079	0	2	15	$4.20	$3.25	$0.00	$0.00	4.79	3.56	2.48	3.54
1076	Lighting	Standard CFL (Replacing CFL)	Lighting	MF	ALL	NC	36.08	67%	24.34	0.032	0.032	-	-	-0.043	0	9	9	$0.01	$0.00	$0.00	$0.00	632.78	7.05	7.01	7.00
1077	Lighting	Specialty CFL (Replacing Specialty CFL)	Lighting	MF	ALL	NC	50.35	77%	38.60	0.050	0.050	-	-	-0.068	0	9	9	$0.99	$0.88	$0.00	$0.00	11.03	5.26	4.18	5.22
1078	Lighting	Standard LED (Replacing CFL)	Lighting	MF	ALL	NC	36.08	85%	30.55	0.040	0.040	-	-	-0.054	0	9	15	$1.92	$2.71	$0.00	$0.00	7.41	4.17	3.10	4.14
1079	Lighting	Specialty LED (Replacing Specialty CFL)	Lighting	MF	ALL	NC	50.35	89%	44.81	0.058	0.058	-	-	-0.079	0	9	15	$4.20	$3.25	$0.00	$0.00	4.79	3.56	2.48	3.54
1080	Lighting	Reflector CFL (Replacing EISA Bulb)	Lighting	MF	ALL	NC	54.55	77%	41.96	0.054	0.054	-	-	-0.074	0	2	9	$2.04	$2.89	$0.00	$0.00	6.77	4.28	3.06	4.25
1081	Lighting	Reflector LED (Replacing EISA Bulb)	Lighting	MF	ALL	NC	54.55	87%	47.50	0.062	0.062	-	-	-0.084	0	2	15	$6.93	$8.43	$0.00	$0.00	3.80	2.86	1.85	2.84
1082	Lighting	Reflector CFL (Replacing CFL)	Lighting	MF	ALL	NC	54.55	77%	41.96	0.054	0.054	-	-	-0.074	0	9	9	$2.04	$2.89	$0.00	$0.00	6.77	4.28	3.06	4.25
1083	Lighting	Reflector LED (Replacing CFL Bulb)	Lighting	MF	ALL	NC	54.55	87%	47.50	0.062	0.062	-	-	-0.084	0	9	15	$6.93	$8.43	$0.00	$0.00	3.80	2.86	1.85	2.84
1084	Lighting	Residential Occupancy Sensors	Lighting	MF	ALL	NC	53.27	30%	15.98	0.044	0.044	-	-	0.000	0	10	10	$30.00	$0.00	$0.00	$0.00	0.16	0.33	0.16	0.25
2001	Appliances	Refrigerators ENERGY STAR	Appliances	SF	NLI	ROB	503.09	10%	48.37	0.008	0.008	-	0%	0.000	0	16	16	$29.24	$0.00	$0.00	$0.00	0.64	1.29	0.64	1.28
2002	Appliances	Refrigerator recycling	Appliances	SF	NLI	RECYCLE	1135.00	100%	1135.00	0.131	0.131	-	0%	0.000	0	8	8	$78.00	$0.00	$0.00	$0.00	3.30	6.65	3.33	6.60
2003	Appliances	Refrigerators ENERGY STAR	Appliances	SF	LI	DI	503.09	10%	48.37	0.008	0.008	-	0%	0.000	0	16	16	$29.24	$0.00	$0.00	$0.00	0.64	0.64	0.64	1.28
2004	Appliances	Refrigerator recycling	Appliances	SF	LI	DI	1135.00	100%	1135.00	0.131	0.131	-	0%	0.000	0	8	8	$78.00	$0.00	$0.00	$0.00	3.30	3.33	3.33	6.60
2005	Appliances	Freezers ENERGY STAR	Appliances	SF	All	ROB	334.59	10%	33.49	0.006	0.006	-	0%	0.000	0	21	21	$10.00	$0.00	$0.00	$0.00	1.54	3.09	1.55	3.07
2006	Appliances	Freezer recycling	Appliances	SF	All	RECYCLE	944.00	100%	944.00	0.116	0.116	-	0%	0.000	0	8	8	$78.00	$0.00	$0.00	$0.00	2.78	5.61	2.80	5.56
2007	Appliances	Room AC recycling	Appliances	SF	All	RECYCLE	113.00	100%	113.00	0.107	0.107	-	0%	0.000	0	8	8	$49.00	$0.00	$0.00	$0.00	0.62	1.24	0.62	1.24
2008	Appliances	ENERGY STAR Dishwasher - elec water heater	Appliances	SF	All	ROB	307.00	8%	25.00	0.080	0.080	-	0%	0.000	323	10	10	$50.00	$0.00	$0.00	$0.00	0.51	0.54	0.27	0.40
2009	Appliances	ENERGY STAR Dishwasher - gas water heater	Appliances	SF	All	ROB	135.08	12%	16.28	0.050	0.050	0.739	12%	0.089	323	10	10	$50.00	$0.00	$0.00	$0.00	0.45	0.43	0.21	0.27
2010	Appliances	Clothes Washer ENERGY STAR, Electric Water heater, G	Appliances	SF	All	ROB	221.87	29%	63.80	0.235	0.235	1.249	21%	0.258	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.38	1.44	0.72	1.43
2011	Appliances	Clothes Washer ENERGY STAR, Electric Water heater, E	Appliances	SF	All	ROB	549.13	23%	126.00	0.466	0.466	-	0%	0.000	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.73	2.13	1.07	2.11
2012	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Gas d	Appliances	SF	All	ROB	38.83	34%	13.20	0.049	0.049	1.874	23%	0.431	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.08	0.82	0.41	0.54
2013	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Electr	Appliances	SF	All	ROB	366.09	21%	75.60	0.279	0.279	0.757	29%	0.218	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.45	1.58	0.79	1.57
2014	Appliances	ENERGY STAR Electric Clothes Dryers	Appliances	SF	All	ROB	768.92	21%	160.44	0.567	0.567	-	0%	0.000	0	14	14	$152.00	$0.00	$0.00	$0.00	0.38	0.77	0.39	1.26
2015	Appliances	ENERGY STAR Gas Clothes Dryers	Appliances	SF	All	ROB	134.72	18%	24.78	0.088	0.088	2.414	18%	0.444	0	14	14	$152.00	$0.00	$0.00	$0.00	0.15	0.30	0.15	0.17
2016	Appliances	ENERGY STAR Dehumidifier	Appliances	SF	All	ROB	624.22	33%	202.90	0.124	0.124	-	0%	0.000	0	12	12	$50.00	$0.00	$0.00	$0.00	1.44	2.89	1.45	2.87
2017	Appliances	Dehumidifier recycling	Appliances	SF	All	RECYCLE	138.50	100%	138.50	0.035	0.035	-	0%	0.000	0	8	8	$49.00	$0.00	$0.00	$0.00	0.62	1.26	0.63	1.25
2018	Appliances	ENERGY STAR Air Purifier	Appliances	SF	ALL	ROB	1054.00	67%	390.00	0.045	0.045	-	0%	0.000	0	9	9	$70.00	$0.00	$0.00	$0.00	1.37	2.75	1.38	2.73
2019	Appliances	Refrigerators ENERGY STAR	Appliances	SF	All	NC	503.09	10%	48.37	0.008	0.008	-	0%	0.000	0	16	16	$29.24	$0.00	$0.00	$0.00	0.64	1.29	0.64	1.28
2020	Appliances	Freezers ENERGY STAR	Appliances	SF	All	NC	334.59	10%	33.49	0.006	0.006	-	0%	0.000	0	21	21	$10.00	$0.00	$0.00	$0.00	1.54	3.09	1.55	3.07
2021	Appliances	ENERGY STAR Dishwasher - elec water heater	Appliances	SF	All	NC	307.00	8%	25.00	0.080	0.080	-	0%	0.000	323	10	10	$50.00	$0.00	$0.00	$0.00	0.51	0.54	0.27	0.40
2022	Appliances	ENERGY STAR Dishwasher - gas water heater	Appliances	SF	All	NC	135.08	12%	16.28	0.050	0.050	0.739	12%	0.089	323	10	10	$50.00	$0.00	$0.00	$0.00	0.45	0.43	0.21	0.27
2023	Appliances	Clothes Washer ENERGY STAR, Electric Water heater, G	Appliances	SF	All	NC	221.87	29%	63.80	0.235	0.235	1.249	21%	0.258	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.38	1.44	0.72	1.43
2024	Appliances	Clothes Washer ENERGY STAR, Electric Water heater, E	Appliances	SF	All	NC	549.13	23%	126.00	0.466	0.466	-	0%	0.000	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.73	2.13	1.07	2.11
2025	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Gas d	Appliances	SF	All	NC	38.83	34%	13.20	0.049	0.049	1.874	23%	0.431	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.08	0.82	0.41	0.54
2026	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Electr	Appliances	SF	All	NC	366.09	21%	75.60	0.279	0.279	0.757	29%	0.218	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.45	1.58	0.79	1.57
2027	Appliances	ENERGY STAR Electric Clothes Dryers	Appliances	SF	All	NC	768.92	21%	160.44	0.567	0.567	-	0%	0.000	0	14	14	$152.00	$0.00	$0.00	$0.00	0.38	0.77	0.39	1.26
2028	Appliances	ENERGY STAR Gas Clothes Dryers	Appliances	SF	All	NC	134.72	18%	24.78	0.088	0.088	2.414	18%	0.444	0	14	14	$152.00	$0.00	$0.00	$0.00	0.15	0.30	0.15	0.17
2029	Appliances	ENERGY STAR Dehumidifier	Appliances	SF	All	NC	624.22	33%	202.90	0.124	0.124	-	0%	0.000	0	12	12	$50.00	$0.00	$0.00	$0.00	1.44	2.89	1.45	2.87
2030	Appliances	ENERGY STAR Air Purifier	Appliances	SF	ALL	NC	1054.00	67%	390.00	0.045	0.045	-	0%	0.000	0	9	9	$70.00	$0.00	$0.00	$0.00	1.37	2.75	1.38	2.73
2031	Appliances	Refrigerators ENERGY STAR	Appliances	MF	NLI	ROB	503.09	10%	48.37	0.008	0.008	-	0%	0.000	0	16	16	$29.24	$0.00	$0.00	$0.00	0.64	1.29	0.64	1.28
2032	Appliances	Refrigerator recycling	Appliances	MF	NLI	RECYCLE	1135.00	100%	1135.00	0.131	0.131	-	0%	0.000	0	8	8	$78.00	$0.00	$0.00	$0.00	3.30	6.65	3.33	6.60

LBWL **Measure Assumption Tab - Residential**

Measure #	End-Use	Measure Name	Program	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Base Fuel Use	% Fuel Savings	Per unit Fuel Saving	Per Unit Water Savings	RC EUL	EE EUL	Measure Cost	O&M Benefits	O&M Costs	Tax Credits	TRC	UCT 50%	UCT 100%	UCT PB
2033	Appliances	Refrigerators ENERGY STAR	Appliances	MF	LI	DI	503.09	10%	48.37	0.008	0.008	-	0%	0.000	0	16	16	$29.24	$0.00	$0.00	$0.00	0.64	0.64	0.64	1.28
2034	Appliances	Refrigerator recycling	Appliances	MF	LI	DI	1135.00	100%	1135.00	0.131	0.131	-	0%	0.000	0	8	8	$78.00	$0.00	$0.00	$0.00	3.30	3.33	3.33	6.60
2035	Appliances	Freezers ENERGY STAR	Appliances	MF	All	ROB	334.59	10%	33.49	0.006	0.006	-	0%	0.000	0	21	21	$10.00	$0.00	$0.00	$0.00	1.54	3.09	1.55	3.07
2036	Appliances	Freezer recycling	Appliances	MF	All	RECYCLE	944.00	100%	944.00	0.116	0.116	-	0%	0.000	0	8	8	$78.00	$0.00	$0.00	$0.00	2.78	5.61	2.80	5.56
2037	Appliances	Room AC recycling	Appliances	MF	All	RECYCLE	113.00	100%	113.00	0.107	0.107	-	0%	0.000	0	8	8	$49.00	$0.00	$0.00	$0.00	0.62	1.24	0.62	1.24
2038	Appliances	ENERGY STAR Dishwasher - elec water heater	Appliances	MF	All	ROB	307.00	8%	25.00	0.080	0.080	-	0%	0.000	323	10	10	$50.00	$0.00	$0.00	$0.00	0.51	0.54	0.27	0.40
2039	Appliances	ENERGY STAR Dishwasher - gas water heater	Appliances	MF	All	ROB	135.08	12%	16.28	0.050	0.050	0.739	12%	0.089	323	10	10	$50.00	$0.00	$0.00	$0.00	0.45	0.43	0.21	0.27
2040	Appliances	Clothes Washer ENERGY STAR, Electric Water heater, G	Appliances	MF	All	ROB	221.87	29%	63.80	0.235	0.235	1.249	21%	0.258	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.38	1.44	0.72	1.43
2041	Appliances	Clothes Washer ENERGY STAR, Electric Water heater, E	Appliances	MF	All	ROB	549.13	23%	126.00	0.466	0.466	-	0%	0.000	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.73	2.13	1.07	2.11
2042	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Gas d	Appliances	MF	All	ROB	38.83	34%	13.20	0.049	0.049	1.874	23%	0.431	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.08	0.82	0.41	0.54
2043	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Electr	Appliances	MF	All	ROB	366.09	21%	75.60	0.279	0.279	0.757	29%	0.218	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.45	1.58	0.79	1.57
2044	Appliances	ENERGY STAR Electric Clothes Dryers	Appliances	MF	All	ROB	768.92	21%	160.44	0.567	0.567	-	0%	0.000	0	14	14	$152.00	$0.00	$0.00	$0.00	0.38	0.77	0.39	1.26
2045	Appliances	ENERGY STAR Gas Clothes Dryers	Appliances	MF	All	ROB	134.72	18%	24.78	0.088	0.088	2.414	18%	0.444	0	14	14	$152.00	$0.00	$0.00	$0.00	0.15	0.30	0.15	0.17
2046	Appliances	ENERGY STAR Dehumidifier	Appliances	MF	All	ROB	624.22	33%	202.90	0.124	0.124	-	0%	0.000	0	12	12	$50.00	$0.00	$0.00	$0.00	1.44	2.89	1.45	2.87
2047	Appliances	Dehumidifier recycling	Appliances	MF	All	RECYCLE	138.50	100%	138.50	0.035	0.035	-	0%	0.000	0	8	8	$49.00	$0.00	$0.00	$0.00	0.62	1.26	0.63	1.25
2048	Appliances	ENERGY STAR Air Purifier	Appliances	MF	ALL	ROB	1054.00	67%	390.00	0.045	0.045	-	0%	0.000	0	9	9	$70.00	$0.00	$0.00	$0.00	1.37	2.75	1.38	2.73
2049	Appliances	Refrigerators ENERGY STAR	Appliances	MF	All	NC	503.09	10%	48.37	0.008	0.008	-	0%	0.000	0	16	16	$29.24	$0.00	$0.00	$0.00	0.64	1.29	0.64	1.28
2050	Appliances	Freezers ENERGY STAR	Appliances	MF	All	NC	334.59	10%	33.49	0.006	0.006	-	0%	0.000	0	21	21	$10.00	$0.00	$0.00	$0.00	1.54	3.09	1.55	3.07
2051	Appliances	ENERGY STAR Dishwasher - elec water heater	Appliances	MF	All	NC	307.00	8%	25.00	0.080	0.080	-	0%	0.000	323	10	10	$50.00	$0.00	$0.00	$0.00	0.51	0.54	0.27	0.40
2052	Appliances	ENERGY STAR Dishwasher - gas water heater	Appliances	MF	All	NC	135.08	12%	16.28	0.050	0.050	0.739	12%	0.089	323	10	10	$50.00	$0.00	$0.00	$0.00	0.45	0.43	0.21	0.27
2053	Appliances	Clothes Washer ENERGY STAR, Electric Water heater, G	Appliances	MF	All	NC	221.87	29%	63.80	0.235	0.235	1.249	21%	0.258	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.38	1.44	0.72	1.43
2054	Appliances	Clothes Washer ENERGY STAR, Electric Water heater, E	Appliances	MF	All	NC	549.13	23%	126.00	0.466	0.466	-	0%	0.000	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.73	2.13	1.07	2.11
2055	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Gas d	Appliances	MF	All	NC	38.83	34%	13.20	0.049	0.049	1.874	23%	0.431	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.08	0.82	0.41	0.54
2056	Appliances	Clothes Washer ENERGY STAR, Gas water heater, Electr	Appliances	MF	All	NC	366.09	21%	75.60	0.279	0.279	0.757	29%	0.218	1518	11	11	$36.57	$0.00	$0.00	$0.00	2.45	1.58	0.79	1.57
2057	Appliances	ENERGY STAR Electric Clothes Dryers	Appliances	MF	All	NC	768.92	21%	160.44	0.567	0.567	-	0%	0.000	0	14	14	$152.00	$0.00	$0.00	$0.00	0.38	0.77	0.39	1.26
2058	Appliances	ENERGY STAR Gas Clothes Dryers	Appliances	MF	All	NC	134.72	18%	24.78	0.088	0.088	2.414	18%	0.444	0	14	14	$152.00	$0.00	$0.00	$0.00	0.15	0.30	0.15	0.17
2059	Appliances	ENERGY STAR Dehumidifier	Appliances	MF	All	NC	624.22	33%	202.90	0.124	0.124	-	0%	0.000	0	12	12	$50.00	$0.00	$0.00	$0.00	1.44	2.89	1.45	2.87
2060	Appliances	ENERGY STAR Air Purifier	Appliances	MF	All	NC	1054.00	67%	390.00	0.045	0.045	-	0%	0.000	0	9	9	$70.00	$0.00	$0.00	$0.00	1.37	2.75	1.38	2.73
3001	Electronics	Smart Strip plug outlet	Electronics	SF	All	RETRO	-	0%	24.00	0.017	0.017	-	0%	0.000	0	5	5	$40.00	$0.00	$0.00	$0.00	0.09	0.19	0.09	0.15
3002	Electronics	Advanced Power Strip Tier 2	Electronics	SF	All	RETRO	600.00	27%	162.00	0.021	0.021	-	0%	0.000	0	8	8	$70.00	$0.00	$0.00	$0.00	0.48	0.98	0.49	0.97
3003	Electronics	ENERGY STAR 7.0 TV (31-40")	Electronics	SF	All	ROB	170.63	61%	104.80	0.057	0.057	-	0%	0.000	0	6	6	$10.00	$0.00	$0.00	$0.00	1.94	3.90	1.95	3.89
3004	Electronics	ENERGY STAR 7.0 TV (over 60")	Electronics	SF	All	ROB	452.64	71%	319.20	0.175	0.175	-	0%	0.000	0	6	6	$10.00	$0.00	$0.00	$0.00	5.92	11.89	5.94	11.84
3005	Electronics	Efficient Set Top Box	Electronics	SF	All	ROB	274.80	58%	160.60	0.018	0.018	-	0%	0.000	0	4	4	$5.00	$0.00	$0.00	$0.00	3.95	7.93	3.97	7.90
3006	Electronics	ENERGY STAR Display	Electronics	SF	All	ROB	66.20	61%	40.20	0.020	0.020	-	0%	0.000	0	5	5	$10.00	$0.00	$0.00	$0.00	0.60	1.20	0.60	1.20
3007	Electronics	ENERGY STAR PC	Electronics	SF	All	ROB	238.50	32%	77.00	0.023	0.023	-	0%	0.000	0	4	4	$8.00	$0.00	$0.00	$0.00	1.16	2.33	1.17	2.31
3008	Electronics	ENERGY STAR Laptop	Electronics	SF	All	ROB	50.30	72%	35.97	0.004	0.004	-	0%	0.000	0	4	4	$8.00	$0.00	$0.00	$0.00	0.52	1.05	0.52	1.04
3009	Electronics	Smart Strip plug outlet	Electronics	SF	All	NC	-	0%	24.00	0.017	0.017	-	0%	0.000	0	5	5	$40.00	$0.00	$0.00	$0.00	0.09	0.19	0.09	0.15
3010	Electronics	Advanced Power Strip Tier 2	Electronics	SF	All	NC	600.00	27%	162.00	0.021	0.021	-	0%	0.000	0	8	8	$70.00	$0.00	$0.00	$0.00	0.48	0.98	0.49	0.97
3011	Electronics	ENERGY STAR 7.0 TV (31-40")	Electronics	SF	All	NC	170.63	61%	104.80	0.057	0.057	-	0%	0.000	0	6	6	$10.00	$0.00	$0.00	$0.00	1.94	3.90	1.95	3.89
3012	Electronics	ENERGY STAR 7.0 TV (over 60")	Electronics	SF	All	NC	452.64	71%	319.20	0.175	0.175	-	0%	0.000	0	6	6	$10.00	$0.00	$0.00	$0.00	5.92	11.89	5.94	11.84
3013	Electronics	Efficient Set Top Box	Electronics	SF	All	NC	274.80	58%	160.60	0.018	0.018	-	0%	0.000	0	4	4	$5.00	$0.00	$0.00	$0.00	3.95	7.93	3.97	7.90
3014	Electronics	ENERGY STAR Display	Electronics	SF	All	NC	66.20	61%	40.20	0.020	0.020	-	0%	0.000	0	5	5	$10.00	$0.00	$0.00	$0.00	0.60	1.20	0.60	1.20
3015	Electronics	ENERGY STAR PC	Electronics	SF	All	NC	238.50	32%	77.00	0.023	0.023	-	0%	0.000	0	4	4	$8.00	$0.00	$0.00	$0.00	1.16	2.33	1.17	2.31
3016	Electronics	ENERGY STAR Laptop	Electronics	SF	All	NC	50.30	72%	35.97	0.004	0.004	-	0%	0.000	0	4	4	$8.00	$0.00	$0.00	$0.00	0.52	1.05	0.52	1.04
3017	Electronics	Smart Strip plug outlet	Electronics	MF	All	RETRO	-	0%	24.00	0.017	0.017	-	0%	0.000	0	5	5	$40.00	$0.00	$0.00	$0.00	0.09	0.19	0.09	0.15
3018	Electronics	Advanced Power Strip Tier 2	Electronics	MF	All	RETRO	600.00	27%	162.00	0.021	0.021	-	0%	0.000	0	8	8	$70.00	$0.00	$0.00	$0.00	0.48	0.98	0.49	0.97
3019	Electronics	ENERGY STAR 7.0 TV (31-40")	Electronics	MF	All	ROB	170.63	61%	104.80	0.057	0.057	-	0%	0.000	0	6	6	$10.00	$0.00	$0.00	$0.00	1.94	3.90	1.95	3.89
3020	Electronics	ENERGY STAR 7.0 TV (over 60")	Electronics	MF	All	ROB	452.64	71%	319.20	0.175	0.175	-	0%	0.000	0	6	6	$10.00	$0.00	$0.00	$0.00	5.92	11.89	5.94	11.84
3021	Electronics	Efficient Set Top Box	Electronics	MF	All	ROB	274.80	58%	160.60	0.018	0.018	-	0%	0.000	0	4	4	$5.00	$0.00	$0.00	$0.00	3.95	7.93	3.97	7.90
3022	Electronics	ENERGY STAR Display	Electronics	MF	All	ROB	66.20	61%	40.20	0.020	0.020	-	0%	0.000	0	5	5	$10.00	$0.00	$0.00	$0.00	0.60	1.20	0.60	1.20
3023	Electronics	ENERGY STAR PC	Electronics	MF	All	ROB	238.50	32%	77.00	0.023	0.023	-	0%	0.000	0	4	4	$8.00	$0.00	$0.00	$0.00	1.16	2.33	1.17	2.31
3024	Electronics	ENERGY STAR Laptop	Electronics	MF	All	ROB	50.30	72%	35.97	0.004	0.004	-	0%	0.000	0	4	4	$8.00	$0.00	$0.00	$0.00	0.52	1.05	0.52	1.04
3025	Electronics	Smart Strip plug outlet	Electronics	MF	All	NC	-	0%	24.00	0.017	0.017	-	0%	0.000	0	5	5	$40.00	$0.00	$0.00	$0.00	0.09	0.19	0.09	0.15
3026	Electronics	Advanced Power Strip Tier 2	Electronics	MF	All	NC	600.00	27%	162.00	0.021	0.021	-	0%	0.000	0	8	8	$70.00	$0.00	$0.00	$0.00	0.48	0.98	0.49	0.97
3027	Electronics	ENERGY STAR 7.0 TV (31-40")	Electronics	MF	All	NC	170.63	61%	104.80	0.057	0.057	-	0%	0.000	0	6	6	$10.00	$0.00	$0.00	$0.00	1.94	3.90	1.95	3.89
3028	Electronics	ENERGY STAR 7.0 TV (over 60")	Electronics	MF	All	NC	452.64	71%	319.20	0.175	0.175	-	0%	0.000	0	6	6	$10.00	$0.00	$0.00	$0.00	5.92	11.89	5.94	11.84
3029	Electronics	Efficient Set Top Box	Electronics	MF	All	NC	274.80	58%	160.60	0.018	0.018	-	0%	0.000	0	4	4	$5.00	$0.00	$0.00	$0.00	3.95	7.93	3.97	7.90
3030	Electronics	ENERGY STAR Display	Electronics	MF	All	NC	66.20	61%	40.20	0.020	0.020	-	0%	0.000	0	5	5	$10.00	$0.00	$0.00	$0.00	0.60	1.20	0.60	1.20
3031	Electronics	ENERGY STAR PC	Electronics	MF	All	NC	238.50	32%	77.00	0.023	0.023	-	0%	0.000	0	4	4	$8.00	$0.00	$0.00	$0.00	1.16	2.33	1.17	2.31
3032	Electronics	ENERGY STAR Laptop	Electronics	MF	All	NC	50.30	72%	35.97	0.004	0.004	-	0%	0.000	0	4	4	$8.00	$0.00	$0.00	$0.00	0.52	1.05	0.52	1.04
4001	Water Heating	Pipe Wrap - gas water heater	Water Heating	SF	NLI	RETRO	-	0%	0.00	0.000	0.000	2.000	65%	1.300	0	15	15	$65.00	$0.00	$0.00	$0.00	0.67	1.35	0.67	0.67
4002	Water Heating	Pipe Wrap - electric water heater	Water Heating	SF	NLI	RETRO	385.00	67%	257.00	0.029	0.029	-	0%	0.000	0	15	15	$65.00	$0.00	$0.00	$0.00	1.41	2.84	1.42	2.82
4003	Water Heating	Low Flow Showerheads 1.5 gpm gas water heater	Water Heating	SF	NLI	RETRO	-	0%	0.00	0.000	0.000	36.711	6%	2.159	4236	10	10	$34.20	$0.00	$0.00	$0.00	6.09	2.92	1.46	1.46
4004	Water Heating	Low Flow Showerheads 1.0 gpm gas water heater	Water Heating	SF	NLI	RETRO	-	0%	0.00	0.000	0.000	36.711	9%	3.239	6355	10	10	$34.20	$0.00	$0.00	$0.00	9.13	4.38	2.19	2.19
4005	Water Heating	Low Flow Showerheads 1.5 gpm electric water heater	Water Heating	SF	NLI	RETRO	1226.86	40%	490.74	0.039	0.039	-	0%	0.000	4236	10	10	$34.20	$0.00	$0.00	$0.00	8.40	7.60	3.80	7.55
4006	Water Heating	Low Flow Showerheads 1.0 gpm electric water heater	Water Heating	SF	NLI	RETRO	1226.86	60%	736.00	0.084	0.084	-	0%	0.000	6355	10	10	$34.20	$0.00	$0.00	$0.00	12.65	11.50	5.75	11.41
4007	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm electric wat	Water Heating	SF	NLI	RETRO	876.84	55%	478.28	0.055	0.055	-	0%	0.000	4987	10	10	$9.50	$0.00	$0.00	$0.00	32.95	26.90	13.45	26.70
4008	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm electric w	Water Heating	SF	NLI	RETRO	200.03	55%	109.11	0.012	0.012	-	0%	0.000	1390	10	10	$9.50	$0.00	$0.00	$0.00	8.51	6.14	3.07	6.09
4009	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm gas water h	Water Heating	SF	NLI	RETRO	-	0%	0.00	0.000	0.000	3.858	55%	2.104	4987	10	10	$9.50	$0.00	$0.00	$0.00	24.72	10.24	5.12	5.12
4010	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm gas water	Water Heating	SF	NLI	RETRO	-	0%	0.00	0.000	0.000	0.881	55%	0.481	1390	10	10	$9.50	$0.00	$0.00	$0.00	6.64	2.34	1.17	1.17
4011	Water Heating	Pipe Wrap - gas water heater	Water Heating	SF	LI	DI	-	0%	0.00	0.000	0.000	2.000	65%	1.300	0	15	15	$65.00	$0.00	$0.00	$0.00	0.67	0.67	0.67	0.67
4012	Water Heating	Pipe Wrap - electric water heater	Water Heating	SF	LI	DI	385.00	67%	257.00	0.029	0.029	-	0%	0.000	0	15	15	$65.00	$0.00	$0.00	$0.00	1.41	1.42	1.42	2.82
4013	Water Heating	Low Flow Showerheads 1.5 gpm gas water heater	Water Heating	SF	LI	DI	-	0%	0.00	0.000	0.000	36.711	4%	1.468	2881	10	10	$34.20	$0.00	$0.00	$0.00	4.14	0.99	0.99	0.99
4014	Water Heating	Low Flow Showerheads 1.0 gpm gas water heater	Water Heating	SF	LI	DI	-	0%	0.00	0.000	0.000	36.711	6%	2.203	4322	10	10	$34.20	$0.00	$0.00	$0.00	6.21	1.49	1.49	1.49
4015	Water Heating	Low Flow Showerheads 1.5 gpm electric water heater	Water Heating	SF	LI	DI	834.39	40%	333.76	0.038	0.038	-	0%	0.000	2881	10	10	$34.20	$0.00	$0.00	$0.00	5.73	2.61	2.61	5.17
4016	Water Heating	Low Flow Showerheads 1.0 gpm electric water heater	Water Heating	SF	LI	DI	834.39	60%	500.64	0.057	0.057	-	0%	0.000	4322	10	10	$34.20	$0.00	$0.00	$0.00	8.60	3.91	3.91	7.76
4017	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm electric wat	Water Heating	SF	LI	DI	876.84	55%	478.28	0.055	0.055	-	0%	0.000	4987	10	10	$9.50	$0.00	$0.00	$0.00	32.95	13.45	13.45	26.70
4018	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm electric w	Water Heating	SF	LI	DI	125.04	55%	68.20	0.008	0.008	-	0%	0.000	869	10	10	$9.50	$0.00	$0.00	$0.00	5.32	1.92	1.92	3.81
4019	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm gas water h	Water Heating	SF	LI	DI	-	0%	0.00	0.000	0.000	3.858	55%	2.104	4987	10	10	$9.50	$0.00	$0.00	$0.00	24.72	5.12	5.12	5.12
4020	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm gas water	Water Heating	SF	LI	DI	-	0%	0.00	0.000	0.000	0.551	54%	0.300	869	10	10	$9.50	$0.00	$0.00	$0.00	4.15	0.73	0.73	0.73
4021	Water Heating	TubSpout with Showerhead 1.5 GPM, electric DHW	Water Heating	SF	All	RETRO	-	0%	542.23	0.043	0.043	-	0%	0.000	4310	10	10	$48.70	$0.00	$0.00	$0.00	6.23	5.90	2.95	5.86
4022	Water Heating	TubSpout with Showerhead 1.5 GPM, gas DHW	Water Heating	SF	All	RETRO	-	0%	0.00	0.000	0.000	0.000	0%	0.000	4310	10	10	$48.70	$0.00	$0.00	$0.00	3.31	0.00	0.00	0.00
4023	Water Heating	Thermostatic Shower Head 2.0 gpm gas water heater	Water Heating	SF	All	RETRO	-	0%	0.00	0.000	0.000	0.384	94%	0.361	653	10	10	$38.20	$0.00	$0.00	$0.00	0.86	0.44	0.22	0.22
4024	Water Heating	Thermostatic Shower Head 2.0 gpm electric water heate	Water Heating	SF	All	RETRO	87.36	94%	82.12	0.009	0.009	-	0%	0.000	653	10	10	$38.20	$0.00	$0.00	$0.00	1.21	1.15	0.57	1.14
4025	Water Heating	Heat Pump Water Heaters, <= 55 gallons	Water Heating	SF	All	ROB	3696.00	52%	1913.00	0.218	0.218	-	0%	0.000	0	13	13	$1,100.00	$0.00	$0.00	$0.00	0.56	1.13	0.56	1.12
4026	Water Heating	High Efficiency Gas Water Heater 0.67 EF, <= 55 gallons	Water Heating	SF	All	ROB	-	0%	0.00	0.000	0.000	20.000	11%	2.100	0	13	13	$440.00	$0.00	$0.00	$0.00	0.14	0.28	0.14	0.14
4027	Water Heating	Super Efficiency Gas Water Heater 0.80 EF, <= 55 gallon	Water Heating	SF	All	ROB	-	0%	0.00	0.000	0.000	20.000	25%	5.000	0	13	13	$520.00	$0.00	$0.00	$0.00	0.28	0.57	0.28	0.28
4028	Water Heating	Instant Gas Water Heater	Water Heating	SF	All	ROB	-	0%	0.00	0.000	0.000	20.000	27%	5.400	0	20	20	$602.00	$0.00	$0.00	$0.00	0.39	0.78	0.39	0.39
4029	Water Heating	Solar Domestic Hot Water - electric water heater	Water Heating	SF	All	ROB	3696.00	56%	2059.00	0.600	0.600	-	0%	0.000	0	20	20	$4,500.00	$0.00	$0.00	$0.00	0.20	0.41	0.20	0.29
4030	Water Heating	Solar Domestic Hot Water - gas water heater	Water Heating	SF	All	ROB	-	0%	0.00	0.000	0.000	20.000	48%	9.500	0	20	20	$4,500.00	$0.00	$0.00	$0.00	0.09	0.18	0.09	0.09
4031	Water Heating	Gravity Film Heat Exchanger GFX electric water heater	Water Heating	SF	All	RETRO	3696.00	6%	208.00	0.034	0.034	-	0%	0.000	0	20	20	$1,022.00	$0.00	$0.00	$0.00	0.09	0.18	0.09	0.10
4032	Water Heating	Gravity Film Heat Exchanger GFX gas water heater	Water Heating	SF	All	RETRO	-	0%	0.00	0.000	0.000	20.000	5%	1.015	0	20	20	$1,022.00	$0.00	$0.00	$0.00	0.04	0.09	0.04	0.04
4033	Water Heating	Pipe Wrap - gas water heater	Water Heating	SF	All	NC	-	0%	0.00	0.000	0.000	2.000	65%	1.300	0	15	15	$65.00	$0.00	$0.00	$0.00	0.67	1.35	0.67	0.67
4034	Water Heating	Pipe Wrap - electric water heater	Water Heating	SF	All	NC	385.00	67%	257.00	0.029	0.029	-	0%	0.000	0	15	15	$65.00	$0.00	$0.00	$0.00	1.41	2.84	1.42	2.82
4035	Water Heating	Low Flow Showerheads 1.5 gpm gas water heater	Water Heating	SF	All	NC	-	0%	0.00	0.000	0.000	36.711	6%	2.159	4236	10	10	$34.20	$0.00	$0.00	$0.00	6.09	2.92	1.46	1.46
4036	Water Heating	Low Flow Showerheads 1.0 gpm gas water heater	Water Heating	SF	All	NC	-	0%	0.00	0.000	0.000	36.711	9%	3.239	6355	10	10	$34.20	$0.00	$0.00	$0.00	9.13	4.38	2.19	2.19
4037	Water Heating	Low Flow Showerheads 1.5 gpm electric water heater	Water Heating	SF	All	NC	1226.86	40%	490.74	0.039	0.039	-	0%	0.000	4236	10	10	$34.20	$0.00	$0.00	$0.00	8.40	7.60	3.80	7.55
4038	Water Heating	Low Flow Showerheads 1.0 gpm electric water heater	Water Heating	SF	All	NC	1226.86	60%	736.00	0.084	0.084	-	0%	0.000	6355	10	10	$34.20	$0.00	$0.00	$0.00	12.65	11.50	5.75	11.41
4039	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm electric wat	Water Heating	SF	All	NC	876.84	55%	478.28	0.055	0.055	-	0%	0.000	4987	10	10	$9.50	$0.00	$0.00	$0.00	32.95	26.90	13.45	26.70
4040	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm electric w	Water Heating	SF	All	NC	200.03	55%	109.11	0.012	0.012	-	0%	0.000	1390	10	10	$9.50	$0.00	$0.00	$0.00	8.51	6.14	3.07	6.09
4041	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm gas water h	Water Heating	SF	All	NC	-	0%	0.00	0.000	0.000	3.858	55%	2.104	4987	10	10	$9.50	$0.00	$0.00	$0.00	24.72	10.24	5.12	5.12
4042	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm gas water	Water Heating	SF	All	NC	-	0%	0.00	0.000	0.000	0.881	55%	0.481	1390	10	10	$9.50	$0.00	$0.00	$0.00	6.64	2.34	1.17	1.17
4043	Water Heating	TubSpout with Showerhead 1.5 GPM, electric DHW	Water Heating	SF	All	NC	-	0%	542.23	0.043	0.043	-	0%	0.000	4310	10	10	$48.70	$0.00	$0.00	$0.00	6.23	5.90	2.95	5.86
4044	Water Heating	TubSpout with Showerhead 1.5 GPM, gas DHW	Water Heating	SF	All	NC	-	0%	0.00	0.000	0.000	0.000	0%	0.000	4310	10	10	$48.70	$0.00	$0.00	$0.00	3.31	0.00	0.00	0.00
4045	Water Heating	Thermostatic Shower Head 2.0 gpm gas water heater	Water Heating	SF	All	NC	-	0%	0.00	0.000	0.000	0.384	94%	0.361	653	10	10	$38.20	$0.00	$0.00	$0.00	0.86	0.44	0.22	0.22
4046	Water Heating	Thermostatic Shower Head 2.0 gpm electric water heate	Water Heating	SF	All	NC	87.36	94%	82.12	0.009	0.009	-	0%	0.000	653	10	10	$38.20	$0.00	$0.00	$0.00	1.21	1.15	0.57	1.14
4047	Water Heating	Heat Pump Water Heaters, <= 55 gallons	Water Heating	SF	All	NC	3696.00	52%	1913.00	0.218	0.218	-	0%	0.000	0	13	13	$1,100.00	$0.00	$0.00	$0.00	0.56	1.13	0.56	1.12
4048	Water Heating	High Efficiency Gas Water Heater 0.67 EF, <= 55 gallons	Water Heating	SF	All	NC	-	0%	0.00	0.000	0.000	20.000	11%	2.100	0	13	13	$440.00	$0.00	$0.00	$0.00	0.14	0.28	0.14	0.14
4049	Water Heating	Super Efficiency Gas Water Heater 0.80 EF, <= 55 gallon	Water Heating	SF	All	NC	-	0%	0.00	0.000	0.000	20.000	25%	5.000	0	13	13	$520.00	$0.00	$0.00	$0.00	0.28	0.57	0.28	0.28
4050	Water Heating	Instant Gas Water Heater	Water Heating	SF	All	NC	-	0%	0.00	0.000	0.000	20.000	27%	5.400	0	20	20	$602.00	$0.00	$0.00	$0.00	0.39	0.78	0.39	0.39
4051	Water Heating	Solar Domestic Hot Water - electric water heater	Water Heating	SF	All	NC	3696.00	56%	2059.00	0.600	0.600	-	0%	0.000	0	20	20	$4,500.00	$0.00	$0.00	$0.00	0.20	0.41	0.20	0.29
4052	Water Heating	Solar Domestic Hot Water - gas water heater	Water Heating	SF	All	NC	-	0%	0.00	0.000	0.000	20.000	48%	9.500	0	20	20	$4,500.00	$0.00	$0.00	$0.00	0.09	0.18	0.09	0.09
4053	Water Heating	Gravity Film Heat Exchanger GFX electric water heater	Water Heating	SF	All	NC	3696.00	6%	208.00	0.034	0.034	-	0%	0.000	0	20	20	$1,022.00	$0.00	$0.00	$0.00	0.09	0.18	0.09	0.10
4054	Water Heating	Gravity Film Heat Exchanger GFX gas water heater	Water Heating	SF	All	NC	-	0%	0.00	0.000	0.000	20.000	5%	1.015	0	20	20	$1,022.00	$0.00	$0.00	$0.00	0.04	0.09	0.04	0.04
4055	Water Heating	Pipe Wrap - gas water heater	Water Heating	MF	NLI	RETRO	-	0%	0.00	0.000	0.000	2.000	65%	1.300	0	15	15	$65.00	$0.00	$0.00	$0.00	0.67	1.35	0.67	0.67
4056	Water Heating	Pipe Wrap - electric water heater	Water Heating	MF	NLI	RETRO	385.00	67%	257.00	0.029	0.029	-	0%	0.000	0	15	15	$65.00	$0.00	$0.00	$0.00	1.41	2.84	1.42	2.82

Measure Assumption Tab - Residential

Measure #	End-Use	Measure Name	Program	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Base Fuel Use	% Fuel Savings	Per unit Fuel Saving	Per Unit Water Savings	RC EUL	EE EUL	Measure Cost	O&M Benefits	O&M Costs	Tax Credits	TRC	UCT 50%	UCT 100%	UCT PB
4057	Water Heating	Low Flow Showerheads 1.5 gpm gas water heater	Water Heating	MF	NLI	RETRO	-	0%	0.00	0.000	0.000	35.883	6%	2.159	4236	10	10	$34.20	$0.00	$0.00	$0.00	6.09	2.92	1.46	1.46
4058	Water Heating	Low Flow Showerheads 1.0 gpm gas water heater	Water Heating	MF	NLI	RETRO	-	0%	0.00	0.000	0.000	35.883	9%	3.239	6355	10	10	$34.20	$0.00	$0.00	$0.00	9.13	4.38	2.19	2.19
4059	Water Heating	Low Flow Showerheads 1.5 gpm electric water heater	Water Heating	MF	NLI	RETRO	1226.86	40%	490.74	0.039	0.039	-	0%	0.000	4236	10	10	$34.20	$0.00	$0.00	$0.00	8.40	7.60	3.80	7.55
4060	Water Heating	Low Flow Showerheads 1.0 gpm electric water heater	Water Heating	MF	NLI	RETRO	1226.86	60%	736.00	0.084	0.084	-	0%	0.000	6355	10	10	$34.20	$0.00	$0.00	$0.00	12.65	11.50	5.75	11.41
4061	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm electric wat	Water Heating	MF	NLI	RETRO	634.23	55%	345.95	0.039	0.039	-	0%	0.000	3607	10	10	$9.50	$0.00	$0.00	$0.00	23.83	19.46	9.73	19.31
4062	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm electric w	Water Heating	MF	NLI	RETRO	200.03	55%	109.11	0.012	0.012	-	0%	0.000	1390	10	10	$9.50	$0.00	$0.00	$0.00	8.51	6.14	3.07	6.09
4063	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm gas water h	Water Heating	MF	NLI	RETRO	-	0%	0.00	0.000	0.000	2.790	55%	1.522	3607	10	10	$9.50	$0.00	$0.00	$0.00	17.88	7.41	3.70	3.70
4064	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm gas water	Water Heating	MF	NLI	RETRO	-	0%	0.00	0.000	0.000	0.881	55%	0.481	1390	10	10	$9.50	$0.00	$0.00	$0.00	6.64	2.34	1.17	1.17
4065	Water Heating	Pipe Wrap - gas water heater	Water Heating	MF	LI	DI	-	0%	0.00	0.000	0.000	2.000	65%	1.300	0	15	15	$65.00	$0.00	$0.00	$0.00	0.67	0.67	0.67	0.67
4066	Water Heating	Pipe Wrap - electric water heater	Water Heating	MF	LI	DI	385.00	67%	257.00	0.029	0.029	-	0%	0.000	0	15	15	$65.00	$0.00	$0.00	$0.00	1.41	1.42	1.42	2.82
4067	Water Heating	Low Flow Showerheads 1.5 gpm gas water heater	Water Heating	MF	LI	DI	-	0%	0.00	0.000	0.000	35.883	4%	1.435	2816	10	10	$34.20	$0.00	$0.00	$0.00	4.05	0.97	0.97	0.97
4068	Water Heating	Low Flow Showerheads 1.0 gpm gas water heater	Water Heating	MF	LI	DI	-	0%	0.00	0.000	0.000	35.883	6%	2.153	4224	10	10	$34.20	$0.00	$0.00	$0.00	6.07	1.46	1.46	1.46
4069	Water Heating	Low Flow Showerheads 1.5 gpm electric water heater	Water Heating	MF	LI	DI	815.59	40%	326.23	0.037	0.037	-	0%	0.000	2816	10	10	$34.20	$0.00	$0.00	$0.00	5.60	2.55	2.55	5.06
4070	Water Heating	Low Flow Showerheads 1.0 gpm electric water heater	Water Heating	MF	LI	DI	815.59	60%	489.35	0.056	0.056	-	0%	0.000	4224	10	10	$34.20	$0.00	$0.00	$0.00	8.41	3.82	3.82	7.59
4071	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm electric wat	Water Heating	MF	LI	DI	634.23	55%	345.95	0.039	0.039	-	0%	0.000	3607	10	10	$9.50	$0.00	$0.00	$0.00	23.83	9.73	9.73	19.31
4072	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm electric w	Water Heating	MF	LI	DI	129.02	55%	70.38	0.008	0.008	-	0%	0.000	897	10	10	$9.50	$0.00	$0.00	$0.00	5.49	1.98	1.98	3.93
4073	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm gas water h	Water Heating	MF	LI	DI	-	0%	0.00	0.000	0.000	2.790	55%	1.522	3607	10	10	$9.50	$0.00	$0.00	$0.00	17.88	3.70	3.70	3.70
4074	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm gas water	Water Heating	MF	LI	DI	-	0%	0.00	0.000	0.000	0.568	55%	0.310	897	10	10	$9.50	$0.00	$0.00	$0.00	4.28	0.75	0.75	0.75
4075	Water Heating	TubSpout with Showerhead 1.5 GPM, electric DHW	Water Heating	MF	All	RETRO	-	0%	530.01	0.042	0.042	-	0%	0.000	4213	10	10	$48.70	$0.00	$0.00	$0.00	6.09	5.77	2.88	5.72
4076	Water Heating	TubSpout with Showerhead 1.5 GPM, gas DHW	Water Heating	MF	All	RETRO	-	0%	0.00	0.000	0.000	0.000	0%	0.000	4213	10	10	$48.70	$0.00	$0.00	$0.00	3.23	0.00	0.00	0.00
4077	Water Heating	Thermostatic Shower Head 2.0 gpm gas water heater	Water Heating	MF	All	RETRO	-	0%	0.00	0.000	0.000	0.376	94%	0.353	638	10	10	$38.20	$0.00	$0.00	$0.00	0.84	0.43	0.21	0.21
4078	Water Heating	Thermostatic Shower Head 2.0 gpm electric water heate	Water Heating	MF	All	RETRO	85.39	94%	80.27	0.009	0.009	-	0%	0.000	638	10	10	$38.20	$0.00	$0.00	$0.00	1.18	1.12	0.56	1.11
4079	Water Heating	Heat Pump Water Heaters, <= 55 gallons	Water Heating	MF	All	ROB	3111.00	52%	1610.00	0.184	0.184	-	0%	0.000	0	13	13	$1,100.00	$0.00	$0.00	$0.00	0.47	0.95	0.47	13.28
4080	Water Heating	High Efficiency Gas Water Heater 0.67 EF, <= 55 gallons	Water Heating	MF	All	ROB	-	0%	0.00	0.000	0.000	16.800	10%	1.700	0	13	13	$440.00	$0.00	$0.00	$0.00	0.11	0.23	0.11	0.11
4081	Water Heating	Super Efficiency Gas Water Heater 0.80 EF, <= 55 gallon	Water Heating	MF	All	ROB	-	0%	0.00	0.000	0.000	16.800	25%	4.200	0	13	13	$520.00	$0.00	$0.00	$0.00	0.24	0.48	0.24	0.24
4082	Water Heating	Instant Gas Water Heater	Water Heating	MF	All	ROB	-	0%	0.00	0.000	0.000	16.800	27%	4.500	0	20	20	$602.00	$0.00	$0.00	$0.00	0.32	0.65	0.32	0.32
4083	Water Heating	Solar Domestic Hot Water - electric water heater	Water Heating	MF	All	ROB	3111.00	66%	2059.00	0.600	0.600	-	0%	0.000	0	20	20	$4,500.00	$0.00	$0.00	$0.00	0.20	0.41	0.20	0.29
4084	Water Heating	Solar Domestic Hot Water - gas water heater	Water Heating	MF	All	ROB	-	0%	0.00	0.000	0.000	16.800	57%	9.500	0	20	20	$4,500.00	$0.00	$0.00	$0.00	0.09	0.18	0.09	0.09
4085	Water Heating	Gravity Film Heat Exchanger GFX electric water heater	Water Heating	MF	All	RETRO	3111.00	4%	134.93	0.022	0.022	-	0%	0.000	0	20	20	$1,022.00	$0.00	$0.00	$0.00	0.06	0.11	0.06	0.06
4086	Water Heating	Gravity Film Heat Exchanger GFX gas water heater	Water Heating	MF	All	RETRO	-	0%	0.00	0.000	0.000	16.800	4%	0.658	0	20	20	$1,022.00	$0.00	$0.00	$0.00	0.03	0.06	0.03	0.03
4087	Water Heating	Pipe Wrap - gas water heater	Water Heating	MF	All	NC	-	0%	0.00	0.000	0.000	2.000	65%	1.300	0	15	15	$65.00	$0.00	$0.00	$0.00	0.67	1.35	0.67	0.67
4088	Water Heating	Pipe Wrap - electric water heater	Water Heating	MF	All	NC	385.00	67%	257.00	0.029	0.029	-	0%	0.000	0	15	15	$65.00	$0.00	$0.00	$0.00	1.41	2.84	1.42	2.82
4089	Water Heating	Low Flow Showerheads 1.5 gpm gas water heater	Water Heating	MF	All	NC	-	0%	0.00	0.000	0.000	35.883	6%	2.159	4236	10	10	$34.20	$0.00	$0.00	$0.00	6.09	2.92	1.46	1.46
4090	Water Heating	Low Flow Showerheads 1.0 gpm gas water heater	Water Heating	MF	All	NC	-	0%	0.00	0.000	0.000	35.883	9%	3.239	6355	10	10	$34.20	$0.00	$0.00	$0.00	9.13	4.38	2.19	2.19
4091	Water Heating	Low Flow Showerheads 1.5 gpm electric water heater	Water Heating	MF	All	NC	1226.86	40%	490.74	0.039	0.039	-	0%	0.000	4236	10	10	$34.20	$0.00	$0.00	$0.00	8.40	7.60	3.80	7.55
4092	Water Heating	Low Flow Showerheads 1.0 gpm electric water heater	Water Heating	MF	All	NC	1226.86	60%	736.00	0.084	0.084	-	0%	0.000	6355	10	10	$34.20	$0.00	$0.00	$0.00	12.65	11.50	5.75	11.41
4093	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm electric wat	Water Heating	MF	All	NC	634.23	55%	345.95	0.039	0.039	-	0%	0.000	3607	10	10	$9.50	$0.00	$0.00	$0.00	23.83	19.46	9.73	19.31
4094	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm electric w	Water Heating	MF	All	NC	200.03	55%	109.11	0.012	0.012	-	0%	0.000	1390	10	10	$9.50	$0.00	$0.00	$0.00	8.51	6.14	3.07	6.09
4095	Water Heating	Low Flow Kitchen Faucet Aerators - 1.0 gpm gas water h	Water Heating	MF	All	NC	-	0%	0.00	0.000	0.000	2.790	55%	1.522	3607	10	10	$9.50	$0.00	$0.00	$0.00	17.88	7.41	3.70	3.70
4096	Water Heating	Low Flow Bathroom Faucet Aerators - 1.0 gpm gas water	Water Heating	MF	All	NC	-	0%	0.00	0.000	0.000	0.881	55%	0.481	1390	10	10	$9.50	$0.00	$0.00	$0.00	6.64	2.34	1.17	1.17
4097	Water Heating	TubSpout with Showerhead 1.5 GPM, electric DHW	Water Heating	MF	All	NC	-	0%	530.01	0.042	0.042	-	0%	0.000	4213	10	10	$48.70	$0.00	$0.00	$0.00	6.09	5.77	2.88	5.72
4098	Water Heating	TubSpout with Showerhead 1.5 GPM, gas DHW	Water Heating	MF	All	NC	-	0%	0.00	0.000	0.000	0.000	0%	0.000	4213	10	10	$48.70	$0.00	$0.00	$0.00	3.23	0.00	0.00	0.00
4099	Water Heating	Thermostatic Shower Head 2.0 gpm gas water heater	Water Heating	MF	All	NC	-	0%	0.00	0.000	0.000	0.376	94%	0.353	638	10	10	$38.20	$0.00	$0.00	$0.00	0.84	0.43	0.21	0.21
4100	Water Heating	Thermostatic Shower Head 2.0 gpm electric water heate	Water Heating	MF	All	NC	85.39	94%	80.27	0.009	0.009	-	0%	0.000	638	10	10	$38.20	$0.00	$0.00	$0.00	1.18	1.12	0.56	1.11
4101	Water Heating	Heat Pump Water Heaters, <= 55 gallons	Water Heating	MF	All	NC	3111.00	52%	1610.00	0.184	0.184	-	0%	0.000	0	13	13	$1,100.00	$0.00	$0.00	$0.00	0.47	0.95	0.47	13.28
4102	Water Heating	High Efficiency Gas Water Heater 0.67 EF, <= 55 gallons	Water Heating	MF	All	NC	-	0%	0.00	0.000	0.000	16.800	10%	1.700	0	13	13	$440.00	$0.00	$0.00	$0.00	0.11	0.23	0.11	0.11
4103	Water Heating	Super Efficiency Gas Water Heater 0.80 EF, <= 55 gallon	Water Heating	MF	All	NC	-	0%	0.00	0.000	0.000	16.800	25%	4.200	0	13	13	$520.00	$0.00	$0.00	$0.00	0.24	0.48	0.24	0.24
4104	Water Heating	Instant Gas Water Heater	Water Heating	MF	All	NC	-	0%	0.00	0.000	0.000	16.800	27%	4.500	0	20	20	$602.00	$0.00	$0.00	$0.00	0.32	0.65	0.32	0.32
4105	Water Heating	Solar Domestic Hot Water - electric water heater	Water Heating	MF	All	NC	3111.00	66%	2059.00	0.600	0.600	-	0%	0.000	0	20	20	$4,500.00	$0.00	$0.00	$0.00	0.20	0.41	0.20	0.29
4106	Water Heating	Solar Domestic Hot Water - gas water heater	Water Heating	MF	All	NC	-	0%	0.00	0.000	0.000	16.800	57%	9.500	0	20	20	$4,500.00	$0.00	$0.00	$0.00	0.09	0.18	0.09	0.09
4107	Water Heating	Gravity Film Heat Exchanger GFX electric water heater	Water Heating	MF	All	NC	3111.00	4%	134.93	0.022	0.022	-	0%	0.000	0	20	20	$1,022.00	$0.00	$0.00	$0.00	0.06	0.11	0.06	0.06
4108	Water Heating	Gravity Film Heat Exchanger GFX gas water heater	Water Heating	MF	All	NC	-	0%	0.00	0.000	0.000	16.800	4%	0.658	0	20	20	$1,022.00	$0.00	$0.00	$0.00	0.03	0.06	0.03	0.03
5001	HVAC Shell	Infiltration reduction - 30%	HVAC Shell	SF	NLI	RETRO	-	-	78.82	0.077	0.123	-	0%	10.071	0	13	13	$258.00	$0.00	$0.00	$0.00	1.28	2.41	1.21	1.61
5002	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	SF	NLI	RETRO	-	-	132.33	0.143	0.228	-	0%	16.933	0	13	13	$258.00	$0.00	$0.00	$0.00	2.17	4.02	2.01	3.27
5003	HVAC Shell	Crawlspace Wall Insulation	HVAC Shell	SF	NLI	RETRO	-	-	-44.77	-0.025	-0.025	-	0%	3.048	0	25	25	$552.11	$0.00	$0.00	$0.00	0.26	0.54	0.28	0.27
5004	HVAC Shell	Basement Wall Insulation	HVAC Shell	SF	NLI	RETRO	-	-	-49.33	-0.055	-0.055	-	0%	9.527	0	25	25	$1,104.21	$0.00	$0.00	$0.00	0.42	0.82	0.42	0.43
5005	HVAC Shell	Floor Insulation	HVAC Shell	SF	NLI	RETRO	-	-	-88.33	-0.020	-0.020	-	0%	6.857	0	25	25	$1,112.84	$0.00	$0.00	$0.00	0.30	0.61	0.32	0.31
5006	HVAC Shell	Wall Insulation	HVAC Shell	SF	NLI	RETRO	-	-	103.37	0.059	0.059	-	0%	11.425	0	25	25	$3,041.11	$0.00	$0.00	$0.00	0.21	0.43	0.21	0.22
5007	HVAC Shell	R-38 Roof Insulation	HVAC Shell	SF	NLI	RETRO	-	-	50.43	0.057	0.077	-	0%	5.555	0	20	20	$2,108.28	$0.00	$0.00	$0.00	0.13	0.27	0.13	0.13
5008	HVAC Shell	R-60 Roof Insulation	HVAC Shell	SF	NLI	RETRO	-	-	68.60	0.081	0.102	-	0%	7.807	0	20	20	$4,549.44	$0.00	$0.00	$0.00	0.08	0.18	0.09	0.08
5009	HVAC Shell	Infiltration reduction - 30%	HVAC Shell	SF	NLI	RETRO	-	-	48.96	0.011	0.018	-	0%	10.438	0	13	13	$258.00	$0.00	$0.00	$0.00	1.26	2.33	1.16	1.44
5010	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	SF	NLI	RETRO	-	-	82.83	0.020	0.033	-	0%	17.517	0	13	13	$258.00	$0.00	$0.00	$0.00	2.12	3.87	1.94	2.68
5011	HVAC Shell	Crawlspace Wall Insulation	HVAC Shell	SF	NLI	RETRO	-	-	3.80	-0.004	-0.004	-	0%	4.125	0	25	25	$552.11	$0.00	$0.00	$0.00	0.39	0.84	0.42	0.39
5012	HVAC Shell	Basement Wall Insulation	HVAC Shell	SF	NLI	RETRO	-	-	23.09	-0.008	-0.008	-	0%	10.056	0	25	25	$1,104.21	$0.00	$0.00	$0.00	0.48	0.95	0.48	0.49
5013	HVAC Shell	Floor Insulation	HVAC Shell	SF	NLI	RETRO	-	-	10.22	-0.003	-0.003	-	0%	5.720	0	25	25	$1,112.84	$0.00	$0.00	$0.00	0.27	0.56	0.28	0.27
5014	HVAC Shell	Wall Insulation	HVAC Shell	SF	NLI	RETRO	-	-	54.82	0.008	0.008	-	0%	11.720	0	25	25	$3,041.11	$0.00	$0.00	$0.00	0.21	0.41	0.20	0.21
5015	HVAC Shell	R-38 Roof Insulation	HVAC Shell	SF	NLI	RETRO	-	-	27.17	0.008	0.011	-	0%	6.087	0	20	20	$2,108.28	$0.00	$0.00	$0.00	0.13	0.27	0.14	0.13
5016	HVAC Shell	R-60 Roof Insulation	HVAC Shell	SF	NLI	RETRO	-	-	37.64	0.012	0.015	-	0%	8.381	0	20	20	$4,549.44	$0.00	$0.00	$0.00	0.08	0.17	0.09	0.08
5017	HVAC Shell	Infiltration reduction - 30%	HVAC Shell	SF	NLI	RETRO	-	-	2298.61	0.077	0.123	-	0%	0.000	0	13	13	$258.00	$0.00	$0.00	$0.00	2.80	5.25	2.63	5.60
5018	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	SF	NLI	RETRO	-	-	3854.93	0.143	0.228	-	0%	0.000	0	13	13	$258.00	$0.00	$0.00	$0.00	4.71	8.72	4.36	9.41
5019	HVAC Shell	Crawlspace Wall Insulation	HVAC Shell	SF	NLI	RETRO	-	-	617.21	-0.025	-0.025	-	0%	0.000	0	25	25	$552.11	$0.00	$0.00	$0.00	0.51	1.05	0.53	1.93
5020	HVAC Shell	Basement Wall Insulation	HVAC Shell	SF	NLI	RETRO	-	-	2038.55	-0.055	-0.055	-	0%	0.000	0	25	25	$1,104.21	$0.00	$0.00	$0.00	0.84	1.64	0.82	1.68
5021	HVAC Shell	Floor Insulation	HVAC Shell	SF	NLI	RETRO	-	-	1433.24	-0.020	-0.020	-	0%	0.000	0	25	25	$1,112.84	$0.00	$0.00	$0.00	0.59	1.23	0.61	3.91
5022	HVAC Shell	Wall Insulation	HVAC Shell	SF	NLI	RETRO	-	-	2619.59	0.059	0.059	-	0%	0.000	0	25	25	$3,041.11	$0.00	$0.00	$0.00	0.40	0.79	0.40	0.93
5023	HVAC Shell	R-38 Roof Insulation	HVAC Shell	SF	NLI	RETRO	-	-	1259.39	0.057	0.077	-	0%	0.000	0	20	20	$2,108.28	$0.00	$0.00	$0.00	0.25	0.52	0.26	0.41
5024	HVAC Shell	R-60 Roof Insulation	HVAC Shell	SF	NLI	RETRO	-	-	1259.39	0.057	0.077	-	0%	0.000	0	20	20	$4,549.44	$0.00	$0.00	$0.00	0.11	0.34	0.17	0.14
5025	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	SF	LI	DI	-	-	132.33	0.143	0.228	-	0%	16.933	0	13	13	$258.00	$0.00	$0.00	$0.00	2.17	2.01	2.01	3.27
5026	HVAC Shell	Crawlspace Wall Insulation	HVAC Shell	SF	LI	DI	-	-	-44.77	-0.025	-0.025	-	0%	3.048	0	25	25	$552.11	$0.00	$0.00	$0.00	0.26	0.28	0.28	0.27
5027	HVAC Shell	Basement Wall Insulation	HVAC Shell	SF	LI	DI	-	-	-49.33	-0.055	-0.055	-	0%	9.527	0	25	25	$1,104.21	$0.00	$0.00	$0.00	0.42	0.42	0.42	0.43
5028	HVAC Shell	Floor Insulation	HVAC Shell	SF	LI	DI	-	-	-88.33	-0.020	-0.020	-	0%	6.857	0	25	25	$1,112.84	$0.00	$0.00	$0.00	0.30	0.32	0.32	0.31
5029	HVAC Shell	Wall Insulation	HVAC Shell	SF	LI	DI	-	-	103.37	0.059	0.059	-	0%	11.425	0	25	25	$3,041.11	$0.00	$0.00	$0.00	0.21	0.21	0.21	0.22
5030	HVAC Shell	R-38 Roof Insulation	HVAC Shell	SF	LI	DI	-	-	50.43	0.057	0.077	-	0%	5.555	0	20	20	$2,108.28	$0.00	$0.00	$0.00	0.13	0.13	0.13	0.13
5031	HVAC Shell	R-60 Roof Insulation	HVAC Shell	SF	LI	DI	-	-	68.60	0.081	0.102	-	0%	7.807	0	20	20	$4,549.44	$0.00	$0.00	$0.00	0.08	0.09	0.09	0.08
5032	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	SF	LI	DI	-	-	82.83	0.020	0.033	-	0%	17.517	0	13	13	$258.00	$0.00	$0.00	$0.00	2.12	1.94	1.94	2.68
5033	HVAC Shell	Crawlspace Wall Insulation	HVAC Shell	SF	LI	DI	-	-	3.80	-0.004	-0.004	-	0%	4.125	0	25	25	$552.11	$0.00	$0.00	$0.00	0.39	0.42	0.42	0.39
5034	HVAC Shell	Basement Wall Insulation	HVAC Shell	SF	LI	DI	-	-	23.09	-0.008	-0.008	-	0%	10.056	0	25	25	$1,104.21	$0.00	$0.00	$0.00	0.48	0.48	0.48	0.49
5035	HVAC Shell	Floor Insulation	HVAC Shell	SF	LI	DI	-	-	10.22	-0.003	-0.003	-	0%	5.720	0	25	25	$1,112.84	$0.00	$0.00	$0.00	0.27	0.28	0.28	0.27
5036	HVAC Shell	Wall Insulation	HVAC Shell	SF	LI	DI	-	-	54.82	0.008	0.008	-	0%	11.720	0	25	25	$3,041.11	$0.00	$0.00	$0.00	0.21	0.20	0.20	0.21
5037	HVAC Shell	R-38 Roof Insulation	HVAC Shell	SF	LI	DI	-	-	27.17	0.008	0.011	-	0%	6.087	0	20	20	$2,108.28	$0.00	$0.00	$0.00	0.13	0.14	0.14	0.13
5038	HVAC Shell	R-60 Roof Insulation	HVAC Shell	SF	LI	DI	-	-	37.64	0.012	0.015	-	0%	8.381	0	20	20	$4,549.44	$0.00	$0.00	$0.00	0.08	0.09	0.09	0.08
5039	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	SF	LI	DI	-	-	3854.93	0.143	0.228	-	0%	0.000	0	13	13	$258.00	$0.00	$0.00	$0.00	4.71	4.36	4.36	9.41
5040	HVAC Shell	Crawlspace Wall Insulation	HVAC Shell	SF	LI	DI	-	-	617.21	-0.025	-0.025	-	0%	0.000	0	25	25	$552.11	$0.00	$0.00	$0.00	0.51	0.53	0.53	1.93
5041	HVAC Shell	Basement Wall Insulation	HVAC Shell	SF	LI	DI	-	-	2038.55	-0.055	-0.055	-	0%	0.000	0	25	25	$1,104.21	$0.00	$0.00	$0.00	0.84	0.82	0.82	1.68
5042	HVAC Shell	Floor Insulation	HVAC Shell	SF	LI	DI	-	-	1433.24	-0.020	-0.020	-	0%	0.000	0	25	25	$1,112.84	$0.00	$0.00	$0.00	0.59	0.61	0.61	3.91
5043	HVAC Shell	Wall Insulation	HVAC Shell	SF	LI	DI	-	-	2619.59	0.059	0.059	-	0%	0.000	0	25	25	$3,041.11	$0.00	$0.00	$0.00	0.40	0.40	0.40	0.93
5044	HVAC Shell	R-38 Roof Insulation	HVAC Shell	SF	LI	DI	-	-	1259.39	0.057	0.077	-	0%	0.000	0	20	20	$2,108.28	$0.00	$0.00	$0.00	0.25	0.26	0.26	0.41
5045	HVAC Shell	R-60 Roof Insulation	HVAC Shell	SF	LI	DI	-	-	1770.05	0.081	0.102	-	0%	0.000	0	20	20	$4,549.44	$0.00	$0.00	$0.00	0.16	0.17	0.17	0.22
5046	HVAC Shell	Duct Insulation	HVAC Shell	SF	All	RETRO	-	-	-4.37	0.023	0.023	-	0%	2.949	0	20	20	$516.00	$0.00	$0.00	$0.00	0.25	0.53	0.26	0.25
5047	HVAC Shell	Duct location	HVAC Shell	SF	All	RETRO	-	-	85.51	0.055	0.064	-	0%	10.444	0	30	30	$1,612.50	$0.00	$0.00	$0.00	0.42	0.88	0.44	0.44
5048	HVAC Shell	Duct sealing 15% leakage base	HVAC Shell	SF	All	RETRO	-	-	23.94	0.018	0.023	-	0%	1.220	0	18	18	$464.02	$0.00	$0.00	$0.00	0.13	0.28	0.14	0.13
5049	HVAC Shell	Duct sealing 30% leakage base	HVAC Shell	SF	All	RETRO	-	-	69.17	0.064	0.064	-	0%	3.131	0	18	18	$464.02	$0.00	$0.00	$0.00	0.34	0.74	0.37	0.38
5050	HVAC Shell	Door weatherstripping	HVAC Shell	SF	All	RETRO	-	-	15.32	0.000	0.000	-	0%	0.447	0	5	5	$86.00	$0.00	$0.00	$0.00	0.09	0.15	0.08	0.10
5051	HVAC Shell	R0 to R19 kneewalls	HVAC Shell	SF	All	RETRO	-	-	78.41	0.084	0.085	-	0%	7.722	0	20	20	$172.53	$0.00	$0.00	$0.00	2.20	4.17	2.09	3.14
5052	HVAC Shell	R6 to R19 kneewalls	HVAC Shell	SF	All	RETRO	-	-	25.73	0.027	0.028	-	0%	3.064	0	20	20	$162.53	$0.00	$0.00	$0.00	0.91	1.77	0.89	1.01
5053	HVAC Shell	Rim Joist Insulation	HVAC Shell	SF	All	RETRO	-	-	41.61	0.023	0.026	-	0%	4.498	0	25	25	$244.20	$0.00	$0.00	$0.00	1.05	2.22	1.11	1.18
5054	HVAC Shell	Window Film	HVAC Shell	SF	All	RETRO	-	-	476.37	0.345	0.401	-	0%	-10.661	0	10	10	$496.05	$0.00	$0.00	$0.00	0.31	0.33	0.22	0.35
5055	HVAC Shell	Window Replacement	HVAC Shell	SF	All	ROB	-	-	401.37	0.439	0.465	-	0%	16.122	0	25	25	$1,382.33	$0.00	$0.00	$0.00	0.80	1.64	0.82	0.99
5056	HVAC Shell	Original double hung window with low U storm	HVAC Shell	SF	All	RETRO	-	-	926.83	0.917	1.067	-	0%	33.554	0	25	25	$4,837.50	$0.00	$0.00	$0.00	0.48	1.01	0.50	0.55
5057	HVAC Shell	Duct Insulation	HVAC Shell	SF	All	RETRO	-	-	-16.47	0.004	0.004	-	0%	2.956	0	20	20	$516.00	$0.00	$0.00	$0.00	0.24	0.49	0.25	0.24
5058	HVAC Shell	Duct location	HVAC Shell	SF	All	RETRO	-	-	25.74	0.009	0.011	-	0%	11.934	0	30	30	$1,612.50	$0.00	$0.00	$0.00	0.45	0.93	0.47	0.45
5059	HVAC Shell	Duct sealing 15% leakage base	HVAC Shell	SF	All	RETRO	-	-	9.15	0.003	0.004	-	0%	1.220	0	18	18	$464.02	$0.00	$0.00	$0.00	0.11	0.22	0.11	0.11
5060	HVAC Shell	Duct sealing 30% leakage base	HVAC Shell	SF	All	RETRO	-	-	28.18	0.011	0.011	-	0%	3.131	0	18	18	$464.02	$0.00	$0.00	$0.00	0.29	0.58	0.29	0.31
5061	HVAC Shell	R0 to R19 kneewalls	HVAC Shell	SF	All	RETRO	-	-	38.02	0.012	0.012	-	0%	7.827	0	20	20	$172.53	$0.00	$0.00	$0.00	2.06	3.93	1.96	2.41
5062	HVAC Shell	R6 to R19 kneewalls	HVAC Shell	SF	All	RETRO	-	-	13.63	0.004	0.004	-	0%	3.107	0	20	20	$162.53	$0.00	$0.00	$0.00	0.86	1.68	0.84	0.91
5063	HVAC Shell	Rim Joist Insulation	HVAC Shell	SF	All	RETRO	-	-	5.94	0.003	0.004	-	0%	4.591	0	25	25	$244.20	$0.00	$0.00	$0.00	0.97	2.04	1.02	0.99
5064	HVAC Shell	Window Film	HVAC Shell	SF	All	RETRO	-	-	37.51	0.057	0.067	-	0%	-10.690	0	10	10	$496.05	$0.00	$0.00	$0.00	0.03	0.00	0.00	0.02

Measure #	End-Use	Measure Name	Program	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Base Fuel Use	% Fuel Savings	Per unit Fuel Saving	Per Unit Water Savings	RC EUL	EE EUL	Measure Cost	O&M Benefits	O&M Costs	Tax Credits	TRC	UCT 50%	UCT 100%	UCT PB
5065	HVAC Shell	Window Replacement	HVAC Shell	SF	All	ROB	-	-	115.23	0.063	0.066	-	0%	16.499	0	25	25	$1,382.33	$0.00	$0.00	$0.00	0.66	1.32	0.66	0.70
5066	HVAC Shell	Original double hung window with low U storm	HVAC Shell	SF	All	RETRO	-	-	313.57	0.153	0.178	-	0%	33.554	0	25	25	$4,837.50	$0.00	$0.00	$0.00	0.39	0.78	0.39	0.41
5067	HVAC Shell	HW pipe insulation	HVAC Shell	SF	All	RETRO	-	-	-8.15	0.000	0.000	-	0%	29.740	0	11	11	$1,404.58	$0.00	$0.00	$0.00	0.53	1.05	0.52	0.54
5068	HVAC Shell	Steam pipe insulation	HVAC Shell	SF	All	RETRO	-	-	-13.15	0.000	0.000	-	0%	50.375	0	11	11	$1,404.58	$0.00	$0.00	$0.00	0.90	1.77	0.89	0.91
5069	HVAC Shell	Duct Insulation	HVAC Shell	SF	All	RETRO	-	-	698.43	0.023	0.023	-	0%	0.000	0	20	20	$516.00	$0.00	$0.00	$0.00	0.56	1.17	0.59	5.17
5070	HVAC Shell	Duct location	HVAC Shell	SF	All	RETRO	-	-	2848.24	0.055	0.064	-	0%	0.000	0	30	30	$1,612.50	$0.00	$0.00	$0.00	0.91	1.88	0.94	1.82
5071	HVAC Shell	Duct sealing 15% leakage base	HVAC Shell	SF	All	RETRO	-	-	318.27	0.018	0.023	-	0%	0.000	0	18	18	$464.02	$0.00	$0.00	$0.00	0.27	0.57	0.28	0.49
5072	HVAC Shell	Duct sealing 30% leakage base	HVAC Shell	SF	All	RETRO	-	-	820.84	0.064	0.064	-	0%	0.000	0	18	18	$464.02	$0.00	$0.00	$0.00	0.70	1.48	0.74	1.40
5073	HVAC Shell	R0 to R19 kneewalls	HVAC Shell	SF	All	RETRO	-	-	1778.67	0.084	0.085	-	0%	0.009	0	20	20	$172.53	$0.00	$0.00	$0.00	4.27	8.27	4.14	8.55
5074	HVAC Shell	R6 to R19 kneewalls	HVAC Shell	SF	All	RETRO	-	-	573.99	0.027	0.028	-	0%	0.590	0	20	20	$162.53	$0.00	$0.00	$0.00	1.62	3.17	1.58	3.24
5075	HVAC Shell	Rim Joist Insulation	HVAC Shell	SF	All	RETRO	-	-	1039.36	0.023	0.026	-	0%	0.000	0	25	25	$244.20	$0.00	$0.00	$0.00	1.98	4.16	2.08	3.96
5076	HVAC Shell	Window Film	HVAC Shell	SF	All	RETRO	-	-	-1793.73	0.345	0.401	-	0%	-0.030	0	10	10	$496.05	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00
5077	HVAC Shell	Window Replacement	HVAC Shell	SF	All	ROB	-	-	3979.65	0.439	0.465	-	0%	0.000	0	25	25	$1,382.33	$0.00	$0.00	$0.00	1.39	2.84	1.42	2.78
5078	HVAC Shell	Original double hung window with low U storm	HVAC Shell	SF	All	RETRO	-	-	8399.96	0.917	1.067	-	0%	0.000	0	25	25	$4,837.50	$0.00	$0.00	$0.00	0.84	1.74	0.87	1.67
5079	HVAC Shell	Infiltration reduction - 30%	HVAC Shell	SF	All	NC	-	-	37.77	0.029	0.046	-	0%	5.301	0	13	13	$258.00	$0.00	$0.00	$0.00	0.67	1.24	0.62	0.74
5080	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	SF	All	NC	-	-	63.25	0.043	0.068	-	0%	8.874	0	13	13	$258.00	$0.00	$0.00	$0.00	1.11	2.06	1.03	1.33
5081	HVAC Shell	Duct Insulation	HVAC Shell	SF	All	NC	-	-	-0.91	0.023	0.023	-	0%	2.184	0	20	20	$516.00	$0.00	$0.00	$0.00	0.19	0.42	0.21	0.19
5082	HVAC Shell	Duct location	HVAC Shell	SF	All	NC	-	-	66.67	0.040	0.046	-	0%	8.783	0	30	30	$1,612.50	$0.00	$0.00	$0.00	0.35	0.72	0.36	0.36
5083	HVAC Shell	Duct sealing 15% leakage base	HVAC Shell	SF	All	NC	-	-	12.059	0.014	0.023	-	0%	0.455	0	18	18	$464.02	$0.00	$0.00	$0.00	0.05	0.12	0.06	0.05
5084	HVAC Shell	Duct sealing 30% leakage base	HVAC Shell	SF	All	NC	-	-	32.082	0.046	0.046	-	0%	1.206	0	18	18	$464.02	$0.00	$0.00	$0.00	0.14	0.32	0.16	0.15
5085	HVAC Shell	Door weatherstripping	HVAC Shell	SF	All	NC	-	-	0.000	0.000	0.000	-	0%	0.000	0	5	5	$86.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00
5086	HVAC Shell	Basement Wall Insulation	HVAC Shell	SF	All	NC	-	-	-4.619	-0.027	-0.031	-	0%	4.311	0	25	25	$1,104.21	$0.00	$0.00	$0.00	0.20	0.34	0.17	0.20
5087	HVAC Shell	Floor Insulation	HVAC Shell	SF	All	NC	-	-	-6.826	0.000	0.000	-	0%	0.853	0	25	25	$1,112.84	$0.00	$0.00	$0.00	0.04	0.08	0.04	0.04
5088	HVAC Shell	Crawlspace Wall Insulation	HVAC Shell	SF	All	NC	-	-	-4.003	0.000	0.000	-	0%	0.062	0	25	25	$552.11	$0.00	$0.00	$0.00	0.01	0.01	0.01	0.01
5089	HVAC Shell	Wall Insulation	HVAC Shell	SF	All	NC	-	-	34.291	0.036	0.042	-	0%	3.387	0	25	25	$3,041.11	$0.00	$0.00	$0.00	0.07	0.12	0.06	0.07
5090	HVAC Shell	Window Film	HVAC Shell	SF	All	NC	-	-	126.706	0.037	0.043	-	0%	-2.538	0	10	10	$496.05	$0.00	$0.00	$0.00	0.07	0.13	0.07	0.08
5091	HVAC Shell	Window Replacement	HVAC Shell	SF	All	NC	-	-	93.430	0.000	0.128	-	0%	1.706	0	25	25	$1,382.33	$0.00	$0.00	$0.00	0.10	0.20	0.10	0.10
5092	HVAC Shell	Infiltration reduction - 30%	HVAC Shell	MF	NLI	RETRO	-	-	39.872	0.078	0.092	-	0%	4.832	0	13	13	$129.00	$0.00	$0.00	$0.00	1.27	2.37	1.18	1.60
5093	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	MF	NLI	RETRO	-	-	68.250	0.133	0.157	-	0%	8.079	0	13	13	$129.00	$0.00	$0.00	$0.00	2.14	3.98	1.99	3.28
5094	HVAC Shell	Basement Wall Insulation	HVAC Shell	MF	NLI	RETRO	-	-	-25.467	-0.021	-0.029	-	0%	4.918	0	25	25	$741.89	$0.00	$0.00	$0.00	0.33	0.76	0.39	0.34
5095	HVAC Shell	Wall Insulation	HVAC Shell	MF	NLI	RETRO	-	-	49.069	0.047	0.048	-	0%	7.180	0	25	25	$2,132.08	$0.00	$0.00	$0.00	0.19	0.44	0.22	0.19
5096	HVAC Shell	Roof Insulation	HVAC Shell	MF	NLI	RETRO	-	-	53.883	0.041	0.041	-	0%	4.522	0	25	25	$813.72	$0.00	$0.00	$0.00	0.33	0.76	0.38	0.34
5097	HVAC Shell	Infiltration reduction - 30%	HVAC Shell	MF	NLI	RETRO	-	-	19.637	0.000	0.000	-	0%	4.659	0	13	13	$129.00	$0.00	$0.00	$0.00	1.12	2.10	1.05	1.24
5098	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	MF	NLI	RETRO	-	-	32.346	0.000	0.000	-	0%	7.794	0	13	13	$129.00	$0.00	$0.00	$0.00	1.86	3.52	1.76	2.23
5099	HVAC Shell	Basement Wall Insulation	HVAC Shell	MF	NLI	RETRO	-	-	18.154	0.000	0.000	-	0%	5.237	0	25	25	$741.89	$0.00	$0.00	$0.00	0.38	0.87	0.44	0.38
5100	HVAC Shell	Wall Insulation	HVAC Shell	MF	NLI	RETRO	-	-	27.551	0.000	0.000	-	0%	6.607	0	25	25	$2,132.08	$0.00	$0.00	$0.00	0.17	0.38	0.19	0.17
5101	HVAC Shell	Roof Insulation	HVAC Shell	MF	NLI	RETRO	-	-	17.383	0.000	0.000	-	0%	4.608	0	25	25	$813.72	$0.00	$0.00	$0.00	0.30	0.70	0.35	0.31
5102	HVAC Shell	Infiltration reduction - 30%	HVAC Shell	MF	NLI	RETRO	-	-	1022.088	0.082	0.095	-	0%	0.000	0	13	13	$129.00	$0.00	$0.00	$0.00	2.53	4.52	2.26	5.07
5103	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	MF	NLI	RETRO	-	-	1703.520	0.138	0.160	-	0%	0.000	0	13	13	$129.00	$0.00	$0.00	$0.00	4.23	7.54	3.77	8.45
5104	HVAC Shell	Basement Wall Insulation	HVAC Shell	MF	NLI	RETRO	-	-	1000.091	-0.022	-0.029	-	0%	0.000	0	25	25	$741.89	$0.00	$0.00	$0.00	0.62	1.35	0.67	5.52
5105	HVAC Shell	Wall Insulation	HVAC Shell	MF	NLI	RETRO	-	-	1495.883	0.047	0.049	-	0%	0.000	0	25	25	$2,132.08	$0.00	$0.00	$0.00	0.33	0.72	0.36	0.61
5106	HVAC Shell	Roof Insulation	HVAC Shell	MF	NLI	RETRO	-	-	998.078	0.035	0.047	-	0%	0.000	0	25	25	$813.72	$0.00	$0.00	$0.00	0.57	1.25	0.62	2.99
5107	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	MF	LI	DI	-	-	68.250	0.133	0.157	-	0%	8.079	0	13	13	$129.00	$0.00	$0.00	$0.00	2.14	1.99	1.99	3.28
5108	HVAC Shell	Basement Wall Insulation	HVAC Shell	MF	LI	DI	-	-	-25.467	-0.021	-0.029	-	0%	4.918	0	25	25	$741.89	$0.00	$0.00	$0.00	0.33	0.39	0.39	0.34
5109	HVAC Shell	Wall Insulation	HVAC Shell	MF	LI	DI	-	-	49.069	0.047	0.048	-	0%	7.180	0	25	25	$2,132.08	$0.00	$0.00	$0.00	0.19	0.22	0.22	0.19
5110	HVAC Shell	Roof Insulation	HVAC Shell	MF	LI	DI	-	-	53.883	0.041	0.041	-	0%	4.522	0	25	25	$813.72	$0.00	$0.00	$0.00	0.33	0.38	0.38	0.34
5111	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	MF	LI	DI	-	-	32.346	0.000	0.000	-	0%	7.794	0	13	13	$129.00	$0.00	$0.00	$0.00	1.86	1.76	1.76	2.23
5112	HVAC Shell	Basement Wall Insulation	HVAC Shell	MF	LI	DI	-	-	18.154	0.000	0.000	-	0%	5.237	0	25	25	$741.89	$0.00	$0.00	$0.00	0.38	0.44	0.44	0.38
5113	HVAC Shell	Wall Insulation	HVAC Shell	MF	LI	DI	-	-	27.551	0.000	0.000	-	0%	6.607	0	25	25	$2,132.08	$0.00	$0.00	$0.00	0.17	0.19	0.19	0.17
5114	HVAC Shell	Roof Insulation	HVAC Shell	MF	LI	DI	-	-	17.383	0.000	0.000	-	0%	4.608	0	25	25	$813.72	$0.00	$0.00	$0.00	0.30	0.35	0.35	0.31
5115	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	MF	LI	DI	-	-	1703.520	0.138	0.160	-	0%	0.000	0	13	13	$129.00	$0.00	$0.00	$0.00	4.23	3.77	3.77	8.45
5116	HVAC Shell	Basement Wall Insulation	HVAC Shell	MF	LI	DI	-	-	1000.091	-0.022	-0.029	-	0%	0.000	0	25	25	$741.89	$0.00	$0.00	$0.00	0.62	0.67	0.67	5.52
5117	HVAC Shell	Wall Insulation	HVAC Shell	MF	LI	DI	-	-	1495.883	0.047	0.049	-	0%	0.000	0	25	25	$2,132.08	$0.00	$0.00	$0.00	0.33	0.36	0.36	0.61
5118	HVAC Shell	Roof Insulation	HVAC Shell	MF	LI	DI	-	-	998.078	0.035	0.047	-	0%	0.000	0	25	25	$813.72	$0.00	$0.00	$0.00	0.57	0.62	0.62	2.99
5119	HVAC Shell	Duct Insulation	HVAC Shell	MF	All	RETRO	-	-	36.171	0.063	0.063	-	0%	2.657	0	20	20	$258.00	$0.00	$0.00	$0.00	0.54	1.31	0.65	0.60
5120	HVAC Shell	Duct location	HVAC Shell	MF	All	RETRO	-	-	77.044	0.138	0.146	-	0%	5.541	0	30	30	$806.25	$0.00	$0.00	$0.00	0.49	1.14	0.57	0.53
5121	HVAC Shell	Duct sealing 15% leakage base	HVAC Shell	MF	All	RETRO	-	-	15.499	0.016	0.016	-	0%	0.887	0	18	18	$232.01	$0.00	$0.00	$0.00	0.19	0.42	0.21	0.20
5122	HVAC Shell	Duct sealing 30% leakage base	HVAC Shell	MF	All	RETRO	-	-	41.134	0.046	0.046	-	0%	2.350	0	18	18	$232.01	$0.00	$0.00	$0.00	0.50	1.12	0.56	0.56
5123	HVAC Shell	Door weatherstripping	HVAC Shell	MF	All	RETRO	-	-	10.954	0.004	0.004	-	0%	0.250	0	5	5	$43.00	$0.00	$0.00	$0.00	0.11	0.18	0.09	0.13
5124	HVAC Shell	Window Film	HVAC Shell	MF	All	RETRO	-	-	446.561	0.462	0.466	-	0%	-9.169	0	10	10	$248.03	$0.00	$0.00	$0.00	0.62	0.49	0.37	0.46
5125	HVAC Shell	Window Replacement	HVAC Shell	MF	All	ROB	-	-	159.895	0.172	0.180	-	0%	6.923	0	25	25	$691.17	$0.00	$0.00	$0.00	0.67	1.50	0.75	0.79
5126	HVAC Shell	Original double hung window with low U storm	HVAC Shell	MF	All	RETRO	-	-	705.483	0.698	0.775	-	0%	47.775	0	25	25	$2,418.75	$0.00	$0.00	$0.00	1.21	3.01	1.51	1.50
5127	HVAC Shell	Duct Insulation	HVAC Shell	MF	All	RETRO	-	-	-1.263	0.000	0.000	-	0%	2.657	0	20	20	$258.00	$0.00	$0.00	$0.00	0.44	1.04	0.52	0.44
5128	HVAC Shell	Duct location	HVAC Shell	MF	All	RETRO	-	-	4.862	0.000	0.000	-	0%	5.541	0	30	30	$806.25	$0.00	$0.00	$0.00	0.41	0.93	0.46	0.41
5129	HVAC Shell	Duct sealing 15% leakage base	HVAC Shell	MF	All	RETRO	-	-	4.165	0.000	0.000	-	0%	0.887	0	18	18	$232.01	$0.00	$0.00	$0.00	0.16	0.35	0.17	0.16
5130	HVAC Shell	Duct sealing 30% leakage base	HVAC Shell	MF	All	RETRO	-	-	11.617	0.000	0.000	-	0%	2.350	0	18	18	$232.01	$0.00	$0.00	$0.00	0.42	0.93	0.47	0.43
5131	HVAC Shell	Window Film	HVAC Shell	MF	All	RETRO	-	-	-39.920	0.000	0.000	-	0%	-9.169	0	10	10	$248.03	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00
5132	HVAC Shell	Window Replacement	HVAC Shell	MF	All	ROB	-	-	27.340	0.000	0.000	-	0%	6.656	0	25	25	$691.17	$0.00	$0.00	$0.00	0.52	1.13	0.57	0.53
5133	HVAC Shell	Original double hung window with low U storm	HVAC Shell	MF	All	RETRO	-	-	299.707	0.016	0.018	-	0%	47.775	0	25	25	$2,418.75	$0.00	$0.00	$0.00	1.08	2.65	1.33	1.18
5134	HVAC Shell	Duct Insulation	HVAC Shell	MF	All	RETRO	-	-	638.898	0.063	0.063	-	0%	0.000	0	20	20	$258.00	$0.00	$0.00	$0.00	1.05	2.48	1.24	2.09
5135	HVAC Shell	Duct location	HVAC Shell	MF	All	RETRO	-	-	1328.371	0.138	0.146	-	0%	0.000	0	30	30	$806.25	$0.00	$0.00	$0.00	0.88	1.96	0.98	1.75
5136	HVAC Shell	Duct sealing 15% leakage base	HVAC Shell	MF	All	RETRO	-	-	216.744	0.016	0.016	-	0%	0.000	0	18	18	$232.01	$0.00	$0.00	$0.00	0.37	0.79	0.39	0.96
5137	HVAC Shell	Duct sealing 30% leakage base	HVAC Shell	MF	All	RETRO	-	-	575.575	0.046	0.046	-	0%	0.000	0	18	18	$232.01	$0.00	$0.00	$0.00	0.98	2.11	1.05	1.96
5138	HVAC Shell	Window Film	HVAC Shell	MF	All	RETRO	-	-	-1305.268	0.433	0.470	-	0%	0.000	0	10	10	$248.03	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00
5139	HVAC Shell	Window Replacement	HVAC Shell	MF	All	ROB	-	-	1962.833	0.245	0.255	-	0%	0.000	0	25	25	$691.17	$0.00	$0.00	$0.00	1.38	2.86	1.43	2.75
5140	HVAC Shell	Original double hung window with low U storm	HVAC Shell	MF	All	RETRO	-	-	8961.519	0.698	0.775	-	0%	0.000	0	25	25	$2,418.75	$0.00	$0.00	$0.00	1.76	4.03	2.01	3.53
5141	HVAC Shell	Infiltration reduction - 30%	HVAC Shell	MF	All	NC	-	-	20.208	0.040	0.040	-	0%	2.619	0	13	13	$129.00	$0.00	$0.00	$0.00	0.69	1.51	0.75	0.76
5142	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	MF	All	NC	-	-	34.140	0.073	0.073	-	0%	4.397	0	13	13	$129.00	$0.00	$0.00	$0.00	1.16	2.52	1.26	1.40
5143	HVAC Shell	Airtight Can Lights	HVAC Shell	MF	All	NC	-	-	15.833	0.029	0.029	-	0%	2.071	0	15	15	$459.90	$0.00	$0.00	$0.00	0.17	0.29	0.15	0.18
5144	HVAC Shell	Duct Insulation	HVAC Shell	MF	All	NC	-	-	49.595	0.076	0.076	-	0%	2.333	0	20	20	$258.00	$0.00	$0.00	$0.00	0.52	1.24	0.62	0.59
5145	HVAC Shell	Duct location	HVAC Shell	MF	All	NC	-	-	80.360	0.132	0.145	-	0%	3.929	0	30	30	$806.25	$0.00	$0.00	$0.00	0.38	0.89	0.45	0.40
5146	HVAC Shell	Duct sealing 15% leakage base	HVAC Shell	MF	All	NC	-	-	10.122	0.013	0.015	-	0%	0.512	0	18	18	$232.01	$0.00	$0.00	$0.00	0.11	0.27	0.13	0.12
5147	HVAC Shell	Duct sealing 30% leakage base	HVAC Shell	MF	All	NC	-	-	29.205	0.033	0.033	-	0%	1.361	0	18	18	$232.01	$0.00	$0.00	$0.00	0.30	0.72	0.36	0.33
5148	HVAC Shell	Door weatherstripping	HVAC Shell	MF	All	NC	-	-	6.483	0.004	0.004	-	0%	0.293	0	5	5	$43.00	$0.00	$0.00	$0.00	0.11	0.18	0.09	0.12
5149	HVAC Shell	Basement Wall Insulation	HVAC Shell	MF	All	NC	-	-	-2.385	-0.012	-0.016	-	0%	2.226	0	25	25	$741.89	$0.00	$0.00	$0.00	0.15	0.34	0.17	0.15
5150	HVAC Shell	Wall Insulation	HVAC Shell	MF	All	NC	-	-	15.485	0.010	0.014	-	0%	2.159	0	25	25	$2,132.08	$0.00	$0.00	$0.00	0.06	0.14	0.07	0.06
5151	HVAC Shell	Roof Insulation	HVAC Shell	MF	All	NC	-	-	17.487	0.007	0.007	-	0%	1.691	0	25	25	$813.72	$0.00	$0.00	$0.00	0.12	0.28	0.14	0.12
5152	HVAC Shell	Cool roof	HVAC Shell	MF	All	NC	-	-	64.941	0.058	0.058	-	0%	-0.450	0	20	20	$822.38	$0.00	$0.00	$0.00	0.04	0.11	0.06	0.04
5153	HVAC Shell	Window Film	HVAC Shell	MF	All	NC	-	-	107.400	0.085	0.085	-	0%	-2.216	0	10	10	$248.03	$0.00	$0.00	$0.00	0.14	0.24	0.14	0.15
5154	HVAC Shell	Window Replacement	HVAC Shell	MF	All	NC	-	-	34.106	0.029	0.029	-	0%	0.814	0	25	25	$691.17	$0.00	$0.00	$0.00	0.09	0.23	0.11	0.09
5155	HVAC Shell	Infiltration reduction - 30%	HVAC Shell	MF	All	NC	-	-	350.574	0.025	0.025	-	0%	0.000	0	13	13	$129.00	$0.00	$0.00	$0.00	0.87	1.71	0.85	1.73
5156	HVAC Shell	Infiltration reduction - 50%	HVAC Shell	MF	All	NC	-	-	584.507	0.040	0.040	-	0%	0.000	0	13	13	$129.00	$0.00	$0.00	$0.00	1.44	2.83	1.42	2.89
5157	HVAC Shell	Airtight Can Lights	HVAC Shell	MF	All	NC	-	-	277.500	0.021	0.021	-	0%	0.000	0	15	15	$459.90	$0.00	$0.00	$0.00	0.21	0.32	0.16	0.35
5158	HVAC Shell	Duct Insulation	HVAC Shell	MF	All	NC	-	-	590.929	0.086	0.098	-	0%	0.000	0	20	20	$258.00	$0.00	$0.00	$0.00	0.99	2.14	1.07	1.97
5159	HVAC Shell	Duct location	HVAC Shell	MF	All	NC	-	-	928.442	0.129	0.149	-	0%	0.000	0	30	30	$806.25	$0.00	$0.00	$0.00	0.62	1.33	0.67	2.58
5160	HVAC Shell	Duct sealing 15% leakage base	HVAC Shell	MF	All	NC	-	-	90.773	0.010	0.011	-	0%	0.000	0	18	18	$232.01	$0.00	$0.00	$0.00	0.16	0.34	0.17	0.21
5161	HVAC Shell	Duct sealing 30% leakage base	HVAC Shell	MF	All	NC	-	-	243.983	0.025	0.025	-	0%	0.000	0	18	18	$232.01	$0.00	$0.00	$0.00	0.42	0.92	0.46	1.37
5162	HVAC Shell	Basement Wall Insulation	HVAC Shell	MF	All	NC	-	-	264.682	0.000	0.000	-	0%	0.000	0	25	25	$741.89	$0.00	$0.00	$0.00	0.16	0.34	0.17	0.22
5163	HVAC Shell	Wall Insulation	HVAC Shell	MF	All	NC	-	-	299.185	0.014	0.014	-	0%	0.000	0	25	25	$2,132.08	$0.00	$0.00	$0.00	0.07	0.15	0.07	0.07
5164	HVAC Shell	Roof Insulation	HVAC Shell	MF	All	NC	-	-	229.290	0.014	0.015	-	0%	0.000	0	25	25	$813.72	$0.00	$0.00	$0.00	0.13	0.31	0.15	0.16
5165	HVAC Shell	Cool roof	HVAC Shell	MF	All	NC	-	-	-8.780	0.051	0.051	-	0%	0.000	0	20	20	$822.38	$0.00	$0.00	$0.00	0.01	0.03	0.02	0.01
5166	HVAC Shell	Window Film	HVAC Shell	MF	All	NC	-	-	-120.328	0.099	0.099	-	0%	0.000	0	10	10	$248.03	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00
5167	HVAC Shell	Window Replacement	HVAC Shell	MF	All	NC	-	-	157.818	0.037	0.037	-	0%	0.000	0	25	25	$691.17	$0.00	$0.00	$0.00	0.12	0.26	0.13	0.14
6001	HVAC Equipment	Furnace/AC - SEER 18	HVAC Equipmen	SF	NLI	ROB	2322.634	0.000	535.993	0.520	0.520	87.300	0%	-2.032	0	15	15	$829.14	$0.00	$0.00	$0.00	0.29	0.40	0.21	0.44
6002	HVAC Equipment	Furnace/AC - SEER 21	HVAC Equipmen	SF	NLI	ROB	2322.634	0.000	694.917	0.745	0.745	87.300	0%	-2.208	0	15	15	$2,211.04	$0.00	$0.00	$0.00	0.14	0.29	0.15	0.17
6003	HVAC Equipment	RCA 10% improvement	HVAC Equipmen	SF	NLI	RETRO	3019.425	0.000	90.849	0.177	0.177	0.000	0%	0.000	0	5	5	$139.00	$0.00	$0.00	$0.00	0.14	0.33	0.16	0.24
6004	HVAC Equipment	High efficiency 94 AFUE furnace with ECM	HVAC Equipmen	SF	NLI	ROB	1216.000	0.000	348.421	0.000	0.000	87.300	0%	14.883	0	15	15	$927.97	$0.00	$0.00	$0.00	0.67	1.29	0.64	0.89
6005	HVAC Equipment	High efficiency 98 AFUE furnace with ECM	HVAC Equipmen	SF	NLI	ROB	1216.000	0.000	348.421	0.000	0.000	87.300	0%	19.837	0	15	15	$1,045.58	$0.00	$0.00	$0.00	0.75	1.45	0.72	0.97
6006	HVAC Equipment	O&M Tune-up - furnace only	HVAC Equipmen	SF	NLI	RETRO	0.000	0.000	0.000	0.000	0.000	87.300	0%	4.436	0	2	2	$90.35	$0.00	$0.00	$0.00	0.24	0.45	0.23	0.24
6007	HVAC Equipment	Boiler 95% plus AFUE	HVAC Equipmen	SF	NLI	ROB	0.000	0.000	-274.652	0.000	0.000	127.500	0%	33.745	0	20	20	$1,583.40	$0.00	$0.00	$0.00	0.81	1.99	1.06	0.86
6008	HVAC Equipment	Boiler 92% plus AFUE	HVAC Equipmen	SF	NLI	ROB	0.000	0.000	-274.652	0.000	0.000	127.500	0%	30.564	0	20	20	$1,270.10	$0.00	$0.00	$0.00	0.89	2.18	1.18	0.96
6009	HVAC Equipment	Boiler Tune-up	HVAC Equipmen	SF	NLI	RETRO	0.000	0.000	0.000	0.000	0.000	127.500	0%	4.612	0	2	2	$90.35	$0.00	$0.00	$0.00	0.25	0.48	0.24	0.25
6010	HVAC Equipment	Furnace/AC - SEER 18	HVAC Equipmen	SF	LI	DI	2322.634	0.000	535.993	0.520	0.520	87.300	0%	-2.032	0	15	15	$829.14	$0.00	$0.00	$0.00	0.29	0.21	0.21	0.44
6011	HVAC Equipment	RCA 10% improvement	HVAC Equipmen	SF	LI	DI	3019.425	0.000	90.849	0.177	0.177	0.000	0%	0.000	0	5	5	$139.00	$0.00	$0.00	$0.00	0.14	0.16	0.16	0.24
6012	HVAC Equipment	High efficiency 94 AFUE furnace with ECM	HVAC Equipmen	SF	LI	DI	1216.000	0.000	361.649	0.000	0.000	87.300	0%	14.883	0	15	15	$927.97	$0.00	$0.00	$0.00	0.67	0.64	0.64	0.91
6013	HVAC Equipment	O&M Tune-up - furnace only	HVAC Equipmen	SF	LI	DI	0.000	0.000	0.000	0.000	0.000	87.300	0%	4.436	0	2	2	$90.35	$0.00	$0.00	$0.00	0.24	0.23	0.23	0.24

LBWL **Measure Assumption Tab - Residential**

Measure #	End-Use	Measure Name	Program	Home Type	Income Type	Replacement Type	Base Annual Electric	% Elec Savings	Per Unit Elec Savings	Per Unit Summer NCP kW	Per Unit Winter NCP kW	Base Fuel Use	% Fuel Savings	Per unit Fuel Saving	Per Unit Water Savings	RC EUL	EE EUL	Measure Cost	O&M Benefits	O&M Costs	Tax Credits	TRC	UCT 50%	UCT 100%	UCT PB
6014	HVAC Equipment	Boiler 92% plus AFUE	HVAC Equipmen	SF	LI	DI	0.000	0.000	-274.652	0.000	0.000	127.500	0%	30.564	0	20	20	$1,270.10	$0.00	$0.00	$0.00	0.89	1.18	1.18	0.96
6015	HVAC Equipment	Boiler Tune-up	HVAC Equipmen	SF	LI	DI	0.000	0.000	0.000	0.000	0.000	127.500	0%	4.612	0	2	2	$90.35	$0.00	$0.00	$0.00	0.25	0.24	0.24	0.25
6016	HVAC Equipment	ASHP - SEER 18 - SEER 14 base	HVAC Equipmen	SF	All	ROB	6603.783	0.000	1439.751	0.584	0.584	0.000	0%	0.000	0	15	15	$1,827.63	$0.00	$0.00	$0.00	0.31	0.62	0.31	0.65
6017	HVAC Equipment	ASHP - SEER 21 - SEER 14 base	HVAC Equipmen	SF	All	ROB	6603.783	0.000	6925.314	0.369	0.369	0.000	0%	0.000	0	15	15	$3,198.36	$0.00	$0.00	$0.00	0.76	0.53	0.26	1.51
6018	HVAC Equipment	GSHP - EER 19 ASHP SEER 14 Base	HVAC Equipmen	SF	All	ROB	6603.783	0.000	2159.626	0.877	0.877	0.000	0%	0.000	0	15	15	$20,313.66	$0.00	$0.00	$0.00	0.04	0.17	0.08	0.05
6019	HVAC Equipment	SEER21 Minisplit Heat pump	HVAC Equipmen	SF	All	ROB	6603.783	0.000	4758.067	0.495	0.495	0.000	0%	0.000	0	15	15	$2,111.74	$0.00	$0.00	$0.00	0.80	1.24	0.62	1.60
6020	HVAC Equipment	SEER21 Minisplit Heat pump	HVAC Equipmen	SF	All	RETRO	27166.674	0.000	10866.670	-1.146	-1.146	0.000	0%	0.000	0	15	15	$4,334.05	$0.00	$0.00	$0.00	0.82	1.35	0.67	1.65
6021	HVAC Equipment	DFHP - SEER 18 with 95 AFUE furnace - SEER 14 base	HVAC Equipmen	SF	All	ROB	6603.783	0.000	1456.949	0.584	0.584	87.300	0%	3.490	0	15	15	$1,189.14	$0.00	$0.00	$0.00	0.58	1.13	0.56	3.02
6022	HVAC Equipment	DFHP - SEER 21 with 95 AFUE furnace - SEER 14 base	HVAC Equipmen	SF	All	ROB	6603.783	0.000	2185.424	0.877	0.877	87.300	0%	5.235	0	15	15	$2,125.65	$0.00	$0.00	$0.00	0.49	0.95	0.47	1.51
6023	HVAC Equipment	Programmable Thermostats Tier 1	HVAC Equipmen	SF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.000	0%	7.516	0	10	10	$42.72	$0.00	$0.00	$0.00	4.07	8.88	4.44	4.07
6024	HVAC Equipment	Programmable Thermostats Tier 2	HVAC Equipmen	SF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.000	0%	24.706	0	10	10	$161.72	$0.00	$0.00	$0.00	3.53	7.71	3.86	3.53
6025	HVAC Equipment	Programmable Thermostats Tier 3	HVAC Equipmen	SF	All	RETRO	1480.099	0.090	133.209	0.000	0.000	87.300	0%	10.246	0	10	10	$323.03	$0.00	$0.00	$0.00	0.84	1.70	0.85	1.15
6026	HVAC Equipment	Programmable Thermostats Tier 1	HVAC Equipmen	SF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.000	0%	0.000	0	10	10	$42.72	$0.00	$0.00	$0.00	0.00	7.42	3.71	0.00
6027	HVAC Equipment	Programmable Thermostats Tier 2	HVAC Equipmen	SF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.000	0%	0.000	0	10	10	$161.72	$0.00	$0.00	$0.00	0.00	6.44	3.22	0.00
6028	HVAC Equipment	Programmable Thermostats Tier 3	HVAC Equipmen	SF	All	RETRO	0.000	#DIV/0!	0.000	0.000	0.000	87.300	0%	10.412	0	10	10	$323.03	$0.00	$0.00	$0.00	0.75	1.49	0.74	0.75
6029	HVAC Equipment	Programmable Thermostats Tier 1	HVAC Equipmen	SF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.000	0%	0.000	0	10	10	$42.72	$0.00	$0.00	$0.00	0.00	12.13	6.07	0.00
6030	HVAC Equipment	Programmable Thermostats Tier 2	HVAC Equipmen	SF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.000	0%	0.000	0	10	10	$161.72	$0.00	$0.00	$0.00	0.00	10.53	5.27	0.00
6031	HVAC Equipment	Programmable Thermostats Tier 3	HVAC Equipmen	SF	All	RETRO	22199.719	0.070	1553.980	0.000	0.000	0.000	0%	0.000	0	10	10	$323.03	$0.00	$0.00	$0.00	1.24	2.47	1.23	2.47
6032	HVAC Equipment	Smartphone Behavior Application	HVAC Equipmen	SF	All	RETRO	8163.479	0.016	133.065	0.000	0.000	94.000	2%	2.134	0	1	1	$5.00	$0.00	$0.00	$0.00	1.89	1.28	0.64	3.77
6033	HVAC Equipment	Smartphone Behavior Application	HVAC Equipmen	SF	All	RETRO			0.000	0.000	0.000	0.000	0%	0.000	0	1	1	$5.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00
6034	HVAC Equipment	Smartphone Behavior Application	HVAC Equipmen	SF	All	RETRO			0.000	0.000	0.000	0.000	0%	0.000	0	1	1	$5.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00
6035	HVAC Equipment	ENERGY STAR Room AC	HVAC Equipmen	SF	All	ROB	537.673	0.091	48.739	0.084	0.084	0.000	0%	0.000	0	15	15	$25.50	$0.00	$0.00	$0.00	1.00	1.72	0.86	2.00
6036	HVAC Equipment	ECM Furnace Fan	HVAC Equipmen	SF	All	RETRO	1216.000	0.600	730.000	0.073	0.073	0.000	0%	0.000	0	10	10	$788.00	$0.00	$0.00	$0.00	0.25	0.50	0.25	0.63
6037	HVAC Equipment	Hot water temperature reset	HVAC Equipmen	SF	All	RETRO	0.000	0.000	-2.374	0.000	0.000	127.500	0%	4.890	0	15	15	$390.00	$0.00	$0.00	$0.00	0.42	0.85	0.43	0.42
6038	HVAC Equipment	ASHP - SEER 18 - SEER 14 base	HVAC Equipmen	SF	All	NC	5071.498	0.000	1071.987	0.413	0.413	0.000	0%	0.000	0	15	15	$1,827.63	$0.00	$0.00	$0.00	0.23	0.45	0.22	0.37
6039	HVAC Equipment	ASHP - SEER 21 - SEER 14 base	HVAC Equipmen	SF	All	NC	5071.498	0.000	6805.886	0.487	0.487	0.000	0%	0.000	0	15	15	$3,198.36	$0.00	$0.00	$0.00	0.75	0.38	0.19	1.49
6040	HVAC Equipment	GSHP - EER 19 ASHP SEER 14 Base	HVAC Equipmen	SF	All	NC	5071.498	0.000	1607.980	0.619	0.619	0.000	0%	0.000	0	15	15	$20,313.66	$0.00	$0.00	$0.00	0.03	0.17	0.09	0.03
6041	HVAC Equipment	SEER21 Minisplit Heat pump	HVAC Equipmen	SF	All	NC	5071.498	0.000	1924.237	0.490	0.490	0.000	0%	0.000	0	15	15	$2,111.74	$0.00	$0.00	$0.00	0.34	0.59	0.29	0.86
6042	HVAC Equipment	DFHP - SEER 18 with 95 AFUE furnace - SEER 14 base	HVAC Equipmen	SF	All	NC	5071.498	0.000	1078.486	0.413	0.413	87.300	0%	1.921	0	15	15	$1,189.14	$0.00	$0.00	$0.00	0.41	0.80	0.40	1.02
6043	HVAC Equipment	DFHP - SEER 21 with 95 AFUE furnace - SEER 14 base	HVAC Equipmen	SF	All	NC	5071.498	0.000	1617.728	0.619	0.619	87.300	0%	2.882	0	15	15	$2,125.65	$0.00	$0.00	$0.00	0.34	0.67	0.33	0.69
6044	HVAC Equipment	Furnace/AC - SEER 18	HVAC Equipmen	SF	All	NC	1445.986	0.000	333.689	0.353	0.353	87.300	0%	-1.554	0	15	15	$829.14	$0.00	$0.00	$0.00	0.18	0.27	0.14	0.23
6045	HVAC Equipment	Furnace/AC - SEER 21	HVAC Equipmen	SF	All	NC	1445.986	0.000	427.495	0.501	0.501	87.300	0%	-1.667	0	15	15	$2,211.04	$0.00	$0.00	$0.00	0.09	0.19	0.10	0.10
6046	HVAC Equipment	ENERGY STAR Room AC	HVAC Equipmen	SF	All	NC	537.673	0.091	48.739	0.084	0.084	0.000	0%	0.000	0	15	15	$25.50	$0.00	$0.00	$0.00	1.00	1.72	0.86	2.00
6047	HVAC Equipment	High efficiency 94 AFUE furnace with ECM	HVAC Equipmen	SF	All	NC	1216.000	0.000	333.099	0.000	0.000	87.300	0%	8.756	0	15	15	$927.97	$0.00	$0.00	$0.00	0.44	0.85	0.43	0.58
6048	HVAC Equipment	High efficiency 98 AFUE furnace with ECM	HVAC Equipmen	SF	All	NC	1216.000	0.000	324.382	0.000	0.000	87.300	0%	11.670	0	15	15	$1,045.58	$0.00	$0.00	$0.00	0.48	0.94	0.47	0.61
6049	HVAC Equipment	ECM Furnace Fan	HVAC Equipmen	SF	All	NC	1216.000	0.600	730.000	0.073	0.073	0.000	0%	0.000	0	10	10	$788.00	$0.00	$0.00	$0.00	0.25	0.50	0.25	0.63
6050	HVAC Equipment	Boiler 92% plus AFUE	HVAC Equipmen	SF	All	NC	0.000	0.000	-165.211	0.000	0.000	127.500	0%	19.039	0	15	15	$1,270.10	$0.00	$0.00	$0.00	0.46	1.14	0.60	0.48
6051	HVAC Equipment	Boiler 95% plus AFUE	HVAC Equipmen	SF	All	NC	0.000	0.000	-165.211	0.000	0.000	127.500	0%	20.900	0	15	15	$1,583.40	$0.00	$0.00	$0.00	0.42	1.02	0.53	0.43
6052	HVAC Equipment	Furnace/AC - SEER 18	HVAC Equipmen	MF	NLI	ROB	1662.605	0.000	383.678	0.451	0.451	56.745	0%	-6.021	0	15	15	$829.14	$0.00	$0.00	$0.00	0.22	0.18	0.11	0.23
6053	HVAC Equipment	Furnace/AC - SEER 21	HVAC Equipmen	MF	NLI	ROB	1662.605	0.000	531.962	0.647	0.647	56.745	0%	-6.160	0	15	15	$2,211.04	$0.00	$0.00	$0.00	0.11	0.20	0.11	0.12
6054	HVAC Equipment	RCA 10% improvement	HVAC Equipmen	MF	NLI	RETRO	2161.386	0.000	81.821	0.156	0.156	0.000	0%	0.000	0	5	5	$139.00	$0.00	$0.00	$0.00	0.12	0.29	0.14	0.20
6055	HVAC Equipment	High efficiency 94 AFUE furnace with ECM	HVAC Equipmen	MF	NLI	ROB	1216.000	0.000	247.130	0.106	0.106	56.745	0%	10.120	0	15	15	$927.97	$0.00	$0.00	$0.00	0.47	0.82	0.41	0.57
6056	HVAC Equipment	High efficiency 98 AFUE furnace with ECM	HVAC Equipmen	MF	NLI	ROB	1216.000	0.000	247.130	0.106	0.106	56.745	0%	13.488	0	15	15	$1,045.58	$0.00	$0.00	$0.00	0.53	0.92	0.46	0.62
6057	HVAC Equipment	O&M Tune-up - furnace only	HVAC Equipmen	MF	NLI	RETRO	0.000	0.000	0.000	0.000	0.000	56.745	0%	3.085	0	2	2	$90.35	$0.00	$0.00	$0.00	0.16	0.29	0.14	0.16
6058	HVAC Equipment	Boiler 92% plus AFUE	HVAC Equipmen	MF	NLI	ROB	0.000	0.000	-437.415	0.000	0.000	82.875	0%	22.152	0	20	20	$1,270.10	$0.00	$0.00	$0.00	0.59	1.37	0.77	0.66
6059	HVAC Equipment	Boiler 95% plus AFUE	HVAC Equipmen	MF	NLI	ROB	0.000	0.000	-437.415	0.000	0.000	82.875	0%	30.123	0	20	20	$1,583.40	$0.00	$0.00	$0.00	0.67	1.34	0.74	0.74
6060	HVAC Equipment	Boiler Tune-up	HVAC Equipmen	MF	NLI	RETRO	0.000	0.000	0.000	0.000	0.000	82.875	0%	5.931	0	2	2	$90.35	$0.00	$0.00	$0.00	0.32	0.59	0.30	0.32
6061	HVAC Equipment	Furnace/AC - SEER 18	HVAC Equipmen	MF	LI	DI	1662.605	0.000	383.678	0.451	0.451	56.745	0%	-6.021	0	15	15	$829.14	$0.00	$0.00	$0.00	0.22	0.11	0.11	0.23
6062	HVAC Equipment	RCA 10% improvement	HVAC Equipmen	MF	LI	DI	2161.386	0.000	81.821	0.156	0.156	0.000	0%	0.000	0	5	5	$139.00	$0.00	$0.00	$0.00	0.12	0.14	0.14	0.20
6063	HVAC Equipment	High efficiency 94 AFUE furnace with ECM	HVAC Equipmen	MF	LI	DI	1216.000	0.000	247.130	0.106	0.106	56.745	0%	10.120	0	15	15	$927.97	$0.00	$0.00	$0.00	0.47	0.41	0.41	0.57
6064	HVAC Equipment	O&M Tune-up - furnace only	HVAC Equipmen	MF	LI	DI	0.000	0.000	0.000	0.000	0.000	56.745	0%	3.085	0	2	2	$90.35	$0.00	$0.00	$0.00	0.16	0.14	0.14	0.16
6065	HVAC Equipment	Boiler 92% plus AFUE	HVAC Equipmen	MF	LI	DI	0.000	0.000	-437.415	0.000	0.000	82.875	0%	22.152	0	20	20	$1,270.10	$0.00	$0.00	$0.00	0.59	0.77	0.77	0.66
6066	HVAC Equipment	Boiler Tune-up	HVAC Equipmen	MF	LI	DI	0.000	0.000	0.000	0.000	0.000	82.875	0%	5.931	0	2	2	$90.35	$0.00	$0.00	$0.00	0.32	0.30	0.30	0.32
6067	HVAC Equipment	ASHP - SEER 18 - SEER 14 base	HVAC Equipmen	MF	All	ROB	6485.794	0.000	1350.377	0.571	0.571	0.000	0%	0.000	0	15	15	$1,827.63	$0.00	$0.00	$0.00	0.29	0.57	0.29	0.57
6068	HVAC Equipment	ASHP - SEER 21 - SEER 14 base	HVAC Equipmen	MF	All	ROB	6485.794	0.000	2025.566	0.856	0.856	0.000	0%	0.000	0	15	15	$3,198.36	$0.00	$0.00	$0.00	0.25	0.49	0.25	0.43
6069	HVAC Equipment	SEER21 Minisplit Heat pump	HVAC Equipmen	MF	All	ROB	6485.794	0.000	1965.082	0.205	0.205	0.000	0%	0.000	0	15	15	$1,052.13	$0.00	$0.00	$0.00	0.66	1.24	0.62	1.33
6070	HVAC Equipment	SEER21 Minisplit Heat pump	HVAC Equipmen	MF	All	RETRO	11219.836	0.000	4487.935	-0.473	-0.473	0.000	0%	0.000	0	15	15	$2,159.34	$0.00	$0.00	$0.00	0.68	1.35	0.67	1.36
6071	HVAC Equipment	PTHP 9.1 EER	HVAC Equipmen	MF	All	ROB	6485.794	0.000	300.583	0.091	0.091	0.000	0%	0.000	0	15	15	$169.21	$0.00	$0.00	$0.00	0.68	1.43	0.72	1.35
6072	HVAC Equipment	DFHP - SEER 18 with 95 AFUE furnace - SEER 14 base	HVAC Equipmen	MF	All	ROB	6485.794	0.000	1335.644	0.571	0.571	56.745	0%	0.056	0	15	15	$1,189.14	$0.00	$0.00	$0.00	0.45	1.01	0.50	1.73
6073	HVAC Equipment	DFHP - SEER 21 with 95 AFUE furnace - SEER 14 base	HVAC Equipmen	MF	All	ROB	6485.794	0.000	2003.465	0.856	0.856	56.745	0%	0.083	0	15	15	$2,125.65	$0.00	$0.00	$0.00	0.38	0.85	0.42	0.99
6074	HVAC Equipment	Programmable Thermostats Tier 1	HVAC Equipmen	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.000	0%	0.000	0	10	10	$1.00*	$0.00	$0.00	$0.00	0.00	#DIV/0!	#DIV/0!	0.00
6075	HVAC Equipment	Programmable Thermostats Tier 2	HVAC Equipmen	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.000	0%	0.000	0	10	10	$1.00*	$0.00	$0.00	$0.00	0.00	#DIV/0!	#DIV/0!	0.00
6076	HVAC Equipment	Programmable Thermostats Tier 3	HVAC Equipmen	MF	All	RETRO	339.124	0.067	22.721	0.000	0.000	56.745	0%	1.748	0	10	10	$161.51	$0.00	$0.00	$0.00	0.29	0.90	0.45	0.31
6077	HVAC Equipment	Programmable Thermostats Tier 1	HVAC Equipmen	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.000	0%	0.000	0	10	10	$1.00*	$0.00	$0.00	$0.00	0.00	#DIV/0!	#DIV/0!	0.00
6078	HVAC Equipment	Programmable Thermostats Tier 2	HVAC Equipmen	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.000	0%	0.000	0	10	10	$1.00*	$0.00	$0.00	$0.00	0.00	#DIV/0!	#DIV/0!	0.00
6079	HVAC Equipment	Programmable Thermostats Tier 3	HVAC Equipmen	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	56.745	0%	1.776	0	10	10	$161.51	$0.00	$0.00	$0.00	0.25	0.79	0.40	0.25
6080	HVAC Equipment	Programmable Thermostats Tier 1	HVAC Equipmen	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.000	0%	0.000	0	10	10	$1.00*	$0.00	$0.00	$0.00	0.00	#DIV/0!	#DIV/0!	0.00
6081	HVAC Equipment	Programmable Thermostats Tier 2	HVAC Equipmen	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	0.000	0%	0.000	0	10	10	$1.00*	$0.00	$0.00	$0.00	0.00	#DIV/0!	#DIV/0!	0.00
6082	HVAC Equipment	Programmable Thermostats Tier 3	HVAC Equipmen	MF	All	RETRO	3786.584	0.070	265.061	0.000	0.000	0.000	0%	0.000	0	10	10	$161.51	$0.00	$0.00	$0.00	0.42	1.31	0.66	0.84
6083	HVAC Equipment	Smartphone Behavior Application	HVAC Equipmen	MF	All	RETRO	4081.739	0.016	66.532	0.000	0.000	47.000	2%	1.067	0	1	1	$5.00	$0.00	$0.00	$0.00	0.94	0.64	0.32	1.89
6084	HVAC Equipment	Smartphone Behavior Application	HVAC Equipmen	MF	All	RETRO			0.000	0.000	0.000	0.000	0%	0.000	0	1	1	$5.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00
6085	HVAC Equipment	Smartphone Behavior Application	HVAC Equipmen	MF	All	RETRO			0.000	0.000	0.000	0.000	0%	0.000	0	1	1	$5.00	$0.00	$0.00	$0.00	0.00	0.00	0.00	0.00
6086	HVAC Equipment	PTAC 9.3 EER	HVAC Equipmen	MF	All	ROB	1662.605	0.000	127.720	0.091	0.091	0.000	0%	0.000	0	15	15	$135.59	$0.00	$0.00	$0.00	0.40	1.02	0.51	1.04
6087	HVAC Equipment	ENERGY STAR Room AC	HVAC Equipmen	MF	All	ROB	537.673	0.091	48.739	0.084	0.084	0.000	0%	0.000	0	15	15	$25.50	$0.00	$0.00	$0.00	1.00	1.72	0.86	2.00
6088	HVAC Equipment	Air-Cooled Recip Chiller COP = 2.8, IPLV = 3.41	HVAC Equipmen	MF	All	ROB	142994.128	0.000	35748.532	5.242	5.242	0.000	0%	0.000	0	20	20	$8,481.25	$0.00	$0.00	$0.00	1.80	4.02	2.01	3.61
6089	HVAC Equipment	CHW reset 10 deg	HVAC Equipmen	MF	All	RETRO	142994.128	0.000	15047.995	0.000	0.000	0.000	0%	0.000	0	5	5	$158.98	$0.00	$0.00	$0.00	13.86	29.97	14.99	27.72
6090	HVAC Equipment	ECM Furnace Fan	HVAC Equipmen	MF	All	RETRO	1216.000	0.600	730.000	0.073	0.073	0.000	0%	0.000	0	10	10	$788.00	$0.00	$0.00	$0.00	0.25	0.50	0.25	0.63
6091	HVAC Equipment	O2 Trim Control	HVAC Equipmen	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	82.875	0%	2.669	0	15	15	$255.00	$0.00	$0.00	$0.00	0.35	0.58	0.29	0.35
6092	HVAC Equipment	Boiler 85% Ec	HVAC Equipmen	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	82.875	0%	13.793	0	20	20	$7,232.27	$0.00	$0.00	$0.00	0.08	0.14	0.07	0.08
6093	HVAC Equipment	Boiler turndown control	HVAC Equipmen	MF	All	RETRO	0.000	0.000	0.000	0.000	0.000	82.875	0%	15.493	0	15	15	$195.00	$0.00	$0.00	$0.00	2.68	3.13	1.56	2.68
6094	HVAC Equipment	ASHP - SEER 18 - SEER 14 base	HVAC Equipmen	MF	All	NC	7287.821	0.000	1480.786	0.622	0.622	0.000	0%	0.000	0	15	15	$1,827.63	$0.00	$0.00	$0.00	0.32	0.63	0.31	0.69
6095	HVAC Equipment	ASHP - SEER 21 - SEER 14 base	HVAC Equipmen	MF	All	NC	7287.821	0.000	2221.179	0.933	0.933	0.000	0%	0.000	0	15	15	$3,198.36	$0.00	$0.00	$0.00	0.28	0.54	0.27	0.51
6096	HVAC Equipment	SEER21 Minisplit Heat pump	HVAC Equipmen	MF	All	NC	7287.821	0.000	794.710	0.202	0.202	0.000	0%	0.000	0	15	15	$1,052.13	$0.00	$0.00	$0.00	0.28	0.59	0.29	0.56
6097	HVAC Equipment	PTHP 9.1 EER	HVAC Equipmen	MF	All	NC	7287.821	0.000	273.686	0.149	0.149	0.000	0%	0.000	0	15	15	$169.21	$0.00	$0.00	$0.00	0.67	1.34	0.67	1.34
6098	HVAC Equipment	DFHP - SEER 18 with 95 AFUE furnace - SEER 14 base	HVAC Equipmen	MF	All	NC	7287.821	0.000	1443.654	0.622	0.622	56.745	0%	0.165	0	15	15	$1,189.14	$0.00	$0.00	$0.00	0.49	1.15	0.57	2.44
6099	HVAC Equipment	DFHP - SEER 21 with 95 AFUE furnace - SEER 14 base	HVAC Equipmen	MF	All	NC	7287.821	0.000	2165.481	0.933	0.933	56.745	0%	0.248	0	15	15	$2,125.65	$0.00	$0.00	$0.00	0.41	0.96	0.48	1.25
6100	HVAC Equipment	Furnace/AC - SEER 18	HVAC Equipmen	MF	All	NC	1479.804	0.000	341.493	0.486	0.486	56.745	0%	-15.430	0	15	15	$1,381.90	$0.00	$0.00	$0.00	0.12	0.10	0.06	0.10
6101	HVAC Equipment	Furnace/AC - SEER 21	HVAC Equipmen	MF	All	NC	1479.804	0.000	518.310	0.743	0.743	56.745	0%	-15.595	0	15	15	$2,211.04	$0.00	$0.00	$0.00	0.12	0.17	0.10	0.11
6102	HVAC Equipment	PTAC 9.3 EER	HVAC Equipmen	MF	All	NC	1479.804	0.000	159.837	0.148	0.148	0.000	0%	0.000	0	15	15	$135.59	$0.00	$0.00	$0.00	0.52	1.15	0.58	2.34
6103	HVAC Equipment	ENERGY STAR Room AC	HVAC Equipmen	MF	All	NC	537.673	0.091	48.739	0.084	0.084	0.000	0%	0.000	0	15	15	$25.50	$0.00	$0.00	$0.00	1.00	1.72	0.86	2.00
6104	HVAC Equipment	Air-Cooled Recip Chiller COP = 2.8, IPLV = 3.41	HVAC Equipmen	MF	All	NC	157645.121	0.000	39411.280	0.000	0.000	0.000	0%	0.000	0	20	20	$8,481.25	$0.00	$0.00	$0.00	1.90	4.17	2.08	3.81
6105	HVAC Equipment	CHW reset 10 deg	HVAC Equipmen	MF	All	NC	157645.121	0.000	16225.201	0.000	0.000	0.000	0%	0.000	0	5	5	$158.98	$0.00	$0.00	$0.00	14.94	31.77	15.88	29.88
6106	HVAC Equipment	High efficiency 94 AFUE furnace with ECM	HVAC Equipmen	MF	All	NC	1216.000	0.000	193.957	0.105	0.105	56.745	0%	7.298	0	15	15	$927.97	$0.00	$0.00	$0.00	0.35	0.68	0.34	0.40
6107	HVAC Equipment	High efficiency 98 AFUE furnace with ECM	HVAC Equipmen	MF	All	NC	1216.000	0.000	193.957	0.105	0.105	56.745	0%	9.726	0	15	15	$1,045.58	$0.00	$0.00	$0.00	0.39	0.75	0.38	0.44
6108	HVAC Equipment	ECM Furnace Fan	HVAC Equipmen	MF	All	NC	1216.000	0.600	730.000	0.073	0.073	0.000	0%	0.000	0	10	10	$788.00	$0.00	$0.00	$0.00	0.25	0.50	0.25	0.63
6109	HVAC Equipment	Boiler 92% plus AFUE	HVAC Equipmen	MF	All	NC	0.000	0.000	-378.551	0.000	0.000	82.875	0%	18.846	0	20	20	$1,270.10	$0.00	$0.00	$0.00	0.52	1.18	0.65	0.57
6110	HVAC Equipment	Boiler 95% plus AFUE	HVAC Equipmen	MF	All	NC	0.000	0.000	-378.551	0.000	0.000	82.875	0%	22.971	0	20	20	$1,583.40	$0.00	$0.00	$0.00	0.53	1.15	0.63	0.57
6111	HVAC Equipment	O2 Trim Control	HVAC Equipmen	MF	All	NC	0.000	0.000	0.000	0.000	0.000	82.875	0%	1.787	0	15	15	$255.00	$0.00	$0.00	$0.00	0.24	0.43	0.22	0.24
6112	HVAC Equipment	Boiler 85% Ec	HVAC Equipmen	MF	All	NC	0.000	0.000	0.000	0.000	0.000	82.875	0%	9.259	0	20	20	$7,232.27	$0.00	$0.00	$0.00	0.06	0.10	0.05	0.06
6113	HVAC Equipment	Boiler turndown control	HVAC Equipmen	MF	All	NC	0.000	0.000	0.000	0.000	0.000	82.875	0%	11.048	0	15	15	$195.00	$0.00	$0.00	$0.00	1.91	2.53	1.46	1.91
7001	Miscellaneous	Pump and Motor Single Speed	Miscellaneous	SF	All	ROB	2120.860	0.327	694.000	0.715	0.000	-	0%	0.000	0	10	10	$85.00	$0.00	$0.00	$0.00	2.31	4.65	2.33	4.62
7002	Miscellaneous	Pump and motor w auto controls - multi speed	Miscellaneous	SF	All	ROB	2120.860	0.510	1081.000	1.592	0.000	-	0%	0.000	0	10	10	$579.00	$0.00	$0.00	$0.00	0.55	1.12	0.56	1.11
7003	Miscellaneous	Pump and Motor Single Speed	Miscellaneous	SF	All	NC	2120.860	0.327	694.000	0.715	0.000	-	0%	0.000	0	10	10	$85.00	$0.00	$0.00	$0.00	2.31	4.65	2.33	4.62
7004	Miscellaneous	Pump and motor w auto controls - multi speed	Miscellaneous	SF	All	NC	2120.860	0.510	1081.000	1.592	0.000	-	0%	0.000	0	10	10	$579.00	$0.00	$0.00	$0.00	0.55	1.12	0.56	1.11
8001	Cross-Cutting	Behavior Modification: Home Energy Reports	Cross-Cutting	SF	All	RETRO	8203.000	0.025	205.075	0.019	0.019	107.500	1%	1.075	0	1	1	$6.77	$0.00	$0.00	$0.00	1.38	2.79	1.40	2.76
8002	Cross-Cutting	Behavior Modification: Home Energy Reports	Cross-Cutting	SF	All	NC	8203.000	0.025	205.075	0.019	0.019	107.500	1%	1.075	0	1	1	$6.77	$0.00	$0.00	$0.00	1.38	2.79	1.40	2.76
8003	Cross-Cutting	Behavior Modification: Home Energy Reports	Cross-Cutting	MF	All	RETRO	4101.500	0.025	102.538	0.009	0.009	53.700	1%	0.537	0	1	1	$6.77	$0.00	$0.00	$0.00	0.69	1.39	0.70	1.38
8004	Cross-Cutting	Behavior Modification: Home Energy Reports	Cross-Cutting	MF	All	NC	4101.500	0.025	102.538	0.009	0.009	53.700	1%	0.537	0	1	1	$6.77	$0.00	$0.00	$0.00	0.69	1.39	0.70	1.38

*GDS notes that the six energy efficiency measures where measure costs are highlighted in green on this page were removed from the MEMD after this study was started. A $1.00 measure cost was used to avoid a circular reference error in the model. There is no participation or associated potential and costs associated with these measures because they have been removed from the MEMD.

APPENDIX B Commercial Measure Detail

LBWL **Measure Assumption Tab -Commercial**

Measure #	End-Use	Measure Name	Per Unit Elec Savings	Per Unit Summer CP kW	MMBTU Savings	Water Savings (Gallons)	Persistence Factor	Measure Life	Effective Measure Life	Cost	Cost/Unit Descriptor	TRC	UCT 100% Incentive	UCT 50% Incentive	UCT TPB Incentive
100	Office Equipment	Energy Star Compliant Refrigerator	48	0.0081	0.0	0	1	16	16	$30.75	Per Unit	0.60	0.60	1.20	0.77
101	Office Equipment	Energy Star office equipment including computers, monitors, copier	631	0.0866	0.0	0	1	5	5	$20.00	per set	4.86	4.86	9.72	16.82
102	Office Equipment	Smart Strip plug outlet	64	0.0053	0.0	0	1	5	5	$30.00	per unit	0.32	0.32	0.64	0.46
104	Office Equipment	PC Network Energy Management Controls replacing no central cont	105	0.0238	0.0	0	1	10	10	$2,444.00	per kW	0.01	0.01	0.02	0.01
105	Office Equipment	Energy Star UPS	474	0.0791	0.0	0	1	5	5	$80.00	per unit	0.92	0.92	1.85	3.19
106	Office Equipment	Vendor Miser for Non-Refrig Equipment	965	0.1090	0.0	0	1	10	10	$450.00	per unit	0.58	0.58	1.16	0.83
107	Office Equipment	High Efficiency Hand Dryer	1,445	0.1650	0.0	0	1	15	15	$480.00	per fan	1.09	1.09	2.18	1.88
108	Office Equipment	Electrically Commutated Plug Fans in data centers	162	0.0213	0.0	0	1	15	15	$62.50	MBH	0.95	0.95	1.90	1.49
109	Office Equipment	High Efficiency CRAC unit	399	0.0409	0.0	0	1	15	15	$82.00	MBH	1.75	1.75	3.51	4.87
111	Office Equipment	Computer Room Hot Aisle Cold Aisle Configuration	90	0.0103	0.0	0	1	15	15	$156.00	MBH	0.21	0.21	0.42	0.23
112	Office Equipment	Computer Room Air Side Economizer	412	0.0000	0.0	0	1	10	10	$25.00	MBH	4.25	4.25	8.50	11.81
113	Office Equipment	VFD for Process Fans -CRAC units	2,279	0.3333	0.0	0	1	15	15	$200.00	per HP	4.19	4.19	8.37	11.63
114	Office Equipment	Computer Room Air Side Heat Exchanger	388	0.0000	0.0	0	1	15	15	$86.75	MBH	1.53	1.53	3.07	4.06
200	Water Heating	Heat Pump Water Heater	184,058	36.5400	0.0	0	1	15	15	$4,000.00	per heater	17.17	17.17	34.35	47.05
201	Water Heating	HP Water Heater - Residential unit in Commercial Application	5,375	1.4610	0.0	0	1	15	15	$1,000.00	per heater	2.06	2.06	4.11	5.63
203	Water Heating	Electric Tankless Water Heater	639	0.0730	0.0	0	1	20	20	$519.00	per heater	0.53	0.53	1.06	0.64
204	Water Heating	Low Flow Faucet Aerator	848	0.0968	0.0	0	1	10	10	$2.00	per unit	115.19	115.19	230.39	315.62
205	Water Heating	Low Flow Showerhead	527	0.0602	0.0	0	1	10	10	$25.00	per unit	5.73	5.73	11.46	15.70
206	Water Heating	Hot Water (DHW) Pipe Insulation	45	0.0051	0.0	0	1	20	20	$6.00	linear ft	3.22	3.22	6.44	8.82
207	Water Heating	Clothes Washer ENERGY STAR, Gas water heater, Gas dryer	32	0.0215	5.1	0	1	7	7	$250.00	per unit	0.37	0.03	0.06	0.03
208	Water Heating	Clothes Washer ENERGY STAR, Gas water heater, Electric dryer	236	0.1573	2.3	0	1	7	7	$250.00	per unit	0.38	0.23	0.45	0.26
209	Water Heating	Clothes Washer ENERGY STAR, Electric Water heater, Gas Dryer	168	0.0112	2.8	0	1	7	7	$250.00	per unit	0.32	0.14	0.27	0.15
210	Water Heating	Clothes Washer ENERGY STAR, Electric Water heater, Electric Drye	371	0.2479	0.0	0	1	7	7	$250.00	per unit	0.35	0.35	0.71	0.45
211	Water Heating	ES Dishwasher, High Temp, Elec Heat, Elec Booster	11,358	1.7280	0.0	0	1	15	15	$770.00	per unit	5.42	5.42	10.84	14.85
212	Water Heating	ES Dishwasher, High Temp, Gas Heat, Elec Booster	4,862	0.7400	25.6	0	1	15	15	$770.00	per unit	3.44	2.32	4.64	6.36
213	Water Heating	ES Dishwasher, High Temp, Gas Heat, Gas Booster	7,241	1.1013	49.6	0	1	15	15	$770.00	per unit	5.63	3.45	6.91	9.46
214	Water Heating	ES Dishwasher, Low Temp, Elec Heat	1,471	0.2200	7.1	0	1	10	10	$120.00	per unit	4.74	3.37	6.73	9.22
215	Water Heating	ES Dishwasher, Low Temp, Gas Heat	584	0.0900	32.6	0	1	20	20	$60.00	per unit	27.72	4.27	8.53	11.69
216	Water Heating	Tank Insulation (electric)	468	0.0535	1.9	0	1	15	15	$1.85	per square foot	126.46	91.71	183.41	251.27
217	Water Heating	Pre Rinse Sprayers (electric)	1,396	0.2330	0.0	0	1	5	5	$35.00	each	6.22	6.22	12.44	17.04
218	Water Heating	ECM Circulator Pump	4,949	1.3162	0.0	0	1	15	15	$300.00	per Motor	6.30	6.30	12.60	17.26
219	Water Heating	Drain water Heat Recovery Water Heater	546	4.4900	0.0	0	1	25	25	$631.00	Per Unit	1.70	1.70	3.40	1.95
220	Water Heating	Efficient Hot Water Pump	587	0.0703	-2.0	0	1	15	15	$33.20	hp	2.15	6.42	12.84	17.60
221	Water Heating	HVAC Condenser Heater Recovery Water Heating	3,537	3.6550	0.0	0	1	15	15	$254.00	ton	6.67	6.67	13.35	18.29
222	Water Heating	Process Cooling Condenser Heater Recovery Water Heating	5,720	1.2050	0.0	0	1	15	15	$254.00	ton	8.44	8.44	16.88	23.12
223	Water Heating	Laminar flow restrictor	240	0.0270	0.0	0	1	10	10	$14.27	per unit	4.57	4.57	9.13	12.51
224	Water Heating	ENERGY STAR Heat Pump Storage Water Heater, > 55 gallons	216	0.0245	0.0	0	1	10	10	$1,574.00	per heater	0.04	0.04	0.07	0.04
225	Water Heating	ENERGY STAR Heat Pump Storage Water Heater, < 55 gallons	10,931	1.2480	0.0	0	1	10	10	$1,574.00	per heater	1.89	1.89	3.77	5.17
300	Pools	Heat Pump Pool Heater	5,732	0.0000	0.0	0	1	10	10	$4,000.00	Per Unit	0.37	0.37	0.75	0.47
301	Pools	High efficiency spas/hot tubs	375	0.0000	0.0	0	1	10	10	$300.00	Per Unit	0.33	0.33	0.65	0.39
302	Pools	VFD Retrofit on Pool Circulation Pump	1,425	0.2540	0.0	0	1	12	12	$200.00	per hp	2.29	2.29	4.58	6.27
420	Ventilation	Economizer	142	-0.0024	-0.2	0	1	15	15	$170.11	ton	0.27	0.29	0.57	0.32
421	Ventilation	Demand-Controlled Ventilation	280	0.1421	21.1	0	1	15	15	$115.00	1000 sq ft cond floor a	7.24	1.05	2.10	1.59
422	Ventilation	VFD Tower Fan	594	0.1832	0.0	0	1	10	10	$221.88	fan hp	0.79	0.79	1.58	1.26
423	Ventilation	VFD Return Fan	849	0.0728	-0.5	0	1	10	10	$221.88	per fan hp	0.98	1.04	2.07	2.22
424	Ventilation	VFD Supply Fan	884	0.1924	-0.5	0	1	10	10	$221.88	fan hp	1.08	1.14	2.27	2.56
425	Ventilation	High Speed Fans	4,427	1.5970	0.0	0	1	7	7	$150.00	per fan	6.67	6.67	13.35	18.47
426	Ventilation	High Volume Low Speed Fans	5,061	1.8400	0.0	0	1	10	10	$4,072.00	per fan	0.37	0.37	0.75	0.45
428	Ventilation	Engineered CKV hood	737	0.1600	19.6	0	1	15	15	$316.00	100 cfm red	2.99	0.89	1.79	1.32
429	Ventilation	ECM on Exterior Condenser Fans	333	0.2663	0.0	0	1	15	15	$240.00	hp	0.66	0.66	1.33	0.82
500	Cooking	HE Steamer	12,914	3.0050	0.0	0	1	12	12	$4,150.00	each	1.03	1.03	2.06	1.82
501	Cooking	HE Combination Oven	18,432	4.2000	0.4	0	1	12	12	$19,340.50	each	0.32	0.31	0.63	0.36
502	Cooking	HE Convection Ovens	1,879	0.4290	0.0	0	1	12	12	$471.00	each	1.32	1.32	2.63	2.97
503	Cooking	HE Holding Cabinet	3,299	0.6033	0.0	0	1	12	12	$1,783.00	each	0.60	0.60	1.20	0.81
504	Cooking	HE Fryer	2,573	0.2000	0.0	0	1	12	12	$1,706.00	each	0.47	0.47	0.93	0.59
505	Cooking	HE Griddle	2,594	0.5930	14.9	0	1	12	12	$3,604.00	each	0.35	0.24	0.48	0.26
506	Cooking	Induction Cooktops	784	3.0000	0.0	0	1	11	11	$3,000.00	Per Unit	0.20	0.20	0.39	0.20
600	Space Cooling	Air-Cooled Recip Chiller	139	0.0936	0.0	0	1	20	20	$90.71	ton	0.80	0.80	1.61	1.02
601	Space Cooling	Air-Cooled Screw Chiller	214	0.1119	0.0	0	1	20	20	$143.72	ton	0.74	0.74	1.49	0.94
602	Space Cooling	Water-Cooled Centrifugal Chiller < 150 ton	192	-0.0835	0.0	0	1	20	20	$348.25	ton	0.19	0.19	0.38	0.21

Measure #	End-Use	Measure Name	Per Unit Elec Savings	Per Unit Summer CP kW	MMBTU Savings	Water Savings (Gallons)	Persistence Factor	Measure Life	Effective Measure Life	Cost	Cost/Unit Descriptor	TRC	UCT 100% Incentive	UCT 50% Incentive	UCT TPB Incentive
603	Space Cooling	Water-Cooled Centrifugal Chiller 150 - 300 ton	215	-0.0515	0.0	0	1	20	20	$193.36	ton	0.42	0.42	0.83	0.49
604	Space Cooling	Water-Cooled Centrifugal Chiller > 300 ton	220	0.0589	0.0	0	1	20	20	$43.27	ton	2.33	2.33	4.65	6.46
605	Space Cooling	Water-Cooled Screw Chiller < 150 ton	175	0.0500	0.0	0	1	20	20	$150.76	ton	0.53	0.53	1.07	0.64
606	Space Cooling	Water-Cooled Screw Chiller 150 - 300 ton	204	-0.0203	0.0	0	1	20	20	$169.66	ton	0.48	0.48	0.96	0.58
607	Space Cooling	Water-Cooled Screw Chiller > 300 ton	250	-0.0631	0.0	0	1	20	20	$40.87	ton	2.28	2.28	4.56	6.33
608	Space Cooling	Chiller Tune Up	88	0.0186	0.0	0	1	5	5	$5.66	ton	2.46	2.46	4.93	6.85
609	Space Cooling	High Efficiency Pumps	337	0.0768	0.0	0	1	15	15	$233.33	per hp	0.55	0.55	1.09	0.68
610	Space Cooling	Efficient Chilled Water Pump	622	0.0861	0.0	0	1	15	15	$78.20	hp	2.88	2.92	5.83	8.10
611	Space Cooling	Chilled Hot Water Reset	460	0.0612	1.9	0	1	5	5	$0.79	ton	117.91	89.41	178.82	248.36
612	Space Cooling	Air-Cooled Chiller Average 10% above IECC standard	121	0.0727	0.0	0	1	20	20	$66.63	ton	0.93	0.93	1.86	1.24
613	Space Cooling	Air-Cooled Chiller Average 0.01 kW/ton IPLV Reduction	8	0.0028	0.0	0	1	20	20	$4.36	ton	0.82	0.82	1.64	1.08
614	Space Cooling	Water-Cooled Chiller Average 10% above IECC standard	112	0.0620	0.0	0	1	20	20	$101.49	ton	0.56	0.56	1.11	0.66
615	Space Cooling	Water-Cooled Chiller Average 0.01 kW/ton IPLV Reduction	7	0.0009	0.0	0	1	20	20	$5.49	ton	0.58	0.58	1.15	0.71
616	Space Cooling	VAV System Conversion	5,144	0.2923	34.1	0	1	20	20	$2,500.00	1000 sq ft cond floor a	1.46	0.87	1.74	1.22
618	Space Cooling	Water-Side Economizer	1,048	0.0000	0.0	0	1	15	15	$50.00	ton	7.30	7.30	14.60	20.28
637	Space Cooling	VFD Tower Fan	594	0.1832	0.0	0	1	10	10	$221.88	fan hp	0.77	0.77	1.55	1.24
638	Space Cooling	Smart Thermostat	461	0.0000	8.9	0	1	10	10	$127.61	1000 sq ft cond floor a	2.57	0.95	1.89	1.91
639	Space Cooling	AC <65k	102	0.0498	-0.2	0	1	15	15	$1,348.76	ton	0.03	0.03	0.06	0.03
640	Space Cooling	AC 65k - 135k	88	0.0832	0.0	0	1	15	15	$277.47	ton	0.15	0.15	0.30	0.16
641	Space Cooling	AC 135k - 240k	63	0.1061	0.0	0	1	15	15	$166.48	ton	0.22	0.22	0.43	0.23
642	Space Cooling	AC 240k - 760k	52	0.0604	0.0	0	1	15	15	$110.99	ton	0.23	0.23	0.47	0.25
643	Space Cooling	AC >760k	37	0.0660	0.0	0	1	15	15	$8.54	ton	2.53	2.53	5.06	6.48
644	Space Cooling	Air Source Heat Pump - Cooling	140	0.0697	0.0	0	1	15	15	$85.18	ton	0.68	0.68	1.36	0.88
645	Space Cooling	Ductless (mini split) - Cooling	270	0.1459	0.0	0	1	15	15	$801.85	ton	0.14	0.14	0.28	0.15
646	Space Cooling	Water Loop Heat Pump (WLHP) - Cooling	36	0.0208	0.0	0	1	15	15	$22.00	ton	0.66	0.69	1.38	0.89
647	Space Cooling	Ground Source Heat Pump - Cooling	1,703	0.1136	0.0	0	1	15	15	$179.79	ton	3.38	3.38	6.77	9.40
648	Space Cooling	Packaged Terminal Air Conditioner (PTAC) - Cooling	140	0.0864	0.0	0	1	15	15	$137.88	ton	0.44	0.44	0.87	0.51
649	Space Cooling	WLHP System (Cooling) New Construction	1,689	0.0407	31.8	0	1	20	20	$5,000.00	1000 sq ft cond floor a	0.42	0.14	0.28	0.15
650	Space Cooling	DX Condenser Coil Cleaning	67	0.0477	0.0	0	1	3	3	$32.40	ton	0.24	0.24	0.47	0.33
651	Space Cooling	Room A/C	52	0.0702	0.0	0	1	15	15	$29.50	per unit	0.92	0.92	1.85	1.23
653	Space Cooling	Improved Duct Sealing - Cooling AC	9	0.0143	1.0	0	1	18	18	$107.91	ton	0.42	0.06	0.12	0.06
654	Space Cooling	Building Operator Certification	11,767	1.3433	156.4	0	1	5	5	$600.00	per participant of 194	6.11	3.03	6.06	8.41
655	Space Cooling	Energy Efficient Windows	666	0.3022	19.0	0	1	25	25	$1,500.00	100SF	0.91	0.26	0.51	0.27
656	Space Cooling	Cool Roof	80	0.0528	-0.7	0	1	20	20	$4,227.34	1000 sq ft roof area	0.01	0.01	0.02	0.01
657	Space Cooling	Ceiling Insulation	94	0.1284	5.6	0	1	30	30	$300.00	1000 sq ft roof area	1.39	0.28	0.55	0.30
658	Space Cooling	Wall Insulation	499	0.0793	42.1	0	1	30	30	$50.00	1000 sq ft wall area	55.78	5.59	11.17	15.88
659	Space Cooling	Roof Insulation	-22	0.0560	3.4	0	1	30	30	$616.06	1000 sq ft roof area	0.33	0.01	0.01	0.01
660	Space Cooling	Window Improvements	230	0.1250	-1.5	0	1	20	20	$5,208.41	100 sq ft glazing	0.02	0.02	0.05	0.02
662	Space Cooling	EMS install	608	0.0227	1.4	0	1	15	15	$3.54	1000 sq ft cond floor a	74.43	60.65	121.30	168.32
663	Space Cooling	EMS Optimization	367	0.0214	0.0	0	1	20	20	$18.62	1000 sq ft cond floor a	8.41	8.37	16.73	23.22
664	Space Cooling	Hotel Guest Room Occupancy Control System	1,114	0.0880	0.0	0	1	8	8	$250.00	per unit	1.01	1.01	2.02	2.66
665	Space Cooling	HVAC Occupancy Sensors	15	0.0033	0.0	0	1	15	15	$10.70	kBtu/hr input capacity	0.62	0.55	1.10	0.69
666	Space Cooling	Thermostat Setback	108	-0.0007	4.9	0	1	9	9	$174.76	1000 sq ft cond floor a	0.73	0.15	0.30	0.16
667	Space Cooling	EMS Pump Scheduling Controls	1,523	0.1421	8.6	0	1	15	15	$1.77	pump Hp	475.35	310.84	621.69	862.66
668	Space Cooling	Web enabled EMS	434	-0.0160	19.2	0	1	15	15	$87.38	1000 sq ft cond floor a	9.12	1.71	3.42	4.74
669	Space Cooling	Zoning	187	0.0000	0.0	0	1	15	15	$500.00	1000 sq ft cond floor a	0.13	0.13	0.26	0.14
670	Space Cooling	Retrocommissioning	3	0.0000	0.0	0	1	7	7	$0.15	sq ft	3.37	3.37	6.74	9.35
671	Space Cooling	Commissioning	5	0.0000	0.0	0	1	7	7	$1.16	sq ft	0.77	0.77	1.54	1.67
1620	Space Heating	Packaged Terminal Air Conditioner (PTAC) - Heating	140	0.0864	0.0	0	1	15	15	$137.88	ton	0.45	0.45	0.89	0.52
1652	Space Heating	Improved Duct Sealing - Heating	9	0.0143	1.0	0	1	18	18	$107.91	ton	0.42	0.06	0.12	0.06
672	Space Heating	Air Source Heat Pump - Heating	278	0.1008	0.0	0	1	15	15	$85.18	ton	1.29	1.29	2.59	2.37
673	Space Heating	Ground Source Heat Pump - Heating	304	0.1275	0.0	0	1	15	15	$179.79	ton	0.69	0.69	1.37	0.90
674	Space Heating	Ductless (mini split) - Heating	270	0.1459	0.0	0	1	15	15	$801.85	ton	0.14	0.14	0.29	0.15
675	Space Heating	VFD Pumps	2,553	0.3179	-0.4	0	1	10	10	$212.29	per CHW pump hp	3.06	3.21	6.42	9.14
676	Space Heating	ECM motors on furnaces	720	0.0722	0.0	0	1	20	20	$250.00	per Furnace	1.21	1.21	2.43	2.03
680	Space Heating	Water Loop Heat Pump (WLHP) - Heating	40	0.0225	0.0	0	1	15	15	$22.00	ton	0.75	0.79	1.59	1.06
681	Space Heating	Building Operator Certification	11,767	1.3433	156.4	0	1	5	5	$600.00	per participant of 194	6.11	3.03	6.06	8.41
682	Space Heating	Energy Efficient Windows	666	0.3022	19.0	0	1	25	25	$1,500.00	100SF	0.91	0.26	0.51	0.27
683	Space Heating	Cool Roof	80	0.0528	-0.7	0	1	20	20	$4,227.34	1000 sq ft roof area	0.01	0.01	0.02	0.01
684	Space Heating	Ceiling Insulation	94	0.1284	5.6	0	1	30	30	$300.00	1000 sq ft roof area	1.39	0.28	0.55	0.30

LBWL **Measure Assumption Tab -Commercial**

Measure #	End-Use	Measure Name	Per Unit Elec Savings	Per Unit Summer CP kW	MMBTU Savings	Water Savings (Gallons)	Persistence Factor	Measure Life	Effective Measure Life	Cost	Cost/Unit Descriptor	TRC	UCT 100% Incentive	UCT 50% Incentive	UCT TPB Incentive
685	Space Heating	Wall Insulation	499	0.0793	42.1	0	1	30	30	$50.00	1000 sq ft wall area	55.78	5.59	11.17	15.88
686	Space Heating	Roof Insulation	-22	0.0560	3.4	0	1	30	30	$616.06	1000 sq ft roof area	0.33	0.01	0.01	0.01
688	Space Heating	Window Improvements	230	0.1250	-1.5	0	1	20	20	$1,395.69	100 sq ft glazing	0.08	0.09	0.17	0.09
689	Space Heating	EMS install	608	0.0227	1.4	0	1	15	15	$3.54	1000 sq ft cond floor a	74.43	60.65	121.30	168.32
690	Space Heating	EMS Optimization	367	0.0214	0.0	0	1	20	20	$18.62	1000 sq ft cond floor a	8.41	8.37	16.73	23.22
691	Space Heating	Hotel Guest Room Occupancy Control System	1,114	0.0880	0.0	0	1	8	8	$250.00	per unit	1.01	1.01	2.02	2.66
692	Space Heating	HVAC Occupancy Sensors	315	0.0803	5.3	0	1	15	15	$500.00	1000 sq ft cond floor a	0.59	0.24	0.48	0.26
693	Space Heating	Thermostat Setback	108	-0.0007	4.9	0	1	9	9	$174.76	1000 sq ft cond floor a	0.73	0.14	0.29	0.16
694	Space Heating	EMS Pump Scheduling Controls	1,523	0.1421	8.6	0	1	15	15	$1.77	pump Hp	468.02	303.52	607.04	842.33
695	Space Heating	Web enabled EMS	434	-0.0160	19.2	0	1	15	15	$87.38	1000 sq ft cond floor a	9.06	1.64	3.29	4.56
696	Space Heating	Web enabled EMS with Electric Heat	10,587	-0.0504	0.0	0	1	15	15	$174.76	1000 sq ft cond floor a	20.27	20.36	40.71	56.49
697	Space Heating	Zoning	187	0.0000	0.0	0	1	15	15	$500.00	1000 sq ft cond floor a	0.13	0.13	0.25	0.13
698	Space Heating	Retrocommissioning	3	0.0000	0.0	0	1	7	7	$0.15	sq ft	3.24	3.24	6.48	9.00
699	Space Heating	Commissioning	5	0.0000	0.0	0	1	7	7	$1.16	sq ft	0.74	0.74	1.48	1.61
700	Space Heating	Smart Thermostat	108	-0.0007	4.9	0	1	9	9	$174.76	1000 sq ft cond floor a	0.73	0.14	0.29	0.16
1677	Space Heating	WLHP System (Heating) New Construction	1,689	0.0407	31.8	0	1	20	20	$5,000.00	1000 sq ft cond floor a	0.41	0.14	0.27	0.14
1679	Space Heating	Integrated Building Design	161,388	110.8500	4.2	0	1	30	30	$166,226.40	per Building	0.59	0.59	1.18	0.70
705	Lighting - Interior	Light Tube	344	0.1290	0.0	0	1	14	14	$500.00	per fixture	0.25	0.25	0.50	0.27
715	Lighting - Interior	LED Screw In (replacing Incandescent)	100	0.0376	0.0	0	1	6	6	$3.00	per lamp	6.24	6.24	12.47	17.09
716	Lighting - Interior	LED Screw In (replacing CFL)	15	0.0058	0.0	0	1	9	9	$16.41	per lamp	0.24	0.24	0.49	0.28
717	Lighting - Interior	LED High bay lighting	4	0.0010	0.0	0	1	18	18	$1.25	per watt reduced	1.37	1.37	2.74	2.55
718	Lighting - Interior	Interior Non Highbay/Lowbay LED Fixtures	3	0.0010	0.0	0	1	18	18	$0.75	per watt reduced	1.51	1.51	3.02	2.99
719	Lighting - Interior	LED Downlight	108	0.0406	0.0	0	1	15	15	$12.74	per fixture	3.21	3.21	6.43	8.80
720	Lighting - Interior	LED Specialty (replacing Incandescent)	114	0.0427	0.0	0	1	9	9	$6.50	per lamp	4.54	4.54	9.08	12.44
721	Lighting - Interior	LED Specialty (replacing CFL)	16	0.0060	0.0	0	1	9	9	$16.41	per lamp	0.25	0.25	0.51	0.30
722	Lighting - Interior	LED Troffer	101	0.0378	0.0	0	1	18	18	$118.00	per fixture	0.36	0.36	0.73	0.41
723	Lighting - Interior	LED Tube Lighting	62	0.0232	0.0	0	1	18	18	$5.99	per lamp	4.38	4.38	8.77	12.01
724	Lighting - Interior	LED Grow Light	4	0.0010	0.0	0	1	11	11	$1.53	per watt reduced	0.84	0.84	1.69	1.40
725	Lighting - Interior	Interior Non Highbay/Lowbay LED Fixtures	3	0.0010	0.0	0	1	18	18	$0.75	per watt reduced	0.00	0.00	0.00	0.00
726	Lighting - Interior	Illuminated Signs to LED	6	0.0010	0.0	0	1	13	13	$4.00	per watt reduced	0.47	0.47	0.94	0.59
727	Lighting - Interior	LED Lighting in Refrigeration	460	0.0527	0.0	0	1	16	16	$356.00	per door	0.48	0.48	0.96	0.59
728	Lighting - Interior	Networked / Advanced Lighting Controls	7,650	2.8571	0.0	0	1	8	8	$16,800.00	10,000 SF	0.11	0.11	0.22	0.11
729	Lighting - Interior	LED Exit Sign	201	0.0230	0.0	0	1	15	15	$25.00	per fixture	2.87	2.87	5.74	7.86
750	Lighting - Interior	Central Lighting Control	8,341	3.1200	0.0	0	1	12	12	$2,700.00	10,000 SF	1.00	1.00	2.00	1.75
751	Lighting - Interior	Daylight Sensor Controls	6,407	2.5068	0.0	0	1	12	12	$3,000.00	10,000 SF	0.69	0.69	1.39	0.99
753	Lighting - Interior	Occupancy Sensor	603	0.0335	0.0	0	1	10	10	$100.00	per sensor	1.60	1.60	3.19	4.37
754	Lighting - Interior	Occupancy & Daylight Sensor	764	0.2637	0.0	0	1	10	10	$150.00	per sensor	1.43	1.43	2.85	3.91
755	Lighting - Interior	Switching Controls for Multilevel Lighting (Non-HID)	5,838	2.1960	0.0	0	1	12	12	$3,000.00	10,000 SF	0.63	0.63	1.26	0.86
756	Lighting - Interior	Lighting Power Density - Interior	2,669	1.0000	0.0	0	1	15	15	$220.00	per kW reduced	4.58	4.58	9.17	12.56
759	Lighting - Interior	Stairwell Bi-Level Control	4,809	0.5500	0.0	0	1	9	9	$825.00	per kW controlled	1.44	1.44	2.88	3.94
760	Lighting - Interior	Occupancy Sensors for LED Refrigerator Lighting	195	0.0216	0.0	0	1	16	16	$20.00	per door	3.62	3.62	7.25	9.93
736	Lighting - Interior	Long Day Lighting Dairy	6	0.0010	0.0	0	1	16	16	$1.79	per watt controlled	1.30	1.30	2.61	2.52
1752	Lighting - Interior	Daylight Sensor Controls - New Construction	10,409	4.0200	0.0	0	1	12	12	$3,000.00	10,000 SF	0.93	0.93	1.86	1.80
729	Lighting - Exterior	LED Fuel Pump Canopy Fixture	136	0.0406	0.0	0	1	21	21	$343.00	Per unit	2.87	2.87	5.74	7.86
730	Lighting - Exterior	LED Traffic Signals	275	0.0850	0.0	0	1	6	6	$50.00	per lamp	0.85	0.85	1.70	2.32
731	Lighting - Exterior	LED Pedestrian Signals	150	0.0440	0.0	0	1	8	8	$100.00	per lamp	0.29	0.29	0.59	0.37
732	Lighting - Exterior	Exterior HID replacement with LEDs	174	0.0400	0.0	0	1	12	12	$200.00	per fixture	0.23	0.23	0.47	0.27
733	Lighting - Exterior	Garage HID replacement with LEDs	611	0.0700	0.0	0	1	12	12	$400.00	per fixture	0.41	0.41	0.82	0.52
757	Lighting - Exterior	Lighting Power Density - Exterior	4,319	1.0000	0.0	0	1	12	12	$220.00	per kW reduced	5.27	5.27	10.54	14.43
758	Lighting - Exterior	Lighting Power Density - Parking Garage	8,760	1.0000	0.0	0	1	12	12	$220.00	per kW reduced	10.69	10.69	21.37	29.28
762	Lighting - Exterior	Garage BiLevel Controls	730	0.2923	0.0	0	1	10	10	$400.00	per fixture	0.43	0.43	0.85	0.57
763	Lighting - Exterior	Sports Field Lighting HiLo Control	149	0.5310	0.0	0	1	10	10	$400.00	per fixture	0.09	0.09	0.17	0.09
1735	Street Lighting	Outdoor LED (< 250W MH)	567	0.1317	0.0	0	1	15	15	$238.50	bulb	0.74	0.74	1.49	1.11
1736	Street Lighting	Outdoor LED (> 250W MH)	754	0.1753	0.0	0	1	15	15	$592.00	bulb	0.49	0.49	0.97	0.59
764	Refrigeration	Vending Miser for Refrigerated Vending Machines	800	0.2100	0.0	0	1	10	10	$216.00	per unit	1.07	1.07	2.13	2.20
765	Refrigeration	Evaporator Fan Motor Controls	563	0.0645	0.0	0	1	5	5	$421.00	per controller	0.20	0.20	0.41	0.25
766	Refrigeration	Zero-Energy Doors	1,360	0.1310	0.0	0	1	10	10	$290.00	per door	1.26	1.26	2.53	3.11
767	Refrigeration	Discus and Scroll Compressors	1,500	0.2846	0.0	0	1	13	13	$825.00	per Unit	0.62	0.62	1.24	0.83
768	Refrigeration	Floating Head Pressure Control	1,264	0.1440	0.0	0	1	15	15	$80.00	per ton	5.73	5.73	11.47	14.10
769	Refrigeration	ENERGY STAR Commercial Solid Door Refrigerators	284	0.0323	0.0	0	1	12	12	$250.00	per unit	0.35	0.35	0.71	0.42

LBWL **Measure Assumption Tab -Commercial**

Measure #	End-Use	Measure Name	Per Unit Elec Savings	Per Unit Summer CP kW	MMBTU Savings	Water Savings (Gallons)	Persistence Factor	Measure Life	Effective Measure Life	Cost	Cost/Unit Descriptor	TRC	UCT 100% Incentive	UCT 50% Incentive	UCT TPB Incentive
770	Refrigeration	ENERGY STAR Commercial Solid Door Freezers	488	0.0558	0.0	0	1	12	12	$150.00	per unit	1.01	1.01	2.02	1.85
771	Refrigeration	ENERGY STAR Commercial Glass Door Refrigerators	410	0.0468	0.0	0	1	12	12	$250.00	per unit	0.51	0.51	1.02	0.66
772	Refrigeration	ENERGY STAR Commercial Glass Door Freezers	935	0.1068	0.0	0	1	12	12	$150.00	per unit	1.94	1.94	3.88	4.77
773	Refrigeration	Energy Star Ice Machines	1,314	0.1507	0.0	0	1	9	9	$981.00	per unit	0.33	0.33	0.67	0.41
774	Refrigeration	Strip Curtains	270	0.0308	1.1	0	1	4	4	$8.97	per square foot	4.95	3.76	7.53	9.26
775	Refrigeration	Anti Sweat Heater Controls	1,251	0.0055	-0.9	0	1	12	12	$30.00	door	6.68	12.35	24.71	30.39
776	Refrigeration	Efficient Refrigeration Condenser	1,288	0.1245	0.0	0	1	15	15	$652.75	ton	0.71	0.71	1.42	0.98
777	Refrigeration	Door Gaskets - Cooler and Freezer	98	0.0110	0.0	0	1	4	4	$2.25	per linear foot	5.45	5.45	10.90	13.41
778	Refrigeration	Reach-in Refrigerated display case door retrofit	1,014	0.2056	5.5	0	1	12	12	$686.00	linear ft	0.70	0.48	0.95	0.60
780	Refrigeration	ECM Case Motors	1,234	0.1410	0.0	0	1	15	15	$226.00	per motor	1.98	1.98	3.96	4.88
781	Refrigeration	Efficient low-temp compressor	875	0.1500	0.0	0	1	13	13	$552.00	per Unit	0.54	0.54	1.07	0.69
782	Refrigeration	Automatic High Speed Doors	968	0.1103	0.0	0	1	12	12	$150.00	SF	2.01	2.01	4.01	4.94
783	Refrigeration	Automatic Door Closers for Refrigerated Walk-in Coolers/Freezers	1,625	0.2230	0.0	0	1	8	8	$156.00	per door	2.39	2.39	4.79	5.89
784	Refrigeration	Refrigerant charging correction	26	0.0360	0.0	0	1	2	2	$10.36	ton	0.24	0.24	0.49	0.37
785	Refrigeration	Walk-in Cooler Evaporator Motor Reduction	1,462	0.1669	0.0	0	1	15	15	$800.00	per motor removed	0.66	0.66	1.33	0.89
786	Refrigeration	Night Covers	16	0.0000	0.0	0	1	5	5	$33.75	LF of case - hr	0.07	0.07	0.14	0.07
787	Refrigeration	Refrigeration Suction and Liquid Pipe Insulation	11	0.0000	0.0	0	1	15	15	$4.50	LF	0.83	0.83	1.65	1.24
788	Refrigeration	VFD on Condenser Fan	274	0.0000	0.0	0	1	10	10	$41.94	per ton of load	1.69	1.69	3.38	4.16
789	Refrigeration	Cold Storage Evaporator ECM Fan Motor	1,396	0.2688	0.0	0	1	15	15	$30.13	per HP	17.41	17.41	34.82	42.83
790	Refrigeration	Refrigeration Air-Side Economizer	1,357	0.0000	0.0	0	1	15	15	$2,558.00	per ton	0.18	0.18	0.37	0.20
791	Refrigeration	Evaporator Coil Defrost Control	197	0.4050	0.0	0	1	10	10	$500.00	per Unit	0.20	0.20	0.40	0.21
850	Compressed Air	Efficient Air Compressors	958	0.1551	0.0	0	1	15	15	$100.00	per HP	3.72	3.72	7.44	10.26
851	Compressed Air	Automatic Drains	2,097	0.3364	0.0	0	1	5	5	$355.00	per drain	0.97	0.97	1.94	2.68
852	Compressed Air	Cycling Dryers	13	0.0021	0.0	0	1	10	10	$20.00	per SCFM	0.19	0.19	0.37	0.20
853	Compressed Air	Low Pressure Drop-Filters	587	0.1138	-0.1	0	1	2	2	$15.00	1000 cfm	2.74	2.79	5.59	7.70
854	Compressed Air	Air-Entraining Air Nozzles	19,899	7.9595	0.0	0	1	15	15	$80.00	each	106.45	106.45	212.89	293.56
855	Compressed Air	Receiver Capacity Addition	9,159	2.3175	0.0	0	1	10	10	$33.75	per Unit	81.68	81.68	163.37	225.27
856	Compressed Air	Compressed Air Audits & Leak Repair	539	0.0818	0.0	0	1	1	1	$8.00	per SCFM	2.43	2.43	4.86	6.70
857	Compressed Air	Compressed Air Pressure Flow Controller replacing no flow controll	74	0.0103	0.0	0	1	10	10	$25.00	per HP	0.85	0.85	1.71	1.45
858	Compressed Air	High Efficiency Air Dryers	49	0.0078	0.0	0	1	10	10	$20.00	per SCFM	0.71	0.71	1.41	1.07
859	Compressed Air	Air Compressor Outdoor Air Intake	110	0.0176	0.0	0	1	20	20	$5.00	per hp	10.16	10.16	20.32	28.03
860	Compressed Air	Variable Displacement Air Compressor	442	0.0705	0.0	0	1	13	13	$340.00	per hp	0.46	0.46	0.92	0.56
861	Compressed Air	Compressed Air Storage Tank	437	0.0710	0.0	0	1	25	25	$36.00	per hp	6.38	6.38	12.75	17.72
862	Compressed Air	Compressed Air Replacement with Air Blowers	5,588	4.8330	0.0	0	1	15	15	$620.00	per hp	4.55	4.55	9.10	12.54
863	Compressed Air	Air Recycling Pneumatic Valve on Pneumatic Cylinder	319	0.0507	0.0	0	1	25	25	$215.00	per valve	0.70	0.70	1.39	0.89
875	Other	NEMA Premium Transformer, single-phase	7	0.0025	0.0	0	1	30	30	$11.98	per kVA	0.32	0.32	0.64	0.36
876	Other	NEMA Premium Transformer, three-phase	10	0.0015	0.0	0	1	30	30	$10.46	per kVA	0.49	0.49	0.98	0.58
877	Other	High Efficiency Transformer, single-phase	2	0.0005	0.0	0	1	30	30	$1.54	per kVA	0.65	0.65	1.31	0.80
878	Other	High Efficiency Transformer, three-phase	7	0.0017	0.0	0	1	30	30	$6.08	per kVA	0.66	0.66	1.32	0.82
879	Other	Optimized Snow and Ice Melt Controls (electric)	0	0.0001	0.1	0	1	15	15	$0.15	SF	13.47	0.32	0.65	0.36
880	Other	Engine Block Heater Timer	576	0.0000	0.0	0	1	5	5	$50.00	per engine block	1.55	1.55	3.10	4.24
881	Other	Parking Garage Exhaust Fan	2,413	0.2754	28.4	0	1	15	15	$800.00	per hp	2.34	1.15	2.30	1.98
886	Motors	Standard to Synchronous Belts on Motors	139	0.0298	0.0	0	1	14	14	$32.00	per hp	1.65	1.65	3.30	4.18
887	Motors	Standard to Cogged Belt on Motors	77	0.0150	0.0	0	1	14	14	$2.00	per hp	14.56	14.56	29.12	40.15
888	Motors	Cogged to Synchronous Belts on Motors	82	0.0175	0.0	0	1	14	14	$30.00	per hp	0.92	0.92	1.84	1.48
2000	Behavioral	Behavior Based Efficiency (Commercial Energy Reports)	7,852	0.8960	0.0	0	1	2	2	$8.88	per report	53.63	53.63	107.25	146.93
2001	Behavioral	SEM	37	0.0010	0.0	0	1	1	1	$1.00	$0.00	1.11	1.11	2.22	3.07
2002	Behavioral	Whole-Building Energy Monitoring	2	0.0002	0.0	0	1	2	2	$1.00	per SqFt	0.10	0.10	0.21	0.14
2003	Behavioral	In-Home Energy Use Displays	23,555	2.6927	0.0	0	1	1	1	$250.00	per Unit	0.00	0.00	0.00	0.00

APPENDIX C Industrial Measure Detail

LBWL **Measure Assumption Tab - Industrial**

Measure #	End-Use	Measure Name	Per Unit Elec Savings	Per Unit Summer CP kW	MMBTU Savings	Water Savings (Gallons)	Persistence Factor	Measure Life	Effective Measure Life	Cost	Cost/Unit Descriptor	TRC	UCT 100% Incentive	UCT 50% Incentive	UCT TPB Incentive
101	Appliances, Computers, Office Equipment	Energy Star Compliant Single Door Refrigerator	48	0.0080	0.0	0	1	16	16	$30.75	per unit	0.59	0.59	1.18	0.75
102	Appliances, Computers, Office Equipment	Energy Star computers	631	0.0870	0.0	0	1	5	5	$20.00	$/unit	4.78	4.78	9.55	477.90
103	Appliances, Computers, Office Equipment	Energy Efficient "Smart" Power Strip for PC/Monitor/Printer	64	0.0040	0.0	0	1	5	5	$30.00	per unit	0.32	0.32	0.63	0.45
104	Appliances, Computers, Office Equipment	PC Network Energy Management Controls replacing no central con	105	0.0060	0.0	0	1	10	10	$2,444.00	per PC	0.01	0.01	0.02	0.01
106	Appliances, Computers, Office Equipment	Energy Star UPS	474	0.0790	0.0	0	1	5	5	$80.00	per kW	0.91	0.91	1.80	5.18
107	Appliances, Computers, Office Equipment	High Efficiency CRAC Unit	399	0.0210	0.0	0	1	15	15	$82.00	MBH	1.70	1.70	3.40	5.29
151	Water Heating	Heat Pump Water Heater	184,058	36.5400	0.0	0	1	15	15	$4,000.00	per heater	17.15	17.15	34.29	1715.00
152	Water Heating	Electric Tankless Water Heater	639	0.0730	0.0	0	1	20	20	$519.00	$/Unit	0.53	0.53	1.06	0.64
154	Water Heating	Efficient Hot Water Pump	525	0.0840	0.0	0	1	15	15	$78.00	$/Unit	1.62	1.62	3.24	25.57
156	Water Heating	Pre-rinse sprayers (electric)	1,396	0.2330	0.0	0	1	5	5	$35.00	$/unit	0.00	0.00	0.00	0.00
164	Water Heating	HVAC Condenser Heater Recovery Water Heating	3,537	3.6550	0.0	0	1	15	15	$254.00	$/unit	6.68	6.68	13.35	667.90
165	Water Heating	Low Flow Faucet Aerator	848	0.1030	0.0	0	1	10	10	$2.00	each	115.03	115.03	230.10	11530.00
166	Water Heating	Low Flow Showerhead	527	0.0602	0.0	0	1	10	10	$25.00	$/unit	0.00	0.00	0.00	0.00
167	Water Heating	Hot Water (DHW) Pipe Insulation	45	0.0086	0.0	0	1	20	20	$6.00	per unit	3.31	3.31	6.62	331.00
168	Water Heating	Tank Insulation (electric)	468	0.0640	0.0	0	1	15	15	$1.85	per unit	92.27	92.27	184.53	9226.90
169	Water Heating	Drain Water Heat Recovery Water Heater	546	4.4900	0.0	0	1	25	25	$631.00	linear ft	1.72	1.72	3.44	1.96
170	Water Heating	ECM Circulator Pump	4,949	1.3162	0.0	0	1	15	15	$300.00	per unit	6.29	6.29	12.58	628.84
171	Water Heating	Process Cooling Condenser Heat Recovery	5,720	1.2050	0.0	0	1	15	15	$254.00	$/unit	8.43	8.43	13.36	842.75
301	Envelope	Integrated Building Design	161,388	37.9100	840.0	0	1	30	30	$166,286.40	$/unit	0.53	0.53	1.06	0.62
302	Envelope	Energy Efficient Windows	424	0.1760	0.0	0	1	25	25	$272.96	100SF	3.72	3.72	7.45	4.75
303	Envelope	Cool Roofing	161	0.1010	-0.8	0	1	20	20	$664.88	1000 sq ft roof area	0.03	0.03	0.06	0.03
304	Envelope	Ceiling Insulation	188	0.1280	0.0	0	1	30	30	$600.00	1000 sq ft roof area	1.29	1.29	2.58	1.35
305	Envelope	Window Improvements	254	0.1000	7.1	0	1	20	20	$1,395.69	1000 sq ft roof area	0.09	0.09	0.18	0.09
306	Envelope	Wall Insulation	998	0.1890	0.0	0	1	30	30	$100.00	1000 sq ft wall area	55.47	55.47	110.94	5547.30
307	Envelope	Roof Insulation	50	0.0360	0.0	0	1	30	30	$54.88	1000 sq ft roof area	3.97	3.97	7.94	4.55
308	Envelope	Improved Duct Sealing	28	0.0170	0.0	0	1	18	18	$107.91	1000 sq ft roof area	0.82	0.82	1.64	0.84
321	Ventilation	Economizer	142	0.0080	-0.1	0	1	15	15	$123.00	ton	0.38	0.38	0.75	0.44
327	Ventilation	EMS for Manufacturing HVAC Fan	2,197	0.2500	0.0	0	1	15	15	$400.00	per Unit	1.98	1.98	3.97	8.46
328	Ventilation	VFD Return Fan	849	0.0510	0.0	0	1	10	10	$155.96	per Unit	1.37	1.37	2.74	5.68
329	Ventilation	VFD Supply Fan	884	0.1600	0.0	0	1	10	10	$155.96	per Unit	1.49	1.49	2.97	7.09
330	Ventilation	High Speed Fans	4,427	1.5970	0.0	0	1	7	7	$150.00	ton	6.46	6.46	12.91	645.59
331	Ventilation	High Volume Low Speed Fans	5,061	1.8400	0.0	0	1	10	10	$4,072.00	per motor	0.36	0.36	0.72	0.44
332	Ventilation	Destratification Fan	17	0.0080	0.0	0	1	15	15	$12.75	1000 sq ft cond floor a	0.53	0.53	1.06	0.65
333	Ventilation	Engineered CKV Hood	737	0.1600	0.0	0	1	15	15	$11.00	per	85.11	85.11	170.23	8511.33
341	Space Cooling - Chillers	Air cooled recip chiller	139	0.0890	0.0	0	1	20	20	$90.71	ton	0.79	0.79	1.59	1.01
342	Space Cooling - Chillers	Air-Cooled Screw Chiller	214	0.1070	0.0	0	1	20	20	$143.92	ton	0.74	0.74	1.47	0.93
343	Space Cooling - Chillers	Water Side Economizer	1,048	0.0000	0.0	0	1	15	15	$50.00	ton	7.29	7.29	14.57	728.69
344	Space Cooling - Chillers	VAV System Conversion	5,144	0.2210	0.0	0	1	20	20	$2,500.00	ton	1.45	1.45	2.90	2.03
345	Space Cooling - Chillers	Water-Cooled Chiller > 300 ton	112	0.0620	0.0	0	1	20	20	$101.49	ton	0.55	0.55	1.11	0.66
346	Space Cooling - Chillers	Motor Belt Replacement	77	0.0140	0.0	0	1	14	14	$2.00	ton	13.70	13.70	27.40	1370.46
347	Space Cooling - Chillers	Chilled Hot Water Reset	460	0.0510	1.9	0	1	5	5	$5.53	ton	16.65	16.65	33.30	1665.00
348	Space Cooling - Chillers	High Efficiency Pumps	337	0.0600	0.0	0	1	15	15	$233.33	ton	5.71	5.71	5.71	5.71
350	Space Cooling - Chillers	Chiller Tune Up	88	0.0160	0.0	0	1	5	5	$2.83	ton	4.85	4.85	9.70	485.23
351	Space Cooling - Chillers	VFD for Chilled Water Pump	478	0.1650	0.0	0	1	15	15	$200.00	ton	0.94	0.94	1.87	1.41
352	Space Cooling - Chillers	VFD for Tower Fans	594	0.1460	0.0	0	1	10	10	$155.96	per hp	1.07	1.07	2.15	2.29
362	HVAC Controls	Smart Thermostats	461	0.0000	0.0	0	1	10	10	$127.61	1000 sq ft cond floor a	2.55	2.55	5.11	5.14
363	HVAC Controls	EMS install	1,215	0.0220	0.0	0	1	15	15	$40.00	1000 sq ft cond floor a	11.73	11.73	23.47	1173.43
364	HVAC Controls	EMS Optimization	367	0.0210	0.0	0	1	20	20	$18.62	1000 sq ft	8.25	8.25	16.49	500.00
365	HVAC Controls	HVAC Occupancy Sensors	15	0.0030	0.0	0	1	15	15	$1.70	per unit	0.00	0.00	0.00	0.00
367	HVAC Controls	Zoning	187	0.0000	2.1	0	1	15	15	$500.00	1000 sq ft cond floor a	0.13	0.13	0.26	0.14
368	HVAC Controls	Thermostat Setback	108	0.0010	0.0	0	1	9	9	$49.71	1000 sq ft cond floor a	0.52	0.52	1.05	0.75
369	HVAC Controls	EMS Pump Scheduling	3,037	0.2802	0.0	0	1	15	15	$1.32	1000 sq ft cond floor a	1201.00	1201.00	2403.00	120145.00
370	HVAC Controls	Web Enabled EMS	869	-0.0170	0.0	0	1	15	15	$49.71	1000 sq ft cond floor a	29.49	29.49	58.98	2948.00
371	HVAC Controls	Retrocommissioning	3	0.0000	0.0	0	1	7	7	$0.15	1000 sq ft cond floor a	3.32	3.32	6.65	332.43
382	Space Cooling - Unitary and Split AC	DX Packaged Sysytem >65000 Btuh CEE Tier 1	63	0.0840	0.0	0	1	15	15	$166.48	ton	0.20	0.20	0.39	0.21
384	Space Cooling - Unitary and Split AC	Split System, <65,000 Btu/hr (CEE Tier 1)	70	0.0870	0.0	0	1	15	15	$801.85	ton	0.04	0.04	0.08	0.05
385	Space Cooling - Unitary and Split AC	Ground Source Heat Pump - Cooling	1,703	0.0930	0.0	0	1	15	15	$179.79	ton	0.64	0.64	1.28	0.84
387	Space Cooling - Unitary and Split AC	Water Loop Heat Pump (WLHP) - Cooling	36	0.0140	0.0	0	1	15	15	$22.00	ton	0.60	0.60	1.20	0.77
389	Space Cooling - Unitary and Split AC	Air Source Heat Pump	140	0.0580	0.0	0	1	15	15	$179.00	ton	1.22	1.22	2.45	2.24
390	Space Cooling - Unitary and Split AC	Advanced Rooftop Controls	2,474	1.9380	0.0	0	1	9	9	$187.50	ton	3.97	3.97	7.94	396.84
391	Space Cooling - Unitary and Split AC	HVAC Tune-up	59	0.0792	0.0	0	1	3	3	$32.00	ton	0.24	0.24	0.48	0.32
392	Space Cooling - Unitary and Split AC	Commercial/Industrial CO2 Heat Pump	275	0.1756	0.0	0	1	20	20	$68.77	ton	2.06	2.06	4.12	4.63
501	Lighting	Lamp & Ballast Retrofit (HPT8 Replacing T12)	54	0.0204	0.0	0	1	15	15	$34.15	per fixture	0.00	0.00	0.00	0.00
502	Lighting	Lamp & Ballast Retrofit (HPT8 Replacing Standard T8)	151	0.0310	-0.3	0	1	15	15	$18.00	per fixture, Replacing	4.65	4.65	4.65	4.65
503	Lighting	Lamp & Ballast Retrofit (Low Wattage HPT8 Replacing T12)	73	0.0275	0.0	0	1	15	15	$37.09	per fixture, Replacing	0.00	0.00	0.00	0.00
505	Lighting	Lamp & Ballast Retrofit (Low Wattage HPT8 Replacing Standard T8)	42	0.0158	0.0	0	1	15	15	$37.09	$/unit	0.00	0.00	0.00	0.00
506	Lighting	High performance T5 (replacing T8)	461	0.0940	-0.8	0	1	15	15	$100.00	per fixture	7.89	7.89	7.89	7.89
507	Lighting	Outdoor LED (>250 W MH)	174	0.0000	0.0	0	1	12	12	$200.00	per fixture	0.26	0.26	0.52	0.30
508	Lighting	Garage HID replacement with LED	611	0.0670	0.0	0	1	12	12	$400.00	per fixture	0.00	0.00	0.00	0.00

Measure #	End-Use	Measure Name	Per Unit Elec Savings	Per Unit Summer CP kW	MMBTU Savings	Water Savings (Gallons)	Persistence Factor	Measure Life	Effective Measure Life	Cost	Cost/Unit Descriptor	TRC	UCT 100% Incentive	UCT 50% Incentive	UCT TPB Incentive
509	Lighting	LED Exit Sign	201	0.0230	-0.2	0	1	15	15	$25.00	per fixture	2.91	2.91	5.81	290.55
512	Lighting	LED High Bay Lighting	4,160	0.9500	-0.9	0	1	16	16	$1,033.65	per lamp	1.55	1.55	3.10	3.53
513	Lighting	LED Low Bay Lighting	2,669	0.4900	-0.5	0	1	18	18	$1,706.00	per lamp	0.64	0.64	1.28	0.82
514	Lighting	Light Tube	344	0.1290	0.0	0	1	14	14	$500.00	per fixture	0.26	0.26	0.52	0.29
515	Lighting	High bay 4 lamp HPT8 vs (Metal halide 250 W)	677	0.1380	-1.2	0	1	15	15	$200.00	per fixture	5.79	5.79	5.79	5.79
516	Lighting	42W 8 lamp Hi Bay CFL	345	0.0790	0.0	0	1	12	12	$395.00	per fixture, Replacing	0.00	0.00	0.00	0.00
517	Lighting	HID Fixture Upgrade - Pulse Start Metal Halide	769	0.1756	0.0	0	1	13	13	$223.63	per fixture	0.00	0.00	0.00	0.00
520	Lighting	Interior Induction Lighting	4	0.0010	0.0	0	1	16	16	$1.53	Watt Reduced	1.07	1.07	2.14	1.72
522	Lighting	CFL Hard Wired Fixture	199	0.0410	-0.4	0	1	12	12	$37.50	per fixture	7.54	7.54	7.54	7.54
523	Lighting	Compact Fluorescent	199	0.0360	-0.4	0	1	3	3	$1.20	per lamp	48.87	48.87	48.87	48.87
524	Lighting	LED Screw In replacing incandescent	100	0.0180	-0.5	0	1	6	6	$3.00	$/unit	4.46	4.46	7.83	391.60
525	Lighting	LED Screw In Replacing CFL	15	0.0045	0.0	0	1	9	9	$16.41	Not Found	0.25	0.25	0.49	0.28
527	Lighting	CFL Reflector Flood	134	0.0245	0.0	0	1	2	2	$6.00	per lamp	0.00	0.00	0.00	0.00
528	Lighting	LED Downlight	108	0.0200	-0.3	0	1	15	15	$12.74	per fixture	2.34	2.34	4.67	233.60
529	Lighting	LED Troffer	101	0.0190	-0.3	0	1	18	18	$118.00	per lamp	0.24	0.24	0.48	0.28
536	Lighting	LED Linear Replacement Lamps	62	0.0110	-0.1	0	1	18	18	$5.99	$/unit	3.85	3.85	7.70	385.25
537	Lighting	LED Grow Light	4	0.0010	0.0	0	1	11	11	$1.53	$/unit	0.86	0.86	1.72	1.43
542	Lighting	Interior Non-Highbay/Lowbay LED Fixtures	3	0.0005	0.0	0	1	18	18	$0.75	$/unit	1.48	1.48	2.96	2.94
543	Lighting	Exterior HID Replaced with CFL	1,021	0.0000	0.0	0	1	12	12	$433.33	$/unit	0.00	0.00	0.00	0.00
544	Lighting	Exterior Linear Fluorescent	4,319	0.0000	0.0	0	1	12	12	$2,500.00	$/unit	0.00	0.00	0.00	0.00
545	Lighting	LED Specialty replacing CFL	16	0.0029	0.0	0	1	9	9	$18.41	$/unit	0.22	0.22	0.44	0.25
547	Lighting	CFL Screw in Specialty	133	0.0244	0.0	0	1	2	2	$4.58	per lamp	0.00	0.00	0.00	0.00
548	Lighting	LED Specialty replacing incandescent	114	0.0210	0.0	0	1	9	9	$6.50	per lamp	4.46	4.46	8.92	446.00
549	Lighting	SEM	37	0.0010	0.0	0	1	1	1	$1.00	per watt reduced	1.21	1.21	2.41	120.57
551	Lighting Controls	Smart Advanced Lighting Controls	2	0.0005	0.0	0	1	10	10	$1.51	per fixture	41.70	41.70	83.42	4170.73
552	Lighting Controls	Smart Web Based Lighting Controls	3	0.0006	0.0	0	1	10	10	$1.15	$/unit	0.83	0.83	1.66	1.44
553	Lighting Controls	Daylight Sensor Controls	6,407	1.3730	0.0	0	1	12	12	$3,000.00	10,000 SF	0.68	0.68	1.37	0.97
554	Lighting Controls	Lighting Power Density- Exterior	398	0.0000	0.0	0	1	10	10	$300.00	10,000 SF	0.35	0.35	0.69	0.42
555	Lighting Controls	Lighting Power Density - Parking Garage	8,760	0.9000	0.0	0	1	12	12	$220.00	per unit	0.00	0.00	0.00	0.00
556	Lighting Controls	Exterior Bi-level controls	531	0.4950	0.0	0	1	10	10	$333.00	per kW controlled	0.42	0.42	0.85	0.55
557	Lighting Controls	Occupancy Sensor	603	0.0160	-0.6	0	1	10	10	$100.00	per sensor	1.44	1.44	2.88	9.06
558	Lighting Controls	Occupancy Sensor & Daylight Sensor	764	0.1290	0.0	0	1	10	10	$150.00	per sensor	1.40	1.40	2.80	4.82
559	Lighting Controls	Central Lighting Control	8,341	1.5290	-7.5	0	1	12	12	$2,700.00	10,000 SF	0.90	0.90	1.80	1.58
560	Lighting Controls	Switching Controls for Multilevel Lighting (Non-HID)	5,838	1.0760	0.0	0	1	12	12	$3,000.00	10,000 SF	0.62	0.62	1.24	0.85
561	Lighting Controls	Lighting Power Density - Interior	2,669	0.4900	-7.5	0	1	15	15	$220.00	per kW reduced	3.35	3.35	6.69	334.66
562	Lighting	Long Day Lighting Dairy	6	0.0000	0.0	0	1	16	16	$1.79	per watt reduced	0.00	0.00	0.00	0.00
801	Space Heating	Air source heat pump heating	278	0.0850	0.0	0	1	15	15	$85.16	ton	1.22	1.22	2.44	2.24
803	Space Heating	Ground Source Heat Pump - Heating	304	0.1050	0.0	0	1	15	15	$179.79	ton	0.64	0.64	1.28	0.84
804	Space Heating	Ductless (mini split) - Heating	270	0.0870	0.0	0	1	15	15	$801.85	ton	0.13	0.13	0.26	0.13
805	Space Heating	Water Loop Heat Pump (WLHP) - Heating	40	0.0100	0.0	0	1	15	15	$22.00	ton	0.61	0.61	1.23	0.82
806	Space Heating	VFD Pump	2,564	0.2980	0.7	0	1	10	10	$149.14	per CHW pump hp	4.61	4.61	9.23	461.40
807	Space Heating	ECM motors on furnaces	720	0.0650	0.0	0	1	20	20	$250.00	per Furnace	1.19	1.19	2.39	2.00
901	Other	High Efficiency Transformer, single-phase	2	0.0010	0.0	0	1	30	30	$1.54	per fan	0.69	0.69	1.37	0.77
902	Other	NEMA Premium Transformer, single-phase	7	0.0030	0.0	0	1	30	30	$11.98	per kVA	0.31	0.31	0.62	0.33
903	Other	NEMA Premium Transformer, three-phase	10	0.0020	0.0	0	1	30	30	$10.46	per kVA	0.48	0.48	0.96	0.55
909	Other	High Efficiency Transformer, three-phase	7	0.0020	0.0	0	1	30	30	$6.08	$/unit	0.64	0.64	1.28	0.77
911	Other	Parking Garage Exhaust Fan CO Control	2,413	0.2754	28.4	0	1	15	15	$800.00	per unit	2.20	2.20	4.40	3.80
912	Other	Optimized Snow and Ice Melt Controls	0	0.0001	0.0	0	1	15	15	$0.15	SF	0.25	0.25	0.50	0.28
913	Other	Engine Block Heater Timer	576	0.8000	0.0	0	1	5	5	$50.00	per engine block	2.28	2.28	4.56	228.10
1001	Machine Drive	Sensors & Controls	1	0.0000	0.0	0	1	15	15	$0.01	per unit	2.68	2.68	5.36	68.87
1002	Machine Drive	Compressed Air Outdoor Air Intake	110	0.0152	0.0	0	1	20	20	$5.00	per hp	9.99	9.99	19.98	999.10
1003	Machine Drive	Electric Supply System Improvements	1	0.0000	0.0	0	1	15	15	$0.01	per unit	3.74	3.74	7.47	373.50
1004	Machine Drive	Advanced Efficient Motors	1	0.0000	0.0	0	1	20	20	$0.04	per unit	0.94	0.94	1.89	1.31
1005	Machine Drive	Industrial Motor Management	1	0.0000	0.0	0	1	5	5	$0.02	per unit	2.07	2.07	4.15	207.32
1006	Machine Drive	Compressed Air Low Pressure Drop Filters	65	0.0104	0.0	0	1	10	10	$22.00	per cfm	1.15	1.15	2.30	0.18
1007	Machine Drive	Motor System Optimization (Including ASD)	1	0.0000	0.0	0	1	15	15	$0.01	per unit	4.00	4.00	8.00	400.50
1008	Machine Drive	Pump System Efficiency Improvements	1	0.0000	0.0	0	1	15	15	$0.01	per unit	4.68	4.68	9.36	468.00
1009	Machine Drive	Fan System Improvements	1	0.0000	0.0	0	1	15	15	$0.02	per unit	1.56	1.56	3.12	3.54
1010	Machine Drive	Efficient Air Compressors	1,390	0.1930	0.0	0	1	15	15	$100.00	per hp	5.31	5.31	10.62	530.80
1011	Machine Drive	Compressed Air Pressure Flow Controller	73	0.0100	0.0	0	1	15	15	$25.00	per cfm	1.12	1.12	2.24	1.88
1012	Machine Drive	VFD for Process Fans	707	0.0000	0.0	0	1	15	15	$46.00	per hp	5.97	5.97	11.94	597.00
1013	Machine Drive	VFD for Process Pumps	1,082	0.0000	0.0	0	1	15	15	$94.00	per hp	4.47	4.47	8.94	447.00
1014	Machine Drive	High Efficiency Pumps	201	0.0000	0.0	0	1	15	15	$31.00	per hp	2.88	2.88	5.75	29.80
1015	Machine Drive	Compressed Air Audits and Leak Repair	496	0.0688	0.0	0	1	1	1	$8.00	per cfm	2.20	2.20	4.40	220.40
1016	Machine Drive	Compressed Air replacement with Air Blowers	5,588	4.1800	0.0	0	1	15	15	$620.00	per hp	4.28	4.28	8.55	427.60
1017	Machine Drive	Compressed Air Automatic Drains	2,097	0.3316	0.0	0	1	5	5	$100.00	per drain	3.41	3.41	6.81	340.70
1018	Machine Drive	Compressed Air Storage Tank	316	0.0500	0.0	0	1	25	25	$36.00	per hp	4.52	4.52	9.05	452.40
1019	Machine Drive	Compressed Air High Efficiency Dryers	53	0.0070	0.0	0	1	10	10	$20.00	per hp	0.78	0.78	1.55	1.23
1020	Machine Drive	Compressed Air Nozzles	21,142	6.3400	0.0	0	1	20	20	$76.75	per cfm	11.78	11.78	21.49	1077.00

LBWL **Measure Assumption Tab - Industrial**

Measure #	End-Use	Measure Name	Per Unit Elec Savings	Per Unit Summer CP kW	MMBTU Savings	Water Savings (Gallons)	Persistence Factor	Measure Life	Effective Measure Life	Cost	Cost/Unit Descriptor	TRC	UCT 100% Incentive	UCT 50% Incentive	UCT TPB Incentive
1026	Process Cooling & Refrig	Sensors & Controls	1	0.0000	0.0	0	1	15	15	$0.01	per unit	2.68	2.68	5.36	68.90
1027	Process Cooling & Refrig	Energy Information System	1	0.0000	0.0	0	1	15	15	$0.06	per unit	0.61	0.61	1.22	0.78
1028	Process Cooling & Refrig	Electric Supply System Improvements	1	0.0000	0.0	0	1	15	15	$0.01	per unit	3.74	3.74	7.47	373.00
1029	Process Cooling & Refrig	Improved Refrigeration	1	0.0000	0.0	0	1	15	15	$0.00	per unit	11.42	11.42	22.85	1142.00
1047	Industrial Other	Dewpoint Sensor Control for Dessicant Plastic Dryer	565	0.1000	0.0	0	1	15	15	$150.00	per unit	1.14	1.14	2.28	0.29
1031	Process Heating	Sensors & Controls	1	0.0000	0.0	0	1	15	15	$0.01	per unit	2.68	2.68	5.36	68.90
1032	Process Heating	Energy Information System	1	0.0000	0.0	0	1	15	15	$0.06	per unit	0.61	0.61	1.22	0.78
1033	Process Heating	Electric Supply System Improvements	1	0.0000	0.0	0	1	15	15	$0.01	per unit	3.74	3.74	7.47	373.00
1034	Process Heating	Decrease Oven Exhaust Flow	399	0.0874	0.0	0	1	20	20	$1.00	per unit	16.57	16.57	29.15	1457.00
1041	Industrial Other	High Efficiency Welders	761	0.3900	0.0	0	1	20	20	$200.00	per unit	2.00	2.00	4.00	4.26
1042	Industrial Other	3 Phase High Eff Battery Charger	2,595	0.2890	0.0	0	1	20	20	$872.50	per unit	1.34	1.34	2.68	2.28
1043	Industrial Other	Barrel Insulation - Inj. Molding (plastics)	1,210	0.2910	0.0	0	1	10	10	$80.00	per sq ft	4.48	4.48	8.96	447.00
1044	Industrial Other	Pellet Dryer Insulation (plastics)	185	0.1000	0.0	0	1	10	10	$40.00	per ft	1.51	1.51	3.02	4.24
1045	Industrial Other	Injection Molding Machine - efficient (plastics)	223	0.0500	0.0	0	1	20	20	$125.00	per ton capacity	0.84	0.84	1.68	1.12
1046	Industrial Other	Fiber Laser Replacing CO2 laser (auto industry)	32,562	5.0000	0.0	0	1	20	20	$60,000.00	per unit	0.25	0.25	0.50	0.27
1051	Agriculture	Other Industrial -Low-Energy Livestock Waterer	1,593	1.0000	0.0	0	1	10	10	$788.00	per unit	0.59	0.59	1.17	0.82
1052	Agriculture	Other Industrial -Dairy Refrigerator Tune-Up	0	0.0000	0.0	0	1	5	5	$0.05	per unit	0.32	0.32	0.64	0.43
1053	Agriculture	Greenhouse Environmental Controls	98	0.0000	0.0	0	1	15	15	$125.00	per unit	0.30	0.30	0.60	0.34
1054	Agriculture	Scroll Compressor with Heat Exchanger for Dairy Refrigeration	190	0.0000	0.0	0	1	15	15	$1,500.00	per unit	0.05	0.05	0.10	0.05
1055	Agriculture	Variable Speed Drive withHeat Exchanger, Milk	878	0.0000	0.0	0	1	15	15	$2,725.00	per unit	0.13	0.13	0.26	0.13
1056	Agriculture	Milk Pre-Cooler Heat Exchanger	1	0.0000	0.0	0	1	15	15	$0.15	per unit	2.59	2.59	5.17	36.50
1057	Agriculture	Variable Speed Drives for Dairy Vacuum Pumps	598	0.0000	0.0	0	1	10	10	$250.00	per unit	0.69	0.69	1.39	1.04
1058	Agriculture	VFD for Process Fans - Agriculture	520	0.0000	0.0	0	1	15	15	$46.00	per unit	4.39	4.39	8.78	439.00
1059	Agriculture	VFD for Process Pumps - Agriculture	290	0.0000	0.0	0	1	15	15	$46.00	per unit	2.45	2.45	4.90	20.20
1060	Agriculture	VFD for Process Pumps - Irrigation	195	0.0000	0.0	0	1	10	10	$46.00	per unit	1.23	1.23	2.46	3.01
1061	Agriculture	Grain Storage Temperature and Moisture Management Controller	349	0.0000	0.0	0	1	15	15	$233.00	per unit	0.58	0.58	1.16	0.73
1062	Agriculture	Low Pressure Sprinkler Nozzles	5	0.0000	0.0	0	1	15	15	$1.00	per unit	1.94	1.94	3.88	6.41
1063	Agriculture	Fan Thermostat Controller	1,586	0.0000	0.0	0	1	15	15	$50.00	per unit	12.32	12.32	24.64	1232.00
1064	Agriculture	LED Poultry Lights	6	0.0010	0.0	0	1	9	9	$1.53	per unit	0.97	0.97	1.94	0.29
1065	Agriculture	Long Daylighting Dairy	6	0.0010	0.0	0	1	16	16	$1.79	per unit	1.25	1.25	2.50	0.22
1066	Agriculture	Evaporator Fan Motor Controls Ag	537	0.2700	0.0	0	1	20	20	$30.13	per unit	8.80	8.80	17.60	71.23

APPENDIX D Global Assumptions

APPENDIX D - GLOBAL ASSUMPTIONS

Annual Avoided Costs							
	($/kWh)				$/kW/yr	$/kW/yr	$/MMBTU
Year	Summer On	Summer Off	Winter On	Winter Off	Capacity	T&D	Gas
2021	3.41	2.22	3.44	2.49	6.41	5.43	2.44
2022	3.42	2.21	3.40	2.44	6.41	5.43	2.49
2023	3.42	2.20	3.37	2.42	6.41	5.43	2.58
2024	3.42	2.24	3.38	2.46	6.41	5.43	2.66
2025	3.45	2.21	3.38	2.42	6.41	5.43	2.76
2026	3.41	2.22	3.34	2.43	6.41	5.43	2.88
2027	3.33	2.25	3.26	2.46	6.41	5.43	3.00
2028	3.21	2.29	3.14	2.50	6.41	5.43	3.12
2029	3.18	2.27	3.12	2.48	6.41	5.43	3.24
2030	3.15	2.26	3.09	2.46	12.05	5.43	3.36
2031	3.13	2.24	3.07	2.45	11.76	5.43	3.48
2032	3.10	2.23	3.04	2.43	11.46	5.43	3.56
2033	3.07	2.21	3.01	2.41	11.46	5.43	3.65
2034	3.04	2.20	2.99	2.40	11.46	5.43	3.74
2035	3.02	2.18	2.96	2.38	10.51	5.43	3.84
2036	2.99	2.17	2.94	2.36	10.51	5.43	3.93
2037	2.97	2.15	2.92	2.35	10.51	5.43	4.03
2038	2.94	2.14	2.89	2.33	10.51	5.43	4.13
2039	2.91	2.13	2.87	2.32	10.51	5.43	4.23
2040	2.89	2.11	2.84	2.30	8.79	5.43	4.34
2041	2.96	2.16	2.91	2.36	9.01	5.57	4.45
2042	3.03	2.22	2.99	2.42	9.23	5.71	4.56
2043	3.11	2.27	3.06	2.48	9.46	5.85	4.67
2044	3.19	2.33	3.14	2.54	9.70	6.00	4.79
2045	3.27	2.39	3.22	2.60	9.94	6.15	4.91
2046	3.35	2.45	3.30	2.67	10.19	6.30	5.03
2047	3.43	2.51	3.38	2.73	10.45	6.46	5.16
2048	3.52	2.57	3.46	2.80	10.71	6.62	5.29
2049	3.61	2.64	3.55	2.87	10.98	6.79	5.42
2050	3.70	2.70	3.64	2.94	11.25	6.95	5.56
2051	3.79	2.77	3.73	3.02	11.53	7.13	5.69
2052	3.88	2.84	3.82	3.09	11.82	7.31	5.84
2053	3.98	2.91	3.92	3.17	12.12	7.49	5.98
2054	4.08	2.98	4.02	3.25	12.42	7.68	6.13
2055	4.18	3.06	4.12	3.33	12.73	7.87	6.29
2056	4.29	3.14	4.22	3.41	13.05	8.07	6.44
2057	4.39	3.21	4.33	3.50	13.37	8.27	6.60
2058	4.50	3.29	4.44	3.59	13.71	8.47	6.77
2059	4.62	3.38	4.55	3.68	14.05	8.69	6.94
2060	4.73	3.46	4.66	3.77	14.40	8.90	7.11

Discount Rate:	4.66%
Inflation Rate:	2.50%

Line Loss Factors

Summer On	Summer Off	Winter On	Winter Off	Capacity	T&D
1.0402	1.0402	1.0402	1.0402	1.0402	1.0402

Demand-Side Management Potential Study

FINAL REPORT- MAY 7, 2020

prepared for

LANSING BOARD OF WATER & LIGHT

May

2020

prepared by

GDS ASSOCIATES INC

SIEMENS ENERGY BUSINESS ADVISORY