Seattle City Light

2026 Demand-Side Management Potential Assessment

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August 2025

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Definition of Terms

aMW	Average megawatt
AC	Air conditioning
BPA	Bonneville Power Administration
CBECS	Commercial Buildings Energy Consumption Survey
CBSA	Commercial Building Stock Assessment
CEIP	Clean Energy Implementation Plan
CETA	Clean Energy Transformation Act
COB	California-Oregon Border
Council	Northwest Power and Conservation Council
CPA	Conservation Potential Assessment
DSM	Demand-Side Management
DSMPA	Demand-Side Management Potential Assessment
ECM	Energy conservation measure
EHD	Environmental Health Disparities
ELCC	Effective Load-Carrying Capacity
EIM	Energy Imbalance Market
EPRI	Electric Power Research Institute
EUL	Effective useful life
EV	Electric vehicle
FPT	Flow Plan Tool
GHG	Greenhouse Gas
GCM	General Circulation Model
HVAC	Heating, Ventilation, and Air Conditioning
I-937	Initiative 937
ICE	Intercontinental Exchange
IRP	Integrated Resource Plan
kWh	Kilowatt-hour
LED	Light-emitting diode
MACA	Multivariate Adaptive Constructed Analogs
Mid-C	Mid-Columbia
MW	Megawatt
MWh	Megawatt-hour
NEEA	Northwest Energy Efficiency Alliance
NREL	National Renewable Energy Laboratory
NWPCC	Northwest Power & Conservation Council
O&M	Operations and maintenance
PV	Photovoltaic
RARE	Resource Adequacy Renewable Energy
RBSA	Residential Building Stock Assessment
RCW	Revised Code of Washington
REC	Renewable Energy Credits
RFP	Request for Proposals
RTF	Regional Technical Forum
RUL	Remaining useful life
S&P	Standard & Poor
SEC	Seattle Energy Code
T&D	Transmission and Distribution
TRC	Total resource cost
UEC	Unit energy consumption
UES	Unit energy savings
WAC	Washington Administrative Code

Acknowledgements

The authors would like to thank the Seattle City Light staff who provided invaluable guidance and support, especially Margaret Frey, Jennifer Finnigan, Verene Martin, Mike Hamilton, Katie Ewing, Rebecca Klein, and Alan Bach. The study required compiling a large amount of data from many sources, including several divisions at City Light.

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1. Executive Summary

1.1. Overview

Seattle City Light (City Light) engaged Cadmus to complete a Demand-Side Management Potential Assessment (DSMPA) to produce rigorous estimates of the magnitude, timing, and costs of conservation (henceforth referred to as "conservation" or "energy efficiency") and demand response resources in its service territory over the next 20 years, beginning in 2026. The DSMPA comprises the conservation potential assessment (CPA) and demand response potential assessment (DRPA). City Light incorporates the CPA and DRPA within the integrated resource planning (IRP) process to identify the cost-effective potential of energy efficiency and demand response, respectively. The DSMPA identifies energy efficiency and demand response potential in City Light's major customer sectors—residential, commercial, and industrial—while accounting for the impacts of climate change and building electrification.[1] The results of this assessment will also help inform the development of City Light's future programs. The study period aligns with the timeline for City Light's 2026 IRP and provides direct inputs into that analysis.

Table 1- shows the 20-year technical, achievable technical, and achievable economic potential for each resource considered in this study. Complete details of the DRPA can be found in Appendix E of this report.

Table 1-1. Summary of Energy Savings and Demand Reduction Potential, Cumulative 2045

	Energy (aMW)			Winter Coincident Peak Capacity (MW)		
Resource	**Technical Potential**	**Achievable Technical Potential**	**Achievable Economic Potential**	**Technical Potential**	**Achievable Technical Potential**	**Achievable Economic Potential**
Energy Efficiency	245	202	103	279	228	108
Demand Response	N/A	N/A	N/A	N/A	193	14

This study accomplishes several objectives:

- Fulfills statutory requirements of Chapter 194-37 of the Washington Administrative Code (WAC), Energy Independence Act (I-937). The WAC requires that City Light identify all achievable, cost-effective conservation potential for the upcoming 10 years.[2] The WAC also specifies that City Light's public biennial conservation target should be no less than the pro rata share of conservation potential over the first 10 years. The study estimates will inform City Light's targets for the 2026-2027 biennium.

[1] For this study, Cadmus estimated demand response potential for managed electric vehicle (EV) charging and conservation potential for efficient, residential EV chargers. We did not estimate conservation potential for efficient EV chargers in the commercial sector.

[2] Washington State Legislature. *Energy Independence Act.* Washington Administrative Code Chapter 194-37.

- Supports City Light's compliance with Washington State's Clean Energy Transformation Act (CETA), passed as Senate Bill 5116 in April 2019, to inform City Light's energy efficiency and demand response short- and long-term targets.[3] In addition, this study will inform City Light's near-term interim targets for its Clean Energy Implementation Plan (CEIP) as required by CETA. CETA sets additional requirements for City Light, such as including the social cost of carbon in avoided energy costs. This study, more broadly, supports City Light's Clean Energy Action Plan, a 10-year action plan described in the 2024 IRP Progress Report to meet CETA requirements.
- Develops up-to-date estimates of energy conservation measure (ECM) datasets for the residential, commercial, and industrial market sectors using measures consistent with the Northwest Power and Conservation Council's (Council) 2021 Power Plan, the Regional Technical Forum (RTF), and other data sources.
- Provides inputs into City Light's IRP and progress update reports, which is completed every two years in accordance with the Revised Code of Washington (RCW) 19.280.[4] City Light's IRP determines the mixture of supply-side and demand-side resources required over the next 20 years to meet customer demand and looks ahead to how City Light plans to meet the 2045 100% non-emitting standard of CETA. The IRP requires a thorough analysis of conservation potential to properly assess the reliability, cost, risk, and environmental impact of different resource portfolios for power generation, as well as to assess other demand-side resources that are not part of the CPA.
- Informs City Light's planning and budget setting for customer programs and City Light's load forecast.

Cadmus relied on City Light–specific data compiled from the 2022 Northwest Energy Efficiency Alliance (NEEA) Residential Building Stock Assessment (RBSA),[5] NEEA's 2019 Commercial Building Stock Assessment (CBSA),[6] and other regional data sources. Our analyses use methodology consistent with the

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[3] CETA requires proposing interim targets for meeting the standard under RCW 19.405.040(1) during the years prior to 2030 and between 2030 and 2045. This study estimates potential over 20 years, from 2026 through 2045.

[4] Under RCW 19.280, electric utilities with more than 25,000 customers that are not full requirements customers must provide progress reports on their IRPs every two years. Additionally, these utilities are required to develop and submit an updated IRP at least every four years.

[5] Northwest Energy Efficiency Alliance. *2022 Residential Building Stock Assessment*.

[6] Northwest Energy Efficiency Alliance. *2019 Commercial Building Stock Assessment*.

supply curve workbooks of the Council's 2021 Power Plan, published in March 2022.[7] We also incorporated savings and costs for all ECMs in the Council's 2021 Power Plan workbooks and selected unit energy savings (UES) workbooks from the RTF.[8] Cadmus did not include results from the Council's Ninth Power Plan as the planned completion will be in fall 2026. However, Cadmus did include draft Ninth Power Plan data where applicable, such as updated regional transmission and distribution avoided costs and program administration cost factors. The *Detailed Methodology* section of this report describes the sources and data used in greater detail.

Cadmus also calculated estimates of the demand response potential that align with the Council's demand response methodology and provide City Light with the data it needs to meet Washington State's CETA requirements. The methodology and findings of the Demand Response Potential Assessment are presented in Appendix E.

City Light's IRP analysis used the solar photovoltaic (PV) and battery potential results from the 2024 DSMPA; therefore, Cadmus did not repeat this analysis as part of the 2026 DSMPA. For a summary of the solar PV and battery potential, see the 2024 DSMPA report appendices. Cadmus used the battery potential (adoption) from the 2024 DSMPA as the basis to assess the demand response opportunities of batteries within the 2026 DRPA.

Cadmus completed the analysis under a condensed timeline by focusing on the following updates from the prior 2024 DSMPA:

- Added five new conservation measures: window heat pump, HVAC sizing, multifamily packaged terminal heat pump, heat pump with gas back-up, and electric vehicle (EV) chargers
- Updated to the latest RTF data for 10 high-impact measures
- Updated residential equipment, end-use saturations, and fuel shares with the most recent 2022 RBSA
- Revised the regional avoided transmission and distribution costs and program administration cost factors based on the draft Council Ninth Power Plan data
- Incorporated City Light's recent evaluation data for ductless heat pumps and heat pump water heaters
- Removed selected measures based on discussions with City Light program staff
- Changes to codes and standards and recent programmatic accomplishments

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[7] The 2021 Power Plan is a regional plan that provides guidance on resources to ensure a reliable and economical regional power system from 2022 to 2041. The Council develops supply curves covering a variety of supply- and demand-side resources, considers how to best meet the region's power needs across a range of future scenarios (balancing cost and risk), develops a draft plan, and gathers public input before releasing the final version.

[8] RCW 19.285.040 requires CPAs to use methodologies consistent with those used by the Council's most recent regional power plan.

- Adjusted achievable technical potential adoption rates to reflect the two-year timestep since the previous DSMPA.
- Removed acceleration of achievable technical potential adoption for certain commercial building types that were least likely to be adopted rapidly due to the WA State Clean Building Performance Standard (CBPS). City Light has seen limited programmatic adoption from these initiatives so far. In addition, there remains some uncertainty in the commercial market as well as uncertainty in number of customers who may opted for non-compliance (prior study assumed 100% compliance).
- Added four new demand response products: commercial EV supply equipment direct load control, commercial time-of-use, residential opt-out time-of-use, and residential non-incentivized behavioral measures.

In addition, City Light updated the IRP modeling tools and analyses that optimize resource selections. More details can be found in the *Long-Term Resource Planning Model for DSMPA* section of this report.

1.2. Scope of Analysis

For this study, Cadmus analyzed three sectors—residential, commercial, and industrial—and, where applicable, considered multiple market segments, construction vintages (new and existing), and end uses:

- **Residential:** Eight segments, including single-family and multifamily homes (including low-rise, mid-rise, and high-rise) and highly impacted[9] single-family and multifamily homes (including low-rise, mid-rise, and high-rise)
- **Commercial:** 20 major commercial segments (including offices, retail, and other segments)
- **Industrial:** Eight segments, including energy-intensive manufacturing, primarily process-driven customers, and water and wastewater treatment plants[10]

For each sector, Cadmus developed a baseline end-use load forecast that assumed no new future programmatic conservation, accounted for the effects of climate change,[11] and building electrification. The baseline forecast largely captured savings from building energy codes, equipment standards, and other naturally occurring market forces. Cadmus calculated energy efficiency potential estimates by

9 Highly impacted communities are defined by the Washington State Department of Heath based on a census tract ranking of 9 or 10 on the Environmental Health Disparities (EHD) Map. This ranking considers 19 factors, such as environmental exposures and effects, socioeconomic factors, and sensitive populations. More details on the definition and how Cadmus disaggregated the data are provided in section 1.3.5 of this report.

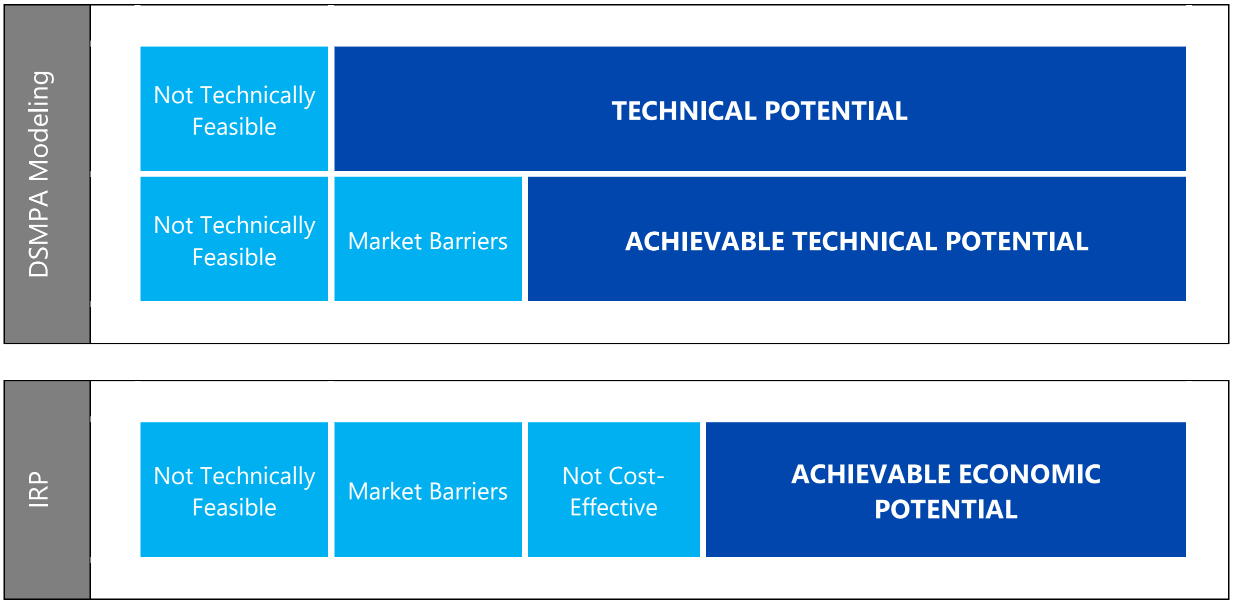
10 In addition to these eight segments, the load forecast included industrial district steam, spot loads, and streetlighting loads provided by City Light. However, Cadmus did not estimate conservation or demand response potential in these segments, so they are excluded from this report.

11 Cadmus did not account for the effects of climate change on the industrial sector.

assessing the impact of each ECM on this baseline forecast. Therefore, conservation potential estimates presented in this report represent savings beyond codes and standards and naturally occurring savings.

Consistent with the WAC requirements, Cadmus considered two types of energy efficiency potential, as shown in Figure 1-1. City Light determined a third potential—achievable economic—through the IRP's optimization modeling.

Figure 1-1. Types of Energy Efficiency Potential



These three types of potential are described as follows:

Technical potential: This is the total amount of energy efficiency that could be collected within City Light's service territory, assuming that all feasible resource opportunities can be captured regardless of cost and market barriers such as customer willingness to adopt. The potential is only limited by physical and operational constraints.

Achievable technical potential: This is the portion of technical potential assumed to be achievable during the study's forecast, regardless of the acquisition mechanism. For example, savings may be acquired through utility programs, improved codes and standards, and market transformation. The achievable technical potential considers market barriers such as customer awareness, willingness to adopt measures, and historical program participation – while not constrained by cost-effectiveness.

Achievable economic potential: This is the portion of achievable technical potential determined to be cost-effective by the IRP's optimization modeling, in which either bundles or individual energy efficiency measures are selected based on cost and savings. The cumulative potential for these selected bundles constitutes achievable economic potential.

Cadmus provided City Light resource planning staff and their IRP modeling consultant, Sylvan Energy Analytics, with forecasts of achievable technical potential, which City Light then entered as variables in the IRP's optimization model to determine achievable economic potential.

To be consistent with WAC requirements of relying on cost-effective energy efficiency, Cadmus bundled the resulting forecasts of achievable technical potential by levelized costs bin for the IRP modeling team. The IRP modeling team then determined the amount of cost-effective energy efficiency that could be considered as a resource within the IRP. See *Long-Term Resource Planning Model for DSMPA s*ection and Appendix D. Measure Details for more information.

1.3. Summary of Results

The study found 124 average megawatts (aMW) of achievable technical conservation potential in the first 10 years (cumulative in 2035) in City Light's service territory.[12] To inform I-937 and CEIP energy efficiency targets, Cadmus calculated two-year and four-year cumulative achievable technical potential. Cumulative achievable technical potential equals 29 aMW in the first two years and 54 aMW in the first four years.

Furthermore, City Light used its IRP optimization model to select measures based on the levelized total resource cost (TRC). Overall, the cumulative 20-year achievable economic potential is 103 aMW, with 78 aMW acquired in the first 10 years. The *pro rata* share (20% of 10-year achievable economic potential), which represents City Light's minimum biennial target, equals 16 aMW. All estimates of potential in this report are presented at the generator, which means they include line losses.[13]

1.3.1. Technical Potential

Table 1- shows the cumulative technical potential for each sector in 2045. Overall, Cadmus identified 245 aMW of technically feasible conservation potential by 2045—the equivalent of 16% of forecasted baseline sales. The study results are presented as a percentage of forecasted baseline sales, which provides a useful benchmark for comparison against City Light's previous studies. The baseline sales reported in the subsequent tables include City Light's EV forecasts for the commercial and residential sectors. They do not include industrial forecasts for spot loads or district steam since these categories require custom engineering work that does not conform to the standard efficiency measures in the industrial sector. Similarly, streetlighting is not included in the baseline sales data, because City Light has installed all efficient measures in this segment and there is no remaining potential. The residential, commercial, and industrial sectors account for 19%, 15%, and 8% of the 20-year technical potential, respectively. Please note that due to rounding, some values presented in the tables and figures may not sum precisely.

[12] An aMW refers to a unit of measure that represent one million watts (MW) delivered continuously 24 hours a day for each day of the year (for a total of 8,760 hours in non-leap years). A detailed description of MW and aMW can be found on the Council's website: https://www.nwcouncil.org/reports/columbia-river-history/megawatt

[13] City Light estimates transmission and distribution line losses to be 8.31%, so the minimum biennial target at a customer site is 14.3 aMW.

Table 1-2. Cumulative Technical Potential by Sector (2026–2045)

Sector	Baseline Sales–20-Year (aMW)	Technical Potential–20-Year (aMW)	Technical Potential as % of Baseline Sales
Residential	512	97	19%
Commercial	908	138	15%
Industrial	109	9	8%
Total	**1,530**	**245**	**16%**

1.3.2. Achievable Technical Potential

Table 1- shows the cumulative achievable technical potential for each sector in 2045. Overall, Cadmus identified 202 aMW of technically feasible achievable potential by 2045—the equivalent of 13% of forecasted baseline sales. The residential, commercial, and industrial sectors account for 16%, 12%, and 7% of the cumulative achievable technical potential, respectively.

Table 1-3. Cumulative Achievable Technical Potential by Sector (2026–2045)

Sector	Baseline Sales–20-Year (aMW)	Achievable Technical Potential–20-Year (aMW)	Achievable Technical Potential as % of Baseline Sales
Residential	512	81	16%
Commercial	908	113	12%
Industrial	109	8	7%
Total	**1,530**	**202**	**13%**

Table 1- provides two-year, four-year, 10-year, 20-year, and pro rata share of the cumulative achievable technical potential by sector.[14] The commercial sector provides the majority of the cumulative achievable technical potential. This is due to the commercial sector's higher baseline sales compared with those of the residential and industrial sectors.

Table 1-4. Cumulative Achievable Technical Potential by Sector and Time Period

Sector	Achievable Technical Potential (aMW)				
	2-Year (2026-2027)	4-Year (2026–2029)	10-Year (2026–2035)	20-Year (2026–2045)	20% of 10-Year Potential
Residential	7	13	35	81	7
Commercial	20	38	82	113	16
Industrial	1	3	6	8	1
Total	**29**	**54**	**124**	**202**	**25**

Table 1- provides the winter and summer technical, achievable technical, and achievable economic capacity savings from energy efficiency by sector in 2045 in megawatts (MW). Capacity savings represent the average demand reduction for each season based on City Light's peak period definitions. The

14 Under Chapter 194-37 of the WAC Energy Independence Act, City Light's public biennial conservation target must be no less than 20% of the 10-year potential—representing its "pro rata share."

commercial sector accounts for the majority of the total cumulative winter and summer capacity achievable technical and economic potential. The residential sector accounts for 51% of the winter capacity achievable technical potential but only 25% of the summer capacity achievable technical potential, which reflects the relatively higher saturation of residential electric space heating loads compared with residential cooling loads.

Table 1-5. Cumulative Winter and Summer Capacity (MW) Savings by Sector (2026–2045)

Sector	Technical Potential		Achievable Technical Potential		Achievable Economic Potential	
	Winter MW	Summer MW	Winter MW	Summer MW	Winter MW	Summer MW
Residential	140	86	116	73	17	11
Commercial	130	248	104	208	82	135
Industrial	9	10	8	8	8	8
Total	**279**	**344**	**228**	**289**	**108**	**154**

Table 1- provides the two-year, four-year, and 10-year summer and winter capacity savings by sector. In the first 10 years of the study period, the cumulative winter achievable technical capacity savings are 138 MW, which is 61% of the 20-year cumulative winter achievable technical capacity savings. The 10-year cumulative summer achievable technical capacity savings are 200 MW, which is 69% of the 20-year cumulative summer achievable technical capacity savings.

Table 1-6. Cumulative Winter and Summer Capacity (MW) Savings by Sector and Time Period

Sector	Cumulative Winter Achievable Technical Potential (MW)			Cumulative Summer Achievable Technical Potential (MW)		
	2-Year (2026-2027)	4-Year (2026–2029)	10-Year (2026–2035)	2-Year (2026-2027)	4-Year (2026–2029)	10-Year (2026–2035)
Residential	10	19	51	6	11	31
Commercial	21	38	76	33	63	148
Industrial	1	3	6	2	3	7
Total	**32**	**60**	**134**	**40**	**77**	**186**

1.3.3. Technical and Achievable Technical Potential Comparison to the 2024 DSMPA

The 2026 DSMPA identified 245 aMW of cumulative, final-year technical potential, compared with 263 aMW in the 2024 DSMPA, as shown in Table 1-. The 7% decrease in cumulative, final-year technical potential is due to several key factors:

The study horizon for the 2024 DSMPA was 22 years, whereas the 2026 DSMPA study horizon is 20 years to align on the final study year of 2045. This is the year that CETA requires a complete transition to clean electricity.

While both studies incorporated the impacts of building electrification and climate change in the baseline forecast, the 2026 DSMPA used updated projections from City Light.[15]

- Cadmus updated residential fuel shares and saturations based on the most recent (2022) NEEA RBSA site data. The 2024 DSMPA used the 2017 RBSA.
- Cadmus incorporated updates to codes and standards since the 2024 DSMPA, such as the 2029 residential federal standard for heat pump water heaters and RCW 70A.230.020 prohibiting fluorescent lighting sales.

Based on discussions with City Light program staff, Cadmus removed measures for streetlighting and controls, residential wastewater impacts, spas, fryers, and refrigerator and freezer recycling. These removals had various reasons ranging from measures achieving market saturation, state and city codes limiting program opportunities, and feasibility in measure implementation within City Light'sd service area.

Table 1-7. Final Year Cumulative Technical Potential Comparison by Sector

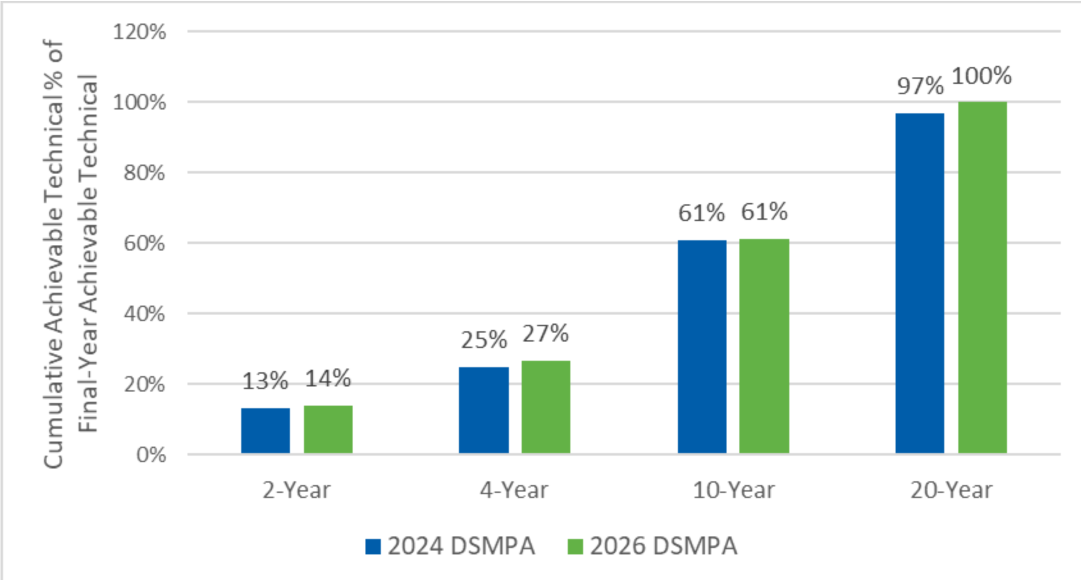
Sector	2026 DSMPA			2024 DSMPA		
	Baseline Sales– 20 Year* (aMW)	Technical Potential– 20 Year (aMW)	Technical Potential as % of Baseline Sales	Baseline Sales– 22 Year* (aMW)	Technical Potential – 22 Year (aMW)	Technical Potential as % of Baseline Sales
Residential	439	97	22%	398	95	24%
Commercial	698	138	20%	718	155	22%
Industrial	109	9	8%	124	13	11%
Total	**1,246**	**245**	**20%**	**1,240**	**263**	**21%**

**Note: The baseline sales do not include EV sales in the residential and commercial sectors for both the 2026 and 2024 DSMPA values*

Figure 1-2 illustrates that the 2026 DSMPA realized a higher proportion of total achievable technical potential in the initial years of the study. This is because the 2026 DSMPA has a 20-year study horizon, whereas the 2024 DSMPA has a 22-year horizon. The two additional years in the 2024 DSMPA's study horizon allow for more achievable technical potential.

[15] Electrification forecast and climate change impacts provided by City Light and based on prior City Light modeling and research.

Figure 1-2. Cumulative Achievable Technical Potential as a Percentage of Total Achievable Technical Potential



To estimate the annual acquisition rate of energy efficiency potential in both the 2024 and 2026 DSMPA, Cadmus used assumptions from the 2021 Power Plan. The 2021 Power Plan identifies ramp rates, also known as adoption curves, for all energy efficiency measures. These ramp rates estimate annual adoption of the measure based on market readiness, adoption barriers, and infrastructure.

The 2021 Power Plan ramp rates cover the 20-year period from 2022 to 2041. Since the study period for both the 2024 and 2026 DSMPA extends to 2045, Cadmus extrapolated these ramp rates to cover the additional years. This is detailed in the *6.2.2 Achievable Technical Potential* section). In addition, Cadmus adjusted the starting point for the ramp rates to 2024 for the 2026 DSMPA and 2022 for the 2024 DSMPA to reflect the adoption of efficiency measures since the publication of the 2021 Power Plan. These adjustments contribute to a higher percentage of overall potential in the initial years of the study period.

Similar to the prior DSMPA, this study shows the savings are front-loaded in the earlier part of the study, with the 10-year estimate representing 61% of the 20-year achievable technical potential. This reflects the assumption (consistent with the Council ramp rates) that the most market-ready retrofit measures and easily adopted energy-efficient equipment will be adopted faster in the first 10 years. In the later years, the remaining potential consists of equipment stock that have long turn-over periods (e.g., long effective-useful lives) as well as the rate of adoption slows for the remaining retrofit measures as the measure approaches full market saturation making it more challenging to implement. Additional detail on ramp rates can be found in the *6.2.2 Achievable Technical Potential* section.

The industrial sector in the 2026 DSMPA included measures and savings methodologies based on the 2021 Power Plan, such as HVAC measures, forklift battery chargers, compressors, fans, pumps, and other motor-driven systems. Similar to the prior DSMPA, Cadmus included non-Council measures, such as industrial generator block heaters, retro-commissioning, and welder system upgrades. Due to following a similar methodology, the potential in the industrial sector did not change significantly compared with the 2024 DSMPA. This is further detailed in the *5.1.3. Changes in Industrial Technical Potential* section.

1.3.4. Incorporating Conservation into City Light's IRP

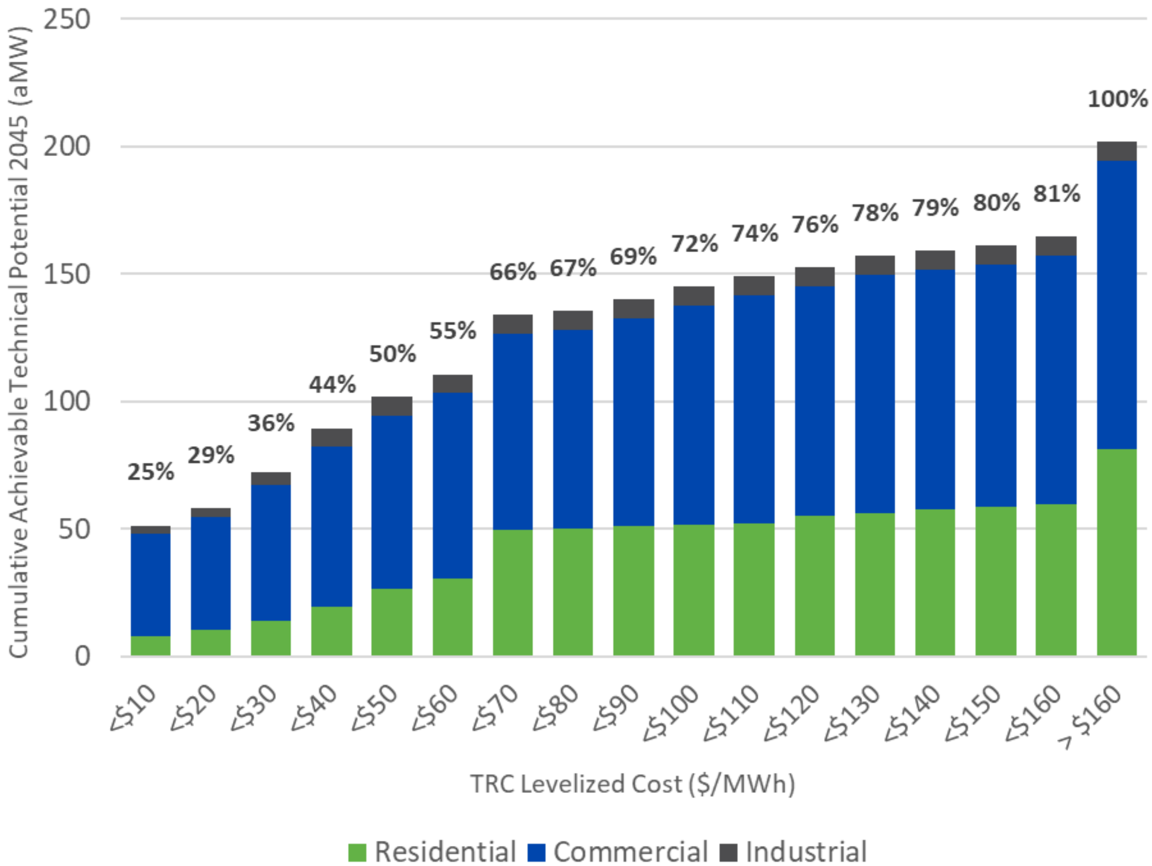
Cadmus summarized the achievable technical potential for energy efficiency, described above, by the levelized cost groups (bins)[16] of conserved energy by customer class for inclusion in City Light's IRP framework.[17] We calculated these costs over a 20-year program life—*Long-Term Resource Planning Model for DSMPA* section provides additional detail on the levelized cost methodology.

Table 1-8 shows the total achievable technical potential available over the 20-year study period, presented in $10 levelized cost increments. For example, 72 aMW, or 36% of the cumulative 2045 achievable technical potential has a levelized cost of less than or equal to $30 per megawatt-hour. Additionally, the figure shows that 19% of the total achievable technical potential has a levelized cost of greater than $160 per megawatt-hour.

[16] Levelized cost groups or "bins" identify a group of measures with similar costs based on a cost per MWh range (e.g., $20 per MWh to $29 per MWh). These bins help planners select groups of energy efficient measures in the IRP.

[17] The customer class the IRP used to group measures included sector, highly impacted community status (for residential customers), and commercial building size status (small or large). It also included a weather sensitivity designation depending on the type of measure being evaluated.

Table 1-8. Electric Supply Curve – Cumulative 20-Year Achievable Technical Potential (Levelized Cost Bins)



1.3.5. Achievable Economic Potential

After incorporating the achievable technical levelized cost of conserved energy bins, the IRP model identified an optimal amount of annual conservation. Bundling resources into distinct cost groups allowed the portfolio optimization model to select the combination of conservation cost bundles by sector that provided City Light with the least-cost portfolio alongside renewable resources while also achieving resource adequacy targets, I-937 requirements, and CETA requirements. Details of resource adequacy can be found in the Resource Adequacy section. By integrating conservation choices alongside renewable supply options into the portfolio optimization model, City Light captured the different value streams from all resources within the same analytical framework.

The resulting IRP analysis selected 103 aMW of achievable economic potential by 2045 with sector-specific selections shown in Table 1-. Cumulative 20-year achievable economic potential accounted for 7% of the total baseline sales in 2045. The commercial sector had the greatest achievable economic potential relative to baseline sales, accounting for 9% of the 2045 commercial baseline sales. This was followed by the industrial sector's cumulative achievable economic potential, which accounted for 7% of the 2045 commercial baseline sales. Finally, the residential sector's cumulative achievable economic potential made up 2% of the 2045 residential baseline sales.

The IRP portfolio optimization model is differentiated the levelized TRC by sector, allowing it to select the specific energy efficiency cost bins that best fits City Light's portfolio and minimize the overall costs. This also recognizes that the conservation supply curves for each sector have different shapes, limits, and elasticities. As shown in Table 1-9, the achievable economic potential represents a levelized TRC of $30 or less per megawatt-hour for residential, $160 or less per megawatt-hour for commercial, and $70 or less per megawatt-hour for industrial.

Table 1-9. Cumulative Achievable Economic Potential by Sector (2026–2045)

Sector	Levelized TRC ($/MWh)	Baseline Sales 20-Year (aMW)	20-Year Achievable Economic Potential (aMW)	Achievable Economic Potential as % of Baseline Sales
Residential	30	512	13	2%
Commercial	160	908	82	9%
Industrial	70	109	8	7%
Total	**N/A**	**1,530**	**103**	**7%**

Table **1-10** provides the two-, four-, 10-, and 20-year cumulative achievable economic potential estimates by sector. The final column shows the pro rata share of the achievable economic potential, which represents the lower limit for the biennial conservation target (as defined by I-937). Overall, 20% of the total 20-year achievable economic potential is achieved in the first two years, and 76% is achieved in the first 10 years.

Table 1-10. Cumulative Achievable Economic Potential by Sector and Time Period

Sector	Achievable Economic Potential – aMW				
	2-Year (2026–2027)	4-Year (2026–2029)	10-Year (2026–2035)	20-Year (2026–2045)	20% of 10-Year Potential
Residential	3	5	9	13	2
Commercial	17	31	62	82	12
Industrial	1	3	6	8	1
Total	**21**	**39**	**78**	**103**	**16**

In Seattle, the 2021 Seattle Energy Code requires new construction buildings to meet stringent energy efficiency standards, particularly for insulation, HVAC systems, lighting, and water heating. These rules are designed to reduce energy use and carbon emissions, often necessitating the use of electric systems over fossil fuels and compliance with advanced performance metrics. Table 1-11 details the achievable economic potential attributed to new construction buildings in the residential and commercial sectors at several timesteps in the study. The potential study did not include any new industrial buildings in City Light's service area that would offer energy efficiency savings opportunities during the study period.

Table 1-11. Cumulative Achievable Economic New Construction Potential by Sector and Time Period

Sector	Achievable Economic Potential – aMW			
	2-Year (2026–2027)	4-Year (2026–2029)	10-Year (2026–2035)	20-Year (2026–2045)
Residential	0.1	0.2	0.6	1.3
Commercial	0.05	0.1	0.3	0.9
Total	**0.2**	**0.3**	**0.9**	**2.2**

Table 1-12 provides achievable economic potential estimates of the two-, four-, and 10-year summer and winter capacity savings by sector.

Table 1-12. Cumulative Winter and Summer Capacity (MW) Savings by Sector and Time Period

Sector	Cumulative Winter Achievable Economic Potential (MW)			Cumulative Summer Achievable Economic Potential (MW)		
	2-Year (2026-2027)	4-Year (2026–2029)	10-Year (2026–2035)	2-Year (2026-2027)	4-Year (2026–2029)	10-Year (2026–2035)
Residential	4	7	14	2	4	8
Commercial	19	34	63	23	44	99
Industrial	1	3	6	2	3	7
Total	**24**	**44**	**83**	**27**	**51**	**114**

Compared to the 2024 DSMPA, the IRP model identified 22% less achievable economic potential. This is largely driven by the IRP selection of residential measures with a total resource cost of less than $30/MWh. In the previous DSMPA, the residential achievable economic potential included all measures with levelized cost values less than $160/MWh. The commercial sector includes slightly more potential due to the inclusion of measures with a higher total resource cost (up to $160/MWh) than the 2024 DSMPA (up to $40/MWh). The industrial achievable economic potential has a slight decrease as a result of the decrease in overall industrial technical potential identified between the two studies. Table 1-13 provides the sector level achievable economic potential identified in each of the two studies.

Table 1-13. Final Year Cumulative Achievable Economic Potential Comparison by Sector

Sector	2026 DSMPA			2024 DSMPA		
	Baseline Sales – 20-Year (aMW)	Achievable Economic Potential – 20-Year (aMW)	Achievable Economic Potential as % of Baseline Sales	Baseline Sales – 22-Year (aMW)	Achievable Economic Potential – 22-Year (aMW)	Achievable Economic Potential as % of Baseline Sales
Residential	439	13	3%	398	50	13
Commercial	698	82	12%	718	72	10
Industrial	109	8	7%	124	10	8
Total	**1,246**	**103**	**8%**	**1,240**	**132**	**11%**

**Note: The baseline sales do not include EV sales in the residential and commercial sectors for both the 2026 and 2024 DSMPA values*

Highly Impacted Communities

Cadmus estimated potential impacts for highly impacted communities within the City Light service area. We used the same approach used in the 2024 DSMPA, which considered equity by including highly impacted communities in the study segmentation. The Washington State Department of Health defines a highly impacted community as "the census tract ranks a 9 or 10 on the Environmental Health Disparities (EHD) Map". They also include the census tracts "covered or partially covered by 'Indian Country' as defined in and designated by statute."[18] The EHD contains 19 criteria, which are grouped under environmental exposures (including fossil fuel pollution and vulnerability to climate change impacts that contribute to health inequities), environmental effects, socioeconomic factors, and sensitive populations. Cadmus selected highly impacted communities as the equity metric because of the data granularity available.

Cadmus disaggregated highly impacted customers within the DSMPA based on income qualification in the City Light Utility Discount Program and Washington EHD index for income-qualified customers.[19,20] Thus, only customers with a household income equal to or less than 70% of the state median income, by household size, and with an EHD rank of 9 and higher were considered highly impacted.

[18] Washington State Department of Health. Accessed June 2023. "Instructions for Utilities to Identify Highly Impacted Communities." https://doh.wa.gov/data-statistical-reports/washington-tracking-network-wtn/climate-projections/clean-energy-transformation-act/ceta-utility-instructions

[19] City of Seattle, Seattle Public Utilities. Accessed June 2023. "Utility Discount Program." https://www.seattle.gov/utilities/your-services/discounts-and-incentives/utility-discount-program

[20] Washington State Department of Health. Accessed June 2023. "Washington Environmental Health Disparities Map." https://doh.wa.gov/data-and-statistical-reports/washington-tracking-network-wtn/washington-environmental-health-disparities-map

Table 1-14 shows the achievable economic potential for the highly impacted communities. The 20-year cumulative, achievable economic potential for these communities represents 31% of the total residential sector's achievable economic potential.

Table 1-14. Highly Impacted Community Achievable Economic Potential by Segment and Time Period

Highly Impacted Segment	Highly Impacted Achievable Economic Potential (aMW)			
	2-Year (2026-2027)	4-Year (2026–2029)	10-Year (2026–2035)	20-Year (2026–2045)
Single-family	0.5	0.8	1.6	2.4
Multifamily Low-rise	0.2	0.3	0.6	0.7
Multifamily Mid-rise	0.1	0.2	0.4	0.5
Multifamily High-rise	0.1	0.1	0.2	0.3
Total	**0.8**	**1.4**	**2.8**	**3.9**

1.4. Organization of This Report

This report presents the study findings in three volumes. Volume I—this document—presents the methodologies and findings of the energy efficiency potential assessment. Volume II contains appendices and provides methodologies and detailed results of demand response potential assessment along with supplemental materials..

Volume I includes the following chapters:

- *Methodology* provides an overview of the methodology Cadmus and City Light used to estimate technical, achievable technical, and achievable economic potential.
- *Baseline Forecast* provides detailed sector-level results for Cadmus' baseline end-use forecasts.
- *Energy Efficiency Potential* provides detailed sector, segment, and end-use specific estimates of conservation potential as well as a discussion of top-saving measures in each sector. It also provides the potential estimates for scenarios.
- *Comparison to* shows how this study's results (the 2026 DSMPA) compared with City Light's prior DSMPA.
- *Detailed Methodology* describes Cadmus' combined top-down/bottom-up modeling approach through several sections.
    - *Developing Baseline Forecasts* provides an overview of Cadmus' approach to producing baseline end-use forecasts for each sector.
    - *Measure Characterization* describes Cadmus' approach to developing a database of ECMs, deriving from the estimates of conservation potential. This section discusses how Cadmus adapted measure data from the 2021 Power Plan, the RTF, the RBSA, the CBSA, and other sources for this study.

- *Estimating Conservation Potential* discusses assumptions and underlying equations used to calculate technical and achievable technical potential.
- *Long-Term Resource Planning Model for DSMPA* describes the DSMPA modeling approach, inputs, and how it informs the forthcoming IRP.

Volume II contains these appendices:

- Appendix A. Washington Initiative 937 (I-937) Compliance Documentation
- Appendix B. Baseline Data
- Appendix C. Detailed Assumptions and Energy Efficiency Potential
- Appendix D. Measure Details[21]
- Appendix E. Demand Response Potential Assessment

[21] Appendix D includes sector, end-use group, and measure-level results by technical, achievable technical, and the IRP model selected potential (achievable economic potential).

2. Methodology

This chapter provides an overview of the methodology Cadmus used in the 2026 DSMPA, followed by an explanation of the considerations for the design of this potential study. The methodology is described in greater detail in the *6. Detailed Methodology* section.

2.1. Overview

Estimating conservation potential draws upon a sequential analysis of various ECMs in terms of technical feasibility (technical potential), expected market acceptance, and the normal barriers that could impede measure implementation (achievable technical potential).

For this assessment, Cadmus followed three primary steps:

1. Developed the baseline forecast, which involved determining the 20-year future energy consumption by sector, market segment, and end use. We calibrated the base year (2025) to City Light's sector-level corporate load forecast produced in 2024. Baseline forecasts in this report included estimated impacts of market-driven efficiency and codes and standards. Forecasts also included the impacts of building electrification and climate change. Cadmus worked with the City Light's load forecast team to determine all of these impacts.
2. Estimated technical potential based on the incremental difference between the baseline load forecast and an alternative forecast reflecting the technical impacts of specific energy efficiency measures.
3. Estimated achievable technical potential by applying ramp rates and achievability percentages to technical potential, which is described in greater detail later in this section.

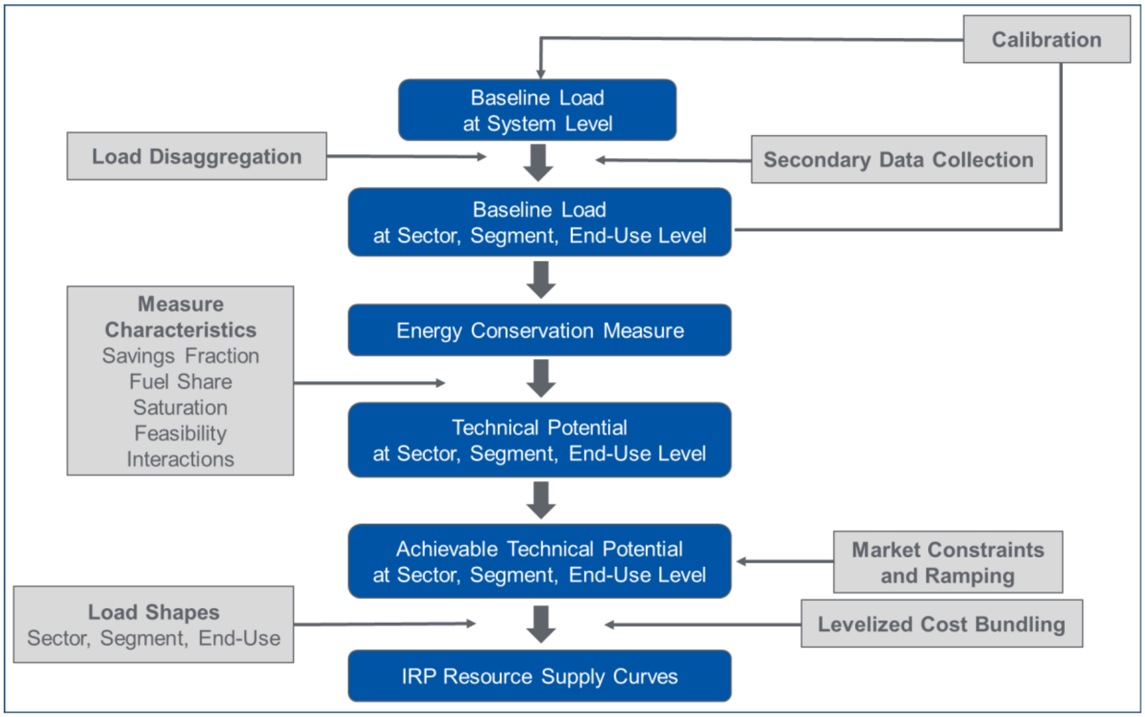
This approach offered two advantages:

Savings estimates were driven by a baseline forecast that is consistent with the assumptions used in City Light's adopted 2024 corporate load forecast. The approach had consistency among all assumptions underlying the baseline and alternative forecasts—technical and achievable technical potential. The alternative forecasts changed relevant inputs at the end-use level to reflect ECM impacts. Because estimated savings represented the difference between baseline and alternative forecasts, they could be directly attributed to specific changes made to analysis inputs.

Cadmus' general methodology can be best described as a combined top-down/bottom-up approach. As shown in Figure 2-1, the top-down component began with the most current load forecast, adjusting for enacted building codes, equipment efficiency standards, climate change, and market trends, including building electrification. We then disaggregated this load forecast into its constituent customer sectors, customer segments, and end-use components.

The bottom-up component estimated electric consumption for each major building end-use and applied the potential technical impacts of various ECMs to each end use. The analysis included assumptions of end-use equipment saturations, fuel shares, ECM technical feasibility, ECM cost, and engineering estimates of ECM unit energy consumption (UEC) and savings. A detailed description of the methodology can be found in the *6. Detailed Methodology* section.

Figure 2-1. Overall Methodology for Assessment of Demand Side Management Potential



In the final step, Cadmus developed energy efficiency supply curves so City Light's IRP portfolio optimization model could identify the amount of cost-effective energy efficiency. The portfolio optimization model required hourly forecasts of electric energy efficiency potential. To produce these hourly forecasts, Cadmus applied hourly end-use load profiles to annual estimates of achievable technical potential for each measure. These profiles are similar to the load shapes the Council used in its 2021 Power Plan supply curves and to those in the RTF's UES measure workbooks. Additionally, Cadmus incorporated a select set of commercial sector end-use load shapes from National Renewable Energy Laboratory's ComStock database.[22]

2.2. Considerations and Limitations

This study provides insights into which measures City Light could offer in future programs and aims to guide program targets. However, various design considerations for this study may lead to differences between future program plans and the study results:

- This potential study uses broad assumptions about the adoption of energy efficiency measures. Program design, however, requires a more detailed examination of historical participation and

[22] Parker, Andrew, Henry Horsey, Matthew Dahlhausen, Marlena Praprost, Christopher CaraDonna, Amy LeBar, and Lauren Klun. March 2023. *ComStock Reference Documentation: Version 1*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5500-83819. https://www.nrel.gov/docs/fy23osti/83819.pdf

incentive levels on a measure-by-measure basis. The study can inform planning for measures City Light has not historically offered or can focus the program design on areas with remaining amounts of potential identified in this study.

- This potential study does not consider program implementation barriers. Though it includes a robust, comprehensive set of efficiency measures, it does not examine whether these measures can be delivered through incentive programs or what incentive rate is appropriate. Many programs require strong trade ally networks or must overcome market barriers to succeed.
- This potential study cannot predict market changes over time. Though it accounts for changes in codes and standards as they are enacted today, the study cannot predict future changes in policies, pending or backsliding codes and standards, and which new technologies may become commercially available. City Light programs are not static and have the flexibility to address changes in the marketplace, whereas the potential study estimates use information collected at a single point in time.
- This potential study does not attempt to forecast or otherwise predict future changes in energy efficiency measure costs. The study includes Council and RTF incremental energy efficiency measure costs, including equipment, labor, and operations and maintenance (O&M), but it does not attempt to forecast changes to these costs during the course of the study (except where the Council makes adjustments). For example, changes in incremental costs may impact some emerging technologies, which may then impact both the speed of adoption and the levelized cost of that measure (impacting the IRP levelized cost bundles). Similarly, this study does not take into account pending tariffs.
- This study estimated the potential for highly impacted communities separately. Because of the lack of data on program and administrative costs, Cadmus used the same program and administration costs across the DSMPA. While this study did use higher incentive costs for highly impacted communities as part of the utility cost analysis, this may not reflect the total cost needed to support this customer group. City Light has reason to believe that these costs would be significantly higher for customers in highly impacted communities compared with customers not in highly impacted communities. City Light continues to refine these assumptions and provide the best service to highly impacted communities.
- Like the prior DSMPA, commercial UEC relies on NEEA's CBSA data, which is supplemented by data from the U.S. EIA's Commercial Buildings Energy Consumption Survey (CBECS). However, these data may not reflect the type of commercial facilities in City Light's territory and have an inherent level of uncertainty. On May 28, 2021, the Council's Conservation Resources Advisory Committee reiterated that additional research for the region is needed to develop more reliable energy use intensity data for commercial buildings. In addition, Seattle contains many large multifamily buildings with insufficient primary data (such as baseline stock characteristics). For example, this potential study assessed the impacts of the 2021 Seattle Energy Code and incorporated the code as best as possible. Data were limited on the natural gas fuel shares of equipment in multifamily construction; therefore, it was difficult to correctly estimate the impact of this 2021 code. As a result, this potential study has limited insight into the remaining potential in this segment and highlights the need for further research.

- This study uses City Light's nonresidential database to identify sales and the number of customers for each commercial market segment. This includes historical sales and the number of customers for nonresidential buildings, as well as annual forecasts of commercial square footage for each commercial market segment.
- This study applied accelerated ramp rates to approximate the impact of the Inflation Reduction Act (IRA), state, and local initiatives under the current (early 2025) landscape. However, there is inherent uncertainty in how policy changes may evolve over the 20-year study horizon.
- This study modeled the impacts of climate change by increasing the cooling load and decreasing the heating load over time. The study assumes cooling loads steadily increase year after year and heating loads steadily decrease. In reality, year-to-year weather fluctuations mean that cooling loads will increase and decrease year-to-year, while the overall trend is increasing cooling loads over time. In addition, this study uses a prediction of weather changes and acknowledges a level of uncertainty in such predictions.

Though these considerations and limitations impact the DSMPA, it is worth noting that Chapter 194-37 of the WAC requires City Light to complete and update a CPA every two years. City Light can then address some of these considerations over time and mitigate short- and mid-term uncertainties by continually revising DSMPA assumptions to reflect changes in the market.

3. Baseline Forecast

An assessment of demand-side management potential begins with developing baseline end-use load forecasts, followed by calibrating results to City Light's corporate load forecast in the base year (2025). This chapter briefly describes the methodology used in this analysis, which is then followed by the results presented by sector.

3.1. Scope of Analysis

Cadmus started the analysis by developing separate baseline end-use load forecasts over a 20-year (2026 to 2045) planning horizon for each of the three sectors: residential, commercial, and industrial. We then calibrated these forecasts to City Light's corporate load forecast in the base year (2025). The forecasts do not include future programmatic conservation, but they do account for enacted equipment standards and building energy codes, building electrification, and climate change. The City Light electrification forecast component accounts for market and policy advancement of electrification adoption consistent with goals and policies. The City Light electrification forecast intent is to account for policies promoting electrification directly and indirectly. This includes goals and policies within the Seattle Climate Action Plan and Seattle Office of Sustainability carbon-based benchmarking requirements. The City Light electrification forecast also indirectly accounts for general policies that contribute to electrification, such as the Building Energy Performance Standards (BEPS) or the Commercial Building Performance Standard (CBPS), since these performance standards do promote some level of electrification for existing buildings as a mechanism to reduce consumptions and emissions.

For each sector, Cadmus further distinguished the results by building segments, facility types, and applicable end uses:

- Sixteen residential segments of existing and new construction:
  - Single-family, single-family highly impacted
  - Multifamily low-rise, multifamily low-rise highly impacted, multifamily mid-rise, multifamily mid-rise highly impacted, multifamily high-rise, multifamily high-rise highly impacted[23]

[23] Multifamily low-rise is defined as multifamily buildings with one to three floors, while mid-rise is defined as buildings with four to six floors and high-rise is defined as buildings with more than six floors. The multifamily common area is treated within the commercial sector.

- Forty commercial segments, which include new and existing construction for 20 standard commercial segments
- Eight industrial segments (existing construction only), including water and wastewater treatment segments[24,25]

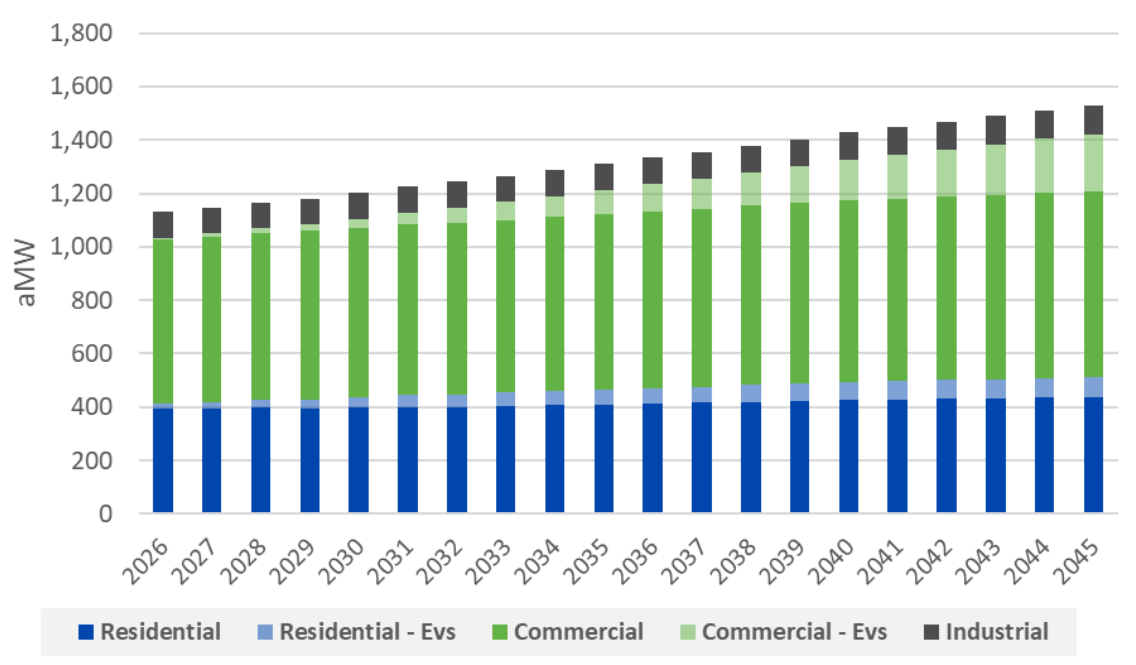
Cadmus and City Light's load forecast team worked together to develop a baseline forecast that aligned with City Light's 2024 adopted corporate load forecast. To achieve this, Cadmus modified the residential baseline forecast to include assumptions about building electrification (based on City Light's prior research and analysis) and climate change (by changing heating and cooling UECs and cooling equipment saturations over time). These changes are detailed in the following section, as well as in the *6. Detailed Methodology* section.

Figure 3-1 shows the distribution of projected sales by sector from 2026 through 2045, with EV forecasts displayed independently of the overall sector totals. In 2045, the commercial sector (excluding EVs) will account for roughly 42% of projected sales, while the residential (excluding EVs) and industrial sectors (excluding EVs) will account for 27% and 7%, respectively. The combined EV forecast makes up 17% of the 2045 baseline sales.

[24] Although City Light's internal classification system considers water and wastewater treatment segments as part of the commercial sector, to align with 2021 Northwest Power Plan, Cadmus included these two segments in the industrial sector. As such, Cadmus removed water and wastewater treatment plants' sales (including the sales of King County Wastewater Treatment Plant and Seattle Public Utilities) from commercial sales and added it to industrial sales.

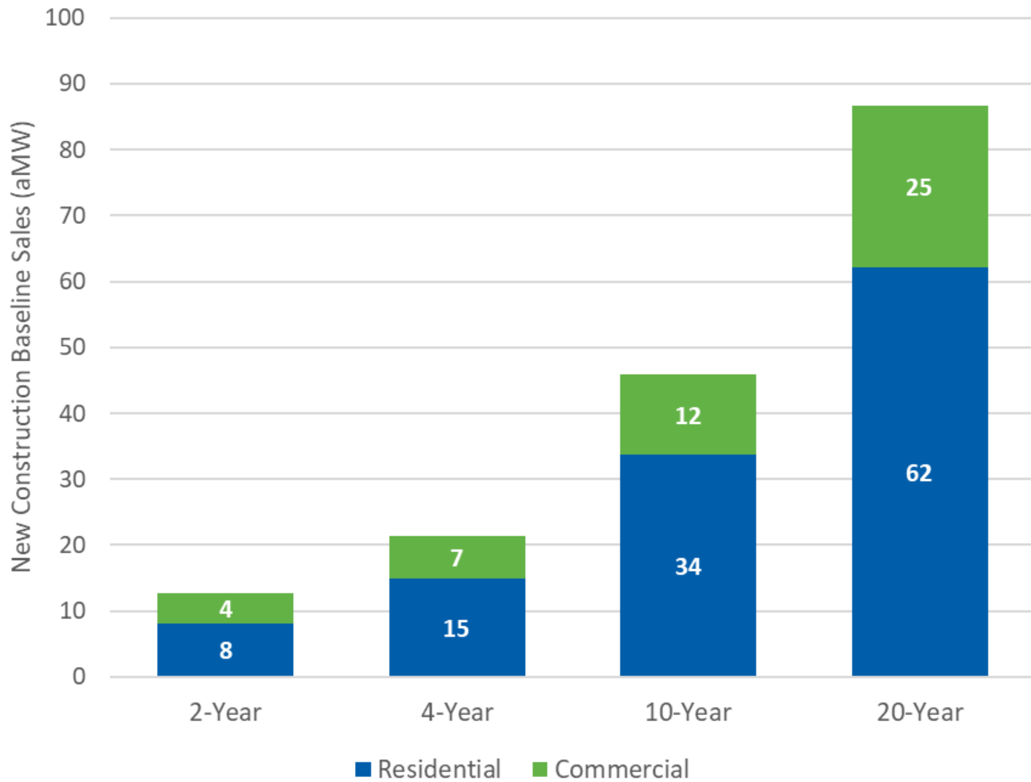
[25] This report does not include industrial district steam, spot loads, and streetlighting in the industrial baseline forecast.

Figure 3-1. Annual Baseline Sales by Sector (2026–2045)



Given the differing building requirements and regulations for new construction buildings, Cadmus seperated the baseline sales for commercial and residential into “construction vintages” to indicate if the sales were associated with new or existing buildings. Figure 3-2 shows the total sales attributed to new construction in both the residential and commercial sectors. The industrial sector does not include any new construction buildings; all sales growth in that sector is assumed to be for existing buildings. By the final year of the study, new construction buildings (those built after 2025) will account for 87 aMW of City Light sales.

Figure 3-2. New Construction Baseline Sales by Time Period and Sector



3.2. Residential

Cadmus considered eight residential segments with 42 end uses. Figure 3-3 lists the residential segments and end uses considered, as well as the broad end-use groups used in this study. Overall, the residential sector accounted for approximately 34% of total baseline sales.

Cadmus used City Light's 2024 residential household forecast in the baseline forecast, disaggregating these households into non-highly impacted and highly impacted segments.

Aligning with the prior 2024 DSMPA, Cadmus first defined equity to represent the vulnerable populations and highly impacted communities within City Light's service area, as described below:

- Vulnerable populations are "population groups that are more likely to be at higher risk for poor health outcomes in response to environmental harms, due to: (i) Adverse socioeconomic factors, such as unemployment, high housing and transportation costs relative to income, limited access to nutritious food and adequate health care, linguistic isolation, and other factors that negatively affect health outcomes and increase vulnerability to the effects of environmental harms; and (ii) sensitivity factors, such as low birth weight and higher rates of hospitalization."[26]

- Highly impacted communities are defined as "the census tract ranks a 9 or 10 on the EHD Map, as designated by the Washington State Department of Health". They also include the census tracts "covered or partially covered by 'Indian Country' as defined in and designated by statute."[27] The EHD contains 19 criteria, which are grouped under environmental exposures (including fossil fuel pollution and vulnerability to climate change impacts that contribute to health inequities), environmental effects, socioeconomic factors, and sensitive populations.

Between the two equity descriptions, Cadmus selected highly impacted communities because of the data granularity available for the DSMPA. In addition, the highly impacted community framework incorporates climate change impacts, which is consistent with other assumptions in the DSMPA. Cadmus conducted the highly impacted disaggregation based on income qualification in the City Light Utility Discount Program and Washington EHD index for income-qualified customers.[28,29] Thus, we only considered customers with a household income equal to or less than 70% of the state median income, by household size, and with an EHD rank of 9 and higher as highly impacted for the analysis.

Cadmus combined the highly impacted communities distributions by building type with residential household forecasts, estimates of end-use saturations, fuel shares, efficiency shares, and UEC to produce a sales forecast through 2045. This approach is described in the *6.1. Developing Baseline Forecasts* section.

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[26] Washington State Legislature. RCW 70A.02.010. "Revised Code of Washington. Title 70A Environmental Health and Safety" https://app.leg.wa.gov/RCW/default.aspx?cite=70A.02.010

[27] Washington State Department of Health. Accessed June 2023. "Instructions for Utilities to Identify Highly Impacted Communities." https://doh.wa.gov/data-statistical-reports/washington-tracking-network-wtn/climate-projections/clean-energy-transformation-act/ceta-utility-instructions

[28] City of Seattle, Seattle Public Utilities. Accessed June 2023. "Utility Discount Program." https://www.seattle.gov/utilities/your-services/discounts-and-incentives/utility-discount-program

[29] Washington State Department of Health. Accessed June 2023. "Washington Environmental Health Disparities Map." https://doh.wa.gov/data-and-statistical-reports/washington-tracking-network-wtn/washington-environmental-health-disparities-map

Figure 3-3. Residential Segments and End Uses

Segments	End-Use Group	End Uses	
Single-Family Multifamily – High-Rise Multifamily – Mid-Rise Multifamily – Low-Rise Single-Family – Highly impacted Multifamily – High-Rise Highly impacted Multifamily – Mid-Rise Highly impacted Multifamily – Low-Rise Highly impacted	Appliances	Cooking Oven Cooking Range Dryer	Freezer Refrigerator
	Cooling	Cool Central	Cool Room
	Electronics	Computer – Desktop Computer – Laptop Copier DVD Player Home Audio System Microwave	Monitor Multifunction Device Plug Load (Other) Printer Set-Top Box Television
	Exterior Lighting	Lighting Exterior Standard	
	Heating	Air-Source Heat Pump with Back-Up Ductless Heat Pump – Central Heat Ductless Heat Pump – Central Heat with Back-Up Ductless Heat Pump – Room Heat Ductless Heat Pump – Room Heat with Back-Up Packaged Terminal Heat Pump (PTHP)	Circulation – Domestic Hot Water Circulation – Hydronic Heating Heat Central Heat Pump Heat Room Ventilation – Air
	Interior Lighting	Lighting Interior Linear Fluorescent Lighting Interior Specialty	Lighting Interior Standard
	Miscellaneous	Air Purifier Other	Wastewater Pool Pump
	Water Heating	Water Heat GT 55 Gallon	Water Heat LE 55 Gallon
	Electric Vehicles	Electric Vehicles	

Figure 3-4 shows residential sales by segment for each year of the study horizon. City Light projects that more than 85,000 new housing units will be built by 2045. New multifamily units account for about 50% of new residential construction, so both multifamily and single-family segment baseline sales are expected to increase at a similar rate (Table 3-).

Figure 3-4. Annual Residential Baseline Sales by Segment (2026–2045)

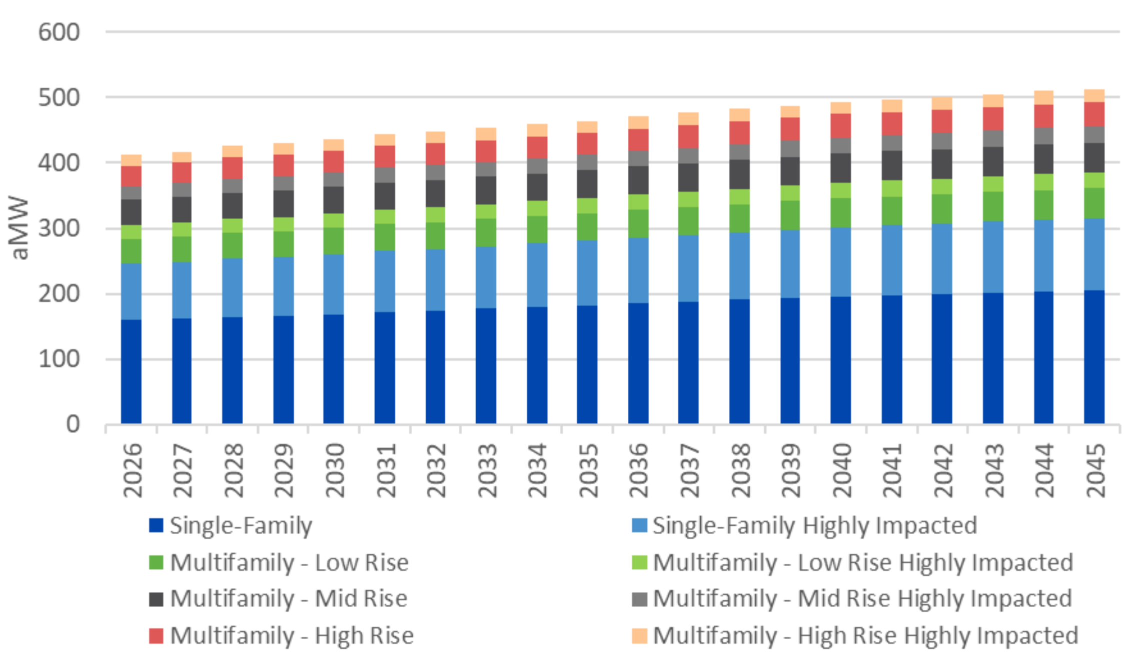


Table 3-1. Residential Baseline Sales and Housing Units by Segment

Sector	Sales (aMW)		Housing Units	
	2026	2045	2026	2045
Single-Family	160	205	161,528	188,285
Single-Family Highly Impacted	86	110	86,975	101,382
Multifamily – Low-Rise	38	45	46,208	54,992
Multifamily – Low-Rise Highly Impacted	21	24	24,881	29,610
Multifamily – Mid-Rise	39	46	49,616	59,047
Multifamily – Mid-Rise Highly Impacted	21	25	26,715	31,794
Multifamily – High-Rise	31	37	40,318	47,982
Multifamily – High-Rise Highly Impacted	17	20	21,709	25,836
Total	**412**	**512**	**457,950**	**538,927**

In the base year (2025), Cadmus calibrated baseline forecasts to City Light's load forecast, ensuring that the study's starting point aligned with the starting point of City Light's forecasts. We then produced a residential forecast.

Figure 3-5 shows the residential baseline forecast by end use. Overall, City Light's residential forecast will increase by approximately 24% over the 20-year horizon. The growth is driven by several factors, including the rising adoption of EVs and heat pumps (due to electrification), increased use of air conditioning (based on climate change assumptions), new housing development, and population growth. Heating and appliances are the two largest consuming end-use groups, together accounting for 50% of residential consumption. The next three highest forecasted end-use groups are electronics (14%), EVs (14%), and water heating (13%).

Figure 3-5. Annual Residential Baseline Forecast by End-Use Group (2026–2045)

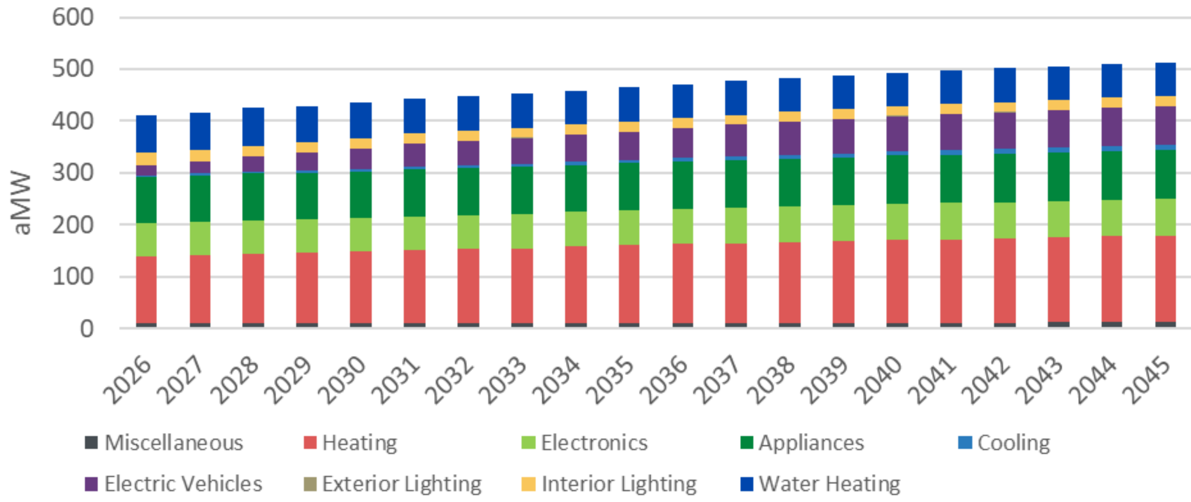


Table 3- shows the assumed average electric consumption per household for each residential segment in 2045. Differences in the average consumption for each segment drive either differences in UEC, saturations, fuel shares,[30] or any combination of differences. Appendix B includes detailed baseline data for the residential sector.

Table 3-2. Per Household Baseline Sales (kWh/Home) by Sector and End-Use Group – 2045

End-Use	Single-Family	Multifamily – Low-Rise	Multifamily – Mid-Rise	Multifamily – High-Rise
Miscellaneous	250	172	126	123
Heating	2,926	2,542	2,412	2,380
Electronics	1,498	776	787	699
Appliances	1,812	1,244	1,191	1,214
Cooling	180	137	132	131
Electric Vehicles	1,196	1,199	1,176	1,176
Exterior Lighting	13	1	1	1
Interior Lighting	493	106	143	94
Water Heating	1,176	1,042	827	884
Total	**9,543**	**7,218**	**6,795**	**6,703**

Note: Highly impacted kilowatt-hour per home values are equivalent to those for non-highly impacted homes.

30 Fuel shares refer to the percentage of end-use equipment that is electric for end uses where customers have the option of electricity or another fuel. Residential end uses where multiple fuels are an option include central furnace space heating, water heating, cooking, and dryers.

Table 3- shows the electric end-use group distributions of the baseline consumption in 2045 by building type. For each building type, heating makes up 30% or greater of the building type consumption in 2045 and is the end-use group with the largest consumption.

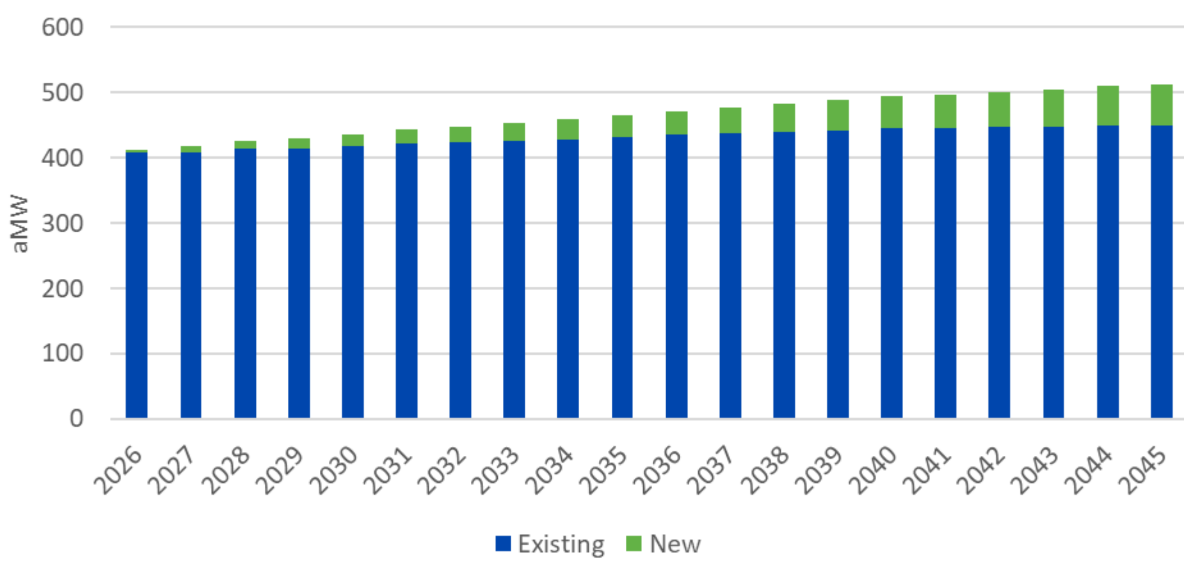
Table 3-3. Residential Consumption End-Use Group Distributions by Segment – 2045

End-Use	Single-Family	Multifamily – Low-Rise	Multifamily – Mid-Rise	Multifamily – High-Rise
Miscellaneous	3%	2%	2%	2%
Heating	31%	35%	35%	36%
Electronics	16%	11%	12%	10%
Appliances	19%	17%	18%	18%
Cooling	2%	2%	2%	2%
Electric Vehicles	13%	17%	17%	18%
Exterior Lighting	0.13%	0.01%	0.01%	0.01%
Interior Lighting	5%	1%	2%	1%
Water Heating	12%	14%	12%	13%
Total	**100%**	**100%**	**100%**	**100%**

Note: Highly impacted end-use percentage distribution values are equivalent to the non-highly impacted.

Figure 3-6 shows forecasted residential sales by construction vintage over the study horizon. Study results indicate that approximately 12% of 2045 sales will derive from new construction homes.

Figure 3-6. Annual Residential Baseline Sales by Construction Vintage (2026–2045)



3.3. Commercial

Cadmus considered 21 commercial building segments and 19 end uses. Table 3- shows the commercial segments and end uses considered in this study, as well as the corresponding segment and end-use groups presented in this report. We chose commercial segments for consistency with the 2021 Power Plan with one exception: the multifamily common area was not a standalone segment in the 2021 Power Plan. Overall, the commercial sector accounts for 908 aMW or 59% of total baseline sales in 2045. While this study captures the commercial sector EVs load, it does not identify any conservation potential for EVs within this sector.

Table 3-4. Commercial Segments and End Uses

Segment Group	Segment
Assembly	Assembly
Data Center	Data Center
Electric Vehicles[b]	Electric Vehicles
Hospital	Hospital
Large Grocery	Supermarket
Large Office	Large Office
	Medium Office
Lodging	Lodging
Multifamily Common Area	Multifamily Common Area
Miscellaneous	Other
Other Health	Residential Care
Restaurant	Restaurant
Retail	Large Retail
	Medium Retail
	Small Retail
	Extra Large Retail
School	School K–12
Small Grocery	Mini Mart
Small Office	Small Office
University	University
Warehouse	Warehouse

End-Use Group	End-Uses
Cooking	Cooking
Cooling	Cooling Chiller
	Cooling Direct Expansion
Data Center	Data Center
	Server
Electric Vehicles[b]	Electric Vehicles
Heat Pump	Heat Pump
Heating	Space Heat
Lighting	Exterior Lighting
	Interior Lighting
Miscellaneous	Computer – Desktop
	Computer – Laptop
	Other [a]
	Plug Load (Other)
	Wastewater
Refrigeration	Refrigeration
Ventilation and Circulation	Ventilation and Circulation
Water Heat	Water Heat GT 55 Gallon
	Water Heat LE 55 Gallon

[a] *Other end uses include all undefined loads, such as elevators, automatic doors, and process loads.*

[b] *In the commercial sector, the EVs segment and end use includes public and workplace charging equipment for personal EVs.*

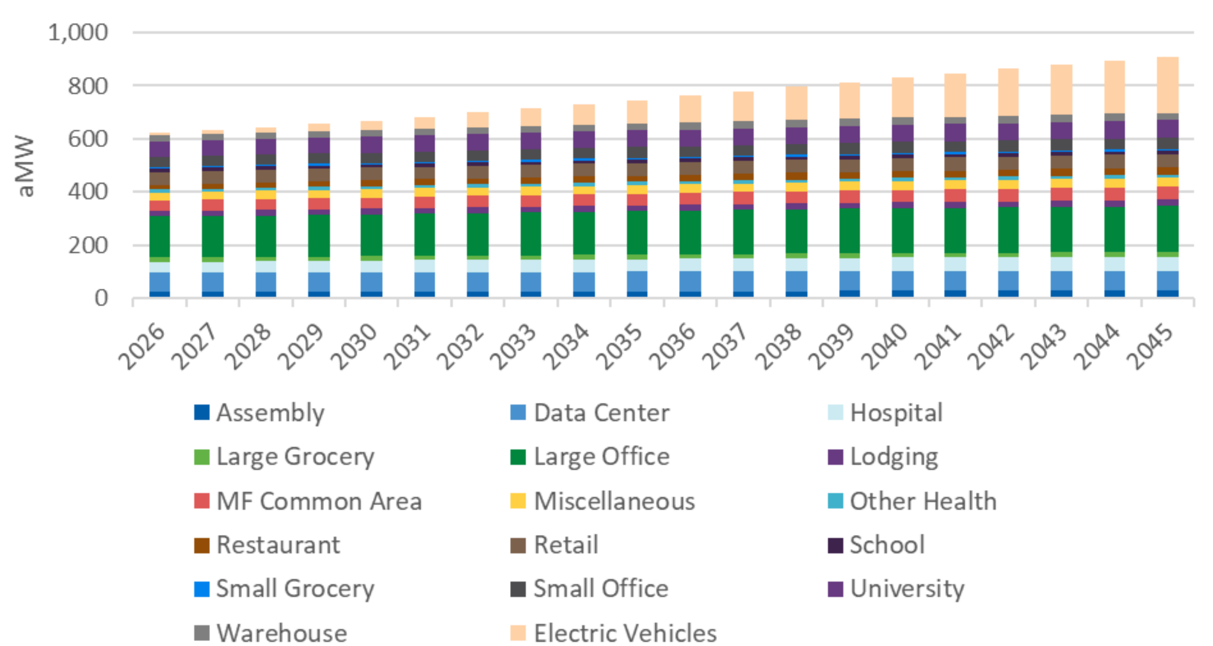
Cadmus used the same segmentation assumptions from the 2024 DSMPA that relied on City Light's nonresidential database to identify sales and the number of customers for each commercial market segment. The database combined City Light's billing data with King County Assessor data, as well as with other secondary data sources, to identify the customer segment and consumption for each nonresidential customer. These data served as the basis for Cadmus' segmentation of the commercial sector.

Cadmus also classified customers as commercial or industrial based on City Light's premise-level nonresidential customer database, mapping commercial customers to the segments listed in Table 3-. (Refer to Table 3-, shown in the *3.4. Industrial* section, for a mapping of iindustrial customers to their respective segments.)

To align with the commercial building square footage in City Light's load forecast, Cadmus adjusted the commercial building counts per segment based on the average square footage per building type from the 2024 DSMPA.

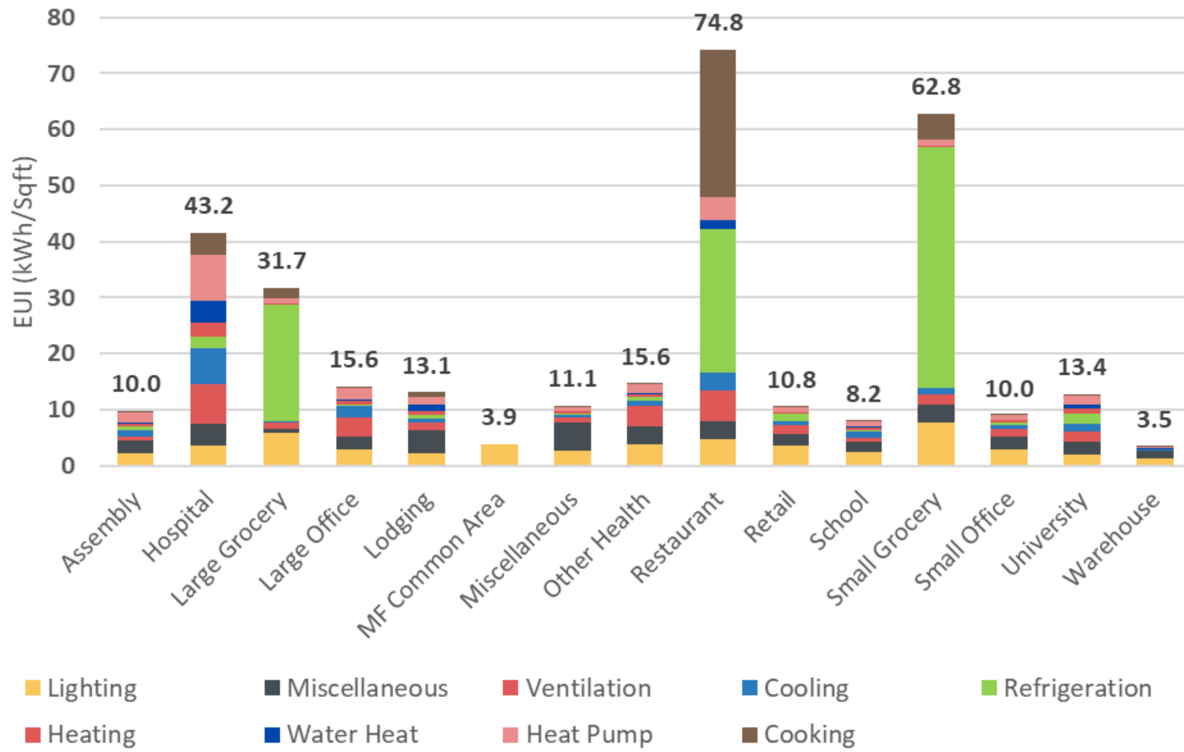
Figure 3-7 shows the distribution of baseline commercial energy consumption by segment for each year of the study. EVs accounted for 23% of commercial baseline sales. Large offices, data centers, and universities accounted for 19%, 8%, and 7% of baseline sales, respectively. Together, these segments represent more than half of all 2045 commercial-sector sales.

Figure 3-7. Annual Commercial Baseline Sales by Segment (2026–2045)



Cadmus developed the whole-building electric energy intensities (total kilowatt-hours per building square feet) based on NEEA's CBSA IV. To develop the end-use intensities, we used the CBSA, the CBECS, and other Cadmus research. Further details are provided in the *6.1 Developing Baseline Forecasts* section. Figure 3-8 shows energy use intensities for each building type and end-use group.

Figure 3-8. Commercial End-Use Group Intensities by Building Type – 2045

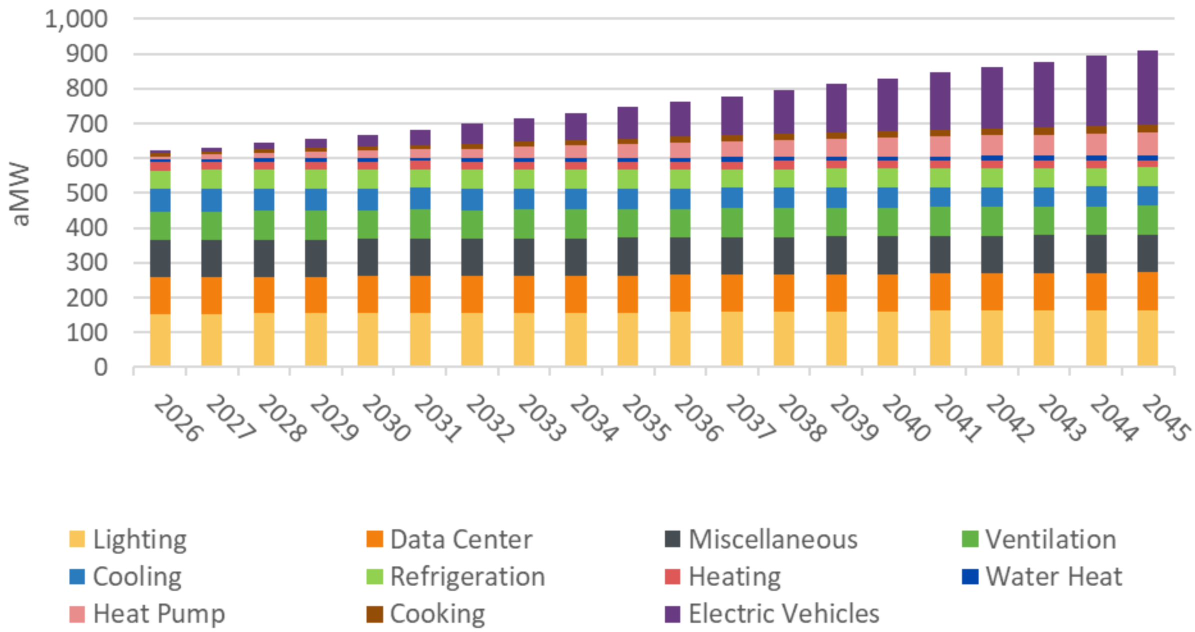


Note: The data center segment energy use intensity of 177.8 kWh per square foot is not included due to scaling. Additionally, all the consumption for the data center segment appears in the data center end-use group.

Figure 3-9 shows the commercial baseline forecast by end-use group. The forecast shows a load growth of commercial sales by roughly 2% on average per year over the study horizon. The highest-consuming end-use group was EVs, accounting for 23% of projected commercial consumption in 2045. The lighting,[31] miscellaneous, and data center end-use groups also account for a large share of consumption at 18%, 12%, and 12% of projected commercial sales in 2045, respectively. Appendix B includes detailed baseline data for the commercial sector.

[31] Due to the timing of the analysis, this study's forecast does not include the impact of Washington State House Bill 1185 (RCW 70A.230.020) limiting the sales of commercial linear fluorescent lamps. However, the energy efficiency potential analysis did account for House Bill 1185.

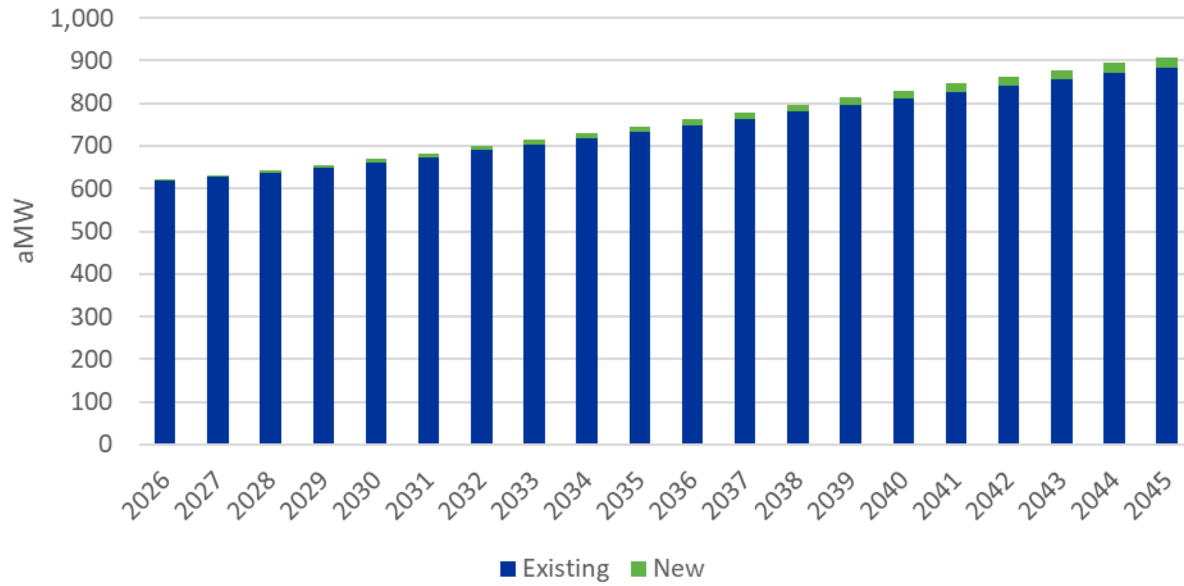
Figure 3-9. Annual Commercial Forecast by End-Use Group (2026–2045)



Note: The Miscellaneous end-use group includes laptops, desktops, and all other plug load and secondary measure savings from wastewater.

From 2026 to 2045, commercial sector sales are forecasted to increase by 2% year-over-year. This growth is primarily driven by EV adoption, which increases at an average year-over-year rate of 20%—rising from 8 aMW in the early years to 211 aMW of commercial sales in 2045. Additional growth can be attributed to new commercial floor space and electrification in the sector. By 2045, new construction is expected to account for 3% of the forecasted load. Figure 3-10 shows the commercial baseline forecast by construction vintage.

Figure 3-10. Annual Commercial Forecast by Construction Vintage (2026–2045)



3.4. Industrial

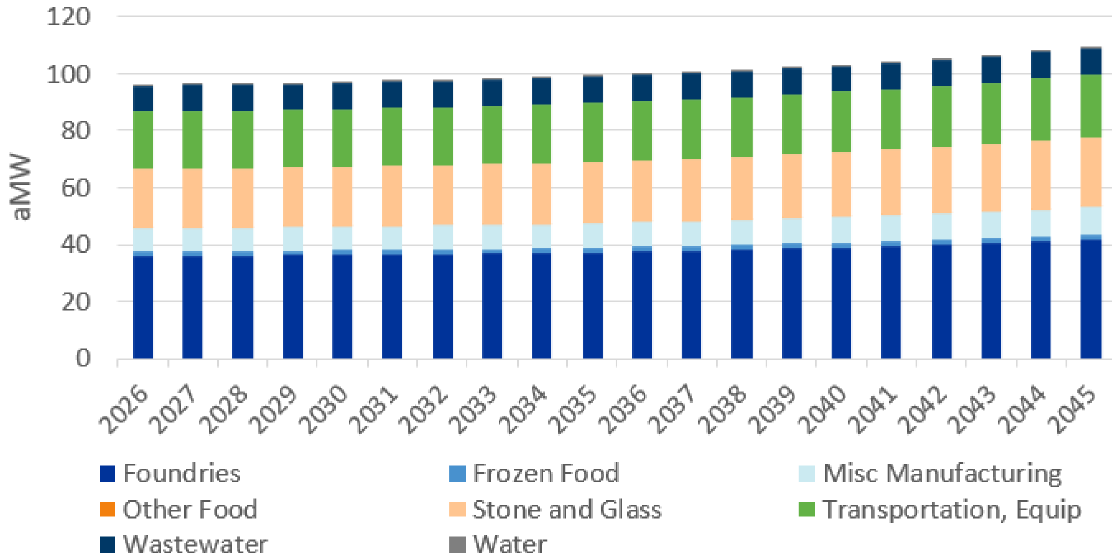
Cadmus disaggregated City Light's forecasted industrial sales into eight facility types (segments) and 11 end uses, as shown in Table 3-. Overall, the industrial sector accounted for 109 aMW, or 7% of City Light's overall forecasted baseline sales in 2045. The sector includes City Light's customers with known industrial processes, as well as those contributing to wastewater and water treatment loads.

Table 3-5. Industrial Segments and End Uses

Segments	End Uses
Foundries	Process Air Compressor
Frozen Food	Lighting
Miscellaneous Manufacturing	Fan
Other Food	Pump
Stone and Glass	Motors (Other)
Transportation, Equipment	Process (Other)
Wastewater	Process Heat
Water	HVAC
	Other
	Process Electro Chemical
	Process Refrigeration

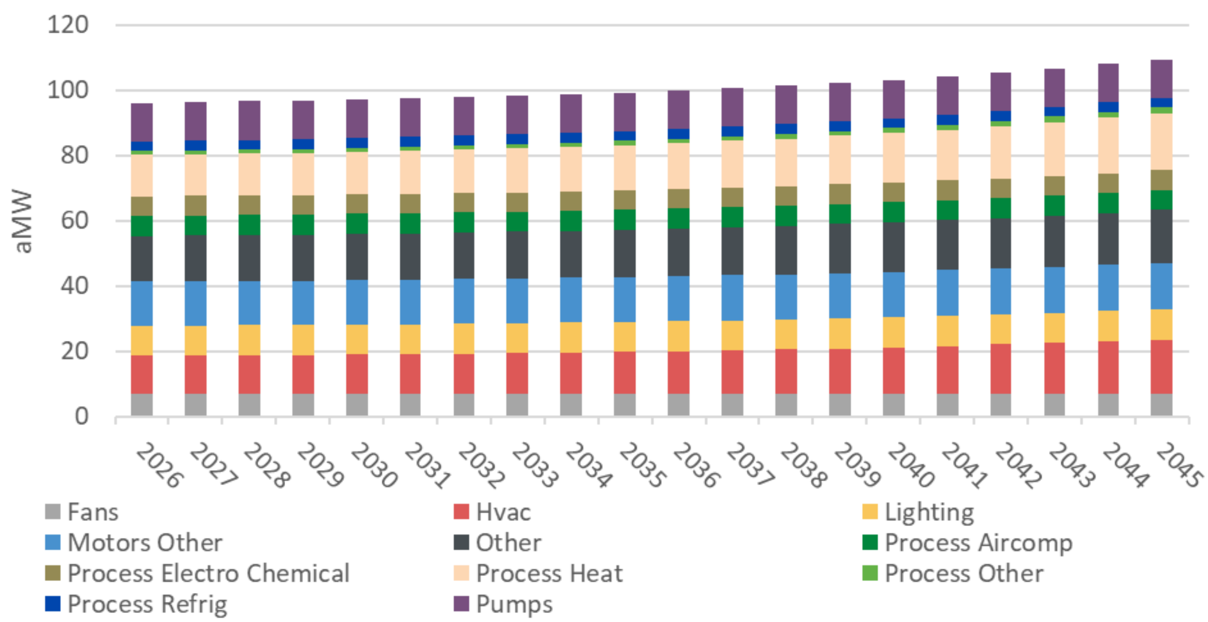
Similar to the commercial sector, Cadmus relied on City Light's nonresidential customer database to determine the distribution of baseline sales by segment. Foundries account for almost 40% of industrial baseline sales, followed by stone and glass (23%) and transportation equipment (20%) (Figure 3-11).

Figure 3-11. Annual Industrial Baseline Sales by Segment (2026–2045)



Cadmus relied on end-use distributions provided in the 2021 Power Plan's industrial tool and the U.S. EIA's Manufacturing Energy Consumption Survey (MECS) to disaggregate segment-specific consumption into end uses. Figure 3-12 shows the industrial baseline sales forecast by end use. The end uses that make up the largest portion of baseline sales in 2045 are process heat (16%) and HVAC (15%),

Figure 3-12. Annual Industrial Baseline Sales by End-Use (2026–2045)



4. Energy Efficiency Potential

City Light requires accurate estimates of technically achievable energy efficiency potential, which are essential for its IRP and program planning efforts. These potentials are then bundled based on the levelized cost of conserved energy so that the IRP model can select the optimal amount of energy efficiency potential.

To support these efforts, Cadmus performed an in-depth assessment of technical potential and achievable technical potential in three sectors: residential, commercial, and industrial. This chapter presents the detailed results of this assessment.

4.1. Overview

This study included a comprehensive set of conservation measures, including those assessed by the Council in the 2021 Power Plan and by the RTF. In consultation with City Light staff, Cadmus also included five new conservation measures: window heat pump, HVAC sizing, multifamily packaged terminal heat pump, heat pump with gas back-up, and EV chargers. Cadmus began its analysis by assessing the technical potential of hundreds of unique conservation measures applicable to each sector, segment, and construction vintage (as discussed in the *Baseline Forecast* section).

Cadmus evaluated 7,189 different combinations—or permutations—of energy conservation measures covering a broad range of technologies and applications. Each permutation represents a unique combination of factors: the specific energy-saving measure, the market sector (such as residential or commercial), customer segment, energy end use (like heating or lighting), building age (new or existing construction), and the type of baseline used for comparison. We only included combinations that offer technical potential for energy savings and excluded those that fell below current efficiency standards.

For example, an ENERGY STAR® air purifier installed in a newly built single-family home is considered a different permutation than the same model installed in an existing single-family home, even if all other factors remain the same. Table 4-Table 4-lists the number of conservation measures and permutations by sector considered in this study.

Table 4-1. Measures and Permutations

Sector	Measures	Permutations
Residential	131	2,152
Commercial	927	4,890
Industrial	29	147
Total	**1,087**	**7,189**

Table 4-Table 4- shows baseline sales and cumulative technical and achievable technical potential by sector. Study results indicate that 245 aMW of technically feasible conservation potential—16% of baseline sales—will be available by 2045 and that 83% of that amount (202 aMW) is considered achievable in 2045. The achievable technical potential corresponds to 13% of baseline sales.

The results in this report account for line losses and represent cumulative energy savings at the generator (unless specified).

Table 4-2. Cumulative Technical and Achievable Technical Potential by Sector (2026-2045)

Sector	Baseline Sales (aMW)	Technical Potential		Achievable Technical Potential	
		aMW	% of Baseline Sales	aMW	% of Baseline Sales
Residential	512	97	19%	81	16%
Commercial	908	138	15%	113	12%
Industrial	109	9	8%	7.6	7%
Total	**1,530**	**245**	**16%**	**202**	**13%**

Note: Industrial sales exclude district steam, spot loads, and streetlighting

The commercial sector represents nearly 60% of baseline energy use and 20-year achievable technical potential, as shown in Figure 4-1. The residential and industrial sectors account for 40% and 4% of the cumulative achievable technical potential in 2045, respectively.

Figure 4-1. 20-Year Achievable Technical Potential by Sector

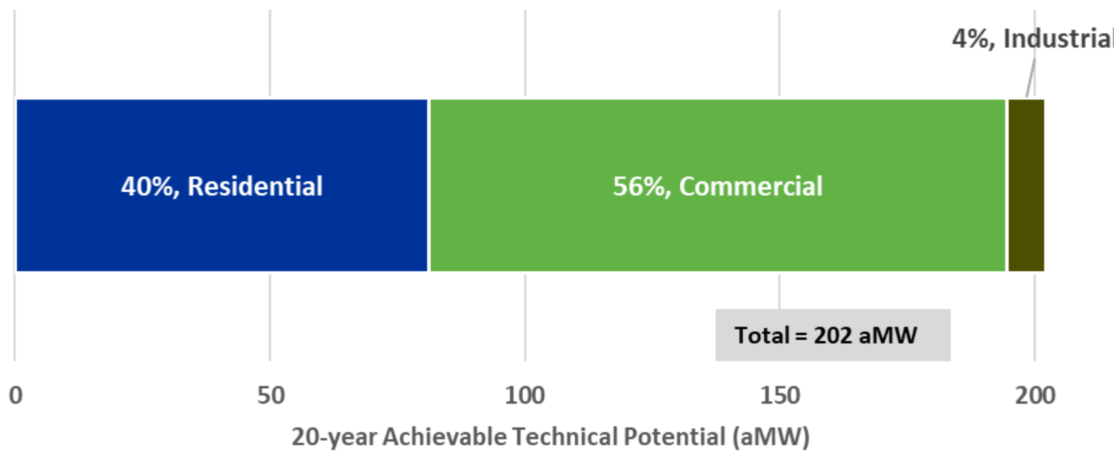


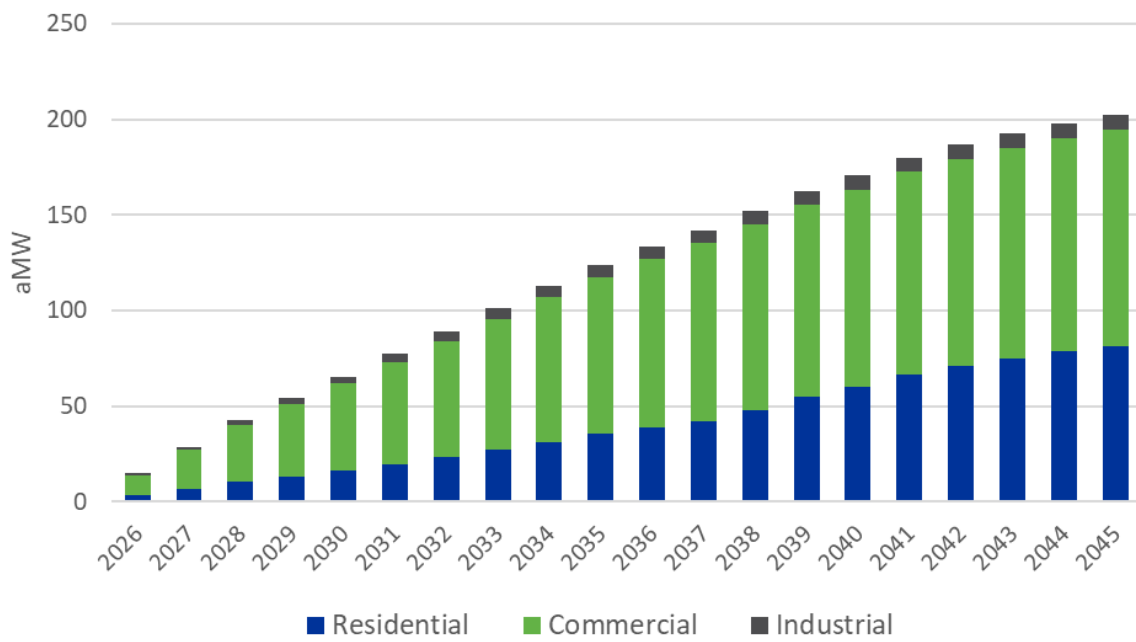
Table 4-Table 4- shows cumulative two-year, four-year, 10-year, and 20-year, as well as 20% of the 10-year achievable technical potential.

Table 4-3. Cumulative Achievable Technical Potential by Sector and Time Period

Sector	Achievable Technical Potential – aMW				
	2-Year (2026-2027)	4-Year (2026-2029)	10-Year (2026-2035)	20-Year (2026-2045)	20% of 10-Year
Residential	7	13	35	81	7
Commercial	20	38	82	113	16
Industrial	1	3	6	8	1
Total	**29**	**54**	**124**	**202**	**25**

Figure 4-2 presents the cumulative achievable technical potential across the study horizon.

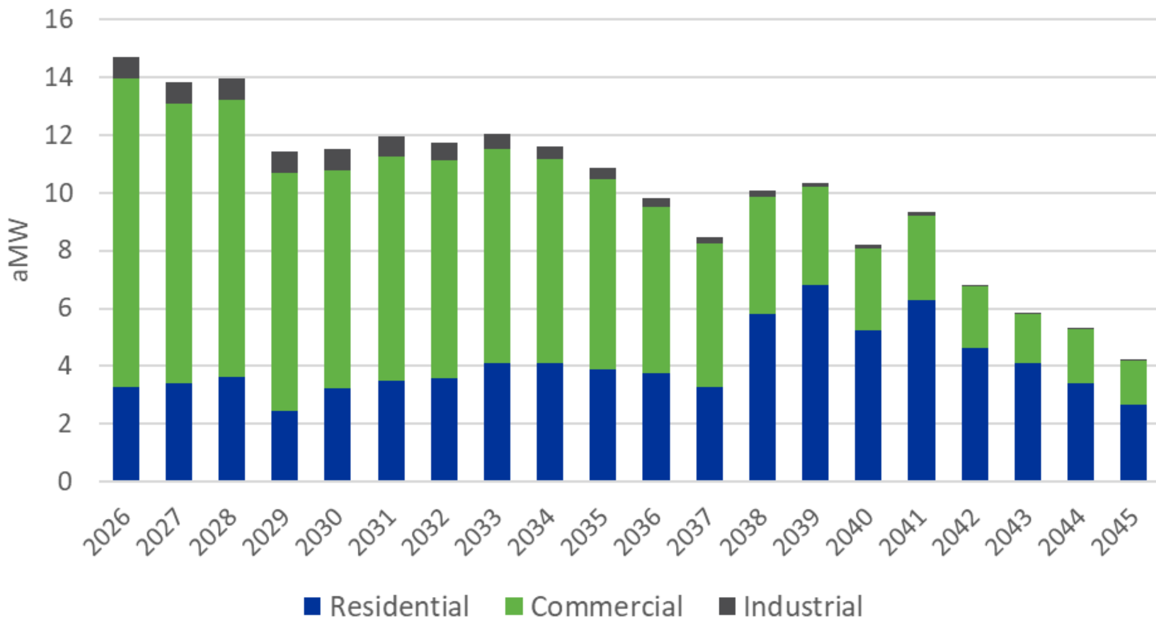
Figure 4-2. Cumulative Achievable Technical Potential by Sector (2026–2045)



Of the cumulative 20-year achievable potential, approximately 27% is acquired in the first four years, and 61% is acquired in the first 10 years. Refer to the *6. Detailed Methodology* section of this report for details the adoption rates.

Cadmus determined incremental achievable technical potential in each year of the study horizon using natural equipment turnover rates and measure-specific ramp rates. Figure 4-3 illustrates this incremental achievable potential. The increase in savings in 2038 is due to the ramp rates applied and the 12-year measure life for the top saving residential measure, heat pump dryers. In 2038, residential market average dryers installed in 2026 will need to be replaced, given their 12-year measure life. Based on the ramp rate in the replacement year (2038), a proportion of these dryers will be replaced by heat pump dryers. Since heat pump dryers are a high-saving measure, there is a large increase in residential incremental achievable potential in 2038.

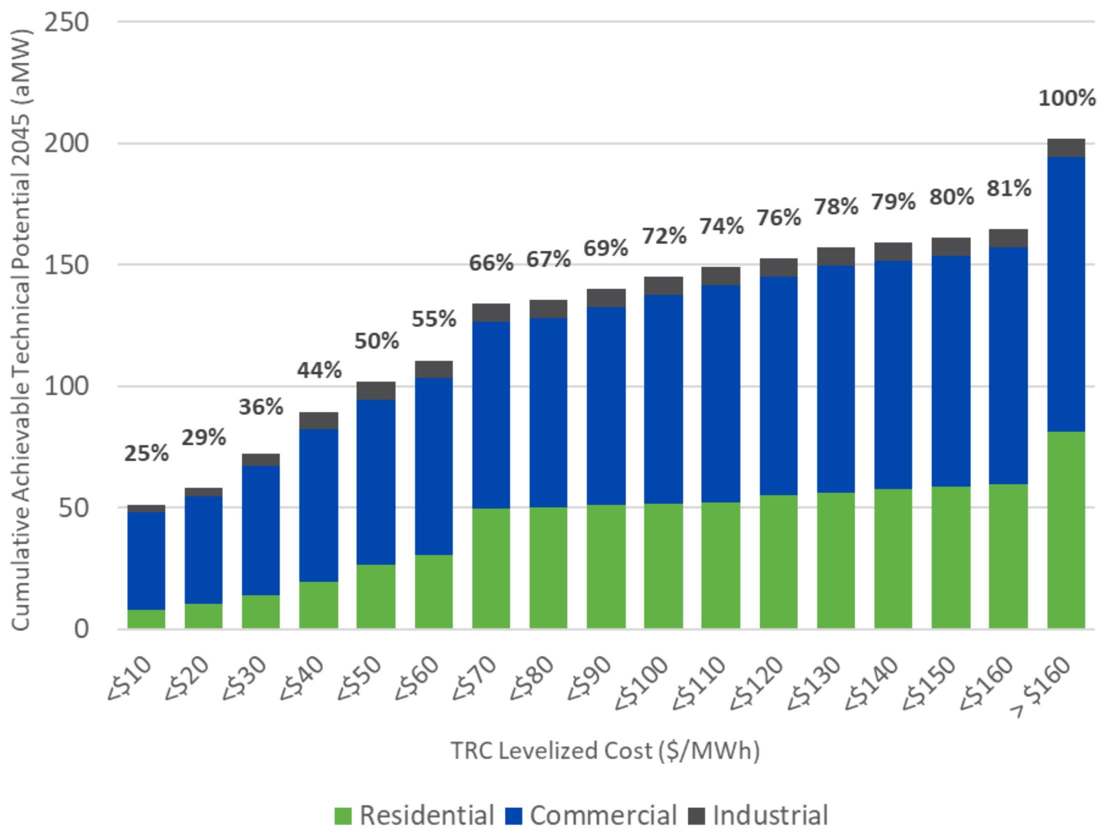
Figure 4-3. Annual Incremental Achievable Technical Potential (2026–2045)



The conservation supply curve in Figure 4-4 shows cumulative achievable potential in $10 per megawatt-hour levelized cost increments, where each bar includes all measures with levelized cost less than the listed amount. The percentage label on the graphic indicates the portion of 20-year achievable technical potential that can be acquired based on a TRC value at or below cost on the x-axis. For example, the analysis revealed that 55% (110 aMW) of the cumulative 2045 achievable technical potential could be acquired at less than or equal to $60 per megawatt-hour.[32] The amount of available achievable technical potential begins to level off at less than or equal to $70 per megawatt-hour, excluding measures that cost more than $160 per megawatt-hour. The 2045 achievable technical potential with a levelized cost of greater than $160 per megawatt-hour makes up 19% of the cumulative achievable technical potential. Many of these costly measures are for emerging technology equipment, heat pumps, and weatherization in the residential and commercial sectors.

32 The levelized cost bundle of less than or equal to $60 per megawatt-hour represents an example value.

Figure 4-4. All Sectors Supply Curve – Cumulative Achievable Technical Potential in 2045 by Levelized Cost



City Light's IRP model selected achievable economic potential is 103 aMW by 2045. Table 4-Table 4- shows cumulative 20-year achievable economic potential by sector, along with the maximum levelized cost for measure permutations within each sector. For example, all residential achievable economic potential can be obtained at a levelized cost of less than or equal to $30 per megawatt-hour. Refer to the *6. Detailed Methodology* chapter for details on the methodology used to determine achievable economic potential.

Table 4-4. Cumulative Achievable Economic Potential by Sector (2026–2045)

Sector	Levelized TRC ($/MWh)	20-Year Achievable Economic Potential (aMW)
Residential	30	13
Commercial	160	82
Industrial	70	8
Total	**N/A**	**103**

Appendix D shows detailed measure-level results, including levelized costs and technical and achievable technical conservation potential for each measure. The remainder of this chapter provides detailed results of technical, achievable technical, and achievable economic potential by sector.

4.2. Residential

Residential customers in City Light's service territory account for 34% of 2045 total baseline sales and 40% of total achievable technical potential. This sector, which is made up of non-highly impacted and highly impacted single-family and multifamily customers, has a variety of sources for potential savings, including equipment efficiency upgrades (such as water heaters and appliances) and improvements to building shells (such as windows, insulation, and air sealing).

Based on the resources in this assessment, Cadmus estimated residential cumulative achievable technical potential of 81 aMW over 20 years, which corresponds to 16% of the forecasted residential load in 2045. Table 4-Table 4- shows the cumulative 20-year residential conservation potential by segment.

Table 4-5. Cumulative Residential Technical, Achievable Technical, and Achievable Economic Potential by Segment in 2045

Segment	Baseline Sales (aMW)	20-Year Technical Potential		20-Year Achievable Technical Potential		20-Year Achievable Economic Potential	
		aMW	% of Baseline Sales	aMW	% of Technical Potential	aMW	% of Technical Potential
Single-Family	205	41	20%	34	83%	6	14%
Single-Family Highly Impacted	110	22	20%	18	83%	2	11%
Multifamily – Low-Rise	45	9	19%	7	83%	2	18%
Multifamily – Low-Rise Highly Impacted	24	5	19%	4	83%	1	15%
Multifamily – Mid-Rise	46	8	17%	7	84%	1	13%
Multifamily – Mid-Rise Highly Impacted	25	4	17%	4	84%	1	12%
Multifamily – High-Rise	37	6	17%	5	84%	1	10%
Multifamily – High-Rise Highly Impacted	20	3	17%	3	84%	0.3	9%
Total	**512**	**97**	**19%**	**81**	**83%**	**13**	**13%**

As shown in Figure 4-5Table 4-, single-family homes account for 64% (52 aMW) of total achievable technical potential, followed by multifamily low-rise (11 aMW), multifamily mid-rise (10 aMW), and multifamily high-rise (8 aMW). The total achievable technical potential for highly impacted customers is 28 aMW or 35%. This distribution is primarily driven by each home type's proportion of baseline sales, but segment-specific end-use saturations and fuel shares have an effect as well. Appendix B includes detailed data on saturations and fuel shares for each segment.[33] Appendix C includes a detailed summary of achievable technical potential by segment and end use for each segment.

Figure 4-5. Residential Cumulative Achievable Technical Potential by Segment (2026–2045)

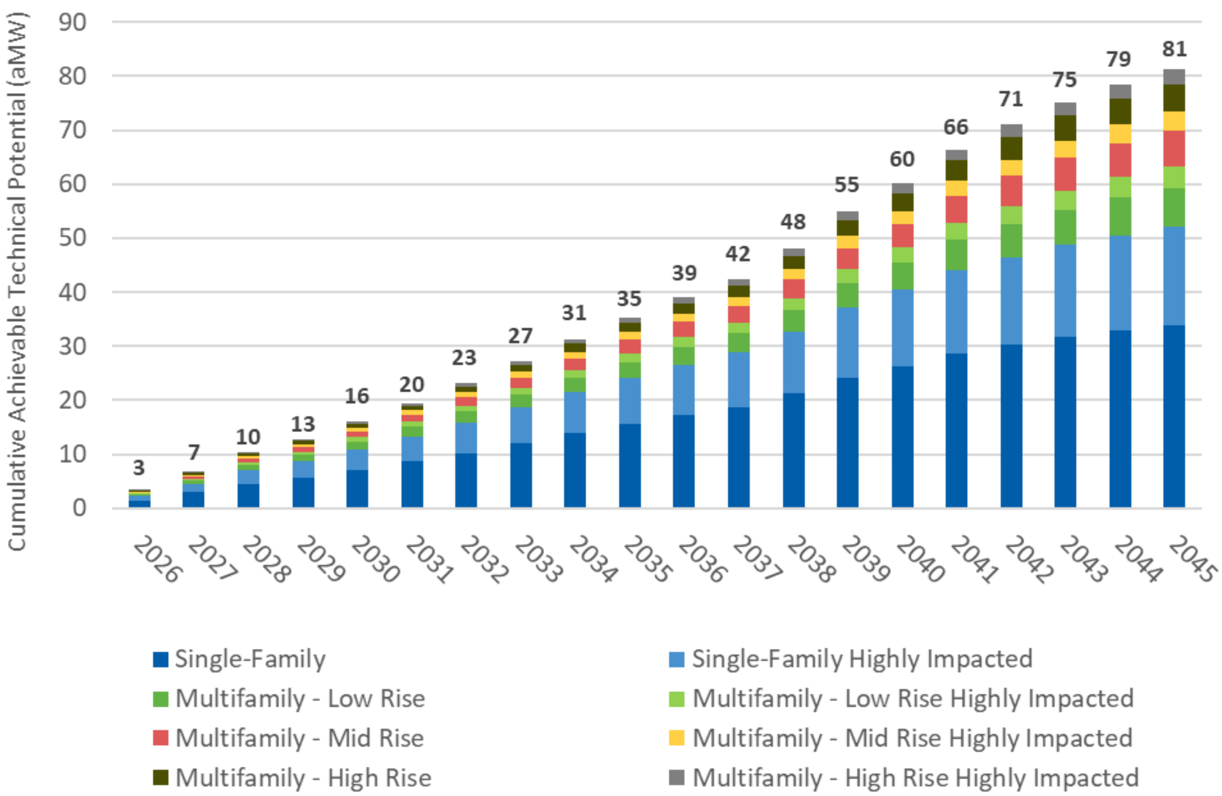


Figure 4-6 presents the cumulative achievable technical potential by construction type for the residential sector. Existing construction represents the majority of achievable technical potential, particularly in the early years of the study, accounting for 94% of the potential in the first four years (2026 through 2029). By the final year of the study period (2045), new construction accounts for 11% of the total cumulative residential achievable technical potential. This is because of the increase in new construction, from roughly 4,931 households in 2026 to over 85,000 households constructed between 2024 and 2045.

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33 The scope of this study does not distinguish differences in end-use saturations and fuel shares between the highly impacted and non-highly impacted segments. Potential for these classifications is defined by customer segmentation. (Refer to Appendix C for potential results by segment, including the highly impacted versus non-highly impacted classification and end use.)

Figure 4-6. Residential Cumulative Achievable Technical Potential by Construction Type (2026–2045)

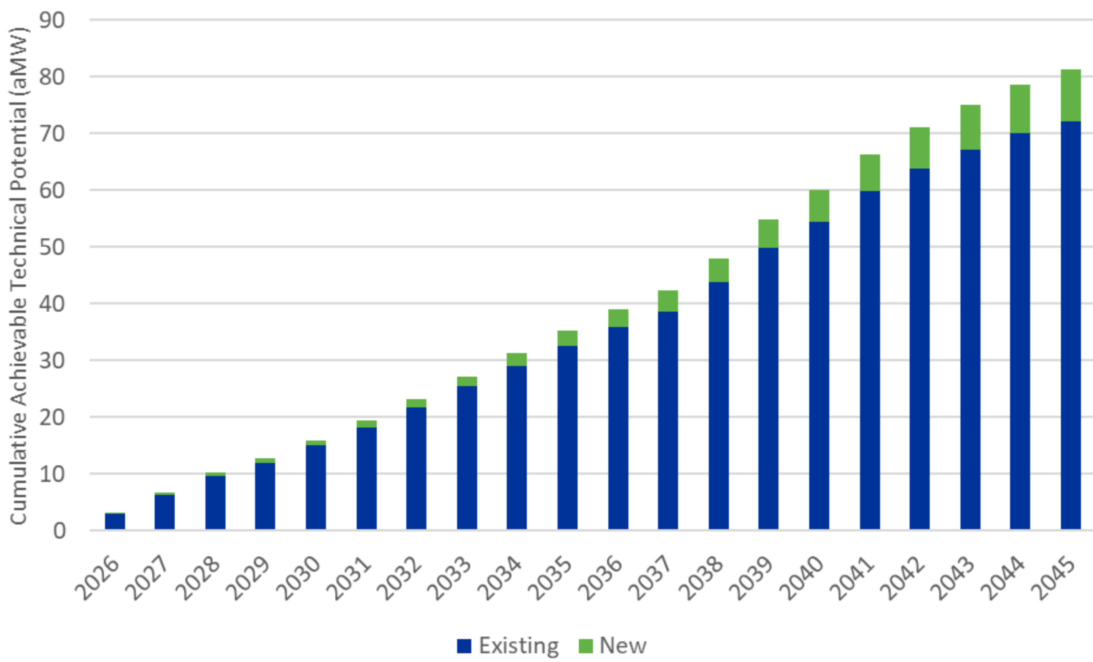


Table 4-6 shows the residential baseline sales and technical and achievable technical potential by end-use group. Heating savings make up the greatest proportion of cumulative achievable technical potential, at 36%. Appliance measures contribute 30% of the total achievable technical potential, followed by water heating measures (21%). Overall, 83% of the technical potential is considered achievable based on adoption patterns from the 2021 Power Plan and adjusted for City Light's historical program success.

Table 4-6. Residential Cumulative Technical, Achievable Technical, and Achievable Economic Potential by End-Use Group in 2045

Segment	Baseline Sales (aMW)	20-Year Technical Potential		20-Year Achievable Technical Potential		20-Year Achievable Economic Potential	
		aMW	% of Baseline Sales	aMW	% of Technical Potential	aMW	% of Technical Potential
Appliances	95	29	30%	24	84%	0.4	24%
Cooling	10	2	21%	2	80%	0.1	7%
Electronics	71	8	11%	7	93%	5	58%
Electric Vehicles	73	0.2	0.3%	0.2	95%	0	0%
Exterior Lighting	0.44	0.02	6%	0.02	84%	0	0%
Heating	166	36	22%	29	81%	4	10%
Interior Lighting	20	1	5%	1	84%	0.1	11%
Miscellaneous	12	1	9%	1	92%	0.3	24%
Water Heating	65	20	31%	17	83%	3	17%
Total	**512**	**97**	**19%**	**81**	**83%**	**13**	**13%**

Incremental and cumulative potential over the 20-year study horizon varies by end-use group due to the application of ramp rates. Cadmus assigned ramp rates to each measure based on factors such as availability, existing program activity, and market trends. We used the same ramp rates for each measure, as assigned by the Council in the 2021 Power Plan, with some adjustments based on City Light's historical program success, as discussed in the *5.2. Achievable Technical Potential and Ramp Rate Comparison* section. Figure 4-7 shows cumulative residential achievable potential by end use.

Figure 4-7. Residential Cumulative Achievable Technical Potential by End Use (2026–2045)

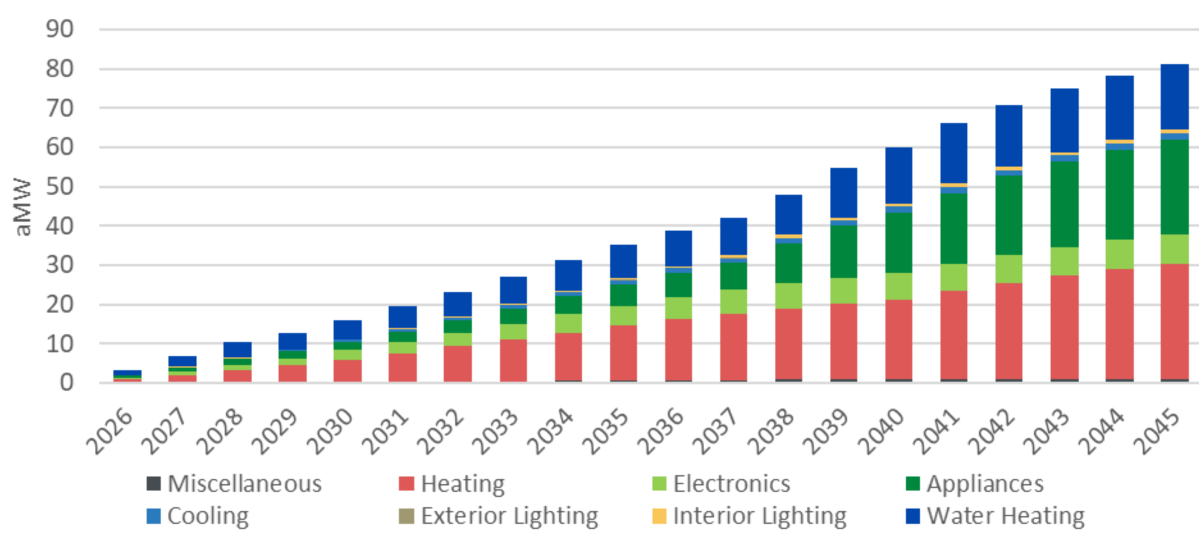


Figure 4-8 shows incremental residential achievable potential. Cadmus used measure ramp rates and effective useful live (EUL)—only for equipment replacement measures—to determine the timing of these savings. The increase in appliance savings in 2038 is due to the high proportion of market average dryers being replaced with more efficient heat pump dryers at the end of their 12-year measure life.

Figure 4-8. Residential Incremental Achievable Technical Potential by End Use (2026–2045)

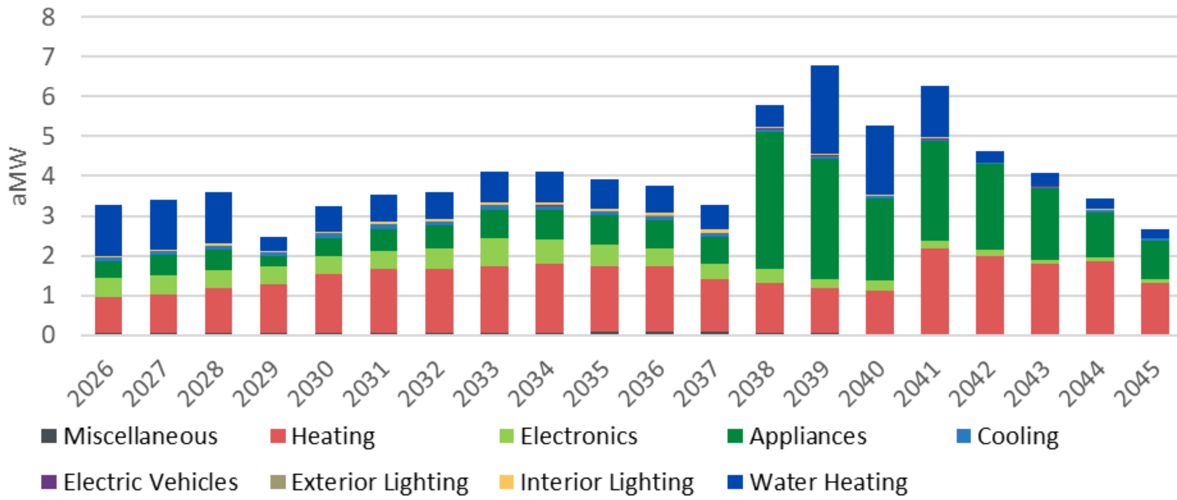


Figure 4-7 lists the 15 highest-saving residential measures sorted by 20-year achievable technical potential. These measures make up 76% of the total residential achievable technical potential. The table also includes the weighted average levelized costs for these measures,[34] which represent the economic equipment and administrative costs while still accounting for energy and non-energy benefits. The measure with the highest cumulative achievable technical potential—heat pump dryers—has a levelized cost of $60 per megawatt-hour. Other measures with potential high savings are window heat pumps, heat pump water heaters, and networked automation controls. Of the highest-savings measures, the least costly are ENERGY STAR TVs and ENERGY STAR printers.

[34] The levelized cost value represents a weighted average across all iterations, including segment and end use. As a result, some permutations of a measure may have a low levelized cost while other permutations have a high levelized cost.

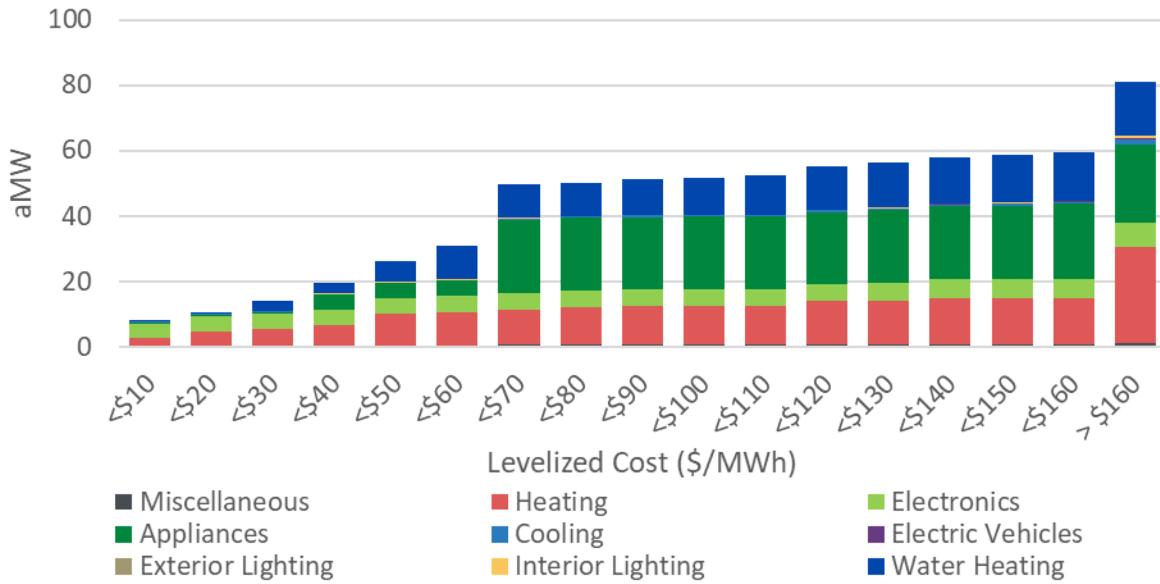
Table 4-7. Top-Saving Residential Measures

Measure Name	Cumulative Achievable Technical Potential (aMW)					Weighted Average Levelized TRC ($/MWh)
	2-Year	4-Year	10-Year	20-Year	% of Total (20-Year)	
Heat Pump Dryer	0.15	0.41	2.25	17.37	21%	$60.51
Window Heat Pump (19 SEER2, 9.3 HSPF)	0.13	0.47	2.94	12.15	15%	$165.40
Heat Pump Water Heater - Tier 4	0.67	1.08	1.94	4.34	5%	$61.35
Networked Automation Controls	0.05	0.21	1.96	3.80	5%	$4,239.03
Heat Pump Water Heater - Tier 3	0.69	1.10	1.54	3.47	4%	$56.78
Refrigerator and Refrigerator-Freezer – Consortium for Energy Efficiency Tier 3	0.59	0.93	1.56	3.19	4%	$34.23
Front Load ENERGY STAR Washer (w/Electric Dryer)	1.03	1.56	2.49	3.06	4%	$20.90
Single-Family Weatherization – Wall Insulation (R-0 to R-11 Heating Zone 1)	0.58	1.15	2.31	2.63	3%	$25.73
ENERGY STAR Office Printer	0.61	1.10	2.04	2.48	3%	$0.00
Convert Electric Forced Air Furnace with Central AC to Heat Pump	0.16	0.37	1.01	1.89	2%	$265.67
ENERGY STAR Ultra-High Definition TV	0.10	0.23	1.16	1.87	2%	$0.00
55-Gallon Heat Pump Water Heater – (2029 Federal Standard)	0.19	0.31	0.31	1.36	2%	$134.55
Residential Retail Valve, Electric Resistance Domestic Hot Water	0.02	0.08	0.70	1.35	2%	$51.37
Clothes Dryer with Heat Recovery	0.02	0.07	0.68	1.27	2%	$35.88
Duct Sealing	0.02	0.07	0.67	1.17	1%	$50.62

[a] *When the net expenses (costs and benefits) are less than zero, the resulting levelized TRC is shown as $0.00 per megawatt-hour and can be considered cost-effective.*

Overall, 16% of residential conservation potential is achievable within the first four years, and 43% is achievable in the first 10 years. Figure 4-9 shows 20-year cumulative residential potential by levelized cost in $10 per megawatt-hour increments.

Figure 4-9. Residential Supply Curve – Cumulative Achievable Technical Potential in 2045 by Levelized Cost



Twenty-seven percent of the residential achievable technical potential is from measures with a levelized cost of over $160 per megawatt-hour. This is partially because the second highest savings measure—window heat pumps—has a levelized cost greater than $160 per megawatt-hour.

City Light's IRP model selected an economic achievable potential of 13 aMW for the residential sector by 2045. Figure 4-10 shows the cumulative 20-year achievable economic potential for the residential sector by end-use group. The two end-use groups with the greatest achievable economic potential are heating and electronics, which collectively represent 67% of the total residential 20-year cumulative achievable economic potential.

Figure 4-10. Residential Cumulative Achievable Economic Potential in 2045 by End-Use Group

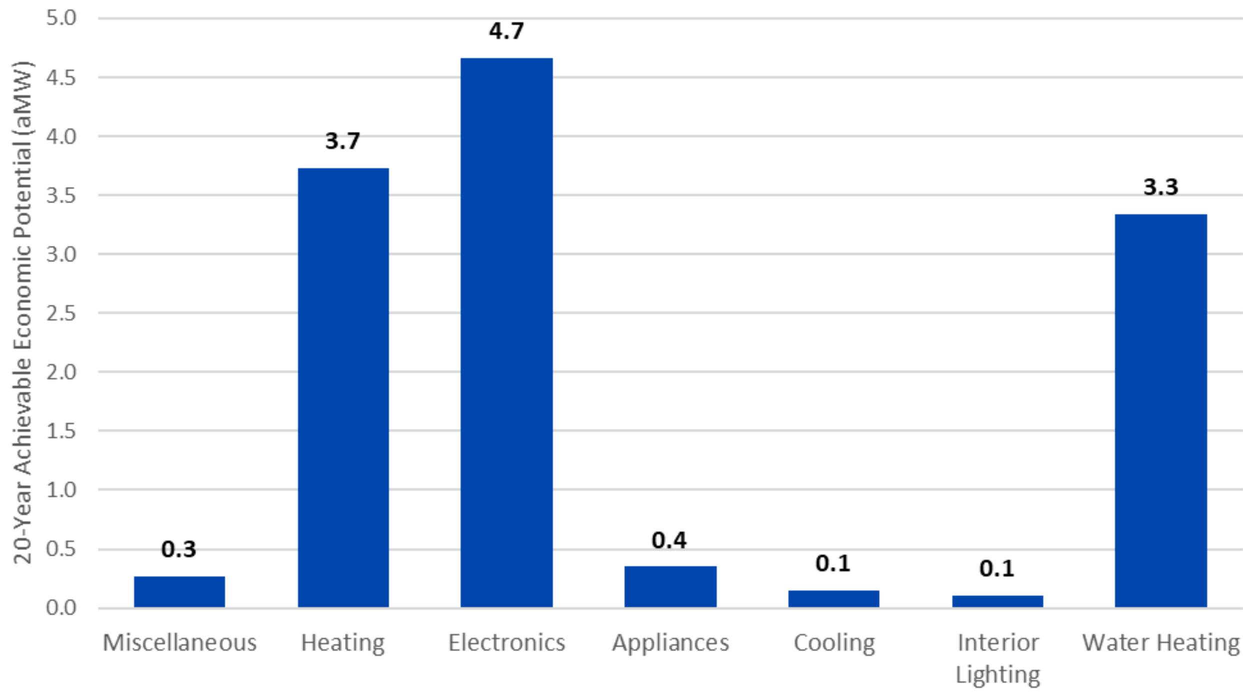


Table 4-8 lists City Light's 15 highest-saving IRP-selected residential measures. These measure permutations all have a levelized cost of less than or equal to $30 per megawatt-hour and make up 95% of the cumulative 20-year achievable economic potential for the residential sector.

Table 4-8. Top-Saving Residential Measures Selected by IRP Model

Measure Name	Cumulative Achievable Economic Potential (aMW) – Less than or Equal to $30/MWh				% of Cumulative 20-Year Achievable Economic Potential
	2-Year	4-Year	10-Year	20-Year	
Front Load ENERGY STAR Washer (w/Electric Dryer)	1.03	1.56	2.49	3.06	24%
ENERGY STAR Office Printer	0.61	1.10	2.04	2.48	20%
ENERGY STAR Ultra-High Definition TV	0.10	0.23	1.16	1.87	15%
Single-Family Weatherization – Wall Insulation (R-0 to R-11 Heating Zone 1)	0.24	0.48	0.96	1.10	9%
Wall Insulation (R-0 to R-11 Heating Zone 1)	0.22	0.45	0.90	1.02	8%
Air Source Heat Pump Upgrade (Advanced) - with Back-up	0.00	0.03	0.27	0.74	6%
Heat Pump Water Heater - Tier 3	0.12	0.20	0.20	0.47	4%
Cooking Range - Federal Standard 2028	0.10	0.10	0.10	0.25	2%
ENERGY STAR Laptops	0.05	0.09	0.14	0.15	1%
ENERGY STAR Home Audio System	0.01	0.02	0.10	0.15	1%
Indirect Evaporative Cooler, 2.5 tons	0.00	0.01	0.06	0.15	1%
Multifamily Door Sweep — Direct Install (Heating Zone 1, CFM50 Air-Leakage Reduction)	0.01	0.03	0.12	0.14	1%
Floor Insulation (R-0 to R-30 Heating Zone 1)	0.03	0.05	0.11	0.12	1%
TLED Linear Fluorescent Lamp Retrofit	0.06	0.11	0.11	0.11	1%
Low-E Storm Window – Double-Pane Metal Frame (Heating Zone 1)	0.01	0.02	0.09	0.10	1%

4.2.1. Highly Impacted Communities

Cadmus estimated the potential for highly impacted communities, as defined earlier in this report. As shown in Figure 4-11, highly impacted community segments constituted 35% (28 aMW) of the total residential achievable technical potential. As noted earlier, this distribution is primarily driven by each home type's proportion of baseline sales, but segment-specific end-use saturations and fuel shares have an effect as well.

City Light's IRP model selected an economic achievable potential of nearly 4 aMW in highly impacted communities by 2045. Figure 4-11 shows the cumulative 20-year achievable economic potential in highly impacted communities by end-use group. The two end-use groups with the greatest achievable economic potential are water heating and electronics, which collectively represent 72% of the total 20-year cumulative achievable economic potential in highly impacted communities.

Figure 4-11. Highly Impacted Communities Cumulative Achievable Economic Potential in 2045 by End-Use Group

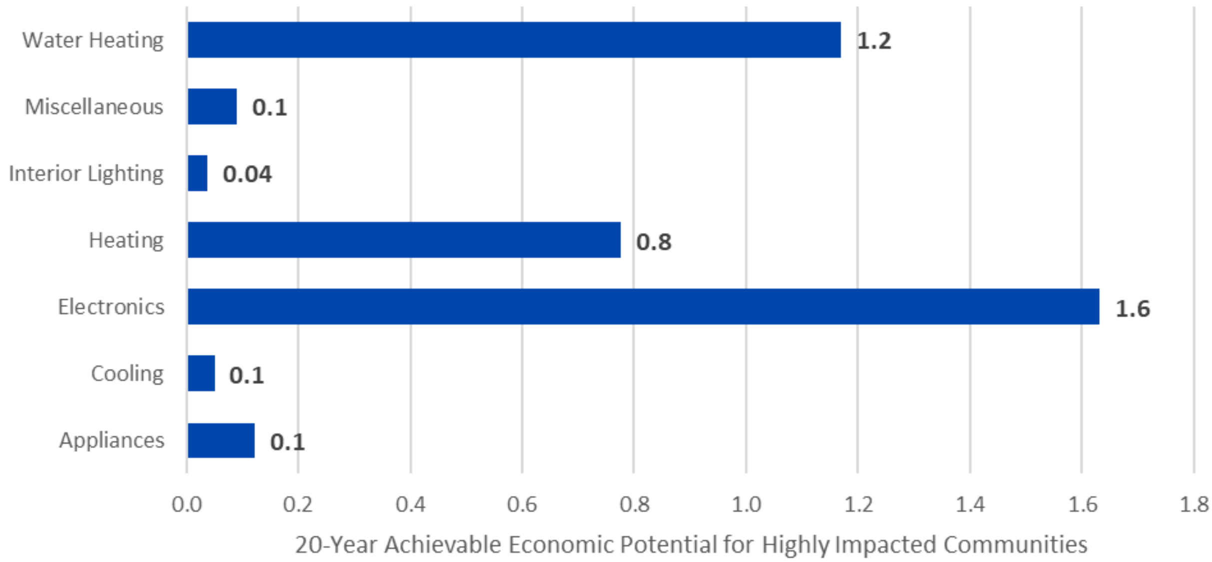


Table 4-9 lists the 15 highest-saving measures City Light's IRP model selected in highly impacted communities. These measure permutations all have a levelized cost of less than or equal to $30 per megawatt-hour and make up 97% of the cumulative 20-year achievable economic potential available for highly impacted communities.

Table 4-9. Top-Saving Residential Measures in Highly Impacted Communities Selected by IRP Model

Measure Name	Cumulative Achievable Economic Potential (aMW) – Less than or Equal to $30/MWh				% of Cumulative 20-year Achievable Economic Potential
	2-Year	4-Year	10-Year	20-Year	
Front Load ENERGY STAR Washer (w/Electric Dryer)	0.36	0.55	0.87	1.07	28%
ENERGY STAR Office Printer	0.21	0.39	0.72	0.87	22%
ENERGY STAR Ultra-High Definition TV	0.03	0.08	0.41	0.65	17%
Single-Family Weatherization – Wall Insulation (R-0 to R-11 Heating Zone 1)	0.08	0.16	0.31	0.36	9%
Air Source Heat Pump Upgrade (Advanced) - with Back-up	0.00	0.01	0.09	0.26	7%
Heat Pump Water Heater - Tier 3	0.04	0.07	0.07	0.17	4%
Cooking Range - Federal Standard 2028	0.03	0.03	0.03	0.09	2%
ENERGY STAR Laptops	0.02	0.03	0.05	0.05	1%
ENERGY STAR Home Audio System	0.00	0.01	0.03	0.05	1%
Indirect Evaporative Cooler, 2.5 tons	0.00	0.00	0.02	0.05	1%
Floor Insulation_(R-0 to R-30_Heating Zone 1)	0.01	0.02	0.04	0.04	1%
TLED Linear Fluorescent Lamp -	0.02	0.04	0.04	0.04	1%
Low-E Storm Window – Double-Pane Metal Frame (Heating Zone 1)	0.00	0.01	0.03	0.03	1%
Double Pane Windows (U22_Heating Zone 1)	0.00	0.01	0.02	0.02	1%
Double Pane Windows (U30_Heating Zone 1)	0.00	0.01	0.02	0.02	0%

4.3. Commercial

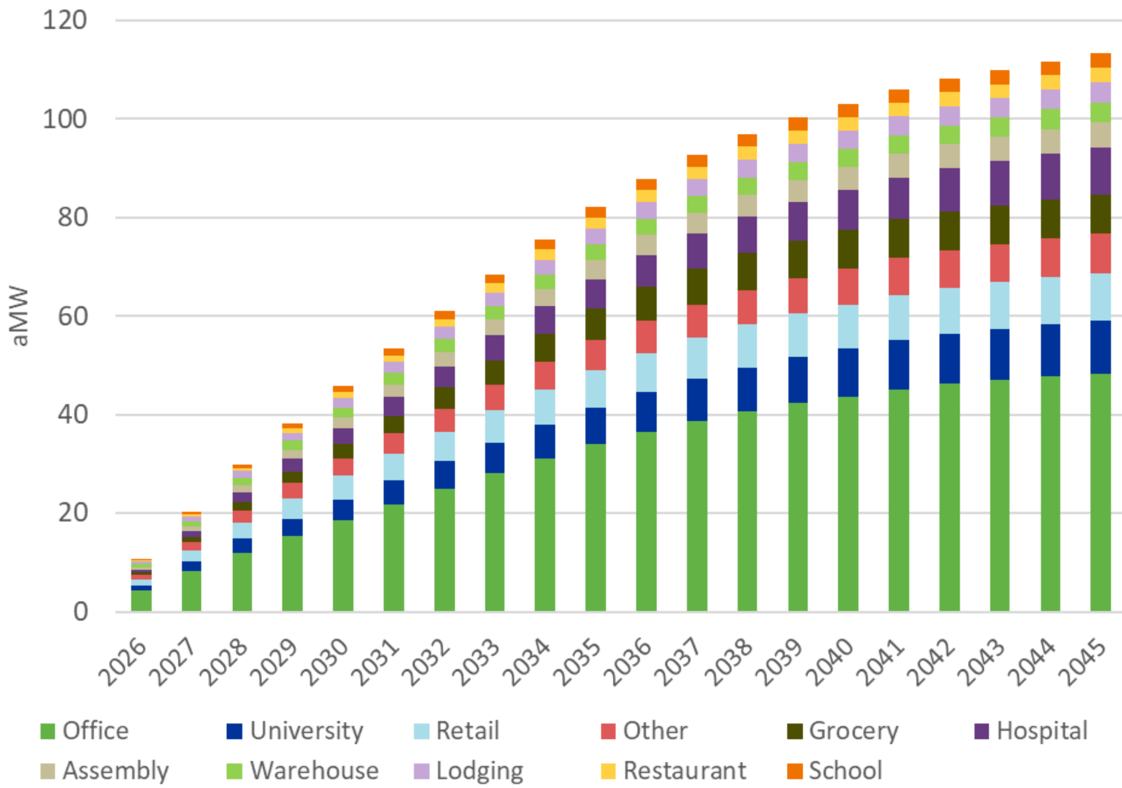
City Light's commercial sector accounts for 59% of its baseline sales in 2045 and 56% of total achievable technical potential. Cadmus estimated the potential for the 20 commercial segments listed above in Table 4-9Table 3- (grouped into 16 segments for this report). Table 4-10 summarizes the 20-year cumulative technical and achievable technical potential by commercial segment. Cadmus did not include an efficiency charger measure for commercial EVs considering the limited applicability for this conservation measure within the commercial sector, but the City Light commercial EV forecast is included in the commercial baseline sales reporting.

Table 4-10. Commercial Cumulative Technical and Achievable Technical Potential by Segment in 2045

Segment	Baseline Sales (aMW)	20-Year Technical Potential		20-Year Achievable Technical Potential	
		aMW	% of Baseline Sales	aMW	% of Technical Potential
Assembly	28	6	23%	5	80%
Data Center	74	0.3	0.5%	0.3	85%
Electric Vehicles	211	0	0%	0	N/A
Hospital	54	12	22%	10	82%
Large Grocery	17	7	43%	6	87%
Large Office	173	43	25%	36	84%
Lodging	23	5	21%	4	82%
MF Common Area	50	0	0%	0	N/A
Miscellaneous	34	7	20%	6	83%
Other Health	13	3	21%	2	80%
Restaurant	26	3	13%	3	84%
Retail	50	12	25%	10	78%
School	14	4	27%	3	82%
Small Grocery	7	2	27%	1	83%
Small Office	41	15	37%	12	80%
University	67	13	20%	11	81%
Warehouse	28	5	20%	4	75%
Total	**908**	**138**	**15%**	**113**	**82%**

Approximately 32% of the 20-year commercial achievable technical potential is from the large office segment, as shown in Figure 4-12. Together, large and small offices (shown as "office" in Figure 4-12) account for 43% of the 20-year commercial achievable technical potential. The large grocery segment has the highest technical potential savings relative to baseline sales due to the high potential associated with refrigeration equipment.

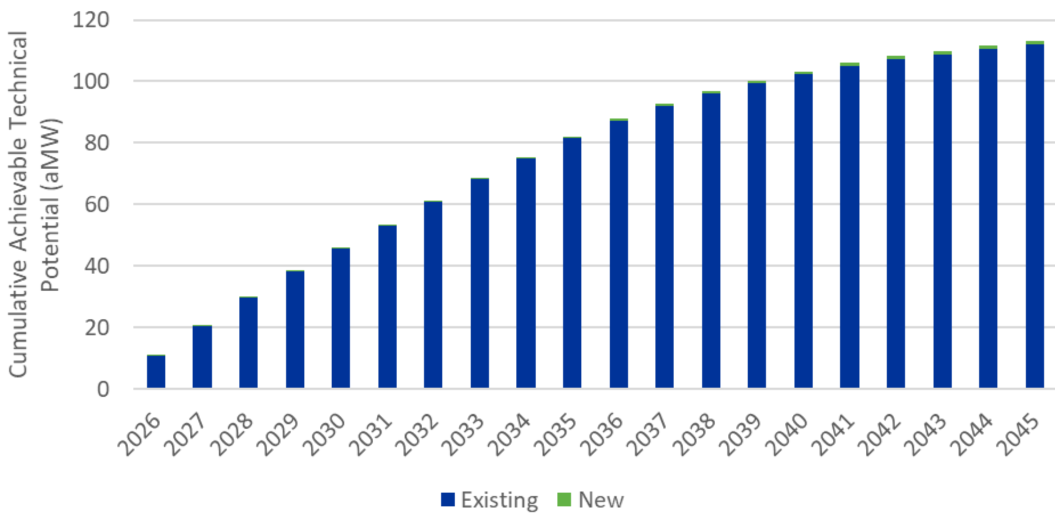
Figure 4-12. Commercial Cumulative Achievable Technical Potential by Segment (2026–2045)



Note: The "Other" segment includes data centers, miscellaneous, and other health.

Figure 4-13 presents the cumulative achievable technical potential by construction vintage for the commercial sector. Existing construction represents the majority of achievable technical potential, particularly in the early years of the study, and accounts for 99.7% of the potential in the first two years (2026 and 2027).

Figure 4-13. Commercial Cumulative Achievable Technical Potential by Construction Type (2026–2045)



Across all end uses, lighting accounts for 20% of total achievable technical potential. Table 4-11 shows the 20-year cumulative commercial potential by end use.

Table 4-11. Commercial Cumulative Technical, Achievable Technical, and Achievable Economic Potential by End-Use Group in 2045

Segment	Baseline Sales (aMW)	20-Year Technical Potential		20-Year Achievable Technical Potential		20-Year Achievable Economic Potential	
		aMW	% of Baseline Sales	aMW	% of Technical Potential	aMW	% of Technical Potential
Cooking	22	1	6%	1.2	85%	1.2	82%
Cooling[a]	56	26	47%	22	83%	12.2	46%
Data Center	107	5	5%	4.6	90%	4.6	90%
Electric Vehicles	211	0	0%	0	N/A	0.0	0%
Heat Pump[b]	67	19	28%	16	87%	9.2	50%
Heating[c]	22	8	35%	6.5	85%	5.4	71%
Lighting	165	33	20%	22	67%	21.8	66%
Miscellaneous	108	4	4%	3.9	88%	2.4	55%
Refrigeration	54	14	25%	13	91%	10.2	74%

Segment	Baseline Sales (aMW)	20-Year Technical Potential		20-Year Achievable Technical Potential		20-Year Achievable Economic Potential	
		aMW	% of Baseline Sales	aMW	% of Technical Potential	aMW	% of Technical Potential
Ventilation	83	24	28%	22	91%	12.9	55%
Water Heating	13	4	32%	3.1	73%	2.6	60%
Total	**908**	**138**	**15%**	**113**	**82%**	**82**	**60%**

[a] The cooling end-use group refers to cooling direct expansion, chiller equipment, and related retrofit measures.
[b] The heat pump end-use group includes air-source heat pumps and related retrofit measures. This differs from heat pump water heaters, which are included in the water heating end-use group.
[c] The heating end-use group refers to non-heat pump electric space heating equipment (such as electric resistance heating).

Compared to the residential sector, a larger proportion of the achievable technical potential is realized in the first 10 years of the study, with 72% of the 20-year cumulative achievable technical potential in the first 10 years (versus 43% for residential sector) and 34% in the first four years (versus 16% for residential sector). Figure 4-14 and Figure 4-15 show cumulative and incremental achievable potential for the commercial sector by end use, respectively. The drop in incremental potential for lighting is due to the incorporation of RCW 70A.230.020 prohibiting fluorescent lighting sales after July of 2029.

Figure 4-14. Commercial Cumulative Achievable Technical Potential by End Use (2026–2045)

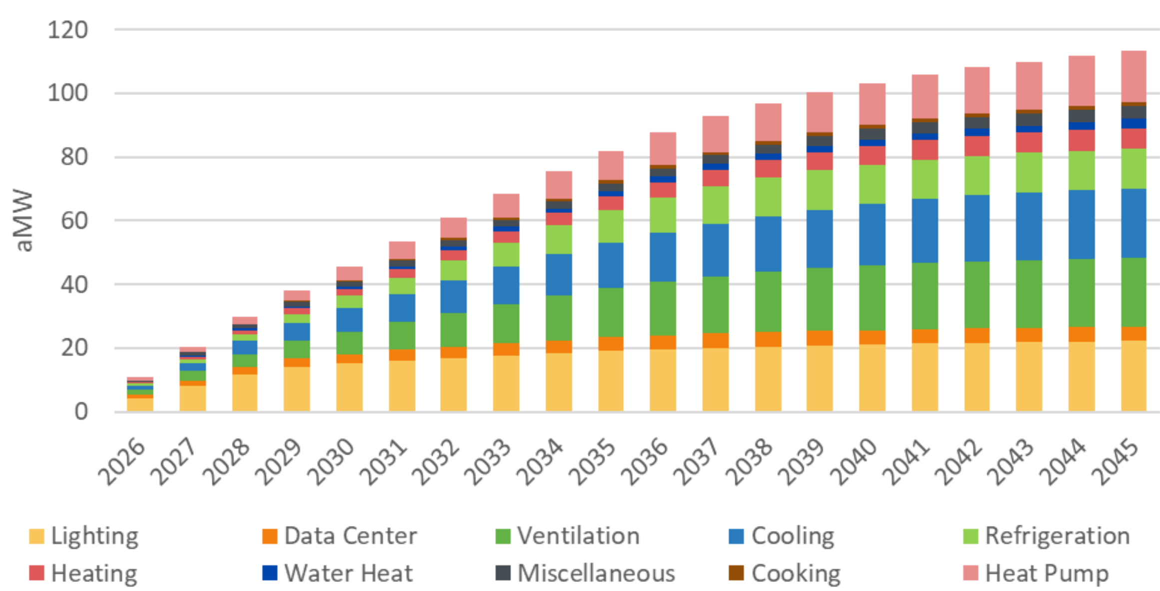


Figure 4-15. Commercial Incremental Achievable Technical Potential by End Use (2026–2045)

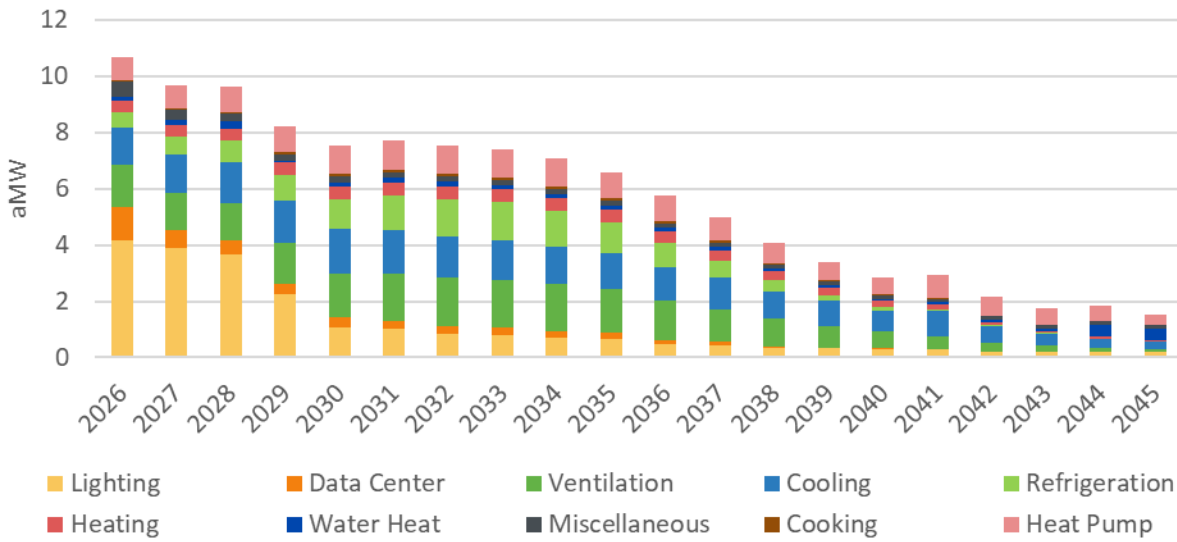


Table 4-12 shows the top 15 commercial measures and their average levelized costs,[35] sorted by 20-year achievable technical potential. Together, these measures represent 41% of the commercial cumulative 2045 achievable technical potential. The highest-saving measure is HVAC retro-commissioning with 7.4 aMW, or 7%, of achievable technical potential. Depending on the application, this measure can also be costly and may not be considered economical, with a weighted average levelized TRC of $159 per megawatt-hour.

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35 The levelized cost value represents a weighted average across all iterations, including segment and end use. As a result, some permutations of a measure may have a low levelized cost while other permutations have a high levelized cost.

Table 4-12. Top-Saving Commercial Measures

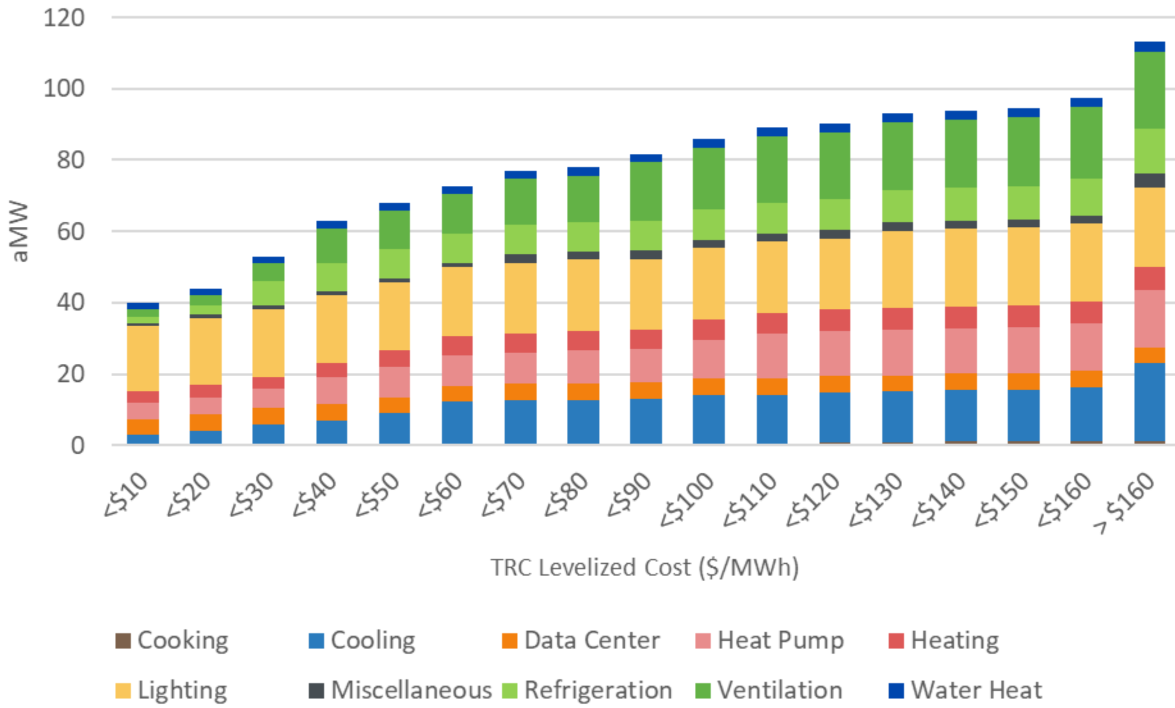
Measure Name	Cumulative Achievable Technical Potential (aMW)					Weighted Average Levelized TRC ($/MWh) [a]
	2-Year	4-Year	10-Year	20-Year	% of Total (20-Year)	
HVAC Retrocommissioning	1.67	3.28	6.51	7.40	7%	$158.59
Building Automation System Upgrades	1.53	3.01	5.97	6.81	6%	$25.58
Strategic Energy Management	0.05	0.19	2.04	5.98	5%	$194.58
Air Source Heat Pump, 240,000 to 759,999 Btu/h, Above Code	0.10	0.29	1.37	3.39	3%	$24.61
New Display Case - Replacement	0.32	0.78	2.79	3.33	3%	$24.52
Air Source Heat Pump, 135,000 to 240,000 Btu/h. Above Code	0.07	0.21	1.03	2.57	2%	$142.49
Thin Triple-Glazed Windows for Large Office with Gas Heating	0.02	0.07	0.77	2.28	2%	$39.69
ENERGY STAR Server	1.40	1.89	2.14	2.16	2%	-$10.99
Server Virtualization	0.20	0.49	1.76	2.11	2%	$4.23
Chiller - Above Code (Air/Water)	0.21	0.51	1.41	1.95	2%	$50.49
Outside Air Economizer	0.44	0.86	1.70	1.93	2%	-$2.03
Circulation Pump with ECM Motor and Advanced Speed Controls	0.45	0.86	1.67	1.89	2%	$83.24
Circulation Pump with ECM Motor and Advanced Run Hour Controls	0.40	0.79	1.57	1.79	2%	$64.72
Double-Sided LED Exit Sign	0.18	0.41	1.30	1.72	2%	$124.93
Large Refrigerator	0.15	0.37	1.32	1.58	1%	$338.10

[a] The average levelized TRC value represents a weighted average across all iterations, including segment and end use. As a result, some permutations of a measure may have a low levelized cost while other permutations have a high levelized cost.

Approximately 72% of 20-year commercial achievable technical potential falls within the first 10 years of the study horizon. Much of the commercial retrofit potential for existing buildings occurs within the first 10 years, largely due to the ramp rates associated with these measures. Additionally, the majority of lighting potential must be acquired prior to July of 2029to comply with RCW 70A.230.020 and is therefore captured early in the study period.

Figure 4-16 illustrates that the commercial levelized cost distributions for the achievable technical potential are similar to those for the residential sector. However, 14% of the achievable technical potential has costs exceeding $160 per megawatt-hour. This is primarily due to the high costs associated with HVAC retro-commissioning and weatherization measures, such as thin triple-pane window replacements, which offer large savings opportunities.

Figure 4-16. Commercial Supply Curve – Cumulative Achievable Technical Potential in 2045 by Levelized Cost



City Light's IRP model selected an achievable economic potential for the commercial sector of 82 aMW by 2045. Figure 4-17 shows the cumulative 20-year achievable economic potential for the commercial sector by end-use group. Achievable economic potential for lighting makes up 26% of the commercial achievable economic potential, followed by ventilation (16%) and cooling (15%).

Figure 4-17. Commercial Cumulative Achievable Economic Potential in 2045 by End-Use Group

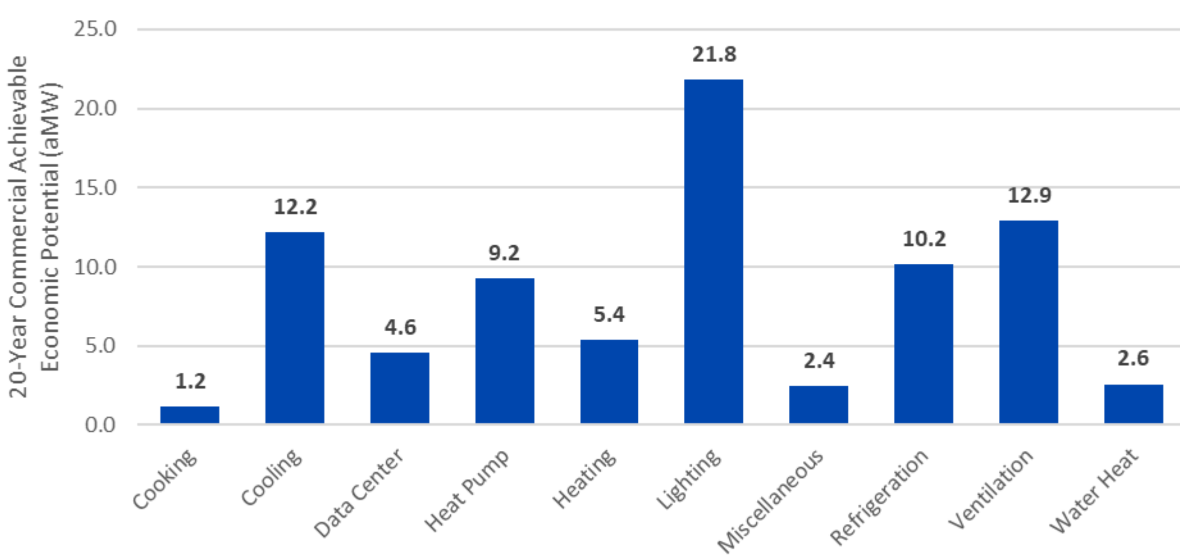


Table 4-13 lists the 15 highest-saving commercial measures City Light's IRP model selected. These commercial achievable economic measure permutations have a levelized cost of less than or equal to $160 per megawatt-hour and make up 44% of the commercial cumulative 20-year achievable economic potential.

Table 4-13. Top-Saving Commercial Measures Selected by IRP Model

Measure Name	Cumulative Achievable Economic Potential (aMW) – Less than or Equal to $160/MWh				% of Cumulative 20-year Achievable Economic Potential
	2-Year	4-Year	10-Year	20-year	
Building Automation System Upgrades	1.42	2.78	5.52	6.30	8%
Air Source Heat Pump, 240,000 to 759,999 Btu/h, Above Code	0.10	0.29	1.37	3.39	4%
New Replacement Display Case	0.32	0.78	2.79	3.33	4%
HVAC Retro-commissioning	0.68	1.37	2.74	3.12	4%
Thin Triple-Glazed Windows for Large Office with Gas Heating	0.02	0.07	0.77	2.28	3%
ENERGY STAR Server	1.40	1.89	2.14	2.16	3%
Server Virtualization	0.20	0.49	1.76	2.11	3%
Strategic Energy Management	0.02	0.06	0.69	2.04	2%
Chiller - Above Code (Air/Water) Heat Pump Water Heater Less than 55 Gallons - Tier 3	0.21	0.51	1.41	1.95	2%
Outside Air Economizer	0.44	0.86	1.70	1.93	2%
Circulation Pump with ECM Motor and Advanced Run Hour Controls	0.40	0.79	1.57	1.79	2%
Double-Sided LED Exit Sign	0.18	0.41	1.30	1.72	2%
Advanced Air-to-water Heat Pump	0.02	0.09	0.86	1.50	2%
Large Office – Linear Fixture Retrofit: Fluorescent Tube to LED Panel	0.53	0.99	1.17	1.37	2%
Web-Enabled Power Monitoring for Small and Medium Businesses	0.02	0.08	0.77	1.36	2%

4.4. Industrial

Cadmus estimated conservation potential for the industrial sector using the Council's 2021 Power Plan analysis tool. The conservation potential addressed eight industrial segments in City Light's service territory based on allocations developed from City Light's nonresidential database. The assessment identified approximately 7.6 aMW of achievable technical potential by 2045. Table 4-14 shows the cumulative industrial potential by segment in 2045.

Table 4-14. Industrial Cumulative Technical and Achievable Technical Potential by Segment in 2045

Segment	Baseline Sales (aMW)	20-Year Technical Potential		20-Year Achievable Technical Potential	
		aMW	% of Baseline Sales	aMW	% of Technical Potential
Foundries	42	3	8%	2.8	85%
Frozen Food	2	0	10%	0.1	83%
Miscellaneous Manufacturing	10	1	9%	0.7	84%
Other Food	0.03	0	11%	<0.01	84%
Stone and Glass	25	0	0%	0	N/A
Transportation Equipment	22	3	11%	2.1	82%
Wastewater	9	2	23%	1.8	85%
Water	0.3	0	8%	0.02	85%
Total	**109**	**9**	**8%**	**8**	**84%**

Figure 4-18 shows the industrial cumulative achievable technical potential by segment and year. Similar to baseline sales, the foundries segment has the largest share (37%) of 20-year industrial achievable technical potential, amounting to 3 aMW. This is followed by transportation equipment and wastewater, which each account for approximately 2 aMW of the total achievable technical potential.

Figure 4-18. Industrial Cumulative Achievable Technical Potential by Segment (2026–2045)

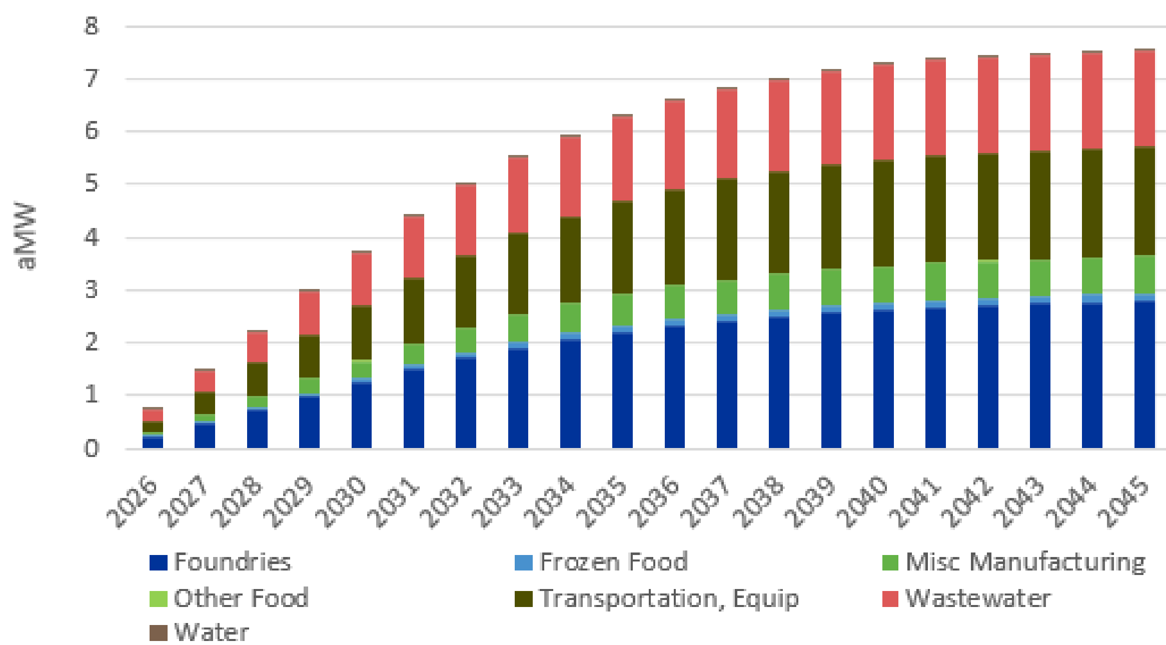


Table 4-15 shows the 20-year potential by industrial end use. The three end uses with the highest industrial achievable technical potential are other, fans, and pumps. The "Other" end-use category includes forklift battery chargers and welder systems, which represent a small portion of the potential, and wastewater and water supply, which represent the majority of potential with the end-use category.

Table 4-15. Industrial Cumulative Technical, Achievable Technical, and Achievable Economic Potential by End Use in 2045

End-Use Category	Baseline Sales (aMW)	20-Year Technical Potential		20-Year Achievable Technical Potential		20-Year Achievable Economic Potential	
		aMW	% of Baseline Sales	aMW	% of Technical Potential	aMW	% of Technical Potential
Fans	7	1.5	21%	1.2	85%	1.2	85%
HVAC	17	0.9	6%	0.8	85%	0.8	85%
Lighting	9	1.3	14%	0.9	73%	0.9	73%
Motors (Other)	14	0.5	4%	0.5	85%	0.5	85%
Other	16	2.2	13%	1.8	85%	1.8	85%
Process Air Compressor	6	0.9	15%	0.8	92%	0.8	92%
Process Electro Chemical	6	0.2	4%	0.2	85%	0.2	85%
Process Heat	17	0.0	0%	0.0	0%	0.0	0%
Process (Other)	2	0.0	0%	0.0	0%	0.0	0%
Process Refrigeration	3	0.1	3%	0.1	85%	0.1	85%
Pumps	12	1.4	12%	1.2	85%	1.2	85%
Total	**109**	**9.0**	**8%**	**7.6**	**84%**	**7.6**	**84%**

Figure 4-19 and Figure 4-20 show cumulative and incremental achievable technical potential by end use over the 20-year study horizon, respectively.

Figure 4-19. Industrial Cumulative Achievable Technical Potential by End Use (2026–2045)

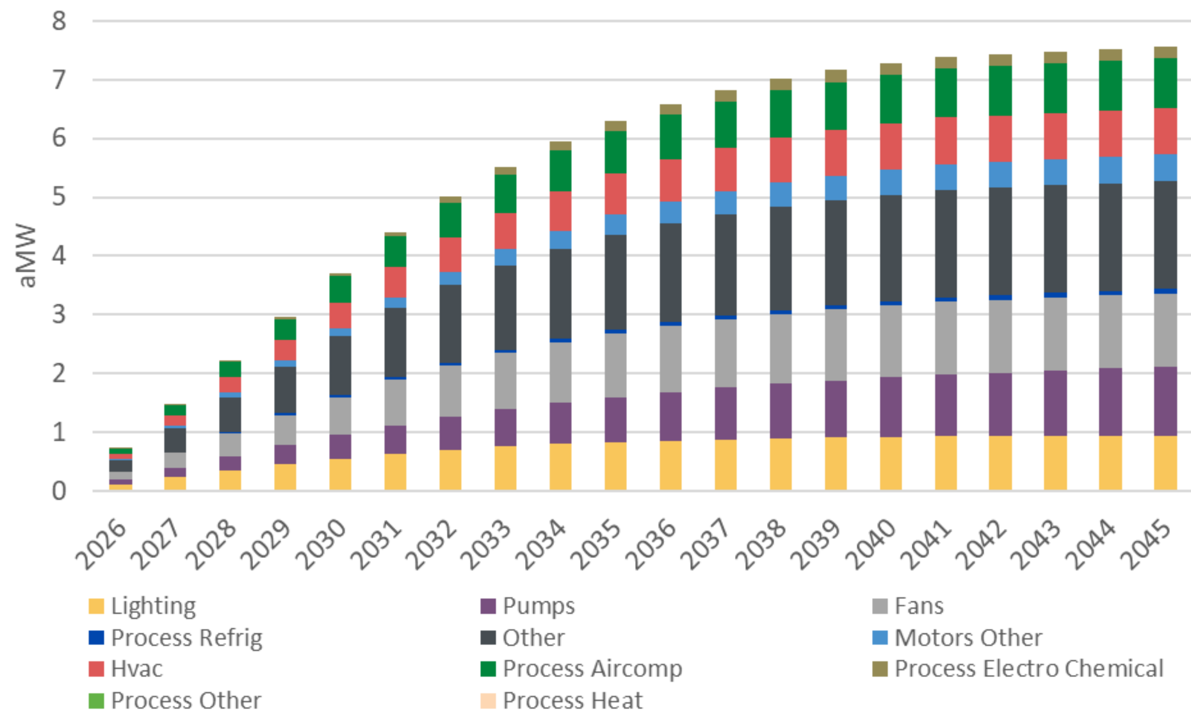


Figure 4-20. Industrial Incremental Achievable Technical Potential by End Use (2026–2045)

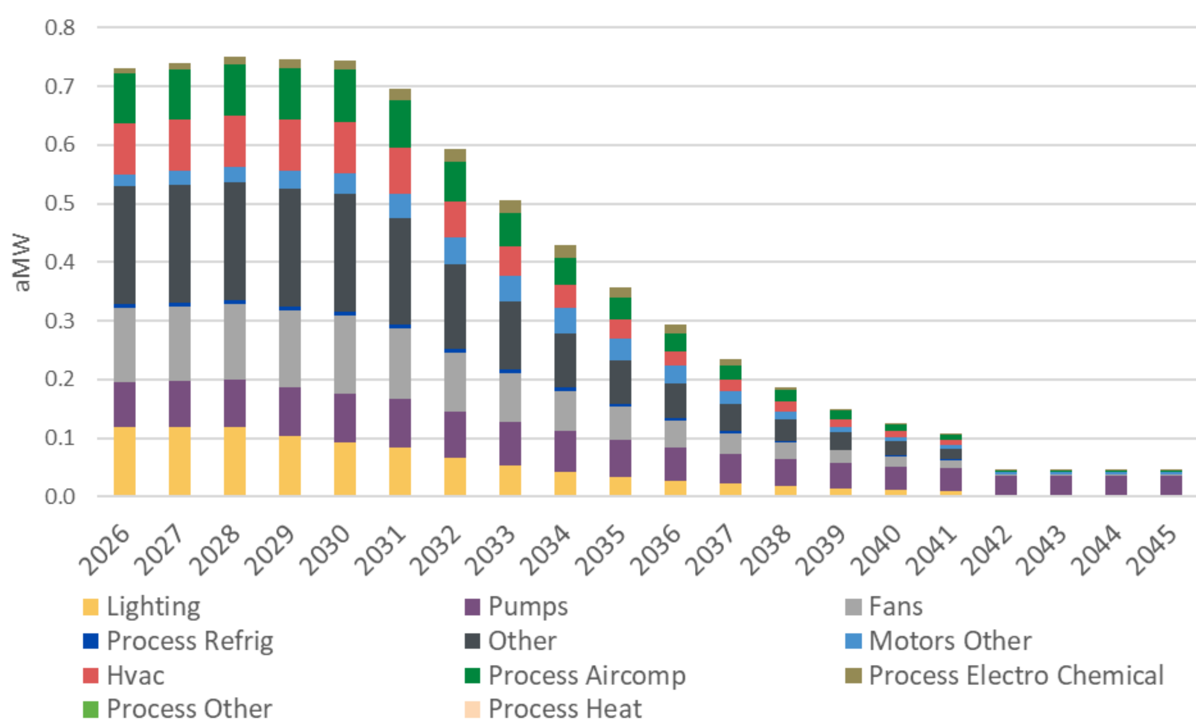


Table 4-16 shows the top-saving industrial measures and their weighted average levelized costs. Collectively, these 15 measures represent 92% of industrial 20-year cumulative achievable technical potential.

Table 4-16. Top-Saving Industrial Measures

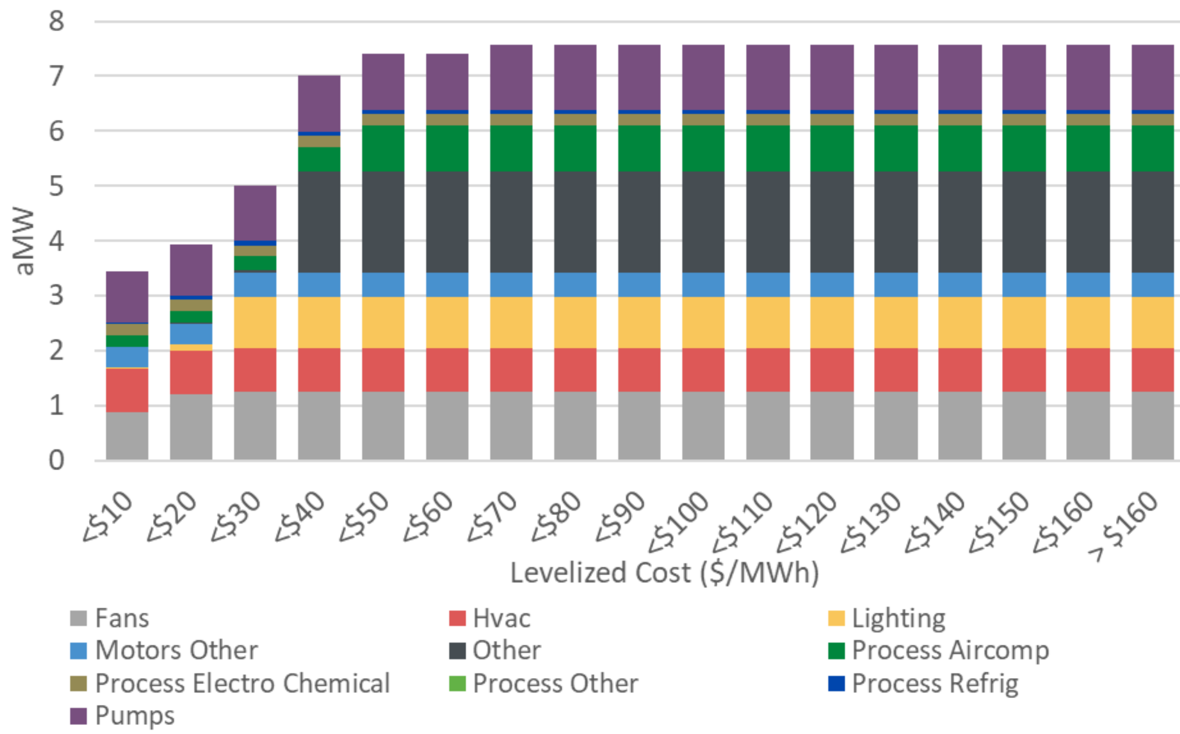
Measure Name	Cumulative Achievable Technical Potential (aMW)					Weighted Average Levelized TRC ($/MWh) [a,c]
	2-Year	4-Year	10-Year	20-Year	% of Total (20-Year)	
Wastewater	0.39	0.79	1.58	1.80	24%	$34.47
Lighting Controls	0.18	0.36	0.72	0.82	11%	$20.72
HVAC	0.17	0.35	0.70	0.79	11%	$0.00
Energy Management[b]	0.05	0.13	0.45	0.54	7%	$6.13
Fan Equipment Upgrade	0.11	0.22	0.45	0.51	7%	$0.00
Pump Optimization	0.05	0.10	0.24	0.49	6%	$0.00
Air Compressor Equipment	0.09	0.17	0.34	0.39	5%	$40.11
Fan Optimization	0.07	0.14	0.29	0.32	4%	$17.58
Energy Management2[b]	0.03	0.05	0.13	0.26	3%	$27.79
Air Compressor Variable Speed	0.04	0.09	0.18	0.20	3%	$34.84
Advanced Motors - Material Handling	0.02	0.05	0.17	0.20	3%	$0.00
Advanced Motors - Material Processing	0.02	0.05	0.17	0.20	3%	$0.00
Pump Variable Speed Trim	0.04	0.07	0.14	0.16	2%	$68.25
Pump Variable Speed	0.03	0.07	0.14	0.15	2%	$0.00
Air Compressor (Large) System Optimization	0.03	0.07	0.13	0.15	2%	$5.08

[a] The average levelized TRC value represents a weighted average across all iterations, including segment and end use. As a result, some permutations of a measure may have a low levelized cost while other permutations have a high levelized cost.
[b] The Council separated the Energy Management measures into two tiers: Level 1 and Level 2. Level 1 represents the standard strategic energy management applied in mostly large industrial facilities. Level 2 represents a share of strategic energy management potential likely found in smaller facilities, which is, therefore, more difficult to achieve. The cost of Level 2 is twice the cost of Level 1 and has half the savings.
[c] When net expenses (costs and benefits) are less than zero, the levelized TRC is shown as $0.00 (per megawatt-hour) and can be considered cost-effective.

Consistent with the Council's approach to the industrial sector, Cadmus modeled all industrial measures as retrofits and did not distinguish between new and existing construction. After applying ramp rates, approximately 83% of 20-year achievable technical potential is realized within the first 10 years.

Industrial measures are generally low cost, so the industrial achievable technical potential by levelized cost distribution does not have the same peak at greater than $160 per megawatt-hour as that for the residential and commercial sectors. In fact, all 7.6 aMW of industrial potential can be achieved at a levelized cost of less than or equal to $70 per megawatt-hour. Figure 4-21 shows cumulative achievable technical potential in 2045 for different levelized cost thresholds.

Figure 4-21. Industrial Supply Curve — Cumulative Achievable Technical Potential in 2045 by Levelized Cost



City Light's portfolio modeling selected all industrial measures for inclusion in the achievable economic potential portfolio. Therefore, the 20-year cumulative achievable economic potential for the industrial sector is 7.6 aMW at a levelized cost of less than or equal to $70 per megawatt-hour. The 15 highest-savings industrial measures the IRP model selected are the same as those reported for achievable technical potential.

5. Comparison to 2024 DSMPA

The 2026 DSMPA focused on final-year cumulative estimates of technical potential and incremental estimates of achievable technical potential. Cadmus defines the final-year cumulative technical potential as the total average megawatt savings that are considered technically feasible to achieve over the study horizon. For the 2024 DSMPA, that horizon was 2024 through 2045 (22 years), while for the 2026 DSMPA, it is 2024 through 2045 (20 years). The final year of each study aligns with the CETA commitment year for achieving greenhouse gas-free emissions. Overall, the 2026 DSMPA identified lower final-year cumulative technical potential and achievable technical potential compared with the 2024 DSMPA. This is partially due to the shorter study horizon but also because of the incorporation of new data sources, codes and standards, as well as the removal of certain measures, which all decreased the cumulative 2045 potential savings. Furthermore, Cadmus adjusted adoption rates to reflect market activity in the past two years that resulted in lower savings in the earlier years of the study. This chapter presents Cadmus' comparison of technical, achievable technical, and achievable economic potential results from these two assessments and details the reasons for the differences in results. In the subsequent tables, the baseline sales for the residential and commercial sectors in the 2026 DSMPA do not include City Light's EV forecasts. This is consistent with the 2024 DSMPA results, which also did not account for EV conservation measures or sales values.

5.1. Technical Potential Comparison

The 2026 DSMPA identified 245 aMW of technical potential in the final year, compared with 263 aMW in the 2024 DSMPA. The 7% decrease in cumulative final-year technical potential is heavily influenced by the shorter study horizon, new codes and standards, removal of measures with more savings than those added, and updated market and customer characterization data based on the 2022 RBSA. Table 5-1 shows a comparison of cumulative technical potential by sector from the 2024 and 2026 DSMPAs.

Table 5-1. Final Year Cumulative Technical Potential Comparison by Sector

Sector	2026 DSMPA			2024 DSMPA			Percentage Change in Technical Potential
	Baseline Sales—20 Year (aMW)	Technical Potential—20 Year (aMW)	Technical Potential as % of Baseline Sales	Baseline Sales—22 Year (aMW)	Technical Potential—22 Year (aMW)	Technical Potential as % of Baseline Sales	
Residential	439	97	22%	398	95	24%	3%
Commercial	698	138	20%	718	155	22%	-11%
Industrial	109	9	8%	124	13	11%	-31%
Total	**1,246**	**245**	**20%**	**1,240**	**263**	**21%**	**-7%**

The following sections detail the differences between the 2026 DSMPA and the 2024 DSMPA by sector.

5.1.1. Changes in Residential Technical Potential

The residential sector technical potential increased from 95 aMW in the final year in the 2024 DSMPA to 97 aMW in the 2026 DSMPA, which is a 3% increase. In the 2026 DSMPA, several factors affected the potential in positive or negative ways and resulted in an overall increase. The factors contributing to increasing potential are an increase in certain appliance saturations based on the incorporation of updated data from the 2022 RBSA, the addition of window heat pumps, and the decrease in the study timeline. In addition, the 2026 DSMPA includes the EV end use and associated potential, unlike the 2024 DSMPA. However, the technical potential due to EVs accounts for only 0.2 aMW in the 2026 DSMPA. Table 5-2 provides a comparison of baseline sales and technical potential and explains the reasons for the differences.

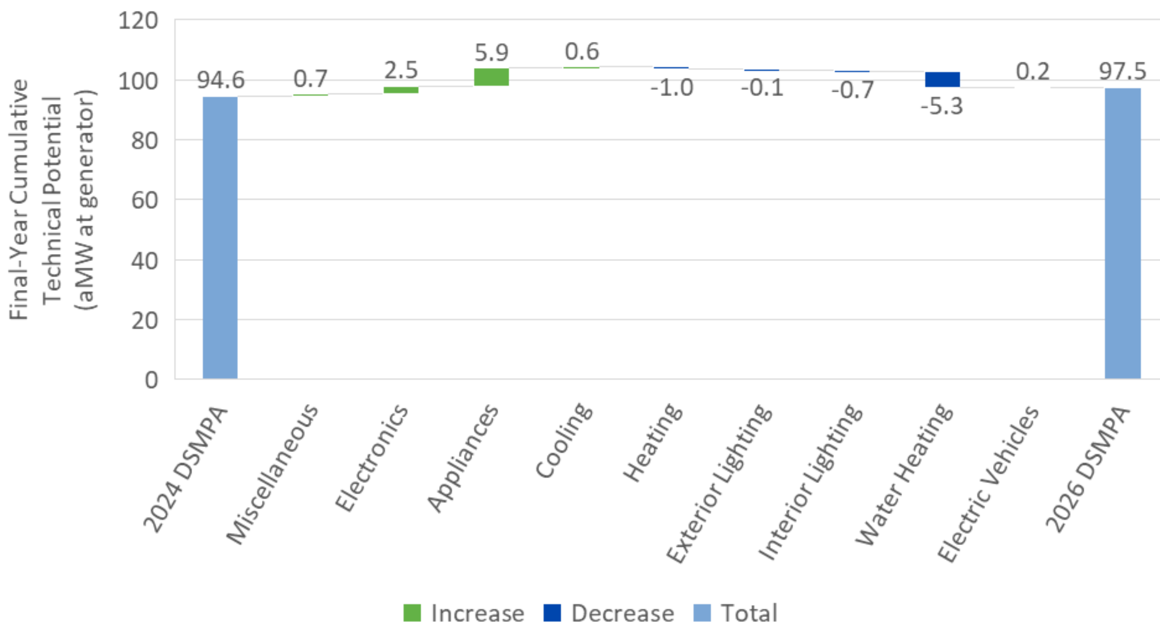
Table 5-2. Residential Cumulative Technical Potential Comparison

Component	2026 DSMPA 20-Year (aMW)	2024 DSMPA 22-Year (aMW)	Percentage Change	Reason for Change
Baseline Sales (aMW)	439	398	10%	Updated sales forecast from City Light with adjustments for building electrification, climate change, and codes and standards. The 2026 DSMPA sales forecast did include electrification in the base forecast and did not include adjustments for COVID-19 (as was done in the 2024 DSMPA).
Technical Potential (aMW)	97	95	3%	Increase in appliance saturations for high savings measures, such as heat pump dryers and TVs, and the addition of window heat pumps
Technical Potential as % of Baseline	22%	24%	N/A	

Note: This comparison does not include EVs

Figure 5-1 shows a comparison of residential technical potential by end-use group. The blue bars indicate all end-use groups that had a decrease in technical potential from the 2024 DSMPA to the 2026 DSMPA. The green bars indicate all end-use groups that had an increase in technical potential. The most significant increase, nearly 6 aMW, comes from the appliances end-use group, which is driven by increased saturations and RTF measure assumptions for appliances such as dryers. Other relatively smaller increases in potential come from electronics due to updated RBSA saturation data. The increase in EV technical potential is due to the addition of EV chargers as a measure. Water heating technical potential decreased by 5.3 aMW from the 2024 DSMPA to the 2026 DSMPA following the incorporation of the 2029 heat pump water heater federal standard.

Figure 5-1. Change in Cumulative Residential Technical Potential by End-Use Group



5.1.2. Changes in Commercial Technical Potential

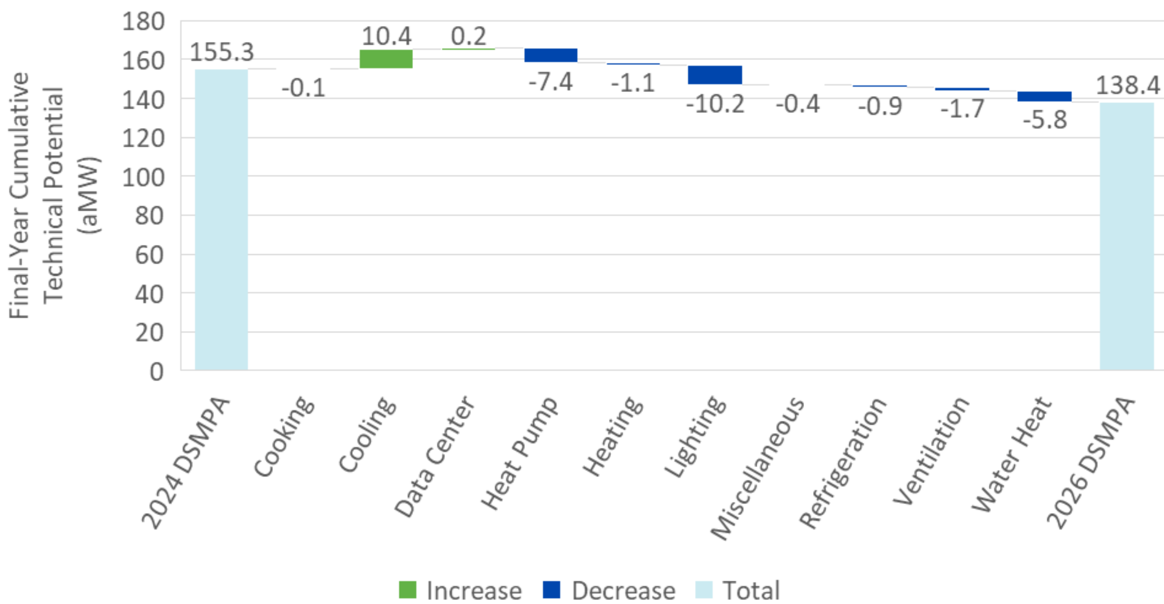
Several factors resulted in the 2026 DSMPA identifying lower final-year cumulative technical potential than the 2024 DSMPA. These factors include the new commercial load forecast being 3% lower in the 2024 DSMPA and the incorporation of new codes and standards that preclude City Light from capturing potential through efficiency programs for lighting and water heating (Table 5-3).

Table 5-3. Commercial Cumulative Technical Potential Comparison

Component	2026 DSMPA 20-Year (aMW)	2024 DSMPA 22-Year (aMW)	Percentage Change	Reason for Change
Baseline Sales (aMW)	698	718	-3%	Updated sales forecast from City Light with adjustments for building electrification, climate change, and codes and standards. The 2026 DSMPA sales forecast did not include adjustments for COVID-19 (as was done in the 2024 DSMPA).
Technical Potential (aMW)	138	155	-11%	Decreased lighting and water heating potential as a result of 2029 Washington codes and federal standards, respectively.
Technical Potential as % of Baseline	20%	22%	N/A	

Figure 5-2 illustrates the change in the commercial technical potential between the 2024 DSMPA and 2026 DSMPA by end-use group. End-use groups with a decrease in technical potential in the 2026 DSMPA include lighting and water heating. The reduction in lighting technical potential reflects the impact of a halt in LED savings beginning in July 2029, when RCW 70A.230.020 takes effect and prohibits fluorescent lighting sales. Savings for lighting measures after 2029 will primarily come from lighting controls. The decrease in water heating potential is due to the 2029 federal standard for heat pump water heaters. Additionally, updates to the RTF's chiller characterization result in higher cooling savings compared to the 2024 DSMPA.

Figure 5-2. Change in Commercial Cumulative Technical Potential by End-Use Group



5.1.3. Changes in Industrial Technical Potential

For the industrial sector, Cadmus did not incorporate any new measures into the 2026 DSMPA based on the 2021 Power Plan; as a result, there were no major changes in the industrial sector's potential compared with the 2022 CPA. The 2026 DSMPA, like the 2024 DSMPA, accounts for building electrification, which increases the opportunity for additional energy efficiency potential.

5.2. Achievable Technical Potential and Ramp Rate Comparison

The 2026 DSMPA shows a lower cumulative achievable technical potential compared to the 2024 DSMPA. This reduction is due to the final-year cumulative achievable technical potential being a subset of technical potential and influenced by the same factors that lowered technical potential. Specifically, the new commercial load forecast being 3% lower in the 2024 DSMPA, and the incorporation of new codes and standards preclude City Light from capturing potential through efficiency programs for lighting and water heating in the latter years of the study period.

The following figures show incremental achievable technical potential from the 2026 DSMPA (Figure 5-3) and the 2024 DSMPA (Figure 5-4). While the 2045 cumulative potential is 11% lower in the 2026 DSMPA compared to the 2024 DSMPA, the near term potential is more consistent between the two studies. Specifically, the cumulative achievable technical potential in the first two years of the 2026 DSMPA is only

5% lower than that in the first two years of the 2024 DSMPA. This slight increase is a result of the abbreviated study period and the incorporation of adjusted ramp rates from the 2021 Power Plan.

Figure 5-3. Incremental Achievable Technical Potential – 2026 DSMPA

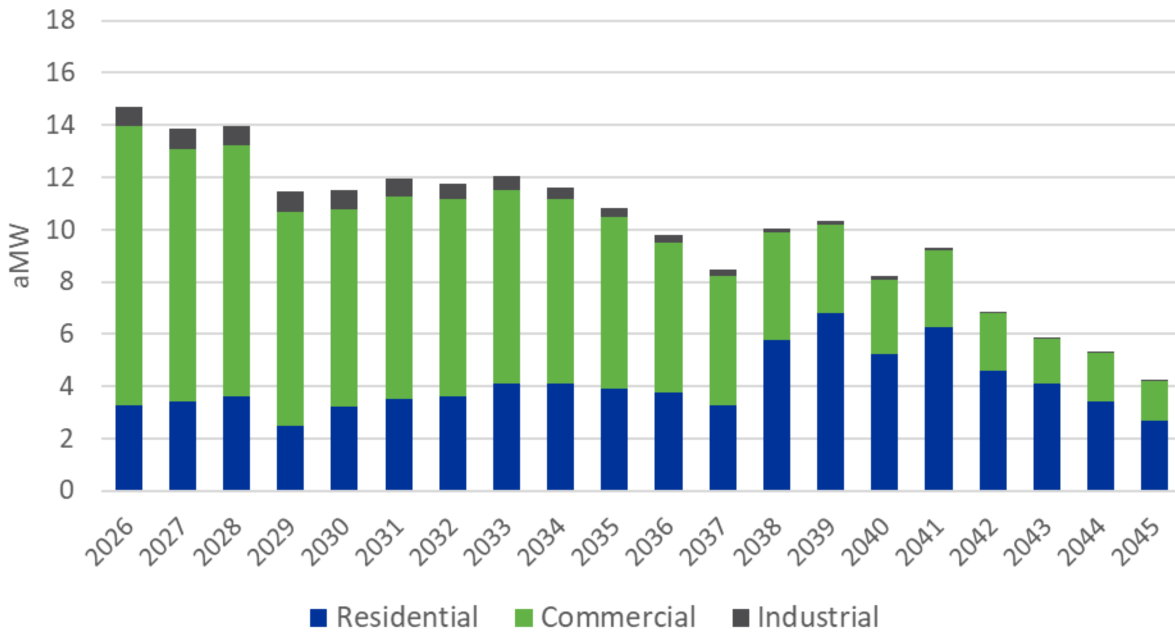
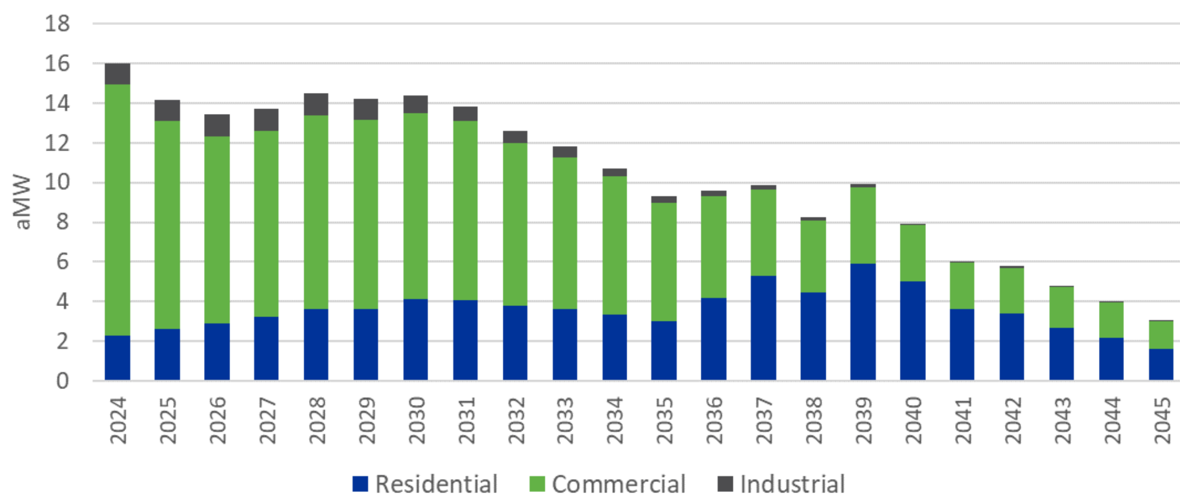


Figure 5-4. Incremental Achievable Technical Potential – 2024 DSMPA



Note that the figures above show the impact of codes and standards that begin taking effect in 2029 and reduce the potential for the remainder of the study period. The two-year achievable potential in the 2024 DSMPA is equal to approximately 13% of the total 22-year achievable technical potential, whereas the two-year achievable potential in the 2026 DSMPA is equal to approximately 14% of the total 20-year achievable technical potential.

5.3. IRP Achievable Economic Potential Comparison

Both the 2024 DSMPA and 2026 DSMPA used the IRP optimization modeling to determine how much energy efficiency, as a resource, is cost-effective compared with other competing resources over the study horizon. For the 2026 DSMPA, City Light updated the IRP optimization modeling process using a new tool. Details of this modeling framework can be found in Long-Term Resource Planning Model for DSMPA section. Table 5-4 shows a comparison of the achievable (economic) potential between the two studies. While both the 2024 DSMPA and the 2026 DSMPA load forecasts accounted for climate change and increased building electrification loads, the 2026 DSMPA did not include adjustments for COVID-19 that were incorporated in the 2024 DSMPA load forecast. . The two studies also have different demand-side potentials and associated costs.

Table 5-4. Economic Cumulative Potential Comparison

Sector	2026 DSMPA			2024 DSMPA		
	Baseline Sales – 20-Year (aMW)	Achievable Economic Potential – 20-Year (aMW)	Achievable Economic Potential as % of Baseline Sales	Baseline Sales – 22-Year (aMW)	Achievable Economic Potential – 22-Year (aMW)	Achievable Economic Potential as % of Baseline Sales
Residential	439	13	3%	398	50	13
Commercial	698	82	12%	718	72	10
Industrial	109	8	7%	124	10	8
Total	**1,246**	**103**	**8%**	**1,240**	**132**	**11%**

The 2026 DSMPA 20-Year residential sector achievable economic potential increased by nearly 75% compared with the 2024 DSMPA. The 2024 DSMPA selected nearly all measures, mostly due to its effectiveness at reducing winter loads, whereas the 2026 DSMPA only selected measures at or below $30/MWh. This excluded many of the high savings measures that were included in the previous DSMPA.

Conversely, the IRP selected more higher cost measures in the commercial sector than in the 2024 DSMPA which led to a 15% increase in 20-year achievable economic potential. The 2026 DSMPA industrial sector achievable economic potential is very similar to that of the 2024 DSMPA with a slight decrease as a result of lower achievable technical potential.

6. Detailed Methodology

Cadmus' general methodology can be best described as a combined top-down/bottom-up approach. We began the top-down component with City Light's most current load forecast. Cadmus adjusted this forecast for building energy codes, equipment efficiency standards, building electrification, and climate change that was not already accounted for through the forecast. We then disaggregated this load forecast into its constituent customer sectors, customer segments, and end-use components and projected the results out 20 years. We also calibrated the base year (2025) to City Light's sector-load forecasts.

For the bottom-up component, Cadmus considered the potential technical impacts of various ECMs and practices on each end use. We then estimated impacts based on engineering calculations, accounting for fuel shares, current market saturations, technical feasibility, and costs. The technical potential presents an alternative forecast that reflects the technical impacts of specific energy efficiency measures. We then determined the achievable technical potential by applying ramp rates and achievability percentages to technical potential. This chapter describes the CPA methodology in detail.

6.1. Developing Baseline Forecasts

City Light's sector-level sales and customer forecasts provided the basis for assessing energy efficiency potential. Prior to estimating potential, Cadmus disaggregated sector-level load forecasts by customer segment (business, dwelling, or facility types), building vintage (existing structures and new construction), and end uses (all applicable end uses in each customer sector and segment).

To develop the baseline forecasts, Cadmus first identified the appropriate customer segments in each sector. For these designations, we used categories from the study's key data sources—primarily City Light's nonresidential customer database for the commercial and industrial sectors and the U.S. Census Bureau's American Community Survey for the residential sector. We then mapped the appropriate end uses to relevant customer segments.

Next, Cadmus produced the baseline end-use load forecasts by integrating current and forecasted customer counts with key market and equipment usage data.

For the commercial and residential sectors, we calculated the total baseline annual consumption for each end use in each customer segment using the following equation:

$$EUSE_{ij} = \sum_{e} ACCTS_i \times UPA_i \times SAT_{ij} \times FSH_{ij} \times ESH_{ije} \times EUI_{ije}$$

Where:

$EUSE_{ij}$ = total electric energy consumption for end-use j in customer segment i

$ACCTS_i$ = number of accounts/customers in customer segment i

UPA_i = units per account in customer segment i (UPA_i generally equals the average square feet per customer in commercial segments, and equals 1.0 in residential dwellings, assessed at the whole-home level)

SAT_{ij}	=	share of customers in customer segment i with end-use j
FSH_{ij}	=	share of end-use j of customer segment i served by electricity
ESH_{ije}	=	market share of efficiency level in equipment for customer segment i and end use j
EUI_{ije}	=	end-use intensity: electric energy consumption per unit (per square foot for commercial) for the electric equipment configuration ije

For each sector, we determined the total annual electric consumption as the sum of $EUSE_{ij}$ across the end uses and customer segments.

Consistent with other conservation potential studies and commensurate with industrial UEC data (which varied widely in quality), we allocated the industrial sector's loads to end uses in various segments based on data available from the U.S. EIA.[36]

6.1.1. Derivation of End-Use Consumption

End-use electric energy consumption estimates by segment, end use, and efficiency level (EUI_{ije}) provided one of the most important components in developing a baseline forecast. In the residential sector, Cadmus used estimates of UEC, representing annual electric energy consumption associated with an end use and represented by a specific type of equipment, such as a central AC or heat pump. We derived the basis for the UEC values from savings in the latest RTF workbooks, the Council's 2021 Power Plan workbooks, and savings analyses to calculate accurate consumption wherever possible for all efficiency levels of end-use technology. When Council workbooks did not exist for certain end uses, we used results from NEEA's 2022 RBSA or City Light's oversample, or we conducted other research (for example, U.S. Department of Energy, ENERGY STAR).

For the commercial sector, Cadmus treated consumption estimates as end-use intensities that represented annual electric energy consumption per square foot served. To develop the end-use intensities, Cadmus developed electric energy intensities (total kilowatt-hours per building square foot) based on NEEA's 2019 CBSA IV. We then benchmarked these electric energy intensities against various other data sources, including the CBSA III, historical forecasted and potential study data from City Light, and historical end-use intensities developed by the Council and NEEA.

To distribute the electric energy intensities to end-use intensities, Cadmus used assumptions specific to each building segment and end use and applied the following methods:

- **Lighting.** To determine lighting end-use, Cadmus analyzed the CBSA IV's lighting power density (lighting wattage per square foot). We then multiplied this by the Council's interior lighting hours of use by building type. After calculating lighting end-use intensity, we subtracted this portion of

36 U.S. Department of Energy, Energy Information Administration. 2010. *Manufacturing Energy Consumption Survey.*

the load from the total CBSA electric energy intensities (for example, to estimate non-lighting intensities).

Non-lighting. To distribute the remaining non-lighting CBSA electric energy intensities into end uses, Cadmus used 2012 CBECS microdata to calculate percentages of end-use intensities across various end-use groups by building types as defined by the Council. We then used the CBSA fuel shares and end-use saturations to adjust the distributions of CBECS end-use intensities to better represent City Light's commercial service territory. These finalized CBECS end-use intensities—adjusted with CBSA values where possible—were the basis for most of the end-use intensities in the commercial sector.

- **Computers and servers.** Cadmus developed energy intensities by building type for computers (desktops and laptops) and servers end uses. Using the CBECS data, Cadmus determined the number of units per square foot and then multiplied this by the consumption per unit.
- **University.** The CBSA IV data lacked information on university building type, and the schools building type represented only K–12, as designated by the Council. To develop a more accurate electric energy intensity specific to universities, Cadmus calculated a ratio between the CBECS's university and school K–12 building types. We then used the CBSA school K–12 lighting power density and applied the Council's university lighting hours of use. Finally, Cadmus verified the reasonableness of the result by benchmarking the university lighting end-use intensity developed for City Light against the ratio of CBECS university and school K–12 lighting loads.
- **Retail.** Low CBSA respondent counts and matching varying definitions of building type in Council and CBECS data caused concern, especially for the large and extra-large retail building types. To address this, Cadmus combined the large and extra-large retail building types for the CBSA electric energy intensities and lighting power density. Similarly, Cadmus combined small and medium retail building types because the counts and definitions were insufficient.

For the industrial sector, end-use electric energy consumption represented the total annual industry consumption by end use, as allocated by the secondary data described above.

6.1.2. City Light Forecast Adjustments

Cadmus worked with the City Light load forecast team to adjust the baseline forecast to account for climate change, equipment standards, building energy codes, and building electrification.

To account for the impacts of climate change, Cadmus used Multivariate Adaptive Constructed Analogs (MACA) scalar-adjusted heating degree days and cooling degree days data provided by City Light. Cadmus applied annual heating and cooling degree days adjustment ratios (called climate change adjustment factors) to cooling, heating, and heat pump UECs for the residential and commercial sectors. Table 6-1 presents the climate change adjustment factors for the heating, cooling, and heat pump end uses for each year.

Table 6-1. Climate Change Adjustment Factors for Residential and Commercial Heating, Cooling, and Heat Pump End Uses for Each Year

Year	Residential and Commercial Heating End-Use Multiplier	Residential and Commercial Cooling End-Use Multiplier	Residential Heat Pump End-Use Multiplier	Average Commercial Heat Pump End-Use Multiplier [a]
2025	0.99	1.02	0.99	1.00
2026	0.98	1.03	0.99	1.00
2027	0.98	1.05	0.98	1.01
2028	0.98	1.06	0.98	1.02
2029	0.97	1.09	0.97	1.02
2030	0.96	1.11	0.97	1.03
2031	0.96	1.12	0.97	1.03
2032	0.96	1.15	0.97	1.05
2033	0.95	1.17	0.96	1.05
2034	0.95	1.20	0.95	1.06
2035	0.94	1.22	0.95	1.06
2036	0.94	1.24	0.95	1.07
2037	0.93	1.27	0.94	1.08
2038	0.92	1.29	0.94	1.09
2039	0.92	1.31	0.93	1.10
2040	0.92	1.34	0.94	1.11
2041	0.91	1.36	0.93	1.11
2042	0.90	1.39	0.92	1.12
2043	0.90	1.41	0.92	1.13
2044	0.90	1.44	0.92	1.14
2045	0.89	1.46	0.91	1.14

[a] Since the heat pump heating/cooling ratio of heat pumps varies by type of commercial building, commercial heat pump consumptions vary by building type. The numbers presented in this table are average multipliers.

For each end use, Cadmus multiplied the base year (2025) UEC by the multipliers shown in the table above to calculate the climate change-adjusted UEC. For example, for cooling, the climate adjustment factor was 1.46 in 2045, and therefore, we multiplied the base year (2025) cooling consumption by 146% in 2045.

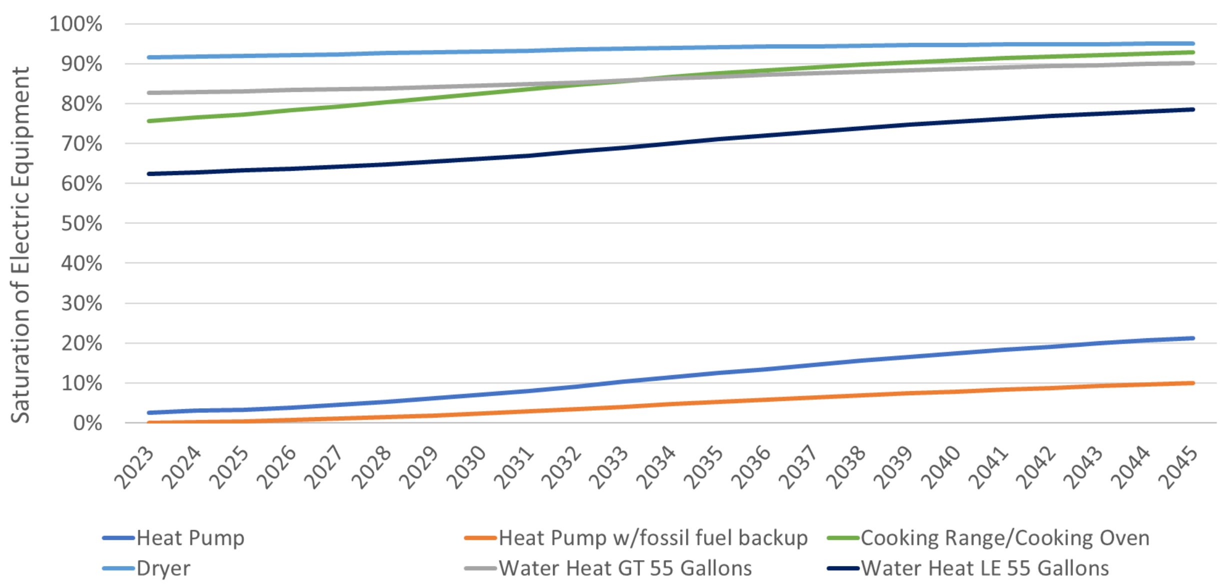
For the commercial sector, heat pump consumptions vary by building type because the heat pump heating/cooling ratio of heat pumps varies by the type of commercial building. On average, we multiplied the base year commercial heat pump consumptions by 114% in 2045. For the residential sector, based on observed increases in the adoption of heat pumps and AC spurred by the 2021 heat dome, Cadmus assumed that future cooling saturation (heat pump plus AC) would reach 70% by 2045. Cadmus implemented this assumption by linearly interpolating between base year (2025) saturation and final year (2045) saturation.

Cadmus further tailored the load forecast embedded with climate change adjustments for the impacts of city and state codes and federal standards that were on the books as of November 2024. We describe the treatment of codes and standards in the 2026 DSMPA in the *Incorporating Federal Standards and State and Local Codes and Policies* section.

Furthermore, Cadmus made adjustments for building electrification based on a 2022 Electric Power Research Institute (EPRI) study.[37] For this 2026 DSMPA, Cadmus applied the EPRI study's moderate market advancement scenario data to account for the impacts of electrification. This scenario is the closest to a "business-as-usual" scenario, where electric transportation adoption continues to grow based on past trajectories. Additionally, the electrification of buildings and industry is driven by customer choice as well as relative economics. The building stock and end-use saturation assumptions of the moderate market advancement scenario are generally consistent with City Light's 2024 load forecast and the 2024 CPA.

Based on moderate market advancement scenario data, Cadmus increased the fuel shares and equipment saturations for the residential sector. This involved converting cooking, dryer, and water heater fuel to electric, which led to an increase in heat pump equipment saturations as non-electric space heating equipment was converted to heat pumps. Figure 6-1 illustrates the change in saturation of electric equipment for cooking, water heating, and HVAC heat pumps with and without fossil fuel backup over the study horizon for single-family houses (existing construction).

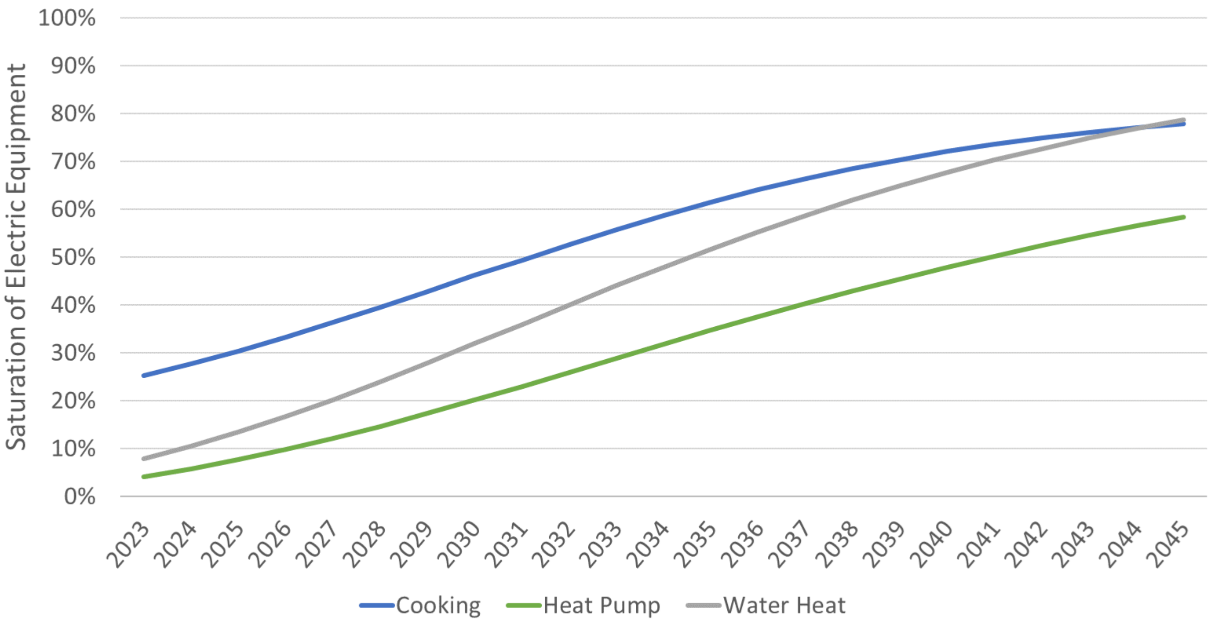
Figure 6-1. Cooking, Water Heating, Heat Pump, and Heat Pump with Fossil Fuel Backup Saturations in Single-Family Houses (Existing Construction)



37 Electric Power Research Institute. January 2022. *Seattle City Light Electrification Assessment, Final Report*.

Similarly, for the commercial sector, the saturation of cooking, water heater, and HVAC heat pump electric equipment increased. As an example, Figure 6-2 illustrates the change in cooking, water heating, and heat pump saturation of electric equipment over the study horizon for restaurants (existing construction).

Figure 6-2. Cooking, Water Heating, and Heat Pump Saturations in Restaurants (Existing Construction)



In this study, all these adjustments occur naturally and do not represent energy efficiency potential.

6.1.3. Measure Characterization

Because technical potential relies on an alternative forecast that includes installations of all technically feasible measures, Cadmus chose the most robust set of appropriate ECMs. We developed a comprehensive database of technical and market data for these ECMs, applicable to all end uses across various market segments.

The database included the following measures:

- All measures in the Council's 2021 Power Plan conservation supply curve workbooks.
- Active UES measures from the RTF, updated to the latest RTF data for 10 high-impact measures.
- Technologies of interest to City Light and included in the 2026 DMSPA, including window heat pump, HVAC sizing, multifamily packaged terminal heat pump, heat pump with gas back-up, and EV chargers.
- Commercial technologies of interest to City Light and included in the 2022 CPA, such as airflow management (data center), building automation system upgrades, computer room AC, cooling towers, economizer (outside air), economizer (water side), freezer (lab grade), heat pump (water

source), heat recovery improvements, HVAC retro-commissioning, LED sign lighting, server (virtualization), and water heater controls.

- Emerging technology measures that are near commercialization or that may become cost-effective within the next five years and can help bridge the gap in declining potential from current technologies:

Residential sector

- Induction cooktop, 2-element
- Induction cooktop, 4-element
- Vinyl siding, insulated
- Structural insulated panels panel framing
- Networked automation controls
- Smart electrical panel
- Smart outlets
- Indirect evaporative cooler, 2.5 tons
- Indirect evaporative cooler, 1.0 tons
- Clothes dryer with heat recovery
- Advanced air-to-water heat pump

Commercial sector

- Induction cooktop
- Commercial/industrial carbon dioxide heat pumps
- Central heat pump water heater with load controls
- Aerofoil outfitted shelving
- Advanced air-to-water heat pump
- Web-enabled power monitoring for small- and medium-sized businesses
- Food truck, efficient electric cooking
- Low global warming potential freezers and refrigerator cases

Cadmus only included the Council and RTF measures applicable to sectors and market segments in City Light's service territory. For example, we did not characterize measures for the agriculture sector or the residential manufactured home segment, as these sectors are a small fraction of City Light's customer mix. We added measures if the RTF workbooks were not included in the Council's 2021 Power Plan or if the RTF workbooks have been updated since the Council's 2021 Power Plan workbooks.

Cadmus classified the electric energy efficiency measures applicable to City Light's service territories into two categories:

- **High-efficiency equipment (lost opportunity) measures** directly affecting end-use equipment (such as high-efficiency domestic water heaters), which follow normal replacement patterns based on expected lifetimes.
- **Non-equipment (retrofit) measures** affecting UEC without replacing end-use equipment (such as insulation). Such measures do not include timing constraints from equipment turnover—except for new construction—and should be considered discretionary, given that savings can be acquired at any point over the planning horizon.

Each measure type had several relevant inputs:

- **Equipment and non-equipment measures**
    - Energy savings: average annual savings attributable to installing the measure, in absolute and/or percentage terms

    - Equipment cost: full or incremental, depending on the nature of the measure and the application
    - Labor cost: the expense of installing the measure, accounting for differences in labor rates by region and other variables
    - Technical feasibility: the percentage of buildings where customers can install this measure, accounting for physical constraints
    - Measure life: the expected life of the measure equipment
- **Non-equipment measures only**
    - Percentage incomplete: the percentage of buildings where customers have not installed the measure but where its installation is technically feasible; this equals 1.0 minus the measure's current saturation
    - Measure competition: for mutually exclusive measures, accounting for the percentage of each measure likely installed to avoid double-counting savings
    - Measure interaction: accounting for end-use interactions (for example, a decrease in lighting power density causing heating loads to increase)

Among various sources, Cadmus primarily derived these inputs from four resources:

- NEEA CBSA IV, including Puget Sound Energy's oversample, where applicable[38]
- NEEA RBSA III with City Light's oversample
- The Council's 2021 Power Plan conservation supply curve workbooks
- The RTF UES measure workbooks

Cadmus reviewed a variety of sources for many equipment and non-equipment inputs. To determine which source to use for this study, Cadmus developed a hierarchy for costs and savings (also shown in Table 6-2):

1. RTF UES measure workbooks, where a more recent version is available than what the Council's 2021 Power Plan used
2. The Council's 2021 Power Plan conservation supply curve workbooks
3. Secondary sources, such as American Council for an Energy-Efficient Economy work papers, Simple Energy and Enthalpy Model building simulations, or various technical reference manuals

Cadmus also developed a hierarchy to determine the source for various applicability factors, such as the technical feasibility and the percentage incomplete. This hierarchy differed slightly for residential and commercial measure lists.

[38] City Light did not have an oversample conducted as part of CBSA IV. To better represent the Seattle area (compared with regional values), Cadmus incorporated Puget Sound Energy's CBSA oversample data.

RBSA Methodology

For residential estimates, Cadmus relied on City Light sites in NEEA's RBSA III (2022). If City Light's subset did not have at least five observations to use for analysis, then we based the analysis on the RBSA Urban Washington building subset. For instances where the data from the 2022 RBSA was not sufficient, Cadmus used historical RBSA II values for City Light's oversample. If we could not calculate applicability factors from NEEA's RBSA, we used applicability factors from the Council's 2021 Power Plan conservation supply curve workbooks. The resulting estimates reflect averages for the Northwest region and were not necessarily specific to City Light's service territory.

CBSA Methodology

For the commercial sector, Cadmus first used the subset of City Light's customers, including Puget Sound Energy's oversample, in NEEA's CBSA IV (2019).

The original CBSA IV weights were constructed to represent the Council's regional building counts. To represent City Light's building counts, Cadmus re-analyzed the CBSA weights based on City Light's totals of building square footage for specific building types. We only included the CBSA data and Puget Sound Energy's oversample in the Council's defined climate heating zone 1. While reviewing whether to only include urban sites in these analyses, Cadmus found that for the heating zone 1 subset, 92% of the buildings were urban, and 95% of the building square footage was urban. Due to the limited rural impact for all sites in the heating zone 1 subset, Cadmus did not make any further adjustments in the overall analysis.

After finalizing City Light's CBSA weights to match City Light's total building square footage by building type, we used these weights for all CBSA analyses in this study. Where respondent counts were sufficient for specific CBSA analyses, we used building type names as defined by the Council to produce more granular results.

If NEEA's CBSA did not have sufficient data to estimate a particular value (for example, applicability factors) for a given measure, Cadmus relied on factors from the Council's 2021 Power Plan conservation supply curve workbooks.

Measure Data Sources

Table 6-2 lists the primary sources referenced in the study by data input.

Table 6-2. Key Measure Data Sources

Data	Residential Source	Commercial Source	Industrial Source
Energy Savings	City Light's recent evaluation data for ductless heat pumps and heat pump water heaters; 2021 Power Plan supply curve workbooks; RTF; Cadmus research	2021 Power Plan supply curve workbooks; RTF; Cadmus research	2021 Power Plan supply curve workbooks; Cadmus research
Equipment and Labor Costs	2021 Power Plan supply curve workbooks; RTF; Cadmus research	2021 Power Plan supply curve workbooks; RTF; Cadmus research	2021 Power Plan supply curve workbooks; Cadmus research
Measure Life	2021 Power Plan supply curve workbooks; RTF; Cadmus research	2021 Power Plan supply curve workbooks; RTF; Cadmus research	2021 Power Plan supply curve workbooks; Cadmus research
Technical Feasibility	NEEA RBSA; Cadmus research	NEEA CBSA; Cadmus research	Cadmus research; Council industrial data
Percentage Incomplete	NEEA RBSA; City Lights program accomplishments; Cadmus research	NEEA CBSA; City Lights program accomplishments; Cadmus research	Cadmus research; Council industrial data
Measure Interaction	2021 Power Plan supply curve workbooks; RTF; Cadmus research	2021 Power Plan supply curve workbooks; RTF; Cadmus research	Cadmus research

6.1.4. Incorporating Federal Standards and State and Local Codes and Policies

Cadmus' assessment accounted for changes in codes, standards, and policies over the planning horizon. These changes not only affected customers' energy-consumption patterns and behaviors, but they also revealed which energy efficiency measures would continue to produce savings over minimum requirements. We captured current efficiency requirements, including those enacted but not yet in effect as of November 2024.

Cadmus reviewed all local and state codes, federal standards, and local and state policy initiatives that could impact this potential study and that were on the books as of November 2024. For the residential and commercial sectors, the potential study considered the local energy codes (2021 Seattle Energy Code with amendments, 2021 Washington State Energy Code, and 2021 RCW) as well as current and pending federal standards. We also assessed if, how, and when Washington State and Seattle City legislation impacted the potential study. This legislation included Seattle's Energy Benchmarking Program (SMC 22.920), Washington's Clean Buildings bill (E3S House Bill 1257), House Bill 1589 and Initiative 2066, and the CETA (194-40-330).

Cadmus reviewed many codes, standards, and policy initiatives:

- **Federal standards.** All technology standards for heating and cooling equipment, lighting, water heating, motors, and other appliances not covered in or superseded by state and local codes.[39]
- **2021 Seattle Energy Code.** The code requires all new commercial buildings and large multifamily buildings above three stories to use the most efficient technologies for space and water heating, which are *de facto* electric heat pumps in most cases. These latest updates to the energy code also apply to HVAC and water heating equipment replacements in existing buildings; however, there are several exemptions such that the impact of this provision on load forecasts is projected to be negligible (regarding existing buildings). All other code provisions took effect on March 15, 2024.[40]
- **2021 Washington State Energy Code.** The code provides requirements for residential and commercial new construction buildings, except in cases where the 2021 Seattle Energy Code supersedes the Washington code. The effective date was March 15, 2024.[41]
- **Seattle's Energy Benchmarking Program (SMC 22.920).** This program requires owners of commercial and multifamily buildings (20,000 square feet or larger) to track and report energy performance annually to the City of Seattle. Though in effect since 2016, full enforcement of the program began on January 1, 2021.[42]
- **2021 RCW 19.260.040.** These codes set minimum efficiency standards for specific types of products, including computers, monitors, showerheads, faucets, residential ventilation fans, general service lamps, air compressors, uninterruptible power supplies, water coolers, portable ACs, high color rendering index fluorescent lamps, commercial dishwashers, steam cookers, hot food holding cabinets, and fryers. The effective dates varied by product, with the 2021 RCW signed on July 28, 2019.[43]

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39 Office of Energy Efficiency & Renewable Energy. Accessed November 2024. "Standards and Test Procedures." https://www.energy.gov/eere/buildings/standards-and-test-procedures

40 City of Seattle, Department of Construction & Inspections. February 1, 2021. "Energy Code - Overview" https://www.seattle.gov/sdci/codes/codes-we-enforce-(a-z)/energy-code

41 Washington State Building Code Council. Accessed November 2024. https://sbcc.wa.gov/state-codes-regulations-guidelines/state-building-code/energy-code

42 City of Seattle, Office of Sustainability and Environment. Accessed June 2021. "Energy Benchmarking." https://www.seattle.gov/environment/climate-change/buildings-and-energy/energy-benchmarking#:~:text=Seattle's%20Energy%20Benchmarking%20Program%20(SMC,to%20the%20City%20of%20Seattle.&text=Compare%20your%20building's%20energy%20performance,started%20saving%20energy%20and%20money.

43 Washington State Legislature. Revised Code of Washington. December 7, 2020. "RCW 19.260.050 Limit on Sale or Installation of Products Required to Meet or Exceed Standards in RCW 19.260.040." https://app.leg.wa.gov/rcw/default.aspx?cite=19.260.050

- **Clean Buildings Bill (E3S House Bill 1257).** The law requires the Washington State Department of Commerce to develop and implement an energy performance standard for the state's existing buildings, especially large commercial buildings (based on building square feet), and provide incentives to encourage efficiency improvements. The effective date was July 28, 2019, with the building compliance schedule set to begin on June 1, 2026. Early adopter incentive applications began in July 2021.[44]
- **CETA (194-40-330).** This act applies to all electric utilities serving retail customers in Washington and sets specific milestones to reach the required 100% clean electricity supply. The first milestone was in 2022, when each utility was required to have prepared and published a CEIP with its own four-year targets for energy efficiency, demand response, and renewable energy.[45]
- **Shoreline's Ordinance No. 948.** [46] This ordinance promotes energy efficiency and the decarbonization of commercial and large multifamily buildings like the Seattle Building Energy Code.
- **House Bill 1589 and Initiative 2066.** House Bill 1589 requires Puget Sound Energy to accelerate the transition away for natural gas impacting City Light's overlapping service territory. In November of 2024, voters of Initiative 2066 overturned parts of the bill. Then in March of 2025, in Washington's Superior Court found the Initiative 2066 unconstitutional. This initiative continues to be challenged in the courts. While this DSPMA did not directly model the impact of this house bill, in part due the uncertainty during the development of this study, City Light does capture electrification within the load forecast.

Applying Federal Standards

Cadmus explicitly accounted for federal codes and standards within the DSMPA modeling. For the residential sector, these included appliance, HVAC, and water heating standards. For the commercial sector, these included appliance, HVAC, lighting, motor, and water heating standards. Figure 6-3 provides a comprehensive list of equipment standards considered in the study. Bars indicate the year in which a new equipment standard was or will be enacted. It is important to note that Cadmus did not attempt to predict how energy standards might change in the future. At the time we finalized the measure list for this study, there were no federal appliance standards pending after 2023. Cadmus completed this study's assessment of federal standard in November of 2024. In February 2025, the current administration have

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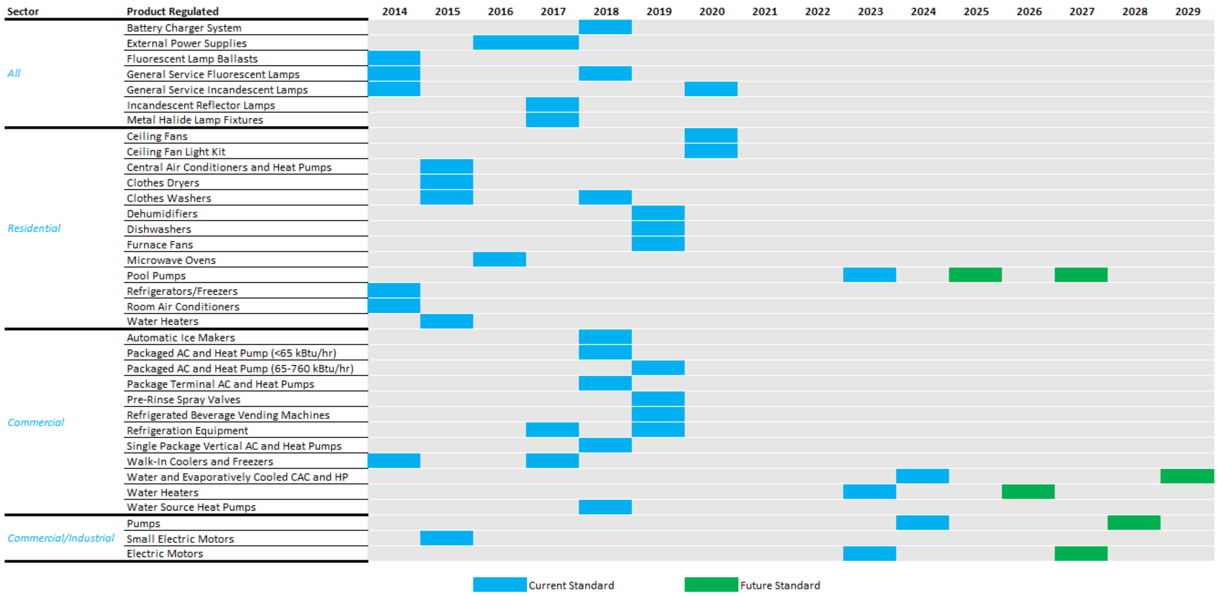
[44] Washington State Department of Commerce. Accessed June 2023. "Clean Buildings." https://www.commerce.wa.gov/growing-the-economy/energy/buildings/

[45] Washington State Department of Commerce. Accessed June 2023. "Clean Energy Transformation Act (CETA)." https://www.commerce.wa.gov/growing-the-economy/energy/ceta/

[46] Ordinance No. 948 "Ordinance of the City of Shoreline, Washington Amending Chapter 15.05, Construction and Building Codes, of the Shoreline Municipal Code, to Provide Amendments to the Washington State Energy Code – Commercial, as Adopted by the State of Washington" took effect on July 1, 2022.

put a hold or potentially rolling back energy efficiency standards. This study kept the known standards in place and did not assume any roll backs in efficiency standards.

Figure 6-3. Equipment Standards Considered (as of Nov. 2024)



Treatment of State and Local Codes and Initiatives

Cadmus identified each type of code (local and state) and initiative (local and state) that would impact measures in the DSMPA. Cadmus sorted each impact into three main categories:

Measure applicability or savings adjustment. Cadmus adjusted measure characterization inputs to account for local and state energy codes (2021 Washington State Energy Code and 2021 RCW 19.27A.160). Where appropriate, we revised measure applicability, savings, and costs to reflect the impact of the code. For example, we removed measures entirely or over time (applicability set to zero) if code baselines were more efficient than the baseline data found in the RTF or Council workbooks (such as for showerheads, fryers, steam cookers, and new construction homes). Notably, the Washington State Energy Code (RCW 19.27A.160) states "…residential and nonresidential construction permitted under the 2031 state energy code must achieve a 70% reduction in annual net energy consumption, using the adopted 2006 Washington state energy code as a baseline." For this purpose, Cadmus adjusted the new construction load forecast periodically so that by 2031, the new construction load would meet the requirement. RCW 19.27A.160 also mandates that the Council report its progress every three years, so we incremented the code adjustment every three years until 2031 to account for future state codes that meet the requirement of RCW 19.27A.160. Cadmus did not predict exactly how each end use would be impacted; rather, we opted for a general reduction to building energy use for new construction across all end uses. Much of the net energy reduction is expected to be achieved through electrification of thermal end uses, an expectation which this study does not fully reflect. That said, we partially capture this expectation by modeling increasing heat pump saturation (and decreasing fossil fuel saturations) in accordance with the moderate electrification scenario from the 2022 EPRI study. We also accounted for these adjustments in the baseline forecast, as mentioned in the *City Light Forecast Adjustments* section.

Equipment saturation adjustment. Cadmus adjusted equipment saturations by year to account for the 2021 Seattle Energy Code (this code largely matches the 2021 Washington State Energy Code). At the time of this study, Cadmus used the draft 2021 Seattle Energy Code version (viewed September/October of 2024). In addition, Cadmus adjusted the space heating equipment saturations for new construction commercial and large multifamily buildings to align with this code (such as for ductless heat pumps and air-source heat pumps). We also accounted for these adjustments in the baseline forecast, as mentioned in the *City Light Forecast Adjustments* section.

Adoption ramp rate adjustment. Cadmus reviewed and adjusted the prescribed ramp rates in the Council's 2021 Power Plan, where necessary to better reflect the expected adoption timelines of impacted measure groups. Changing the ramp rates (in most cases) will not impact the cumulative potential; rather, it changes the timing of when the potential occurs. For measures currently included in City Light's residential programs, Cadmus increased the Council's assigned ramp rates by one tier—for example, adjusting a slow ramp to a medium ramp—to reflect more aggressive uptake..

In the commercial sector, Cadmus worked with City Light to determine the appropriate Council ramp rates so that City Light's program measures better align with historical program acquisition as well as with local and state policies promoting energy efficiency. The intent behind shifting the ramp rates is to account for initiatives and policies that promote energy efficiency through customer incentives, penalties, or feedback on energy use, such as Seattle's Energy Benchmarking Program, Building Energy Performance Standards (BEPS) and the WA State Clean Building Performance Standard (CBPS).[47] City Light can claim energy impacts through these initiatives and policies; therefore, removing measures or adjusting baselines may not be appropriate within the context of the DSMPA. These initiatives and policies encourage existing customers to conserve energy, thereby accelerating the rate of the adoption of energy efficiency through energy reduction requirements. The 2026 DMSPA updating these ramp rate acceleration adjustments (from the prior DSMPA) to account for limited historical programmatic adoption from these initiatives, the uncertainty in the commercial market, and the uncertainty in non-compliance (prior study assumed 100% compliance). Cadmus took a more targeted approach. Rather than adjusting ramp rates across the entire sector, Cadmus worked with City Light to differentiate by building type. As a result, we increased ramp rates for data center and lodging measures using the same tiered approach as in the residential sector. Ramp rates for other commercial building types remained aligned with the original 2021 Power Plan assignments. Changing the ramp rates (in most cases) will not impact the cumulative potential; rather, it changes the timing of when the potential occurs.

In some cases no adjustment was needed (already accounted for in the existing data). For example, the Council's 2021 Power Plan workbooks and Cadmus' equipment characterization may have already accounted for the federal standards and, in some cases, the 2021 RCW. Therefore, Cadmus did not make additional adjustments those measures.

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47 This includes CETA in setting statewide goals that require City Light to establish performance targets.

Additional Codes and Standards Considerations

Cadmus identified three considerations around codes and standards that impact the characterization of this potential study.

First, starting with residential lighting, Cadmus reviewed the codes and standards as well as assessed the current saturation of LED lighting in the residential sector. The Council's 2021 Power Plan and RTF residential lighting workbooks account for the Washington State Code requirement (House Bill 1444) of the Energy Independence and Security Act backstop provision. Originally adopted from the federal standard, the Act's backstop provision requires higher-efficiency technologies (45 lumens per watt or better). The savings in the most recent RTF lighting workbook use an LED baseline (for Washington only).

After reviewing the Council and RTF workbooks, Cadmus concluded that the 2026 DSMPA should use an LED baseline. Currently, there are no lighting technologies on the market that meet the 45 lumens per watt requirement other than CFLs or LEDs. Furthermore, major manufacturers have phased out the production of CFLs. The market is rapidly adopting LEDs (according to the RBSA saturations and Council and RTF projections), which are becoming the *de facto* baseline. Considering that LEDs are the only viable technology that meets the Washington code, Cadmus used LEDs as the baseline for all non-highly impacted applications but for highly impacted homes assumed a small amount of available potential remaining. This adjustment to the lighting loads is effectively accounted for in City Light's baseline forecast and the 2026 DSMPA.

Secondly, the 2021 Washington State Energy Code includes new construction prescriptive and performance path requirement options for both residential and commercial. The DSMPA characterizes efficiency improvements on a measure basis that aligns with the prescriptive path. The performance path includes the HVAC total system performance ratio requirement, defined as the ratio of the sum of a building's annual heating and cooling load compared with the sum of the annual carbon emissions from the energy consumption of the building's HVAC systems. The variability in the HVAC total system performance ratio from building to building cannot be easily captured in the DSMPA; so, for this study, Cadmus followed the prescriptive requirements in the 2021 Washington State Energy Code.

As part of the 2026 DSMPA, Cadmus developed a codes and standards forecast for City Light to understand the impact of naturally occurring savings derived from codes and standards over the study timeframe. To quantify expected savings from naturally occurring potential, Cadmus produced two baseline forecasts—one with naturally occurring potential embedded into the forecast, and one without. Our approach essentially turned off how we model turnover and changes in codes and standards to determine an alternative forecast without naturally occurring savings. The net difference between these two forecasts results in the naturally occurring potential.

Our analysis accounts for naturally occurring conservation in two ways:

- Cadmus assumes gradual increases in efficiency due to retiring older equipment in existing buildings and homes and replacing them with units meeting or exceeding minimum standards at the time of replacement (e.g., stock turnover). For example, the existing single-family residential building construction stock includes several central air conditioning units that do not meet current minimum federal efficiency standards. The baseline forecast assumes gradual replacement with units that meet those standards.

- Cadmus accounts for pending improvements to equipment efficiency standards that will take effect during the planning horizon. As well as accounting for future changes in state and local codes for new construction buildings.[48]
  - **Federal standards.** All technology standards for heating and cooling equipment, lighting, water heating, motors, and other appliances not covered in or superseded by state and local codes. These federal standards include 2028 cooking range, 2026 Room AC, 2028 dryer, 2029 freezer and refrigerator, and 2029 heat pump water heater standards.
  - **2021 Seattle Energy Code (SEC).** The code regulates the energy-use features of new commercial and large multifamily buildings above three stories, including building envelope, heating and cooling, water heating, lighting, metering, plug load controls, transformers and motors.
  - **2021 Washington State Energy Code (WSEC).** The code provides requirements for residential and commercial new construction buildings, except in cases where the 2021 Seattle Energy Code supersedes the Washington code.[49] Tightening new construction codes over time through 2031 (RCW 19.27A.160) impacts the load forecast as a reduction in new construction load forecast.
  - **Shoreline's Ordinance 948.** This ordinance promotes energy efficiency and the decarbonization of commercial and large multifamily buildings like the Seattle Building Energy Code.

To produce a codes and standards forecast, Cadmus developed an alignment between the load forecast and WSEC (RCW 19.27A.160) which requires "… residential and nonresidential construction permitted under the 2031 state energy code achieve a 70% reduction in annual net energy consumption, using the adopted 2006 Washington state energy code as a baseline." Cadmus adjusted the new construction load forecast annually so that by 2031 the new construction load meets the requirement. According to RCW 19.27A.160, "The Council shall report its progress … every three years…".[50] Since the length of code cycle is three years, Cadmus changed the magnitude of impact for every three years until 2031 accounting for future state codes that meet the requirement of RCW 19.27A.160.

Additionally, Cadmus provided alignment between the load forecast and 2021 SEC over WSEC, Cadmus used the information from "Seattle Energy Code Savings and Attribution Analysis" report prepared for City

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48 City/State Initiatives such as the Seattle's Energy Benchmarking program, the Clean Buildings bill, and CETA are not considered energy codes as utilities can still claim savings but will inherently speed up the rate of the adoption of energy efficiency through energy reduction requirements.

49 Washington State Building Code Council, https://sbcc.wa.gov/

50 The Council referred to in RCW 19.27A.160 is the Washington State Building Code Council.

Light by Ecotopia and A2 Efficiency and adjusted the equipment saturations in new construction multifamily-mid rise and multifamily-high rise buildings.

6.1.5. Adapting Measures from the RTF and 2021 Power Plan

To ensure consistency with methodologies employed by the Council and to fulfill requirements of WAC 194-37-070, Cadmus relied on ECM workbooks developed by the RTF and the Council to estimate measure savings, costs, and interactions. In adapting these ECMs for this study, we adhered to two principles:

Deemed ECM savings in RTF or Council workbooks must be preserved: City Light relies on deemed savings estimates provided by the Bonneville Power Administration (BPA) that largely remain consistent with savings in RTF workbooks in demonstrating compliance with I-937 targets. Therefore, Cadmus sought to preserve these deemed savings in the potential study to avoid possible inconsistencies among estimates of potential, targets, and reported savings.

Use inputs specific to City Light's service territory: Some Council and RTF workbooks relied on regional estimates of saturations, equipment characteristics, and building characteristics derived from the RBSA and CBSA. Cadmus updated regional inputs with estimates calculated from City Light's oversample of CBSA and RBSA or from estimates affecting the broader Puget Sound area. This approach preserved consistency with Council methodologies while incorporating Seattle-specific data.

Cadmus' approach to adapting the Council's and RTF's workbooks varied by sector, as described in the following sections.

Residential and Commercial

Cadmus reviewed each residential Council workbook and extracted savings, costs, and measure lives for inclusion in this study. We largely used applicability factors (such as the current saturation of an ECM) from City Light's oversample of RBSA, adjusting them for City Light's program accomplishments. If we could not develop a City Light–specific applicability factor from the RBSA, we used the Council's regional value.

In addition to extracting key measure characteristics, Cadmus identified each measure as an equipment replacement measure or a retrofit measure. There are two key distinctions between these two types of measures:

Equipment replacement (i.e., lost opportunity): We calculated savings for equipment replacement measures as the difference between measure consumption and baseline consumption. For instance, for the heat pump water heater measure, Cadmus estimated the baseline consumption of an average market water heater and used the Council's deemed savings to calculate the consumption for a heat pump water heater. This approach preserved the deemed savings in the Council's workbooks.

Retrofit (i.e., discretionary): We calculated savings for retrofit measures in percentage terms relative to the baseline UEC but reflected the Council's and RTF's deemed values. For instance, if the Council's deemed savings were 1,000 kWh per home for a given retrofit measure and Cadmus estimated the baseline consumption for the applicable end use as 10,000 kWh, relative savings for the measure were

10%. We did not apply relative savings from the Council's workbooks to baseline UEC because doing so would lead to per-unit estimates that differed from Council and RTF values.

Cadmus also accounted for interactive effects presented in Council and RTF workbooks. For instance, the Council estimated water heating, heating, and cooling savings for residential heat pump water heaters, with the heating and cooling savings as the interactive savings. Because the installation of a heat pump water heater represents a single installation, Cadmus employed a stock accounting model, which combined interactive and primary end-use effects into one savings estimate. Though we recognize that this approach could lead to overstating or understating savings in an end use, in aggregate—across end-uses—savings matched the Council's deemed values.

Cadmus generally followed the same approach with the commercial sector; however, because of the mixture of lighting measures considered in the Council's 2021 Power Plan, we chose to model all commercial lighting measures as retrofits and none as equipment replacements. Savings and costs for these measures reflected this decision.

Industrial

Cadmus adapted measures from the Council's Industrial_Tool_2021P_v08 and IND_AllMeasures_2021P_V8 workbooks for inclusion in this study for four key industrial measure inputs:

- Measure savings (expressed as end-use percentage savings)
- Measure costs (expressed in dollars per kilowatt-hour saved)
- Measure lifetimes (expressed in years)
- Measure applicability (percentage)

Cadmus mapped each Council industry type to industries found in City Light's service territory: these included foundries, miscellaneous manufacturing, stone and glass, transportation equipment manufacturing, other food, frozen food, water, and wastewater. We identified applicable end uses using the Council's assumed distribution of UEC in each industry. Table 6-3 shows the distribution of end-use consumption and the list of industries considered in this study.

Table 6-3. Distribution of End Use Consumption by Segment

Segment	Process Air Comp	Lighting	Fans	Pumps	Motors Other	Process Other	Process Heat	HVAC	Other	Process Electro-Chemical	Process Refrigeration
Foundries	7%	9%	10%	18%	15%	0%	21%	9%	5%	6%	0%
Frozen Food	4%	8%	4%	4%	12%	0%	4%	7%	1%	3%	53%
Misc. Manufacturing	7%	11%	7%	10%	16%	0%	11%	17%	9%	6%	6%
Other Food	12%	4%	2%	8%	11%	0%	0%	9%	8%	2%	44%
Transportation Equipment	6%	20%	6%	8%	11%	0%	0%	28%	7%	14%	0%
Wastewater	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
Water	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%
Stone and Glass	8%	5%	7%	13%	21%	6%	20%	6%	3%	2%	8%

To incorporate broader secondary data, Cadmus aggregated some Council end uses into broader end uses. Table 6-4 shows the mapping of Council end uses to Cadmus end uses.

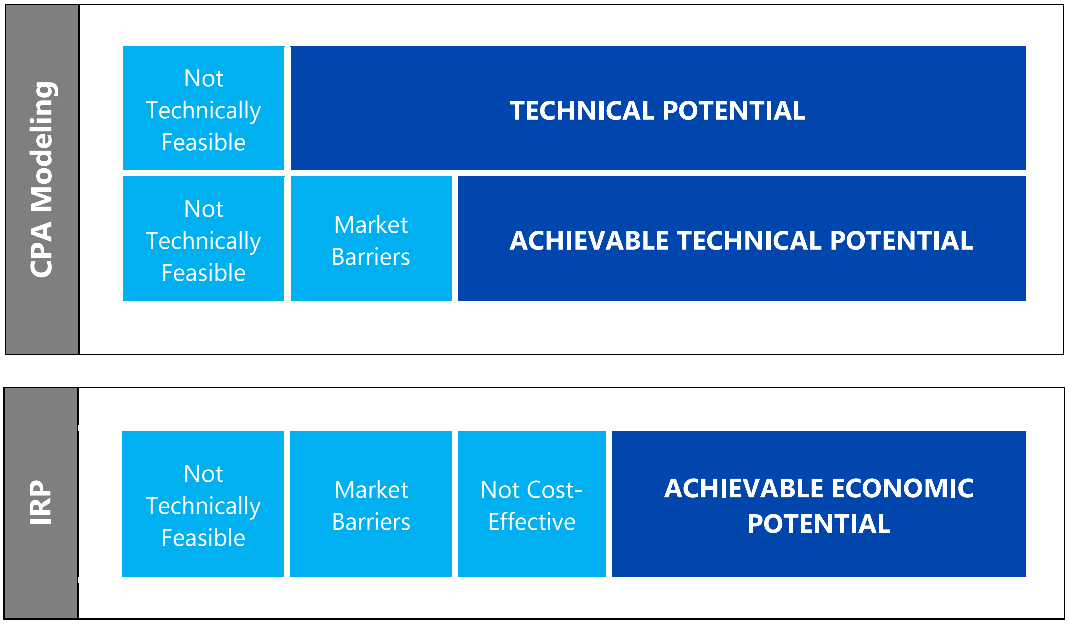
Table 6-4. Council and Cadmus End Uses

Council End Use	Cadmus End Use
Pumps	Pumps
Fans and Blowers	Fans
Compressed Air	Process Air Compressor
Material Handling	Process Electrochemical
Material Processing	Motors Other
Low Temp Refer	Process Refrigeration
Med Temp Refer	Process Refrigeration
Pollution Control	Other
Other Motors	Motors Other
Drying and Curing	Process Heat
Heat Treating	Process Heat
Heating	Process Heat
Melting and Casting	Process Heat
HVAC	HVAC
Lighting	Lighting
Other	Other

6.2. Estimating Conservation Potential

As discussed, Cadmus estimated two types of conservation potential, and City Light determined a third potential—achievable economic—through the IRP's optimization modeling, as shown in Figure 6-4.

Figure 6-4. Types of Conservation Potential



Technical potential is the total amount of energy efficiency that could be achieved within City Light's service territory, assuming that all feasible resource opportunities can be captured regardless of cost and market barriers such as customer willingness to adopt. The potential is only limited by physical and operational constraints.

Achievable technical potential is the portion of technical potential assumed to be achievable during the study's forecast, regardless of the acquisition mechanism. For example, savings may be acquired through utility programs, improved codes and standards, and market transformation. The achievable technical potential considers market barriers such as customer awareness, willingness to adopt measures, and historical program participation. However, it is not constrained by cost-effectiveness considerations.

Achievable economic potential is the portion of achievable technical potential determined to be cost-effective by the IRP's optimization modeling, in which either bundles or individual energy efficiency measures are selected based on cost, savings, and timing. The cumulative potential for these selected bundles constitutes achievable economic potential.

The following sections describe Cadmus' approach to estimating technical and achievable technical potential as well as to developing the conservation IRP inputs. The last section of this chapter explains the approach City Light used to estimate achievable economic potential.

6.2.1. Technical Potential

Technical potential includes all technically feasible ECMs, regardless of costs or market barriers and is divided into two classes: discretionary (retrofit) and lost opportunity (new construction and replacement of equipment on burnout).

Another important aspect in assessing technical potential is, wherever possible, to assume installations of the highest-efficiency equipment that is commercially available. For example, this study examined central air conditioners of varying efficiencies in residential applications, including SEER 20 and SEER 18 air conditioners. In assessing technical potential, Cadmus assumed that, as equipment fails or new homes are built, customers will install SEER 20 air conditioners wherever technically feasible, regardless of cost. Where applicable, we assumed SEER 18 would be installed in homes where the SEER 20 equipment was not feasible. Cadmus treated competing non-equipment measures in the same way, assuming installation of the highest-saving measures where technically feasible.

In estimating technical potential, it is inappropriate to merely sum up savings from individual measure installations. Significant interactive effects can result from the installation of complementary measures. For example, upgrading a heat pump in a home where insulation measures have already been installed can produce less savings than upgrades in an uninsulated home. Cadmus' analysis of technical potential accounts for two types of interactions:

Interactions between equipment and non-equipment measures: As equipment burns out, technical potential assumes it will be replaced with higher-efficiency equipment, reducing average consumption across all customers. Reduced consumption causes non-equipment measures to save less than they would if the equipment had remained at a constant average efficiency. Similarly, savings realized by replacing equipment decrease upon installation of non-equipment measures.

Interactions between non-equipment measures: Two non-equipment measures applying to the same end use may not affect each other's savings. For example, installing a low-flow showerhead does not affect savings realized from installing a faucet aerator. Insulating hot water pipes, however, causes the water heater to operate more efficiently, thus reducing savings from the water heater. Cadmus accounted for such interactions by stacking interactive measures, iteratively reducing baseline consumption as measures were installed, thus lowering savings from subsequent measures.

Although, theoretically, all retrofit opportunities in existing construction—often called discretionary resources—could be acquired in the study's first year, this would skew the potential for equipment measures and provide an inaccurate picture of measure-level potential. Therefore, Cadmus assumed that these opportunities would be realized in equal annual amounts over the 20-year planning horizon. By applying this assumption, natural equipment turnover rates, and other adjustments described above, we could estimate the annual incremental and cumulative potential by sector, segment, construction vintage, end use, and measure.

To estimate technical potential, Cadmus drew upon best-practice research methods and standard utility industry analytic techniques. Such techniques remained consistent with the conceptual approaches and methodologies used by other planning entities (such as by the Council in developing regional energy efficiency potential) and remained consistent with methods used in City Light's previous potential assessments.

6.2.2. Achievable Technical Potential

The achievable technical potential summarized in this report is a subset of the technical potential that accounts for market barriers such as customer awareness, market or infrastructure readiness, and product availability. However, the achievable technical potential does not account for certain real-world constraints that can affect program implementation. These can include factors such as contractor and work force limitations, behavioral inertia, or the influence of media or policy signals. Because the impacts of these barriers can be challenging to predict and quantify, they are not explicitly considered in the analysis.

To refine the technical potential into achievable technical potential, Cadmus followed the Council’s approach and employed two factors:

Maximum achievability factors that represent the maximum proportion of technical potential that can be acquired over the study horizon.

Ramp rates that are annual percentage values representing the proportion of cumulative 20-year technical potential that can be acquired in a given year (discretionary measures) or the proportion of technical annual potential that can be acquired in a given year (lost opportunity measures).

Achievable technical potential combines technical potential and both the maximum achievability factor and the ramp rate percentage. Cadmus assigned maximum achievability factors to measures based on the Council’s 2021 Power Plan supply curves. We based the measure-specific ramp rates on the ramp rates developed for the Council’s 2021 Power Plan supply curves, accelerating them based on City Light’s program accomplishments.

Cadmus applied measure ramp rates to lost opportunity and discretionary resources, although the interpretation and application of these rates differed for each class, as described below. We based measure ramp rates on the Council’s 2021 Power Plan. As described above in *Treatment of State and Local Codes and Initiatives* section, Cadmus accounted for initiatives and legislation that promote energy efficiency through customer incentives or penalties (Seattle's Energy Benchmarking Program and Clean Buildings Bill, as well as the federal Inflation Reduction Act) by accelerating ramp rates for measures that are offered by City Light programs for residential buildings and certain commercial buildings. These initiatives and legislation (including CETA) are viewed as mechanisms to speed up the adoption of energy efficiency.

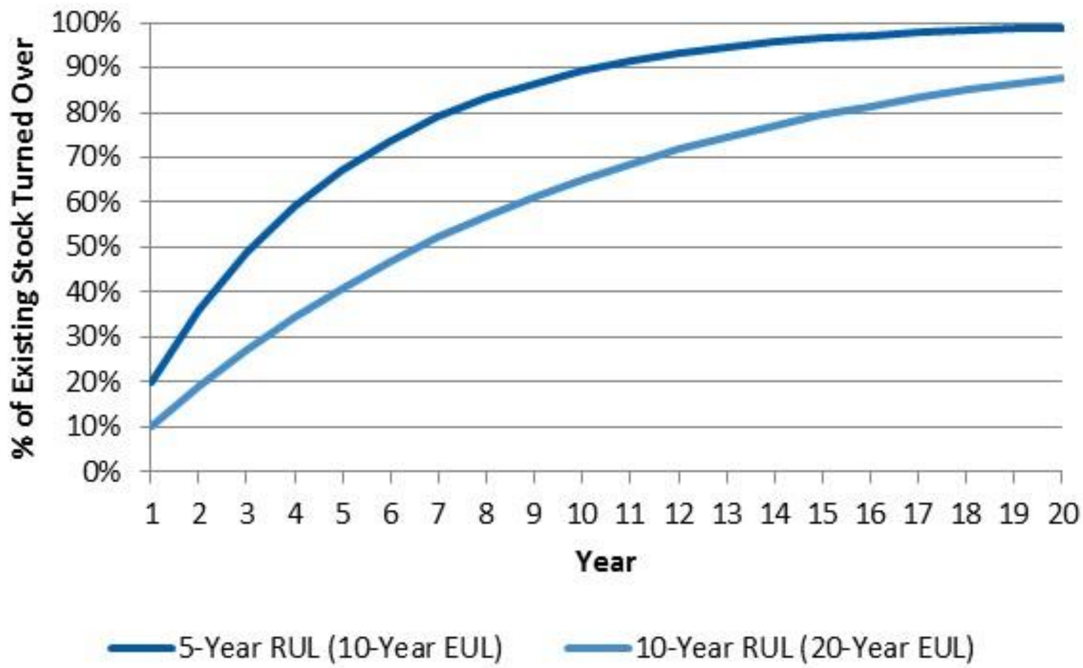
For measures not specified in the 2021 Power Plan, Cadmus assigned an appropriate ramp rate for that technology (for example, using the same ramp rate as similar measures in the 2021 Power Plan).

Lost Opportunity Resources

To quantify achievable technical potential for lost opportunity resources each year, Cadmus determined the potential technically available through new construction and natural equipment turnover. We used new construction rates from City Light’s customer forecast and developed equipment turnover rates by dividing units into each year by the measure life. For example, if 100 units initially had a 10-year life, one-tenth of units (10) would be replaced. The following year, 90 units would remain, and one-tenth of these (9) would be replaced, and so on over the study timeline.

As the mix of existing equipment stock ages, the remaining useful life (RUL) would equal—on average—one-half of the EUL. The fraction of equipment turning over each year would be a function of this RUL; thus, technical potential for lost opportunity measures would have an annual shape before applying ramp rates, as shown in Figure 6-5. This same concept applied to new construction, where opportunities became available only during home or building construction. In addition to showing an annual shape, demonstrates that the amount of equipment turnover during the study period was a function of the RUL: the shorter the RUL, the higher the percentage of assumed equipment turnover.

Figure 6-5. Existing Equipment Turnover for Two Remaining Useful Life Scenarios



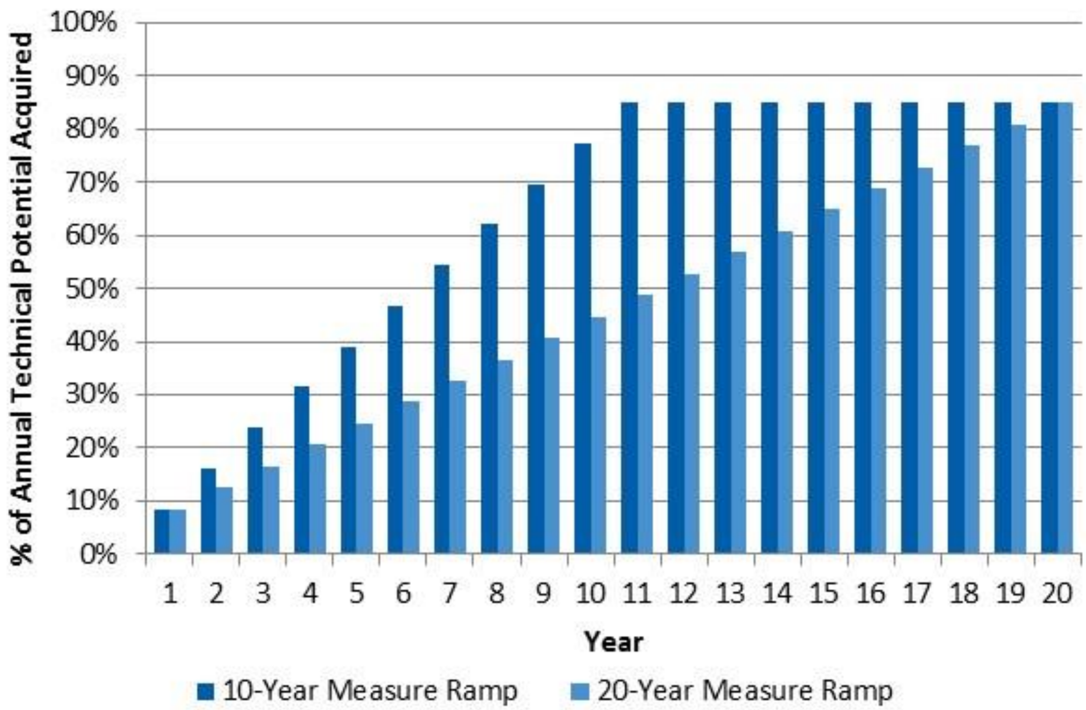
In addition to natural timing constraints of equipment turnover and new construction rates, Cadmus applied measure ramp rates to reflect other resource acquisition limitations (such as market availability over the study's horizon). For lost opportunity measures, we used the same ramp rates as those developed by the Council for its 2021 Power Plan supply curves. However, since the 2021 Power Plan ramp rates cover the 2022 to 2041 timeline, we first took these ramp rates beginning in 2024 and applied them for the first 18 years of the study (from 2026 to 2043), extrapolating them to extend from 2043 to the final year of the study (2045) following the last three years' trend. Figure 6-6 presents two examples of how Cadmus converted 2021 Power Plan ramp rates (example: Lost Opportunity 12 Medium and Lost Opportunity 5 Medium) for this study. The value (12 and 5 medium) represent the max pace of acquisition in conjunction with annual unit count. As such, 12 medium starts higher on the curve and has a faster pace than 5 medium.

Figure 6-6. 2021 Power Plan Ramp Rate Conversion for 2026 DSMPA

Year	LO12Med (Lost Opportunity 12 Medium)		LO5Med (Lost Opportunity 5 Medium)		
	2021 Power Plan	2026 DSMPA	2021 Power Plan	2026 DSMPA	
2022	10.9%	N/A	4.3%	N/A	
2023	21.9%	N/A	9.6%	N/A	
2024	32.8%	N/A	16.0%	N/A	
2025	43.7%	N/A	23.5%	N/A	
2026	54.7%	32.8%	32.1%	16.0%	Study Period
2027	64.5%	43.7%	42.1%	23.5%	
2028	72.4%	54.7%	53.1%	32.1%	
2029	78.7%	64.5%	64.3%	42.1%	
2030	83.7%	72.4%	74.8%	53.1%	
2031	87.8%	78.7%	83.9%	64.3%	
2032	91.0%	83.7%	90.9%	74.8%	
2033	93.6%	87.8%	95.8%	83.9%	
2034	95.6%	91.0%	98.7%	90.9%	
2035	97.3%	93.6%	100.0%	95.8%	
2036	98.6%	95.6%	100.0%	98.7%	
2037	99.7%	97.3%	100.0%	100.0%	
2038	99.7%	98.6%	100.0%	100.0%	
2039	99.7%	99.7%	100.0%	100.0%	
2040	99.7%	99.7%	100.0%	100.0%	
2041	99.7%	99.7%	100.0%	100.0%	
2042	N/A	99.7%	N/A	100.0%	
2043	N/A	99.7%	N/A	100.0%	
2044	N/A	99.7%	N/A	100.0%	
2045	N/A	99.7%	N/A	100.0%	

Figure 6-7 shows a measure with a maximum achievability of 85% that ramps up over 10 years (for example, XXYY measure). This measure would reach full market maturity—85% of annual technical potential—by the end of that period, while another measure (for example, AABB measure)might take 20 years to reach full maturity. Measures that Cadmus ramped over 20 years in this study included some newer technologies, such as heat pump dryers, dedicated outside air systems, and emerging technology measures as listed in the *6.1.3. Measure Characterization* section. On the other hand, measures that Cadmus ramped over a shorter time period included more mature and accepted technologies, such as ENERGY STAR computers and laptops, and ENERGY STAR office equipment.

Figure 6-7. Examples of Lost Opportunity Ramp Rates



To calculate annual achievable technical potential for each lost opportunity measure, Cadmus multiplied technical resource availability and measure ramping effects together, consistent with the Council's methodology. In the early years of the study horizon, a gap occurs between assumed acquisition and the maximum achievability. These lost resources can be considered unavailable until the measure's EUL elapses. Therefore, depending on EUL and measure ramp rate assumptions, some potential may be pushed beyond the 20th year, and the total lost opportunity achievable economic potential may be less than the maximum achievable percentage of the technical potential.

Figure 6-8 shows a case for a measure with a five-year RUL and 10-year EUL. The spike in achievable technical potential starting in Year 11—after the measure's EUL—results from the acquisition of opportunities missed at the beginning of the study period.

Figure 6-8. Example of Combined Effects of Resource Availability and Measure Ramping Based on 10-Year EUL

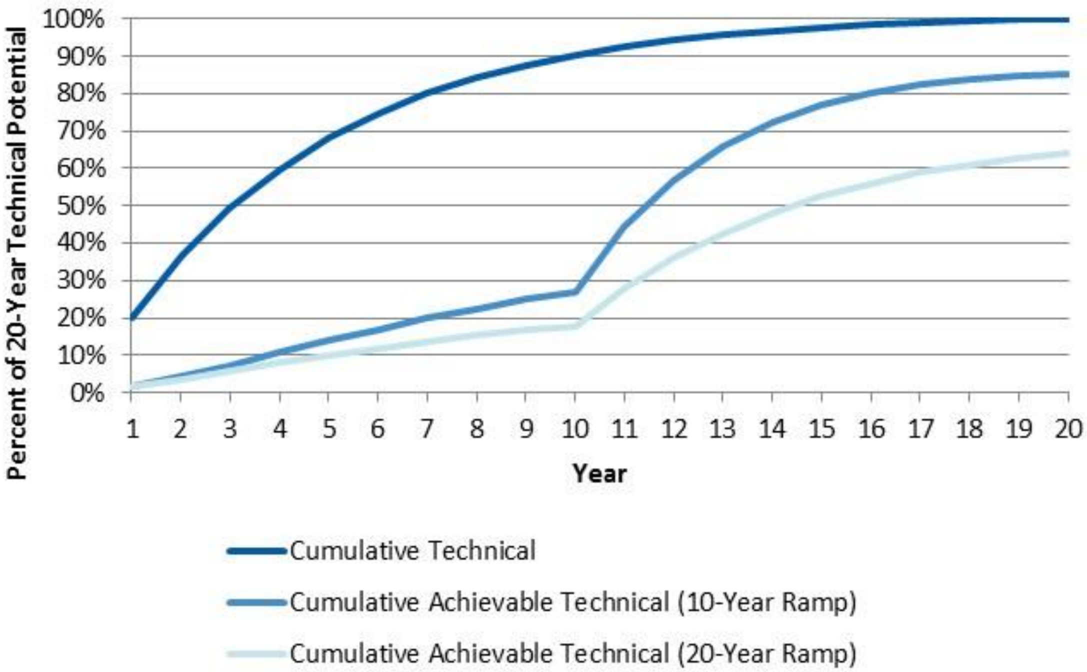


Table 6-5 illustrates this method, based on the same five-year RUL and 10-year EUL measures, with a 10-year ramp rate (the light blue line in Figure 6-8), assuming that 1,000 inefficient units would be in place by Year 1. In the first 10 years, lost opportunities would accumulate as the measure ramp-up rate caps the availability of high-efficiency equipment. Starting in the eleventh year, the opportunities lost during the previous 10 years become available again. Figure 6-8 also shows that this EUL and measure ramp rate combination results in 85% of technical potential being achieved by the end of the study period.

As described, amounts of achievable potential are a function of the EUL and measure ramp rate. The same 10-year EUL measure, on a slower 20-year ramp rate, would achieve less of its 20-year technical potential. Across all lost opportunity measures in this study, approximately 83% of technical potential appears achievable over the 20-year study period.

Table 6-5. Example of Lost Opportunity Treatment: 10-Year EUL Measure on a 10-Year Ramp

Study Year	Incremental Stock Equipment Turnover (Units)	Cumulative Stock Equipment Turnover (Units)	Measure Ramp Rate	Installed High-Efficiency Units	Missed Opportunities for Acquisition in Later Years (Units)	Missed Opportunities Acquired (Units)	Cumulative Units Installed	Cumulative Percentage of Technical Achieved
1	200	200	9%	17	180	0	17	9%
2	160	360	16%	26	130	0	43	12%
3	128	488	24%	30	92	0	73	15%
4	102	590	31%	32	65	0	106	18%
5	82	672	39%	32	44	0	138	20%
6	66	738	47%	31	29	0	168	23%
7	52	790	54%	29	19	0	197	25%
8	42	832	62%	26	11	0	223	27%
9	34	866	70%	23	6	0	246	28%
10	27	893	77%	21	2	0	267	30%
11	21	914	85%	18	0	153	438	48%
12	17	931	85%	15	0	110	563	60%
13	14	945	85%	12	0	78	653	69%
14	11	956	85%	9	0	55	717	75%
15	9	965	85%	7	0	38	762	79%
16	7	972	85%	6	0	25	793	82%
17	6	977	85%	5	0	16	814	83%
18	5	982	85%	4	0	10	828	84%
19	4	986	85%	3	0	5	836	85%
20	3	988	85%	2	0	2	840	85%

Discretionary Resources

Discretionary resources differ from lost opportunity resources due to their acquisition availability at any point within the study horizon. From a theoretical perspective, this suggests that all achievable technical potential for discretionary resources could be acquired in the study's first year. From a practical perspective, however, this outcome is realistically impossible due to infrastructure and budgetary constraints and customer considerations.

Furthermore, due to interactive effects between discretionary and lost opportunity resources, immediate acquisition distorts the potential for lost opportunity resources. For example, if one assumes that all homes are weatherized in the program's first year, potentially available high-efficiency HVAC equipment would decrease significantly (for example, a high-efficiency heat pump would save less energy in a fully weatherized home).

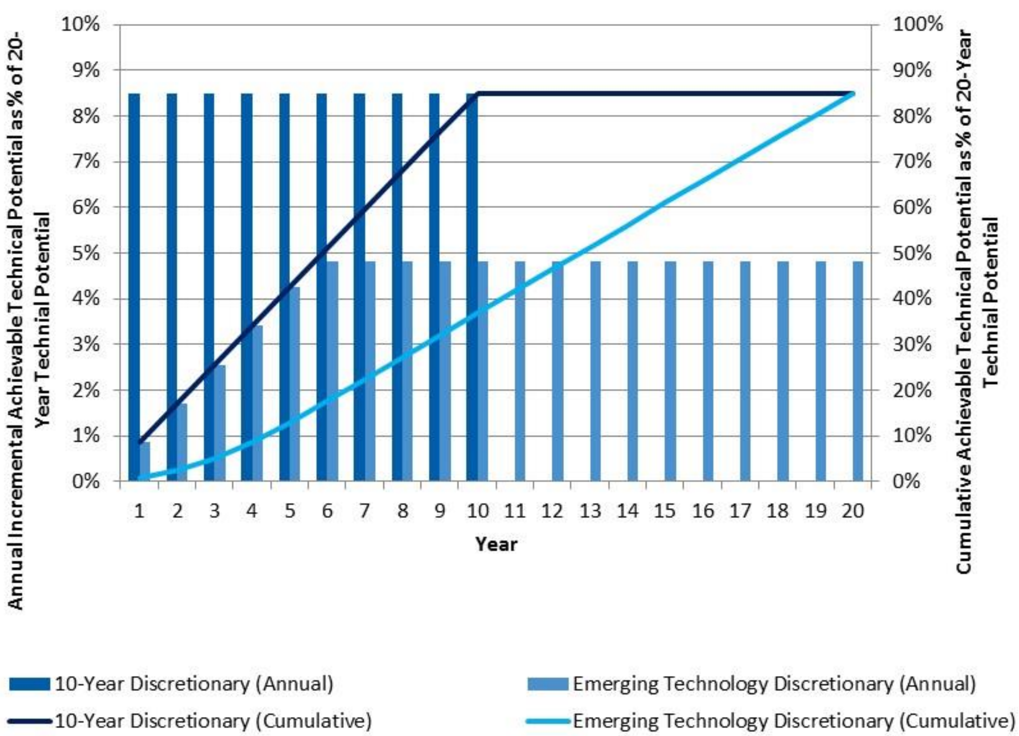
Consequently, Cadmus addressed discretionary resources via two steps:

1. Developed a 20-year estimate of discretionary resource technical potential, assuming that technically feasible measure installations would occur equally (at 5% of the total available) for each year of the study, avoiding the distortion of interactions between discretionary and lost opportunity resources previously described.
2. Overlayed a measure ramp rate to specify the timing of achievable discretionary resource potential, thus transforming a 20-year cumulative technical value into annual, incremental achievable technical values.

The discretionary measure ramp rates specify only the timing of resource acquisition and do not affect the portion of the 20-year technical potential achievable over the study period.

Figure 6-9 shows incremental (bars) and cumulative (lines) acquisitions for two different discretionary ramp rates. A measure with an 85% maximum achievability on the 10-year discretionary ramp rate reaches full maturity in 10 years, with market penetration increasing in equal increments each year. A measure with an 85% maximum achievability on the emerging technology discretionary ramp rate would take longer to reach full maturity, though also gaining 85% of the total technical potential. Ultimately, it would arrive at the same cumulative savings as the measure on the 10-year ramp rate.

Figure 6-9. Examples of Discretionary Measure Ramp Rates



7. Long-Term Resource Planning Model for DSMPA

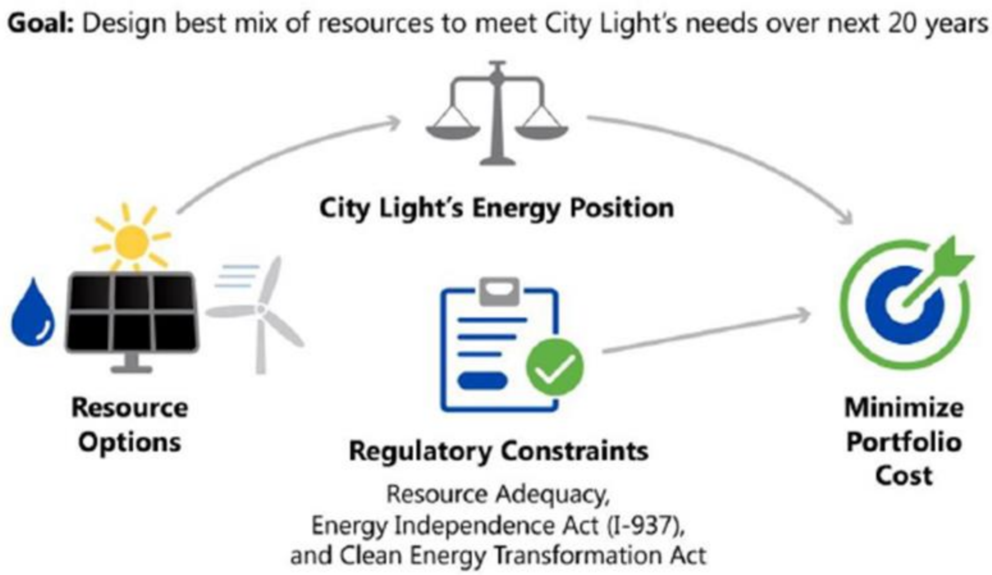
City Light uses long-term resource planning studies, such as the DSMPA, to identify the least-cost candidate resource portfolio, given a portfolio of existing resources, available resource options, available wholesale market depth, reliability requirements, and any operational and applicable policy constraints. Per WAC 194-37-070, City Light must perform a long-term resource planning study that includes candidate demand-side management (DSM, previously known as conservation) resources, with up-to-date estimates of those resources' energy or capacity potentials and demand-side resource valuations based on avoided costs of equivalent wholesale energy market purchases.

Similar to City Light's 2022 CPA and 2024 DSMPA study methodologies, City Light used a mathematical optimization modeling framework for the 2026 DSMPA to identify the most cost-effective (economic) demand-side resources. These demand-side resources comprise energy efficiency measures and demand response programs) to supplement City Light's existing power supply portfolio. The 2026 DSMPA study used City Light's system load forecast and model constraints representing policy requirements through the 20-year study period, 2026 through 2045. These demand-side resources also competed for selection by the model with supply-side candidate resources, providing further insight into the optimal demand- and supply-side resource mix that would enable City Light to keep rates as low as possible for its customer-owners.

7.1. DSMPA Model Framework

City Light collaborated with Sylvan Energy Analytics (Sylvan) to model City Light's existing resource portfolio, operational constraints, candidate demand- and supply-side resources, wholesale energy market prices, and applicable environmental policy requirements in Grid Path, an open-source long-term resource planning model framework. Sylvan then used the City Light instance of Grid Path to select the most economic demand-side resource additions to City Light's portfolio to meet expected future loads reliably through the 20-year study period. Figure 7-1 shows a high-level overview of City Light's resource planning model framework.

Figure 7-1. High-Level Overview of Resource Planning Model Framework



7.1.1. New Model Framework: Grid Path

City Light worked closely with Sylvan to model City Light's resource portfolio, modernizing City Light's previous model framework to better support the utility's decision-making processes in the rapidly evolving energy landscape. City Light, in collaboration with Sylvan, used Grid Path for the 2026 DSMPA study to determine the economic potential of demand-side resources provided by Cadmus. For the 2026 IRP modeling work scheduled to take place in late 2025 and early 2026, Sylvan and City Light will again use GridPath, with a focus on candidate supply-side resource additions to City Light's portfolio. By using GridPath for both the 2026 DSMPA and 2026 IRP modeling, as well as to support other simultaneous long-term resource portfolio decision-making internally at the utility, City Light will maintain consistency among long-term resource planning activities.

GridPath presents some notable advantages for modeling City Light's resource portfolio and candidate demand- and supply-side resource selections compared to the model framework used in prior DSMPAs and IRPs at City Light. First, GridPath dynamically dispatches generation from flexible resources both within City Light's existing resource portfolio and from flexible candidate resources. For example, the model can adjust the rate of discharge at the Skagit and Boundary hydroelectric projects as needed (within modeled operating constraints), thereby shifting the use of water for additional electricity generation between hours within a day or between days within a one- or two-week period. GridPath similarly takes advantage of the flexibility of other dispatchable candidate resources like demand response programs or utility-scale short-term battery energy storage systems. This ensures guidance from the model provides maximum reliability of candidate portfolios and reduces the risk of capacity overbuilds by the model. By contrast, the previous model framework could only dynamically dispatch Skagit and Boundary generation on an hourly basis within five-day intervals.

Secondly, Grid Path's capacity expansion model utilizes hourly capacity profiles of available resources, contracts, and market purchases to build optimal candidate portfolios. The previous 2024 model framework could not incorporate capacity profiles at an hourly resolution and instead relied on single-value effective load-carrying capacities (ELCCs) for each candidate resource considered in the model. The previous methodology utilizing ELCCs was computationally expensive and prone to underestimating resource requirements needed to meet resource adequacy thresholds based on the capacity expansion model's optimal candidate portfolios.

Thirdly, GridPath's zonal transmission module uses physics-based constraints at key flowgates in the region, which more realistically constrains available market depth and cost-effective wholesale energy marketing activity. The previous 2024 model framework was not able to effectively model transmission-based constraints and could only account for transmission costs through sensitivity analyses; for the 2024 DSMPA, the model framework was run 20 times, resulting in 20 distinct "optimal" portfolios for each transmission-cost threshold. By incorporating both candidate resources and the commensurate transmission required to meet reliability thresholds through the study period, GridPath eliminated the need for modeling multiple distinct transmission-cost sensitivities.

Finally, in modeling the reliability and portfolio values of demand-side resources to City Light, the new model framework using GridPath allows wholesale energy market arbitrage. This reflects more realistic operations and recognizes any additional value from demand-side resources to City Light ratepayers. There were some limitations on modeled arbitrage opportunities into and out of California, including participation in the Energy Imbalance Market (EIM). To account for these limitations, GridPath applies estimates that will conservatively overestimate the costs of the optimized candidate portfolios. The next section discusses in more depth the development of market price scenarios at Mid-Columbia (Mid-C) and California-Oregon Border (COB) market settlement points used in the GridPath DSMPA study.

7.1.2. Wholesale Market Price Forecasts

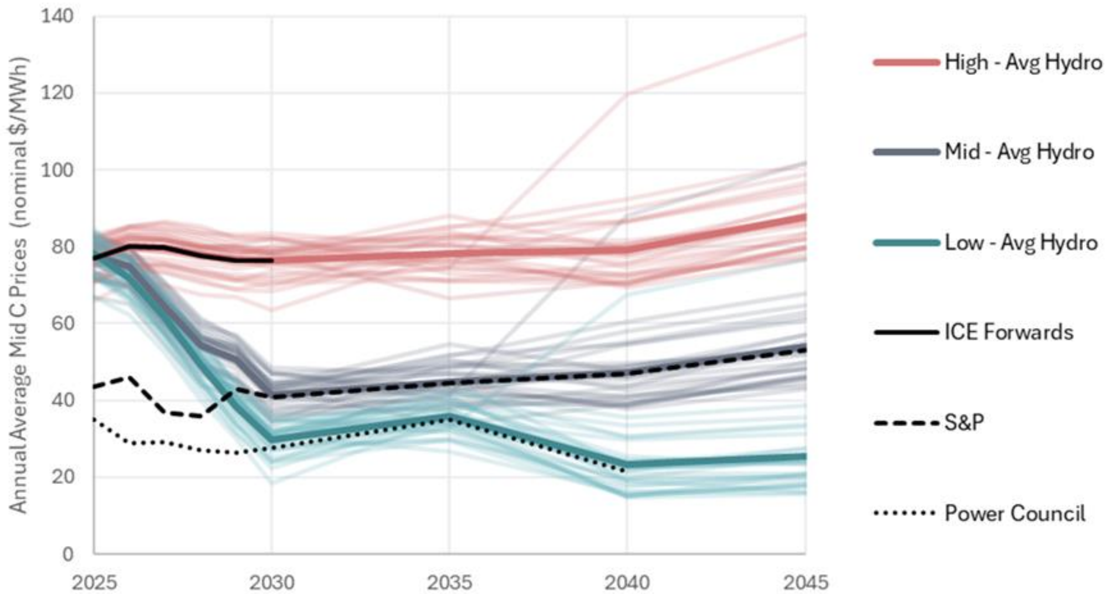
Sylvan developed three scenarios (low, mid, and high) for hourly wholesale price forecasts at the Mid-C market settlement point. All three price scenarios used a different entity's hourly market price forecast as a starting point (discussed below), but City Light made adjustments to develop 30 distinct hydro traces in each of the low-, mid-, and high-price scenarios. The Council's 2021 Power Plan developed these market price adjustments by hydro year. Sylvan applied price adders for each trace based on the monthly average price deviation in the Council's modeling for that hydro future.

- The mid-market price ensemble forecast reflects near-term market scarcity and long-term expectations that align with Standard & Poor's (S&P's) market price forecasts prior to adjustment by hydro year future.
- The low scenario reflects near-term market scarcity and long-term expectations that align with the Council's price forecast ensemble rather than S&P.

The high scenario reflects persistent scarcity into the future by using the 2030 Mid-C Intercontinental Exchange (ICE) forward prices as the basis of the forecast through the end of the study period rather than S&P.

Since S&P price forecasts employ a floor of $0, it was necessary for City Light to apply this same price floor to each hourly price scenario trace after making all other adjustments. Figure 7-2 shows the monthly average aggregations of the resulting price forecasts.

Figure 7-2. Mid-C Prices across Hydro Futures



Equivalent hourly price forecasts for the same horizons were not available for the COB market settlement point or the EIM. However, Sylvan was able to develop reasonable hourly COB prices by extrapolating from the Mid-C price traces described above based on historical relationships. Because the S&P hourly price forecasts for Mid-C employed a price floor of $0/MWh, Sylvan had to apply the same price floor to COB prices. Thus, the actual typical midday negative pricing at COB due to surplus solar generation in California was not captured in the price forecast traces for COB. The underrepresentation of opportunity for negative pricing arbitrage at COB by City Light results in more conservative (lower) market revenues than recognized by the model compared to if the COB price forecasts include actual negative midday pricing.

Sylvan also allowed the model to purchase month-long capacity products from the wholesale market on days when wholesale energy was assumed unavailable on the spot market (more discussion on this topic in the City Light's Modeled Existing Portfolio section below). Monthly capacity products represent capacity purchased on a forward basis. Sylvan set the prices of these capacity products in the model to equal the BPA demand rate. This assumes BPA sets forward capacity pricing on a competitive basis with the market. Based on internal analysis at City Light, BPA's demand rate may currently be low-biased on an expected basis through the study period, making capacity products look slightly more attractive to the model. However, other capacity pricing through the study period was not readily available.

7.2. City Light's Modeled Existing Portfolio

City Light's instance of GridPath models the existing power supply portfolio, including system load forecast, owned large hydroelectric generation assets and transmission, and long-term resource (energy, capacity, and transmission) contracts.

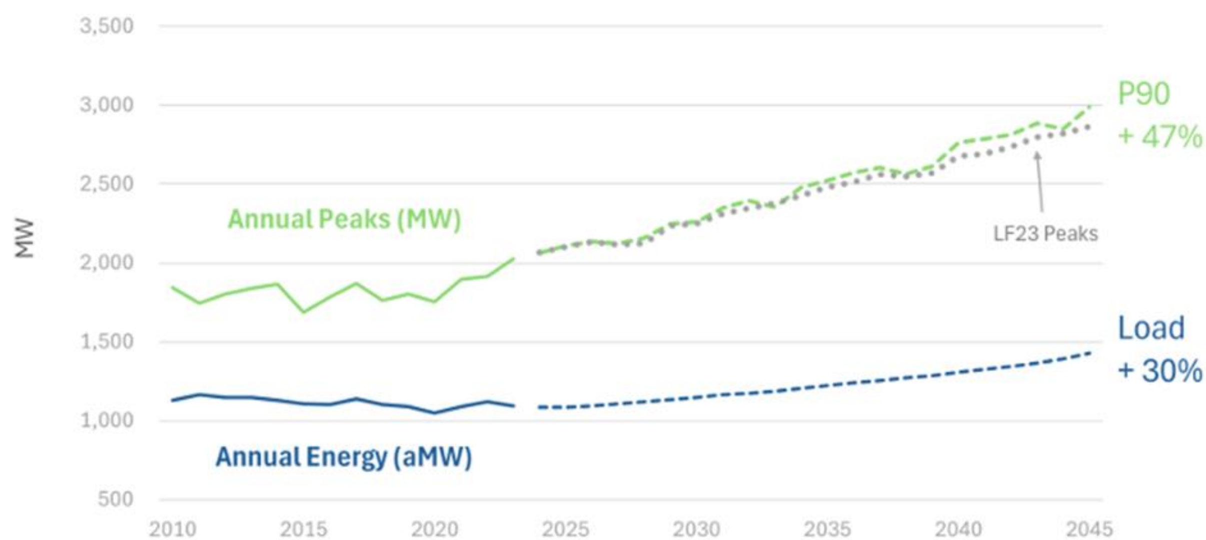
7.2.1. Load Forecast

An end-use model developed City Light's system load forecast, which extends from the present through 2045. Each target year of the forecast comprises an ensemble of 30 weather-normalized historical years.

To account for the impact of climate change on Seattle's load over the study period, City Light created linear regression models for each calendar month, fit using multiple general circulation models (GCMs) that cover Seattle's balancing area. City Light then used those models to apply scale factors to temperatures in each forecast month and combined these base temperatures with the end-use load forecasts to arrive at a final load forecast for the balancing area.

City Light's system load forecast shows increasing loads over the 20-year DSMPA study period, primarily driven by building and transportation electrification. City Light expects annual peak loads to grow at a faster rate over the study period than annual average loads, as shown in Figure 7-3. The growth rate of annual peak loads represents a slight increase over the previous year's load forecast peak load (LF23 Peaks in the figure below) growth rate. This is consistent with the findings of many other load-serving entities across the Pacific Northwest and presents a particular challenge for these entities, including City Light, to procure a higher ratio of firm capacity to energy than expected based on previous load forecast iterations.

Figure 7-3. 2024 Peak Forecast



7.2.2. Large Hydro Projects

The Council's model data supporting the Ninth Power Plan includes weather-driven models of regional conditions for 30 water years under three different spatially downscaled GCMs.[51, 52] The Council used their 30 years of modeled weather to drive regional hydro conditions, subsequent operations of regional hydroelectric projects, and corresponding wholesale energy market prices at Mid-C. Sylvan and City Light obtained hourly Council model data for City Light's Skagit and Boundary projects, as well as Mid-C price data, at an hourly granularity, for use in City Light's DSMPA modeling.

To alleviate some computational expense, City Light used the modeled natural inflows into City Light's Skagit project to calculate daily average discharge flows at Ross, Diablo, and Gorge, using an internally developed operations planning tool called the Flow Plan Tool (FPT). The FPT incorporates the many operational constraints at the Skagit project set out in the project's Federal Energy Regulatory Commission (FERC) license #533, Fisheries Settlement Agreement for the protection of fish habitats, mitigation of flood risk, and facilitation of summer recreation at Ross Reservoir. However, the FERC license for the Skagit expired in April 2025; City Light expects the new license to go into effect by the late 2020s and will prescribe updated operations requirements. One such update will allow Ross Reservoir to have a summer operating range from 1594.5 ft to 1602.5 ft, which is significantly more flexible than the previous summer operating range from 1600.0 to 1602.5 ft permitted. This update increases City Light's ability to meet resource adequacy needs in summer months and was incorporated into both the FPT and GridPath.

After the FPT model meets seasonal operational requirements, the output of the FPT provides weekly (or biweekly) water budgets for GridPath to optimize Skagit project operations at an hourly granularity for load service and to participate in wholesale energy and capacity markets. To avoid over-fitting Skagit generation to short-term fluctuations in modeled market prices, Sylvan applied additional ramping constraints to the hydro generators, which ensured modeled operations were realistic; this can also be viewed as simulating imperfect foresight of wholesale market prices within GridPath.

7.2.3. BPA Products

Under City Light's current BPA contract, effective through the end of September 2028 (the end of water year 2028), City Light purchases BPA's Diurnal Block product. As a part of the DSMPA study, Sylvan modeled City Light as taking the Diurnal Block product through the end of September 2028. Beginning in October 2028 (the start of water year 2029), City Light will start a new contract with BPA and will purchase the Monthly Block/Slice product.

The Provider of Choice contracts extend only through water year 2044, but Sylvan continued use of the Monthly Block/Slice product through the last DSMPA study year (water year 2045). This models the assumption that City Light would engage with BPA in an equivalent product choice under the subsequent

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[51] A water year is the consecutive 12-month period from October through the following September. The water year number is equal to the calendar year in the latter nine months of the water year. For example, water year 2026 spans October 2025 through September 2026.

[52] CanESM2, CCSM4, and CNRM-CM5, all using emissions scenario RCP 8.5.

contract. This assumption was the most reasonable option for modeling the last year of the DSMPA study period, given the lack of information about the nature of a BPA product contract for preference customers after water year 2044.

7.3. Environmental Policy Compliance in GridPath

City Light's long-term resource plans are subject to several legislative requirements, as described below.

7.3.1. Washington Energy Independence Act (I-937)

In 2006, Washington voters approved Initiative 937 (I-937), which requires that major utilities invest in all cost-effective energy efficiency measures and sets targets for adding Northwest renewable energy as a percentage of load. I-937 requires City Light to identify all achievable, cost-effective conservation potential for the upcoming 10 years and to specify City Light's public biennial conservation target should be no less than the pro rata share of conservation potential over the first 10 years. Previously, City Light followed the I-937 no load growth compliance pathway, but due to City Light's current and forecasted future load growth, City Light must now comply with the applicable regulations for load growth utilities.

7.3.2. Washington Clean Energy Transformation Act (CETA)

Approved by the Washington State legislature in 2019, CETA provides electric utilities in Washington with a clear mandate to phase out greenhouse gas emissions. CETA requires that utilities eliminate the use of coal-fired resources after December 31, 2025. Additionally, all electricity sold to customers must be greenhouse gas- (GHG-) neutral by January 1, 2030. To qualify as GHG-neutral, a utility must supply at least 80% of its load with a combination of renewable and non-emitting resources. Utilities may use alternative compliance options for no more than 20% of the load. CETA requires utilities to serve load with 100% GHG-free (renewable or non-emitting resources) by January 1, 2045.

GridPath was set up to assume that City Light retains the environmental attributes, renewable energy credits (RECs), or carbon-free credits associated with all eligible generation in its portfolio (see below for REC price forecast). City Light did not include a mechanism in the GridPath model to distinguish specified from unspecified wholesale energy market purchases;[53] this allows the model to realistically simulate dispatch decisions in response to market prices but leaves the problem of calculating GHG emissions associated with City Light's marketing activities. For the purposes of modeling compliance with emissions-related legislation, Gridpath assumed all market purchases simulated in GridPath were unspecified. GridPath ensures portfolios adhere to emissions requirements set out by CETA, and emissions limitations do not exceed City Light's allowances set out by the Department of Ecology.

CETA also requires utilities to ensure that the clean energy transition benefits highly impacted communities (HIC). City Light ensured that its DSMPA benefits HIC in two ways. First, the GridPath model

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[53] An unspecified energy market purchase is a market purchase without specific detail of which generator produced the electricity. This is important for emissions accounting because an unspecified market purchase cannot be assumed to have been produced from a non-emitting resource.

includes programs that specifically benefit HIC as candidate resources. Second, after the model selected its portfolios, City Light evaluated the programs that were just above the cutoff of the highest cost program (on a $/MWh basis). If any of these programs above the cutoff were focused on highly impacted communities, City Light considered swapping the program with a similar program selected by the model that does not specifically benefit highly impacted communities.

REC Price Forecast

When the most cost-effective option become available, the GridPath model allows City Light to purchase RECs at the prices shown in Table 7-1.

Table 7-1. REC Price Forecast

Year	E3 REC Price Forecast (2023$)
2024	$14.64
2025	$16.83
2026	$18.09
2027	$19.32
2028	$20.26
2029	$19.94
2030	$19.39
2031	$18.79
2032	$18.14
2033	$17.55
2034	$16.95
2035	$16.44
2036	$16.09
2037	$15.95
2038	$15.97
2039	$16.31
2040	$16.99
2041	$17.83
2042	$18.66
2043	$19.29
2044	$19.79
2045	$20.31

7.3.3. Washington Climate Commitment Act (CCA)

Approved in 2021, the CCA creates a cap on carbon emissions in Washington's most polluting industries. City Light and other utilities must purchase carbon allowances to cover the potential emissions from its electricity imports from other states. Per regulations specified by the CCA, for each year throughout the duration of the 2026 DSMPA study period, the Washington State Department of Ecology will grant City Light no-cost carbon allowances to limit the cost impacts of the CCA on City Light's customers.[5] In 2026, City Light's no-cost carbon allowance allocation is 251,767 metric tons of CO_2 equivalent.[6]

7.4. GridPath Set Up for DSMPA

7.4.1. Supply-Side Candidate Resources

A key change in the 2026 DSMPA model framework compared to previous cycles is that supply-side resources are allowed to compete with demand-side resources in the capacity expansion model. This enables candidate portfolios to be more highly optimized compared to previous model results produced by City Light, which retained the supply-side candidate resources selected by the prior IRP and only chose the optimal demand-side resources to fill the remaining resource gap.

To avoid introducing highly uncertain price, performance, and commercial availability assumptions around emerging utility-scale resource technologies, Sylvan and City Light only allowed established and presently commercially available resource technologies to be selected within GridPath's capacity expansion functionality. These established technologies are onshore wind farms, solar PV plants, and short-duration battery storage systems. Table 7-2 provides more details on the model's supply-side candidate resources.

Table 7-2. Modeled Supply-Side Candidate Resources

Technology	Location(s)	Data Sources and Notes
Onshore Wind	Gorge (WA/OR border) Idaho Montana	NREL-based wind shapes RARE renewable dataset RFP responses NREL ATB
Solar PV	Central WA Gorge (WA/OR border) Idaho	NREL-based solar shapes RFP responses NREL ATB
Battery storage	On-system On BPA's system Co-located with renewables	RFP responses NREL ATB 85% round-trip efficiency Duration selected by model (4-hr min)

7.4.2. Capacity Expansion Model

Sylvan identified the combination of one water year trace from the Council model data and one load forecast trace from City Light's system load forecast that resulted in approximately median conditions over the 20-year 2026 DSMPA study period. Sylvan used this synthetic median year as the basis for solving for the optimal mix of demand- and supply-side candidate resources.

Sylvan modeled study years 2026 to 2030, 2035, 2040, and 2045 explicitly in GridPath, using price, hydro, load, and weather simulations based on the identified median year conditions. Results for years not explicitly modeled were linearly interpolated between explicitly modeled years. Since forecast uncertainty increases significantly with an increasing forecast horizon, City Light expects this extrapolation to have minimal impact on key near-term results.

Cadmus provided hourly shapes for representative weeks by calendar month for non-dispatchable demand-side resources. Cadmus also provided season-specific potentials for dispatchable demand-response resources for each year in the study period. Additional details about the modeled demand-side resources are discussed below. To model a typical year in GridPath creates a size and computational issue, therefore to reduce the size problem the modeling used 12 typical weeks per year. To further reduce computational complexity, Sylvan selected one representative weekday and one representative weekend day from each of the unique 12 weeks to be modeled explicitly in GridPath.

7.4.3. Resource Adequacy

Sylvan assumed energy would be available to purchase through wholesale energy markets during all modeled hours except on explicitly defined resource adequacy-constrained days. Sylvan referred to the 2024 Western Assessment of Resource Adequacy report produced by the Western Electricity Coordination Council to determine the number of resource adequacy-constrained days to add to each year explicitly modeled in GridPath. The number of resource adequacy-constrained days incorporated into the GridPath model originated from the Western Assessment of Resource Adequacy's 55% demand at risk scenario as the most conservative scenario available in the reported results. Representative weekdays, representative weekend days, and resource adequacy-constrained days were assigned weights in GridPath proportional to their presence in each modeled year. To meet load in all hours of all modeled study years, Sylvan allowed GridPath to select demand-side candidate resources provided by Cadmus (described in more detail in the next section), commercially established supply-side candidate resources (solar PV, wind, and short-term batteries), wholesale energy marketing on non-resource adequacy-constrained days, and monthly capacity products priced at the BPA demand rate.

7.5. Development of DSM GridPath Model Inputs

Cadmus worked with City Light to determine the format for inputs into the DSM GridPath model. This potential study provided the demand-side candidate resources for the DSMPA model framework described above. Cadmus compiled DSM potential into the levelized costs bundles to be used within the GridPath model to determine the preferred resource at a given cost.

7.5.1. Levelized Cost of Energy

Cadmus calculated the levelized cost of energy as the net present value of a given resource or portfolio over the entire study period, divided by (or "levelized" by) the total amount of energy provided by that resource over the study period. In the following calculation, Cadmus discounted the energy provided by the resource at the same rate as was used to discount costs in the calculation of net present value.

Cadmus derived the levelized cost of energy for each measure using the following formula.

$$LCOE = \frac{\sum_{t=0}^{n} \frac{Expenses_t}{(1+i)^t}}{\sum_{t=0}^{n} \frac{E_t}{(1+i)^t}}$$

Where:

$LCOE$	=	levelized cost of conserved energy for a measure
E_t	=	energy conserved in year t
n	=	lifetime of the analysis (20 years)
$Expenses_t$	=	all net expenses in the year t for a measure using the costs and benefits
i	=	discount rate

Cadmus grouped the energy efficiency measures by levelized cost over the 20-year study period, allowing GridPath to select the optimal energy efficiency potential bundles, given various assumptions regarding future resource requirements and costs. The 20-year total resource levelized cost calculation incorporates numerous factors, which are consistent with the expense components shown in **Error! Reference source not found.**.

Table 7-3. Levelized Cost Components

Type	Component
Costs	Incremental Measure Equipment and Labor Cost
	Incremental O&M Cost
	Administrative Adder
Benefits	Present Value of Non-Energy Benefits
	Present Value of Transmission and Distribution Deferrals
	Secondary Energy Benefits
	10% Conservation Credit

7.5.2. Candidate DSM Resource Present Value Components

Cadmus used the economic inputs shown in Table 7-4 to model DSM product performances, parameters, and costs through the 20-year DSMPA study period, with all costs reported in 2026 U.S. dollars.

Table 7-4. Economic Inputs

7.5.3. Economic Inputs Included

Discount Rate	3.00%
Inflation Rate	2.53%
Line Loss Rate	8.31%
T&D Deferral Costs ($/kW-yr) ($2026)	$41.08

T&D = Transmission and Distribution

The costs and benefits (equivalent to negative costs) of demand-side resources calculated by Cadmus incorporated several components, described in more detail below.

7.5.4. Costs

Incremental technology costs: The present value of a demand-side resource cost as compared the baseline technologies (such as a energy efficient heat pump versus cheaper, but less energy-efficient heat pump).

Administrative adder: Program administrative costs based on the draft Ninth Power Plan representing the cost to conversed energy ($0.18 per kWh for residential, $0.12 per kWh for commercial, and $0.07 per kWh for industrial.

Incremental O&M costs: The present value of each demand-side resource includes typical costs for any required operations and maintenance, such as reduced operational costs from reduction in water usage.

7.5.5. Benefits

Non-energy benefits: Treated as a reduction in demand-side resource costs commensurate with the dollar value of non-energy-related savings. For example, the installation of a low-flow showerhead would reduce a demand-side resource's cost by the value of the conserved water. The Council's RTF workbooks provided measure-level non-energy benefit assumptions that Cadmus applied in this DSMPA study.

T&D deferrals: Treated as a reduction in the cost of demand-side resources by $41.08/kW-yr, based on the value of the deferred need for additional transmission and distribution procurement that would have been required for supply-side resource additions. City Light calculated the value of the T&D deferral rate, incorporating the following:

- Annual social cost of GHG from the Washington State Utilities and Transportation Commission (adjusted to 2026 U.S. dollars)
- Monthly REC prices forecasted by E3, purchased by City Light
- Monthly energy prices forecasted S&P, purchased by City Light
- Monthly expected costs of purchasing transmission on BPA's transmission system

10% conservation credit: Energy efficiency measures received a credit in the form of a flat reduction of 10% of the present costs. This credit is intended to account for other unquantified external benefits from conservation when compared with alternate resources and is consistent with the Northwest Power Act and the Council's Power Plans.

Secondary energy benefits: Treated as a benefit as a reduction in levelized costs for demand-side resources that save energy on secondary fuels. For example, consider the cost for R-11 wall insulation for a home with an electric central cooling system and a natural gas furnace. For the central cooling end-use, Cadmus considered the energy savings that R-11 insulation produces for natural gas furnace systems, conditioned on the presence of electric central cooling, as a secondary benefit that reduces the levelized cost of the measure. This adjustment impacts only the measure's levelized costs; the magnitude of energy savings for the R-11 measure on the electric supply curve is not impacted by considering secondary energy benefits.

7.5.6. Other Adjustments to Present Value

End-effects: If the useful life of a DSM resource did not extend through the end of the study, Cadmus incorporated an end effect to the total cost by treating the resource's levelized cost over its useful life as an annual reinstallation cost for the remainder of the study period. If a resource's useful life extended beyond the study period, Cadmus levelized resource costs over the resource's useful life and treated as annual costs within the study period. This approach is consistent with the Council's approach and consistent with the approach employed in City Light's previous IRP and DSMPA studies.

7.6. Modeling DSM Candidate Resources in GridPath

Cadmus provided two types of candidate demand-side resources for input into GridPath: dispatchable and non-dispatchable. In previous DSMPA modeling work, City Light modeled all candidate demand-side resources statically, meaning they could not be dispatched dynamically by the model to most effectively meet the load. For the present DSMPA study, GridPath was able to treat dispatchable demand response programs dynamically.

7.6.1. Non-Dispatchable Candidate Resource Inputs

GridPath modeled non-dispatchable demand-side resources with a fixed hourly shape across a typical calendar year. The potential of these programs increases through the study period based on product- and study year-specific multipliers determined through Cadmus's DSM study for City Light's balancing area. Non-dispatchable demand-side resources include some demand response programs, all energy efficiency measures, and all customer solar programs.

GridPath included the customer solar programs selected in the 2024 DSMPA in the modeling of City Light's existing portfolio. Historically, City Light has not updated the set of candidate programs for every iteration of the DSMPA (or CPA). For the 2026 DSMPA, City Light chose to maintain existing customer solar programs, pausing the update of the customer solar programs in the DSMPA portfolio modeling to make updates to the demand-side distributed energy resource products that will set City Light's near-term targets. City Light will update customer solar programs in the 2028 DSMPA modeling. Even though the selected programs did not change with this 2026 study, Gridpath allowed the generation output of the previously selected customer solar programs to vary with modeled weather conditions.

To improve computational tractability when modeling thousands of candidate energy efficiency measures, Cadmus grouped non-dispatchable measures into incremental cost bundles, aggregating resource costs and energy contributions based on ranges of the levelized cost of energy (LCOE) of the given resource. The cost thresholds of the LCOE bundles are shown in Table 7-5. Within the cost bundles, Cadmus split out subgroups for customer class (residential, commercial, or industrial), weather sensitivity (yes or no), and measures focused on highly impacted communities (yes or no).

Table 7-5. Levelized Cost Bundle Ranges

Bundle	$/MWh
1	($9,999,999) to $10
2	$10 to $20
3	$20 to $30
4	$30 to $40
5	$40 to $50
6	$50 to $60
7	$60 to $70
8	$70 to $80
9	$80 to $90
10	$90 to $100
11	$100 to $110
12	$110 to $120
13	$120 to $130
14	$130 to $140
15	$140 to $150
16	$150 to $160
17	$160 to $9,999,999

Table 7-6 shows an example of the subbundle attributes within each LCOE bundle.

Table 7-6. Example Subgroups within Each Levelized Cost Bundle Range:

Example: Bundle #1 Sub-bundles	Customer Class	Weather Sensitivity	Highly Impacted Community
1.a.	Residential	Yes	Yes
1.b.	Residential	Yes	No
1.c.	Residential	No	Yes
1.d.	Residential	No	No
1.e	Commercial	Yes	Yes
1.f.	Commercial	Yes	No
1.g.	Commercial	No	Yes
1.h.	Commercial	No	No
1.i.	Industrial	Yes	Yes
1.j.	Industrial	Yes	No
1.k.	Industrial	No	Yes
1.l.	Industrial	No	No

In the previous DSMPA and CPA studies, City Light had further aggregated Cadmus' LCOE bundles into cumulative groups, such that each bundle included all resources below a specified incremental LCOE threshold, under the assumption that City Light would pursue lower-cost demand-side resources before any higher LCOE resources. City Light also performed further bundling had also been performed by grouping cumulative cost bundles when incremental energy provided by the next highest cost bundle was deemed negligible. However, aggregating energy efficiency measures into cumulative LCOE-bundles introduced artificial constraints to the capacity expansion model. For the current DSMPA work, City Light recognizes that it could be more optimal to choose energy efficiency measures with a higher LCOE, compared to lower LCOE products, if those higher LCOE measures more effectively meet City Light's net load at critical times, thereby offsetting the need to acquire more expensive alternate resources or market products. As such, Sylvan did not perform additional cumulative bundling for the 2026 DSMPA and, instead, allowed GridPath to select any of the incremental LCOE sub-bundles to meet resource needs with the combination of measures that resulted in the minimum total portfolio cost.

7.6.2. Dispatchable Candidate Resource Inputs

Cadmus provided parameters for dispatchable candidate demand response resources. These parameters primarily describe achievable potentials and upper limits to the number of calls and durations of calls allowed in each of the summer and winter seasons in the study period. Gridpath modeled dispatchable demand response resources as individual decision variables, meaning the model could choose to select any individual resource and dispatch it as needed within the specified resource parameters. This allowed dispatchable demand response resources to be considered on equal footing with candidate supply-side resources.

Dispatchable demand response programs can be further subcategorized by their impact on load; per NREL nomenclature, these subcategories are shift, shed, and shimmy. Programs could fall into one or more of these sub-categories.

Shift. Demand response resources that shift load are resources that allow a reduction in load when an event is called, but the magnitude of the energy reduction is added back onto the load after the event ends. An example of this is commercial EV supply equipment; when an event is called, normal energy use by this equipment is reduced for up to four hours by preventing charging of the EVs during the event. However, EVs still need to be charged before their next use and are assumed to charge instead during the four hours following the event.

Cadmus' study showed these programs to be effective when called four to 12 times per season for up to four hours at a time.

Shed. Demand response resources allow City Light to reduce energy consumption without the need to deliver that energy at a later time. Many demand response programs identified by the Cadmus study fell into this category; a typical example of this is curtailment of load, where customers reduce their usage of electronics and energy-intensive electrical equipment during an event.

Similar to shift programs, Cadmus' study allowed events for shed programs to be called four to 12 times per season for up to four hours each.

Shimmy. Load shimmy programs allow dispatchers to follow the load on a minute-by-minute basis, providing frequency regulation to the grid. Dispatchable demand response resources that are able to shimmy load and that were identified in the DSMPA study were primarily residential and commercial batteries and water heater-related resources. Within GridPath, Sylvan modeled these resources effectively like batteries, down to a minimum temporal granularity of one hour.

The DSMPA study showed shimmy demand response programs to be effective when called for up to four hours on modeled resource adequacy-constrained days. When two or more resource adequacy-constrained days occur in a row, such as during a multi-day heat wave or cold snap, these programs can be called for multiple consecutive days. However, these programs are not intended to be called on days when City Light's service area experiences more typical conditions.

7.6.3. Results

Scenarios with Monthly Capacity Products

Sylvan completed GridPath model runs, as described in the previous section, for the three different price forecast sensitivities: low, mid, and high, where monthly capacity products were available to purchase to meet City Light's resource needs (referred to as the scenarios with capacity products). The candidate portfolios for the low- and mid-price scenarios resulted in reasonable economic achievable potentials (magnitude of demand-side product capacities) across customer classes, but the high-price scenario produced inconsistent and unrealistic results, so Sylvan ran another scenario with an additional constraint to produce more informative results from the high-price scenario, as discussed in more detail below.

Demand Response Low- and Mid-Price Scenarios with Capacity Products

The model found the same demand response economic achievable potential result for the low- and mid-price scenarios. It determined that only a relatively small portion of the demand response achievable potential was cost-effective compared to the other candidate resource types selected in the optimal portfolio. The demand response economic achievable potential was primarily concentrated in the commercial customer class, and the model selected only winter demand response rather than summer demand response programs. This seasonal result matches City Light's past experience, as well as modeled future expectations, that the net load in the winter is, and will continue to be, greater than the net load in the summer.

Figure 7-1. Comparison of 2026 Demand Response Scenarios to 2024 Preferred Portfolio

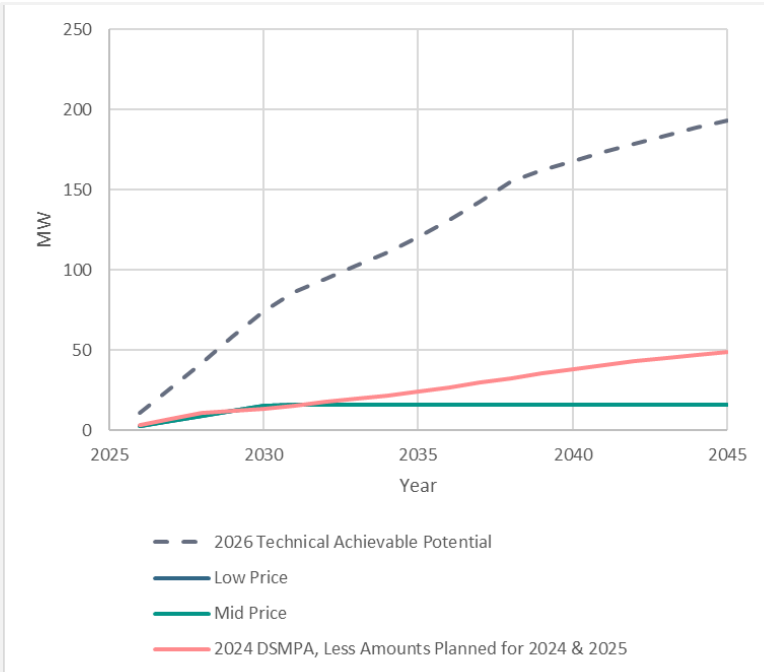
2026 Scenario	Customer Class	2-Year MW (2026-2027)	4-Year MW (2026-2029)	10-Year MW (2026-2035)	20% of 10-year
2026 DSMPA: Low Price	Commercial	**6**	**12**	**15**	**3**
2026 DSMPA: Mid Price	Commercial	**6**	**12**	**15**	**3**
2026 DSMPA: High Price (sensitivity)	Commercial	**7**	**14**	**18**	**4**
2024 Results	**Customer Class**	**2-Year MW (2024-2025)**	**4-Year MW (2024-2027)**	**10-Year MW (2024-2033)**	**20% of 10-Year**
2024 DSMPA: Preferred Portfolio	Commercial	6	13	23	4
	Residential	0	0	4	1
	Total	**6**	**13**	**26**	**5**

Compared to the demand response selected in the preferred portfolio from the 2024 DSMPA, the 2026 DSMPA model selected similar commercial winter economic achievable potential early in the study period, particularly in the first two and four years. The primary change was that the 2026 DSMPA did not select any additional residential demand response programs or additional commercial programs that contributed to economic potential, primarily in the latter years of the study period. This change was likely driven by the additional flexibility of GridPath's capacity expansion model, which allowed it to account directly for weather-sensitive contributions to resource adequacy needs and allowed a more cost-effective mix of energy efficiency measures rather than demand response programs to be selected to meet demonstrated resource adequacy needs.

In the 2024 DSMPA, the demand response programs provided capacity in both summer and winter, whereas the 2026 DSMPA shows only winter demand response programs are economic. This was likely a result of the increased flexibility of City Light's Skagit hydro project expected in the new FERC license. The increased summer elevation operating range at Ross Reservoir allows the Skagit project to provide significantly more resource adequacy contribution in the summer months.

Figure 7-2 depicts the differences between the winter demand response economic achievable potential identified by the 2024 DSMPA and the low- and mid-price runs' winter demand response economic achievable potential for the 2026 DSMPA. Note that the demand response economic achievable potentials were the same for both the low- and mid-price scenarios. For reference, the total demand response technical achievable potential identified by Cadmus' study is included in the same plot.

Figure 7-2. Comparison of 2026 and 2024 DSMPA Winter Demand Response



7.6.4. Energy Efficiency Low- and Mid-Price Runs with Capacity Products

The optimal portfolios resulting from the low- and mid-price runs contained energy efficiency economic achievable potentials significantly higher than their respective demand response economic achievable potentials in all years of the study. The 2026 DSMPA energy efficiency economic potential in the first several years of the study period in the low-price run was lower than that in the 2024 DSMPA preferred portfolio, while that in the mid-price run was higher than that in the 2024 DSMPA preferred portfolio. The 2026 DSMPA energy efficiency economic potential landed well below the 2024 DSMPA results by year 10 and through the remainder of the 20-year study period, as GridPath relied more heavily on supply-side candidate resource builds and capacity products to meet resource needs a decade or more in the future in both the low- and the mid-price runs. The similarity of the energy efficiency economic potentials identified in the near term for the 2026 DSMPA low- and mid-price runs and the 2024 DSMPA preferred portfolio results in energy efficiency potential through the study period represented measures benefiting highly impacted communities.

Figure 7-3. Comparison of 2026 Energy Efficiency Scenarios to 2024 Preferred Portfolio

2026 Scenario	Sector	2-Year aMW (2026-2027)	4-Year aMW (2026-2029)	10-Year aMW (2026-2035)	20-Year aMW (2026-2045)
2026 DSMPA: Low Price	Commercial	14	26	49	62
	Industrial	1	3	6	8
	Residential (HIC)	1 (0)	3 (1)	6 (2)	8 (3)
	Total	**17**	**32**	**61**	**78**
2026 DSMPA: Mid Price	Commercial	17	31	62	82
	Industrial	1	3	6	8
	Residential (HIC)	3 (1)	5 (1)	9 (3)	13 (4)
	Total	**21**	**39**	**78**	**103**
2026 DSMPA: High Price (sensitivity)	Commercial	18	34	71	96
	Industrial	1	3	6	8
	Residential (HIC)	4 (1)	7 (2)	15 (4)	23 (5)
	Total	**24**	**44**	**92**	**126**
2024 Results	**Sector**	**2-Year aMW (2024-2025)**	**4-Year aMW (2024-2027)**	**10-Year aMW (2024-2033)**	**22-Year aMW (2024-2045)**
2024 DSMPA	Commercial	12	23	49	72
	Industrial	2	4	8	10
	Residential (HIC)	4 (1)	8 (2)	22 (6)	50 (13)
	Total	**18**	**35**	**79**	**132**

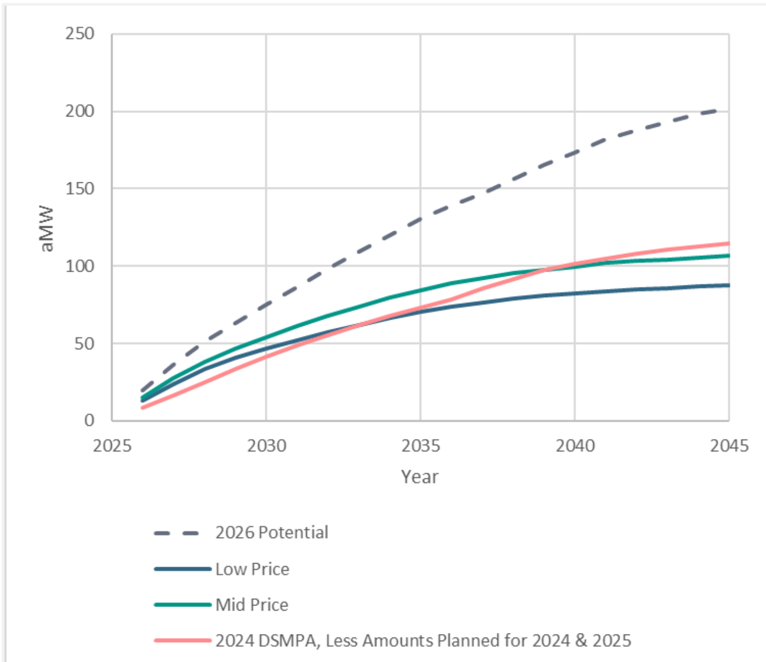
Even though the 2026 DSMPA study selected a greater proportion of energy efficiency economic potential from the commercial customer class than the other customer classes, City Light selected, so it is likely that the additional flexibility to select distinct incremental price sub-bundles allowed GridPath to select more energy efficiency that better fit the shape of the resource need across hours of the day, months of the year, and years of the study period, rather than simply selecting the lowest cost bundles first. This was the same reasoning as with demand response economic achievable potential increases.

Impacts of recent legislation will lead directly or indirectly to increased commercial energy efficiency in the latter years of the study period, but City Light will not be able to recognize them as part of our achievements through energy efficiency measures. For example:

- City of Seattle Building Performance Standards and other initiatives make additional achievable potential available in the near term but eliminates that potential in the latter years of the study period.
- House Bill 1185 requires phasing out of sales of lighting containing mercury by 2029, which would instead be replaced by more efficient LEDs. City Light would continue to be able to recognize lighting efficiencies prior to 2029 as part of its programs but would no longer be able to recognize those efficiencies after the legislation goes into effect.

Figure 7-4 illustrates the differences between the energy efficiency economic achievable potentials identified in 2024 DSMPA and the low- and mid-price runs' energy efficiency economic achievable potentials for 2026. The figure also shows how these compare to the total energy efficiency technical achievable potential identified by Cadmus' updated DSMPA study.

Figure 7-4. Comparison of 2026 and 2024 DSMPA Energy Efficiency



7.6.5. High-Price Scenario Sensitivity Run with Capacity Products

Unlike the low- and mid-price runs with capacity products, the candidate portfolio resulting from the high-price scenario with capacity products selected an unrealistically high quantity of supply-side resources and extremely low demand-side resources because excess energy from supply-side resources could be sold back to the market at a premium due to sustained scarcity pricing through the study period. The model's price-taker wholesale market price forecasts are treated as static inputs to the optimization problem and thus cannot reflect realistic market dynamics. High quantities of resource capacity built in response to sustained high regional wholesale market prices would subsequently act to suppress market prices as energy supply increases relative to demand. This would, in turn, likely make the large amounts of supply-side resource additions to City Light's portfolio uneconomic. Since this scenario produced unrealistic results, City Light did not consider the candidate portfolio resulting from the high-price scenario to be a viable solution.

To remedy this situation, Sylvan ran an additional high-price scenario where the total capacity of supply-side resources selected by the model was artificially limited to 130% of the supply-side capacity selected in the mid-price scenario. Even though it introduces an artificial constraint, this scenario represents a more realistic future scenario where new construction of wind, solar, and short-term batteries is limited, justifying continued scarcity pricing in the wholesale market through the end of the study period.

Sensitivity Run Demand Response Results

In this high-price capped supply-side sensitivity run, only slightly less demand-side management capacity was selected than in the mid- or low-price runs. In particular, the demand response products selected were also a commercial winter demand response program, and it contributed proportionally more capacity in the first two and four years of the study period than in the last 10 years when compared to the 2024 DSMPA preferred portfolio's demand response economic potential. This further supports the conclusions from the low- and mid-price runs that demand response programs contributing greater achievable potential in the winter and in the early years of the study period provide greater value than those that contribute more in the latter years.

Sensitivity Run Energy Efficiency Results

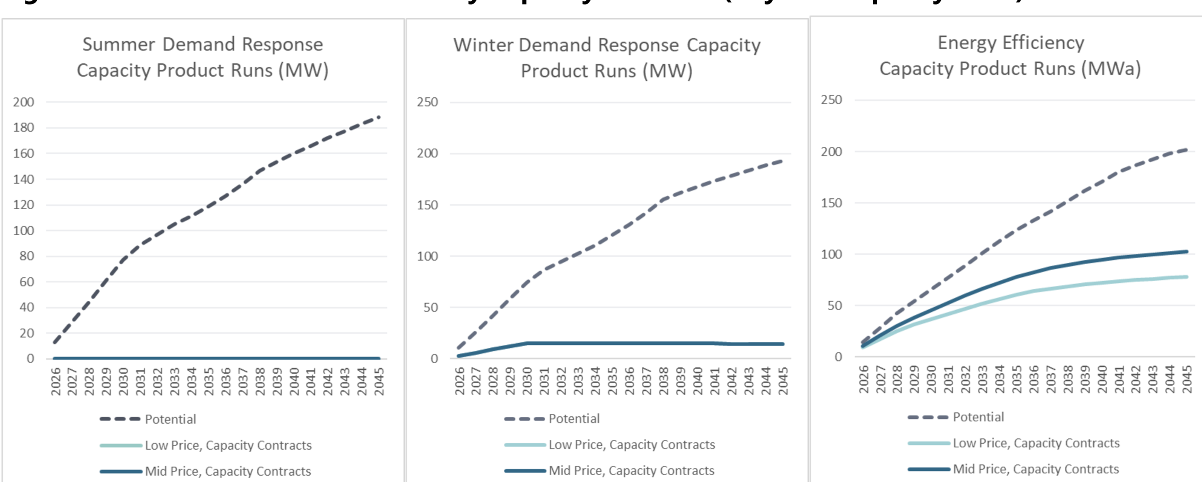
The high-price sensitivity run's optimal portfolio included greater energy efficiency economic potential than the low-and mid-price runs, with greater weighting on the latter years. This suggests that some energy efficiency measures not selected in the low- and mid-price scenarios are the next most cost-effective in the case that the acquisition of supply-side resources is infeasible at the optimal rate identified by the IRP. Indeed, materials shortages, increases in supply costs, and delays in deployment are already obstacles impacting the industry and are all feasible contingencies that are prudent considerations for long-term resource planning.

Similar to the low- and mid-price runs, the high-price sensitivity run selected a high proportion of commercial customer class energy efficiency measures. In addition, the high-price scenario is consistent with the 20% to 25% of economic programs focused on highly impacted communities, as shown in the low- and mid-price run results.

Sensitivity Run Conclusions

The demand response and energy efficiency economic potentials identified in the high-price sensitivity run further support the conclusion that the commercial customer class may provide the greatest benefit over the cost of implementation for both demand response and energy efficiency resources and that energy efficiency appears to be more cost-effective on the whole, as opposed to demand response, regardless of the possible range of wholesale market prices.

Figure 7-5. Scenarios without Monthly Capacity Products (Physical Capacity Runs)



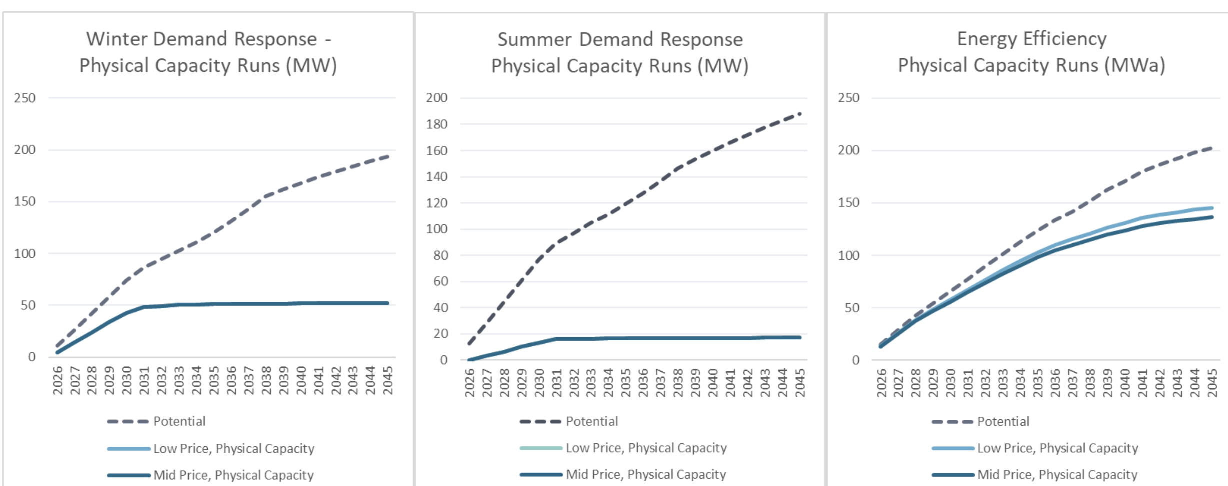
Because the demand response economic achievable potentials in the model runs described above were notably less than what was identified in the 2024 DSMPA, Sylvan executed model runs to test whether this was a result of the inclusion of wholesale market capacity products to meet resource adequacy needs in the 2026 DSMPA model. Sylvan ran two additional scenarios: one using the low wholesale energy price forecast and the other using the mid wholesale energy price forecast, but this time without capacity products available as candidate resources. While the resultant optimal portfolios produced by these two runs showed unrealistically large buildouts of the wind, solar, and short-term battery supply-side candidate resources to meet City Light's anticipated future resource adequacy needs, they provided insight into the economic achievable potential of demand-side resources.

Demand Response and Energy Efficiency Results of Physical Capacity Runs

The amount of energy efficiency economic potential overall increased from about 50% of the total achievable potential in the low- and mid- price runs with capacity products to about 75% of the total in the low- and mid- price physical capacity runs. The demand response economic achievable potential selected in these two new scenarios nearly tripled in all study years when capacity products were removed as candidate resources but still only reached about 25% of the total achievable potential by the end of the study period. This confirms that, overall, more of the achievable potential from energy efficiency measures is economic compared to demand response programs. The inclusion of forward monthly capacity products as candidate resources remains a more economic resource for meeting City Light's resource adequacy needs in the latter part of the study period.

These two portfolios are discussed here to gain insight into the value of demand-side management resources, especially in comparison to supply-side resource options. However, due to the unlikelihood that forward monthly capacity products, which are commonly available products across current power markets, would be unavailable going forward, the resultant portfolios are not considered for the purpose of setting City Light's demand-side management targets. Further, the infeasibility of the large supply-side buildouts in these portfolios makes them unrealistic and not cost-effective for future resource planning purposes.

Figure 7-6. Scenarios with Monthly Capacity Products (Physical Capacity Runs)



7.7. Conclusions and Recommendation

The collaboration with Sylvan in the implementation of GridPath for City Light's DSMPA has facilitated significant improvements to City Light's DSMPA modeling process. While many inputs to the DSMPA model still carry significant uncertainty, this updated model and analyses have attempted to quantify and account for much of that uncertainty in determining the optimal future demand-side resource mix. City Light are encouraged to see that, even with such significant updates to the model framework, the economic achievable potential of energy efficiency and demand response in the first several years are a comparable order of magnitude to those resulting from the previous model framework used for the 2024 DSMPA and prior long-term resource planning studies.

Five total scenarios represented reasonable future scenarios for consideration. However, City Light recognizes that three of those portfolios (high price with capacity products and limited supply-side resource buildout, low price with capacity product purchases limited to zero, and mid-price with capacity product purchases limited to zero) introduced artificial limitations to explore "what if" scenarios and assess the stability of the solution space. While they provide useful results for comparison among scenarios, they are less defensible for use in setting demand-side management targets due to artificial limitations.

Among the two scenarios that did not introduce artificial constraints (the low- and mid-wholesale market price scenarios with capacity products), the mid-price scenario represents a future where prices begin at current-day Mid-C ICE Forward prices, representing current regional market scarcity, but by 2030 they align with expected energy price futures from S&P. These prices persist some amount of market scarcity pricing above those assumed by the Council's price forecasts, which accounts more for imperfect resource buildout in the region, which could be argued to be the most realistic price scenario. Additionally, the mid-price scenario's economic achievable potential selected by the model aligns well with the results from the previous model framework used in the 2024 IRP Progress Report and the 2024 DSMPA and does not differ hugely from the low-price scenario's direction.

However, as the mid-wholesale market price portfolio still represents an incremental increase in recognized demand-side efficiencies, as shown in Figure 7-7, City Light would require immediate additional resources, especially in terms of personnel and information technology, to capture these demand-side economic potentials; acquisition of requisite additional resources does not represent an insurmountable obstacle for the utility.

Thus, the optimal portfolio resulting from the mid-wholesale market price (with capacity products) scenario is City Light's choice for setting realistic, economic achievable potential targets for the next two and four years. This portfolio best positions City Light to make investments in customer-side energy solutions while allowing room to adjust course as needed with future model enhancements and updated forecasts.

Figure 7-7. 2026 Portfolio Based on Mid-Price Scenario Compared to 2024 Preferred Portfolio

2026 DSMPA Results	2-Year (2026-2027)	4-Year (2026-2029)	10-Year (2026-2035)	20% of 10-Year
Commercial	17	31	62	12
Industrial	1	3	6	1
Residential	3	5	9	2
2026 Total (aMW)	**21**	**39**	**78**	**16**
Demand Response (MW)	*6*	*12*	*16*	

2024 DSMPA Results	2-Year (2024-2025)	4-Year (2024-2027)	10-Year (2024-2033)	20% of 10-Year
Commercial	12	23	49	10
Industrial	2	4	8	2
Residential	4	8	22	4
2024 Total (aMW)	**18**	**35**	**79**	**16**
Demand Response (MW)	*6*	*13*	*31*	

8. Glossary of Terms

These definitions draw heavily from the NAPEE Guide for Conducting Energy Efficiency Potential Studies and the State and Local Energy Efficiency Action Network.[54]

Achievable potential: The amount of energy use that efficiency can realistically be expected to displace.

Conservation potential assessment: A quantitative analysis of the amount of energy savings that exists, proves cost-effective, or could potentially be realized through implementation of energy-efficient programs and policies.

Cost-effectiveness: A measure of relevant economic effects resulting from implementing an energy efficiency measure. If the benefits of this selection outweigh its costs, the measure is considered cost-effective.

Economic potential: Refers to the subset of technical potential that is economically cost-effective compared with conventional supply-side energy resources.

End use: A category of equipment or service that consumes energy (such as lighting, refrigeration, heating, or process heat).

End-use consumption: Used for the residential sector, this represents per-UEC consumption for a given end use, expressed in annual kilowatt-hours per unit (also called unit energy consumption).

End-use intensities: Used in the commercial and institution sectors, this represents the energy consumption per square foot for a given end use, expressed in annual kilowatt-hours per square foot per unit.

Energy efficiency: The use of less energy to provide the same or an improved service level to an energy consumer in an economically efficient way.

Effective useful life: An estimate of the duration of savings from a measure. EUL is estimated through various means, including the median number of years that energy efficiency measures installed under a program remain in place and operable. EUL also is sometimes defined as the date at which 50% of installed units remain in place and operational.

Levelized cost: The result of a computational approach used to compare the cost of different projects or technologies. The stream of each project's net costs is discounted to a single year using a discount rate (creating a net present value) and divided by the project's expected lifetime output (MWhs).

Lost opportunity: Refers to an efficiency measure or efficiency program seeking to encourage the selection of higher-efficiency equipment or building practices than that typically chosen at the time of a purchase or design decision.

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[54] Schiller Consulting, Inc. 2012. *Energy Efficiency Program Impact Evaluation Guide. NAPEE Guide for Conducting Energy Efficiency Potential Studies and the State and Local Energy Efficiency Action Network.* Prepared by SEEAction. www.seeaction.energy.gov

Measure: Installation of equipment, subsystems, or systems, or modifications of equipment, subsystems, systems, or operations on the customer side of the meter designed to improve energy efficiency.

Portfolio: Either (a) a collection of similar programs addressing the same market, technology, or mechanisms or (b) the set of all programs conducted by one organization.

Program: A group of projects with similar characteristics and installed in similar applications.

Retrofit: An efficiency measure or efficiency program intended to encourage the replacement of functional equipment before the end of its operating life with higher-efficiency units (also called early retirement) or the installation of additional controls, equipment, or materials in existing facilities for reducing energy consumption (such as increased insulation, lighting occupancy controls, or economizer ventilation systems).

Resource adequacy*:* Having sufficient resources, generation, energy efficiency, storage, and demand-side resources to serve loads across a wide range of conditions.

Technical potential: The theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints (such as cost-effectiveness or the willingness of end users to adopt the efficiency measures).

Total resource cost test: A cost-effectiveness test that assesses the impacts of a portfolio of energy efficiency initiatives on the economy at large. The test compares the present value of efficiency costs for all members of society (including costs to participants and program administrators) compared with the present value of benefits, including avoided energy supply and demand costs.