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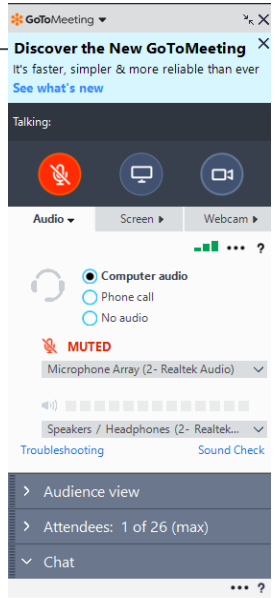
- Be considerate of others waiting to participate
- We will try to get to all questions



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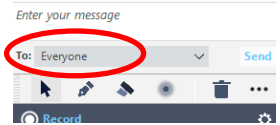


PUGET SOUND ENERGY

2021 IRP Webinar #4: Demand Side Resources

July 14, 2020

Agenda

- Safety moment
- Speaker Introductions and Preliminaries
- Overview of CPA in IRP
- CPA – methodology
- Electric Potential
  - Energy Efficiency
  - Demand Response
  - Distributed Solar pV
  - Combined Heat and Power
- Natural Gas Potential
- Distribution Efficiency Potential
- CPA input to IRP modeling
- Feedback and Final Q&A
- Next steps
- Appendix

PSE PUGET SOUND ENERGY

Safety Moment

SOURCE: https://www.mayoclinic.org/healthy-lifestyle/adult-health/multimedia/back-pain/sls-20076866?s=2

Start in a safe position

Maintain the natural curve in your lower back

Use your legs

Squatting instead of kneeling

Let your legs do the work

Avoid twisting

PSE PUGET SOUND ENERGY

Today's Speakers

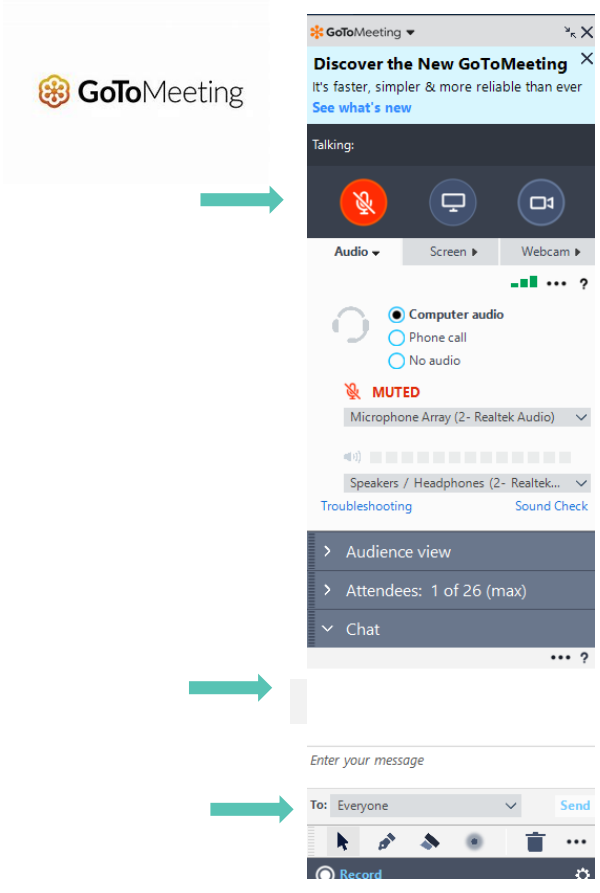
Gurvinder Singh
Senior Resource Planning Analyst, PSE

Lakin Garth
Senior Associate, Cadmus

Alexandra Streamer & Alison Peters
Co-facilitators, EnviroIssues

PUGET SOUND ENERGY

Welcome to the webinar and thank you for participating!



Virtual webinar link: https://global.gotomeeting.com/join/356063605

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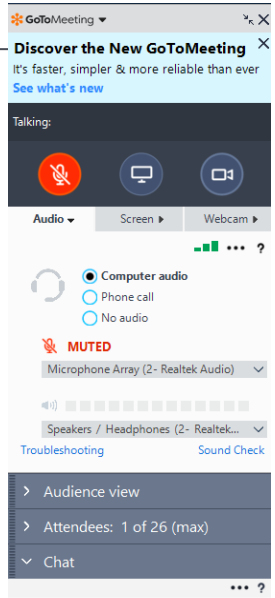

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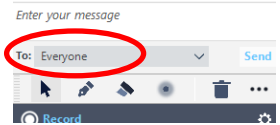

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Participation Objectives

- Stakeholders share input on conservation potential assessment
- Stakeholders share input on sensitivities with demand side resources

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Overview of the Conservation Potential Assessment in the IRP

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How is the Conservation Potential Assessment (CPA) used?

- The CPA is used in the IRP to determine the cost effective amount of demand side resources (energy efficiency, distribution efficiency, combined heat, demand response)
  - Cost effective conservation is used to inform the program target setting process:
    - For energy efficiency based on EIA/HB1257
    - For Demand Response per CETA
- CPA and cost-effective conservation will be used to inform the
  - Clean Energy Action Plan
  - Clean Energy Implementation Plan
- The CPA will also provide conservation forecast at the zip code level to be used by Delivery System Planning in their distributed energy resource planning process, also known as the non-wires alternative solutions
- Sensitivities can be used to test various assumptions and their impact on the output in the IRP

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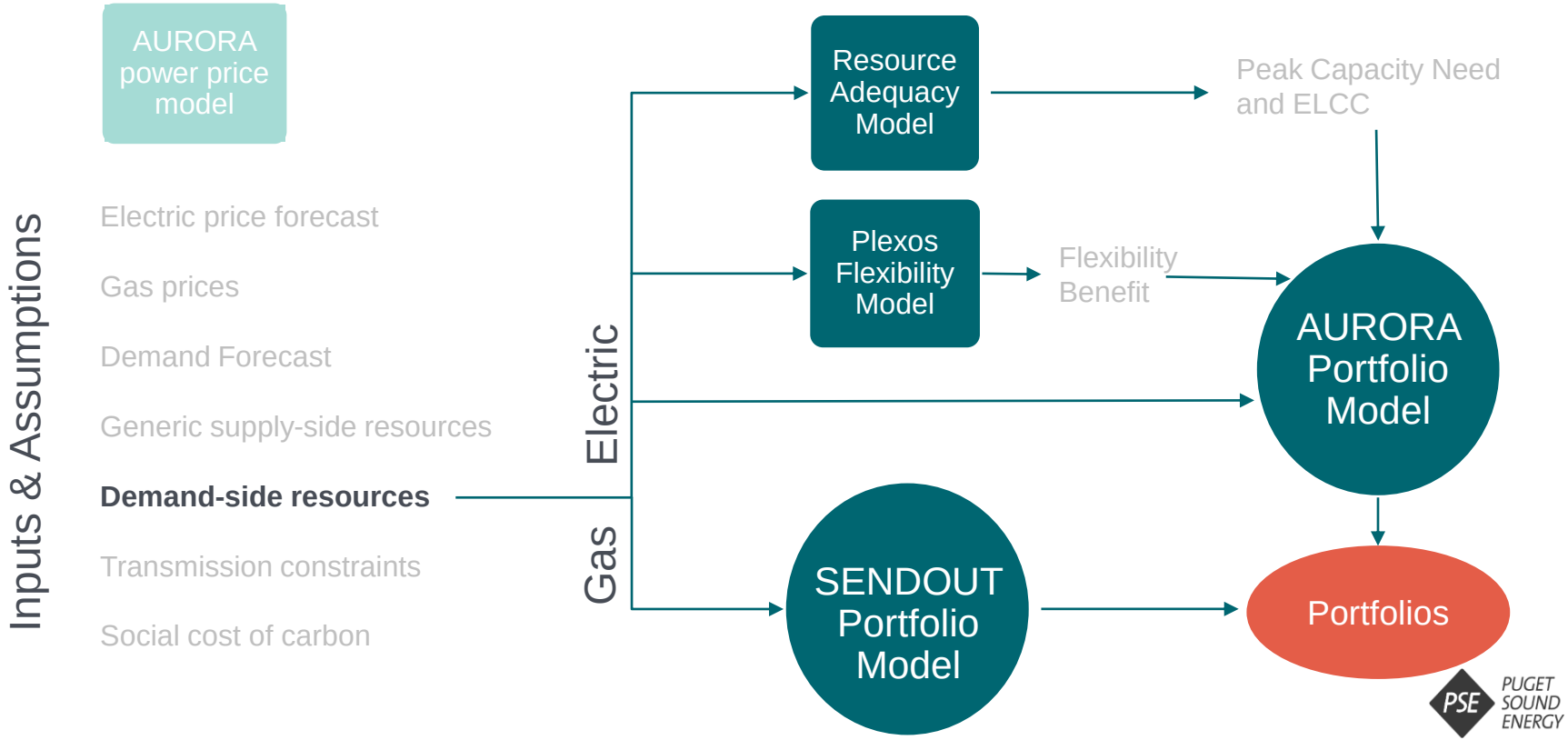
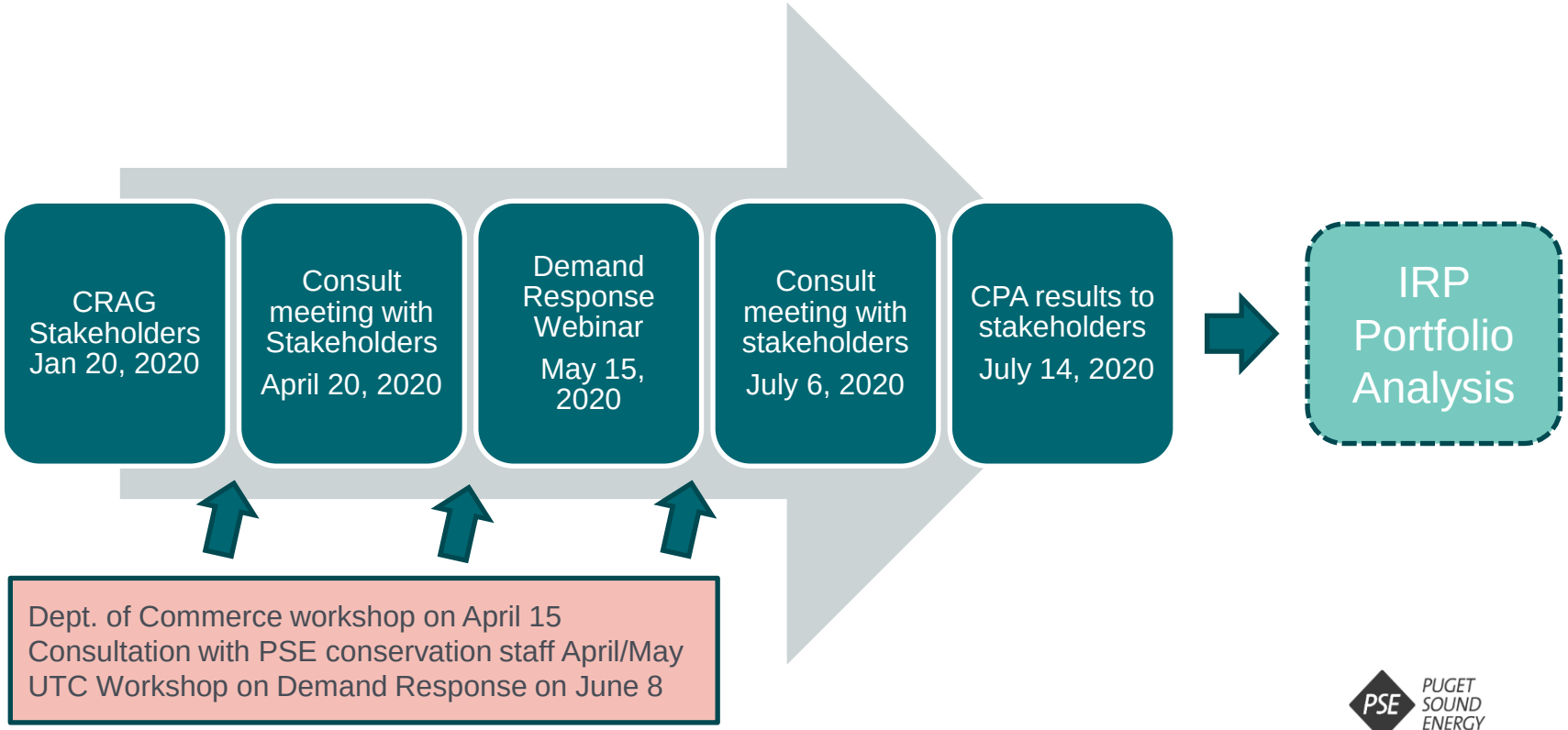
Electric and Gas IRP Models



Consultations along the way



Updates in 2021 CPA: T&D deferral benefit

- Updated T&D capital deferral benefit:

PSE deferral costs	$/kW-yr	$/kW-yr 2020$
Transmission	$ 5.22	$ 5.22
Distribution	$ 7.40	$ 7.40
T&D Deferral Costs	$ 12.61	**$ 12.61**

Power Council deferral costs 2021 Plan	$/kW-yr 2016$	$/kW-yr 2020$
Transmission	$ 3.08	$ 3.35
Distribution	$ 6.85	$ 7.45
T&D Deferral Costs	$ 9.93	**$ 10.79**

Power Council deferral costs 7th Plan	$/kW-yr 2012$	$/kW-yr 2020$
Transmission	$ 26.00	$ 29.55
Distribution	$ 31.00	$ 35.23
T&D Deferral Costs	$ 57.00	**$ 64.77**

- We will also be updating the gas distribution deferral benefit

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Consistency with Council's Methodology

Energy Independence Act Statute RCW 19.285.040

…using methodologies consistent with those used by the Pacific Northwest electric power and conservation planning council in the most recently published regional power plan…

…Nothing in the rule adopted under this subsection precludes a qualifying utility from using its utility specific conservation measures, values, and assumptions in identifying its achievable cost-effective conservation potential.

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CADMUS

DSR Potential Study Draft Results

Cadmus

Brief company overview

Our team has performed 40+ demand-side resource potential studies in the last ten years

Range of Clients	• Investor-owned utilities • Public power utilities • Public utility commissions • Federal and state agencies
Client Needs	• Integrated Resource Planning support • Program planning • Target setting and regulatory compliance
Demand-Side Management Resources	• Energy efficiency • Demand response • Customer-sited distributed energy resources • Electric utility infrastructure

Energy Efficiency

Methodology

Study Overview

Primary Objectives

- Produce updated forecasts of achievable technical potential
- Electric: 2022 - 2045
- Gas: 2022 - 2041
- Develop supply curve inputs
- Align savings and costs

Updated Data

- Load and customer forecasts
- Updated commercial square footage data
- PSE measure case and Regional Technical Forum unit-energy savings updates
- 2018 & 2019 PSE program accomplishments
- 2019 Legislation updates
- Council 2021 Plan updates

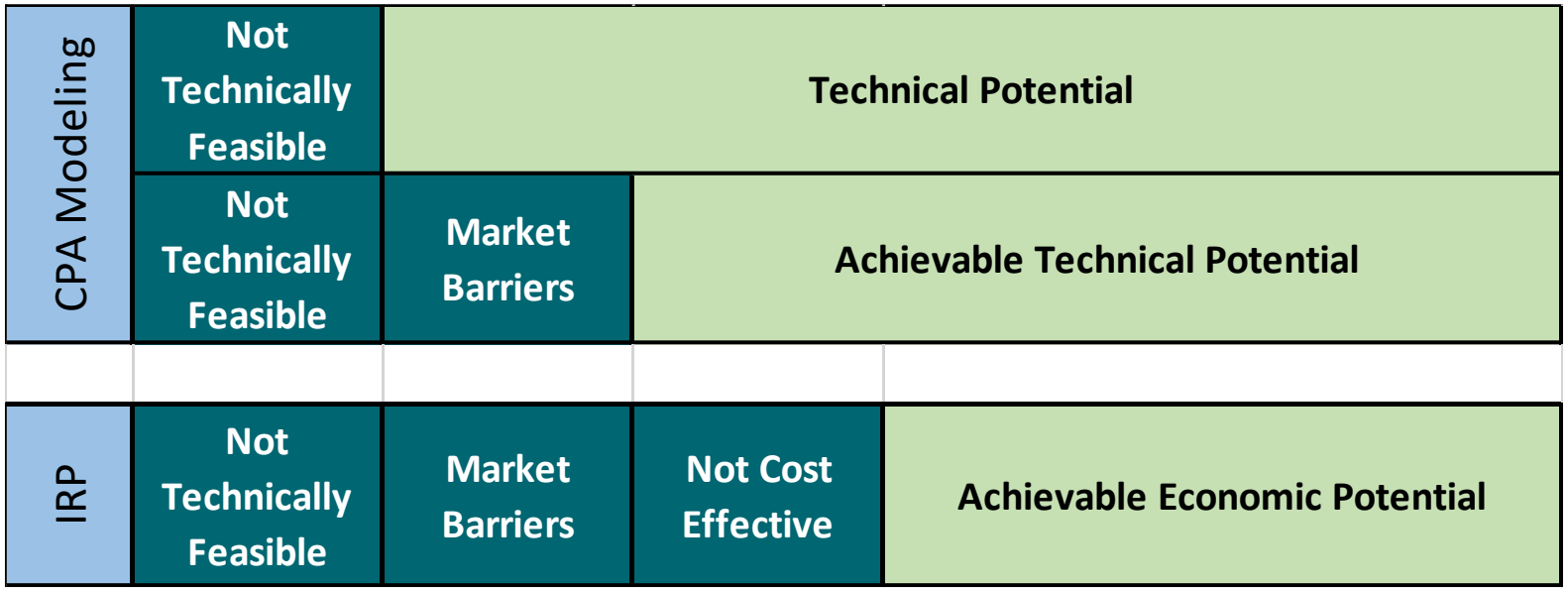
Scope of the Analysis

Five Sources	• Energy Efficiency • Demand Response • Distributed Solar Photovoltaics • Combined Heat and Power • Distribution Efficiency

Two Fuels	• Electric.
	  • Energy efficiency, Distributed Solar PV, Demand Response, Combined Heat and Power, and Distribution Efficiency
	• Natural Gas
	  • Energy Efficiency

Potential Types	• **Technical Potential**: All technically feasible potential • **Achievable Potential**: The subset of technical potential that homes and business will realistically adopt • **Economic Potential**: The cost-effective portion of achievable potential selected by PSE's Integrated Resource Plan
Comprehensive	• Over 300 unique electric and natural gas energy efficiency measures considered. Thousands of permutations • Five Combined Heat and Power technologies and up to six capacity bins for each technology • Sixteen demand response products

Types of Energy Efficiency Potential



Methodology

Steps for estimating conservation potential

1. Compile Measure Data
2. Develop Units Forecast
3. Calculate Levelized Costs
4. Calculate Technical Potential
5. Calculate Achievable Technical Potential
6. Develop Supply Curves for IRP Modeling

Step 1. Compile Measure Data

Steps for estimating conservation potential

1

Determine unique measures: Includes measures from the following:
- PSE Measure Cases
- Regional Technical Forum unit energy savings
- Council Plans
- Cadmus supplemental measures

2

Compile measure data and determine PSE-specific inputs:

- Costs
- Applicability
- Per-unit savings
- Measure lives
- Saturations; number of units

Step 2. Develop Units Forecasts

Steps for estimating conservation potential

Data Sources

- PSE customer and load forecast
- PSE Residential Characteristics Study
- PSE Non-residential customer database
- PSE supplemental customer data files (e.g. indoor ag)
- Regional stock assessment data (Northwest Energy Efficiency Alliance's Commercial Building Stock Assessment and Residential Building Stock Assessment)
- Council's Power Plans
- U.S. Census Bureau American Community Survey

Step 3. Calculate Levelized Costs

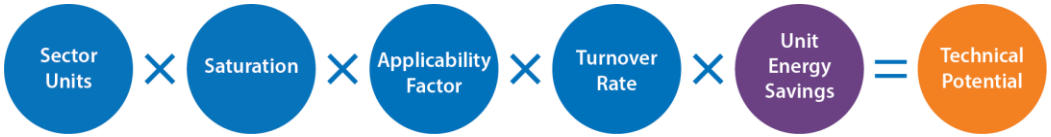
Steps for estimating conservation potential

- Compiled PSE financial assumptions
  - discount rates, line losses, etc.
- Levelized costs calculated using the costs and benefits below:

Costs Included	Benefits Netted Out
Capital and Labor	Deferred Transmission & Distribution Expansion
Annual Operations and Maintenance	Regional Act Credit
Program Administration	Avoided Periodic Replacement
Periodic Replacement	Other Fuel Benefits
Other Fuel Costs	Non-Energy Impacts
Non-Energy Impacts	

Step 4. Estimate Technical Potential

Steps for estimating conservation potential



Unit energy savings derived from:

- PSE measure cases,
- Regional Technical Forum unit-energy savings workbooks,
- Council Plan, and
- Cadmus supplemental measures (e.g. commercial cooling)

- For a number of measures, Cadmus will change inputs into some RTF and 7th / 2021 Plan measures with PSE-specific values
- For example, the number of bathrooms per home or occupants per household for measures including showerheads, clothes washers, etc.

Step 5. Estimate Achievable Technical Potential

Steps for estimating conservation potential

Maximum Achievability Factor	▪ Previous potential assessments: 85% ▪ 2021 update: vary by measure, Council 2021 Plan as a start
Ramp Rate Percent	▪ 10-year flat ramp for discretionary measures ▪ Adapted Council 2021 Plan ramp rates for lost opportunity measures

Step 6. Develop Supply Curves for IRP Modeling

Steps for estimating conservation potential

For each fuel type, the supply curve graph shows the relationship of:

- cumulative achievable technical potential, and
- levelized cost

Cost are levelized over the study time frame, accounting for “end effects”

Potential is then “bundled” or “binned” by levelized cost ranges

For the 2021 CPA update, we will create additional bins, particularly at higher levelized cost ranges

- This is because, when accounting for the Social Cost of Carbon, we expect the value of energy efficiency to increase

Finally, we disaggregate annual potential into hourly estimates (for electric) and monthly (for gas) using end-use load shapes

2019 Legislative Updates

Considerations in 2021 CPA

HB1444	• 16 new appliance and equipment standards • Includes first-in-nation water heat standard • Enables low cost deployment of demand response communications • All energy efficiency baselines reviewed and updated where necessary (e.g. showerheads) to meet HB1444 standards
HB1257	• State energy performance standard for commercial buildings • Compliance with energy use index energy use intensity (EUI) targets or develop and implement energy efficiency measures • Performance-based incentive program in 2021 and mandatory requirement beginning in 2026 • Will spur efficiency improvement adoptions • Reflected in more aggressive ramp rates for lost opportunity measures • Retrofit measures all ramped in the first 10 years

Electric Energy Efficiency Results

Electric Energy Efficiency Potential

Achievable Technical Potential

Sector	2023	2031	2041	2045
Cumulative Achievable Technical Potential (aMW)				
Residential	24	169	314	339
Commercial	24	153	228	250
Industrial	2	9	10	10
Total	**51**	**331**	**552**	**600**
Percent of Baseline Sales				
Residential	1.8%	11.2%	18.0%	18.5%
Commercial	2.4%	13.6%	18.0%	18.8%
Industrial	1.4%	7.5%	8.3%	8.4%
Total	**2.1%**	**12.3%**	**18.1%**	**18.3%**

Comparison to 2019 CPA

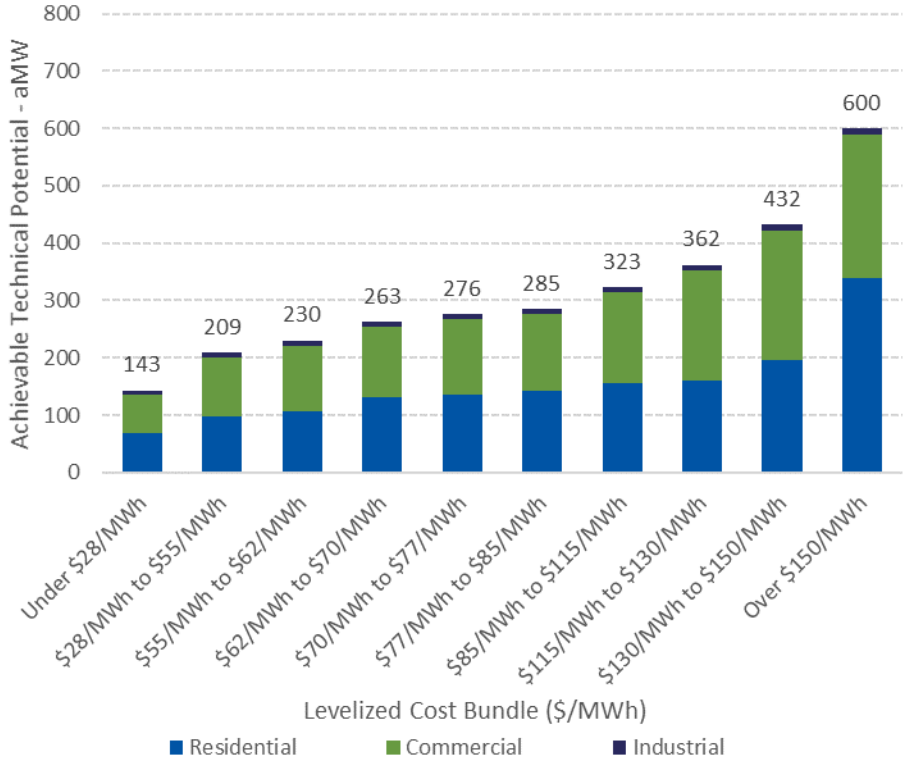
Electric Achievable Technical Potential

Electric	20-Year Achievable Technical Potential (Percent of Sales)			Total Achievable Technical Potential (aMW)
	Residential	Commercial	Industrial	
Energy Efficiency Potential				
2021 IRP	18%	18%	8%	552
2019 IRP	21%	16%	26%	692

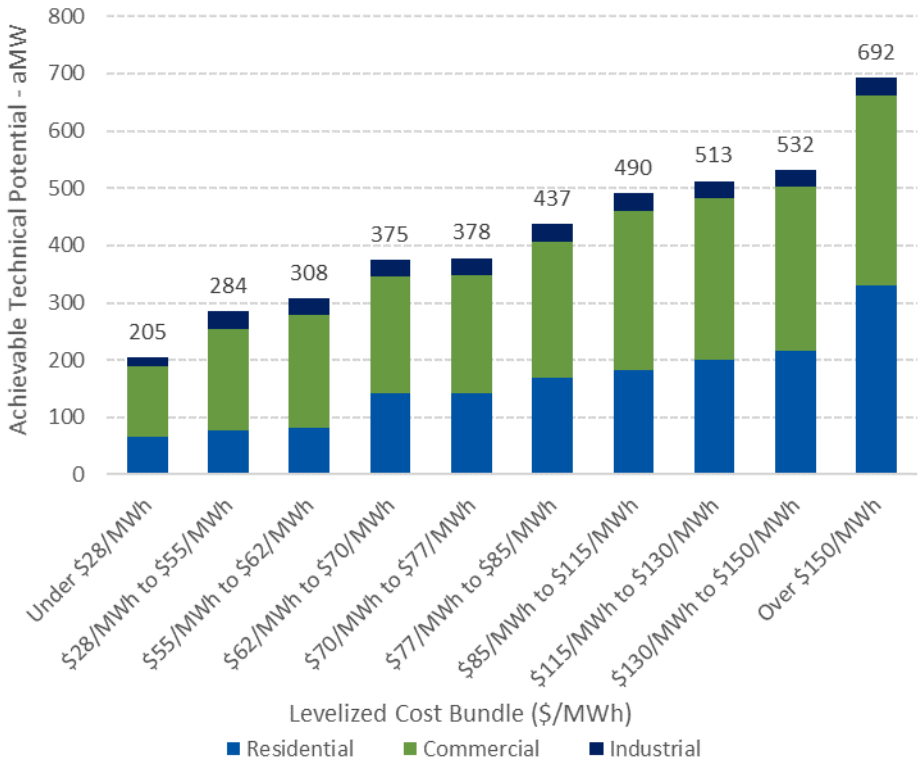
The 2021 IRP electric study period spans 24 years;
this table shows only the first 20 years for comparison purposes

Comparison to the 2019 CPA

2021 CPA Supply Curve



2019 CPA Supply Curve



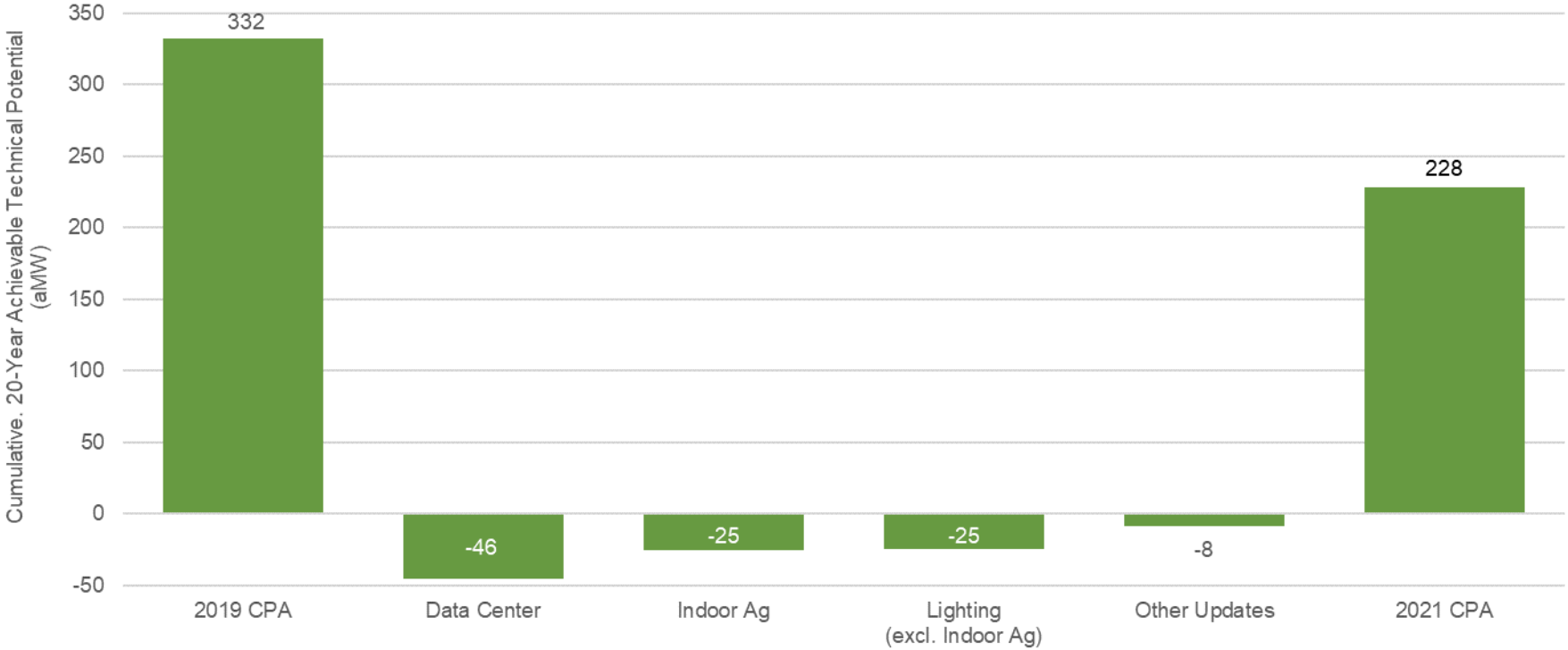
Comparison to the 2019 CPA

Electric Achievable Technical Potential

RESIDENTIAL	• Similar total potential • Estimated low income customer potential • Modeled new construction potential from whole home perspective • Slightly higher electric residential customer forecast
COMMERCIAL	• No enterprise data center potential • Lower interior lighting potential • Lower indoor agricultural potential • Lower electric commercial customer forecast
INDUSTRIAL	• Re-classification of some customer loads to commercial

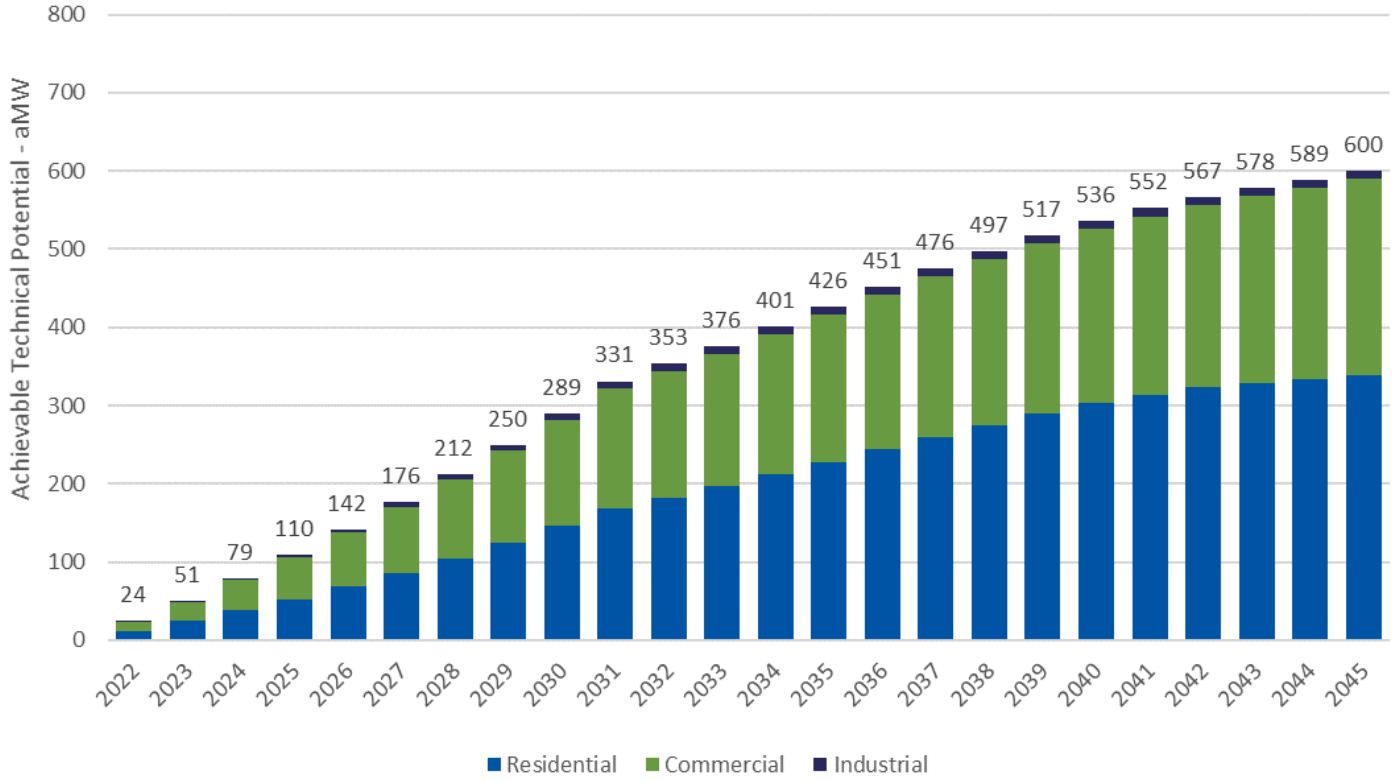
Commercial Electric Potential

Updates to 2021 CPA



Electric Energy Efficiency Forecast

Cumulative Achievable Technical Potential Forecast



- Discretionary measures receive a flat 10-year ramp rate
- Lost opportunity measures (new construction and natural replacement) receive 2021 Plan ramp rates
- Cadmus adjusted some ramp rates to match program activity and expectations

Top Residential Measures

Electric Energy Efficiency Potential

Measure Category	Weighted Average Levelized Cost ($/kWh)	Cumulative 10-Year Achievable Technical Potential	Cumulative 24-Year Achievable Technical Potential
Ductless Heat Pump	$0.270	16.3	58.0
Whole Home	-$0.044	5.2	57.7
Heat Pump Water Heater	$0.087	11.2	34.5
Window	$0.400	26.3	26.3
Clothes Dryer	$0.275	8.2	17.0
Home Energy Report	$0.003	16.6	16.6
Heat Pump	$0.152	4.9	17.7
Clothes Washer	-$0.064	5.9	14.2
Refrigerator	$0.147	5.1	12.7
Thermostat	$0.056	9.5	9.5
Solar Water Heater	$1.000	3.9	3.9
Ground Source Heat Pump	$0.100	0.7	8.1
Duct Sealing and Insulation	$0.077	5.4	5.4
Wall Insulation	$0.061	7.2	7.2
Duct Sealing	$0.063	4.9	4.9

- Levelized costs in this table are savings-weighted across individual measures and their applications (e.g. single family, low income, etc.).
- Some levelized costs may be negative due to non-energy impacts, periodic replacement benefits, the Council credit, and deferred transmission and distribution benefits.
- Retrofit measure savings are captured in the first 10 years and therefore have the same values in the 10- and 24-year columns.

Top Commercial Measures

Electric Energy Efficiency Potential

Measure Category	Weighted Average Levelized Cost ($/kWh)	Cumulative 10-Year Achievable Technical Potential	Cumulative 24-Year Achievable Technical Potential
LED Panel	$0.141	27.5	44.8
Variable Speed Efficient Motor	$0.066	11.6	40.4
Linear LED	$0.121	7.7	18.4
Variable Refrigerant Flow	$0.064	4.4	10.6
Wastewater	$0.059	9.6	9.6
High Bay LED Panel	$0.145	5.2	8.1
Circulator Pump (Bronze or Stainless Learning Run Hours)	-$0.147	7.1	7.1
Refrigeration Electrically-Commutated Motors	$0.050	6.7	6.7
Commercial Strategic Energy Management	$0.004	4.2	4.9
Pool Pump	$0.007	1.3	4.6
Parking Garage Lighting	-$0.014	4.5	4.5
LED Sign	$0.063	4.5	4.5
Residential-type Heat Pump Water Heater	$0.073	1.0	4.3
LED Other	-$0.135	4.2	4.2
Cooling DX 65 to 135 kBtuh Premium	$0.238	0.9	4.1

- Individual measure applications are grouped into categories in this table
- The top 15 measure categories account for about 71% of the total commercial electric achievable technical potential
- Retrofit measure savings are captured in the first 10 years and therefore have the same values in the 10- and 24-year columns.

Top Industrial Electric Measures

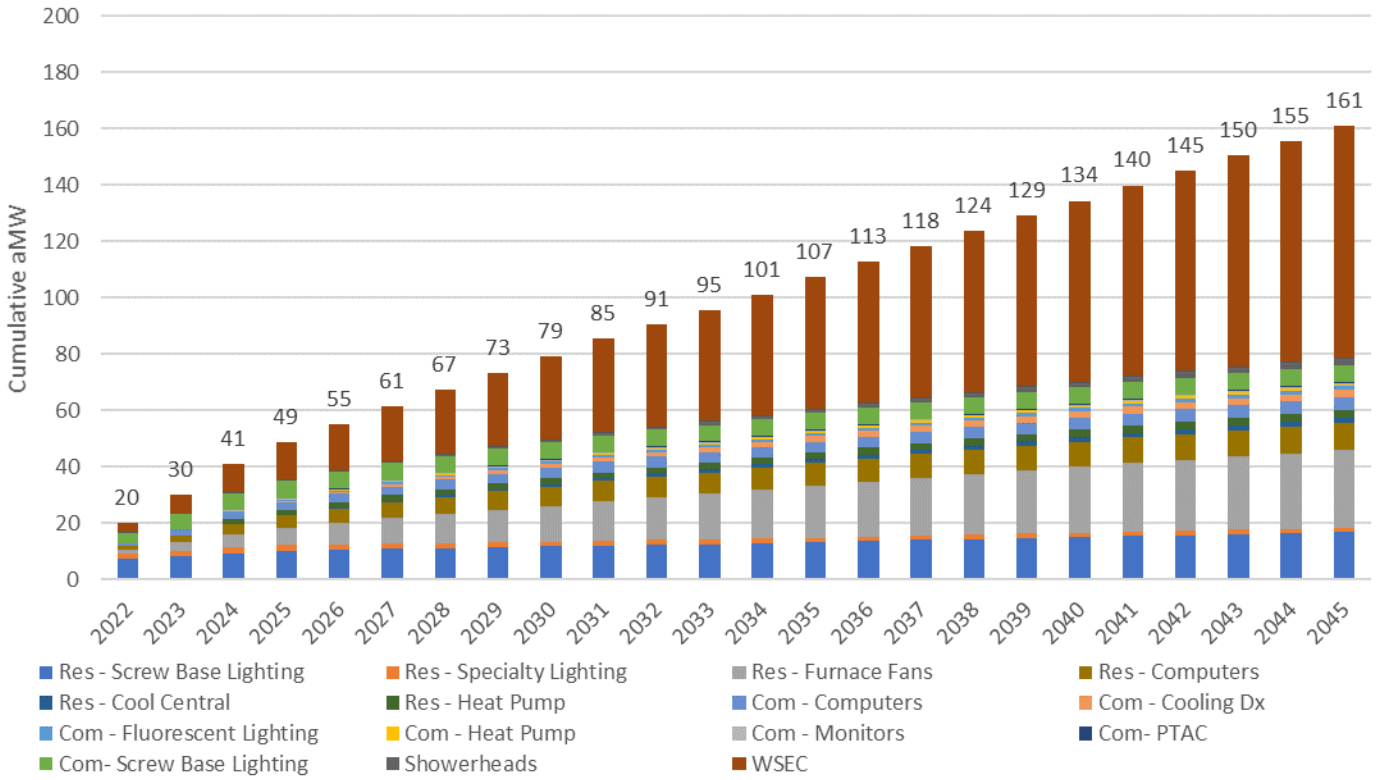
Electric Energy Efficiency Potential

Measure Category	Weighted Average Levelized Cost ($/kWh)	Cumulative 10-Year Achievable Technical Potential	Cumulative 24-Year Achievable Technical Potential
Plant Energy Management	$0.034	1.1	1.1
LED Streetlight - MH 400W – NR	-$0.022	0.7	0.9
Energy Project Management	$0.055	0.7	0.7
Fan System Optimization	$0.016	0.6	0.6
Integrated Plant Energy Management	-$0.004	0.6	0.6
Fan Equipment Upgrade	$0.049	0.6	0.6
Pump System Optimization	-$0.032	0.5	0.5
Pump Equipment Upgrade	$0.057	0.5	0.5
LED Streetlight - HPS 250W – NR	-$0.048	0.3	0.4
LED Streetlight - HPS 100W – NR	-$0.109	0.3	0.4
Wood: Replace Pneumatic Conveyor	-$0.079	0.3	0.3
Clean Room: Change Filter Strategy	-$0.002	0.3	0.3
Material Handling Variable Frequency Drive	$0.056	0.3	0.3
LED Streetlight - MH 200W - NR	-$0.077	0.2	0.2

- Individual measure applications are grouped into categories in this table
- The 15 measure categories account for about 75% of the total industrial electric achievable technical potential
- Retrofit measure savings are captured in the first 10 years and therefore have the same values in the 10- and 24-year columns.

Electric Codes and Standards Savings

Electric Energy Efficiency Potential



- Estimated the impact of the Washington State Energy Code (WSEC) and federal and state equipment standards
- WSEC accounts for 51% of codes and standards savings (82 aMW by 2045)

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Demand Response Potential

Demand Response Products

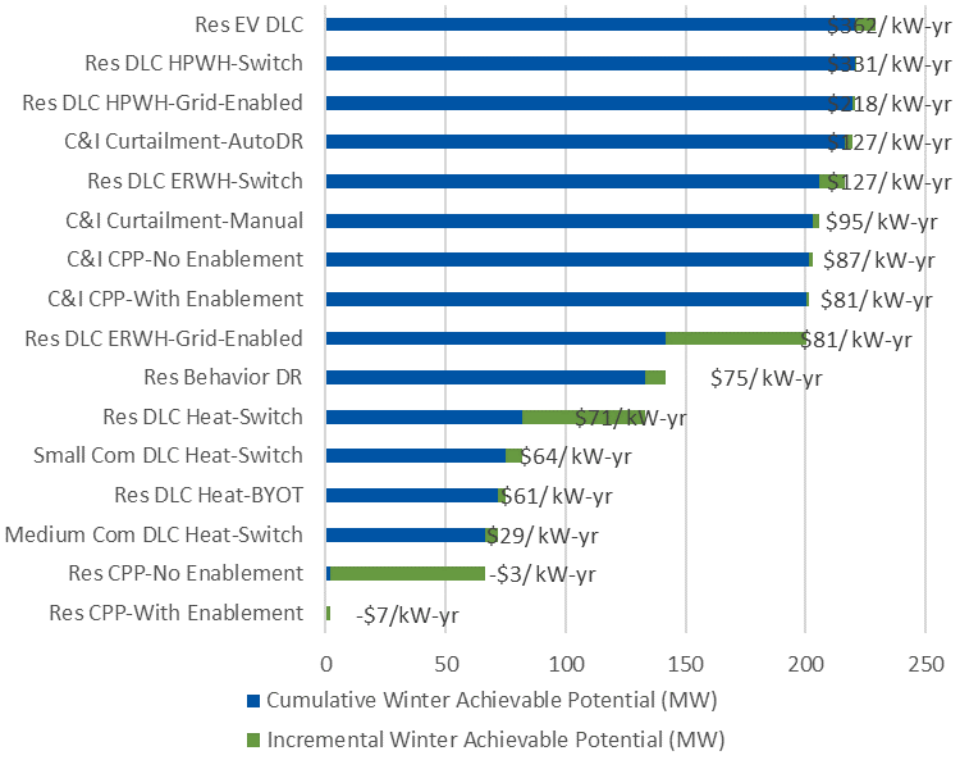
Direct Load Control (DLC)	• **Space Heat**. (smart thermostat or switch) • **Water Heat**. (switch or grid-enabled water heater) • **Electric Vehicle Supply Equipment**. Residential at-home charging
Critical Peak Pricing (CPP)	• Customers are sent a utility price signal prior to a peak event • With or without a smart thermostat
Commercial and Industrial Curtailment	• **Manual**: customers manually reduce energy usage during peak events • **Automated**: technology and controls are programmed to reduce usage during peak events
Behavioral Demand Response	• Similar to home energy reports offered by efficiency programs • Participants receive prior notification, usually day-ahead, via text or email notifying them of a peak event

Demand Response Product Matrix

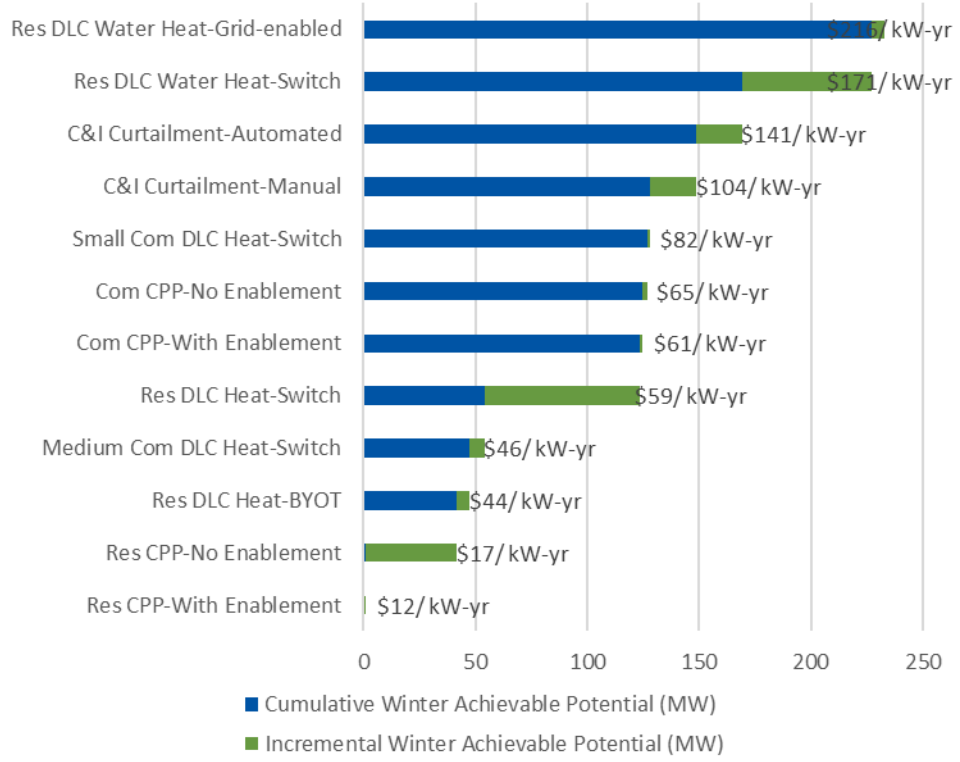
Demand Response Product	Demand Response Product Group	Number of Events and Hours Curtailed	Notification Type (e.g. day-ahead, hour-ahead, etc.)
Res CPP-No Enablement	Residential Critical Peak Pricing	Up to ten 4-hour events	Day-ahead (non-dispatchable)
Res CPP-With Enablement	Residential Critical Peak Pricing	Up to ten 4-hour events	Day-ahead
Res DLC Heat-Switch	Residential DLC Space Heat	Up to ten 4-hour events	0-min
Res DLC Heat-Thermostat (BYOT)	Residential DLC Space Heat	Up to ten 4-hour events	0-min
Res DLC ERWH-Switch	Residential DLC Water Heat	Up to ten 4-hour events	0-min
Res DLC ERWH-Grid-Enabled	Residential DLC Water Heat	Unlimited	0-min
Res DLC HPWH-Switch	Residential DLC Water Heat	Up to ten 4-hour events	0-min
Res DLC HPWH-Grid-Enabled	Residential DLC Water Heat	Unlimited	0-min
Small Com DLC Heat-Switch	Commercial DLC Space Heat	Up to ten 4-hour events	0-min
Medium Com DLC Heat-Switch	Commercial DLC Space Heat	Up to ten 4-hour events	0-min
C&I Curtailment-Manual	Commercial and Industrial Curtailment	Up to ten 4-hour events	Day-ahead (or as late as 2-hour-ahead)
C&I Curtailment-AutoDR	Commercial and Industrial Curtailment	Up to ten 4-hour events	0-min
C&I CPP-No Enablement	Commercial Critical Peak Pricing	Up to ten 4-hour events	Day-ahead (non-dispatchable)
C&I CPP-With Enablement	Commercial Critical Peak Pricing	Up to ten 4-hour events	Day-ahead
Res Electric Vehicle DLC	Residential Electric Vehicles	Up to ten 4-hour events	Day-ahead
Res Behavior DR	Residential Behavioral	Up to ten 4-hour events	Day-ahead (non-dispatchable)

Comparison to the 2019 CPA

2021 CPA Supply Curve



2019 CPA Supply Curve



Comparison to the 2019 CPA

Demand Response Achievable Technical Potential

RESIDENTIAL	• Added behavioral demand response • Added residential Electric Vehicle Service Equipment DLC • Applied grid-enabled and switch water heat DLC to both electric resistance and heat pump water heaters • Lowered space heating DLC per unit kW impacts • Neither study considers smart appliance DLC due to uncertainties regarding customer acceptance
COMMERCIAL AND INDUSTRIAL	• No new products • Adjusted C&I curtailment program participation rate

Demand Response Considerations

Three highest-saving DR products

Residential Water Heat DLC (71 MW)	• Estimated potential across four electric water heater combinations • (1) electric resistance, (2) grid-enabled electric resistance, (3) heat pump, and (4) grid-enabled heat pump • Methodology similar to Council's for 2021 Plan • Standard units turn over to grid-enabled as measure lives expire
Residential Critical Peak Pricing (66 MW)	• With or without a smart thermostat • Participation limited to 15% of customers with electric service • Impacts vary by customer segment
Residential Space Heat DLC (54 MW)	• Participation limited to eligible customers with electric space heat • Peak load impacts vary by control option: BYOT or switch

Demand Response Considerations

Interactions with Energy Efficiency

Assume energy efficiency takes place first

Adjusted Forecast	• Uses sales forecast net of technical achievable conservation as starting point for top-down products • Uses technical achievable end use saturations (e.g. smart thermostat penetration rates) for bottom-up products

Distributed Solar PV Potential

Distributed Solar PV Methodology

Achievable Potential

We estimate market penetration as function of customer payback.

Customer payback is a key input to a Bass diffusion model function.

For each scenario, we calculate annualized simple payback (ASP) for each year of the study

ASP for an average system in a given year is used to calculate the market penetration of solar for that year

Market penetration (MP) in a given year is taken as the fraction of technical potential that can be considered achievable potential

$$ASP = \frac{Net\ Costs\ (after\ incentives)}{Annual\ Energy\ Savings + Production\ Based\ Incentives}$$

$$MP = e^{(-sensitivity\ to\ payback\ *ASP)}$$

Achievable Potential Assumptions

Two Scenarios

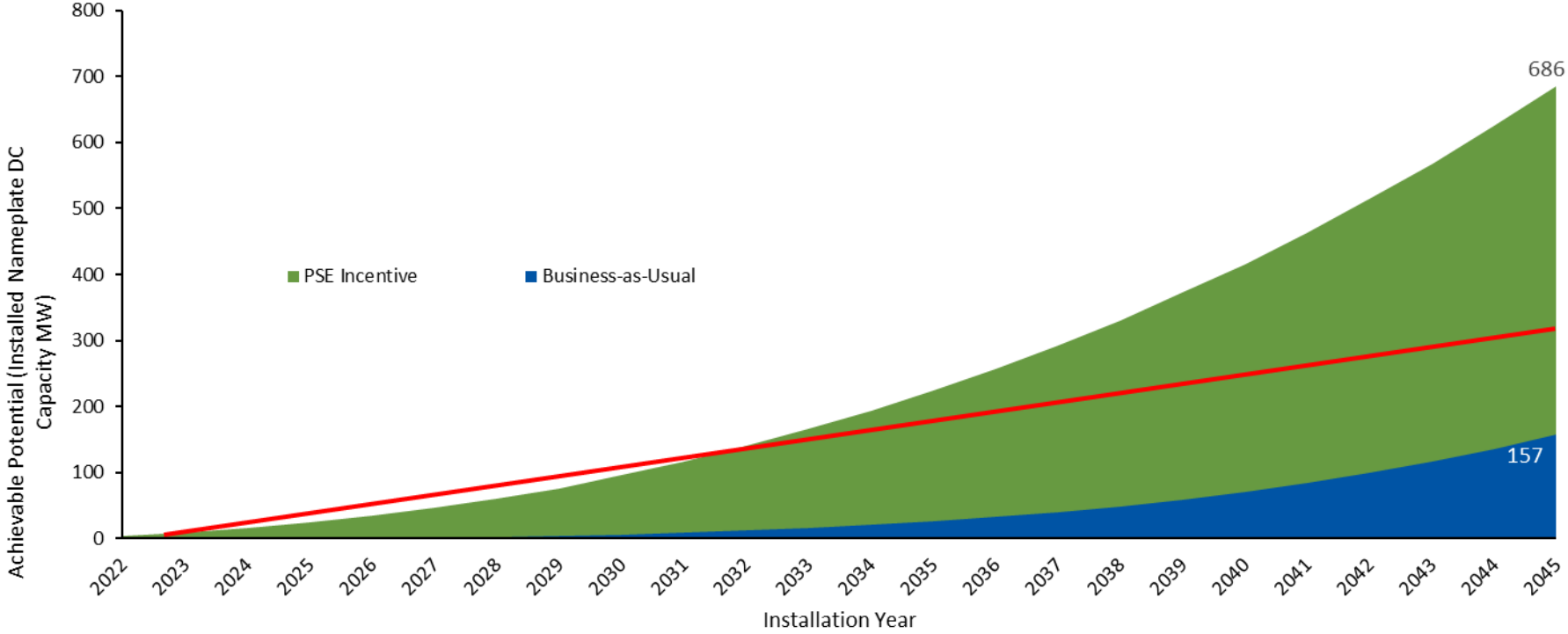
Business as Usual

- Continuation of federal Investment Tax Credit in its current form:
  - 0% in 2022 for residential
  - 10% for commercial
- Washington State Renewable Energy System Incentive Program (RESIP) applications ended December 2019
- Net metering
- 5-year Modified Accelerated Cost Recovery System (MACRS) depreciation for commercial

Utility Incentive

- Business as usual, plus
- Utility incentive equal to $0.048/kWh
- Calculated from the 2019 Integrated Resource Plan as a levelized value of the 2022-2045 electric avoided costs
- Factoring in a 5% assumption for admin costs

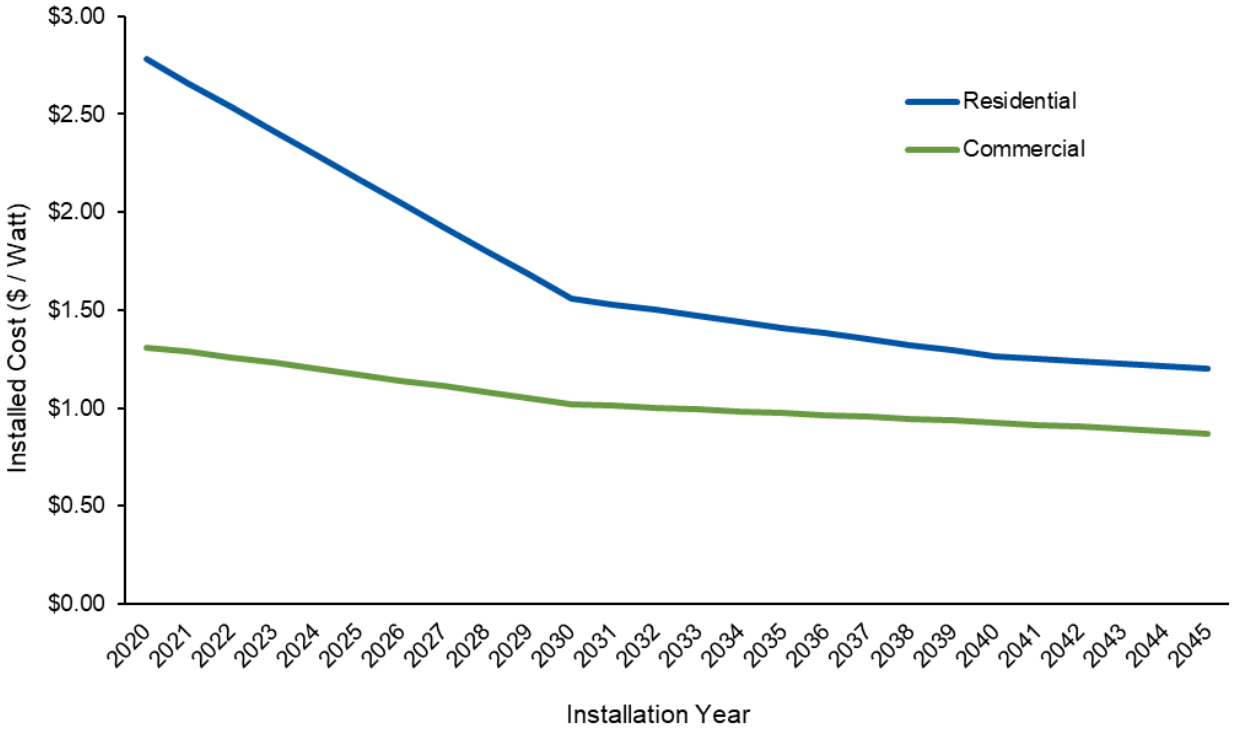
Distributed Solar PV Achievable Potential



Red line represents PSE program team trend line projection ~ 300MW
The inherent disconnect is that there are no incentives currently available in business as usual

Distributed Solar PV Cost Forecast

Residential and Commercial Installed Cost



Reviewed actual and forecasted costs from Lazard, Wood Mackenzie, EnergySage and National Renewable Energy Laboratory

Residential costs varied between:

- Lazard ($2.88/watt)
- Wood Mackenzie ($2.84/w)
- EnergySage ($2.78/w).

➢ Used EnergySage costs and applied NREL cost forecasts.

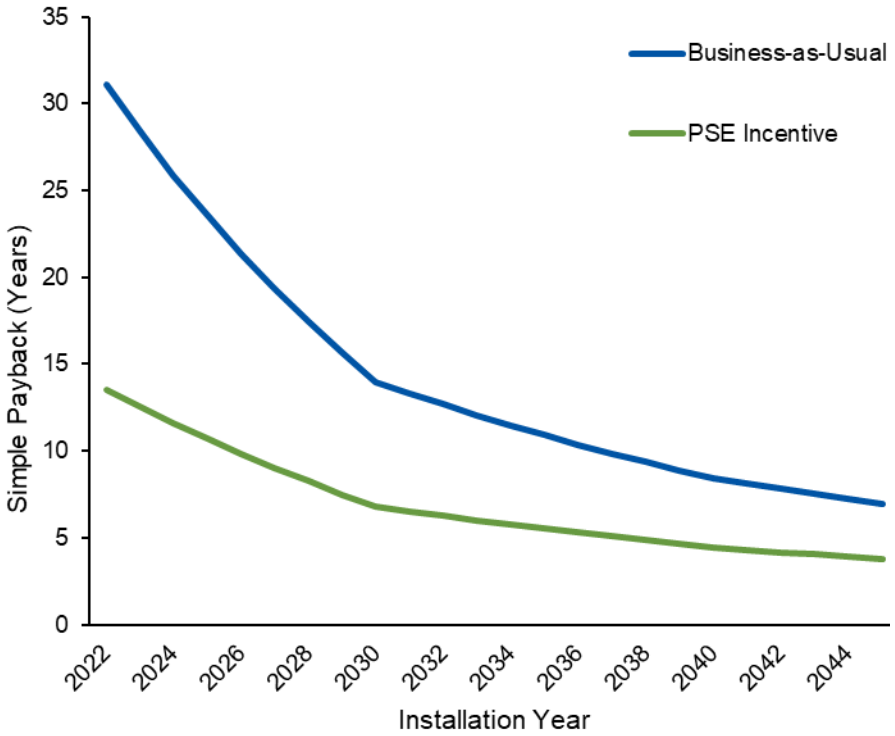
Commercial costs varied between:

- Lazard ($2.35/w)
- Wood Mackenzie ($1.39/w)

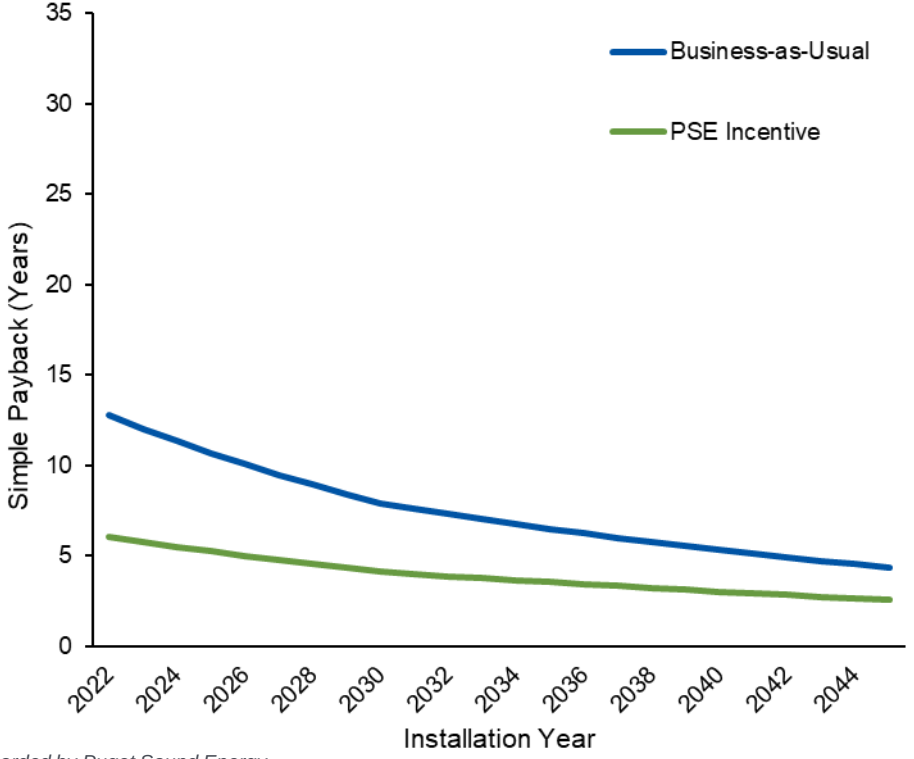
➢ Used Wood Mac costs and cost forecasts from NREL.

Distributed Solar PV Payback

Residential Payback Periods



Commercial Payback Periods



Combined Heat and Power Potential

Methodology

Combined Heat and Power

Technical Potential

- Non-renewable technologies:
  - Reciprocating engines
  - Microturbines
  - Gas turbines
- Renewable technologies:
  - Industrial biomass
  - Biogas
- Applicability
  - PSE electric customers with any gas service
  - C&I facilities with average monthly demand >= 30kW
  - Assume warehouses with high load are refrigerated – CHP ineligible

Achievable Potential

- ACEEE Study & CHP Install Database
- CHP Favorable States
  - CA: 0.66% per year
  - CT: 0.25% per year
  - MA: 0.27% per year
- Washington (non-favorable):
  - 0.13% per year
- Our Assumption
  - PSE Territory: 0.20% per year
- Higher than calculated value (0.13%) from ACEEE and CHP Install Database due to utility incentives

Achievable Potential Results

Combined Heat and Power

2045 Cumulative Achievable Potential (aMW) at Generator

Technology	2045
Nonrenewable - Natural Gas (Total)	
30–99 kW	1.04
100–199 kW	0.83
200–499 kW	1.10
500–999 kW	0.76
1–4.9 MW	1.41
5.0 MW+	0.96
Renewable - Biomass (Total)	
< 500 kW	0.00
500-999 kW	0.00
1–4.9 MW	0.01
5.0 MW+	0.35
Renewable - Biogas (Total)	
Landfill	0.21
Farm	0.85
Paper Mfg	0.03
Wastewater	0.26
Total CHP	**7.82**

2045 Cumulative System Installations

Technology	2045
Nonrenewable - Natural Gas (Total)	**45**
Reciprocating Engine	25
Gas Turbine	18
Microturbine	2
Renewables	**2**
Total CHP	**47**

Natural Gas Energy Efficiency Potential Results

Natural Gas Energy Efficiency Potential

Achievable Technical Potential

Sector	2023	2031	2041
Cumulative Achievable Potential (MMTherms)			
Residential	15.5	91.5	147.1
Commercial	3.0	18.2	25.0
Industrial	0.3	1.7	1.7
Total	**18.9**	**111.4**	**173.8**
Percent of Baseline Sales			
Residential	2.4%	13.3%	19.4%
Commercial	1.0%	5.4%	6.9%
Industrial	1.4%	7.0%	7.6%
Total	**2.0%**	**10.8%**	**15.5%**

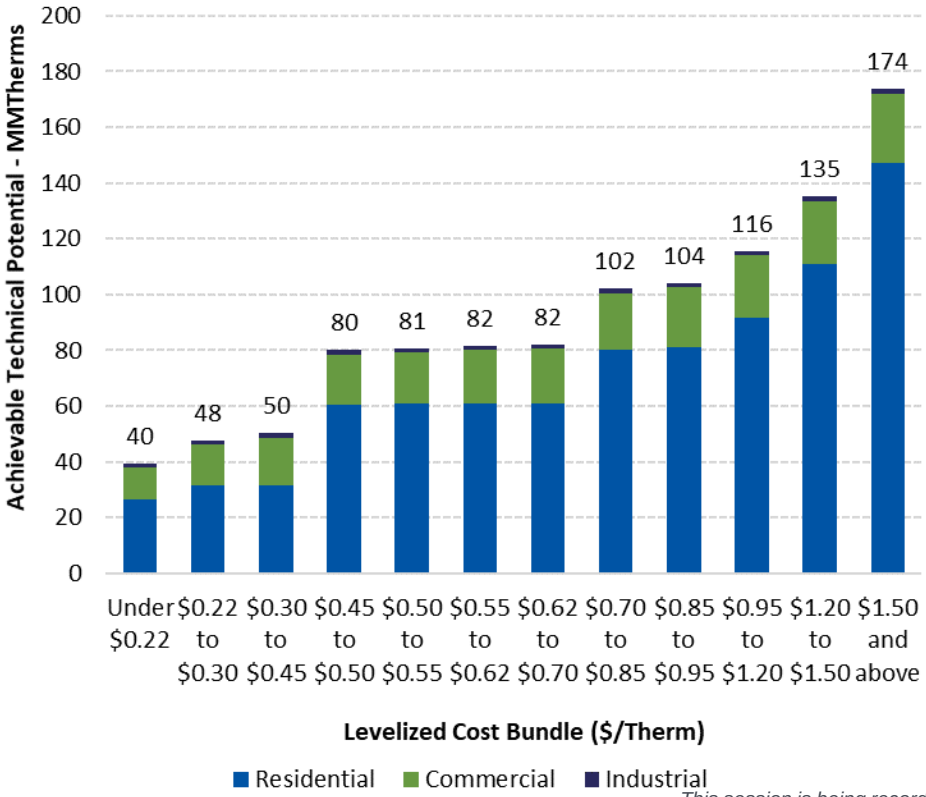
Comparison to 2019 CPA

Natural Gas Achievable Technical Potential

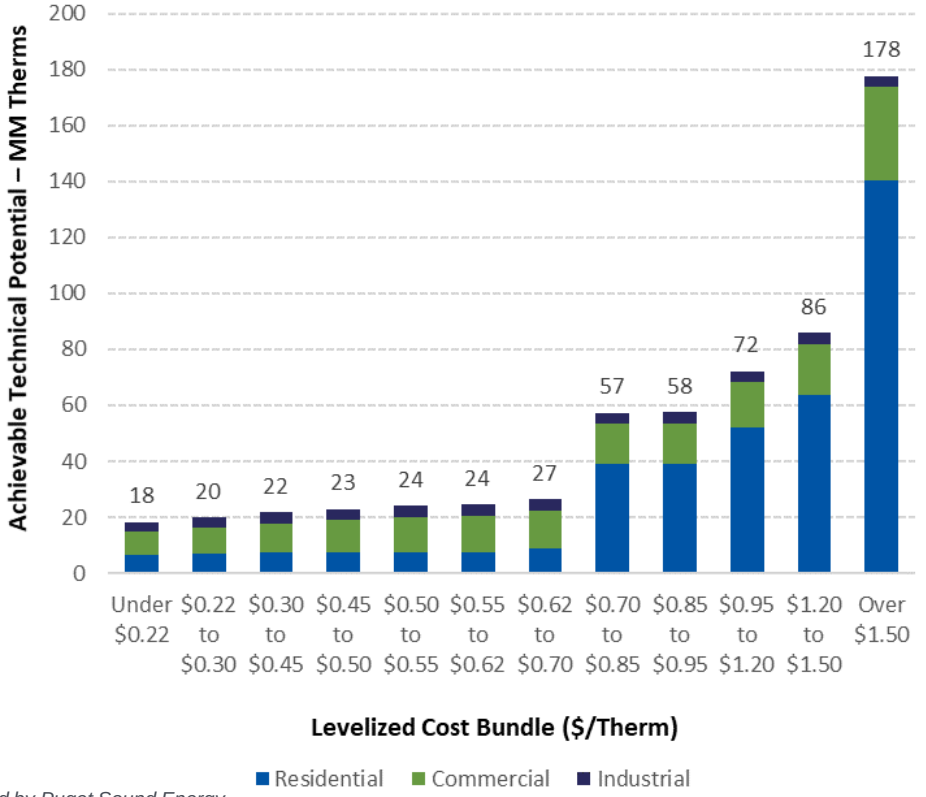
	20-Year Achievable Technical Potential (% of Sales)			Total Achievable Technical Potential (MMTherms)
	Residential	Commercial	Industrial	
Energy Efficiency Potential				
2021 IRP	19%	7%	8%	174
2019 IRP	20%	8%	17%	178

Comparison to the 2019 CPA

2021 CPA Supply Curve



2019 CPA Supply Curve



Top Residential Gas Measures

Natural Gas Energy Efficiency Potential

Measure Name	Weighted Average Levelized Cost ($/Therm)	Cumulative 10-Year Achievable Technical Potential (MM Therms)	Cumulative 20-Year Achievable Technical Potential (MM Therms)
Furnace	$0.822	12.8	32.1
Whole Home	$0.354	3.3	25.7
Water Heater	$1.612	5.1	16.3
Thermostat	$0.823	11.2	11.2
Window	$19.353	10.5	10.5
Wall Insulation	$1.491	7.3	7.3
Duct Sealing and Insulation	$1.358	7.1	7.1
Duct Sealing	$1.219	5.4	5.4
Home Energy Report	$0.226	5.2	5.2
Thermostatic Restrictor Valve	-$2.087	3.1	3.1
Whole House Sealing	$4.615	3.0	3.0
Floor Insulation	$3.332	2.6	2.6
Showerhead	-$0.797	2.4	2.4
Aerators	-$2.791	2.3	2.3
Solar Water Heater	$22.668	2.3	2.3

- Individual measure applications are grouped into categories in this table
- The top 15 measure categories account for about 93% of the total residential achievable technical potential
- Retrofit measure savings are captured in the first 10 years and therefore have the same values in the 10- and 20-year columns.

Top Commercial Gas Measures

Natural Gas Energy Efficiency Potential

Measure Name	Weighted Average Levelized Cost ($Therm)	Cumulative 10-Year Achievable Technical Potential (MM Therm)	Cumulative 20-Year Achievable Technical Potential (MM Therm)
Gas Rooftop Unit Supply Fan Variable Frequency Drive and Controller	$0.457	3.0	3.0
Furnace (< 225 kBtuh High AFUE 92%)	$0.231	1.0	1.8
Furnace (< 225 kBtuh Premium AFUE 94%)	$0.356	0.8	1.9
Ozone Laundry	$0.260	1.5	1.5
Pool Heat Recovery	$0.107	1.0	1.0
Direct Digital Controls Energy Management	-$11.032	1.5	1.7
Commissioning Retro	$7.239	1.5	1.5
Boiler (300 to 2500 kBtuh AFUE 95%)	$1.048	0.4	1.1
Clothes Washer	-$16.976	0.5	0.9
Boiler (300 to 2500 kBtuh AFUE 85%)	$0.480	0.3	0.8
Demand Controlled Ventilation Kitchen	$0.881	0.6	0.6
Oven Double Rack	$0.202	0.2	0.6
Gas Water Heater 94% Efficient	$0.663	0.2	0.5
Boiler 300 to 2500 kBtuh AFUE 79%	$0.950	0.2	0.6
Convection Oven	$0.044	0.2	0.5

- Individual measure applications are grouped into categories in this table
- The top 15 measure categories account for about 72% of the total commercial gas achievable technical potential
- Retrofit measure savings are captured in the first 10 years and therefore have the same values in the 10- and 20-year columns.

Top Industrial Measures

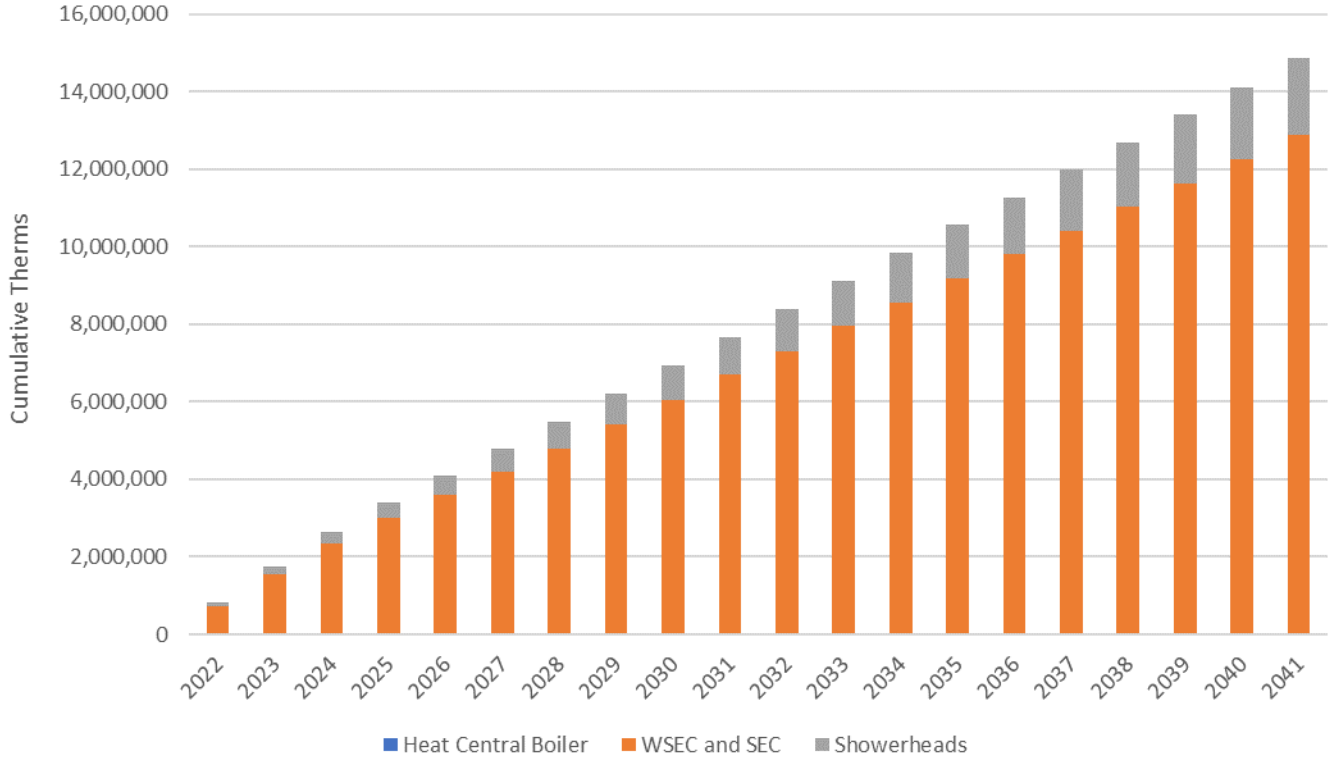
Industrial Natural Gas Energy Efficiency

Measure Name	Weighted Average Levelized Cost ($/Therm)	Cumulative 10-Year Achievable Technical Potential (Therm)	Cumulative 20-Year Achievable Technical Potential (Therm)
Equipment Upgrade - Replace Existing HVAC Unit With High Efficiency Model	$0.017	196,537	196,537
Process Improvements To Reduce Energy Requirements	$0.014	174,386	174,386
Improve Combustion Control Capability And Air Flow	-$0.027	138,408	138,408
HVAC Equipment Scheduling Improvements - HVAC Controls, Timers Or Thermostats	$0.070	114,484	114,484
Install Or Repair Insulation On Condensate Lines And Optimize Condensate	-$0.017	110,464	110,464
Optimize Ventilation System	$0.343	93,553	93,553
Waste Heat From Hot Flue Gases To Preheat	$0.015	86,669	86,669
Heat Recovery And Waste Heat For Process	$0.018	75,334	75,334
Equipment Upgrade - Boiler Replacement	$0.081	71,916	71,916
Optimize Heating System To Improve Burner Efficiency	-$0.054	71,900	71,900
Building Envelope Infiltration Improvements	-$0.015	64,671	64,671
Building Envelope Insulation and Window/Door Improvements	$0.289	62,980	62,980
Thermal Systems Reduce Infiltration; Isolate Hot Or Cold Equipment	$0.018	59,471	59,471
Replace Steam Traps	-$0.016	58,755	58,755
Repair And Eliminate Steam Leaks	-$0.007	53,159	53,159

- Individual measure applications are grouped into categories in this table
- The top 15 measure categories account for about 72% of the total industrial gas achievable technical potential
- Retrofit measure savings are captured in the first 10 years and therefore have the same values in the 10- and 20-year columns.

Natural Gas Codes and Standards Savings

Natural Gas Energy Efficiency Potential



- Estimated the impact of the Washington State Energy Code (WSEC), the Seattle Energy Code (SEC) and federal and state equipment standards
- WSEC accounts for 87% of codes and standards savings (13 MM therms by 2041)
- The overall impact of the boiler standard is relatively small

Distribution Efficiency

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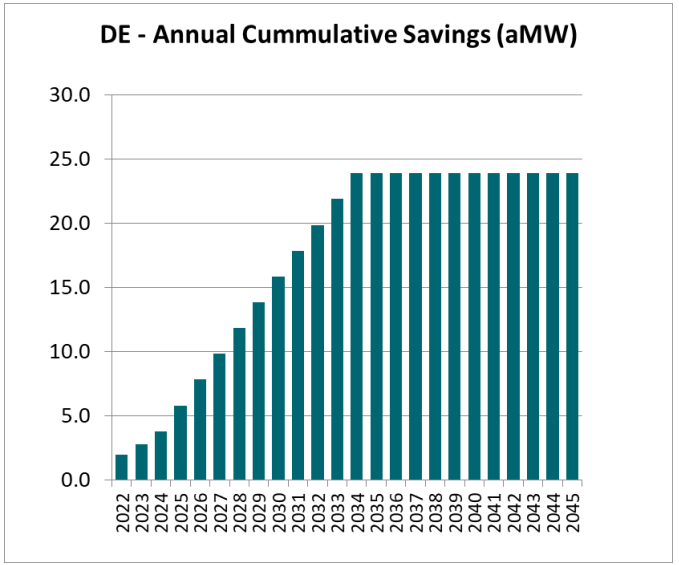
Distribution Efficiency Potential

- Alignment with Automated Metering Infrastructure (AMI) and Advanced Distribution Management Systems (ADMS) business cases
- Schedule feasibility and infrastructure requirements when implementing Volt-VAR Optimization (VVO)

By the numbers:

- 153 Substations total
- 17 complete by end of 2020
- Remaining 136 – 2019 IRP study period
- 2022 onwards incorporate controls to maintain stability in system
    - Shift from Line Drop Compensation (LDC) to Volt-VAR Optimization (VVO)



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CPA input to the IRP analysis

- End use load shapes applied to measure level and measures and sectors are aggregated into levelized price points on the conservation supply curve:
  - Energy efficiency (programmatic and codes & standards), combined heat and power, and distribution efficiency are hourly inputs
  - Conservation bundles are 20 year vector (24 year electric), available in year one of study
- Distributed solar pV – hourly input, market bundle, no cost in IRP
- Similarly, gas conservation supply curve is input on a monthly basis by sector.
- The benefit of SCGHG to DSR is applied in the portfolio models

Additional Data:

- The CPA will also create disaggregated gas and electric bundles by zip code to inform Delivery System Planning

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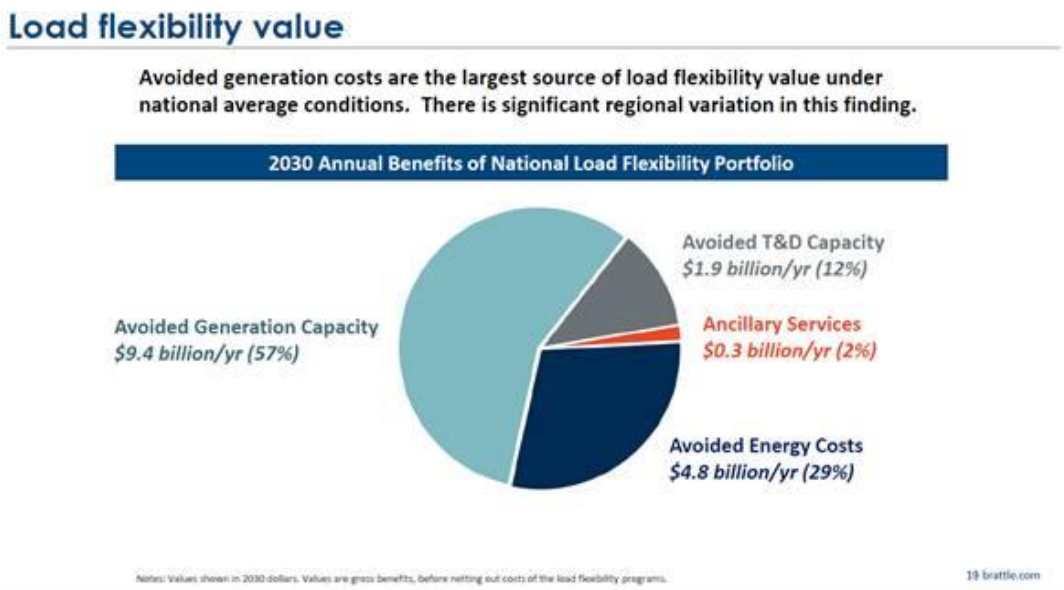
Demand Response in the 2021 IRP



Demand response is a capacity resource:

- Each program group's ELCC is determined in resource adequacy model: nameplate capacity is converted to peak contribution values ➔ decrement to capacity in the portfolio model
- Demand response programs are also input thru the flexibility model to obtain their flexibility benefits value ➔ added to the value of DR in the portfolio model
- Portfolio model can optimize by program capacity and timing of the program start year

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Stakeholder Feedback on DSR Sensitivities

- The purpose of the sensitivity is to test different resources in PSE's portfolio.
- We have done sensitivities in the past IRPs:
  - Alternate discount rate
  - Extended DSR

We are asking for **stakeholder input on** what **DSR sensitivities** to consider for the 2021 IRP. We already have a couple to start.

Proposed sensitivities:

1. Distributed Solar pV – with PSE incentive
2. Distributed Solar pV – with PSE ownership.
3. **More??**

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Questions & Answers

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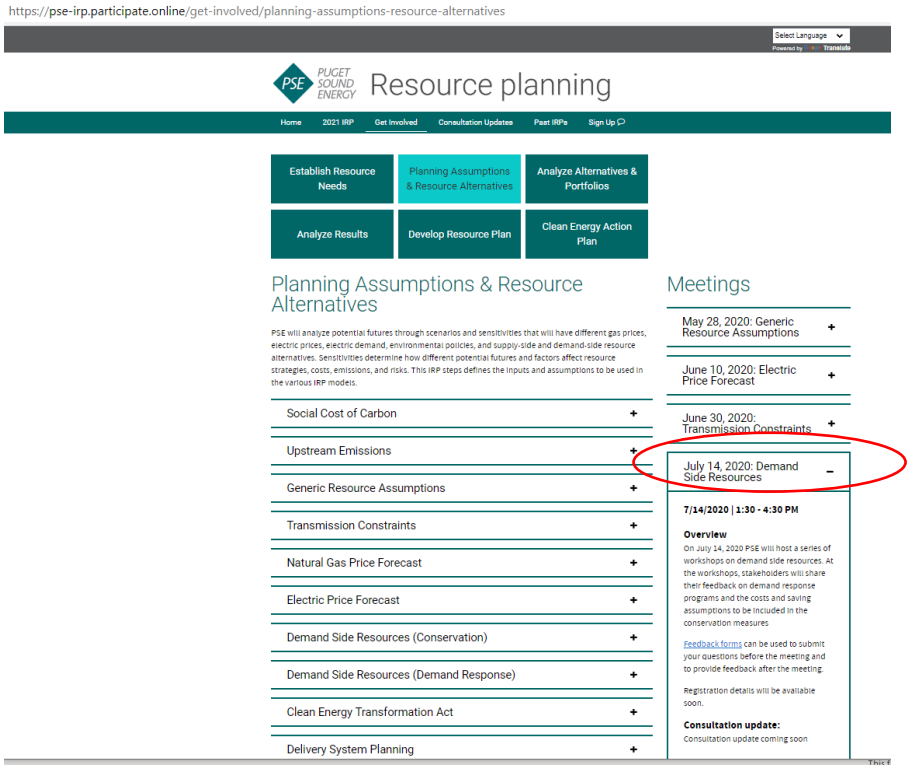
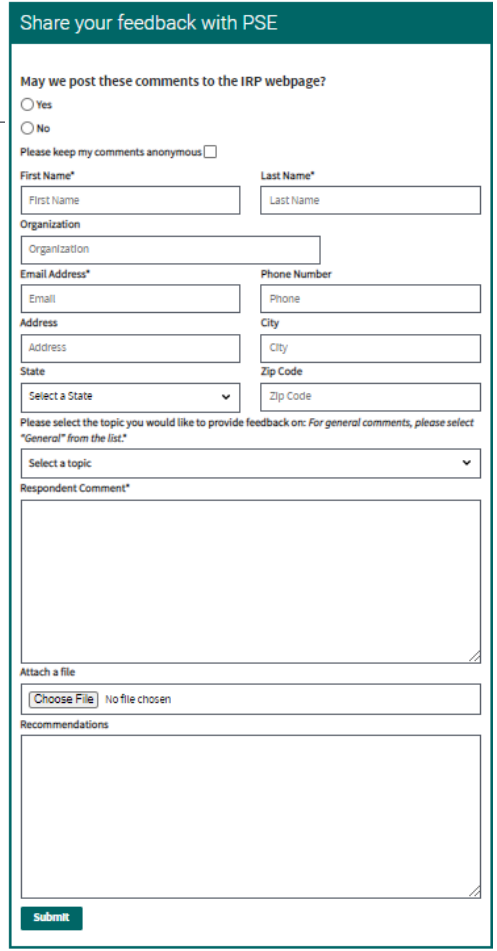
Feedback Form





Feedback Form

- An important way to share your input
- Available on the website 24/7
- Comments, questions and data can be submitted throughout the year, but timely feedback supports the technical process
- Please submit your Feedback Form within a week of the meeting topic

Feedback Form → **Feedback Report** → **Consultation Update**

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Next steps

- Submit Feedback Form to PSE by **July 21, 2020**
- A recording and the chat from today's webinar will be posted to the website **tomorrow**
- PSE will compile all the feedback in the Feedback Report and post all the questions by **July 28, 2020**
- The Consultation Update will be shared on **August 4**

PUGET SOUND ENERGY

Details of upcoming meetings can be found at pse.com/irp

Date	Topic
July 21, 1:30 – 4:30 pm	Social Cost of Carbon
August 11, 8:30 am – 12:30 pm	Portfolio sensitivities development (electric & gas) CETA assumptions Distributed energy resources
September 1, 1:00 – 5:00 pm	Demand forecast (electric & gas) Resource adequacy Resource need: peak capacity, energy & renewable energy need
October 20, 1:30 – 4:30 pm	Portfolio sensitivities draft results Flexibility analysis
November 4, 1:00 – 4:30 pm	Clean Energy Action Plan 10-year Distribution & Transmission Plan
December 9, 1:00 – 4:30 pm	Portfolio draft results Stochastic analysis Wholesale market risk

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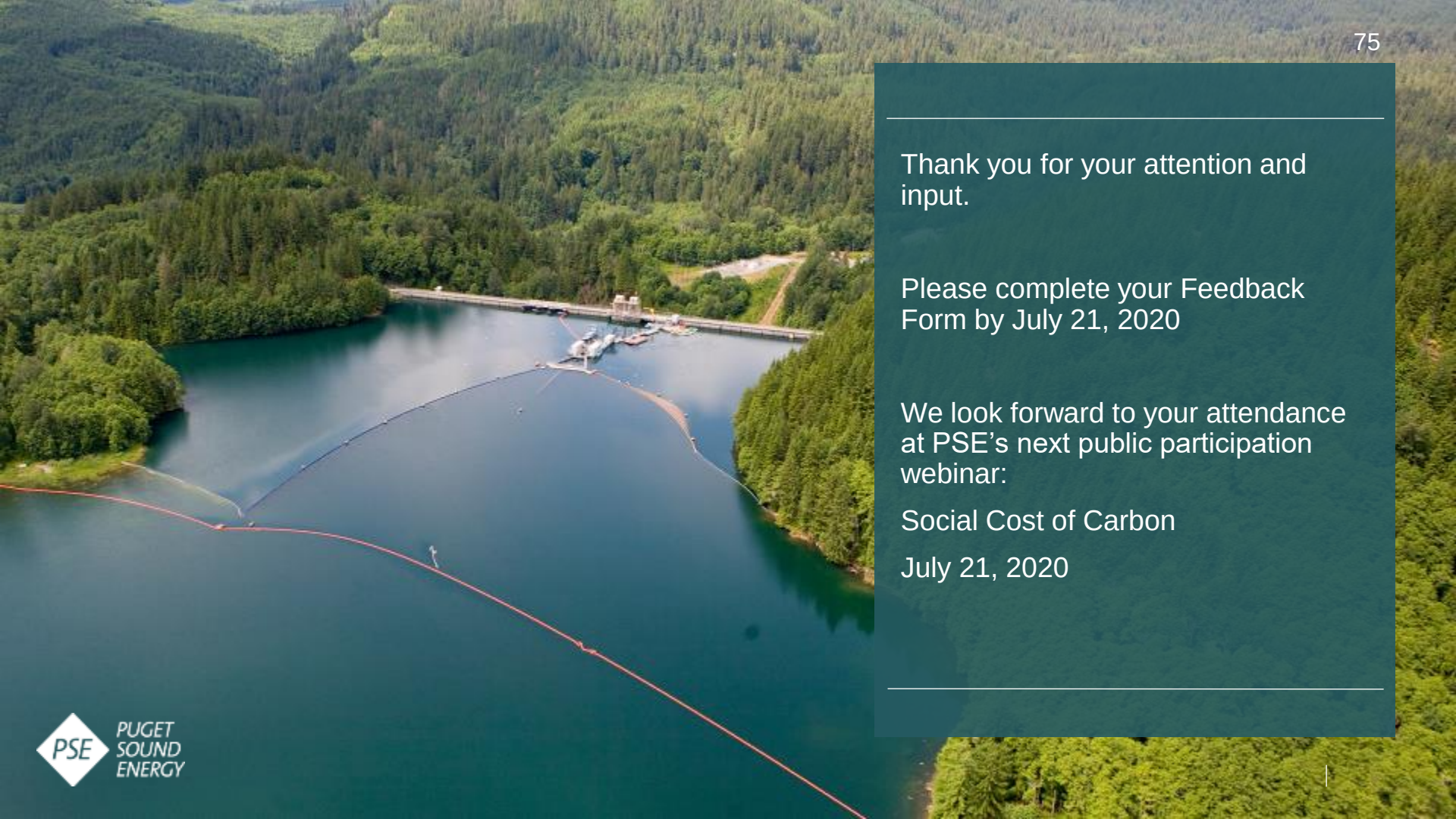


Thank you for your attention and input.

Please complete your Feedback Form by July 21, 2020

We look forward to your attendance at PSE's next public participation webinar:

Social Cost of Carbon

July 21, 2020

PSE PUGET SOUND ENERGY

Appendix

PSE PUGET SOUND ENERGY

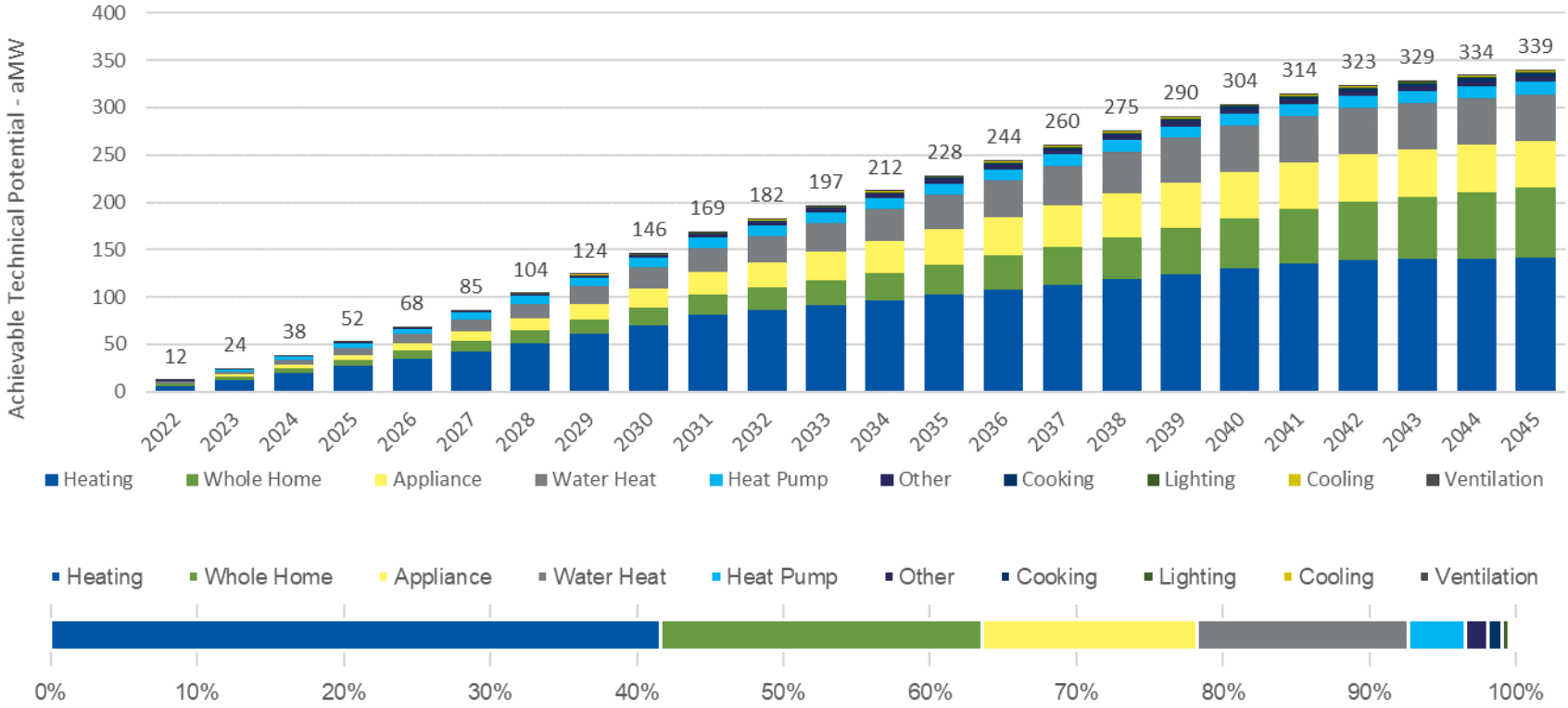
Residential Electric Potential Summary

Residential Supply Curve

- Cumulative, 24-Year Achievable Technical Potential is 339 aMW
- Residential accounts for 57% of the total, 24-year achievable technical potential
- About 21% of residential electric potential costs less than $28/MWh, levelized
- About 59% (199 aMW) costs less than $1500/MWh, levelized

Residential Electric Potential Summary

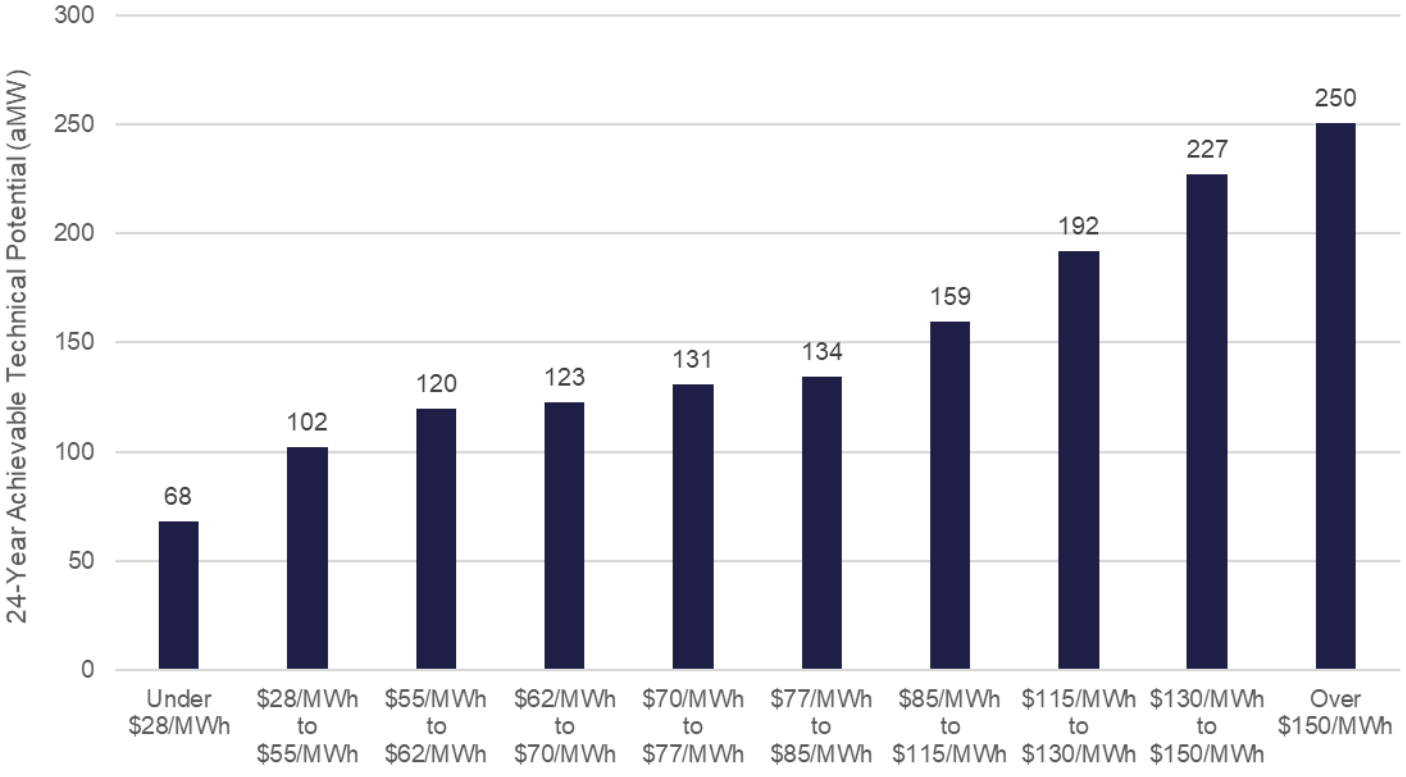
Savings by End Use



CADMUS

Commercial Electric Potential Summary

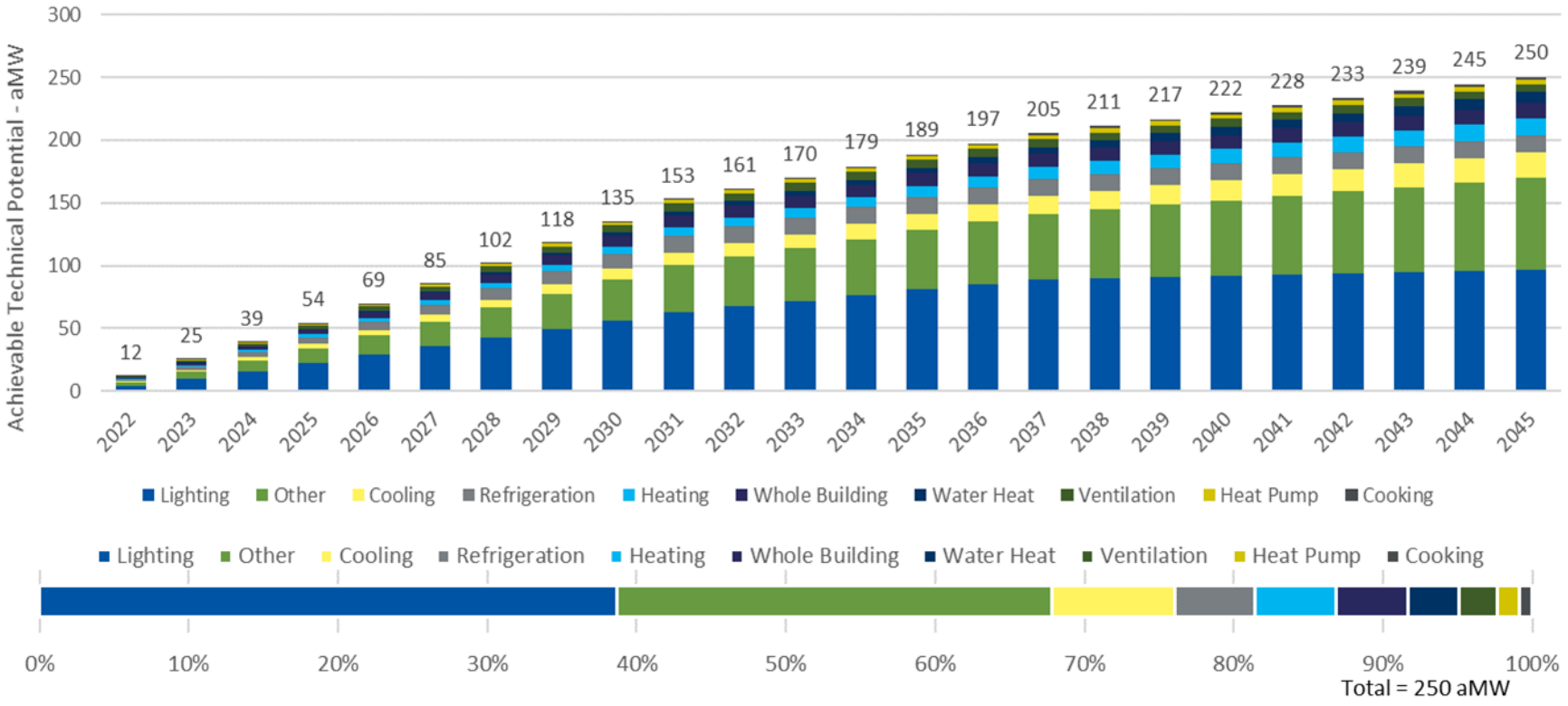
Commercial Electric Supply Curve



- Cumulative, 24-Year Achievable Technical Potential is 250 aMW
- Commercial accounts for 42% of the total, 24-year achievable technical potential
- About 27% of commercial electric potential costs less than $28/MWh, levelized
- About 91% (199 aMW) costs less than $150/MWh, levelized

Commercial Electric Potential Summary

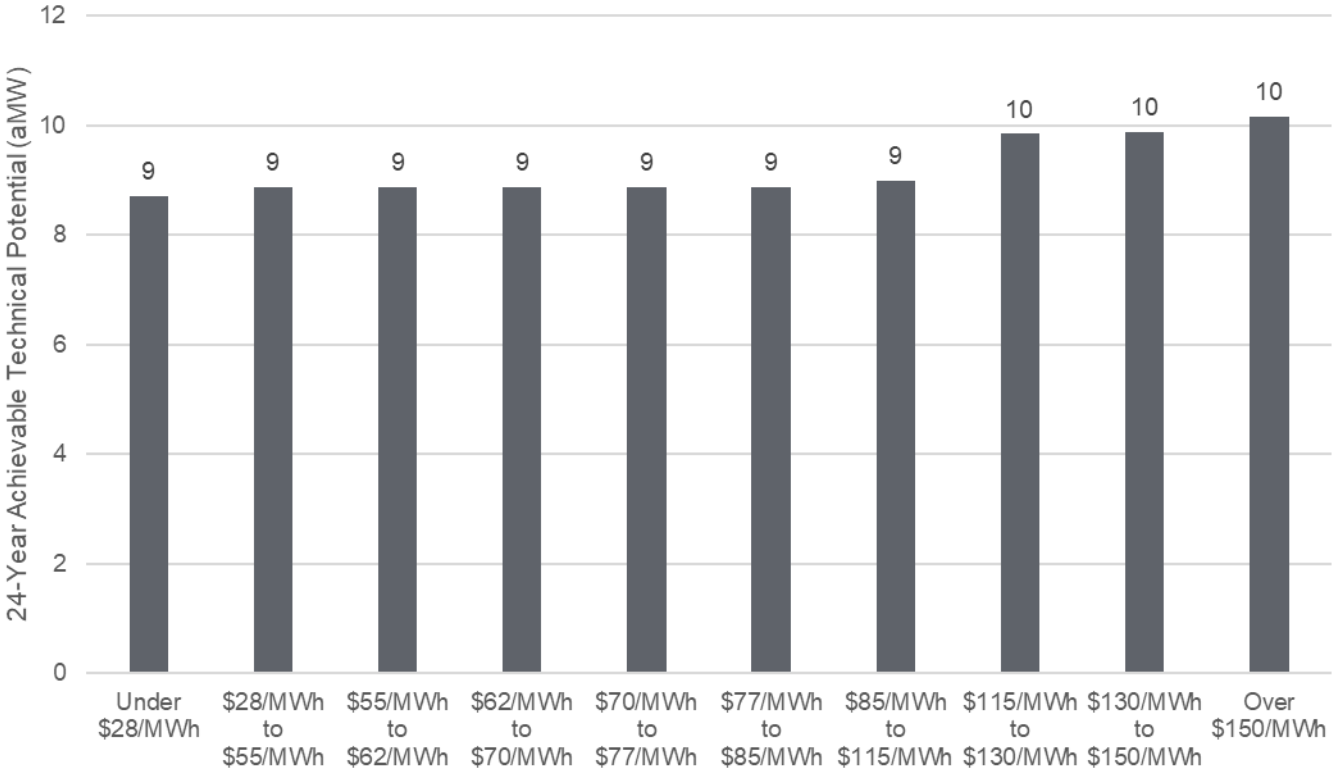
Savings by End Use



CADMUS

Industrial Electric Potential Summary

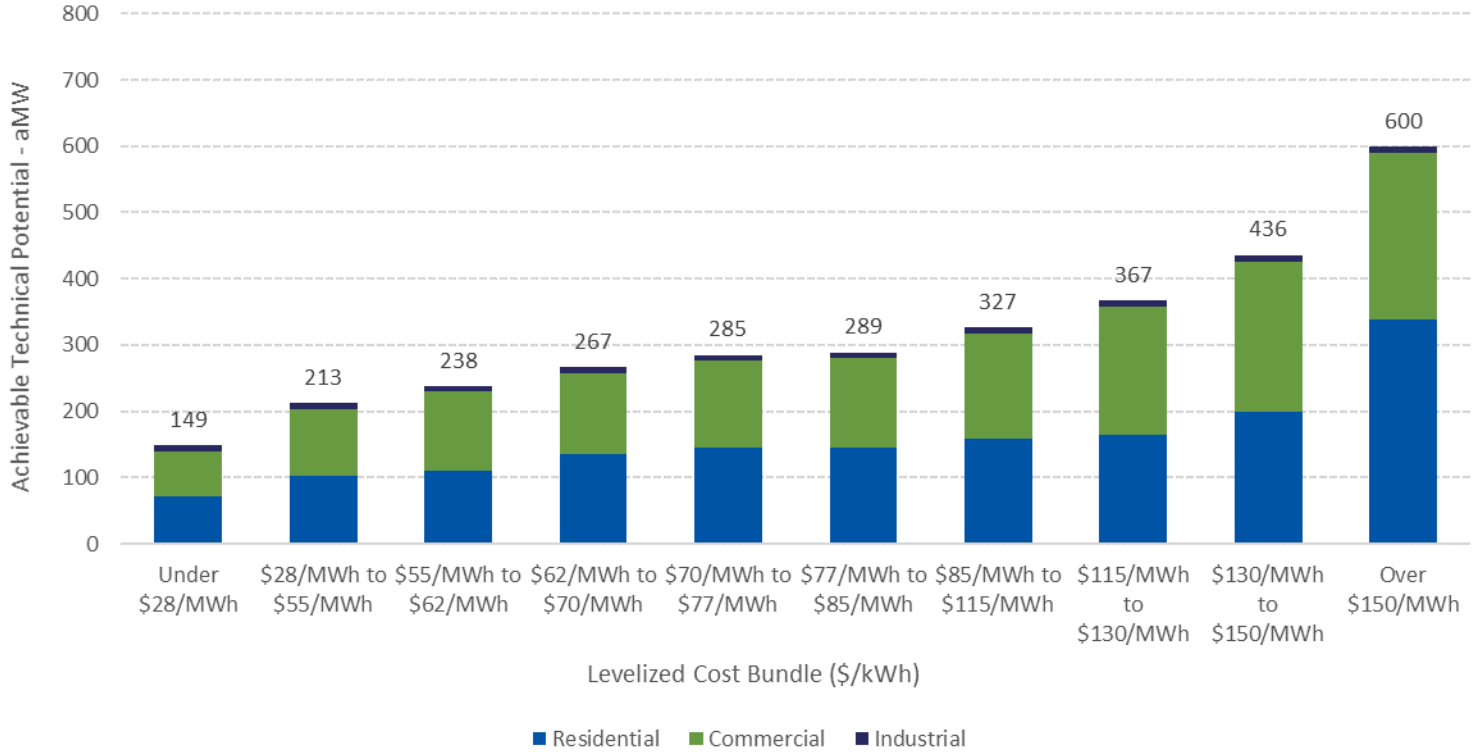
Industrial Supply Curve



- Cumulative, 24-Year Achievable Technical Potential is 10 aMW
- Industrial accounts for 2% of the total, 24-year achievable technical potential
- About 86% of commercial electric potential costs less than $28/MWh, levelized
- About 97% (199 aMW) costs less than $150/MWh, levelized

Electric Supply Curve

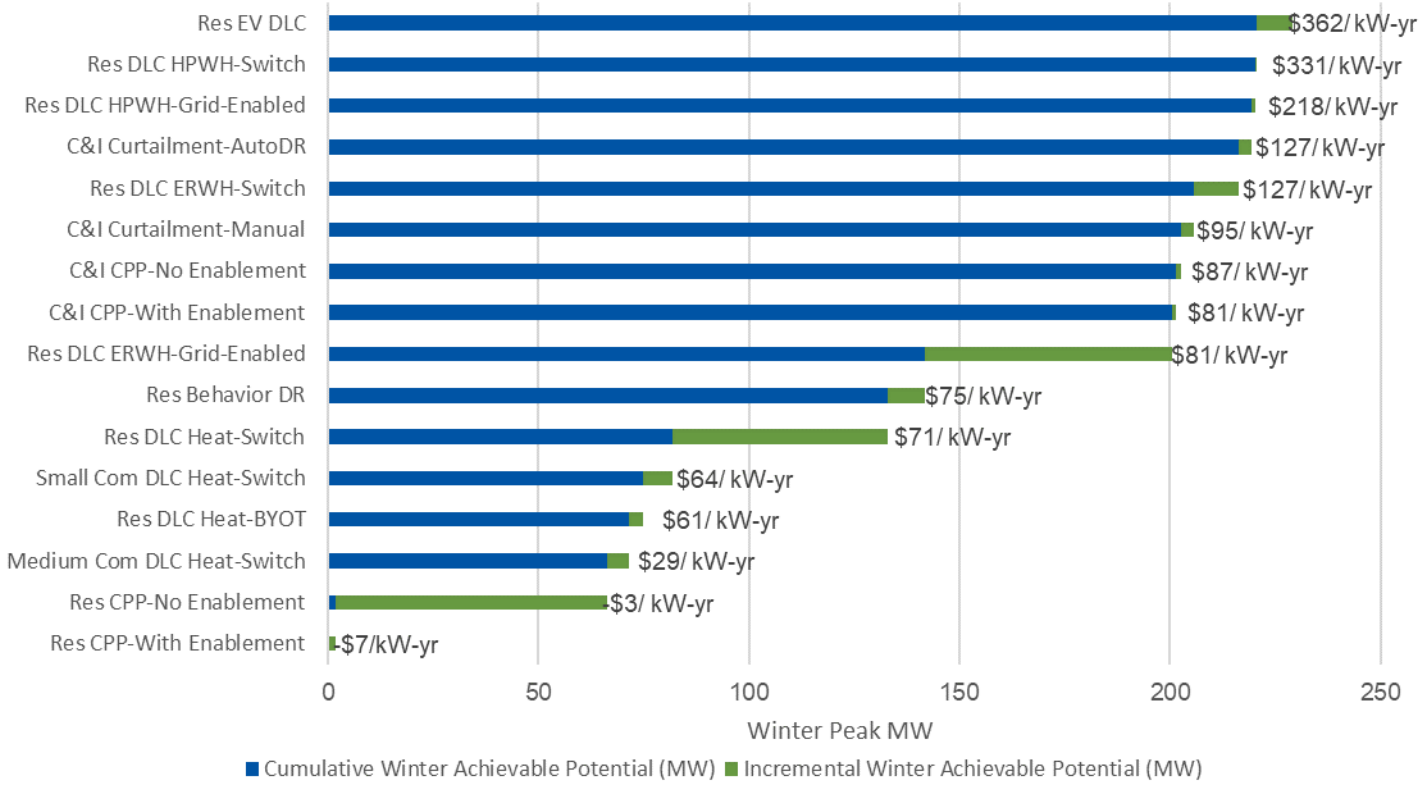
Cumulative 24-Year Achievable Technical Potential by Levelized Cost Bundle



- 25% of the 24-year cumulative achievable technical potential costs less than $28/MWh, levelized
- 73% of the 24-year cumulative achievable technical potential costs less than $150/MWh, levelized

Demand Response Supply Curve

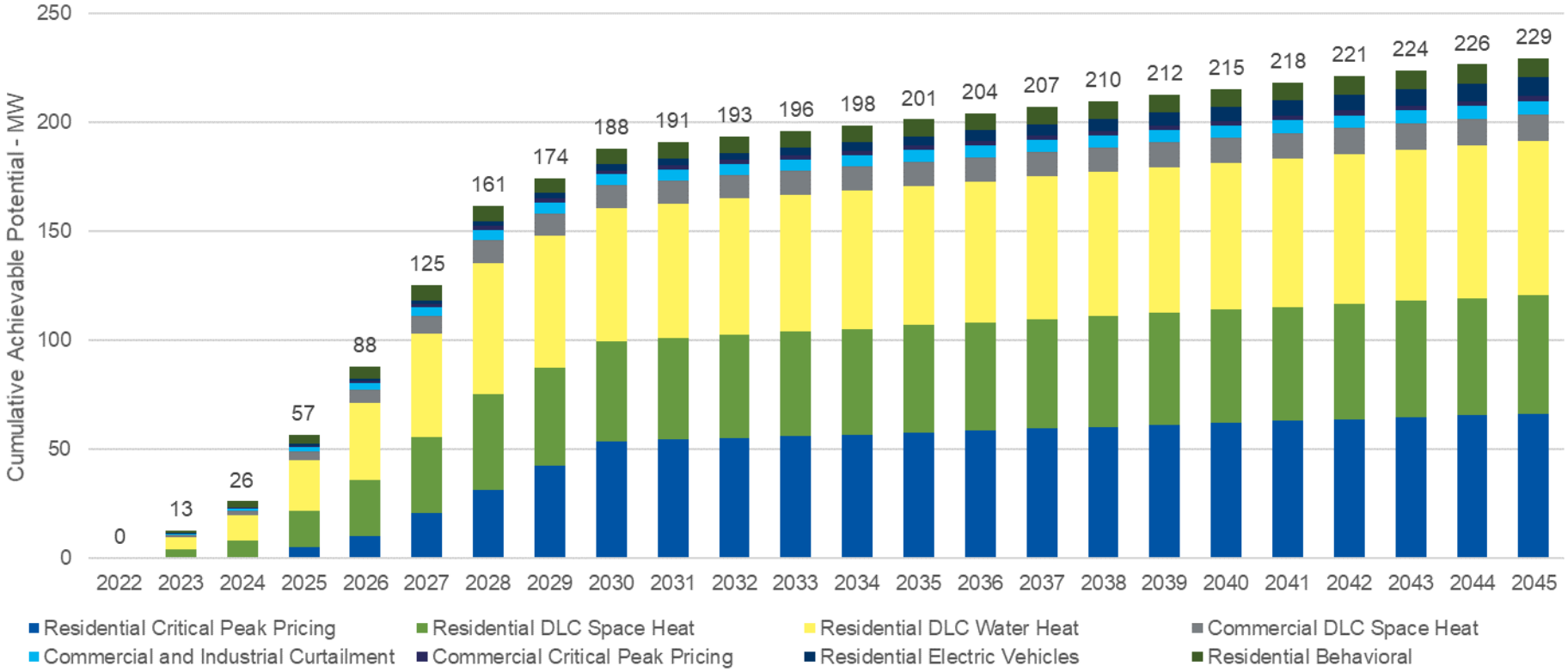
24-Year Demand Response Potential and Levelized Costs



- The total, cumulative 24-year demand response achievable technical potential equals approximately 4.6% of the 2045 forecast electric system peak
- About 90% of the 24-year cumulative achievable technical potential costs less than $100/kW-year, levelized

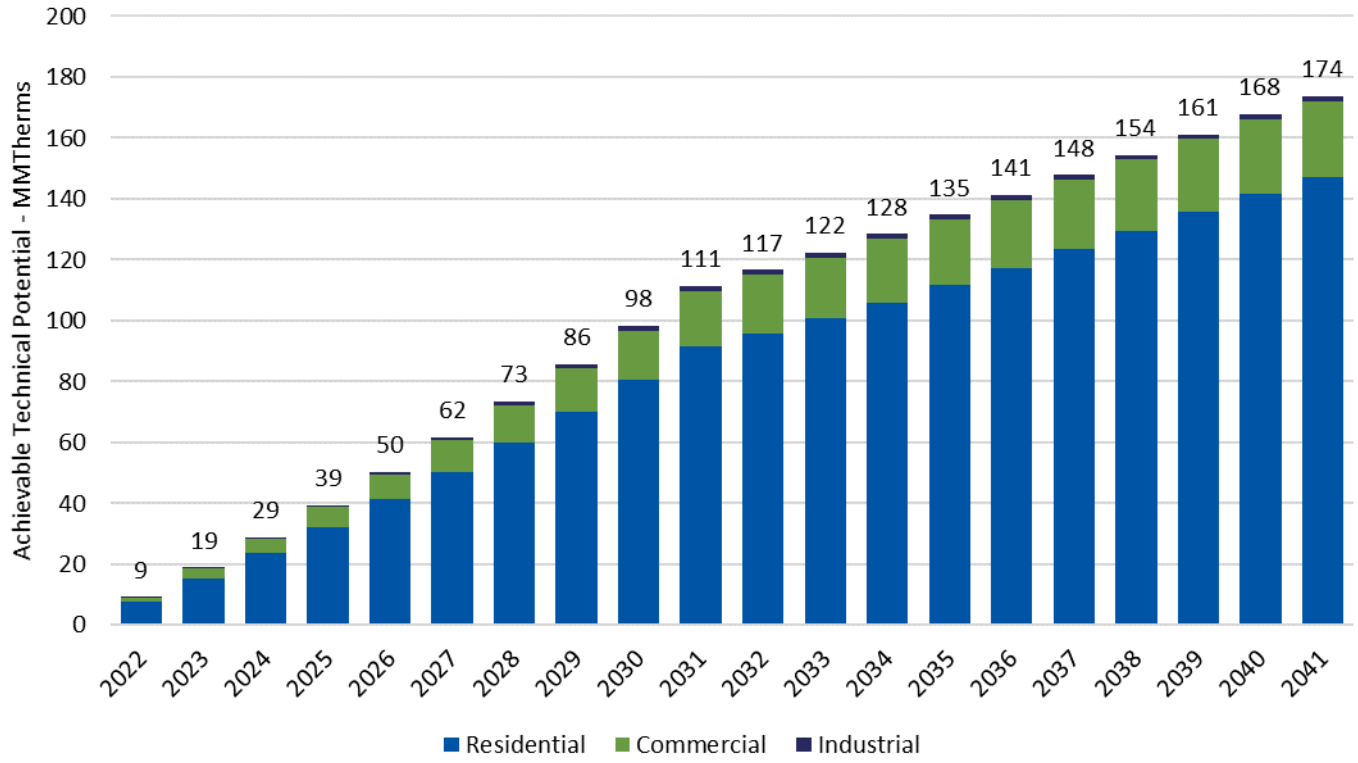
Overview of Results

Total 24-Year Demand Response Potential, by Year and Product Group



Natural Gas Conservation Forecast

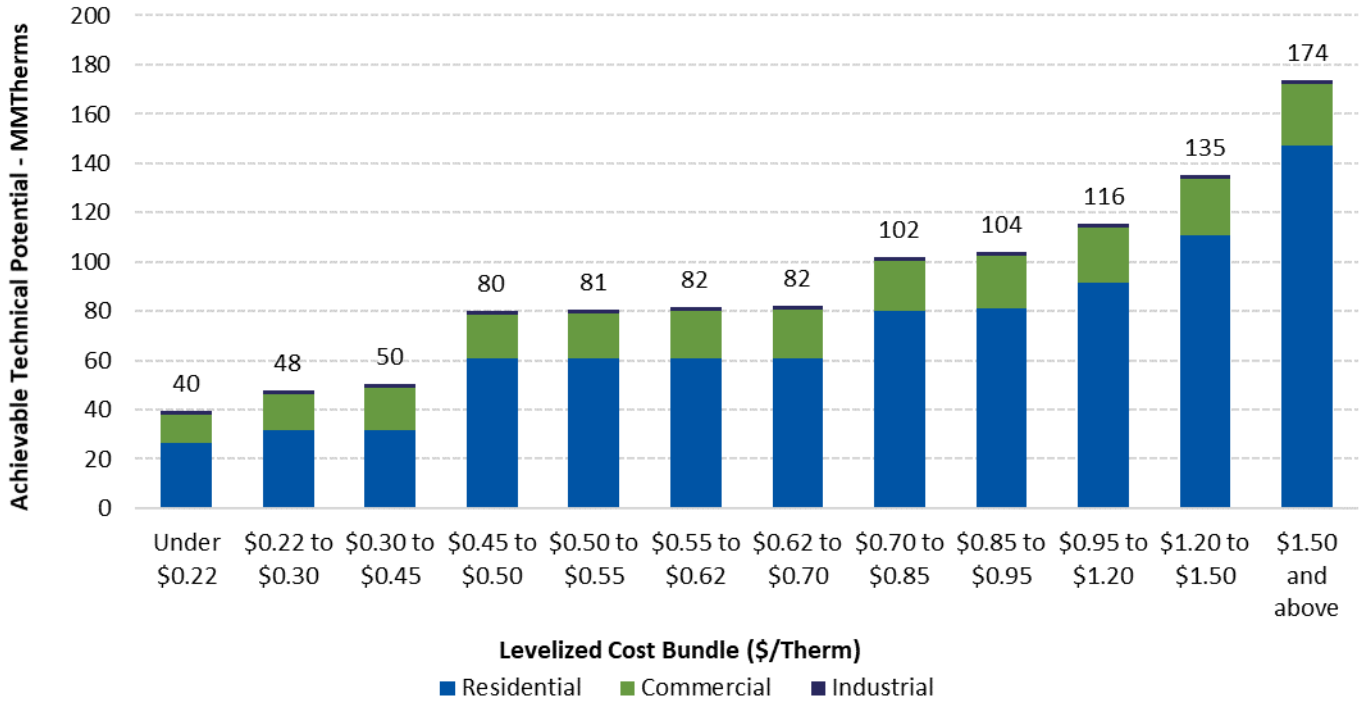
Cumulative Achievable Technical Potential Forecast



- Discretionary measures receive a flat 10-year ramp rate
- Lost opportunity measures (new construction and natural replacement) receive 2021 Plan ramp rates
- Cadmus adjusted some ramp rates to match program activity and expectations

Natural Gas Supply Curve

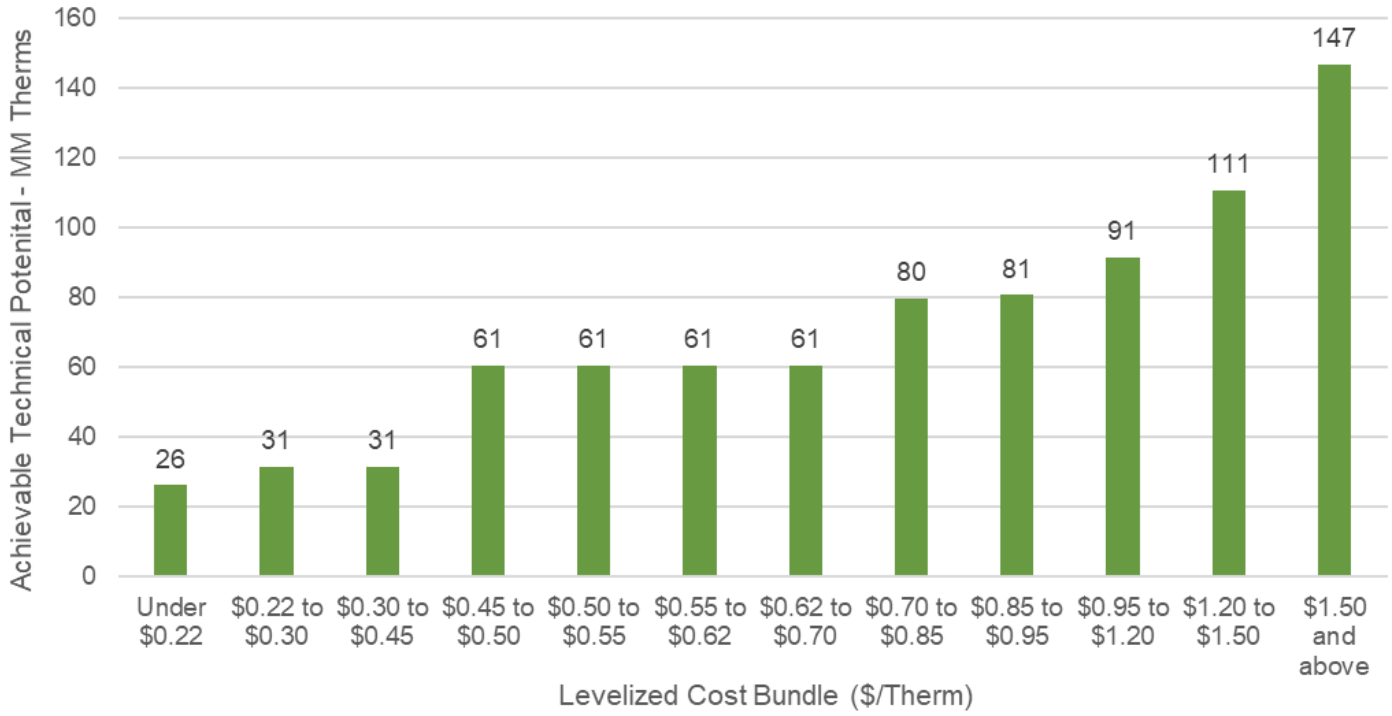
Cumulative 20-Year Achievable Technical Potential by Levelized Cost Bundle



- About 23% of the 20-year cumulative achievable technical potential costs less than $0.22/therm, levelized
- About 47% of the 20-year cumulative achievable technical potential costs less than $0.70/therm, levelized

Residential Gas Potential Summary

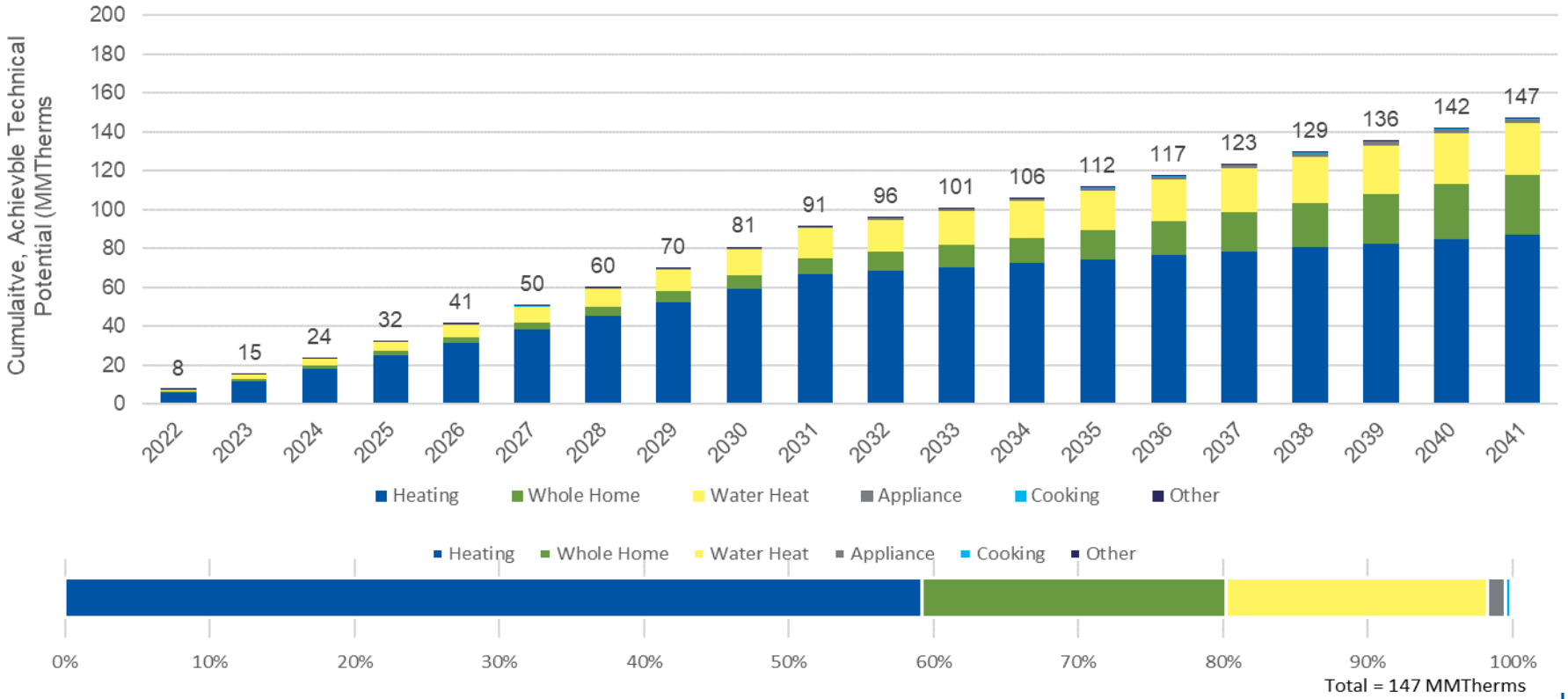
Residential Gas Supply Curve



- Cumulative, 20-Year achievable technical potential is 147 million therms
- Residential accounts for 85% of the total, 20-year achievable technical potential
- About 18% of residential gas potential costs less than $0.22/therm, levelized
- About 41% (61 MM therms) costs less than $0.70/therm, levelized

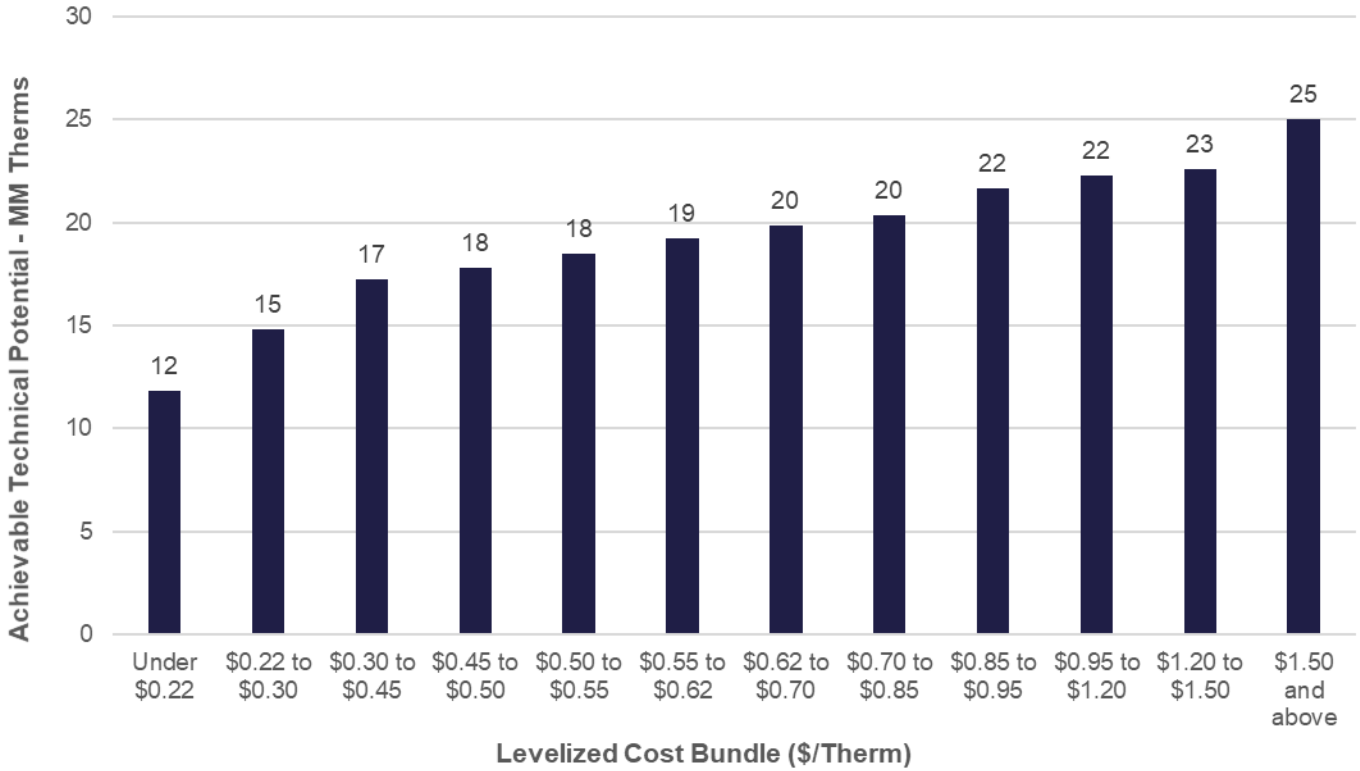
Residential Gas Potential Summary

Natural Gas Energy Efficiency Potential – by End Use



Commercial Gas Potential Summary

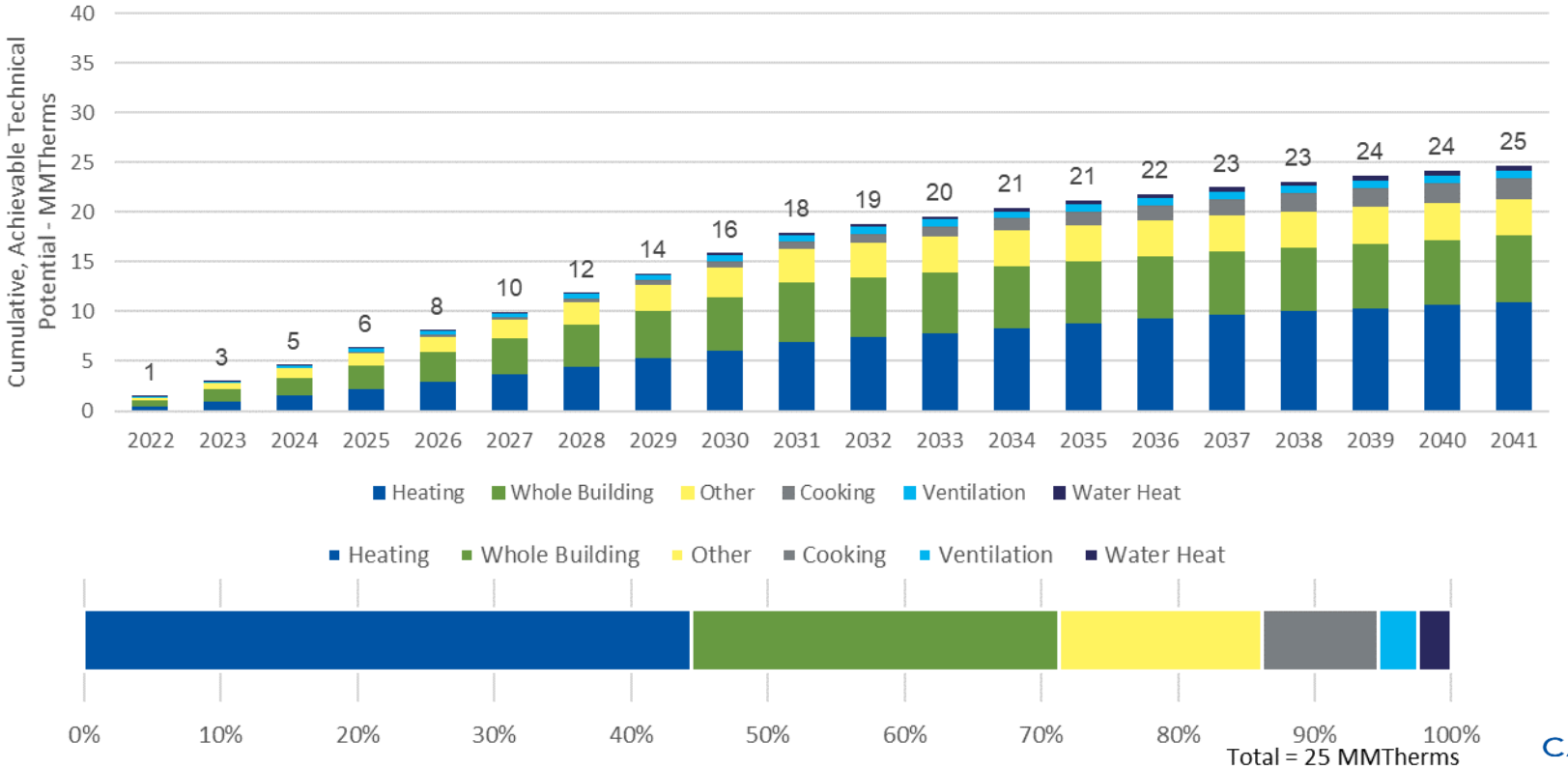
Commercial Gas Supply Curve



- Cumulative, 20-Year achievable technical potential is 25 million therms
- Commercial accounts for 14% of the total, 20-year achievable technical potential
- About 47% (12 MM therms) of commercial gas potential costs less than $0.22/therm, levelized
- About 79% (20 MM therms) costs less than $0.70/therm, levelized

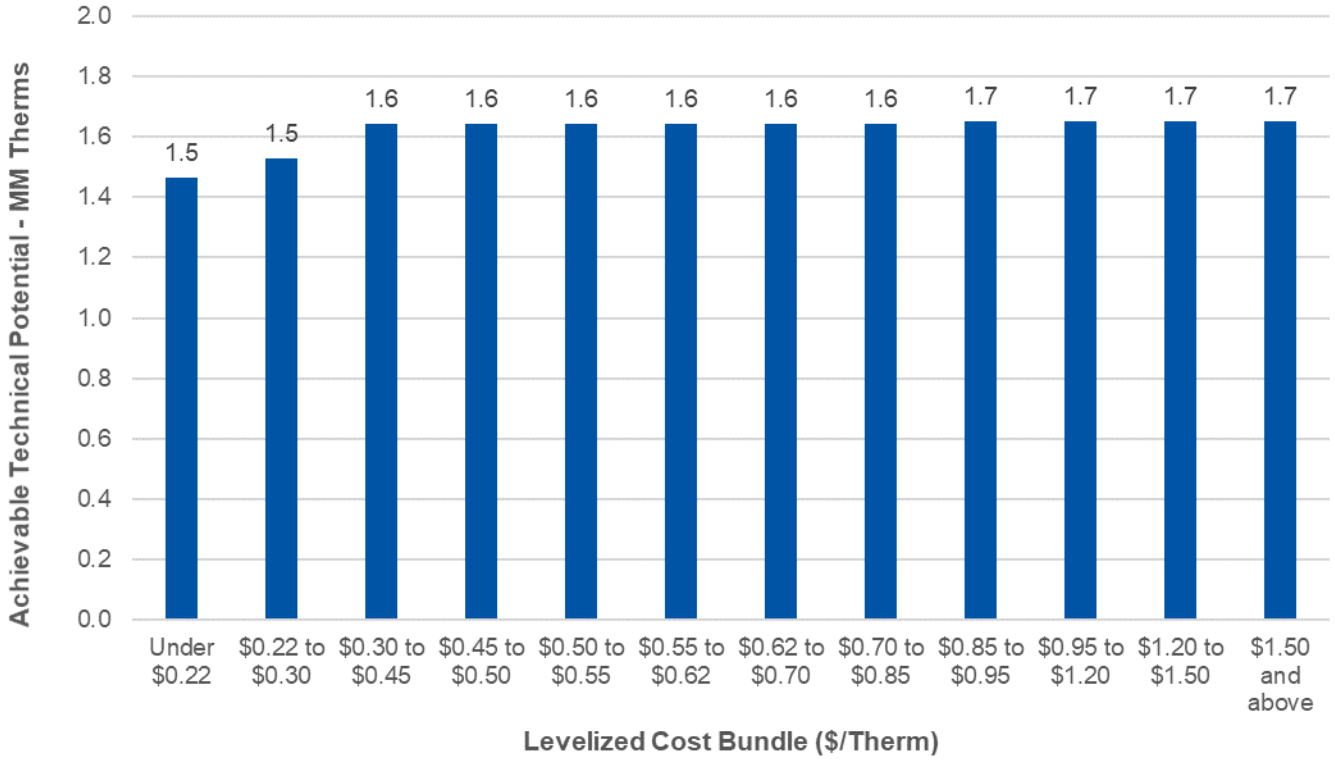
Commercial Gas Potential Summary

Natural Gas Energy Efficiency Potential – by End Use



Industrial Gas Potential Summary

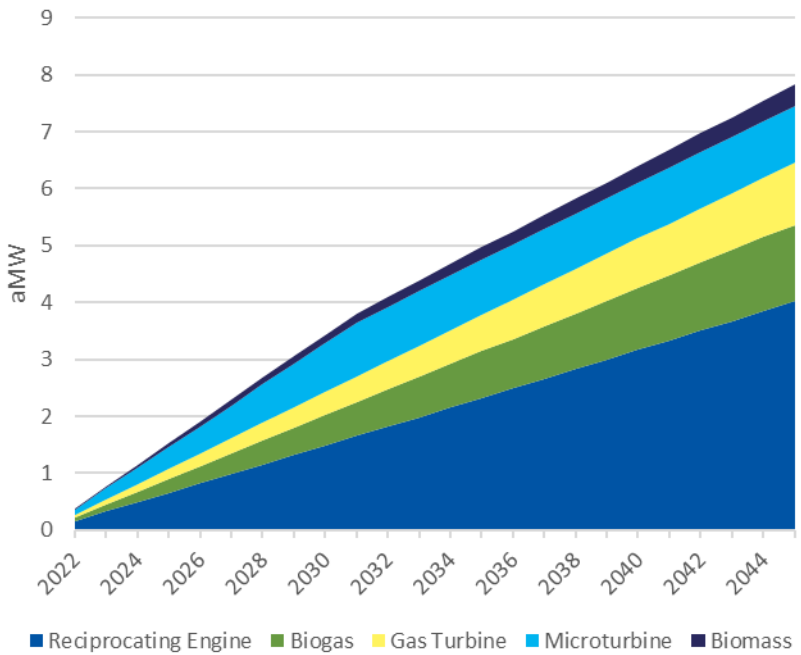
Industrial Gas Supply Curve



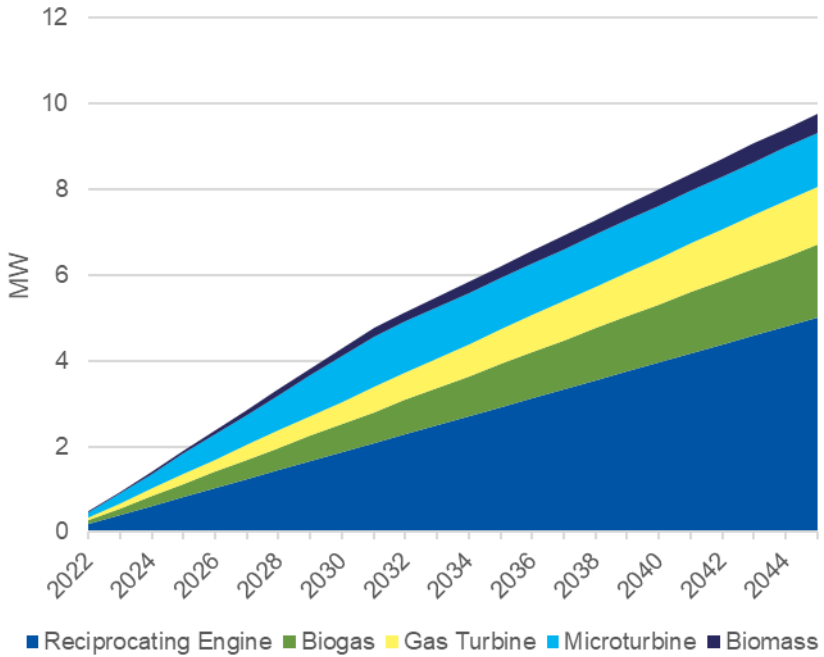
- Cumulative, 20-Year achievable technical potential is about 1.7 million therms
- Industrial accounts for 1% of the total, 20-year gas achievable technical potential
- About 89% (1.5 MM therms) of commercial gas potential costs less than $0.22/therm, levelized

Achievable Potential Results

2045 Achievable Potential – Energy



2045 Achievable Potential – Capacity



Achievable Potential Results

Supply Curve

Solar PV Key Data Inputs

Technical Potential

Total Available Roof Area	• Building square footage (RBSA & CBSA) • Number of floors • Customer counts
Adjusted Available Roof Area	• Adjustment factor from LIDAR or other data source • Accounts for orientation, shading, and obstructions • International Fire Code Article 605.11.3
Module Power Density	• Derived from regional datasets • Forecast future model power density from International Technology Roadmap for Photovoltaic
Electricity Generation	• Capacity factor value • PSE-specific data
Annual Production Degradation	• Applied annually • 2012 NREL study

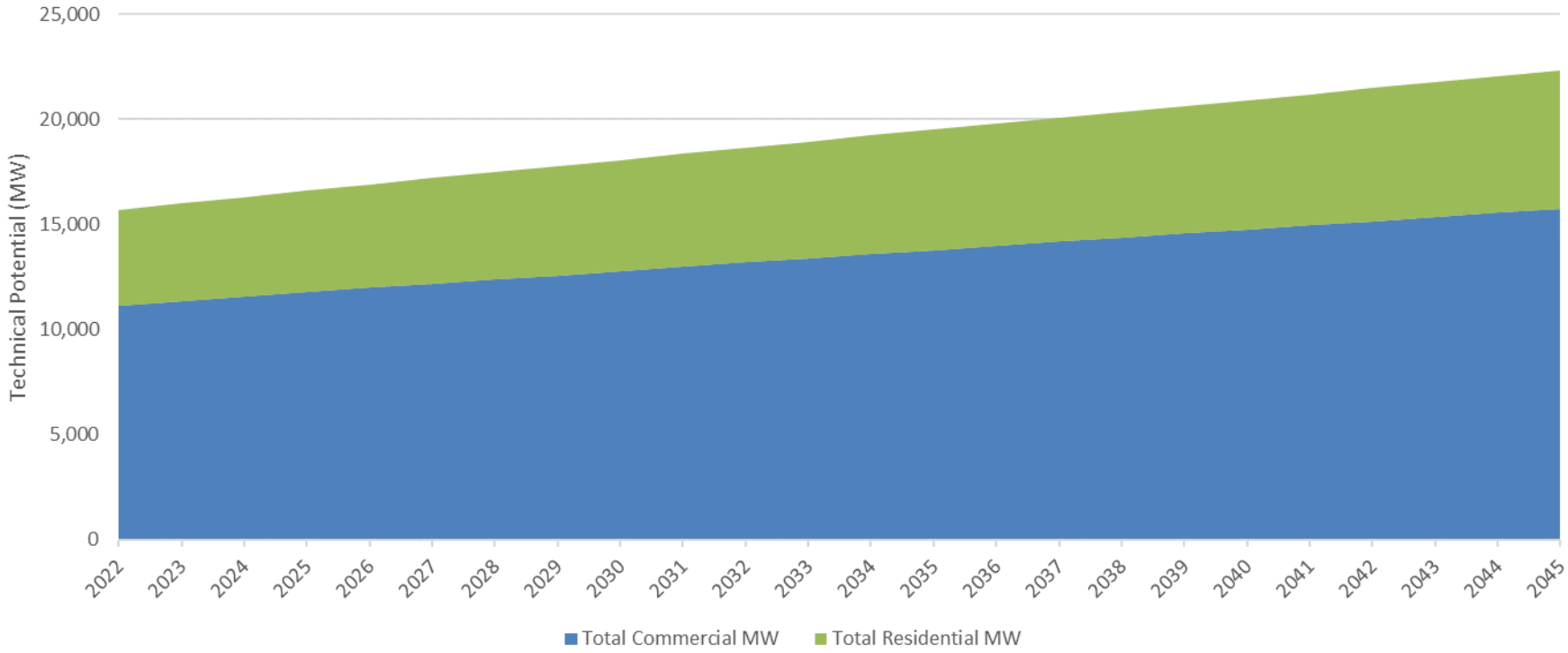
Solar PV Key Data Inputs

Achievable Potential

Electric Retail Rates	• PSE electric res and com general service rates • Rate escalation factors calculated from historical NREL data • Customer counts
Solar System Costs	• Regional installation data • Other sources include Wood Mackenzie and EnergySage • Future cost estimates based on data collected from NREL
Average System Capacity	• Derived from PSE-specific data
Achievable Potential Scenarios	• Business as usual • Utility incentive scenario
Cash Flow Calculation	• Projected retail rates, system install costs, and federal and state incentives • Derive a simple payback period for both res and com for each year

Solar PV Technical Potential

Residential and Commercial Sectors



Achievable Potential Assumptions

Two Scenarios

Business as Usual

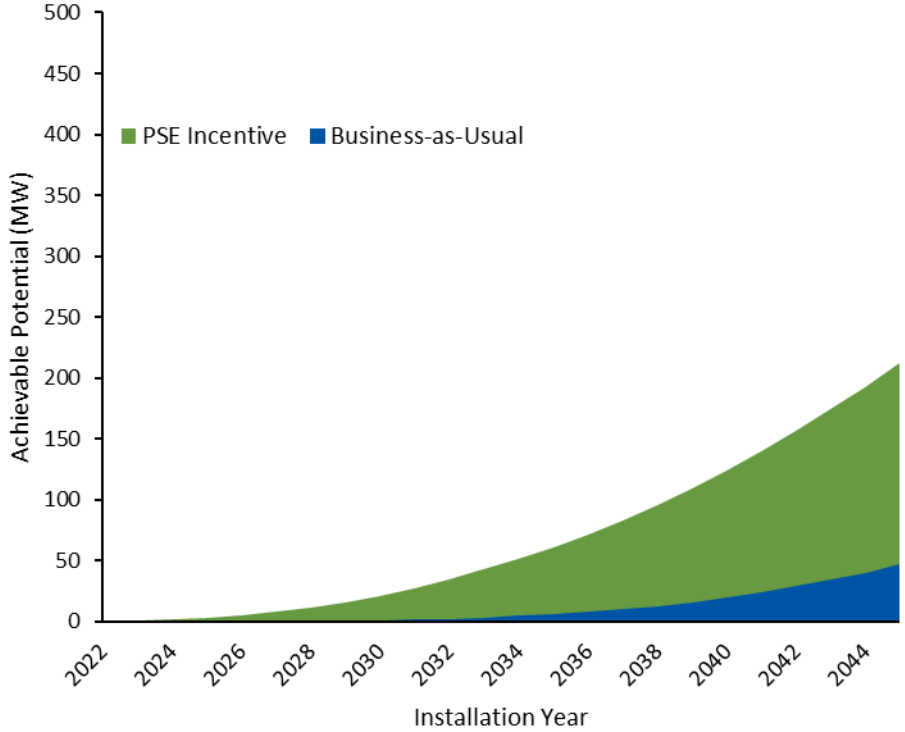
- Continuation of federal ITC in its current form:
  - 0% in 2022 for residential
  - 10% for commercial
- WA RESIP applications ended December 2019
- Net metering
- 5-year MACRS depreciation for commercial

Utility Incentive

- Business as usual, plus
- Utility incentive equal to $0.048/kWh
- Calculated from the 2019 IRP as a levelized value of the 2022-2045 electric avoided costs
- Factoring in a 5% assumption for admin costs

Solar PV Achievable Potential

Residential



Commercial