2019 IRP TAG Meeting #3: Demand side resources for electric and natural gas

Welcome

- Safety message
- Opening remarks
- Introductions

PUGET SOUND ENERGY

Meeting objectives

- PSE explains how the demand side resources (conservation potential assessment) are used in the IRP
- PSE provides Cadmus an opportunity to share information about demand side resources

PUGET SOUND ENERGY

Action items from prior IRPAG and TAG meetings

Open action items from previous IRPAG and TAG meetings

Action item #	Description (and meeting reference)	PSE action	Status
1	Identify contact for PSE's carbon reduction goals. (IRPAG #1, May 30, 2018)	PSE is planning a listening session with PSE executives and the public is welcome to participate.	In progress
2	Include carbon impact in scenarios or sensitivities. (IRPAG #1, May 30, 2018 and TAG #2, October 11, 2018)	PSE will model various carbon impacts.	In progress
3	Include a discussion of the social cost of carbon at the October 11 TAG meeting. (IRPAG #1, May 30, 2018 and IRPAG #2, August 28, 2018)	PSE included this discussion in the October 11 TAG meeting.	Complete

PSE PUGET SOUND ENERGY

Open action items from previous IRPAG and TAG meetings (continued)

Action item #	Description (and meeting reference)	PSE action	Status
4	Share final HDR report. (TAG #1, July 26, 2018 and TAG #2, October 11, 2018)	PSE uploaded the final report to www.pse.com/irp on October 19, 2018.	Complete
5	Finalize meeting notes from TAG #2. (TAG meeting #2, October 11, 2018)	PSE distributed the meeting notes on October 25; stakeholders provided feedback by November 1; and PSE posted notes on November 7.	Complete

Open action items from previous IRPAG and TAG meetings (continued)

Action item #	Description (and meeting reference)	PSE action	Status
6	Follow-up with Virginia Lohr concerning the publication dates of the notes from the previous IRPAG meeting. (TAG meeting #2, October 11, 2018)	Michele Kvam emailed Virginia on October 17.	Complete
7	Investigate converting the gas emission rate to a percentage. (TAG meeting #2, October 11, 2018)	PSE will include gas emission rate as a percentage in the draft IRP and the final IRP.	In progress

Open action items from previous IRPAG and TAG meetings (continued)

Action item #	Description (and meeting reference)	PSE action	Status
8	Investigate the viability of "deep retrofits" as a sensitivity. Reach out to Doug Howell, Sierra Club, to help provide details to facilitate this review. (TAG meeting #2, October 11, 2018)	Gurvinder Singh emailed Doug Howell on October 22.	Complete
9	Provide graphics to illustrate the IRP process. (TAG meeting #2, October 11, 2018)	PSE will provide a graphic at the December 6 TAG meeting and relevant graphics throughout the rest of the 2019 IRP process.	In progress

PUGET SOUND ENERGY

Open action items from previous IRPAG and TAG meetings (continued)

Action item #	Description (and meeting reference)	PSE action	Status
10	Distribute the updated sensitivity handout on October 19. (TAG meeting #2, October 11, 2018)	PSE distributed the portfolio sensitivities for consideration on October 19 to the TAG members via email.	In progress (PSE will report on the selected sensitivities during the January 9 TAG #4 meeting)

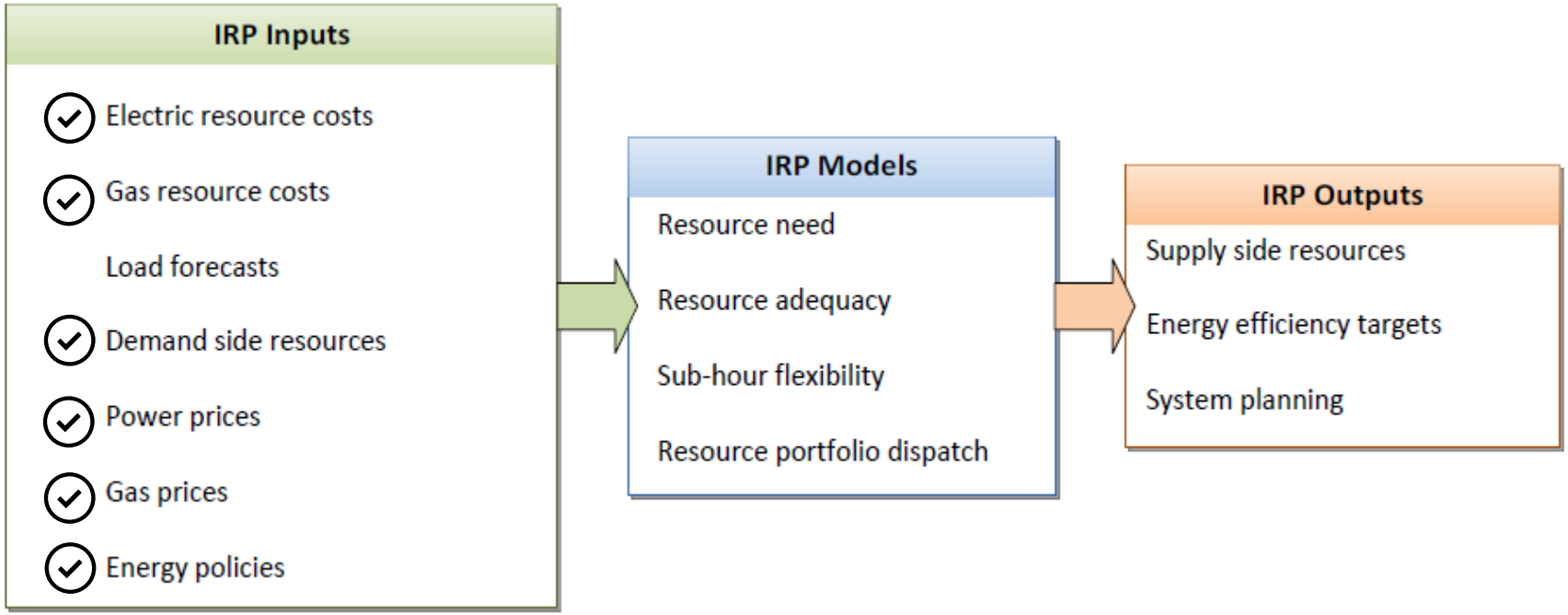
PUGET SOUND ENERGY

Demand side resources overview

December 6, 2018 TAG #3

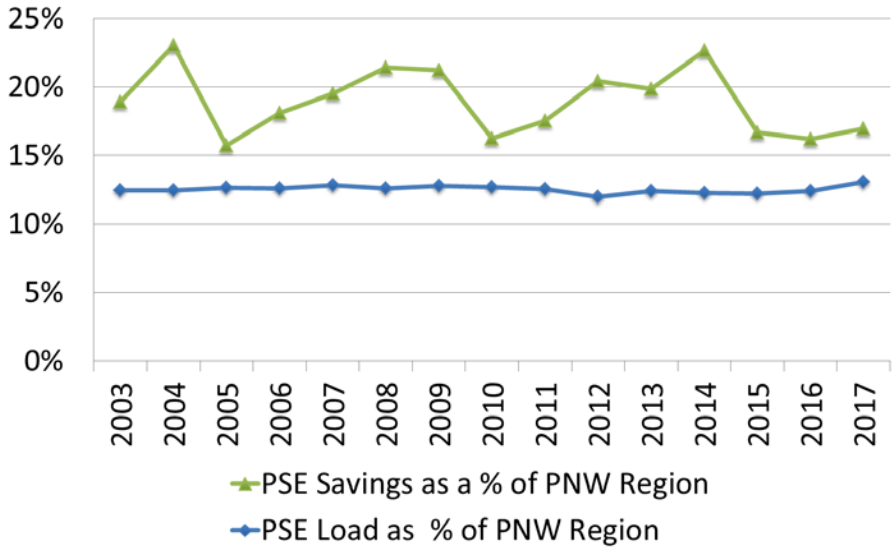
IRP analytical process overview

- PSE has established an analytical framework to develop its **20-year forecast of demand side resources and supply side resources** that appear to be cost effective to meet the growing needs of our customers.



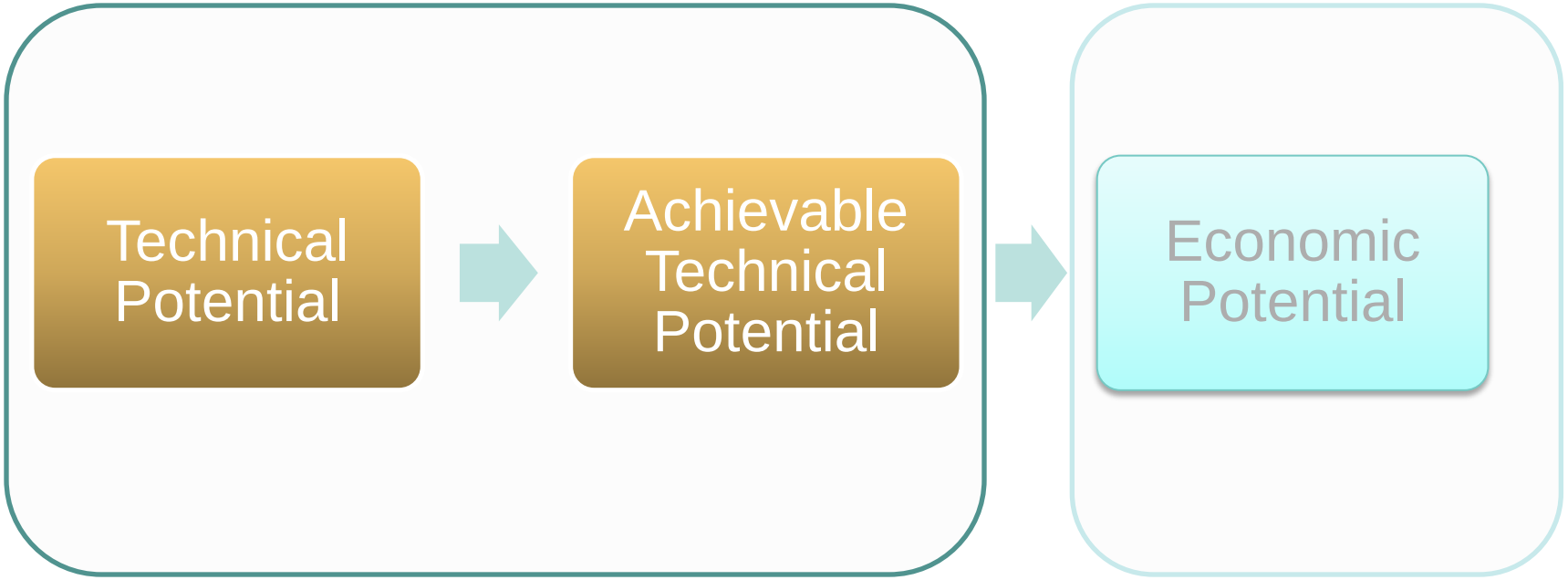
PSE's History of Energy Efficiency Achievements

- PSE is a leader in the region when it comes to energy efficiency
- PSE share of savings in the PNW region is close to 20% versus share of load is only 13%
- PSE has spent close to $1 billion over the last 15 years on electric energy efficiency
- PSE has spent close $200 million over the last 15 years on gas energy efficiency



PUGET SOUND ENERGY

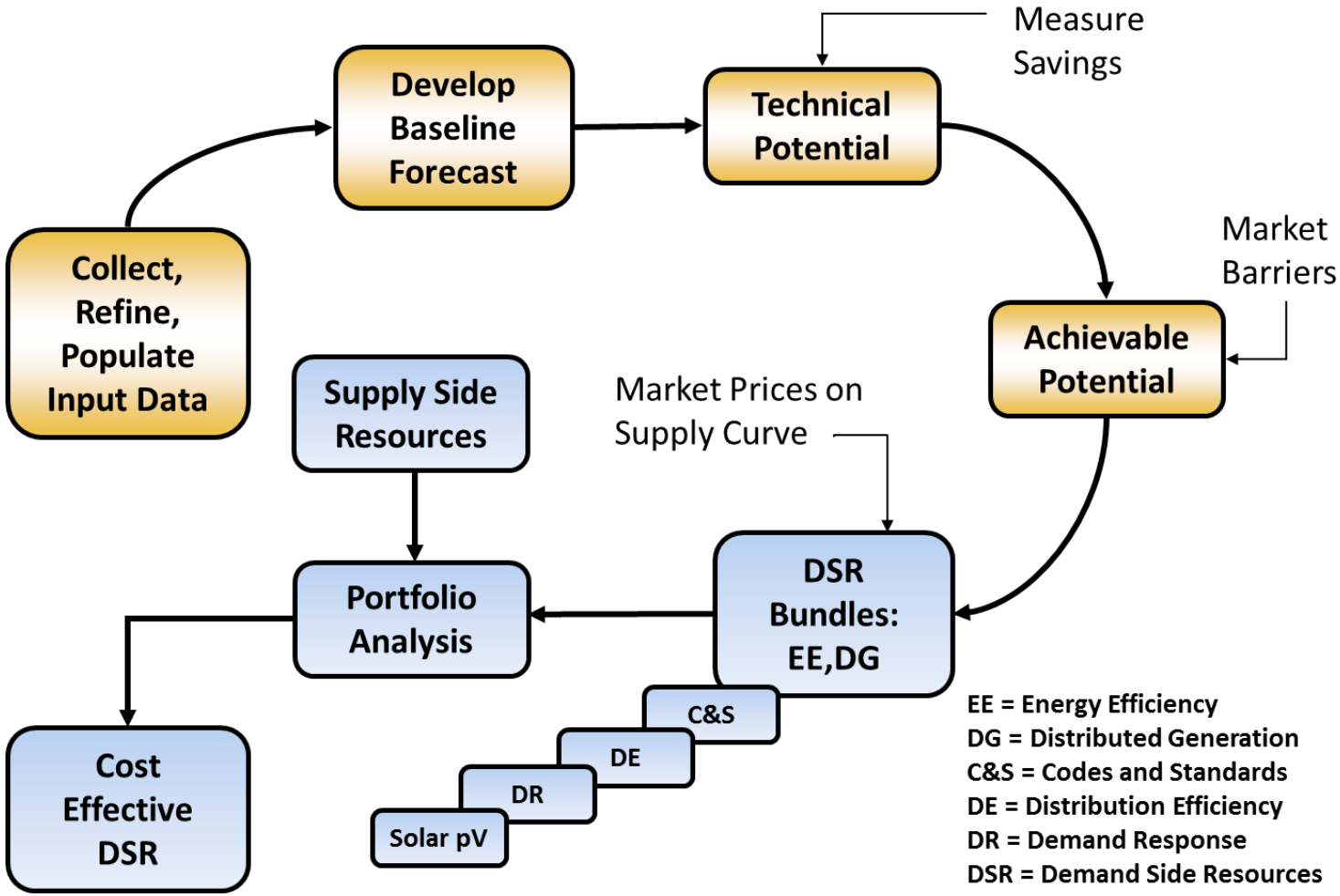
Demand side resource (DSR) methodology



- DSR potential assessment
- DSR results are an output

- IRP portfolio analysis
- DSR results are an input

Demand side resource (DSR) methodology



PUGET SOUND ENERGY

Electric demand side resources

Cadmus presentation

December 6, 2018 TAG #3

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Overview of Results

Puget Sound Energy 2019 Demand-Side Resources Potential Study

December 6, 2018

Agenda

10:00am - Noon

Electric

- Energy Efficiency
- Demand Response
- Distributed Generation
- Codes and Standards
- Distribution Efficiency

Noon – 1pm – Lunch

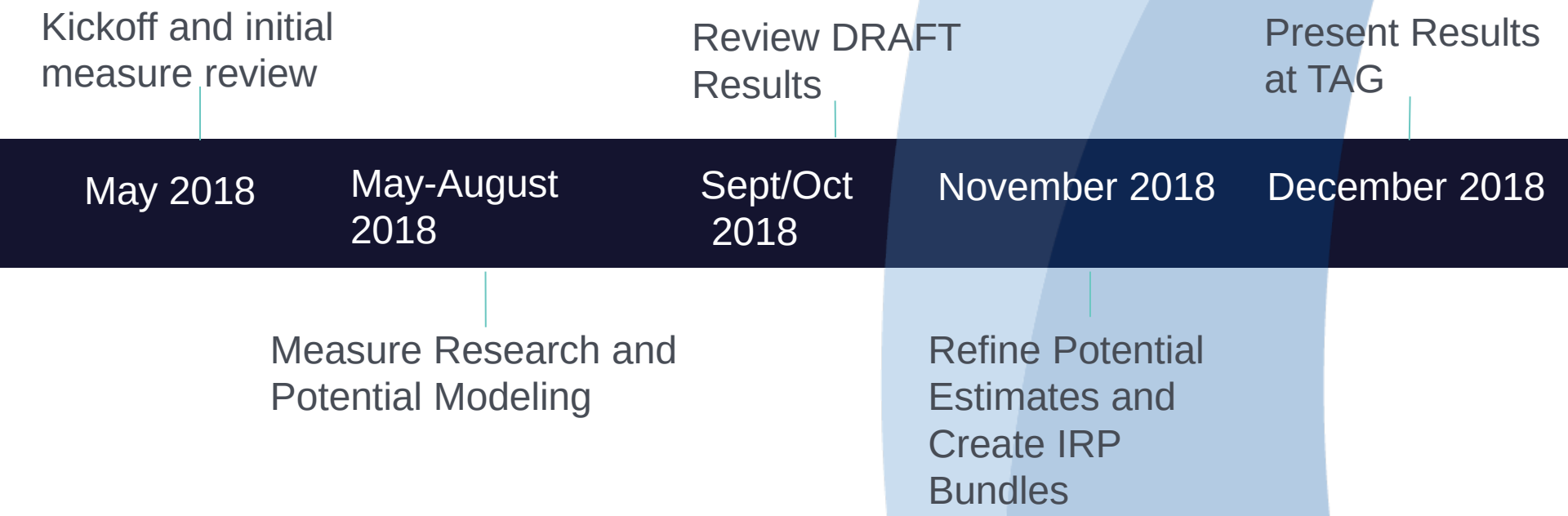
1:00pm - 2:00pm:

Natural Gas

DSR Sensitivities

Next Steps

Status Update



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About Cadmus

- Established in 1983, employee-owned company with more than 500 consultants (200+ in Energy Services)
- More than 30 years of experience delivering market research, energy efficiency planning and modeling expertise
- Project team staff have led 40+ potential studies for 24 clients since 2006
- Specializes DSM potential studies for utilities in the Northwest. Completed studies for:
  - Seattle City Light
  - Bonneville Power Administration
  - Snohomish PUD

Energy Efficiency

Methodology

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Study Overview

Produce 20-year (2020-2039) forecasts of achievable technical conservation, distributed generation, and demand response potential for inclusion in PSE's IRP

Use up-to-date data including:

- PSE's load and customer forecasts
- Residential Building Stock Assessment (RBSA) II
- PSE's Residential Characteristics Study (RCS)
- Measure updates from PSE and the Regional Technical Forum (RTF).

Scope of the Analysis

Five sources of potential

- Energy efficiency
- Demand Response
- Solar PV
- Combined Heat and Power
- Codes and Standards

Two fuels

- Electric – Energy Efficiency, Solar PV, Demand Response, CHP, Codes and Standards
- Natural gas – Energy Efficiency, Codes and Standards

Two types of potential estimated (and a third considered in IRP modeling)

- **Technical Potential:** All technically feasible potential
- **Achievable Potential:** The subset of technical potential that homes and businesses will realistically adopt
- **Economic potential:** The cost-effective portion of achievable potential selected by PSE's IRP

A Comprehensive Assessment

- Over 300 unique electric and natural gas energy efficiency measures considered. Thousands of permutations
- Five CHP technologies and up to six capacity bins for each technology
- Twelve demand response products
- Eleven codes and standards

Methodology

Steps for estimating conservation potential

1. Compile Measure Data
2. Develop Units Forecast
3. Calculate levelized costs
4. Forecast Technical Potential
5. Forecast Achievable Potential
6. Develop supply curves for IRP modeling

1. Compile Measure Data

1. **Determine unique measures: Includes all measures from the 7th Power Plan, RTF, and PSE's programs**

2. **Compile measure data and determine PSE-specific inputs:**
   - Costs
   - Applicability
   - Per-unit savings
   - Saturations; Number of Units

Unique Measures and Measure Applications

Sector	Unique Measures	Measure Applications
Residential	159	606
Commercial	134	3,398
Industrial	72	1,558
Total	**365**	**5,562**

2. Develop Units Forecasts

Using:

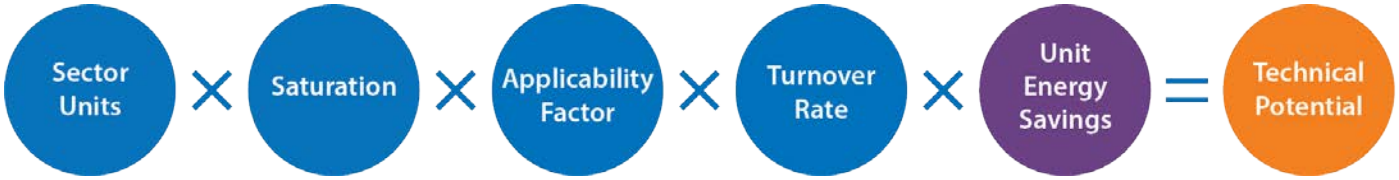
- Regional stock assessment data (CBSA and RBSA)
- PSE Residential Characteristics Study (RCS)
- PSE's load forecast
- U.S. Census Bureau American Community Survey

3. Calculate Levelized Costs

- 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 T&D Expansion
Annual O&M	Regional Act Credit
Program Administration	Avoided Periodic Replacement
Periodic Replacement	Other Fuel Benefits
Other Fuel Costs	Non-Energy Impacts
Non-Energy Impacts	

4. Forecast technical potential



Unit energy savings derived from PSE business cases, RTF workbooks, and 7th Plan

- Changed inputs into some RTF and 7th Plan measures with PSE-specific values

5. Forecast Achievable Technical Potential

Ramp rates:

- 10-year flat ramp for discretionary measures
- Adapted 7th Plan ramp rates for lost opportunity measures
- Developing custom ramp rates to reflect PSE's program accomplishments

Maximum achievable factor: 85%

What changed from the 2017 CPA?

- New measures and sources. Updates to existing measures
  - PSE business cases and RTF
- PSE Residential Characteristics Survey (RCS) data
- RBSA II data
- New load and customer forecasts
- Commercial floor space estimates derived from CBSA II building catalog

Electric Conservation Potential Results

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Electric Conservation Potential

Achievable Technical Conservation Potential

Sector	2021	2029	2039
Cumulative Achievable Potential (aMW)			
Residential	37	227	306
Commercial	36	208	318
Industrial	6	28	28
Total	**79**	**463**	**652**
Percent of Baseline Sales			
Residential	3%	17%	21%
Commercial	3%	16%	20%
Industrial	4%	24%	26%
Total	**3%**	**17%**	**20%**

Comparison to 2017 CPA

Electric Achievable Technical Potential

	20-Year Achievable Technical Potential (% of Sales)			Total Achievable Technical Potential (aMW)
	Residential	Commercial	Industrial	
Electric Resources				
2019 IRP	21%	20%	26%	652
2017 IRP	20%	21%	17%	598

Comparison to the 2017 CPA

Electric Achievable Technical Potential

RESIDENTIAL	• Heat Pump water heater potential ~20 aMW higher • DHP potential ~ 17 aMW higher • Windows ~ 12 aMW higher • Lighting ~30 aMW lower
COMMERCIAL	• Similar top measures: LED tubes, commissioning • New measures: embedded data centers and indoor agriculture
INDUSTRIAL	• Higher energy management potential

Residential Lighting

- Residential lighting has been one of the highest-saving measures in PSE's previous potential studies and energy efficiency programs. This study identified much lower lighting potential due to:
  - **Energy Independence and Security Act backstop provision:** Requires bulbs manufactured after 2020 achieve 45 lumens/watt. LEDs are the most likely technology
  - **Discontinued exemptions for specialty lighting:** Previously, specialty lighting (reflectors, 3-way) have been exempted from the EISA backstop, however, DOE has discontinued this exemption. Specialty now covered under EISA
  - **Efficient market average:** A large share of bulbs entering the market are LEDs. The market is transforming.

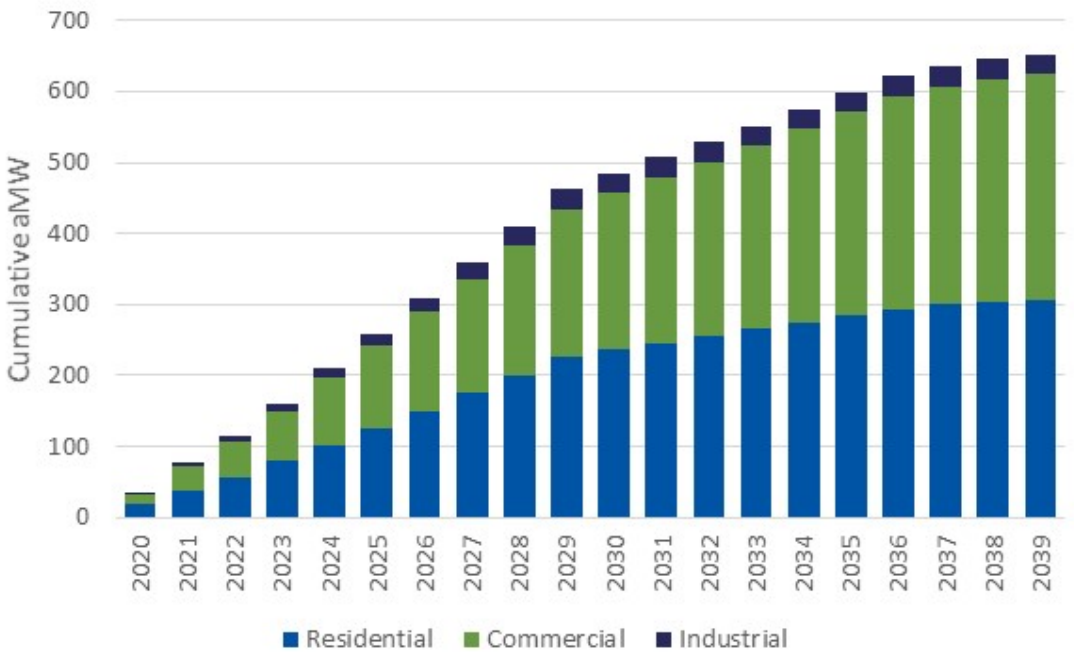
Electric Conservation Forecast

Cumulative Achievable Technical Potential Forecast

Discretionary measures receive a flat 10-year ramp rate

Lost opportunity measures (new construction and natural replacement) receive 7th Plan ramp rates

Cadmus adjusted some ramp rates to match program activity and expectations



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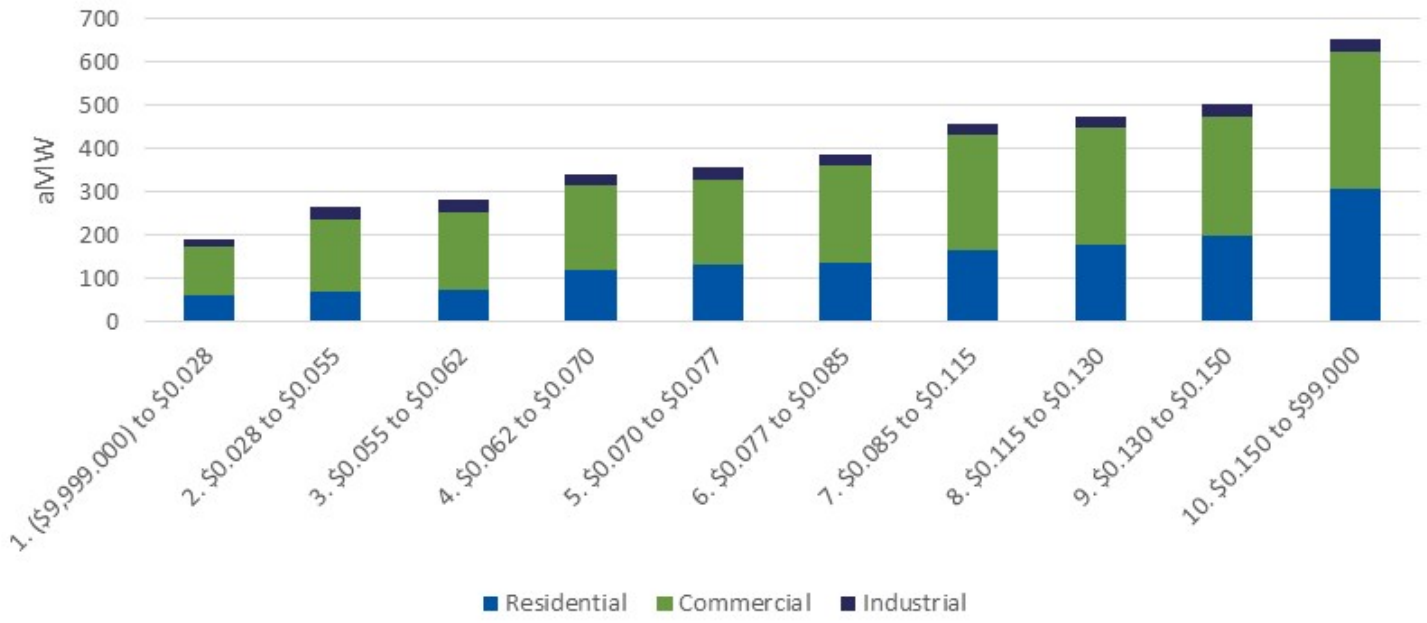
Electric Supply Curve

Cumulative 20-Year Achievable Technical Potential by Levelized Cost Bundle



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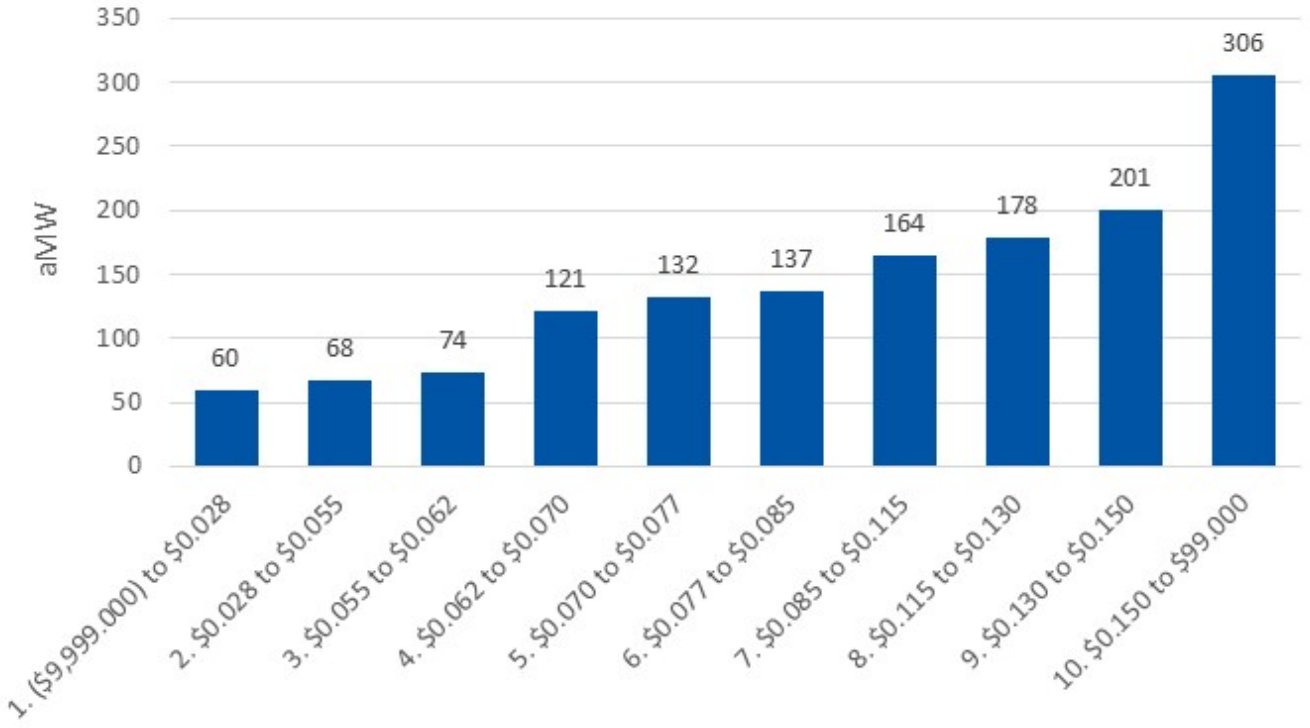
Residential Electric Potential Summary

Residential Supply Curve



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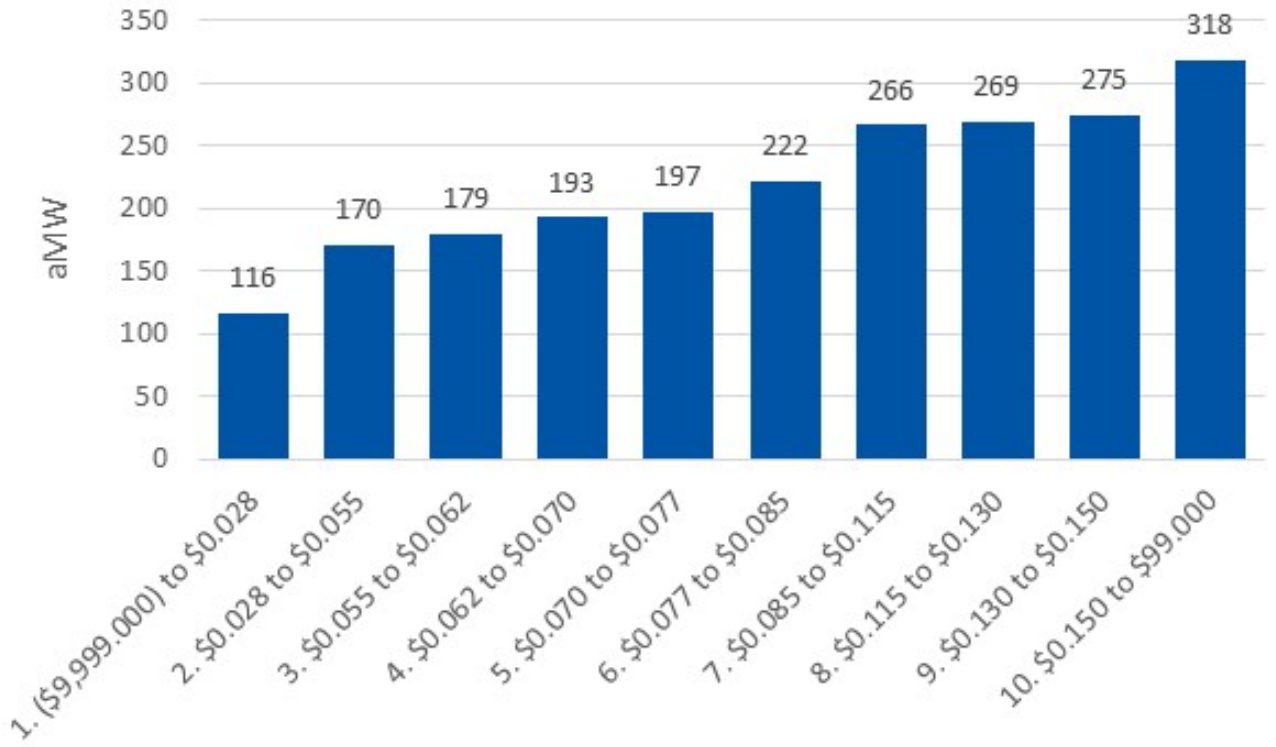
Top Residential Measures

Measure Name	Cumulative 10-Year Achievable Technical Potential	Cumulative 20-Year Achievable Technical Potential
HPWH_Tier 2	14	33
Install Ductless Heat Pump in House with Existing FAF	12	30
Windows_Double Pane - U30	28	28
Web Enabled Thermostat	17	17
Home HVAC Conversion - Convert FAF to Heat Pump	16	16
Zonal to DHP_HSPF 9.0 to 11.0	16	16
Home Energy Reports	13	13
Infiltration Reduction - CFM50 reduction	11	11
Standard Size Refrigerator and Refrigerator-freezer - CEE Tier 1	4	10
Existing Manufactured Home HVAC Conversion	4	10
ENERGY STAR Most Efficient Electric Clothes Washer	3	7
Duct Sealing	7	7
HPWH_Tier 3_NoResistance_SplitSystem	2	6
Wall Insulation_R0 - R11	6	6
HRV	6	6

Commercial Electric Potential Summary

Commercial Supply Curve



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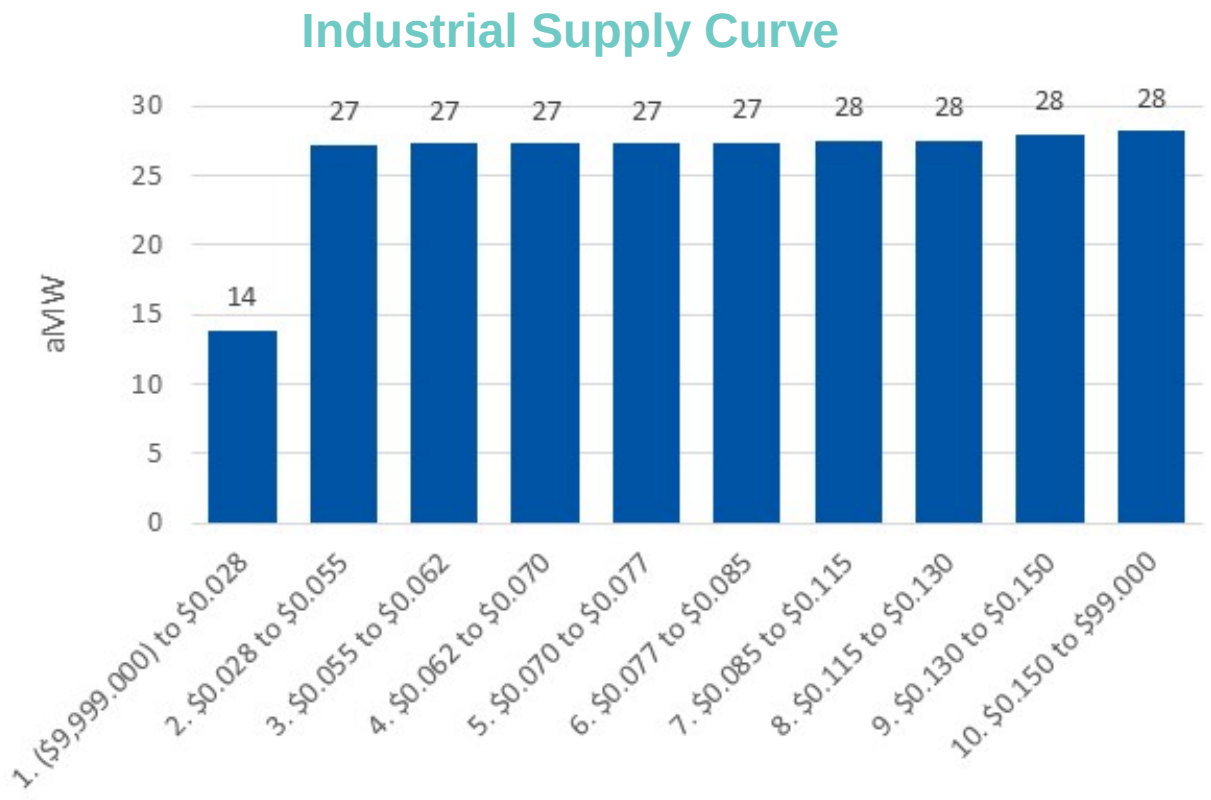
Top Commercial Measures

Measure Name	Cumulative 10-Year Achievable Technical Potential	Cumulative 20-Year Achievable Technical Potential
LED Linear Fixture	49	69
Data Center Best Practice	4	27
Commissioning	22	22
Indoor Agriculture Lighting	21	21
Variable Refrigerant Flow	6	19
Advanced Rooftop Controls	9	16
Data Center Commercial Technology	2	12
LED Highbay	6	11
RTU Supply Fan VFD and Controller	6	10
Cooling DX Tune Up and Maintenance	8	8
Parking Garage Lighting	7	8
LED Other	8	8
Cooling DX 135 to 240 kBtuh Premium	3	7
Optimize Municipal Sewage	7	7
Cooling DX 135 to 240 kBtuh Standard	2	4

Industrial Electric Potential Summary



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Top Industrial Electric Measures

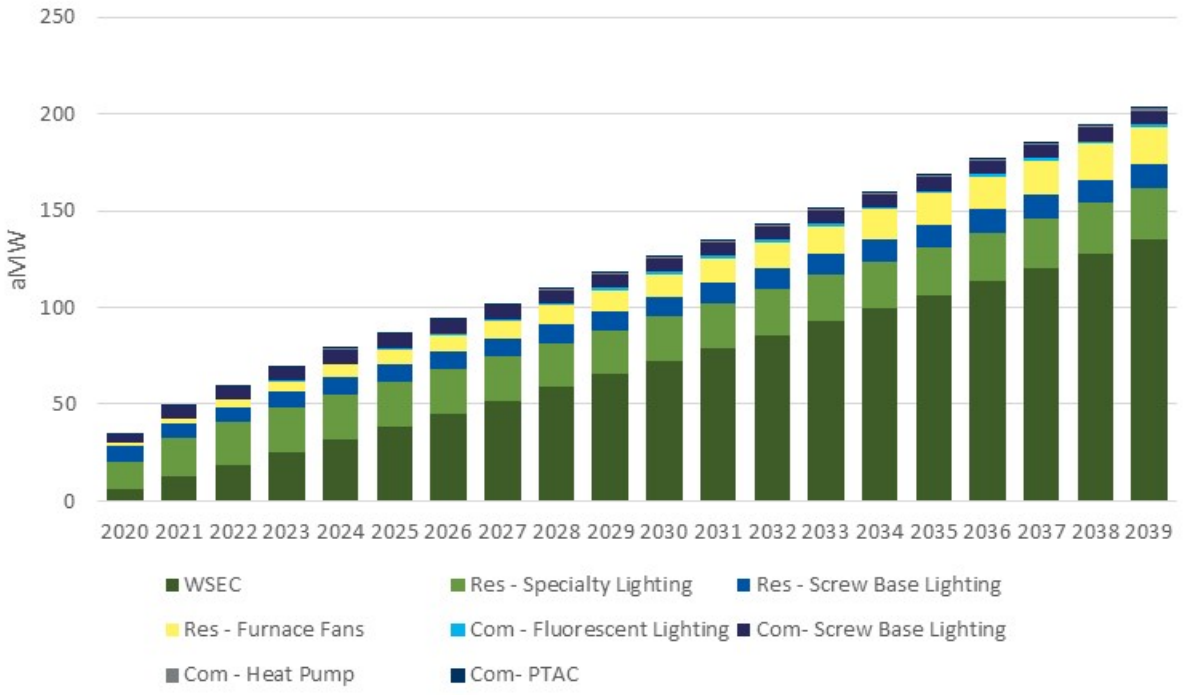
Measure Name	Cumulative 10-Year Achievable Technical Potential (kWh)	Cumulative 2-Year Achievable Technical Potential (kWh)
Energy Project Management	3.5	3.5
Plant Energy Management	3.3	3.3
Integrated Plant Energy Management	3.1	3.1
Pump System Optimization	3.0	3.0
Pump Equipment Upgrade	2.9	2.9
Fan System Optimization	2.2	2.2
Fan Equipment Upgrade	1.6	1.6
Pump Energy Management	1.0	1.0
Air Compressor Optimization	0.7	0.7
Clean Room: Change Filter Strategy	0.7	0.7
Lighting Controls	0.7	0.7
Highbay Lighting	0.6	0.6
Fan Energy Management	0.6	0.6
Wood: Replace Pneumatic Conveyor	0.6	0.6
Air Compressor Demand Reduction	0.5	0.5

Electric Codes and Standards Savings Forecast

Estimated the impact of the Washington State Energy Code (WSEC) and federal equipment standards

WSEC accounts for 66% of C&S savings (135 aMW by 2039)

Residential lighting accounts for nearly 19% of C&S savings (39 aMW) due to EISA backstops for standard lighting and the discontinued exemption for specialty lighting



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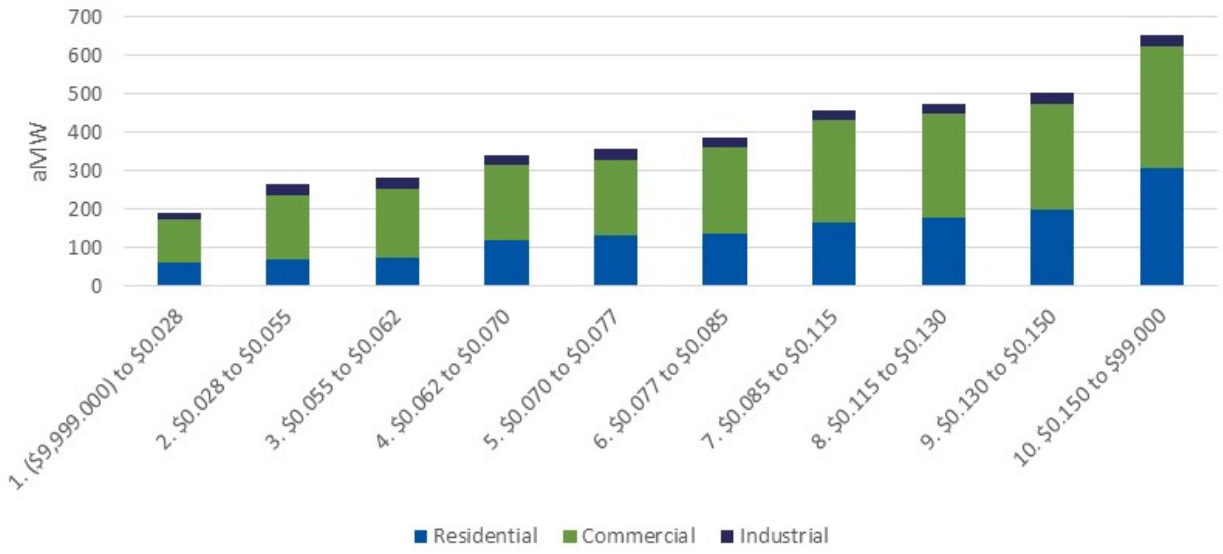
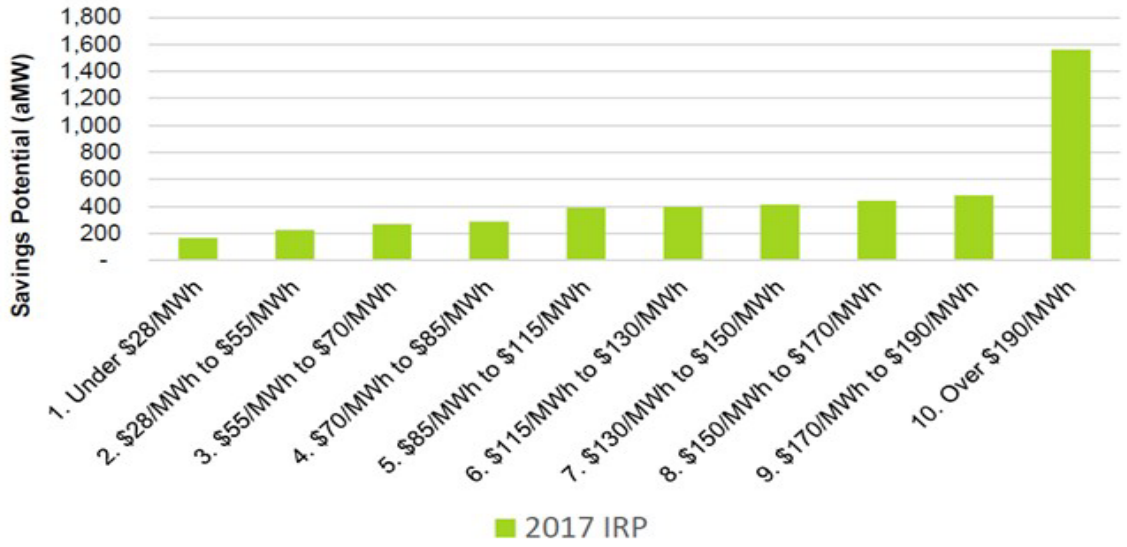
Comparison to the 2017 CPA

2019 CPA Supply Curve



2017 CPA Supply Curve



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Demand Response

Products Considered

C&I Curtailment

Large commercial and industrial

- Manual: Customers manually reduce use during peak events
- Automatic: Technology and controls are programmed to reduce use during peak events

Critical Peak Pricing

Residential and small commercial

- Customers sent a price signal leading up to a peak event.
- Either with or without a smart thermostat

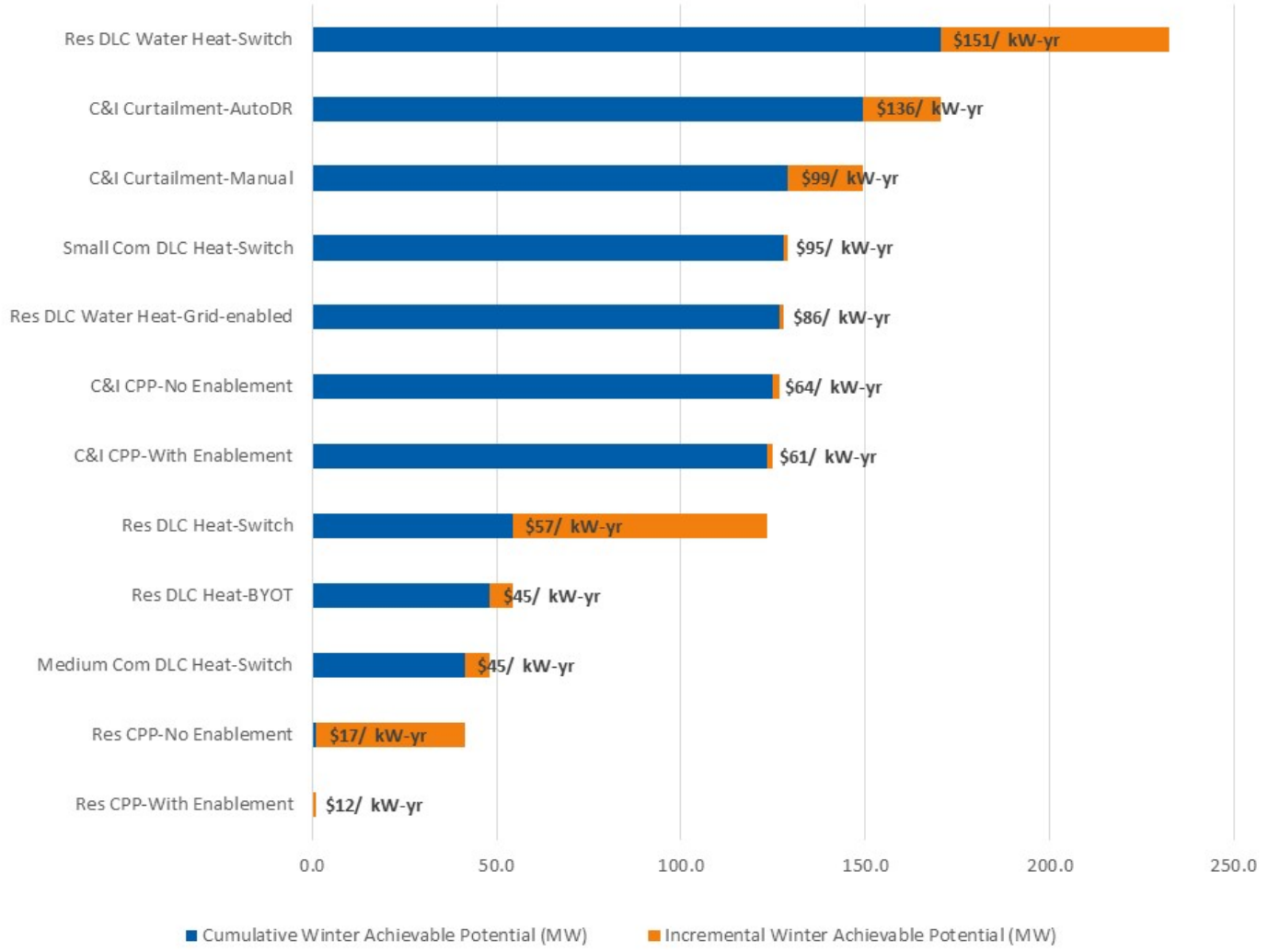
Direct Load Control

Residential and small commercial

- End uses are curtailed during peak events. End uses and control mechanisms vary
- Space heat
  - Either with a smart thermostat or with a switch
- Water heat
  - Either with a switch or through a “grid enabled” communicating water heater

DR Supply Curve

20-Year Potential and Levelized Costs



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Overview of Results

Total 20-Year DR Potential and levelized Costs

Product/Scenario	Number of events and hours curtailed (e.g. 10 4-hour events)	Notification Type (e.g. day-ahead, hour-ahead, etc.)	Achievable Potential (MW)	Percent of System Peak	Levelized Cost ($/kW-year)
Res CPP-No Enablement	10 4-hour events	Day-ahead	40.22	0.94%	$17.22
Res CPP-With Enablement	10 4-hour events	Day-ahead	1.1	0.03%	$11.91
Res DLC Heat-Switch	10 4-hour events	0-min	69.03	1.61%	$57.36
Res DLC Heat-BYOT	10 4-hour events	0-min	5.99	0.14%	$45.48
Res DLC Water Heat-Switch	10 4-hour events	0-min	62.04	1.45%	$150.75
Res DLC Water Heat-Grid-Enabled	Unlimited	0-min	1.07	0.03%	$85.77
Small Com DLC Heat-Switch	10 4-hour events	0-min	1.26	0.03%	$95.25
Medium Com DLC Heat-Switch	10 4-hour events	0-min	6.97	0.16%	$45.29
C&I Curtailment-Manual	10 4-hour events	Day-ahead (or could be as late as 2-hour-ahead)	20.46	0.48%	$99.38
C&I Curtailment-AutoDR	10 4-hour events	0-min	21	0.49%	$136.38
C&I CPP-No Enablement	10 4-hour events	Day-ahead	1.92	0.04%	$63.97
C&I CPP-With Enablement	10 4-hour events	Day-ahead	1.44	0.03%	$60.63
Total			**232.5**	**5.43%**	

Solar PV Potential

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Solar PV Technical Potential

Solar PV technical potential depends on:

Raw roof area: Building floor space, estimated number of floors, and total roof area derived from CBSA and RBSA.

Adjusted roof area: determined the portion of total roof area that can be used for Solar PV. Considers azimuth, tilt, shading, and obstructions.

Power Density: Estimates of power generated per unit area derived from the International Technology Roadmap for PV (IRTPV). Power densities increase from Roughly 16 w/sqft in 2018 to 19.4 w/sqft in 2039.

Energy Generation: Use PVWatts to determine the generation profile. Approximately 953-1090 kWh per year generated for every kW of DC nameplate capacity

Roof Area Adjustments

Building Type	Total Usable Sq. Ft (%)
Single Family Dwelling	17%
Multi Family Dwelling	35%
Commercial	65%

Solar PV Technical Potential

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Solar PV Market Potential

Calculate payback using:

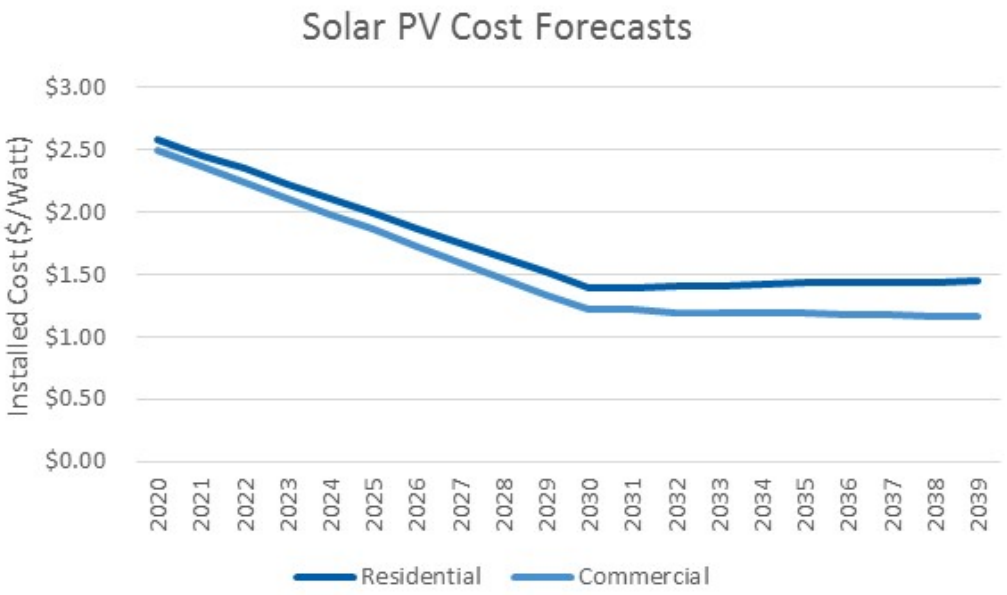
- Installed cost
- State incentives
- Federal incentives (investment tax credit)
- Energy savings

Estimate penetration using bass diffusion equation

$$MP = e^{-0.3*ASP}$$

- Where MP is the market penetration and ASP is the simple payback from the customers' perspective

Solar PV Cost Forecast



Reviewed actual and forecasted costs Lazard, NREL and EnergySage

- Similar 2017 residential costs from the three sources (~$3.3/watt). Applied NREL cost forecasts in the residential sector
- Commercial 2017 costs varied between Lazard ($2.88/watt) and NREL ($2.30/watt). Used Lazard 2017 costs and cost forecasts from NREL

Other Market Potential Assumptions

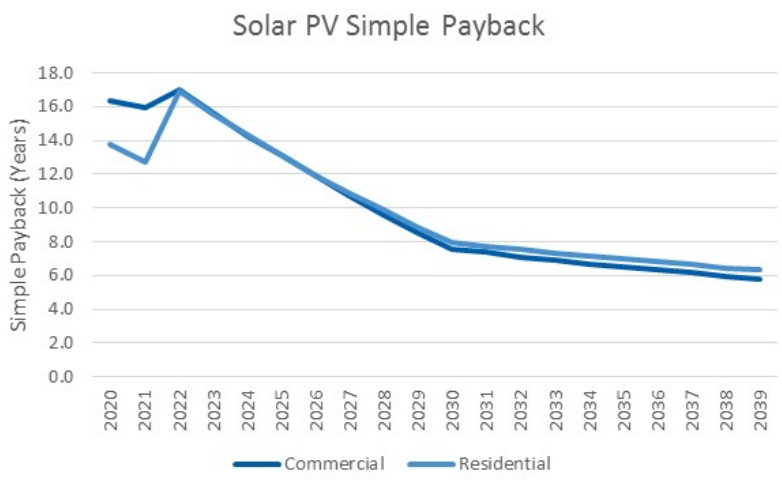
State incentives

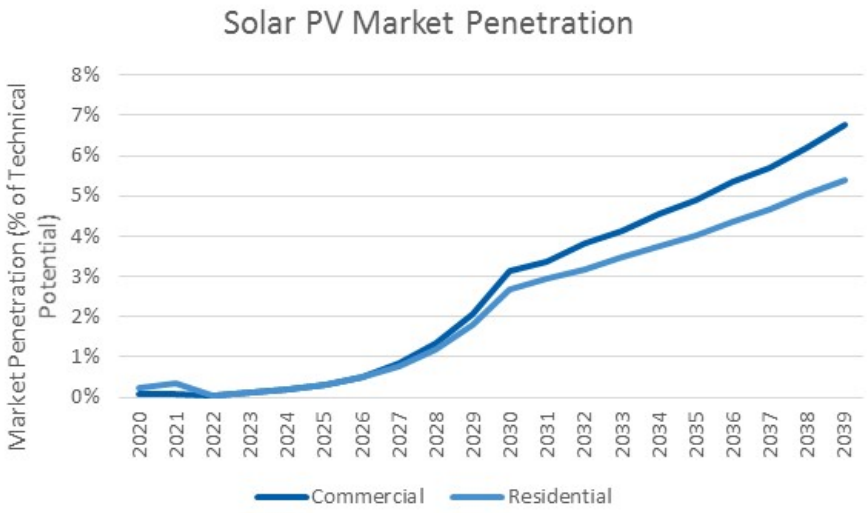
- Washington State Renewable Energy System Incentive Program (RESIP) will stop accepting applications after February 2019
- No state tax credit

Federal incentives:

- Federal ITC is 26% in 2020 and 22% in 2021. After 2021 ITC is 10% for commercial and 0% for residential

Solar PV Simple Payback and Market Penetration





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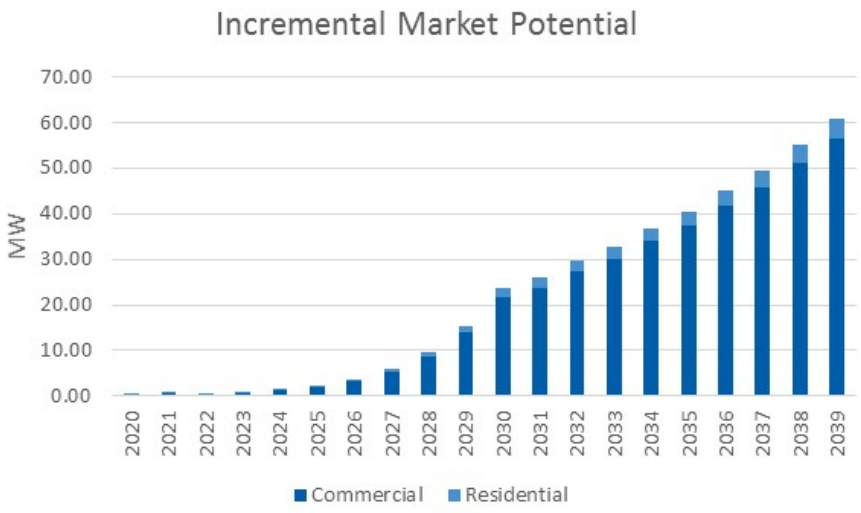
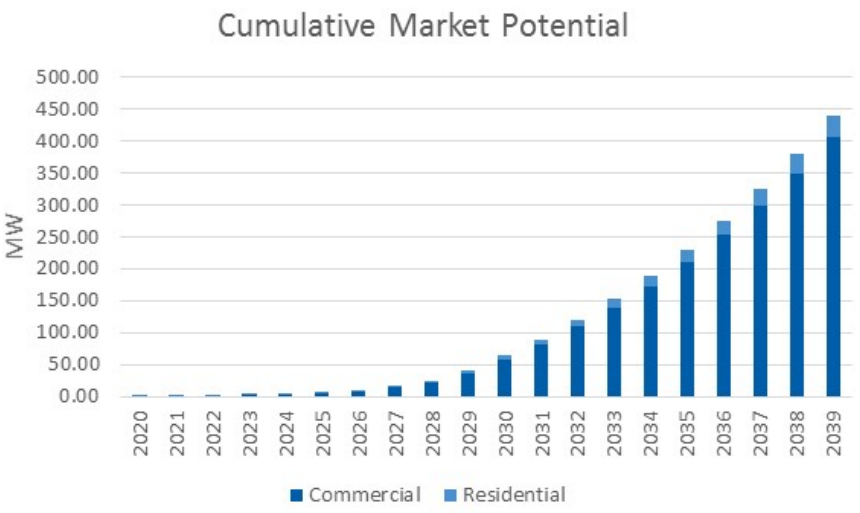
Solar PV Market Potential – Nameplate MW





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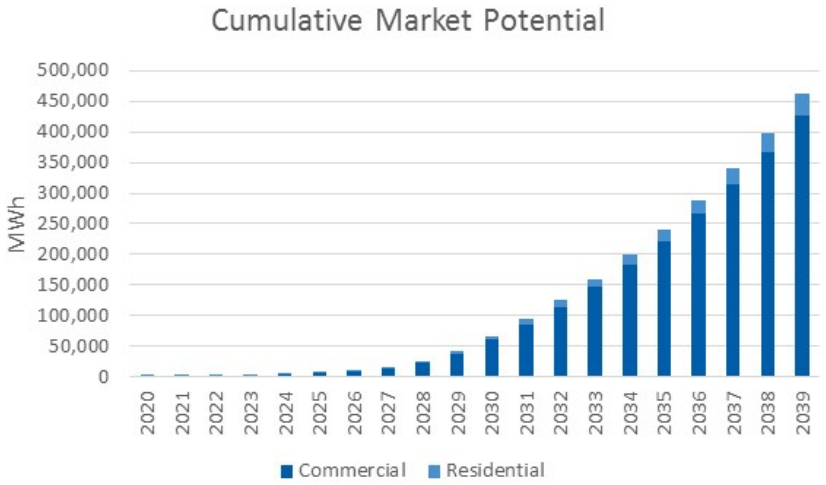
Solar PV Market Potential - MWh



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Combined and Heat and Power Potential

Technical Potential Methodology

CHP Technologies and Applicability

Nonrenewable Technologies

- Reciprocating Engines
- Microturbines
- Gas Turbines

Renewable Technologies

- Industrial Biomass (Lumber, Pulp, Paper mfg)
- Biogas (Anaerobic Digester)

Applicability

- PSE electric customers with any gas service
- C&I facilities with average monthly loads >= 30 kW
- Assume warehouses with high load are refrigerated – CHP ineligible

Technical Potential Results

2039 Cumulative Technical Potential

Existing CHP by Fuel

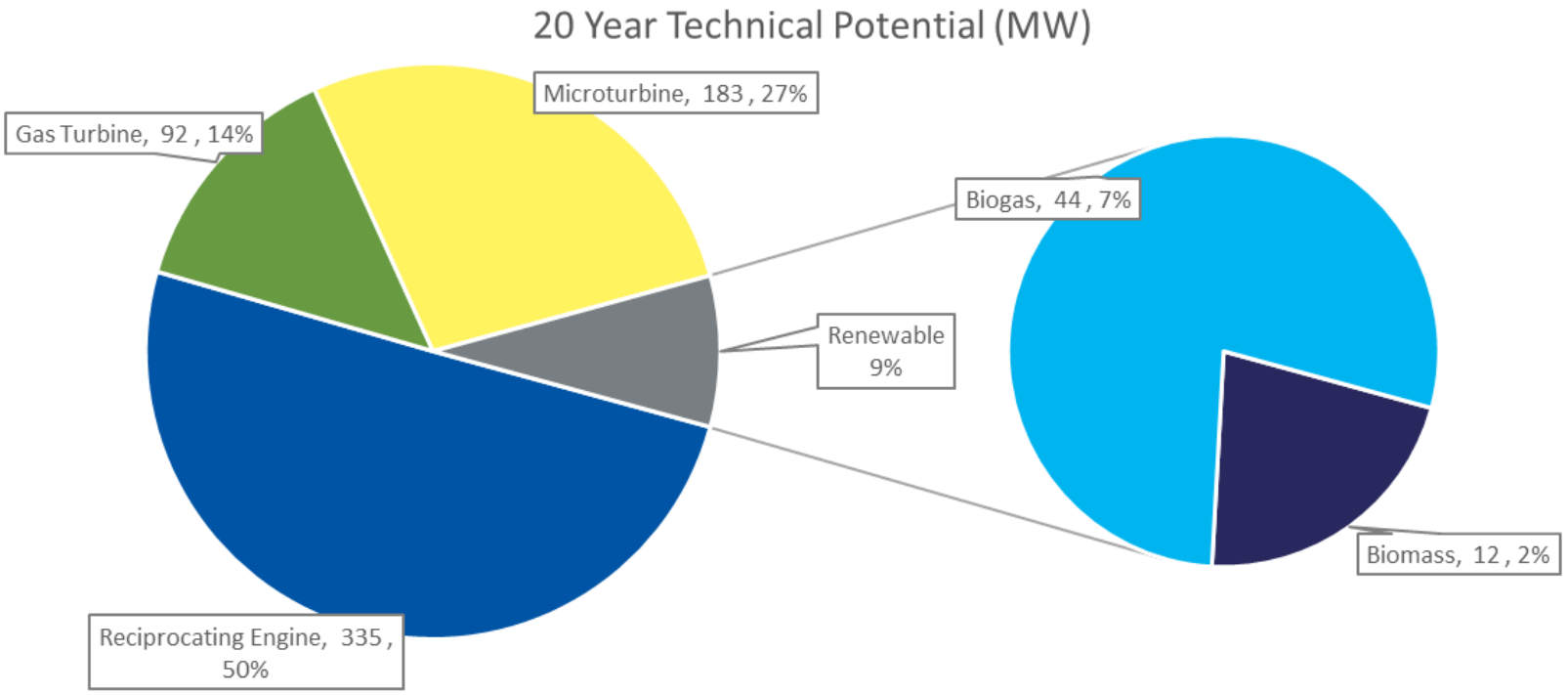
PSE	Existing Capacity
Commercial	
Natural gas MW	5
Number of sites	1
Industrial	
Natural gas MW	78
Number of sites	7
Biomass and biogas MW	0
Number of sites	0
Industrial total MW	**78**
Industrial total number of sites	**7**
Total	
Total MW	83
Total number of sites	8

CHP 2039 Cumulative Technical Potential by Fuel

PSE	Technical Potential
Commercial	
Natural gas MW	466
Number of sites	3,904
Industrial	
Natural gas MW	144
Number of sites	510
Biomass and biogas MW	56
Number of sites	103
Industrial total MW	**200**
Industrial total number of sites	**613**
Total	
Total MW	666
Total number of sites	4,517

Technical Potential Results

2039 Cumulative Technical Potential



Achievable Potential Methodology

Annual % Technical to Market

ACEEE Study & CHP Install Database

- CHP Favorable States
  - California: 0.66% per year
  - Connecticut: 0.25% per year
  - Massachusetts: 0.27% per year
- Washington (Non-favorable): 0.13% per year (2.5% over 20 years)

Navigant Assumption

- PSE Territory: 2.5% per year (50% over 20 years)

Our Assumption

- PSE Territory: 0.20% per year (4% over 20 years)
- Higher than calculated value (0.13%) from ACEEE and CHP Install Database due to incentives

Achievable Potential Results

2039 Cumulative Achievable Potential (MW) at Generator

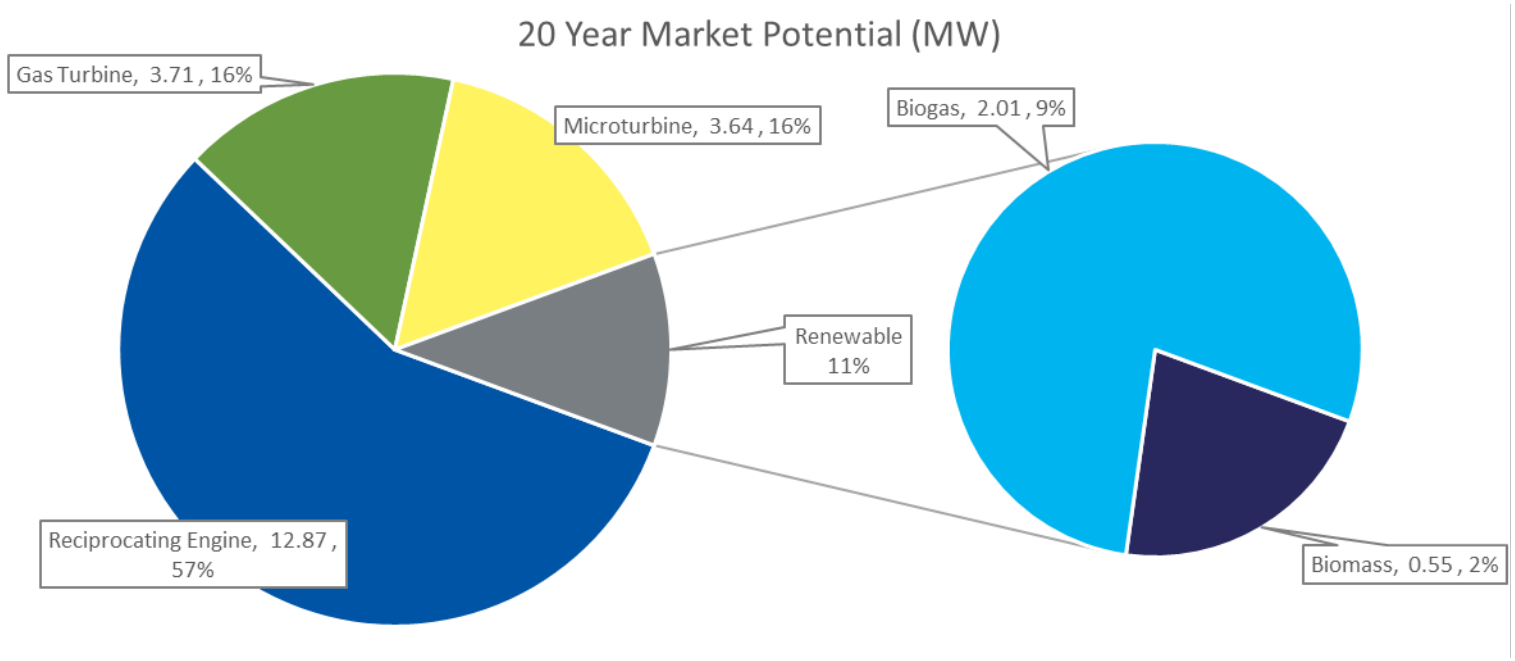
Technology	2039 MW
Nonrenewable – Natural Gas	**20.22**
30–99 kW	3.17
100–199 kW	2.79
200–499 kW	3.81
500–999 kW	2.83
1–4.9 MW	3.83
5 MW+	3.79
Renewable – Biomass	**0.55**
< 500 kW	0.00
500-999 kW	0.00
1–4.9 MW	0.02
5 MW+	0.53
Renewable – Biogas	**2.01**
Landfill	0.22
Farm	0.88
Paper Mfg	0.64
Wastewater	0.27
Total CHP	**22.78**

2039 Cumulative System Installations

Technology	Installs
Nonrenewable – Natural Gas	**110**
Reciprocating Engine	59
Gas Turbine	1
Microturbine	49
Renewables	**4**
Total CHP	**114**

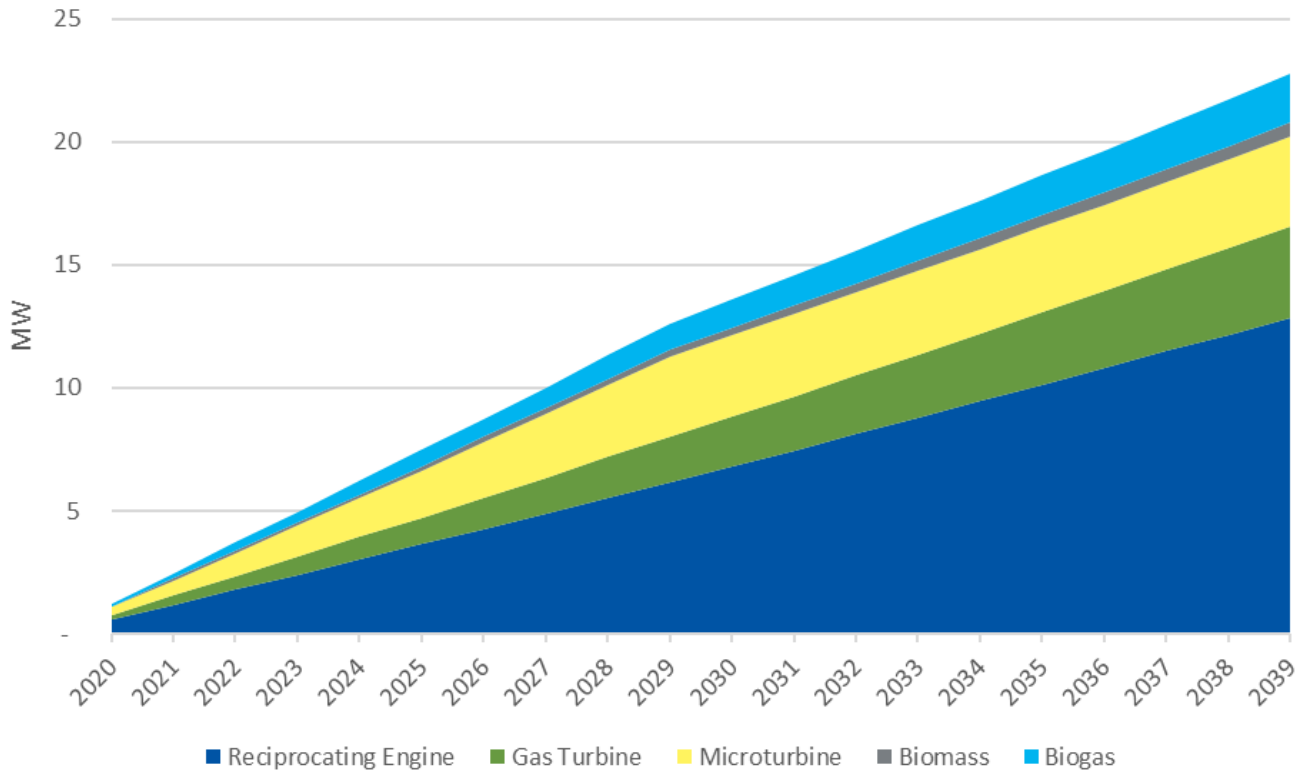
Achievable Potential Results

2039 Cumulative Achievable Potential (MW)



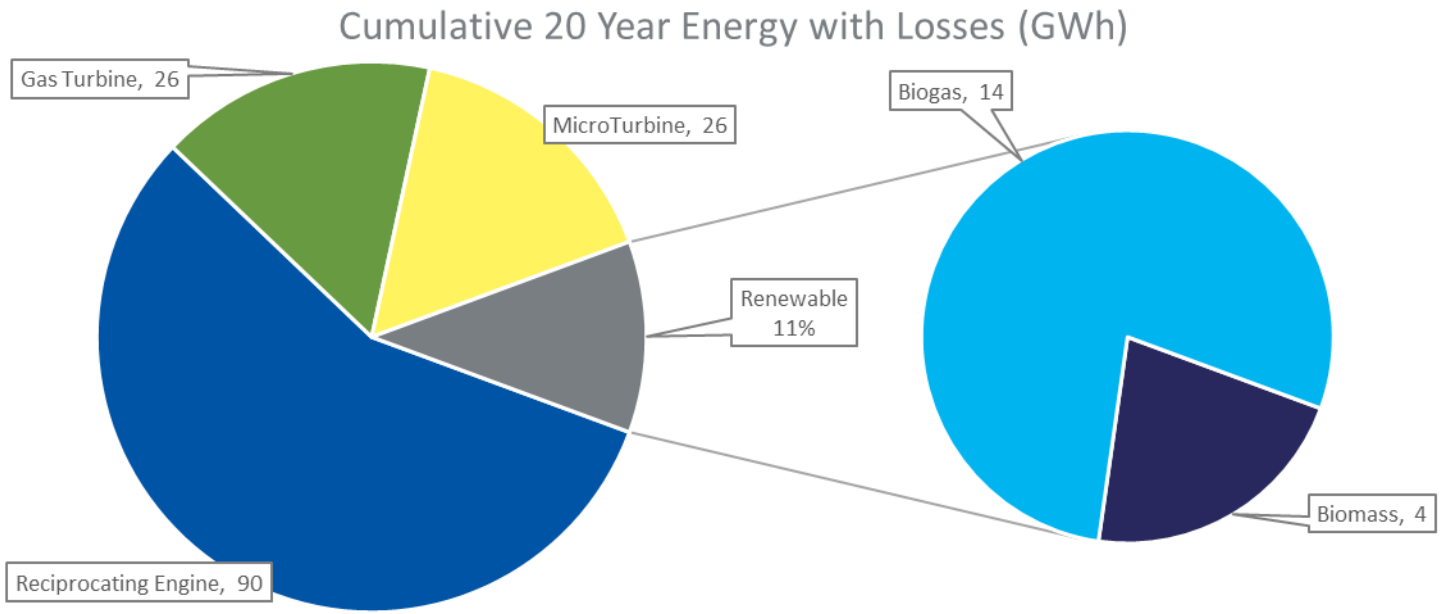
Achievable Potential Results

2039 Cumulative Achievable Potential – Nameplate Capacity



Achievable Potential Results

2039 Cumulative Achievable Potential of 18 aMW



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LCOE Methodology

Levelized Cost of Energy

Cost divided by generated energy ($/kWh)

- Net present value over equipment lifetime

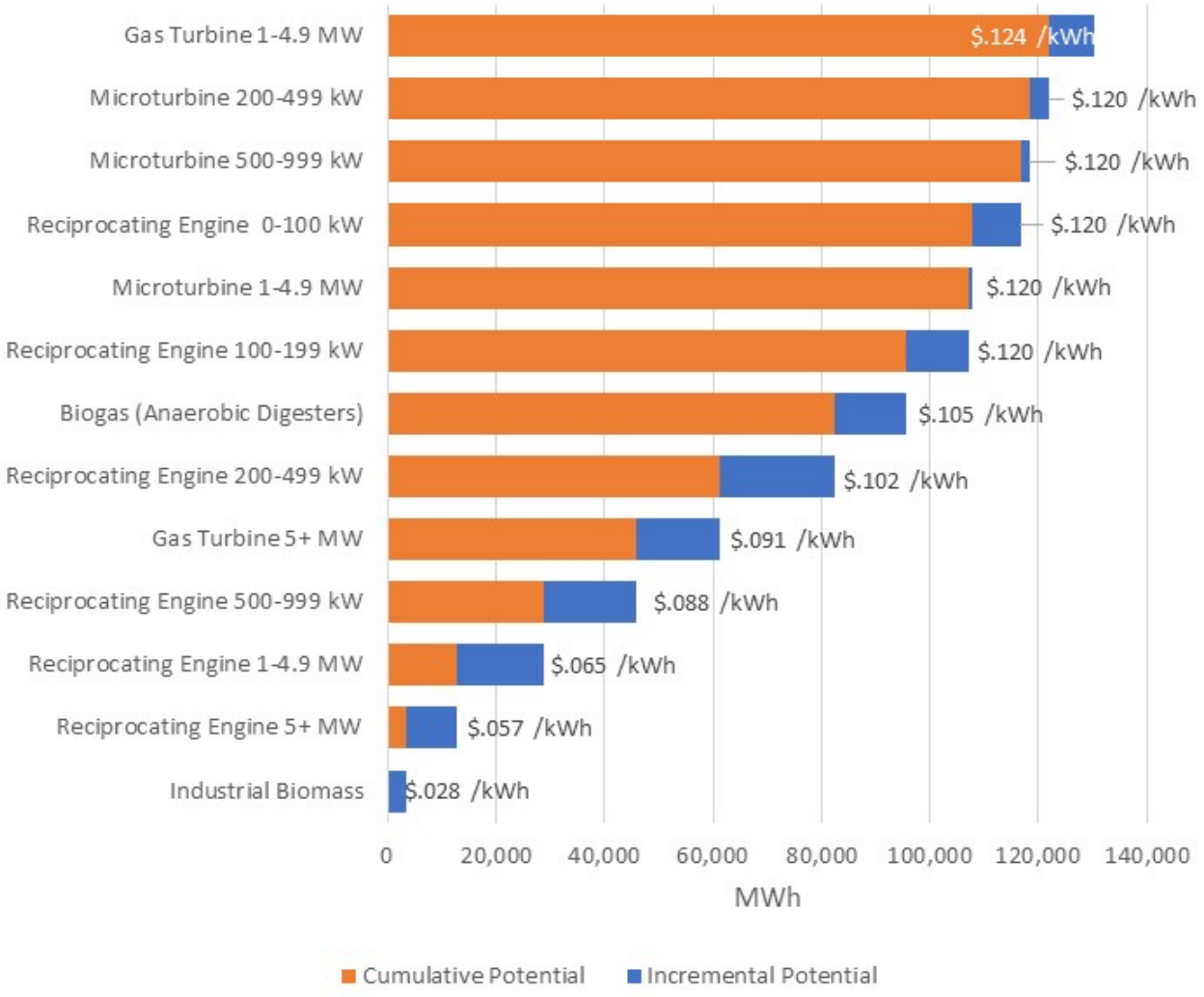
Costs

- Capital costs
- Federal tax credits and other non-PSE incentives
- Operation and maintenance costs
- Fuel costs
  - Heat produced by CHP equipment accounted for by reduced fuel costs

Generation

- Electricity generated

CHP Supply Curve



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Comparison to 2017 CPA

	2017 IRP	2019 IRP
Achievable Potential	933 aMW	18 aMW

- The 2017 IRP technical potential included the residential sector, while the 2020 IRP does not. Residential made up 62% of the 2017 IRP technical potential
- 2020 IRP does not include standalone generation (without heat recovery), which accounted for 66% of the 2017 IRP achievable potential
- Achievable potential rate was smaller in the 2020 IRP (0.2% per year versus 2.5% per year)

Distribution Efficiency Achievable Potential

- Alignment with AMI and ADMS business cases
- Schedule of ADMS project
- Schedule feasibility and infrastructure requirements when implementing Volt-VAR Optimization (VVO)

By the numbers:

- 158 Substations total out of 297 meet criteria of 50% residential Load
- 10 Complete by end of 2018
- 3 complete in 2019
- Remaining 137 – 2019 IRP study period
- Future will incorporate additional controls to maintain stability in system
    - Shift from Line Drop Compensation (LDC) to Volt-VAR Optimization (VVO)

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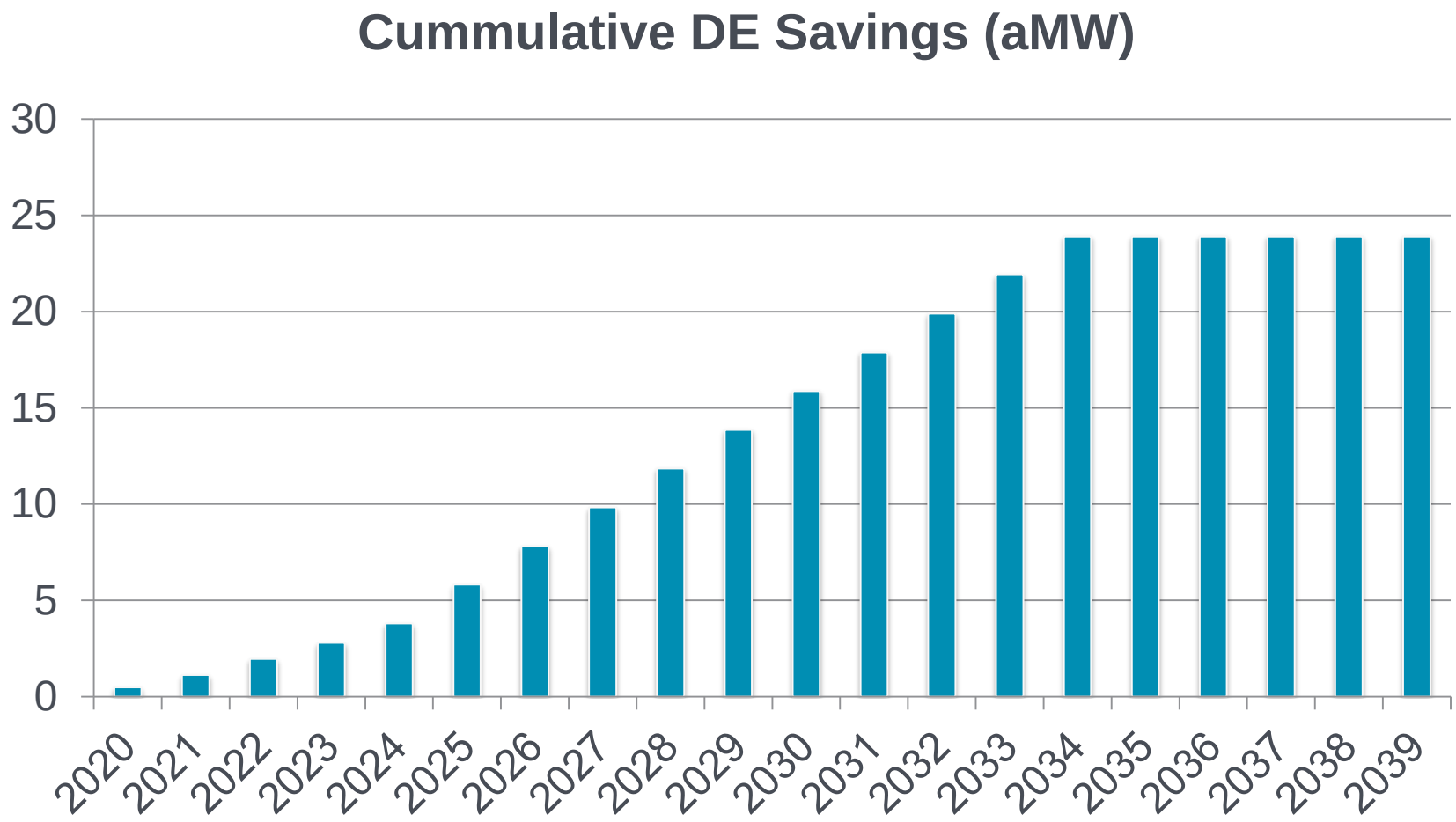
Distribution Efficiency Achievable Potential



PUGET SOUND ENERGY

Break for lunch on your own

Natural gas demand side resources and DSR sensitivities

Cadmus presentation

December 6, 2018 TAG #3

Natural Gas Conservation Potential Results

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Natural Gas Conservation Potential

Achievable Technical Conservation Potential

Sector	2021	2029	2039
Cumulative Achievable Potential (MMTherms)			
Residential	19	106	140
Commercial	4	25	33
Industrial	1	4	4
Total	**23**	**136**	**177**
Percent of Baseline Sales			
Residential	3%	16%	20%
Commercial	1%	7%	8%
Industrial	3%	16%	17%
Total	2%	13%	16%

Comparison to 2017 CPA

	20-Year Achievable Technical Potential (% of Sales)			Total Achievable Technical Potential (MMTherms)
	Residential	Commercial	Industrial	
Natural Gas Resources				
2019 IRP	20%	8%	17%	177
2017 IRP	14%	15%	17%	164

Comparison to the 2017 CPA

Natural Gas

- Efficient furnaces are the highest saving measure in both assessments
  - ~20 MMTherms in the 2017 study and 35 MMTherms in the 2019 study
- The 2017 identified higher commissioning potential
  - Approximately 14 MMTherms in the 2017 study and nearly 7 MMTherms in the 2019 study
- New weatherization measures, such as low-e storm windows, contribute to higher gas potential

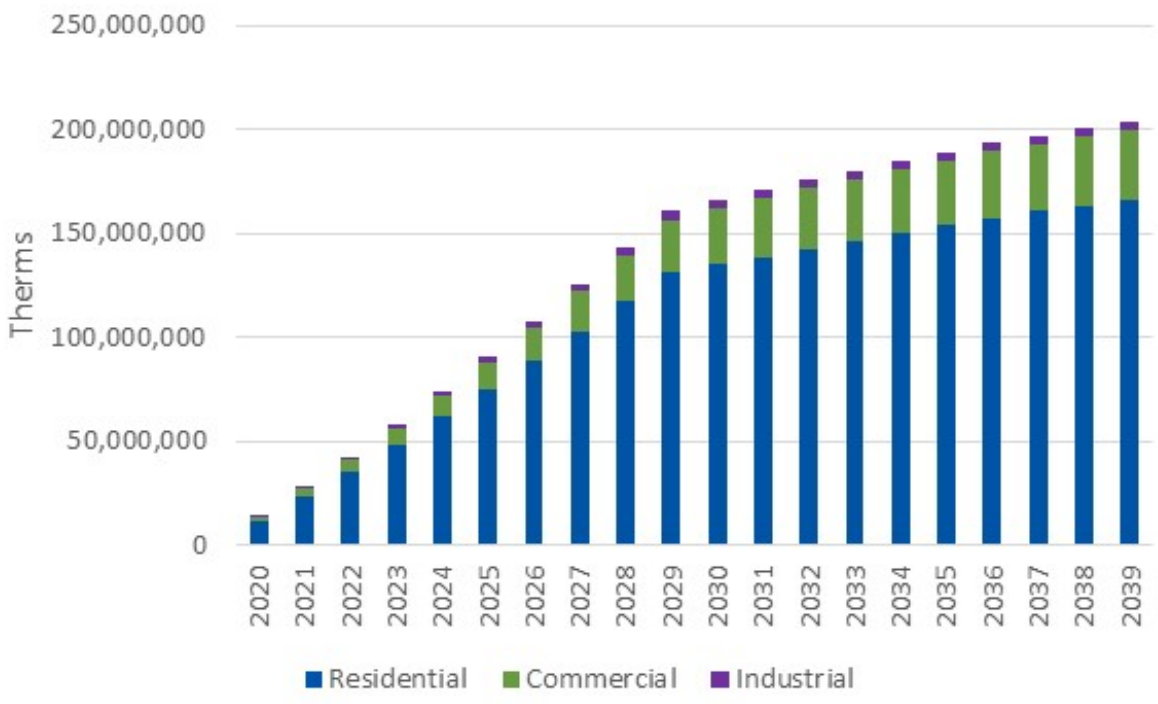
Natural Gas Conservation Forecast

Cumulative Achievable Technical Potential Forecast

Discretionary measures receive a flat 10-year ramp rate

Lost opportunity measures (new construction and natural replacement) assigned 7th Plan ramp rates

Cadmus adjusted ramp rates to match program activity and expectations



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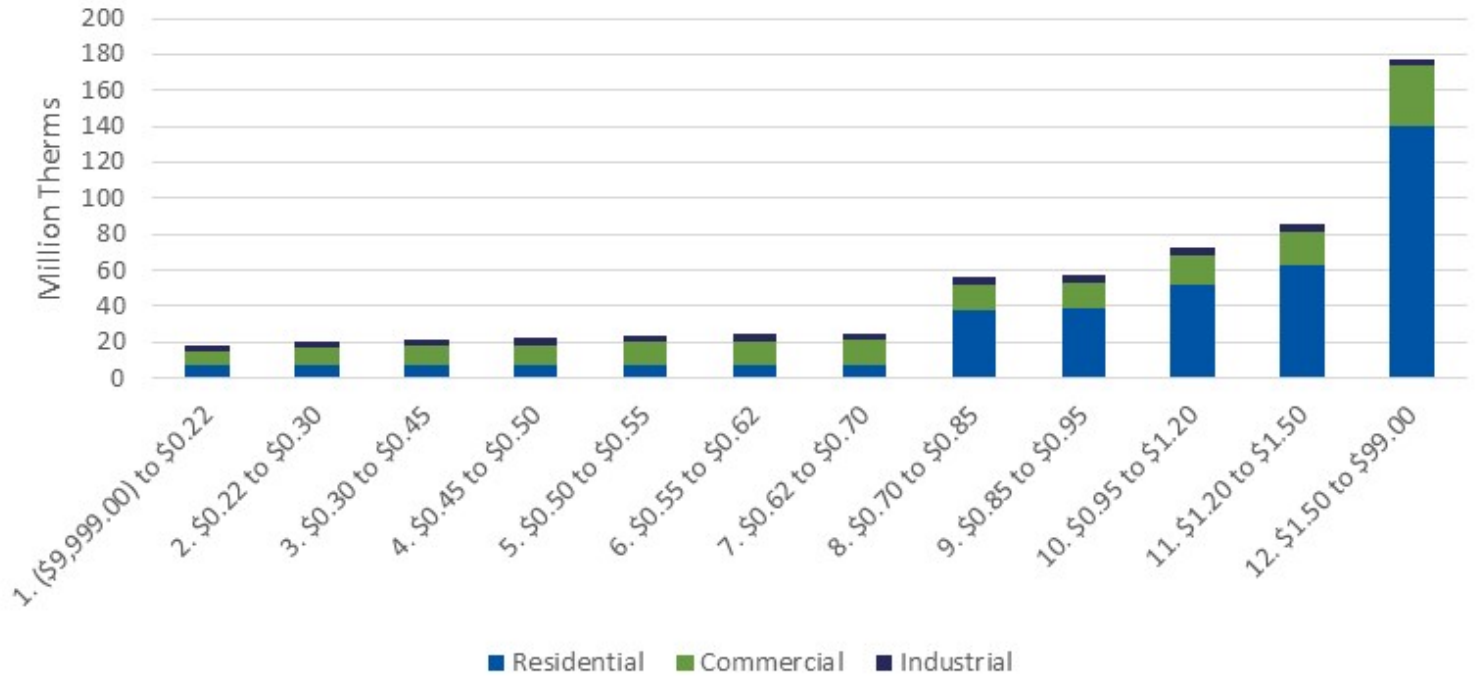
Natural Gas Supply Curve

Cumulative 20-Year Achievable Technical Potential by Levelized Cost Bundle



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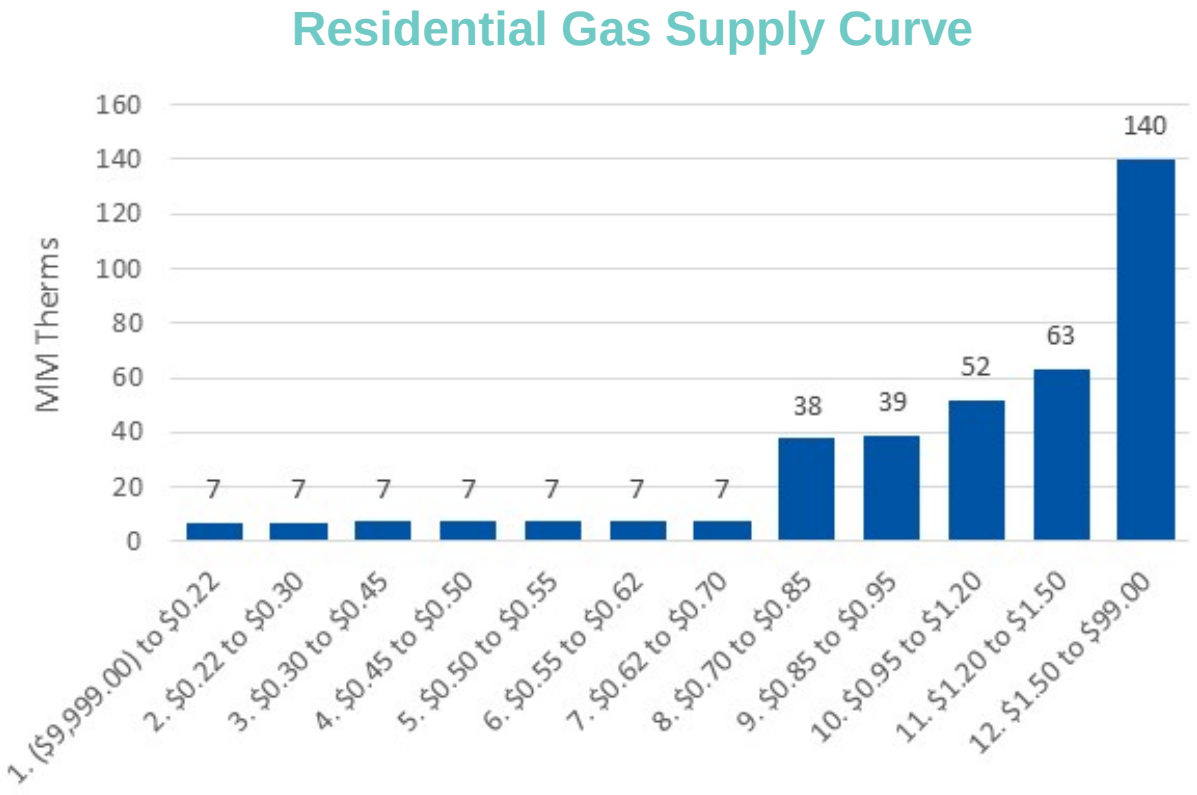
Residential Gas Potential Summary



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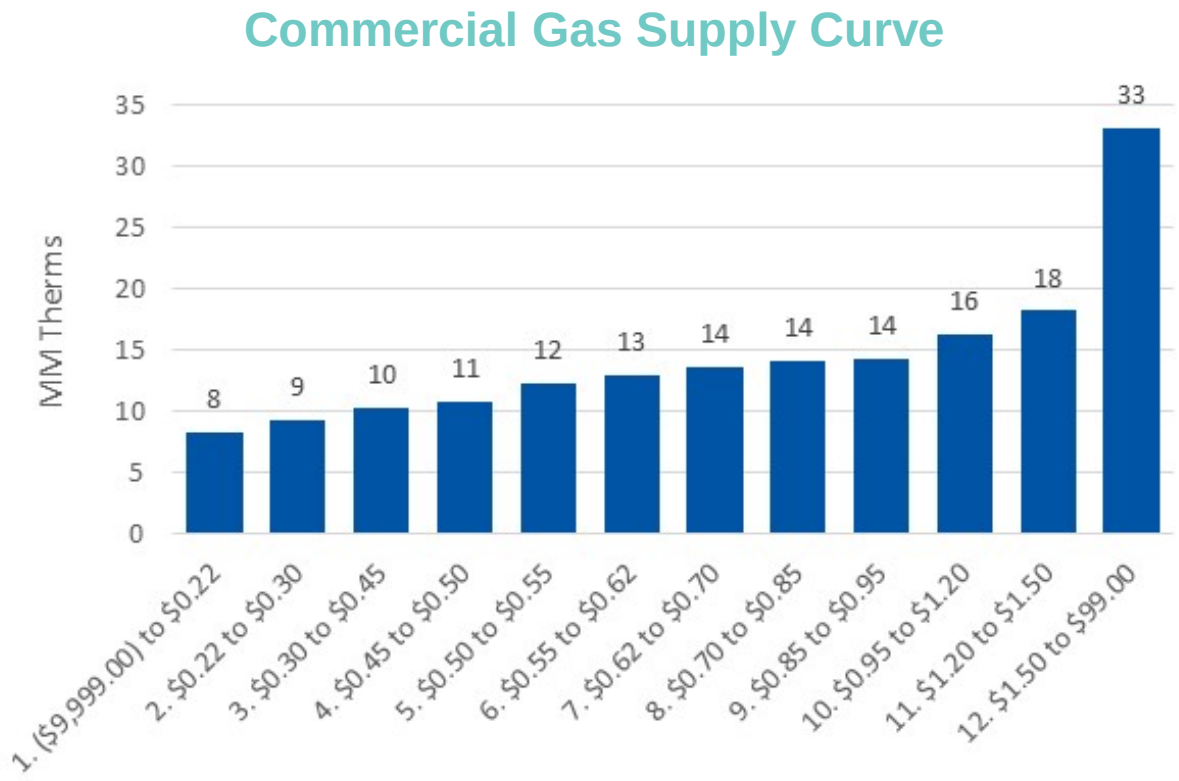
Top Residential Gas Measures

Measure Name	Cumulative 10-Year Achievable Technical Potential (MDth)	Cumulative 20-Year Achievable Technical Potential (MDth)
Windows Double Pane - U30	2,611	2,611
Infiltration Reduction - CFM50 reduction	1,202	1,202
Wall Insulation_R0 - R11	971	971
ENERGY STAR Furnace	880	3,172
Web-Enabled Thermostat	769	769
Duct Insulation - R0 to R8	603	603
Door Weatherstripping	417	417
Home Energy Reports	378	378
Attic Insulation_R0 - R38	273	273
Duct Sealing	263	263
Windows_Single Pane - U30	216	216
Storage Water Heater .67 EF	213	664
Low E Storm Window_Double Pane Metal Frame	210	210
Tankless Water Heater .91 EF	178	606
Floor Insulation_R0 - R19	173	173

Commercial Gas Potential Summary



Top Commercial Gas Measures

Measure Name	Cumulative 10-Year Achievable Technical Potential (MDth)	Cumulative 20-Year Achievable Technical Potential (MDth)
Commissioning	675	675
Advanced Rooftop Controls	207	358
Refrigerated Display Case Door	333	333
Furnace LT 225 kBtuh High AFUE 92% Non-Weatherized	141	297
Connected Thermostats	236	283
Commercial SEM	157	157
Furnace GT 225 kBtuh High 92% TE CWAF	61	151
Steam Cooker	76	124
Integrated Space and Water Heat 90% AFUE	22	72
Secondary Glazing Window	72	72
Rack Oven	55	65
Boiler 300 to 2500 kBtuh AFUE 95%	27	57
Boiler LT 300 kBtuh AFUE 90%	26	55
Economizer	54	54
Conveyor Ovens	45	53

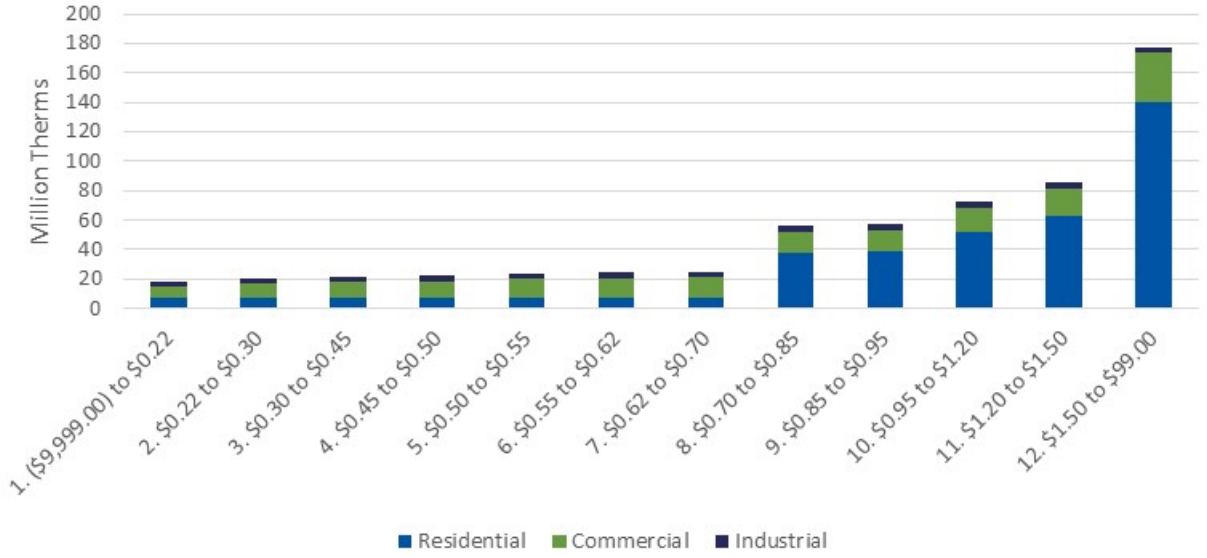
Top Industrial Measures

Measure Name	Cumulative 10-Year Achievable Technical Potential (MDth)	Cumulative 20-Year Achievable Technical Potential (MDth)
Optimize Ventilation System	37	37
Building Envelope Insulation Improvements	33	33
Analyze Flue Gas For Proper Air/Fuel Ratio	32	32
Equipment Upgrade - Replace Existing HVAC Unit With High Efficiency Model	31	31
Improve Combustion Control Capability And Air Flow	29	29
HVAC Equipment Scheduling Improvements - HVAC Controls, Timers Or Thermostats	29	29
Building Envelope Infiltration Improvements	26	26
Optimize Heating System To Improve Burner Efficiency, Reduce Energy Requirments And Heat Treatment Process	25	25
Waste Heat From Hot Flue Gases To Preheat	25	25
Install Or Repair Insulation On Condensate Lines And Optimize Condensate	25	25
Heat Recovery And Waste Heat For Process	19	19
Equipment Upgrade - Boiler Turbulators	18	18
Boiler - Operation, Maintenance, And Scheduling	18	18
Repair Or Replace Steam Traps	16	16
Isolate And Prevent Infiltration Of Heat Loss From Equipment	15	15

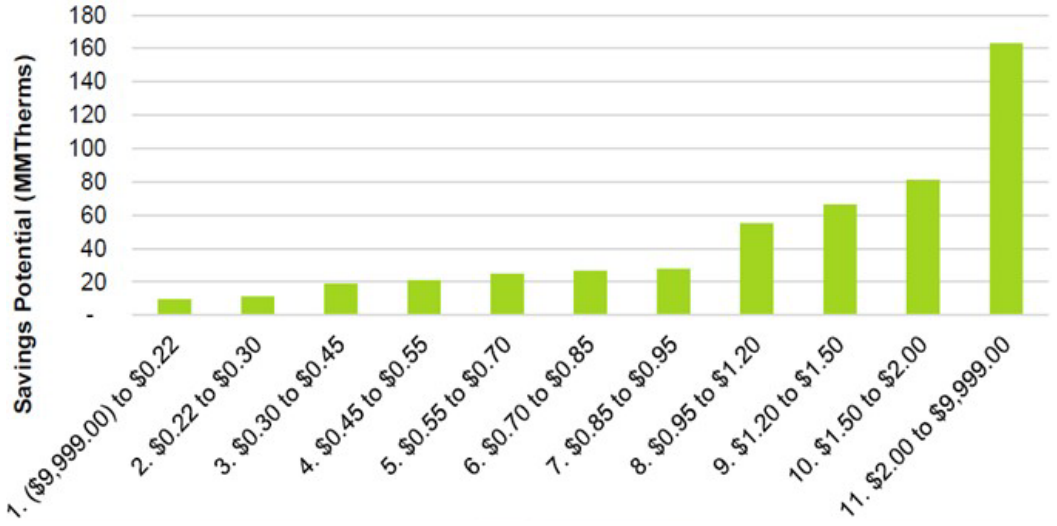
Comparison to the 2017 CPA

Supply Curves

2019 CPA



2017 CPA



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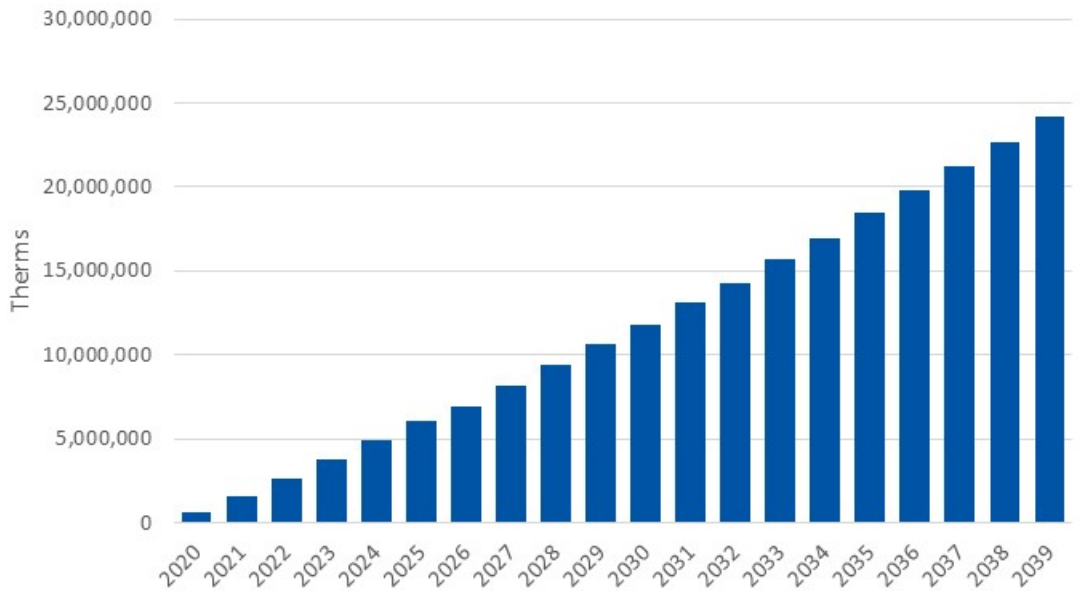
Natural Gas Codes and Standards

Analysis considers the impact of federal boiler standards (84% AFUE), the Washington State Energy Code (WSEC) and the Seattle Energy Code (SEC).

Nearly all of the savings identified comes from building energy codes



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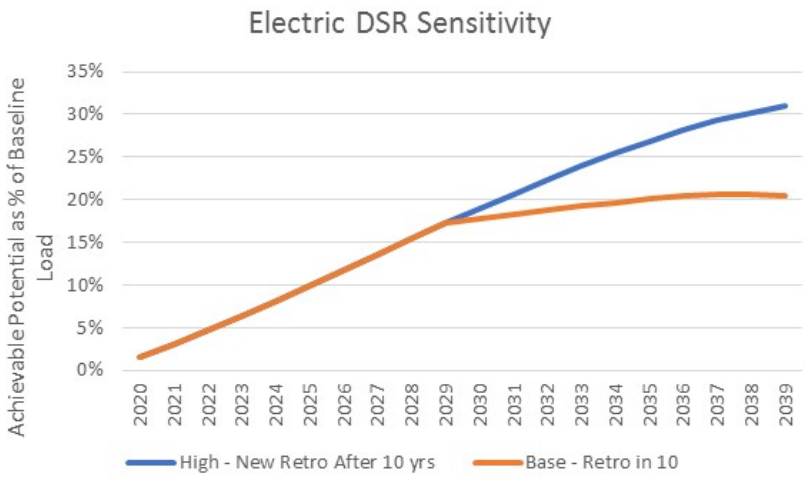
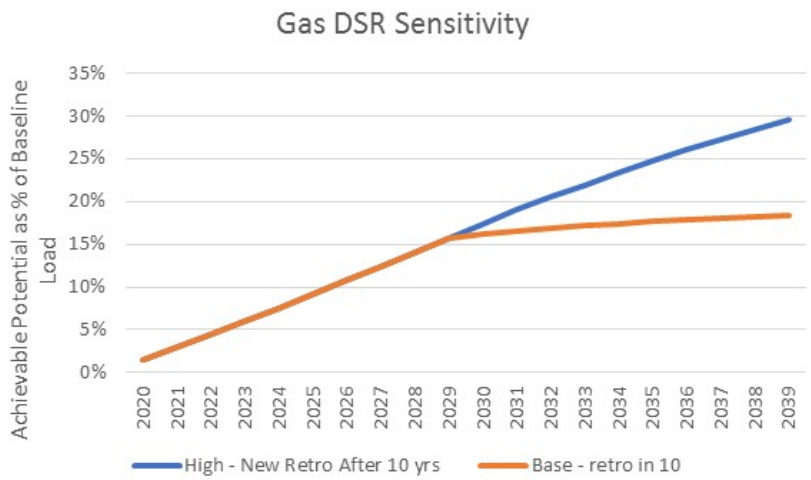
DSR Sensitivities

DSR Sensitivity – Retrofit Ramping

Two Scenarios:

- Base: Retrofit savings from known technologies are acquired over 10 years.
- High: Retrofit savings from new (unknown) technologies produce savings after the 10th year.





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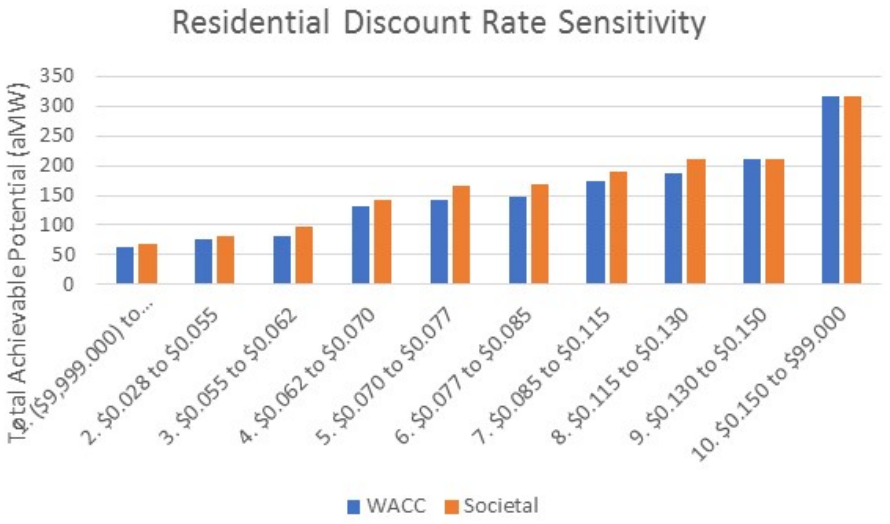
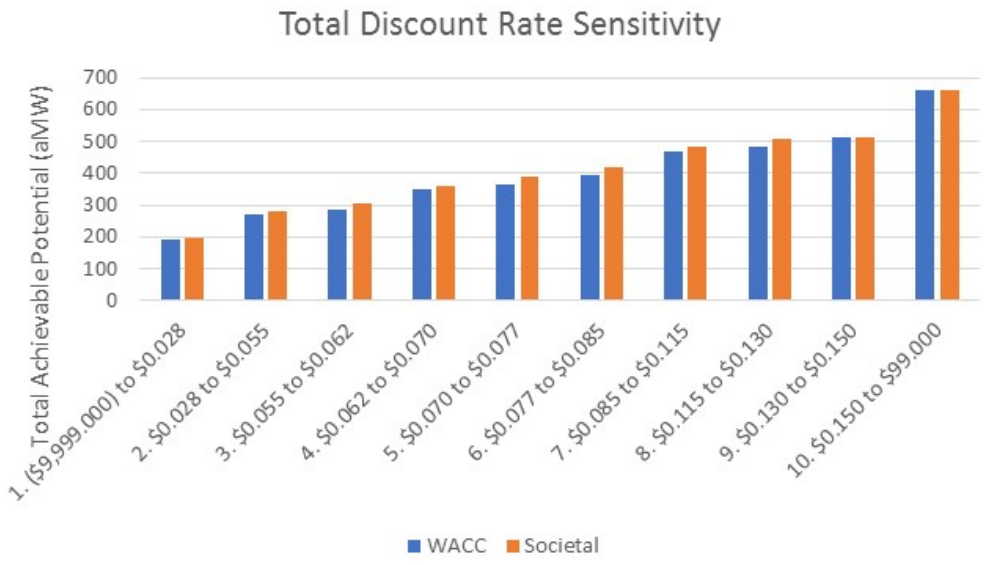
DSR Sensitivity – Residential Discount Rate

Electric

Tested the sensitivity to using a different discount rate in the residential sector:

- WACC: Discount rate in all sectors equal to PSE's weighted average cost of capital (7.6% nominal)
- Societal: Discount rate in the residential sector equal to 7th Plan discount rate (4% real)





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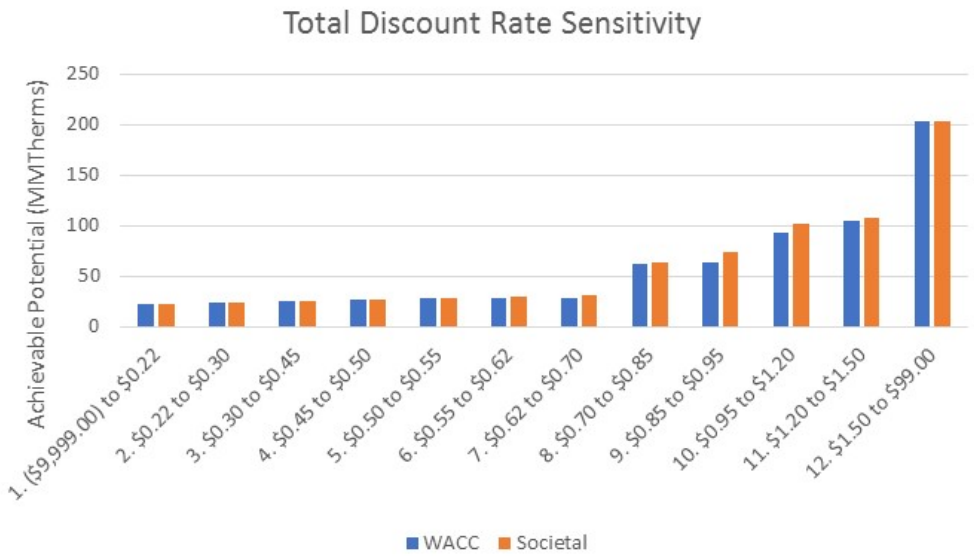
DSR Sensitivity

Natural Gas



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Next Steps

- Include demand-side resources in IRP modeling
- Draft report Issued with Draft IRP
- Final report with Final IRP

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Travis Walker

Senior Associate | Energy Services

503.575.4564

Action items and next steps

Next steps

Date	Action
December 20, 2018	PSE posts draft meeting notes with action items on IRP website and distributes draft meeting notes to TAG members
December 27, 2018	TAG members review meeting notes and provide comments to PSE
January 3, 2019	PSE posts final meeting notes on IRP website

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IRP comment period

December 6, 2018 TAG #3