Avoided Costs and Demand Side Resources for the 2022 IRP-Technical Working Group #4

Avoided Costs and Demand Side Resources (IRP-TWG #4)
April 13, 2022

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Forward Looking Statement

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This and other presentations made by NW Natural from time to time, may contain forward-looking statements within the meaning of the U.S. Private Securities Litigation Reform Act of 1995. Forward-looking statements can be identified by words such as "anticipates," "intends," "plans," "seeks," "believes," "estimates," "expects" and similar references to future periods. Examples of forward-looking statements include, but are not limited to, statements regarding the following: including regional third-party projects, storage, pipeline and other infrastructure investments, commodity costs, competitive advantage, customer service, customer and business growth, conversion potential, multifamily development, business risk, efficiency of business operations, regulatory recovery, business development and new business initiatives, environmental remediation recoveries, gas storage markets and business opportunities, gas storage development, costs, timing or returns related thereto, financial positions and performance, economic and housing market trends and performance shareholder return and value, capital expenditures, liquidity, strategic goals, greenhouse gas emissions, carbon savings, renewable natural gas, hydrogen, gas reserves and investments and regulatory recoveries related thereto, hedge efficacy, cash flows and adequacy thereof, return on equity, capital structure, return on invested capital, revenues and earnings and timing thereof, margins, operations and maintenance expense, dividends, credit ratings and profile, the regulatory environment, effects of regulatory disallowance, timing or effects of future regulatory proceedings or future regulatory approvals, regulatory prudence reviews, effects of regulatory mechanisms, including, but not limited to, SRRM and the Company's infrastructure investments, effects of legislation, including but not limited to bonus depreciation and PHMSA regulations, and other statements that are other than statements of historical facts.

Forward-looking statements are based on our current expectations and assumptions regarding our business, the economy and other future conditions. Because forward-looking statements relate to the future, they are subject to inherent uncertainties, risks and changes in circumstances that are difficult to predict. Our actual results may differ materially from those contemplated by the forward-looking statements, so we caution you against relying on any of these forward-looking statements. They are neither statements of historical fact nor guarantees or assurances of future performance. Important factors that could cause actual results to differ materially from those in the forward-looking statements are discussed by reference to the factors described in Part I, Item 1A "Risk Factors," and Part II, Item 7 and Item 7A "Management's Discussion and Analysis of Financial Condition and Results of Operations," and "Quantitative and Qualitative Disclosure about Market Risk" in the Company's most recent Annual Report on Form 10-K, and in Part I, Items 2 and 3 "Management's Discussion and Analysis of Financial Condition and Results of Operations" and "Quantitative and Qualitative Disclosures About Market Risk", and Part II, Item 1A, "Risk Factors", in the Company's quarterly reports filed thereafter.

All forward-looking statements made in this presentation and all subsequent forward-looking statements, whether written or oral and whether made by or on behalf of the Company, are expressly qualified by these cautionary statements. Any forward-looking statement speaks only as of the date on which such statement is made, and we undertake no obligation to publicly update any forward-looking statement, whether as a result of new information, future developments or otherwise, except as may be required by law.

Today’s Agenda- Demand-Side Resources

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- Procedures and Introductions
- Recap of Previous TWGs
- Avoided Costs
- OR Sales Customer Energy Efficiency Projection- Energy Trust of Oregon
- OR Transportation Schedule Energy Efficiency Projection – AEG
- WA Energy Efficiency Projection
- Emerging Demand-side Technologies – GTI and NEEA
- Demand-side Options Assumptions

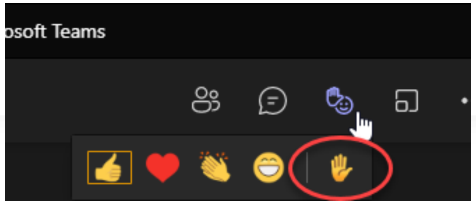
Procedures for Participation

- Please mute your microphones during the presentation, except when commenting and or asking a question
- All participants are muted upon entry into the meeting

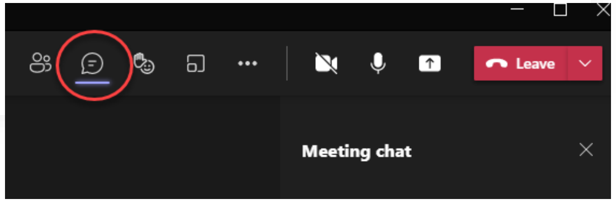
- Cameras are optional and up to each participant to use
- All participants cameras are set to off upon entry into the meeting

- Add a comment or question at any time using the “raised hand” or the chat box

Raised hand function is found in the reactions

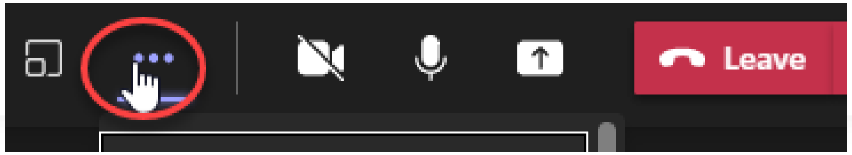


Chat box will open when you click on the conversation bubble



- Microsoft Teams has a live caption function for any participant to use

Click the ellipses, then chose “turn on live captions”



2 Minutes for Safety:

Birthday Party Safety Tips

Food Safety & Allergies

- Avoid highly allergenic foods & provide options for those with allergies or intolerances
- If possible, let guests know of the menu choices ahead of time & label items when served
- Always follow proper food handling & storage procedures

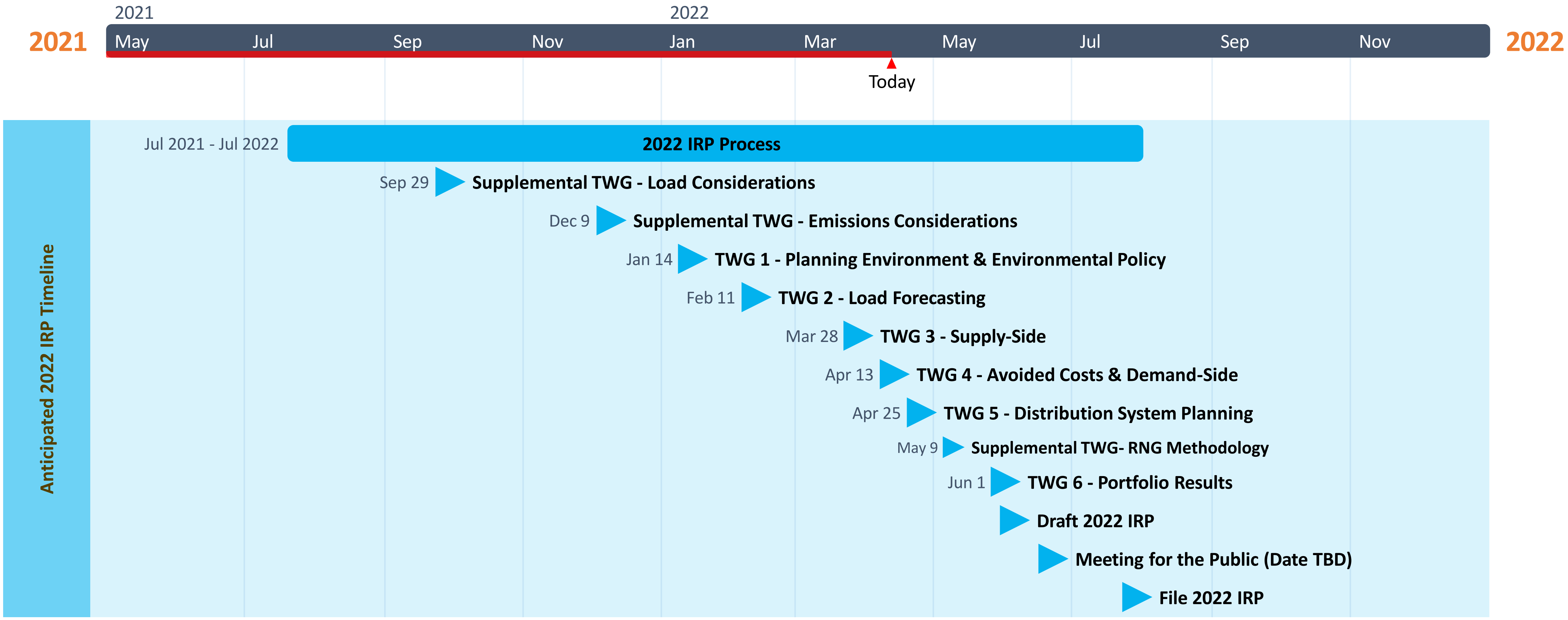
Fire Safety

- Even birthday candles can pose a fire risk:
  - Observe basic fire safety
  - Be mindful of flammable decorations &/or other items that may be near the candles
  - Grilling or BBQ?
    - Be sure to keep little ones at a safe distance
    - Keep a fire extinguisher nearby

Party Favors & Entertainment

- Be mindful of potential choking hazards from party favors such as cake toppers, balloons, & noise makers
- Pinatas, Pools, Bounce Houses, & other forms of party entertainment:
  - Consider safety hazards & act accordingly

2022 IRP Anticipated Timeline



IRP on the NW Natural website

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Find information about NW Natural's IRP on our website

- Integrated Resource Plan page: https://www.nwnatural.com/about-us/rates-and-regulations/resource-planning

Integrated Resource Plan

- Resource planning process +
- IRP working groups & public meetings +
- Current and previous IRPs +
- 2018 IRP - letter from David H. Anderson, NW Natural President and CEO +

Click the tabs to expand each section

IRP working groups & public meetings −

Please feel free to get in touch with us with questions about the IRP, or to be added to a workshop or Technical Working Group (TWG) for our next plan.

All meetings listed below are tentative and subject to change.

Workshops
TBD

2022 IRP Technical Working Groups (TWG)	Date
TWG 1 - Planning Environment and Environmental Policy Presentation - TWG 1 (.pdf) Erratum Notice (.pdf)	January 14, 2022
TWG 2 - Load Forecasting Presentation - TWG 2 (.pdf) Erratum Notice (.pdf)	February 11, 2022
TWG 3 - Avoided Costs and Demand-Side Resources	April 13, 2022
TWG 4 - Supply-Side Resources	March 28, 2022
TWG 5 - Distribution System Planning	April 25, 2022
TWG 6 - Portfolio Results & Actions	May 9, 2022

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IRP Process, Objectives, and Evolution

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The IRP process is a public process and we welcome your feedback and participation!

- IRP participants come to the process with varying backgrounds and familiarity with IRP planning, and that is ok! Our IRP benefits from diverse perspectives
- We strive to strike the right balance in terms of the technical material presented, but are always evaluating the appropriate level of detail and might not always get it right

NW Natural's views on scope and role of the IRP:

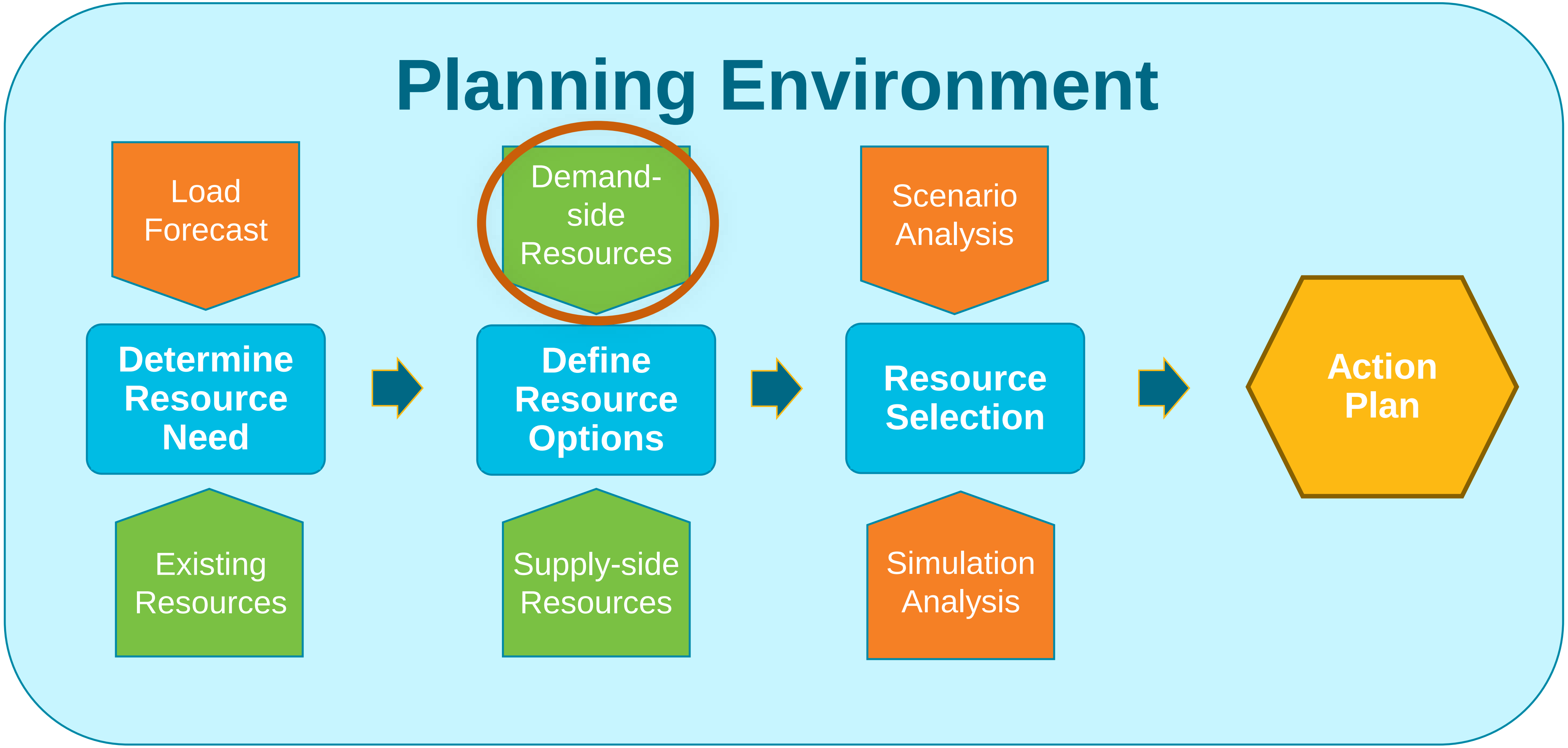
- Rules and guidelines from the legislature and our regulatory commissions define the scope and purpose of IRPs and are grounded in a least cost-least risk approach to utility resource planning
- IRP rules and guidelines require robust planning that is highly complex and requires advanced modeling techniques and tools that are critical to serving our customers' needs as best we can
- IRPs assess the implications of the policy and market environment and how changes to that environment would impact meeting customer needs
- The IRP process is not a policy *making* process nor the best forum to discuss what policies should (or should not) be adopted

NW Natural acknowledges that IRPs are evolving and the active discussions about the role of IRPs and ways to make the process more inclusive and transparent as well as coordinate work across utilities

- We are proactively looking at ways to improve our IRP process and outreach and are excited to be able to lean on the experience and expertise of the Community and Equity Advisory Group NW Natural is forming moving forward

We value open and constructive discussion and IRP workshops are *LONG* meetings; we are bound to misspeak from time to time and we apologize in advance!

IRP Process



Green = Resources   Orange = Tools

Overview of Previous TWG

TWG #3- Supply Side Resources – Presentation Topics

Scenario Feedback

- The IRP team reviewed, at a high level, feedback received from stakeholders on the 2022 IRP scenarios and NW Natural's proposal to utilize the average of simulation draws as the base case to account for uncertainty in load scenarios.

Focus on Supply-side Resources

- Differences and overlap between gas supply capacity and distribution capacity resources
- Existing supply-side resources and an overview of conventional market fundamentals
- Portland LNG contribution to serving current load
  - Overview of the required cold box to continue operations at Portland LNG
  - Overview of alternatives to the cold box to maintain reliable service for current peak day operations
- ICF reviewed and discussed the availability of Renewable Natural Gas (RNG) and hydrogen resources at a national level
- Policy environment and markets for RNG and Hydrogen, as well as current NW Natural projects
- A brief overview of NW Natural's methodology for evaluating the incremental cost of RNG resources

Avoided Costs

What are Avoided Costs?

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- A way to compare the costs of a resource against the costs that are saved (avoided) by having that resource in the portfolio
- A comparison of a "but for" world
- Example question:

  "If we incur the costs to acquire this energy efficiency, how much cost would that save in terms of the energy that would not need to be delivered to customers?"

  - Alternately can we ask the same question this way: "If we acquire this energy efficiency, how much cost would we avoid?"
- At a high level, when the costs of a resource are lower than the avoided costs, the resource is a cost-effective resource
- How do we calculate this "but for" world? (i.e. how do we calculate avoided costs?)
- OPUC Order No. 94-590: "Avoided Cost calculations should be based on the marginal costs of a fully-integrated resource stack, which includes both supply- and demand-side resources"

Avoided Cost Applications

Examples where avoided cost values are used in cost-effectiveness evaluations:

- Demand-Side Management
  - Energy efficiency/Conservation Potential Assessment (CPA)
  - Demand response (due to time constraints to be covered at future TWG)
- On-system gas supply resources
- Low carbon sources of energy (RNG, H_2)
- Capacity Recall agreements

Principles of Avoided Costs

- Principles for employing avoided costs to evaluate resources:
  - Equal treatment of resources
  - Capture associated costs and benefits
  - Transparency
  - Regulatory compliance

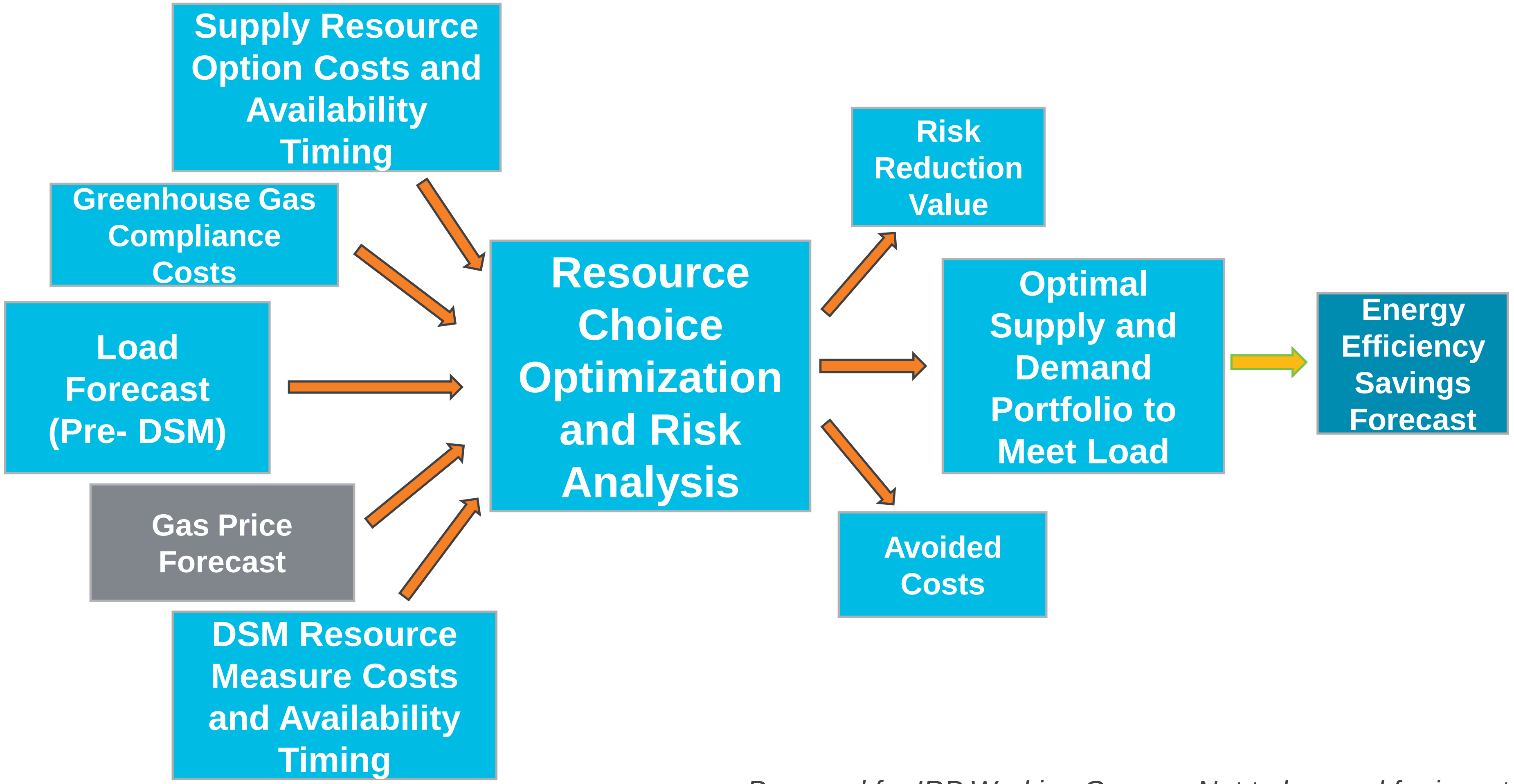
- Two standard approaches are used for evaluating energy efficiency:

  1. Energy efficiency projection an output of the portfolio model
  2. EE projection an output of outside energy efficiency cost-effectiveness evaluation process

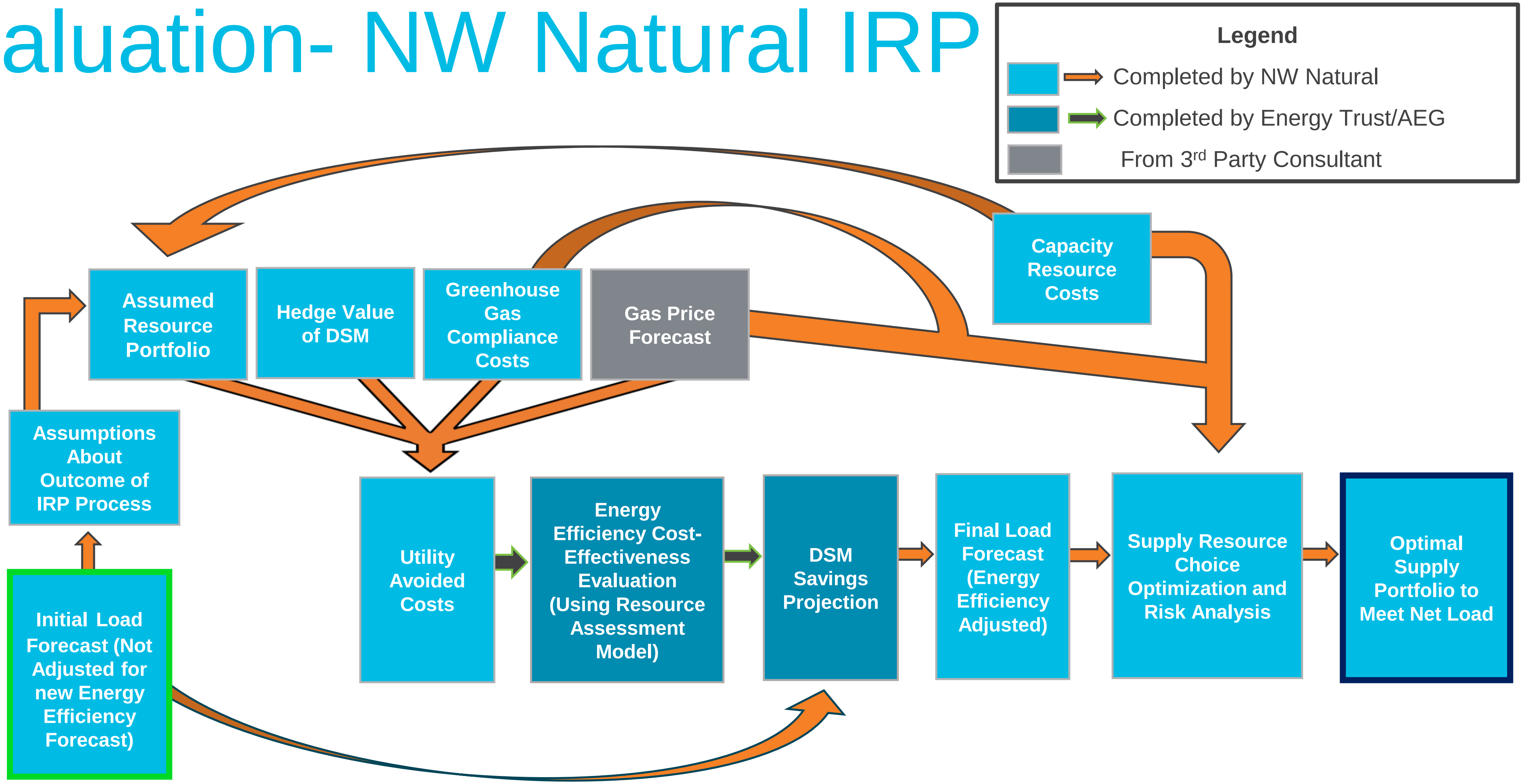
Given that the cost-effectiveness evaluation of our customers' resources is completed by Energy Trust of Oregon, NW Natural utilizes the second approach

Both approaches have been a standard in the industry

Energy Efficiency When All Resource Options are Output of Optimization



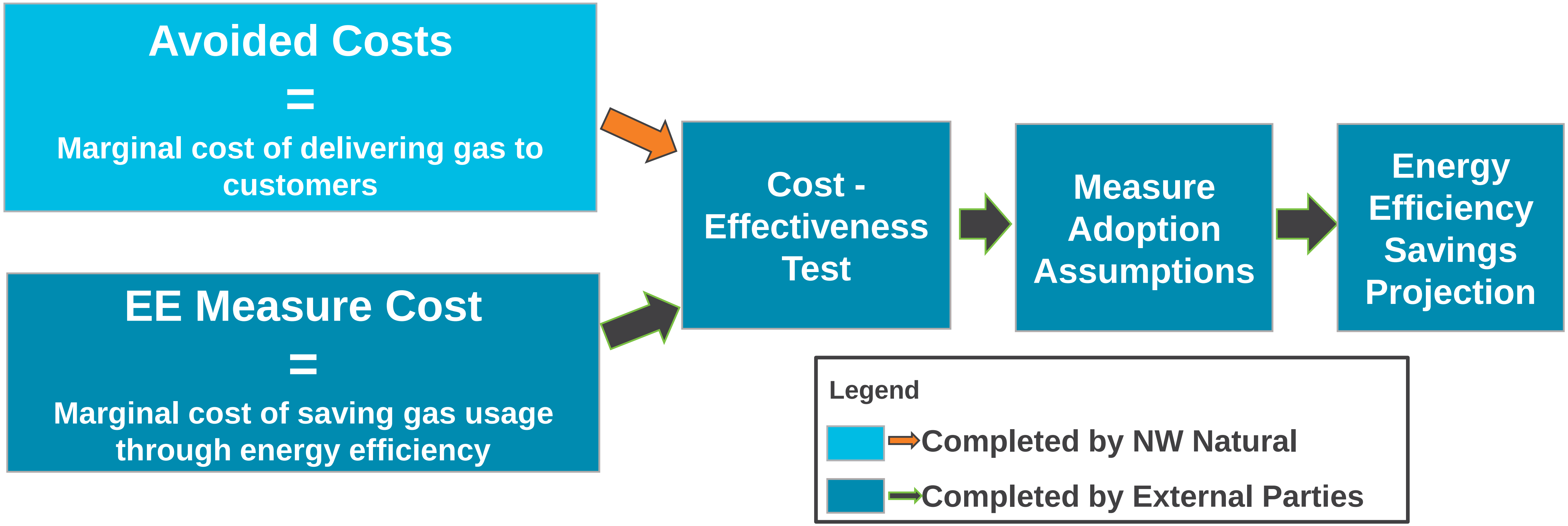
Energy Efficiency as Standalone Evaluation- NW Natural IRP



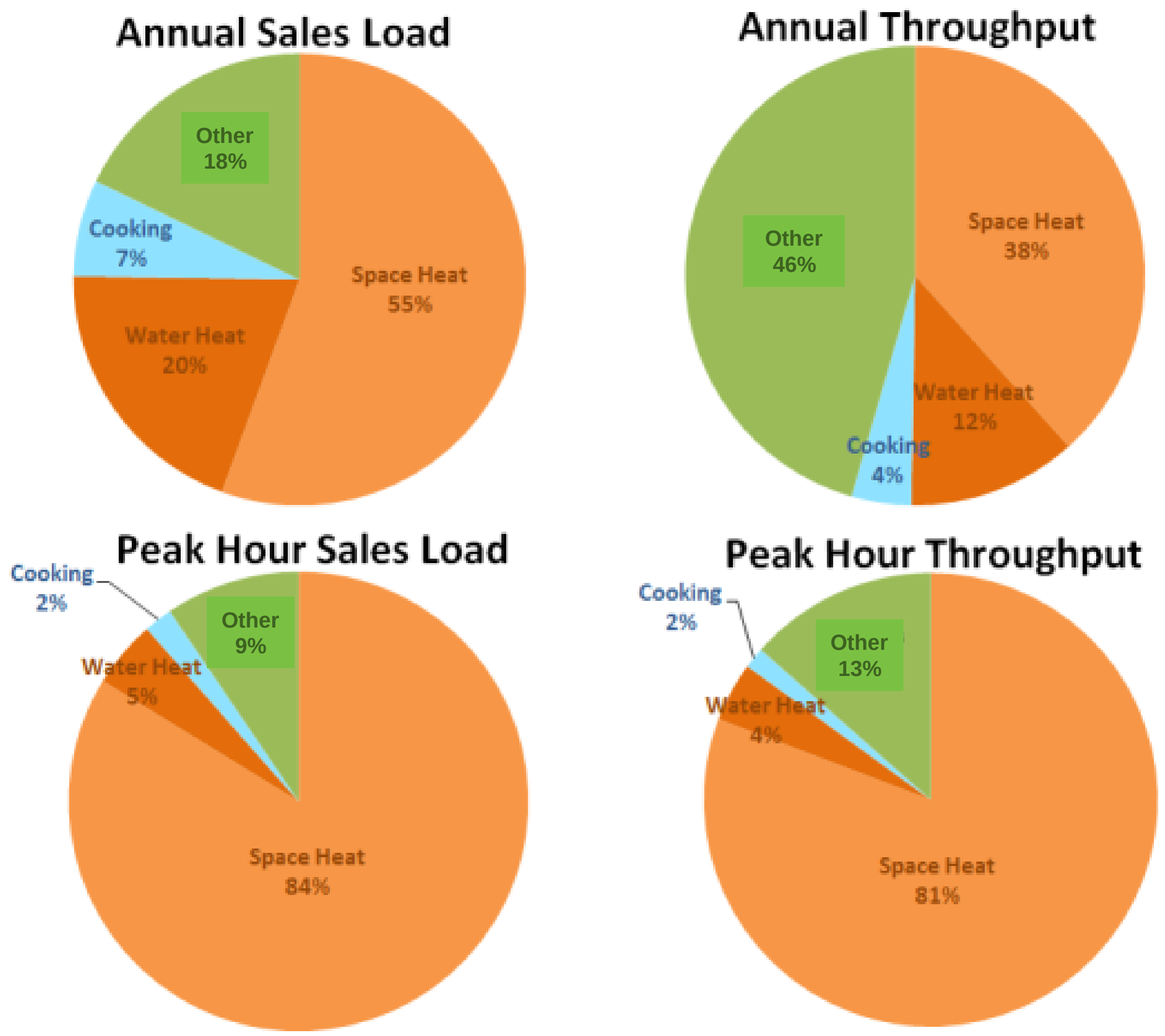
Assumptions about the outcome of the supply resources modeling completed in the IRP process need to be made to provide avoided costs to Energy Trust/AEG for energy efficiency cost-effectiveness modeling. *Prepared for IRP Working Group - Not to be used for investment purposes.*

Energy Efficiency Savings Projection Process

For Each Measure:



Where are the Potential Energy Saving Opportunities?



Avoided Costs Provided For the Following End Uses
Residential Space Heating
Residential Hearths and Fireplaces
Commercial Space Heating
Water Heating
Cooking
Process and Undefined Load
Interruptible Load

Since space heating represents such a large share of NW Natural’s load building shell and heating equipment measures are the measures with the potential to save the most energy, particularly during peak

Avoided Costs Components

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Avoided Cost Components			
Category	**Component**	**Varies by End Use?**	**Varies by Location?**
Commodity Related Costs	Commodity and Transportation Costs	Yes	No
	Greenhouse Gas Costs	No	Yes
	Commodity Price Risk Reduction Cost (Hedge Value)	No	No
Infrastructure Related Costs (Capacity Deferral)	Supply Resource Costs	Yes	No
	Distribution Resource Costs	Yes	Yes
Conservation Adder	10% Power Council Credit	Yes	No

While commodity related costs are saved no matter *when* energy is saved, savings during peak times reduce the infrastructure needed to serve customers and the need to purchase seasonally higher priced gas. Consequently, savings from end uses that contribute more to peak load avoid more costs.

Avoided Cost Component Applications

Costs Avoided		Resource Option Application					
		Demand-Side Resources			Supply-Side Resources		
			Demand Response		Low-Carbon Gas Supply		
		Energy Efficiency	Interruptible Schedules	Other DR	On-System Resources	Off-System Resources	Recall Agreements
Commodity Related Avoided Costs	Natural Gas Purchase and Transport Costs	✓			✓	✓	
	Greenhouse Gas Compliance Costs	✓			✓	✓	
	Commodity Price Risk Reduction Value	✓			✓	✓	
Infrastructure Related Avoided Costs	Supply Capacity Costs	✓	✓	✓	✓		✓
	Distribution System Costs	✓	✓	✓	✓		
Unquantified Conservation Costs	10% Northwest Power & Conservation Council Credit	✓			?	?	

Teaser: Avoided Cost Summary

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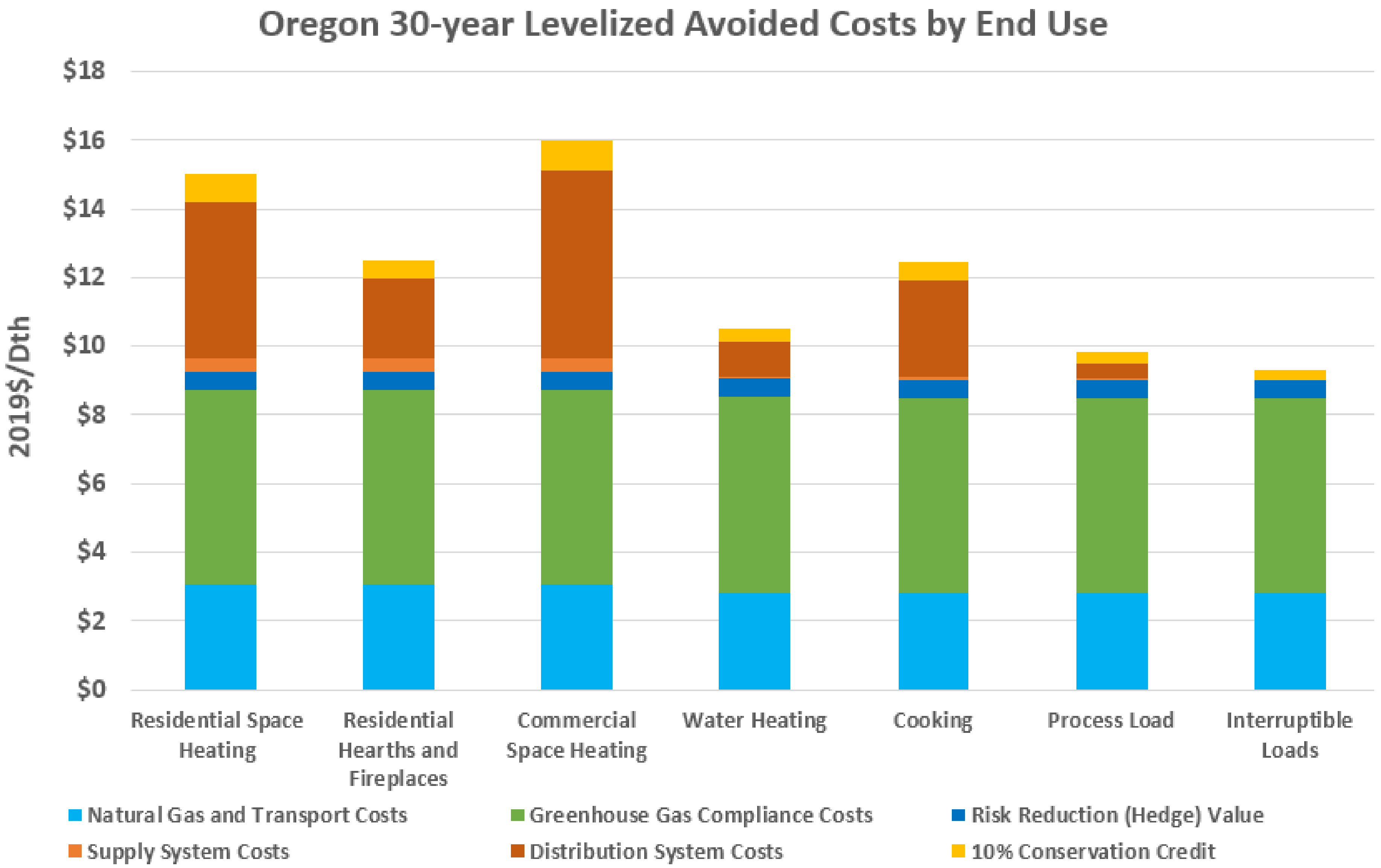


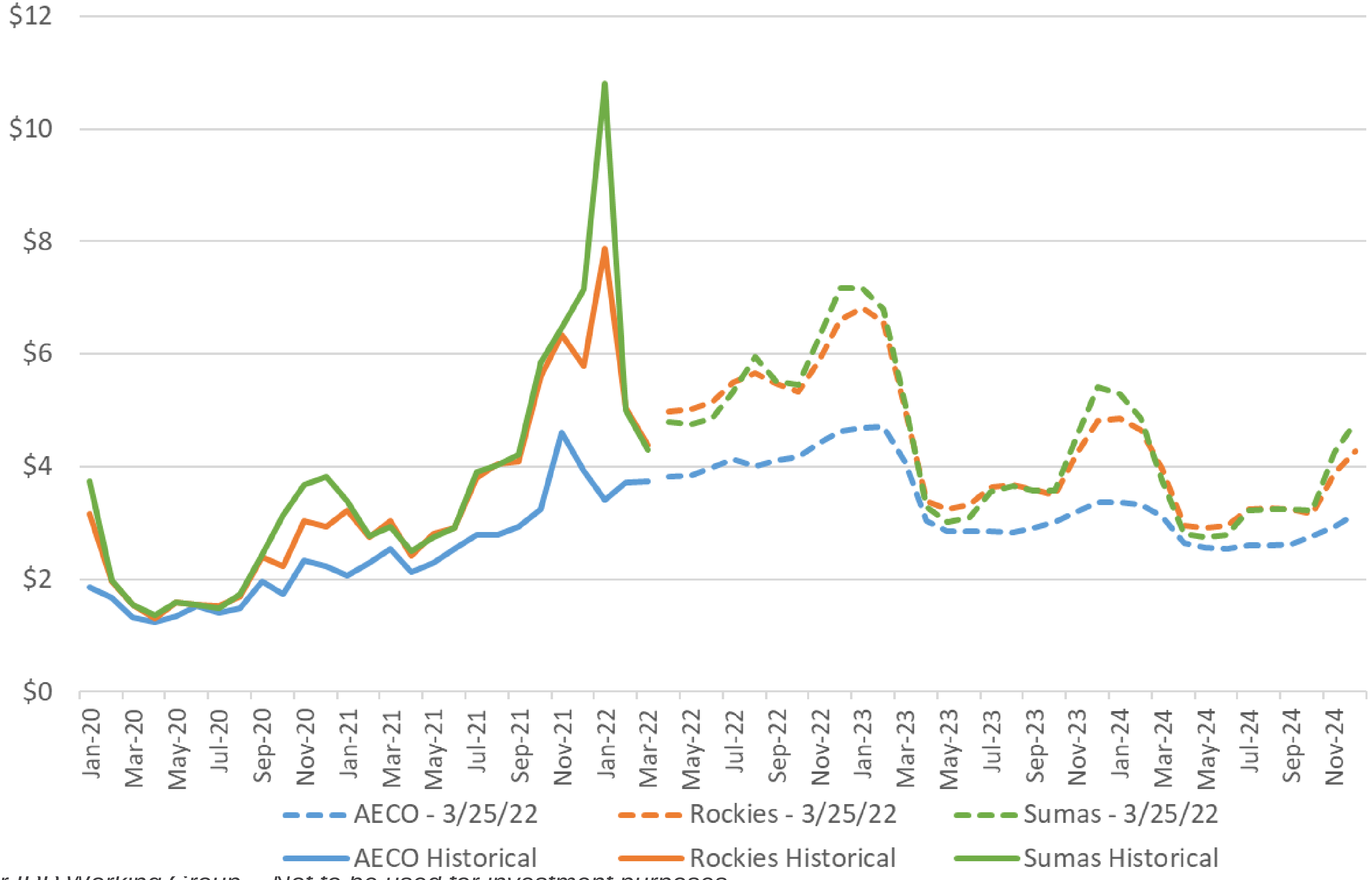
Energy Related Avoided Costs

Energy And Transport Costs Avoided

Question: *Given its resource portfolio, if NW Natural needed to serve one less unit of load for any given day, how much cost would be avoided?*

- Each day gas is purchased/scheduled to serve load or fill storage for winter needs
- SENDOUT is used to determine the cost that would be avoided for each day in the planning horizon if load was one therm less for that day (i.e. most expensive unit of gas that would be expected to be purchased on a given day)
  - This includes the cost of the gas that is used to deliver the procured gas to NW Natural's customers and/or the cost to hold gas in storage (depending on the day)
  - The therm avoided could be purchased at any of the relevant natural gas trading hubs and transported to NWN's system or be a withdrawal from a storage facility (of gas purchased at a relevant trading hub during the injection season)
  - Turned into a monthly average for use in energy efficiency
- This daily figure is matched with the load profile of each end use to determine the commodity costs that would be avoided if gas was saved from that end use
  - Currently this is done on a monthly basis, though it is planned to be done on a daily basis for the next IRP

Energy and Transport Costs Avoided



Avoided energy costs on each day is the associated with the **marginal** purchase on that day

Energy and Transport Costs Avoided

For each end use, *U*, and each year, *Y:*

$$Gas\ and\ Transport\ Avoided\ Costs_{U,Y} = \sum_{i=1}^{12} Monthly\ gas\ and\ transport\ costs_{Y,i} * Monthly\ share\ of\ annual\ load_{U,i}$$

Gas and transport costs (will be updated March 1, 2021 and will go through 2050):

Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	3040	Levelized
Gas and Transport Costs (2019$/Dth)	$1.45	$1.88	$2.08	$2.34	$2.54	$2.57	$2.71	$2.91	$3.09	$3.23	$3.32	$3.41	$3.42	$3.55	$3.52	$3.46	$3.66	$3.81	$3.78	$3.78	$2.85

Monthly Gas Cost Shares	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
20 Year Average Monthly Factor of Annual Average	113%	117%	113%	114%	106%	95%	89%	89%	90%	90%	90%	93%

Shares are different in each forecast year; 20 year average shown for illustrative purposes

End Use Energy and Transport Costs

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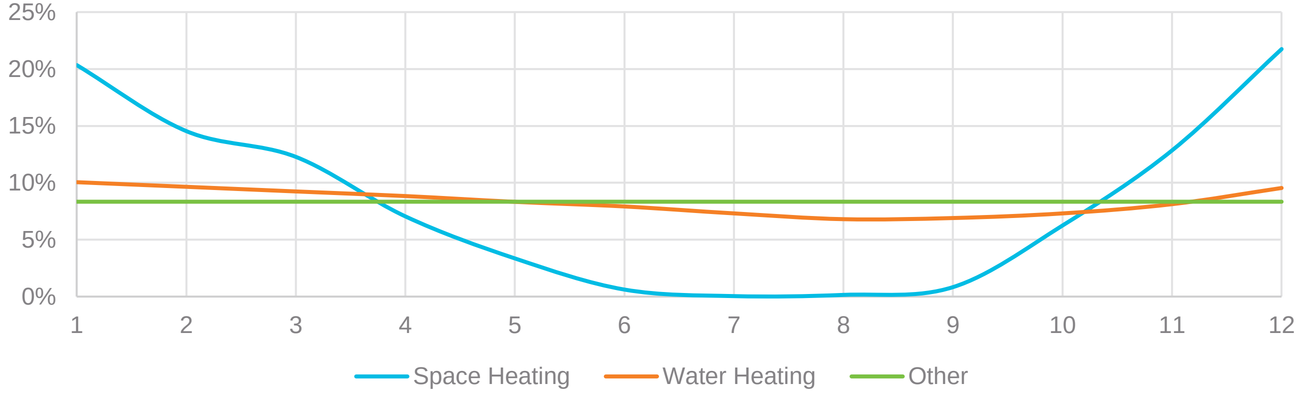
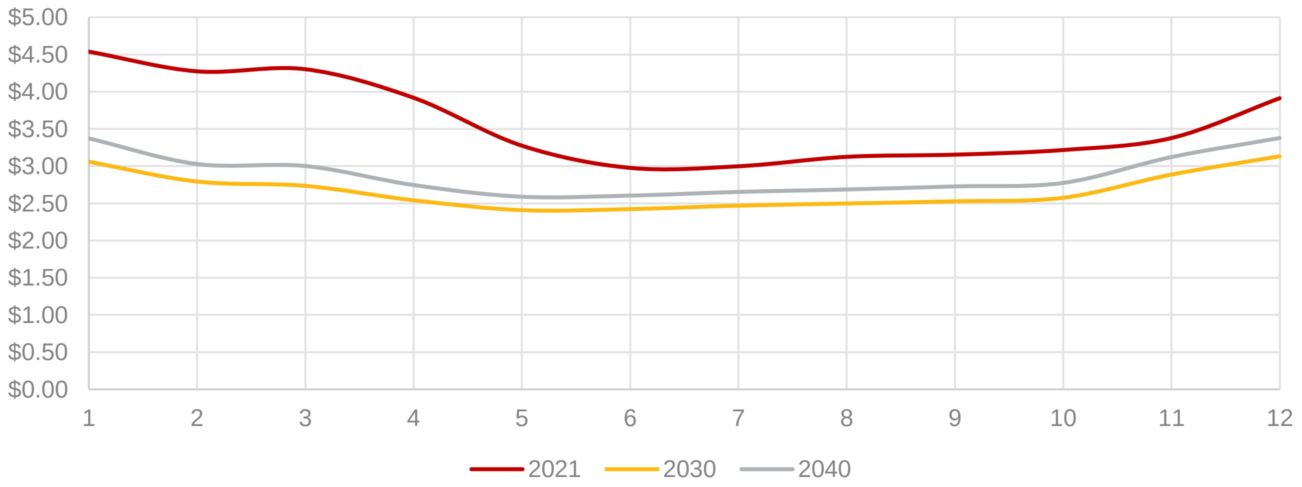
Share of Annual Load by Month



Marginal Gas and Transport Costs by Month



Avoided Commodity and Transport Costs by End Use (2020$)				
	Space Heating	Water Heating	Other	Process Load
2022	$3.99	$3.65	$3.59	$3.59
2023	$3.37	$3.17	$3.13	$3.13
2024	$2.86	$2.69	$2.67	$2.67
2025	$2.83	$2.63	$2.60	$2.60
2026	$2.81	$2.60	$2.57	$2.57
2027	$2.77	$2.57	$2.55	$2.55
2028	$2.75	$2.56	$2.54	$2.54
2029	$2.78	$2.56	$2.54	$2.54
2030	$2.83	$2.63	$2.61	$2.61
2031	$2.88	$2.69	$2.67	$2.67
2032	$2.90	$2.69	$2.66	$2.66
2033	$2.85	$2.63	$2.60	$2.60
2034	$2.89	$2.66	$2.63	$2.63
2035	$2.87	$2.68	$2.65	$2.65
2036	$2.89	$2.67	$2.65	$2.65
2037	$2.95	$2.70	$2.67	$2.67
2038	$3.00	$2.76	$2.73	$2.73
2039	$3.07	$2.84	$2.82	$2.82
2040	$3.13	$2.90	$2.87	$2.87
2041	$3.13	$2.92	$2.89	$2.89
2042	$3.14	$2.92	$2.89	$2.89
2043	$3.12	$2.93	$2.90	$2.90
2044	$3.16	$2.97	$2.95	$2.95
2045	$3.25	$3.08	$3.06	$3.06
2046	$3.25	$3.07	$3.05	$3.05
2047	$3.22	$3.06	$3.04	$3.04
2048	$3.21	$3.05	$3.03	$3.03
2049	$3.31	$3.17	$3.16	$3.16
2050	$3.24	$3.19	$3.18	$3.18
Levelized	**$3.036**	**$2.829**	**$2.802**	**$2.802**
Levelized-	**$3.036**	**$2.775**	**$2.745**	**$2.745**
Levelized-	**$3.036**	**$2.775**	**$2.746**	**$2.746**

Environmental Related Avoided Costs

Greenhouse Gas Compliance Costs

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- In previous IRPs an assessment was made about prospective greenhouse gas policies that would impact resource planning
  - Meaningful climate policies have been enacted since 2018 IRP
  - Point to using the Social Cost of Carbon (SCC) for evaluating resources
- NW Natural has used the SCC for base case avoided costs for a few years
- Sensitivities based upon uncertainty in SCC and in Oregon inclusion of upstream emissions and comparison against low carbon gas supply

Calculating GHG Price Component of Avoided Costs

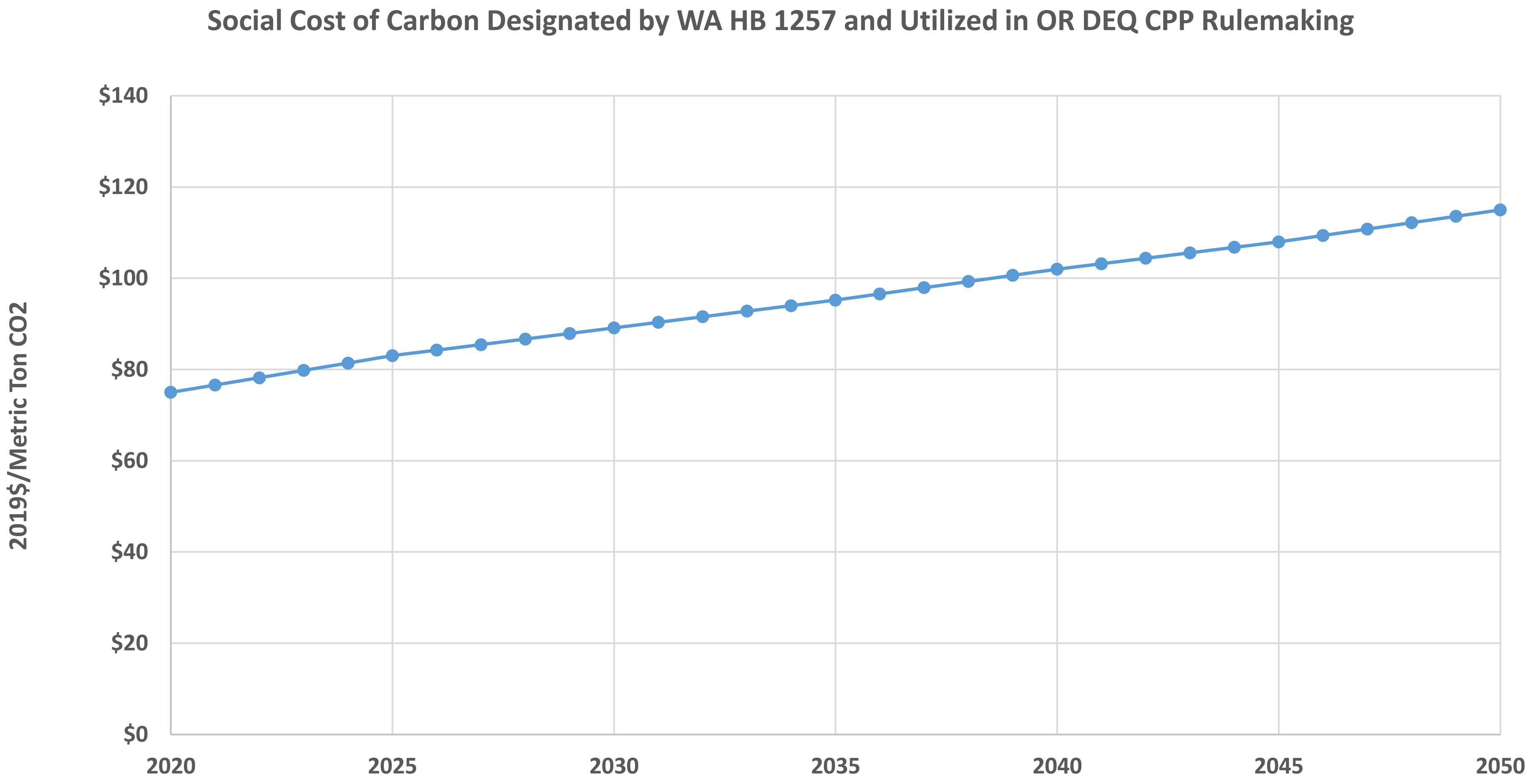
For each of the following sources of emissions:

1. Combustion by end use customers
2. Fugitive and combustion in natural gas production
3. Fugitive and combustion in natural gas processing
4. Fugitive and combustion in natural gas transmission and storage upstream of NW Natural’s system
5. Fugitive and combustion in natural gas distribution and storage on NW Natural’s system

the following calculation is completed in carbon dioxide equivalent (CO_2e):

$$\textit{Avoided Costs}\left(\frac{\$}{Dth}\right) = \textit{Social Cost of Carbon}\left(\frac{\$}{MT}\right) * \textit{Emissions Intensity}\left(\frac{MT}{Dth}\right)$$

Social Cost of Carbon



https://www.utc.wa.gov/regulatedIndustries/utilities/Pages/SocialCostofCarbon.aspx

Lifecycle Emissions Intensity

Fugitive Methane Emissions Rates†					
	Production	Processing	Transmission	Distribution	**Total**
Canada	0.370%	0.000%	0.012%	0.109%	**0.491%**
United States	0.465% *	0.063%	0.328%	0.109%	**0.965%**
Weighted Avg	0.409%	0.026%	0.142%	0.109%	**0.685%**

Lifecycle Emissions from Combustion (Share of Gas Delivered Equivalent)‡					
	Production	Processing	Transportation	Distribution	**Total**
Canada	4.35%	6.46%	2.25%	0.28%	**13.34%**
United States	4.06%	4.46%	3.11%	0.28%	**11.92%**
Weighted Avg.	4.23%	5.64%	2.60%	0.28%	**12.76%**

Lifecycle Emissions Increase Relative to Direct Emissions in CO2e			
	Combustion	Fugitive Methane	**Total**
Production	4.23%	3.93%	8.16%
Processing	5.64%	0.25%	5.89%
Transmission	2.60%	1.36%	3.96%
Distribution	0.28%	1.04%	1.32%
Total	12.76%	6.58%	**19.34%**

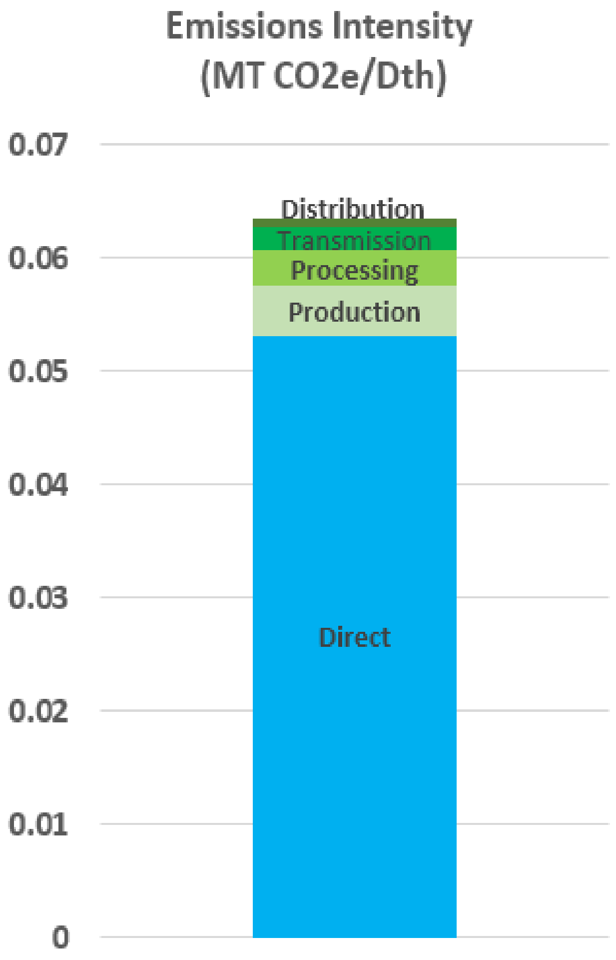
*** Reduced by 20% via NW Natural's Targeted Responsible Gas Production Purchasing Program**

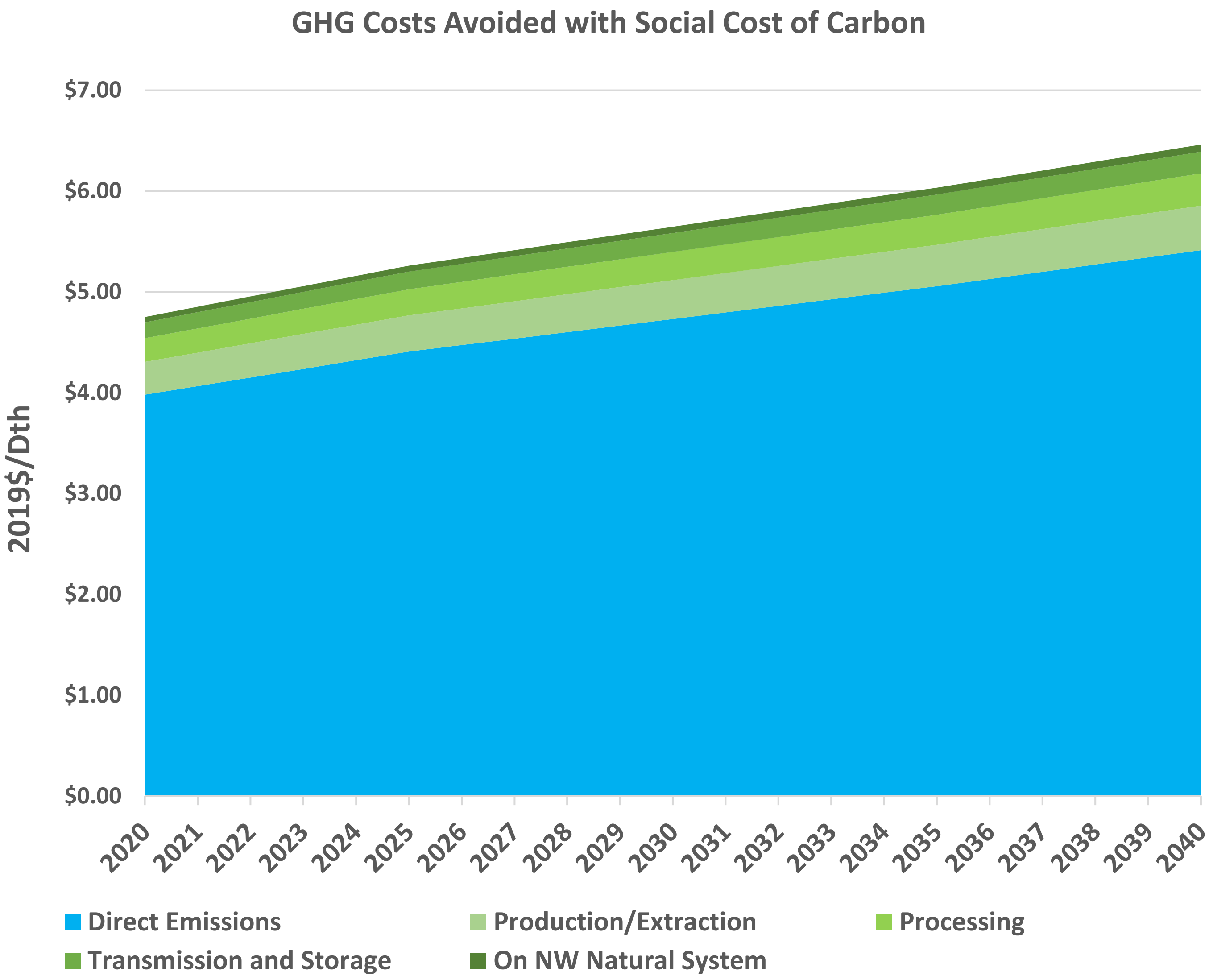
† Lifecyle system leakage in the form of CH_4. Converted to CO_2e by most recent IPCC report 100-year Global Warming Potential Factor for CH_4 of 28 on a weight basis (noting when one ton of CH_4 is combusted the result is roughly 3 tons of CO_2)

‡ Lifecycle Combustion Emissions include use of natural gas to fuel production, processing, transmission, storage and distribution to end users in the form of CO_2 (e.g. diesel use in production and natural gas usage to fuel compressors in transmission and storage)

Data Sources:
EPA SubpartW
GREET 2018
GHGenius 5.0
GHGenius 4.0

GHG Costs Avoided





10% Conservation Adder

NW Natural includes region's longstanding convention from the Northwest Power and Conservation Council of applying a 10% conservation credit to avoided costs to account for the unquantified benefits of conservation

NW Natural has adopted Energy Trust's practice of applying the 10% credit to call components of avoided cost except the risk reduction value and greenhouse gas costs

While the 10% credit is applied consistently across all end uses the variation in avoided costs by end use results in this value varying by end use

Risk Reduction Value

Commodity Price Risk Reduction Cost (Hedge Value)

Resources are evaluated based on a risk-adjusted present value revenue requirement (rPVRR) basis using the following formula:

<u>Portfolio rPVRR</u>

rPVRR = 75%*base case PVRR+ 25%* 95th percentile stochastic PVRR

Risk Premium

NW Natural is proposing a new methodology to measure the reduction in price risk (hedge value) for avoided costs that uses the same risk assessment as the portfolio rPVRR and is based on the same stochastic simulations to evaluate uncertainty. This methodology aligns measuring the hedge value with the rest of the IRP in assessing risk.

Risk adjusted cost of gas = 75%*Base Case Price + 25%* 95th percentile stochastic Price

Risk Reduction Value = Risk adjusted cost of gas – deterministic price

Commodity Price Risk Reduction Cost (Hedge Value)

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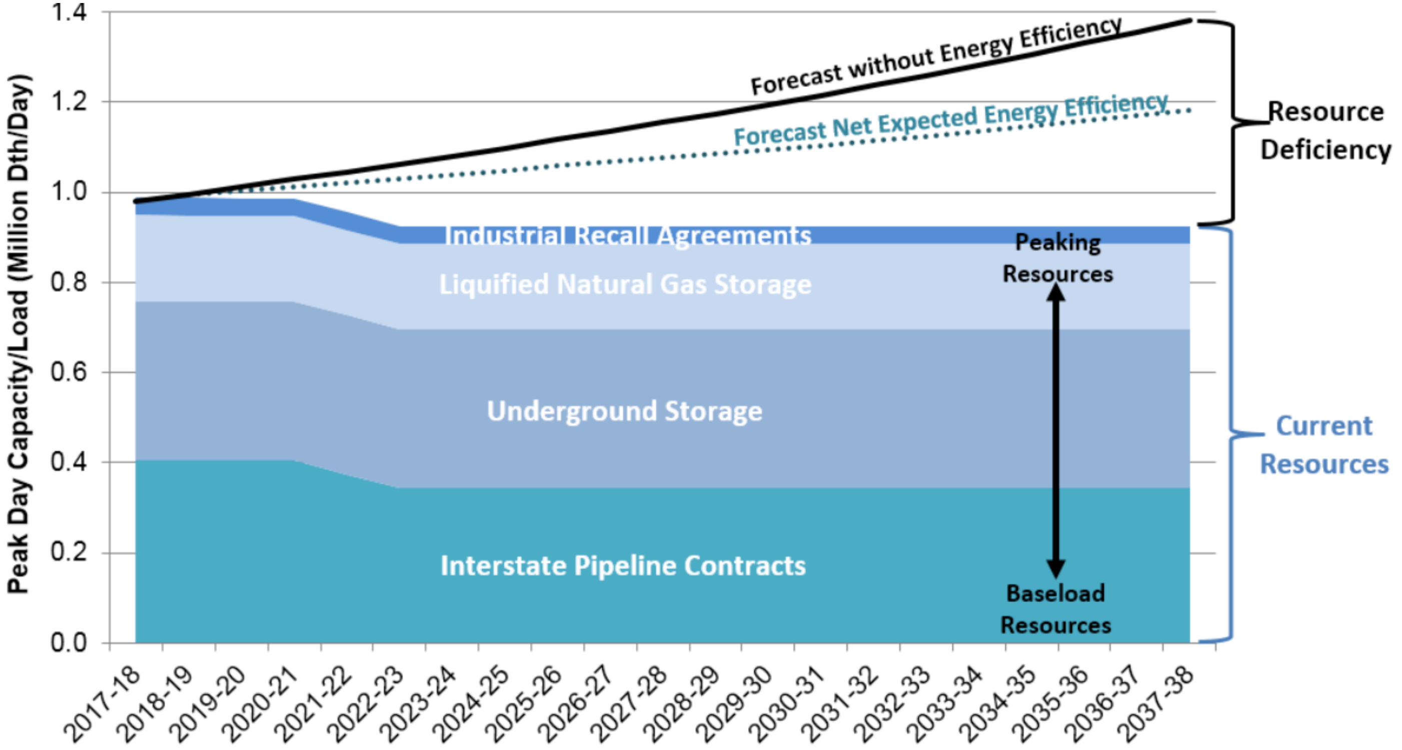
The Sumas hub experiences the most price volatility where NW Natural purchases gas and is most commonly the location where the marginal unit of gas is purchased in our analysis. The Monte Carlo simulation of Sumas prices is used for measuring the price risk reduction.

Component	$/Dth
Average Present Value Deterministic Prices of Sumas	$2.81
Average Present Value Price of the 95th Percentile	$4.91
Risk Adjusted Price	$3.33
Hedge Value	**$0.52**

Infrastructure/Capacity Avoided Costs

Infrastructure Costs Avoided with Peak Saving

Supply Capacity Resources & Peak Day Forecast (2018 IRP Update)



- Capacity resources are procured based upon peak day (supply capacity) and peak hour (distribution capacity) needs

When usage that contributes to peak day and peak hour loads are reduced, this avoids infrastructure costs

Often referred to as a "capacity deferral"

Capacity Cost Avoided/Deferred

$$\textit{Capacity costs avoided}(\$)$$
$$= \textit{cost to serve additional peak load}\left(\frac{\$}{\textit{Dth of Peak Load}}\right)$$
$$* \textit{ amount of peak load saved}(\textit{Dth})$$

- Given that most programs (like energy efficiency) evaluate resources on a state-wide, the cost to serve additional peak load is assumed to be the same in any given geographic area in the state, irrespective of end use
    - This assumption is not used for distribution system planning and NW Natural is actively pursuing geographically-targeted resource planning of its distribution system (this will be discussed at next TWG)
- The amount of peak load saved by a specific measure can vary drastically based upon the energy needs the measure is providing savings from
- Savings from customers on interruptible schedules do not save any peak load since this is demand response and interruptible customers are “interrupted” during peak events (i.e. they elect to have a lower cost service in return for an assurance they are not contributing to peak load)

Key Capacity Avoided Cost Assumptions

NW Natural®

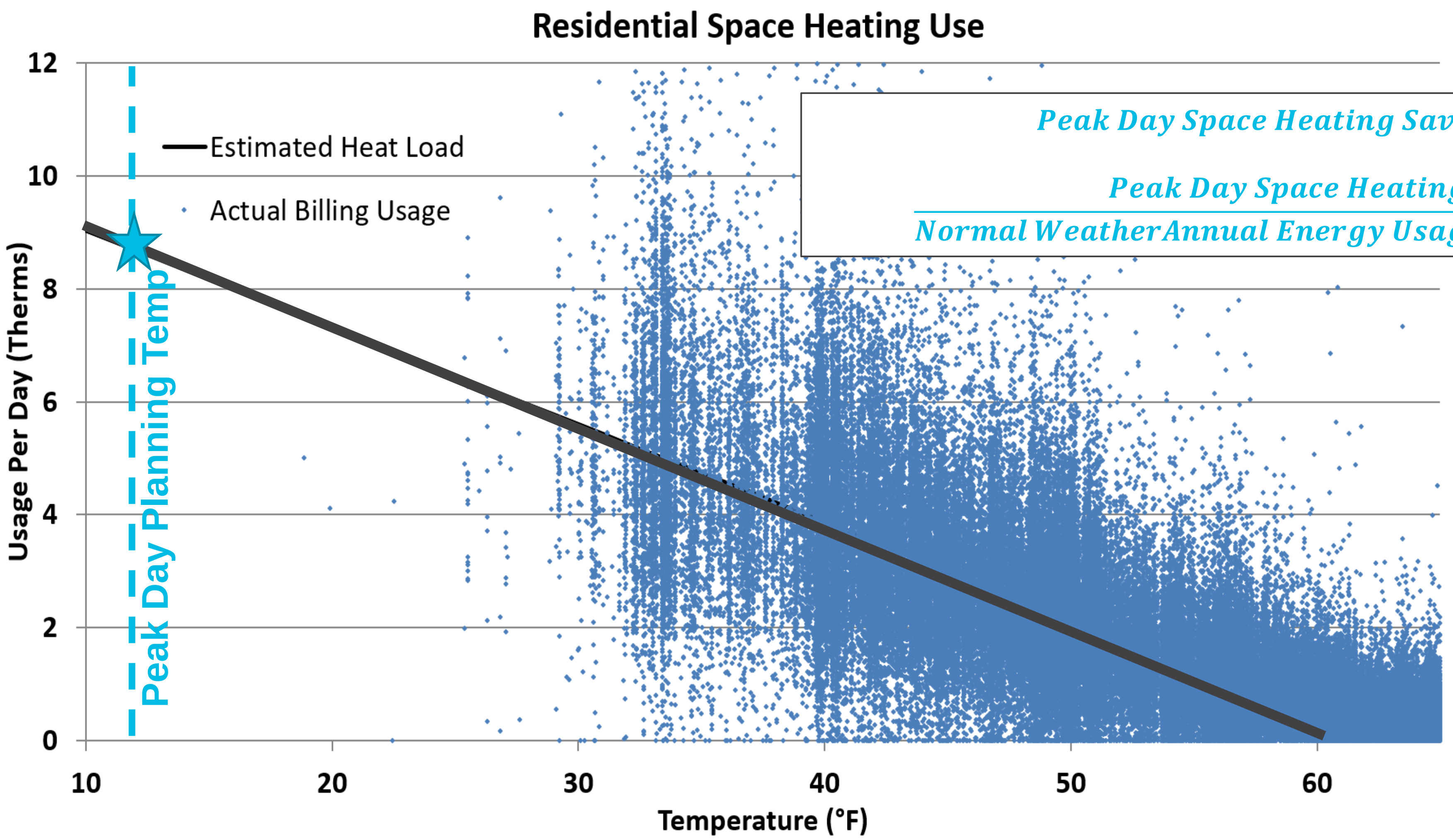
- Peak day savings from DSM/EE are a firm resource that is 100% reliable
- Both supply and distribution resources are incremental/divisible and the full value of the incremental resource is avoided for each unit of gas savings from DSM/EE
- Capacity resource costs are represented on a capacity *cost of service* for the marginal resource by year basis, converted to a per unit of gas value using a peak load ratio estimate
- Methodology designed to be compatible with conservation measures savings estimates, which are reported in normal weather annual savings terms
- Supply resource costs are used on a system-wide basis
  - based upon assumptions about the portfolio that will come out of the 2021 IRP process
  - using the most recent cost of service estimates for the supply resource options being considered in this IRP
- Distribution system costs are state specific
  - Based upon estimated costs of serving additional peak hour load in Washington

Capacity Avoided Costs Process

For each end use:

1. Determine the average normal weather annual usage
2. Determine the average peak day and peak hour usage
   - Peak day usage is for supply resource costs avoided
   - Peak hour usage is for distribution system costs avoided (hourly load shape applied to peak day usage)
3. Calculate the peak day and peak hour to annual normal weather usage ratios (divide (2) by (1))
4. Determine the costs of serving an additional therm of peak day and peak hour load by year of the planning horizon
   - Determining the best incremental resource required each year of the planning horizon to reliably serve customers is the key output of the IRP process
   - Completing this task for energy efficiency requires assumptions about the outcome of the IRP before it is complete
5. Determine the costs avoided through saving one therm with energy efficiency (multiply (3) by (4))
   - Uses the key assumption that load profiles and energy savings profiles from energy efficiency measures are the same

End Use Peak Contribution Estimation: Residential Space Heating Example

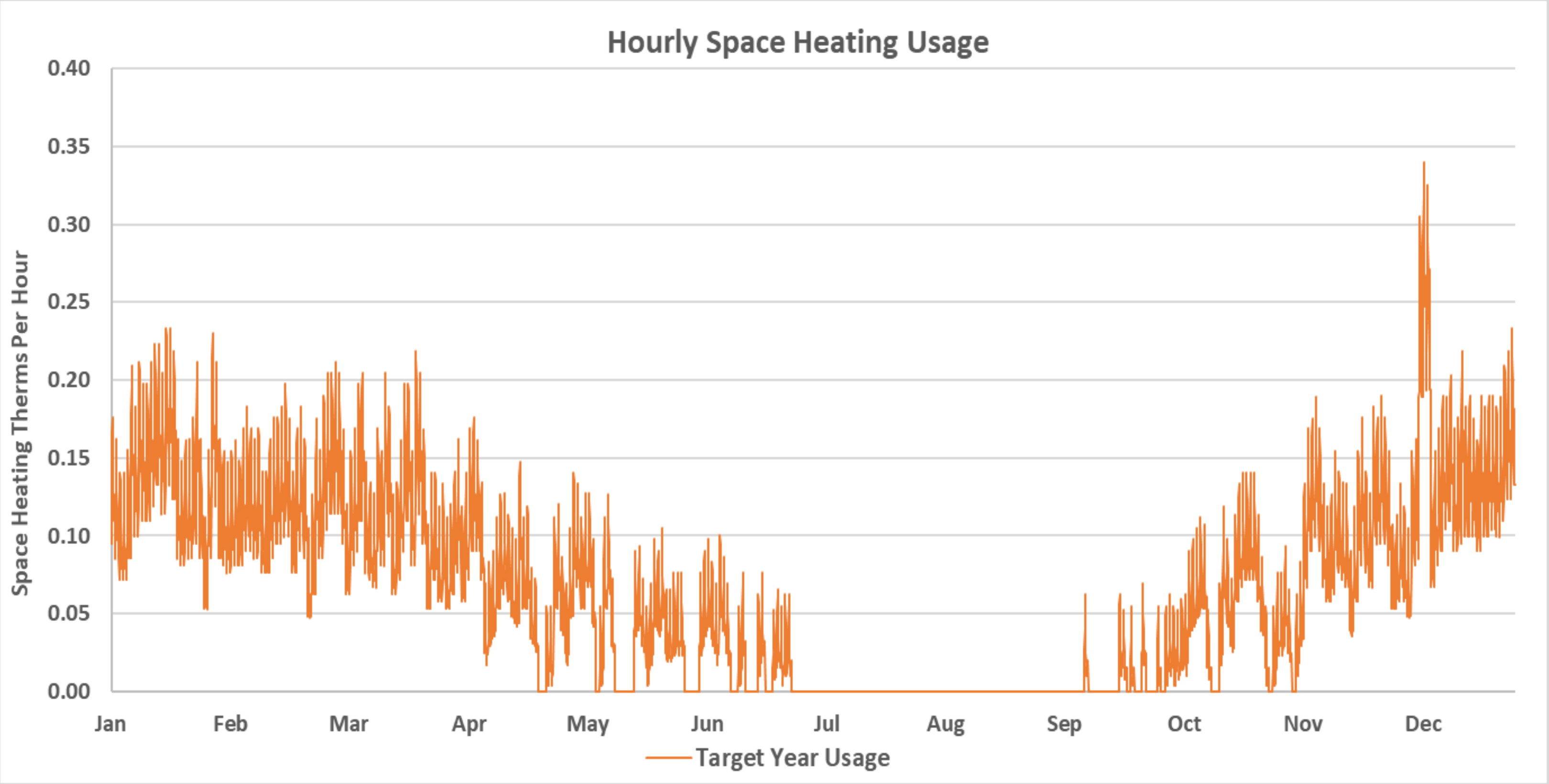


$$\textit{Peak Day Space Heating Savings Ratio} = \frac{\textit{Peak Day Space Heating Usage}}{\textit{Normal Weather Annual Energy Usage for Space Heating}}$$

Sample representing ~1% of NW Natural bills used in regression shown on graph

End Use Peak Contribution Estimation: Residential Space Heating Example

$$\textit{Peak Hour Space Heating Savings Ratio} = \textit{Peak Day Space Heating Ratio} * \frac{\textit{Peak Hour Space Heating Usage}}{\textit{Peak Day Space Heating Usage}}$$



- It is critical that peak planning assumptions are applied to end use load research to be used in valuing capacity
- Representative load shapes can vary significantly from load shapes under peak planning conditions

Peak Day And Hour Ratios

Peak DAY Usage to Normal Weather Annual Usage Factors for SUPPLY Costs		Source of Information	Improvement Planned for 2020 IRP?*
Residential Space Heating (Including Hearths and Fireplaces)	**0.0176**	NW Natural Regressions	Yes
Commercial Space Heating	**0.0157**	NW Natural Regressions	Yes
Water Heating	**0.0033**	NW Natural Regressions and NEAA Water Heater Study	Yes
Cooking	**0.0036**	Analysis of ODOE RECS data	No
Process Load	**0.0027**	Annual/365	Yes

Peak HOUR Usage to Normal Weather Annual Usage Factors for DISTRIBUTION System Costs		Source of Information	Improvement Planned for 2020 IRP?*
Residential Space Heating	**0.00102**	NWN System Hourly Flows & EPRI Load Shape	Yes
Hearths and Fireplaces	**0.00051**	EPRI Load Shape	No
Commercial Space Heating	**0.00123**	NWN System Hourly Flows & EPRI Load Shapes	Yes
Water Heating	**0.00026**	NWN System Hourly Flows & Ecotope water heating study and	Yes
Cooking	**0.00071**	EPRI Load Shape	No
Process Load	**0.00011**	Daily/24	Yes

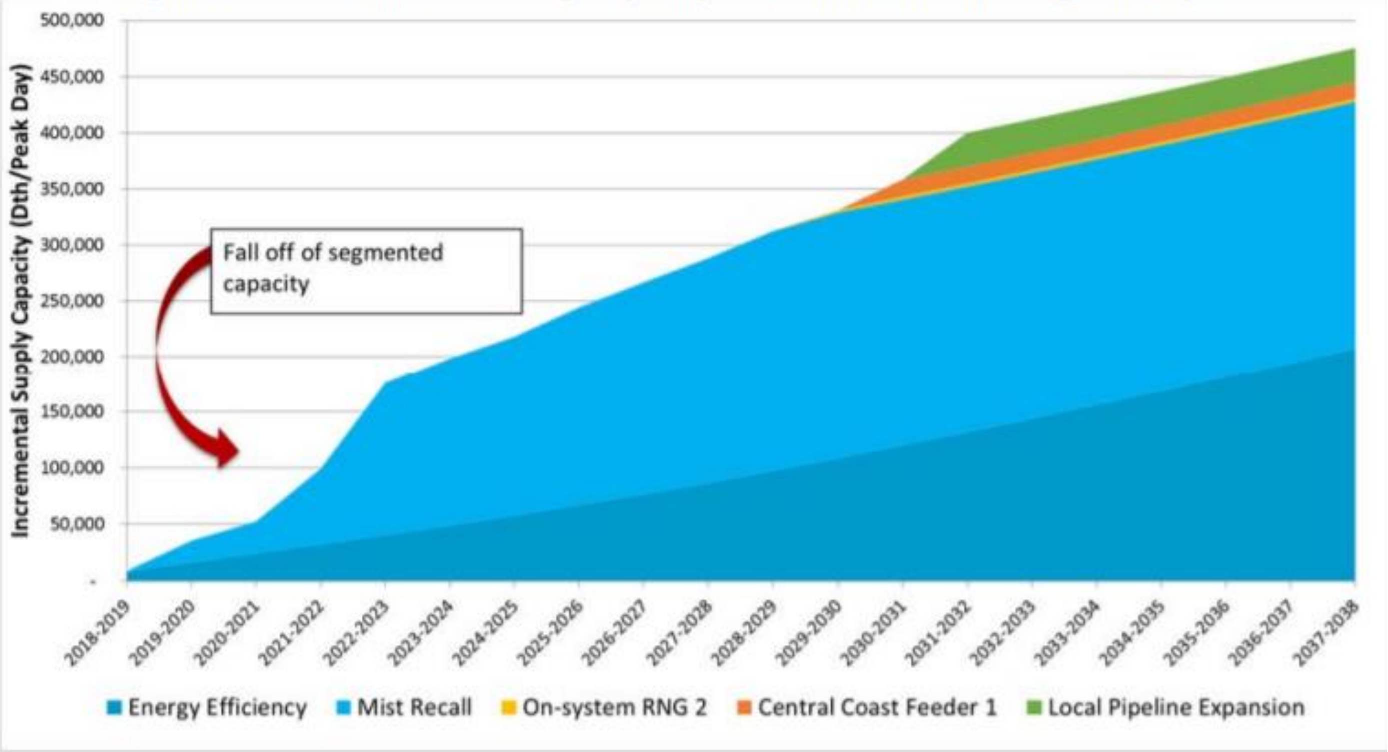
Peak Ratio Highlights

- Residential space heating has the highest peak *day* ratio of the end uses studied
- Commercial space heating has the highest peak *hour* ratio of the end uses studied
  - More commercial space heating concentrated during the 7am peak hour than residential space heating
- Water heating load is seasonal, but not nearly as seasonal as space heating
  - More hot water is used during the winter months and the temperature of the water to be heated is colder
- Potential for NW Natural to provide hourly energy profiles for customers with high frequency metering (only large customers have these types of meters) for their tailored offerings to large commercial and industrial customers

How much does the marginal unit of peak load cost to serve?

For Gas Supply Resources (system-wide portfolio):

Figure 7.2: Base Case Peak Day Capacity Additions – No New Regional Pipeline



Capacity Resources	Cost ($/Dth/day)
Mist Recall	0.05 - 0.11
North Mist II	0.38 - 0.54
North Mist III	0.35 - 0.50
Local Pipeline Expansions	1.10 - 1.70
Regional Pipeline Expansions	0.50 - 1.20
Central Coast Feeder 1-3	0.08 - 1.20

Current expectations: Mist recall expected to be sufficient until after 2040

How much does the marginal unit of peak load cost to serve?

NW Natural®

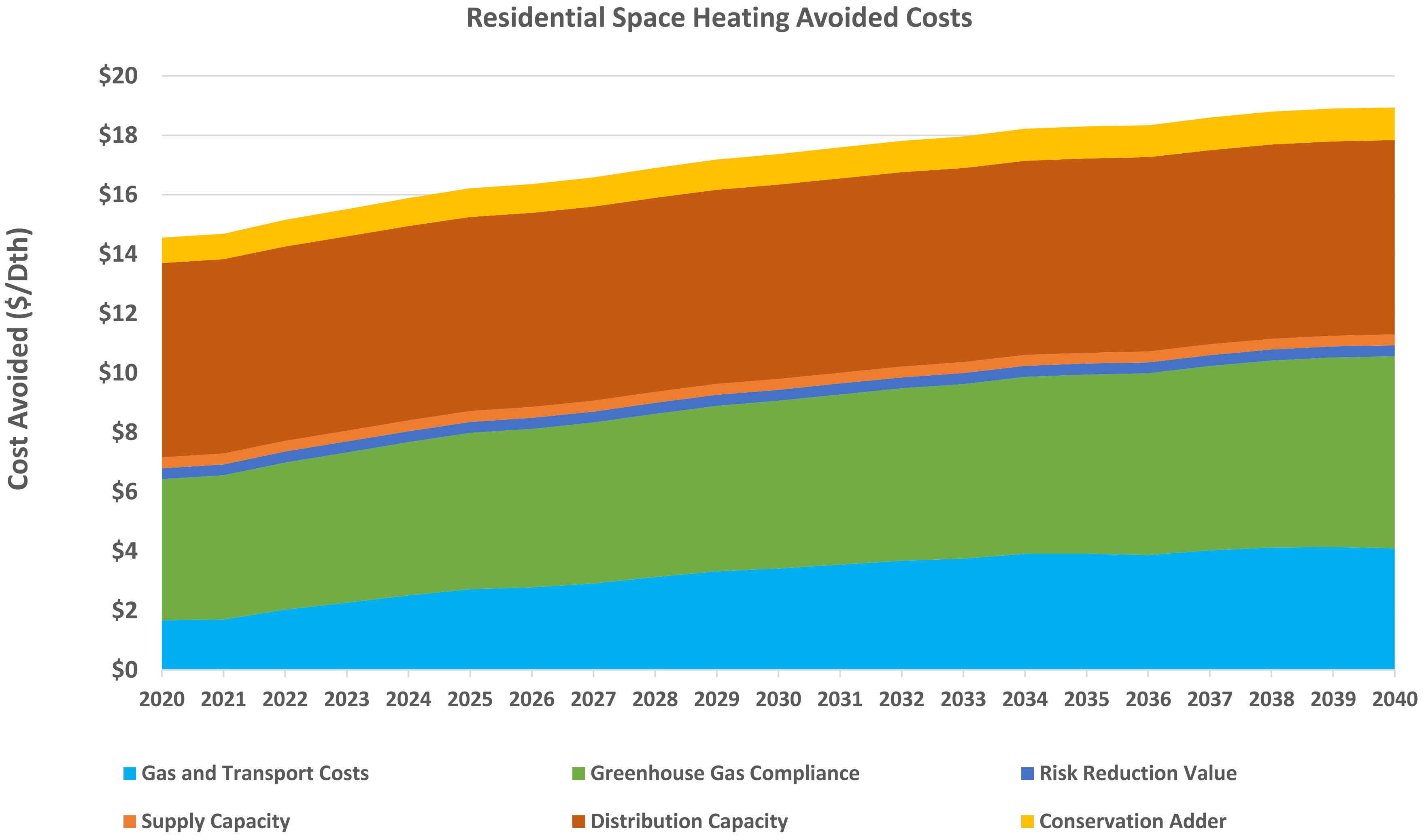
For NW Natural's Distribution System:

	Oregon	Washington
	2009-2018	2009-2018
Average Annual Increase in Peak Hour Load (Therms)	3,369	582
Average Annual Rev Req Increase from System Reinforcement Projects ($)	$1,305,898	$373,453
Incremental Revenue Requirement per Incremental Therm of Peak Hour Load ($/Therm)	$388	$642
Distribution System Avoided Costs ($/Therm/Hour)	$0.0442	$0.0732

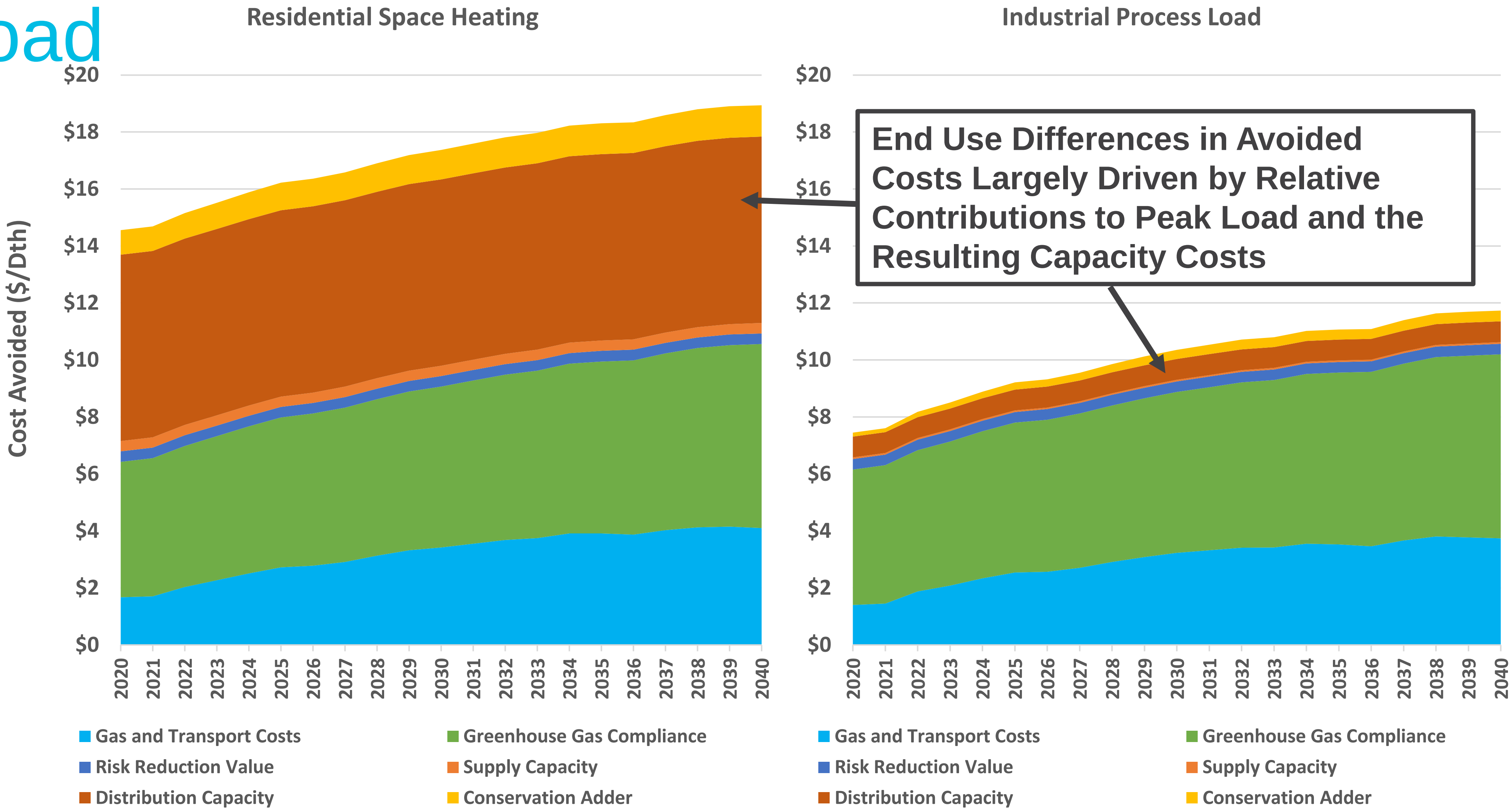
Average costs to serve incremental peak hour load over the last decade are assumed to remain constant in real terms going forward

Avoided Costs Results

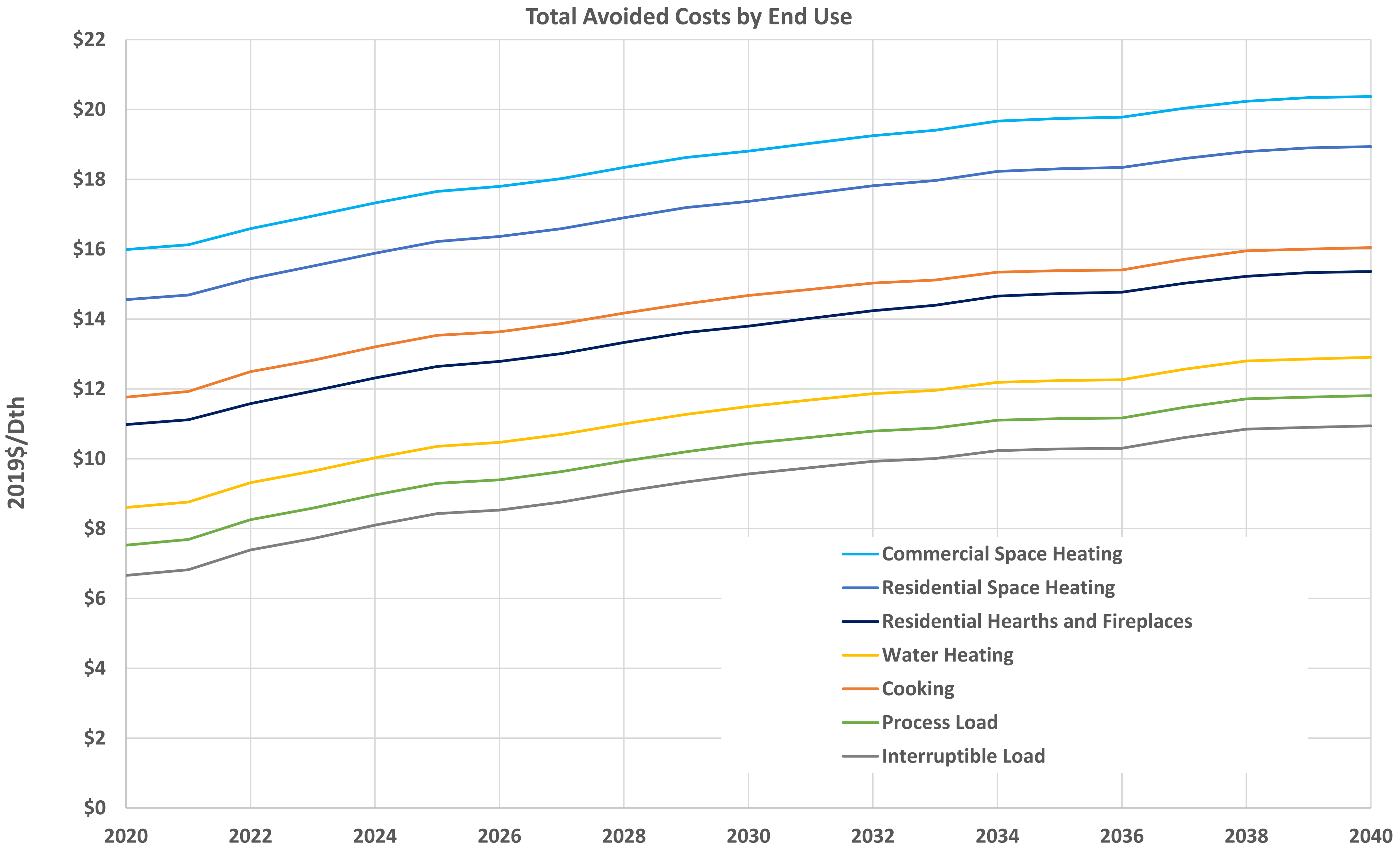
Avoided Cost Breakdown: Residential Space Heating Example



Avoided Cost Comparison: Residential Space Heating vs. Industrial Process Load



Prepared for IRP Working Group - Not to be used for investment purposes.

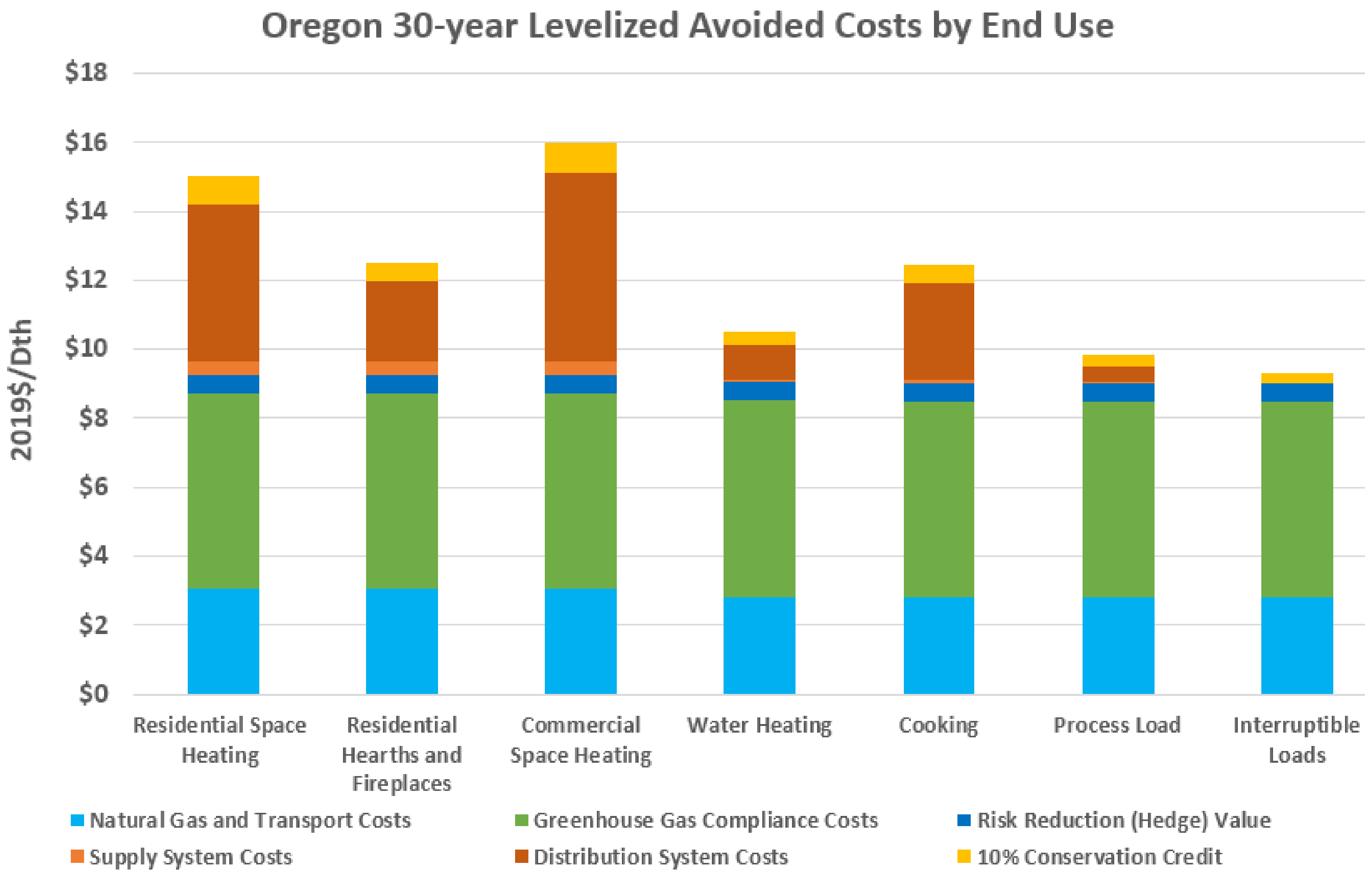


Total Avoided Costs by End Use
2019$/Dth
$22
$20
$18
$16
$14
$12
$10
$8
$6
$4
$2
$0
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
Commercial Space Heating
Residential Space Heating
Residential Hearths and Fireplaces
Water Heating
Cooking
Process Load
Interruptible Load

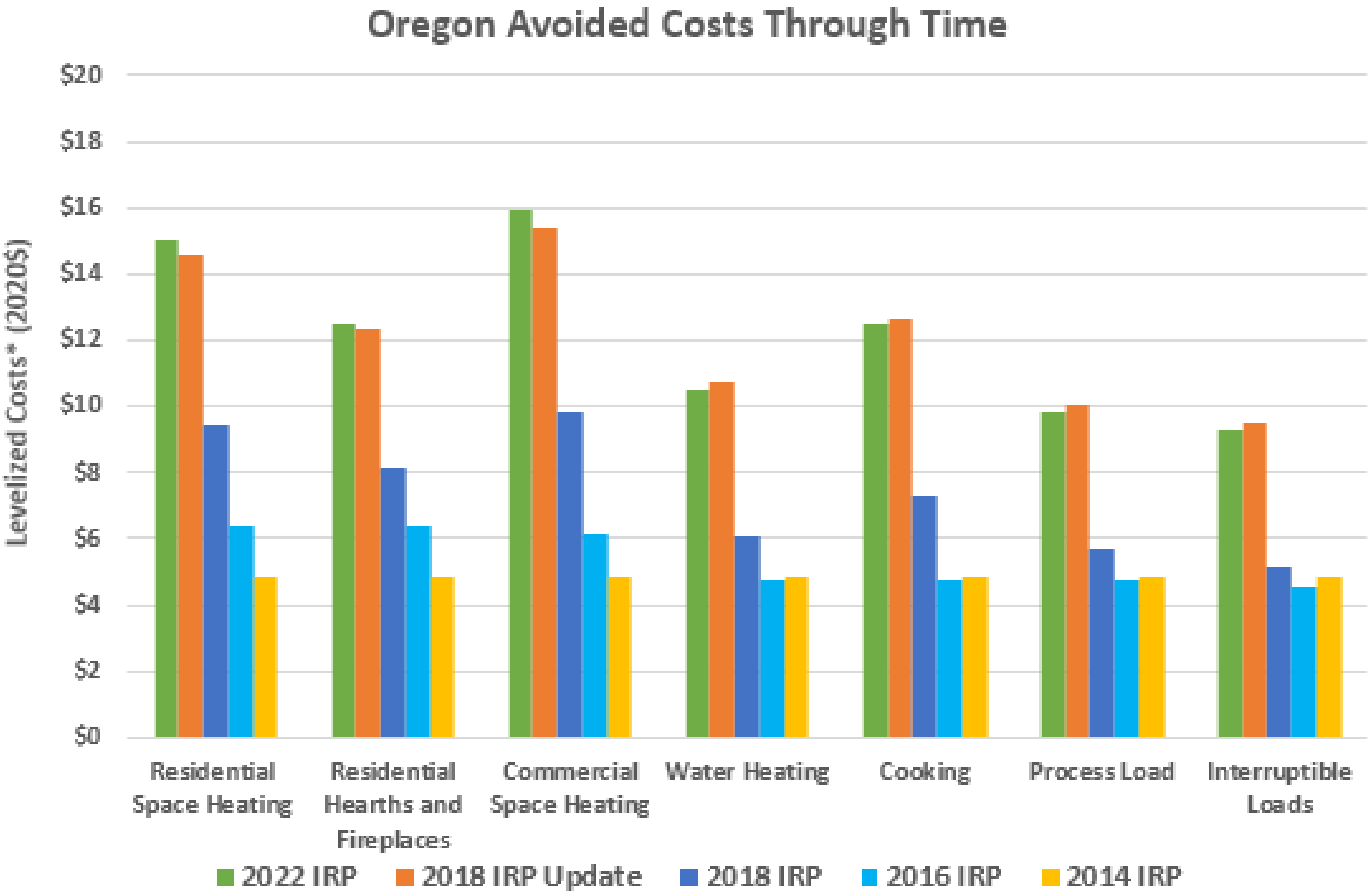
NW Natural®

Avoided Cost Summary- Oregon

NW Natural®

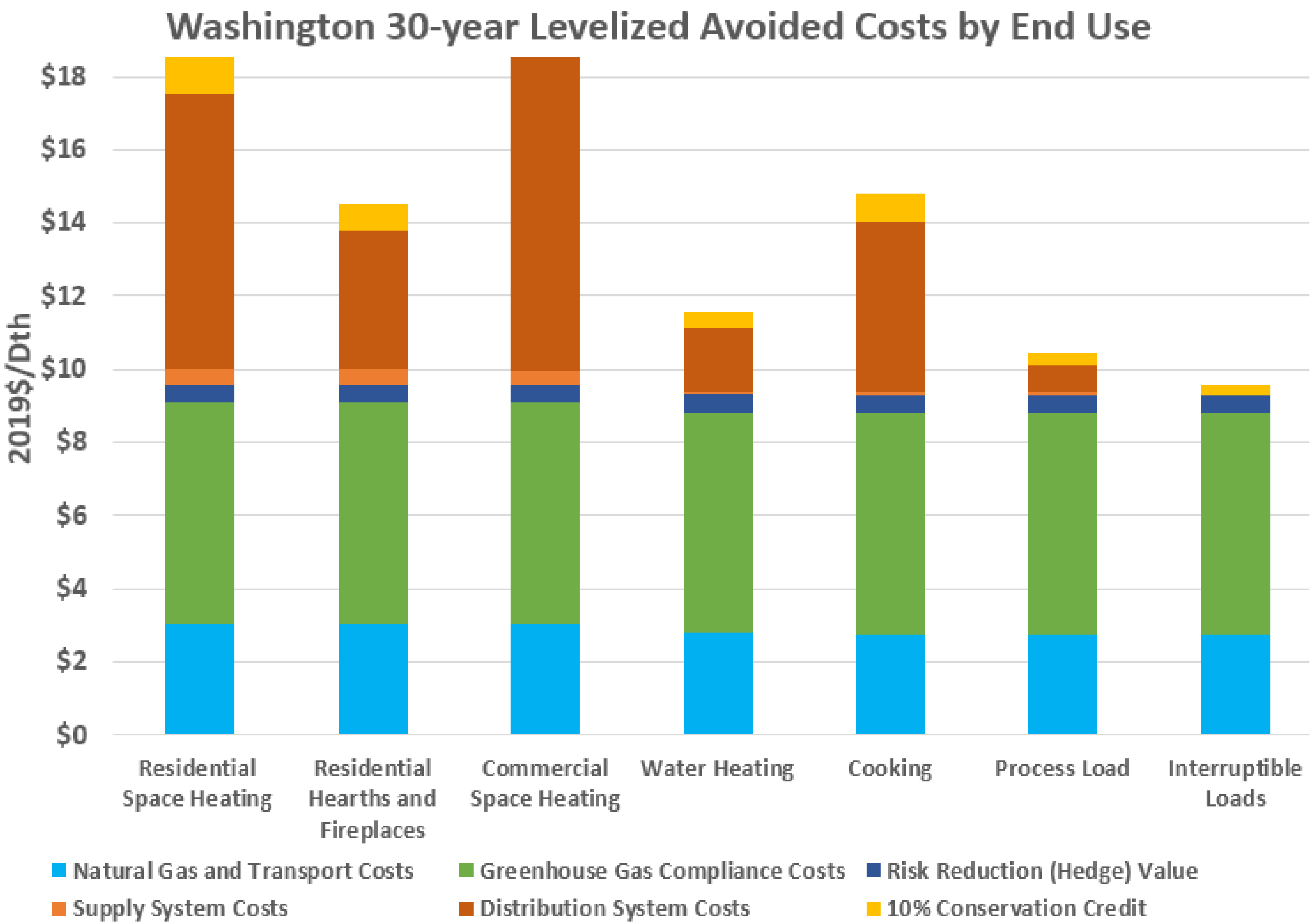


Avoided Costs Through Time-Oregon



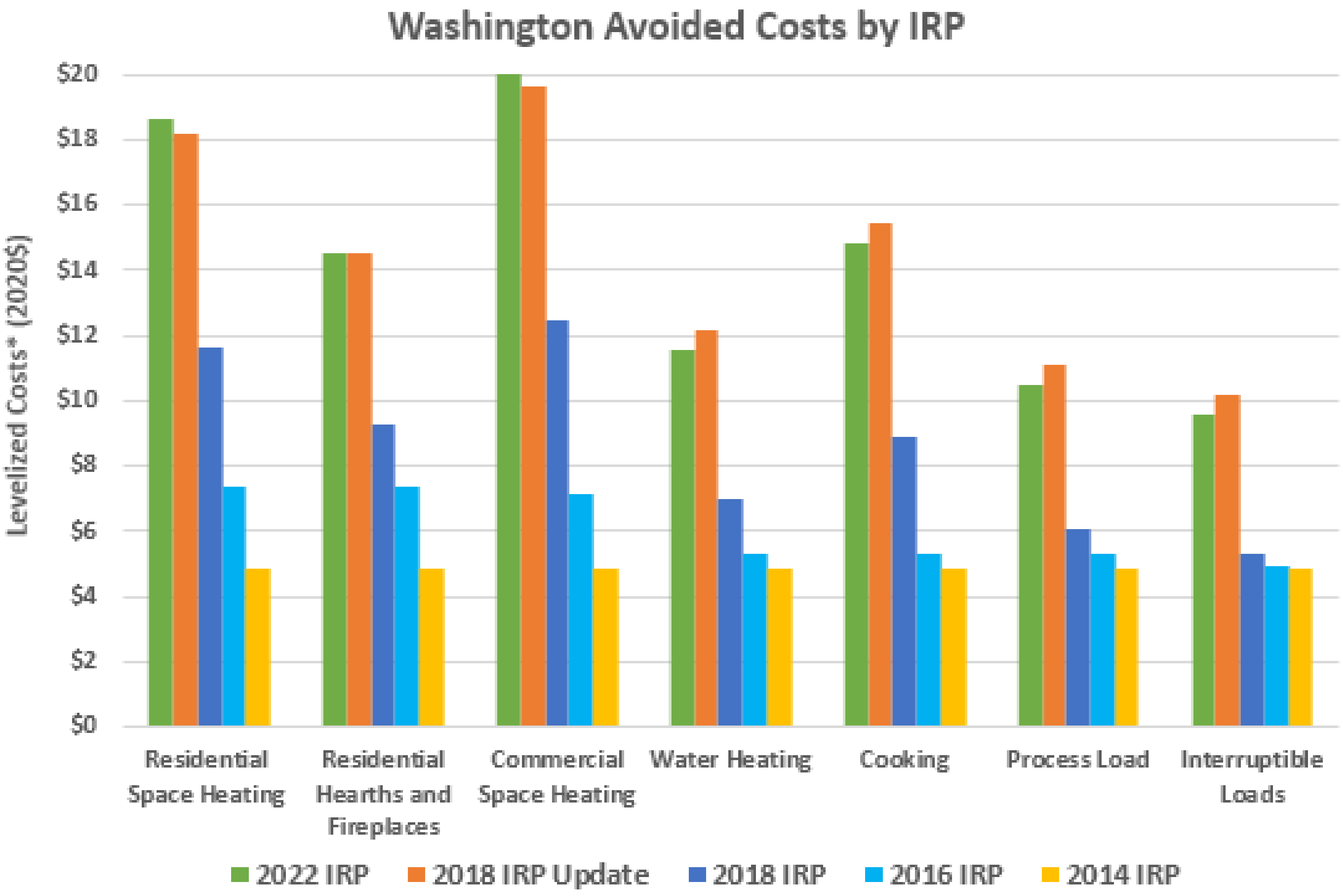
*2022 IRP and 2018 IRP Update are 30-year levelized figures where earlier figures are 20-year levelized figures

Avoided Cost Summary- Washington



Prepared for IRP Working Group - Not to be used for investment purposes.

Avoided Costs Through Time-Washington

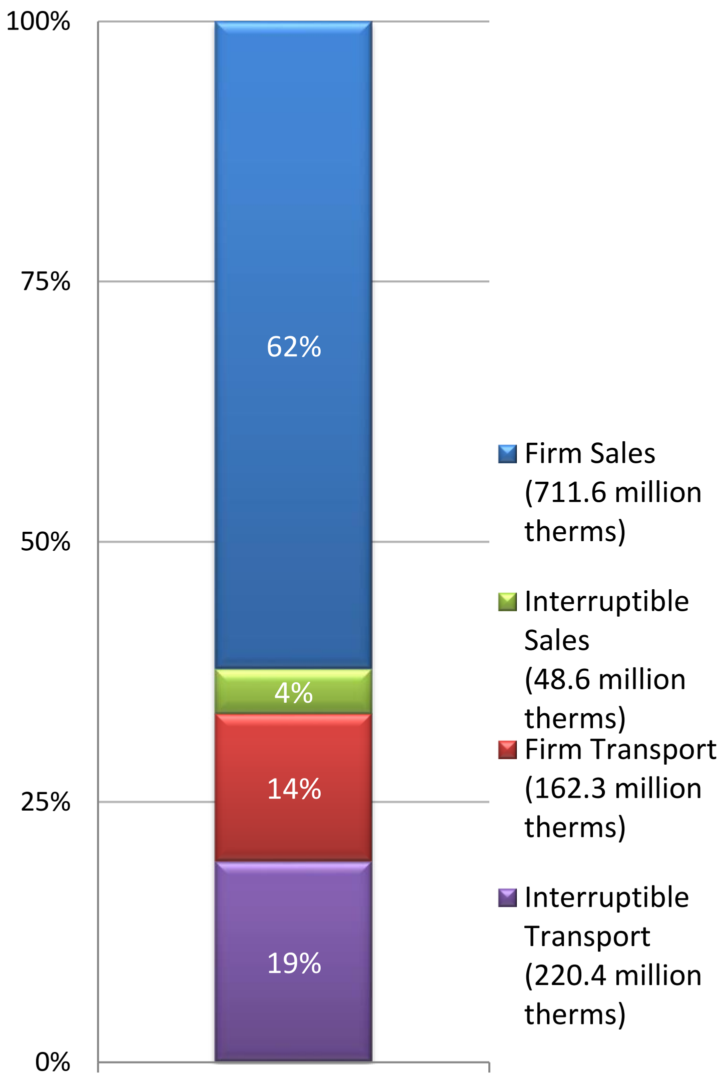


*2022 IRP and 2018 IRP Update are 30-year levelized figures where earlier figures are 20-year levelized figures

Customer Types and Resource Planning

Customer Category	System Capacity Resource Planning: Design Winter Weather Energy Requirements	System Capacity Resource Planning: Peak Day Capacity Requirements	System Capacity Resource Planning: Emission Compliance	Distribution System Planning: Peak Hour Capacity Requirements
Firm Sales	✓	✓	✓	✓
Interruptible Sales	✓		✓	
Firm Transport			✓	✓
Interruptible Transport			✓	

Note: Transport customers pay NW Natural to provide distribution services to *transport* the gas from the interstate pipeline to the customer's site location but are responsible for purchasing and upstream shipping of their gas.



Percentage of YE Volume 2020 by Service Type

Who is doing what Energy Efficiency Work

NW Natural®

	Energy Trust	Applied Economics Group (AEG)
CPA – OR Sales Load	✓	
CPA – OR Transport Load		✓
CPA – WA Sales Load		✓
CPA –WA Transport Load		✓
OR Program Implementation	✓	
WA Program Implementation	✓	

OR CPA for Sales Customers – Presented by Energy Trust of Oregon

Energy Efficiency Resource Assessment for NWN's 2022 IRP

April 13th, 2022

Energy Trust of Oregon

Agenda

- About Energy Trust
- Energy Trust's Resource Assessment Model Overview and Methodology
- IRP Savings Projection Overview
  - The Deployment of Cost-Effective Achievable Savings
- Forecast Results

About us

Independent nonprofit

Serving 1.8 million customers of Portland General Electric, Pacific Power, NW Natural, Cascade Natural Gas and Avista

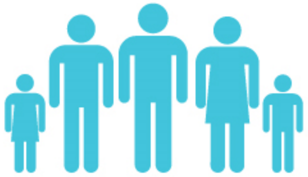
Providing access to affordable energy

Generating homegrown, renewable power

Building a stronger Oregon and SW Washington

Clean and affordable energy since 2002

From Energy Trust's investment of $2.2 billion in utility customer funds:



Nearly 770,000 sites transformed into energy efficient, healthy, comfortable and productive homes and businesses

18,000 clean energy systems generating renewable power from the sun, wind, water, geothermal heat and biopower

$8.9 billion in savings over time on participant utility bills from their energy-efficiency and solar investments

36.2 million tons of carbon dioxide emissions kept out of our air, equal to removing 7 million cars from our roads for a year

2022 Programs – Acquiring all C/E Efficiency

- Residential – Existing and New Homes
  - Single family, moderate income, rental, manufactured homes
  - Weatherization (insulation, windows, air sealing)
  - Gas fireplaces, furnaces
  - Water heaters

- Commercial – Existing, New, Multifamily, SEM in Oregon
  - Retail, offices, schools, groceries….all market segments
  - HVAC, controls, water heating, windows, insulation

- Industrial & Agriculture in Oregon– Non transport sites
  - Manufacturing facilities, greenhouses
  - HVAC, O&M, process improvements

Northwest Natural Gas & Energy Trust

- Serving Oregon for over 19 years, since 2003:
  - Served over 296,000 households, over 14,800 commercial sites and over 460 industrial sites

- Serving SW Washington since 2009
  - Served over 21,600 households and 460 commercial sites

Energy Trust's Resource Assessment Model Overview

Resource Assessment (RA) Purpose

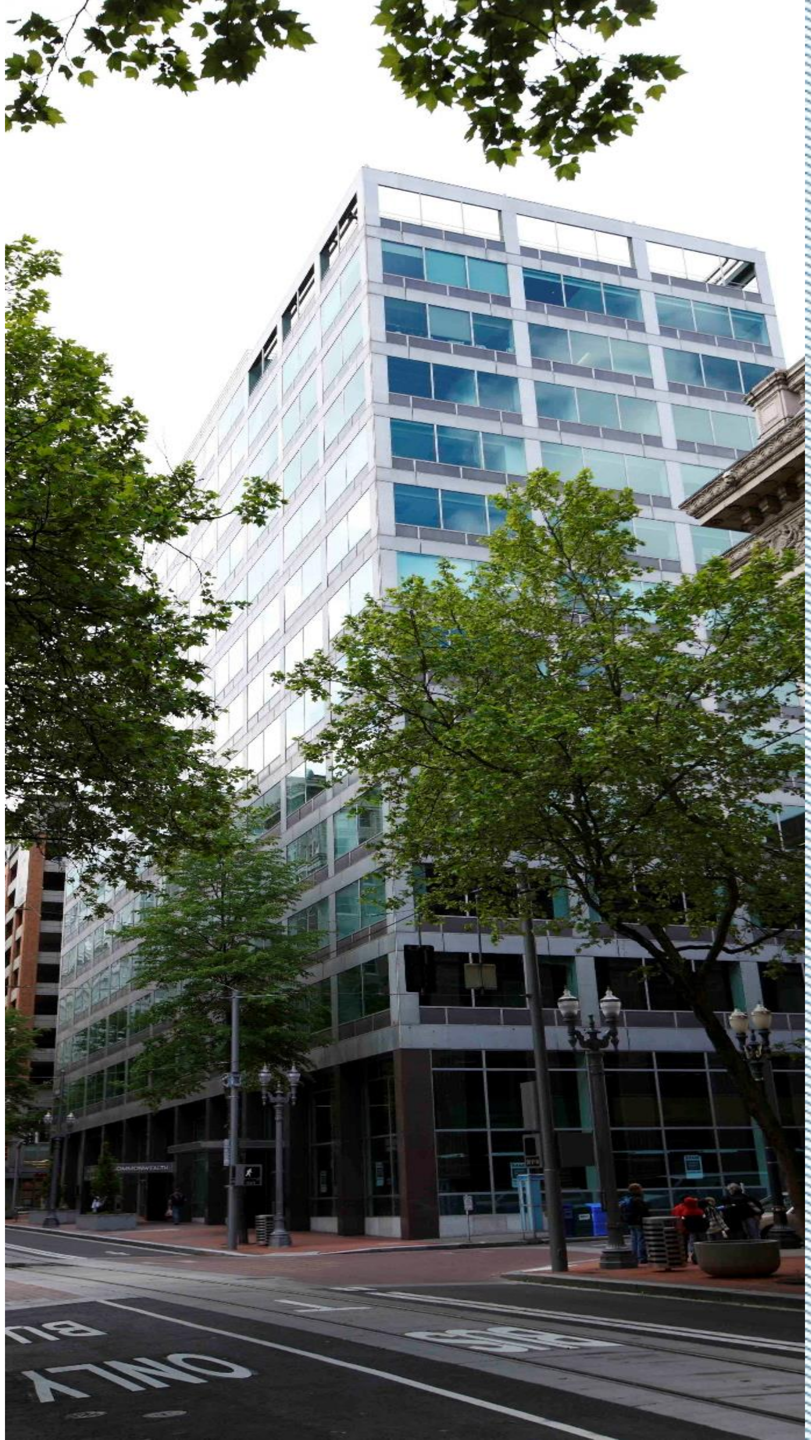
- Informs utility Integrated Resource Planning (IRP)
- Provides estimates of 20-year energy efficiency potential and the associated load reduction
- Helps utilities to strategically plan future investment in both demand and supply side resources

RA Model Background

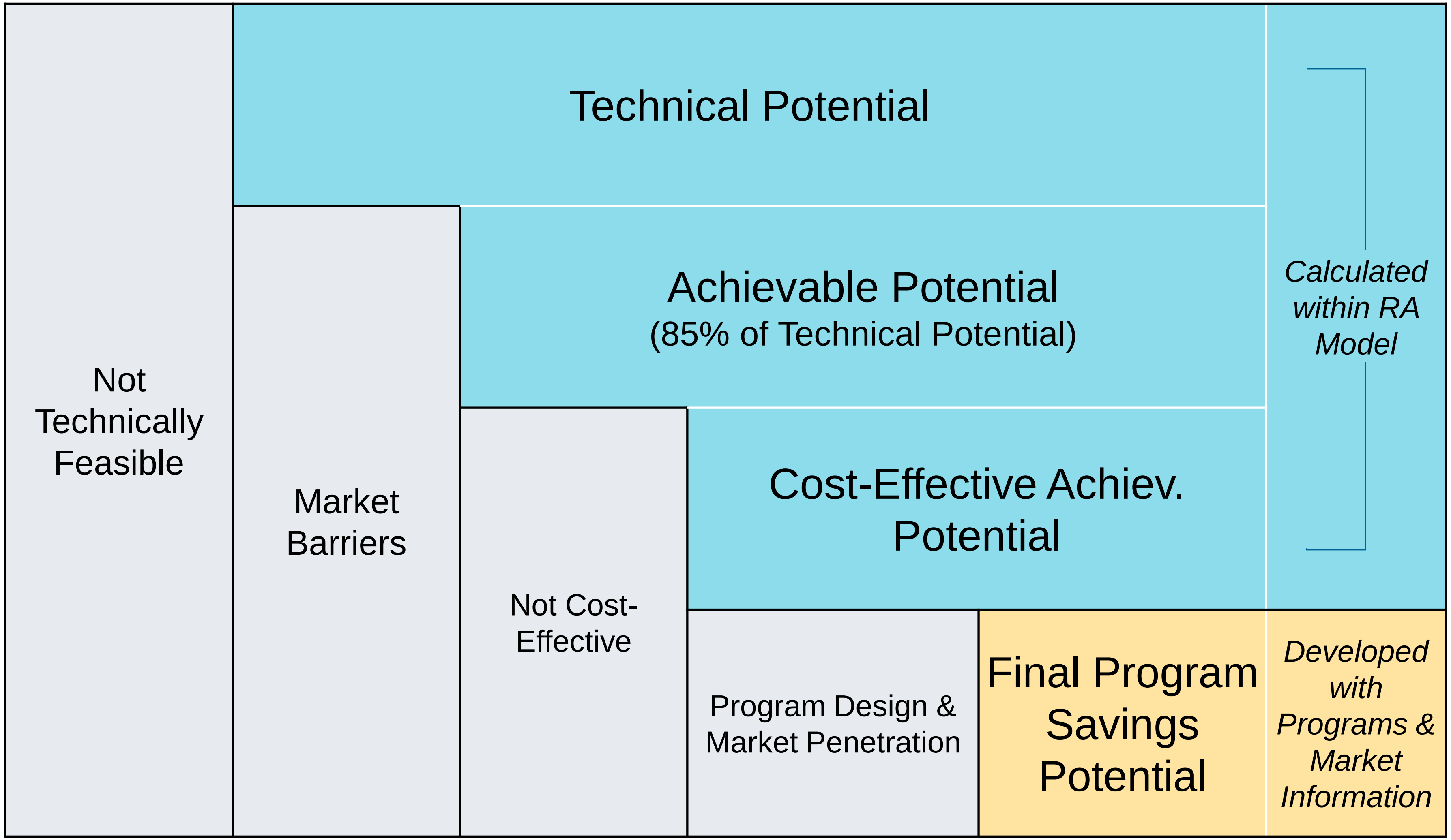
- 20-year energy efficiency potential estimates
- “Bottom-up” modeling approach – measure level inputs are scaled to utility level efficiency potential
- Energy Trust uses a model in *Analytica* that was developed by Navigant Consulting in 2014
  - The *Analytica* RA Model calculates Technical, Achievable and Cost-Effective Achievable Energy Efficiency Potential.
  - Final program/IRP targets are established via a deployment protocol exogenous of the model.
- Inputs refreshed to reflect most up to date assumptions according to IRP schedules
- A “living model” which is constantly being improved

Changes to Modeling Since 2020 IRP

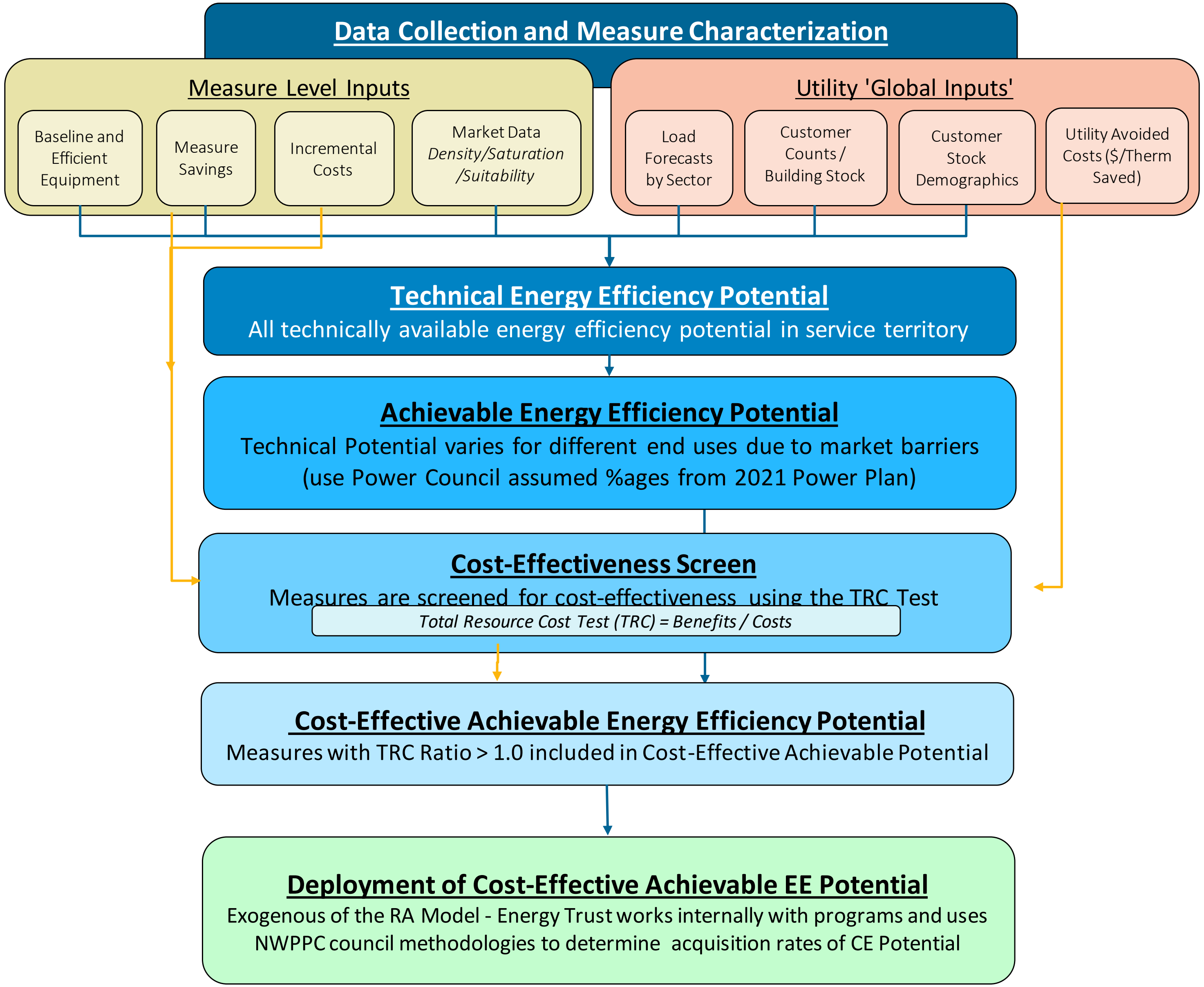
- Lost opportunity/unconstrained potential
- Align with NWPCC achievability assumptions
- Measure updates, new measures and new emerging technologies included in the model



Forecasted Potential Types



20-Year IRP EE Forecast Flow Chart



Methodology Overview

‘Bottom-up’ modeling approach:

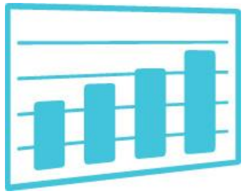
1. Measure inputs are characterized per unit
2. Number of units per scaling basis are estimated
   - *Residential*: # of Homes Served
   - *Commercial*: 1000s of Sq. Ft. Served
   - *Industrial*: Customer Segment Load Forecasts
3. The savings and costs of each measure are scaled to the utility level based on scaling basis inputs provided by NWN

Simple Example *(Illustrative Numbers)*

Eff. Gas Furnace – 100 Therms Savings → 1 Gas Furnace per home and 50% at baseline efficiency → 25,000 Homes served by utility → 100 x 1 x 0.50 x 25,000 = 1,250,000 savings potential

- Measure Data
- Market Data
- Utility Data
- Total Potential

RA Model inputs



Measure Level Inputs

Measure Definition and Application:
- Baseline/efficient equip. definition
- Applicable customer segments
- Installation type (RET/ROB/NEW)*
- Measure life

Measure Savings

Measure Cost
- Incremental cost for ROB/NEW measures
- Full cost for retrofit measures

Market Data (for scaling)
- Density
- Baseline/efficient equipment saturations
- Suitability

Utility 'Global' Inputs

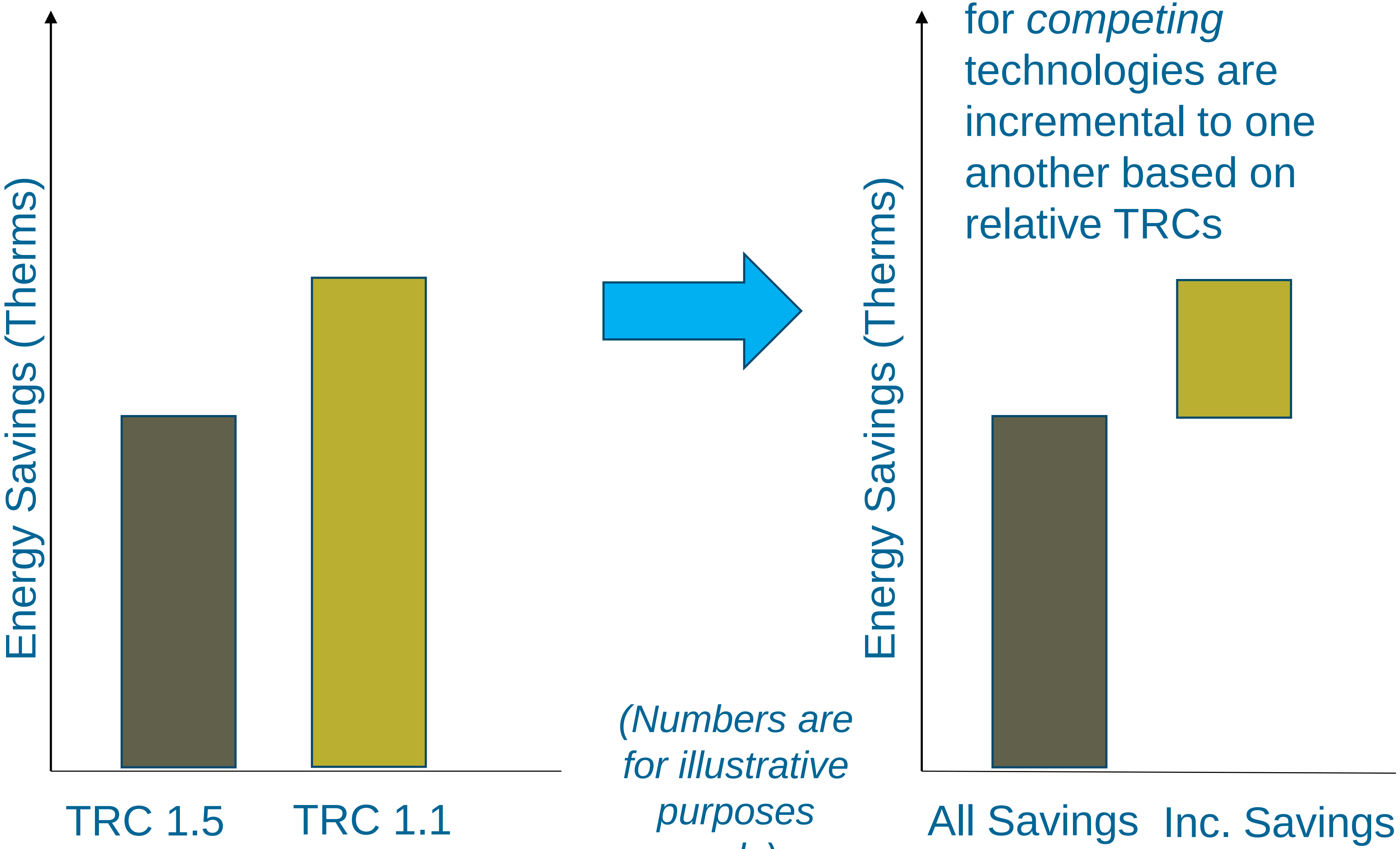
Customer and Load Forecasts
- Used to scale measure level savings to a service territory
  - Residential Stocks: # of homes
  - Commercial Stocks: 1000s of Sq.Ft.
  - Industrial Stocks: Customer load

Avoided Costs (provided by utilities)

Customer Stock Demographics:
- Heating fuel splits
- Water heat fuel splits

** RET = Retrofit; ROB = Replace on Burnout; NEW = New Construction*

Incremental Measure Savings Approach
Competition groups



Savings potential for *competing* technologies are incremental to one another based on relative TRCs

(Numbers are for illustrative purposes only)

Cost-Effectiveness Screen

- Energy Trust utilizes the Total Resource Cost (TRC) test to screen measures for cost effectiveness

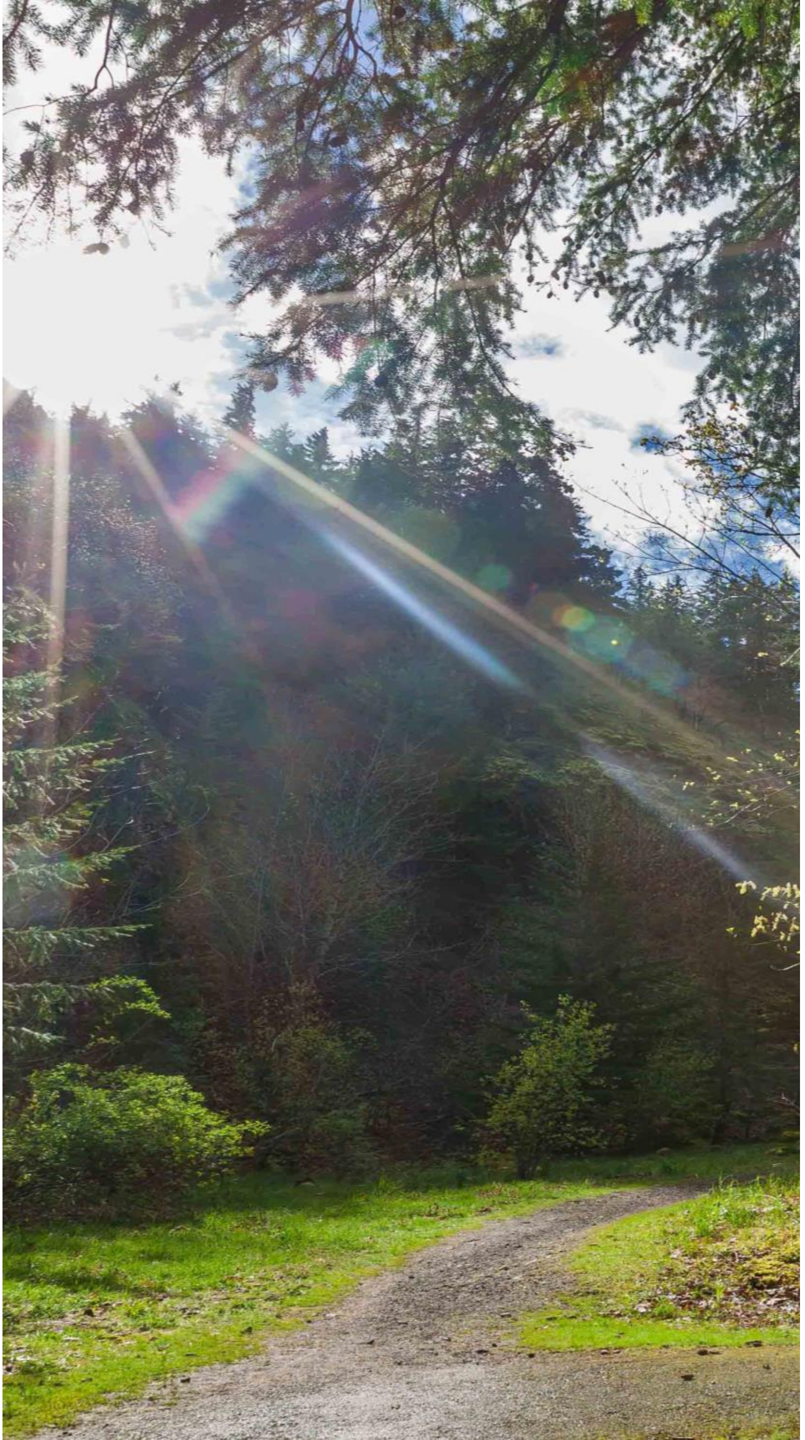
$$\text{TRC} = \frac{\textit{Measure Benefits}}{\textit{Total Measure Cost}}$$

- If TRC is > 1.0, it is cost-effective

- Measure Benefits:
  - Avoided Costs (provided by NWN)
    - Annual measure savings x NPV avoided costs per therm
  - Quantifiable Non-Energy Benefits
    - Water savings, etc.

Total Measure Costs:

- The customer cost of installing an EE measure (full cost if retrofit, incremental over baseline if replacement)



Cost-Effectiveness Override in Model

Energy Trust applied this feature to measures found to be NOT Cost-Effective in the model but are offered through Energy Trust programs.

Reasons:

1. Blended avoided costs may produce different results than utility specific avoided costs
2. Measures offered under an OPUC exception per UM 551 criteria.

Model Outputs

Types of Potential:
- Technical
- Achievable
- Cost-Effective Achievable

Levelized Cost

Measure Costs & Benefits

Supply Curves

IRP Savings Projections:

Methodology to Deploy Cost-Effective Achievable Potential

Why Deploy?

- The RA model results represent the maximum savings potential in a given year.
- Ramp rates are an estimate of how much of that available potential will come off NWN's system.
- Energy Trust ramp rates are based on NWPCC methods and ramp rates, but calibrated to be specific to Energy Trust.

Ramp Rate Overview

- Total RA Model cost-effective potential is different depending on the measure type.
  - **Retrofit measure savings** are 100% of all potential in every year, therefore must be distributed in a curve that adds to 100% over the forecast timeframe (bell curve)
  - **Lost opportunity measure savings** are the savings available in that year only and deployment rates are what % of that available potential rate can be achieved – results in an s-curve
- Generally follows the NWPCC deployment methodology
  - 100% cumulative penetration for retrofit measures over 20-year forecast
  - 100% annual penetration for lost opportunity by end of 20-year forecast (program or code achieved)
  - Hard to reach measures or emerging technologies do not ramp to 100%

Ramp Rate Examples

Ramp Rate Calibration

Energy Trust calibrates the first five years of energy efficiency acquisition ramp rates to program performance and budget goals.

Years 1-2

- Program forecasts – based on budget and current market conditions

Years 3-5

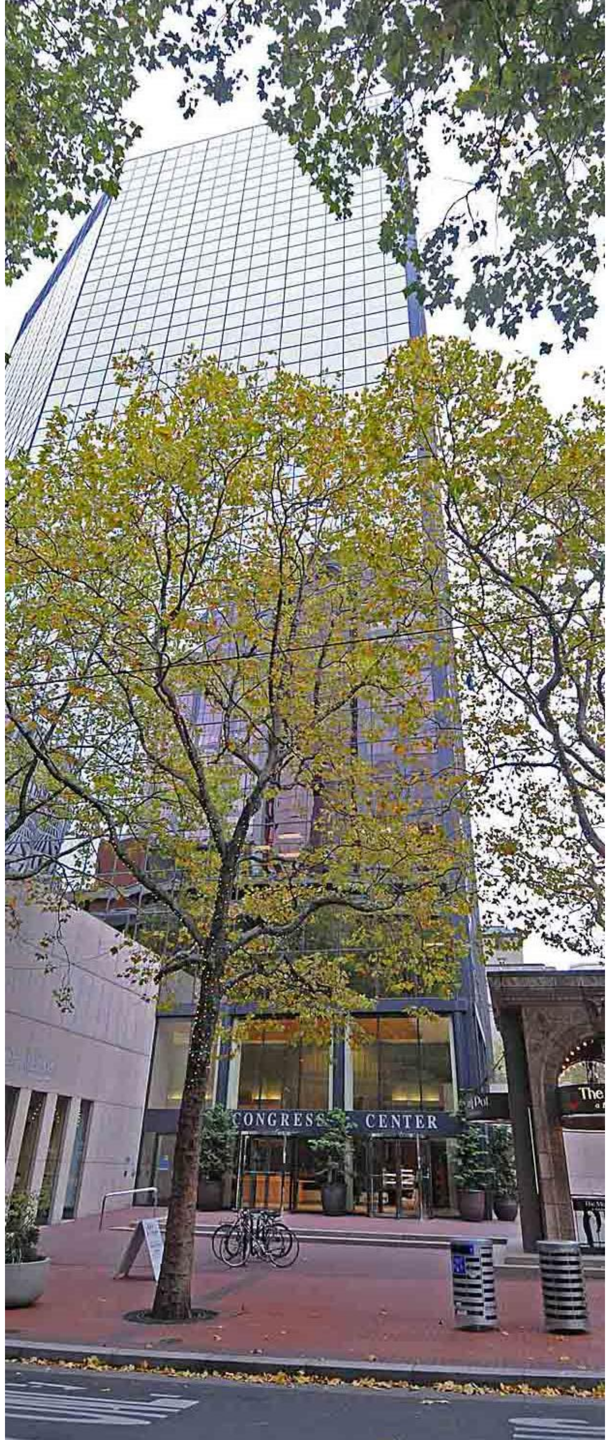
- Planning and Programs work together to create forecast

Years 6-20

- Planning forecasts long-term acquisition rate to generally align NWPCC

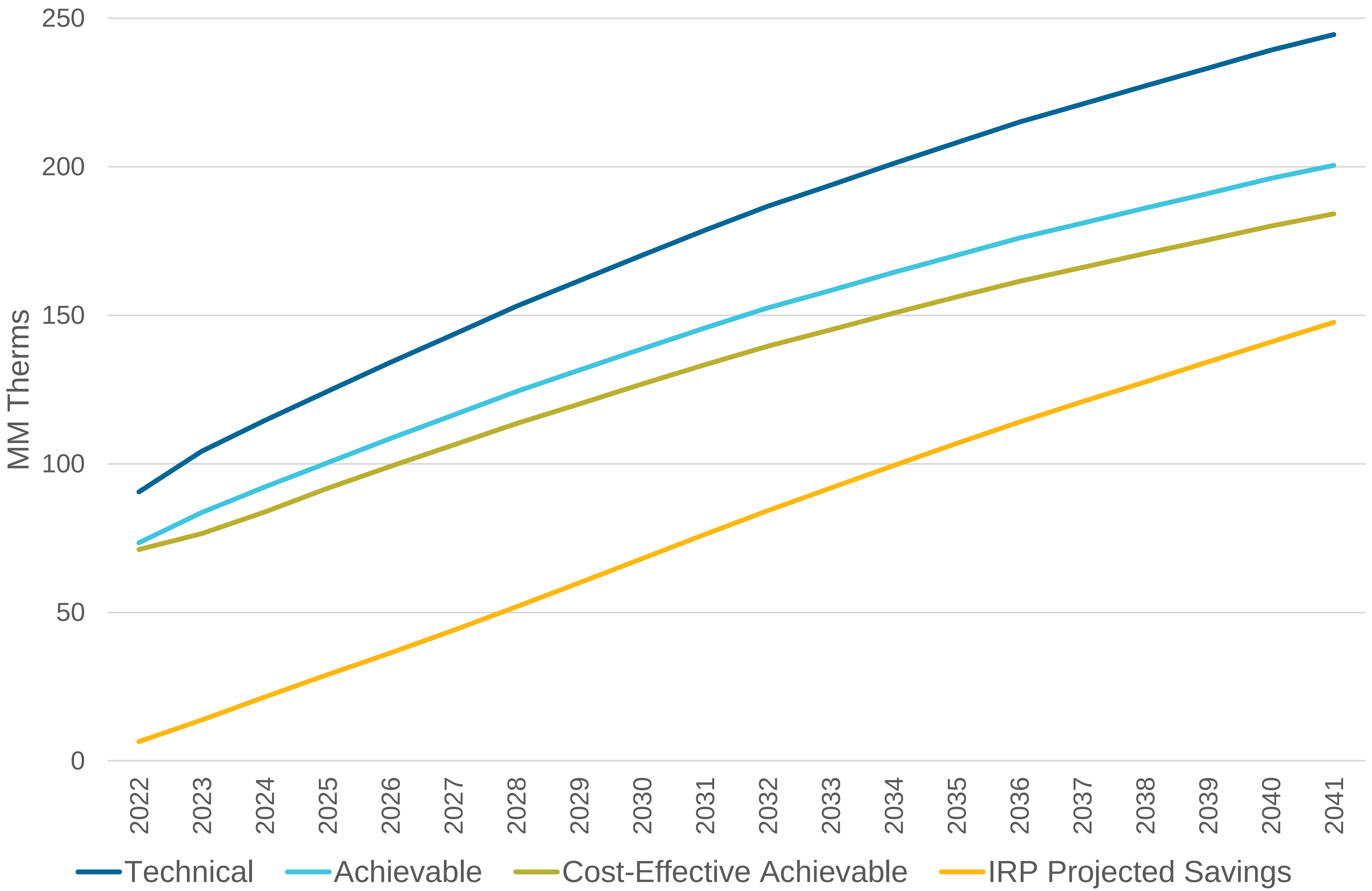
Application of Ramp Rates & Relation to RA Model Results

- Energy Trust's calibration process means ramp rates are not the same as the NWPCC, but follow similar methods.
- Ramp rates are specific to NWN.
- The application of these ramp rates is the reason why not all of the RA Model Cost-Effective Achievable Potential is forecasted to be acquired.
- The deployment process is done exogenously of the RA Model.

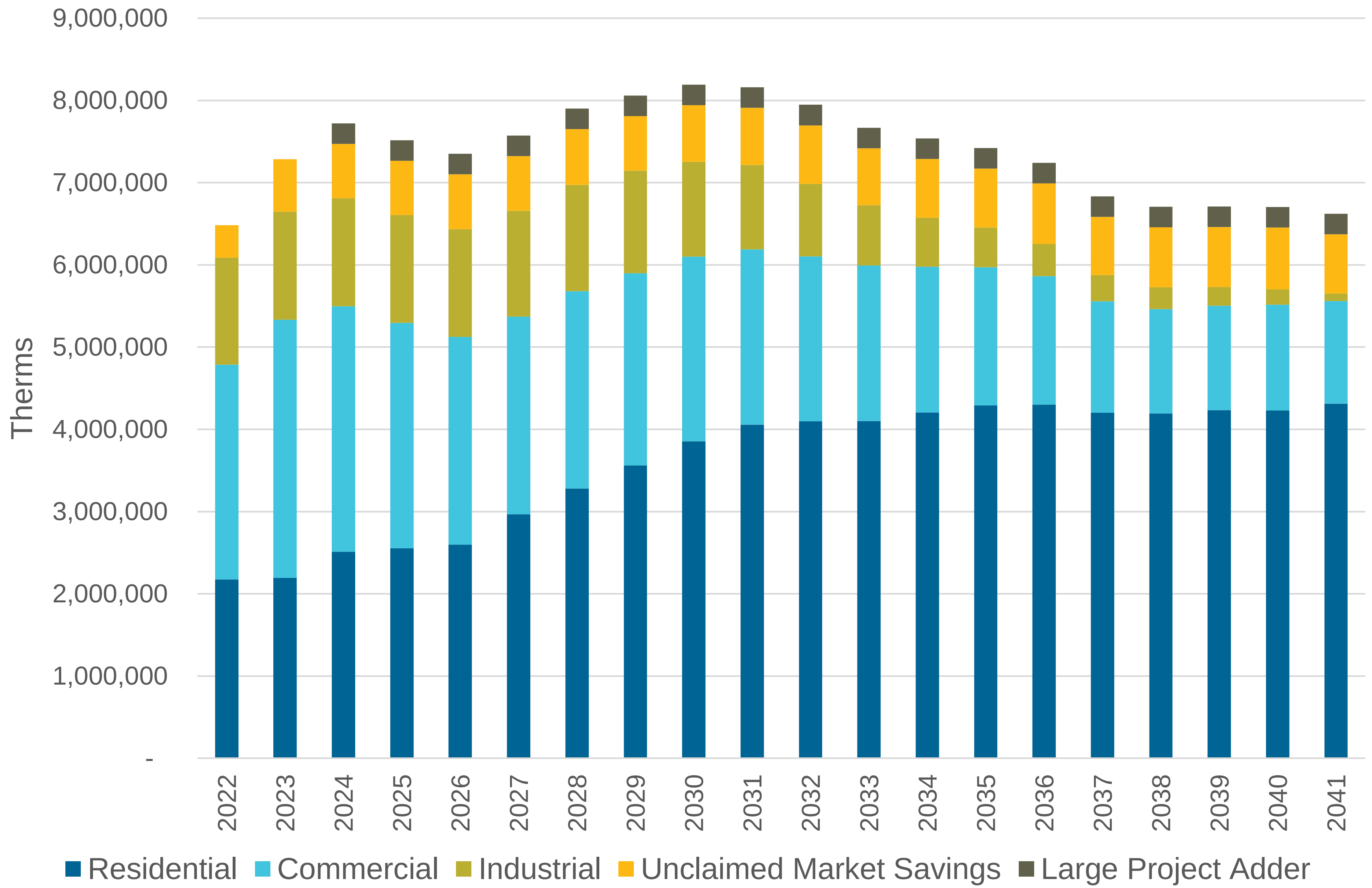


NWN’s 2022 IRP Results

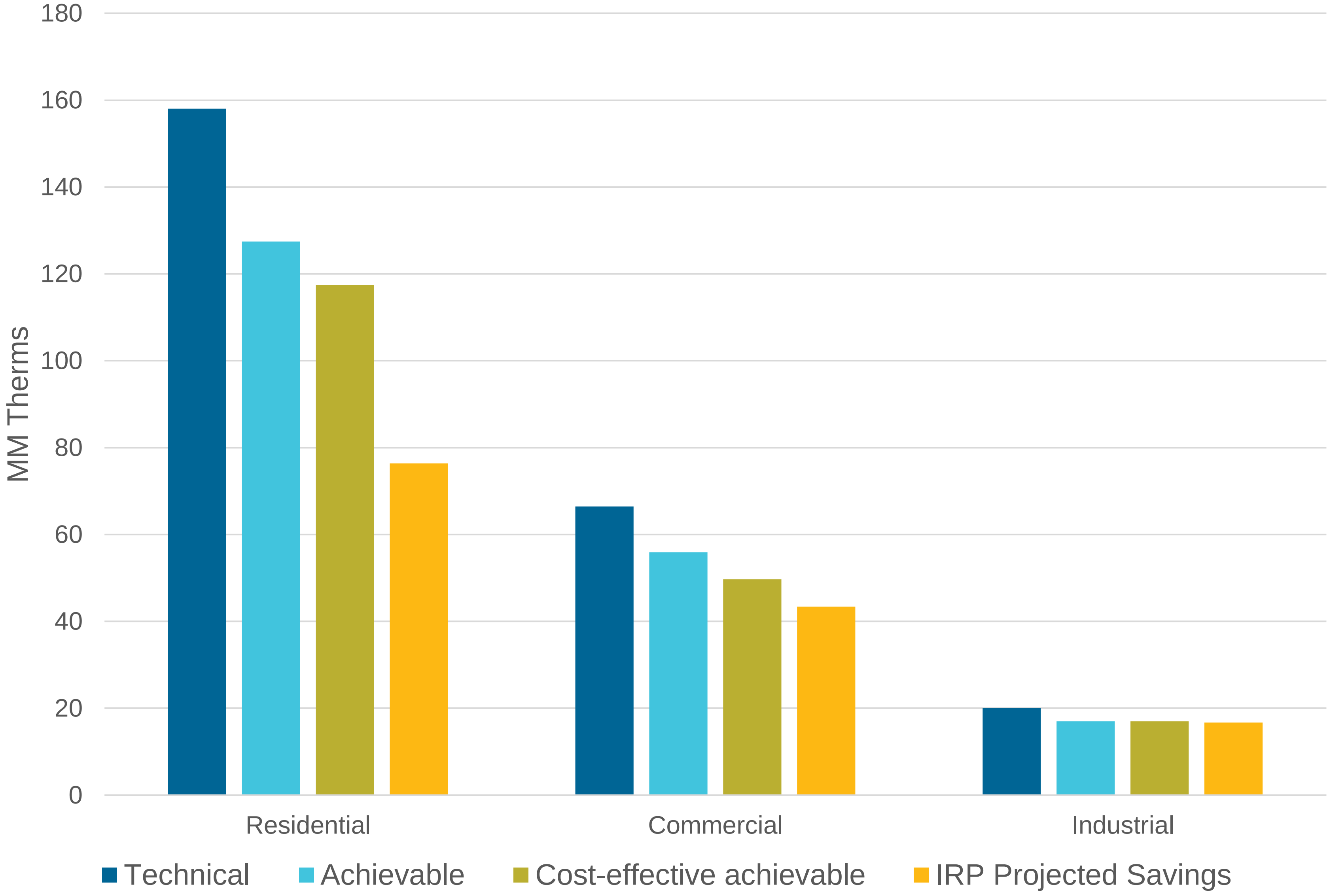
Cumulative Savings by Type and Year



Annual Deployed IRP Forecasted Savings



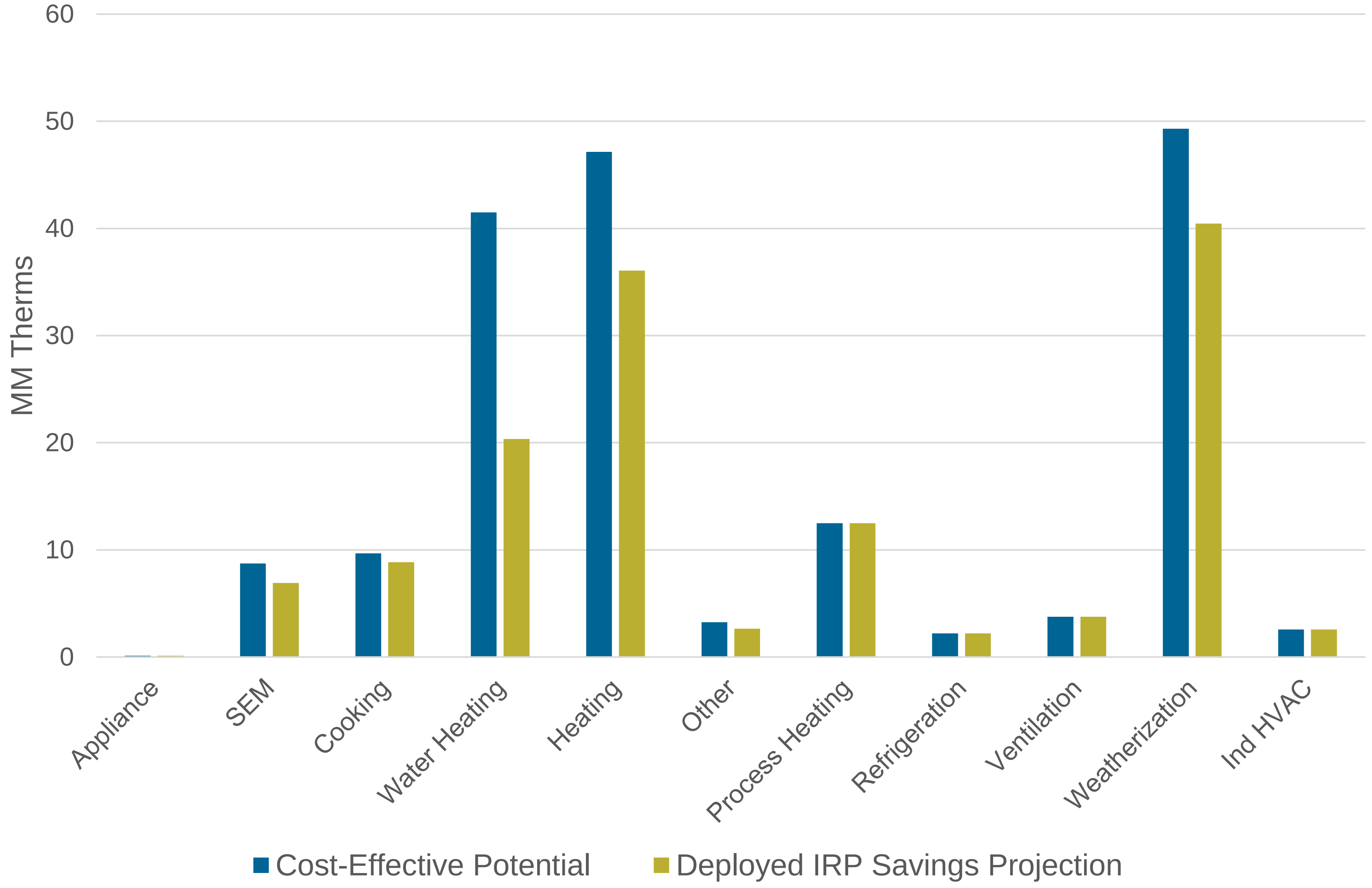
Cumulative Savings by Sector and Type



Cumulative Savings by Sector and Type (Therms)

	Residential	Commercial	Industrial	All Sectors
Technical Potential	158,065,739	66,466,669	20,029,105	244,561,513
Achievable Potential	127,477,540	55,931,239	17,024,739	200,433,518
Cost-effective Achievable Potential	117,451,969	49,684,558	17,024,739	184,161,265
IRP Projected Savings	76,355,753	43,364,083	16,733,280	136,453,116

Cumulative Cost-Effective Savings & IRP Savings Projections by End-Use Compared



Cost Effective Override Effect

Energy Trust applied this feature to measures found to be NOT Cost-Effective in the model but are offered through Energy Trust programs under OPUC Exception

Measures that are Overridden	Override Applied?	Notes
Res - Attic/Ceiling insulation	TRUE	OPUC Exception
Res - Floor insulation	TRUE	OPUC Exception
Res - Wall insulation	TRUE	OPUC Exception
Res – Efficient Gas Clothes Washer	TRUE	OPUC Exception
Res – Gas heated new manufactured homes	TRUE	OPUC Exception
Com – Wall insulation	TRUE	OPUC Exception
Com – Flat roof insulation	TRUE	OPUC Exception

Cost Effective Override Effect

Energy Trust applied this feature to measures found to be NOT Cost-Effective in the model but are offered through Energy Trust programs under OPUC Exception

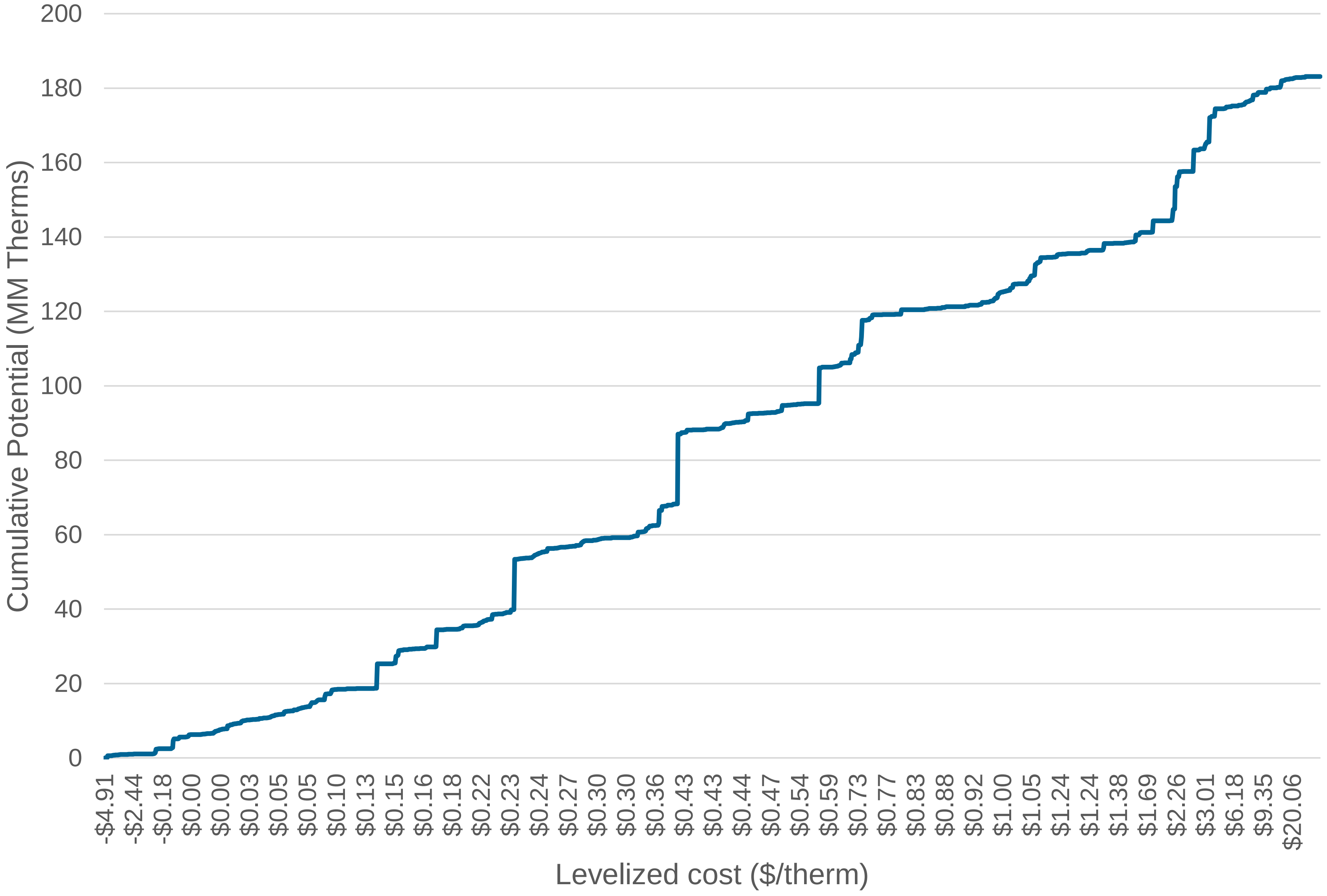
Total Cumulative Potential	Cost-Effective Potential	Deployed IRP Savings Projection
Savings with CE Override (MM Therms)	184.16	147.63
Savings with NO CE Override (MM Therms)	157.23	139.61
Variance (MM Therms)	26.93	8.02
CE Overridden % of Total Potential	**14.6%**	**5.4%**

Peak Day Factors and Cumulative Peak Day Savings Estimates

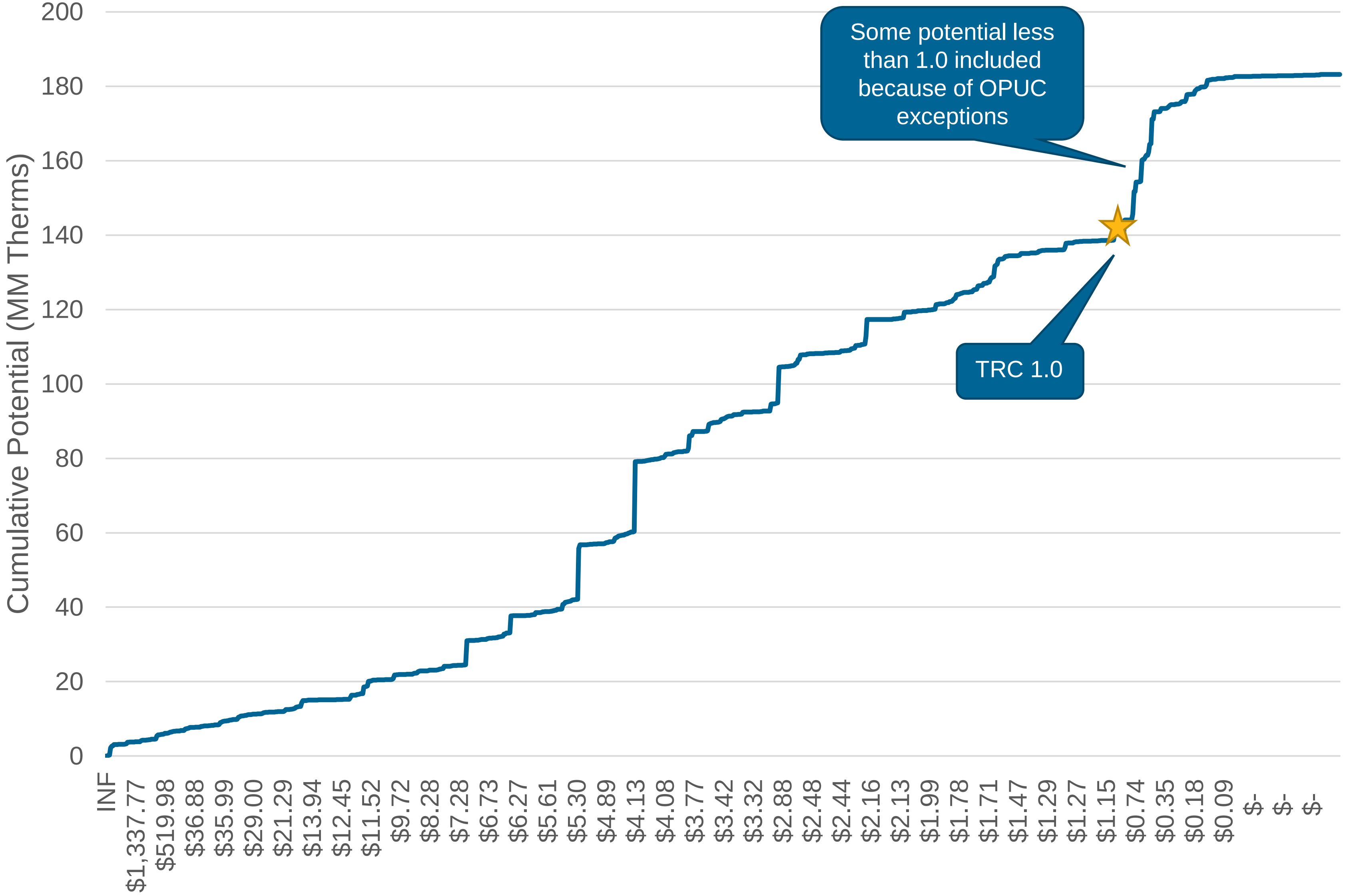
- Energy Trust also provides estimates of a peak day reduction in peak day consumption
- Peak Day factors derived from Energy Trust avoided cost calculations

	Peak Day Factor	CE Potential Peak Day Therms (cumulative)	IRP Savings Targets Peak Day Therms (cumulative)
Cooking	0.27%	35,044	24,675
Com Heating	1.77%	8,985,391	630,234
Domestic Hot Water	0.33%	239,028	55,956
FLAT	0.27%	217,435	24,884
Res Heating	1.98%	8,942,379	1,303,661
Res Clotheswasher	0.20%	108	104

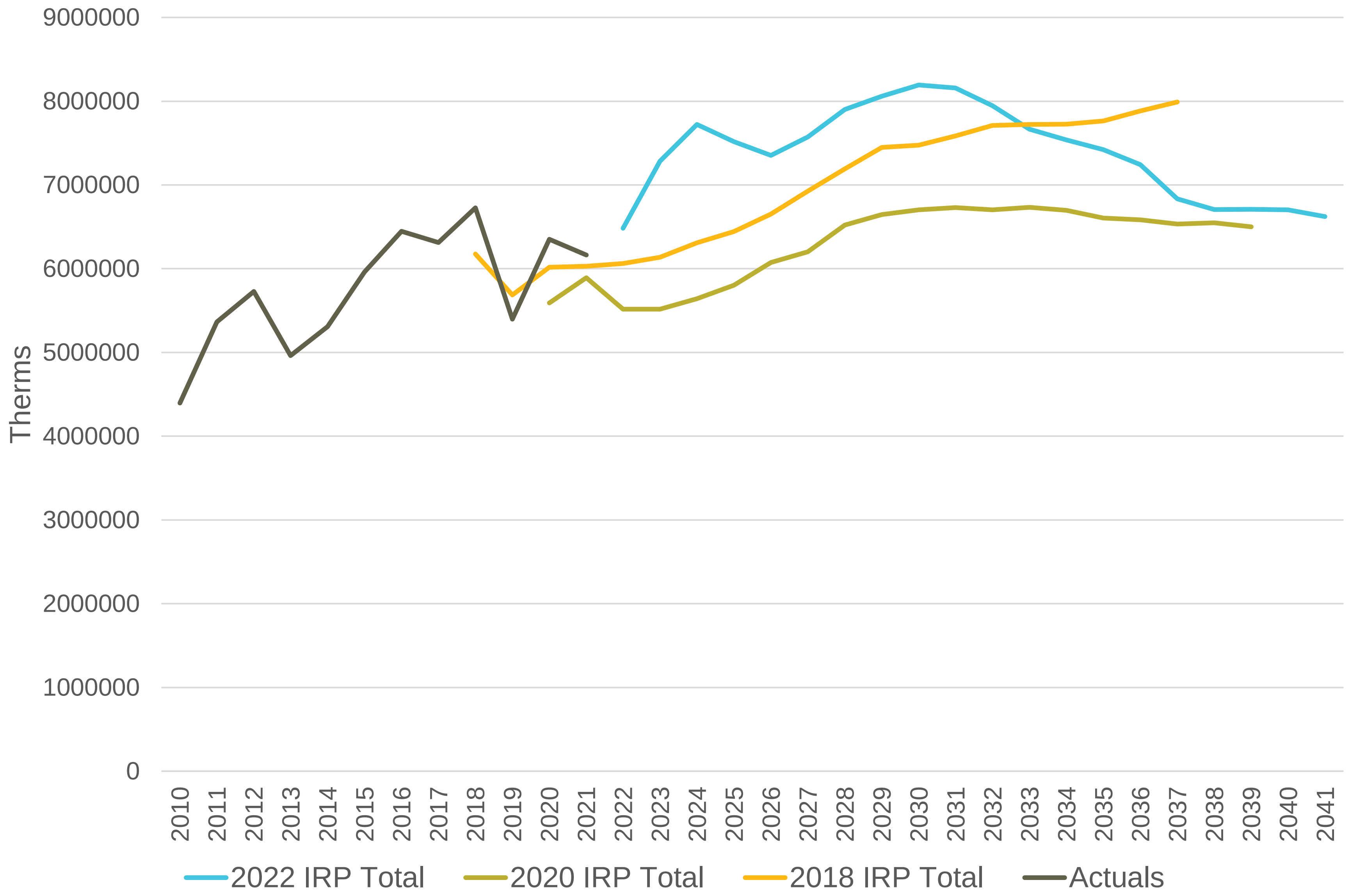
Supply Curve by Levelized Cost (20 year Cumulative Achievable Potential)



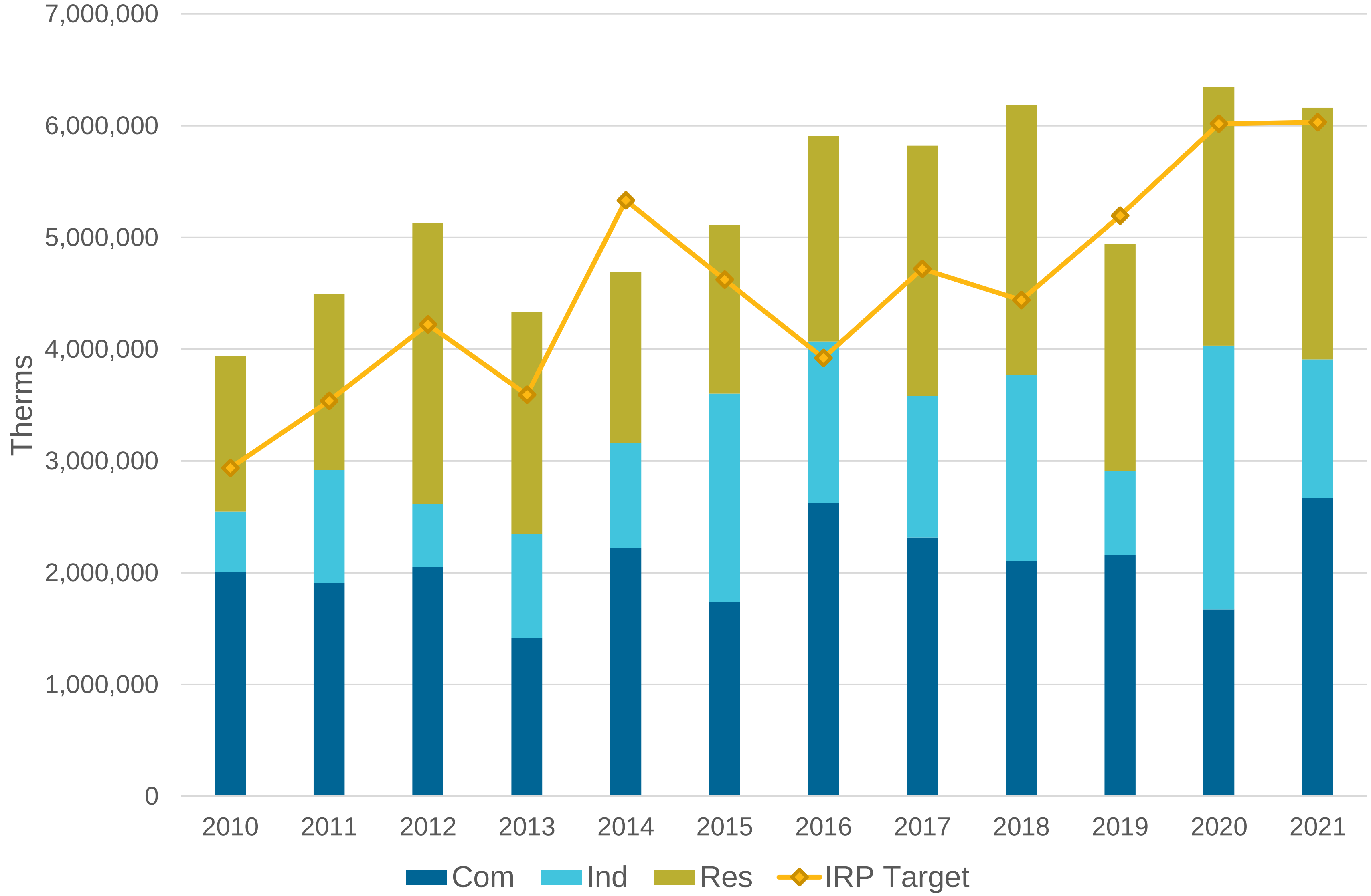
Supply Curve by TRC Ratio (20 year Cumulative Achievable Potential)



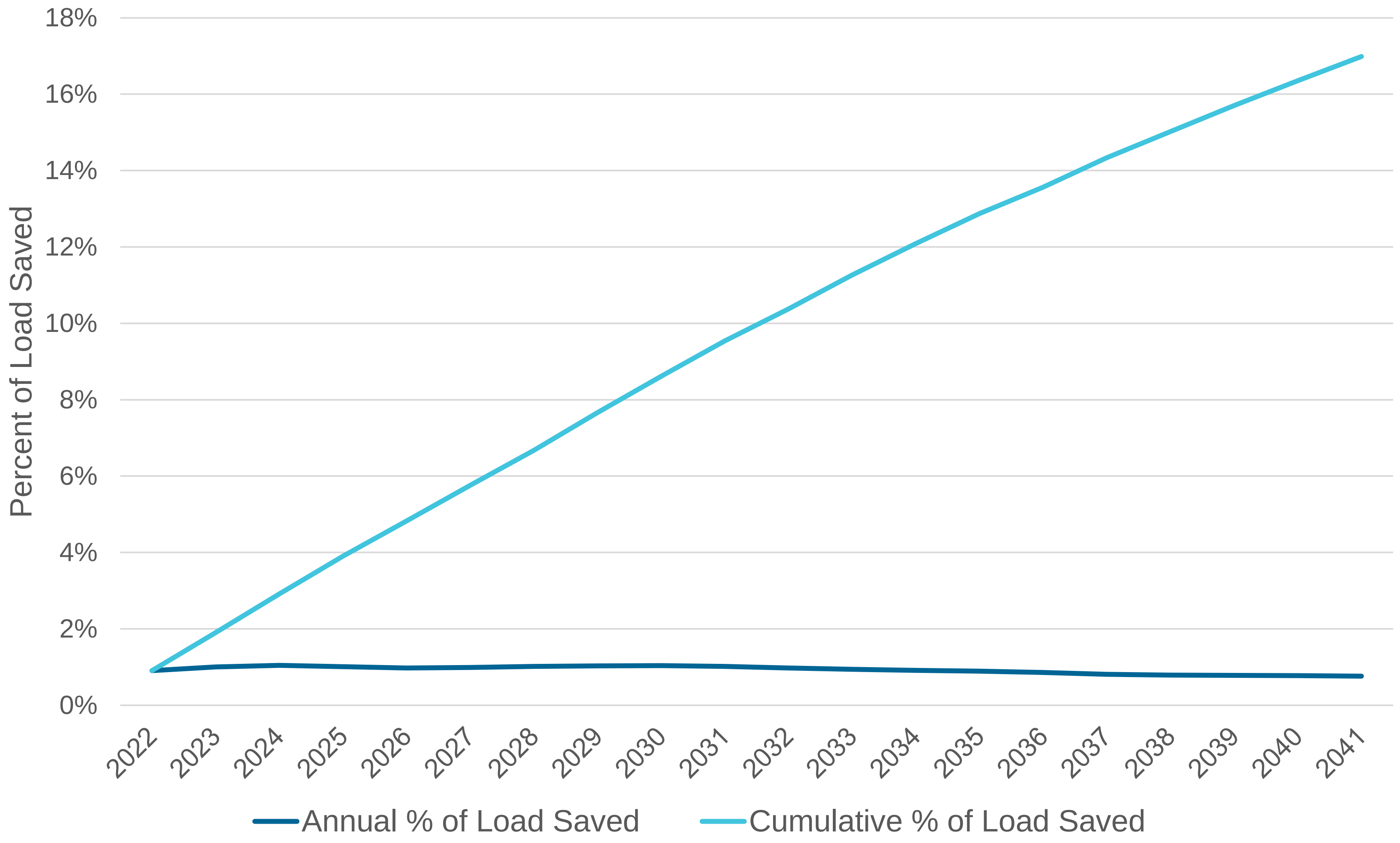
IRP Forecasts Compared to Actual Savings (Annual Gross Therms)



Historical Performance compared to IRP targets (Annual *Net* Therms)



Savings as a Percent of Load Forecast



Average Annual % of Load Saved = 0.93%

Thank you

Kyle Morrill
Sr. Project Manager, Planning

Kyle.Morrill@energytrust.org

Energy Trust of Oregon

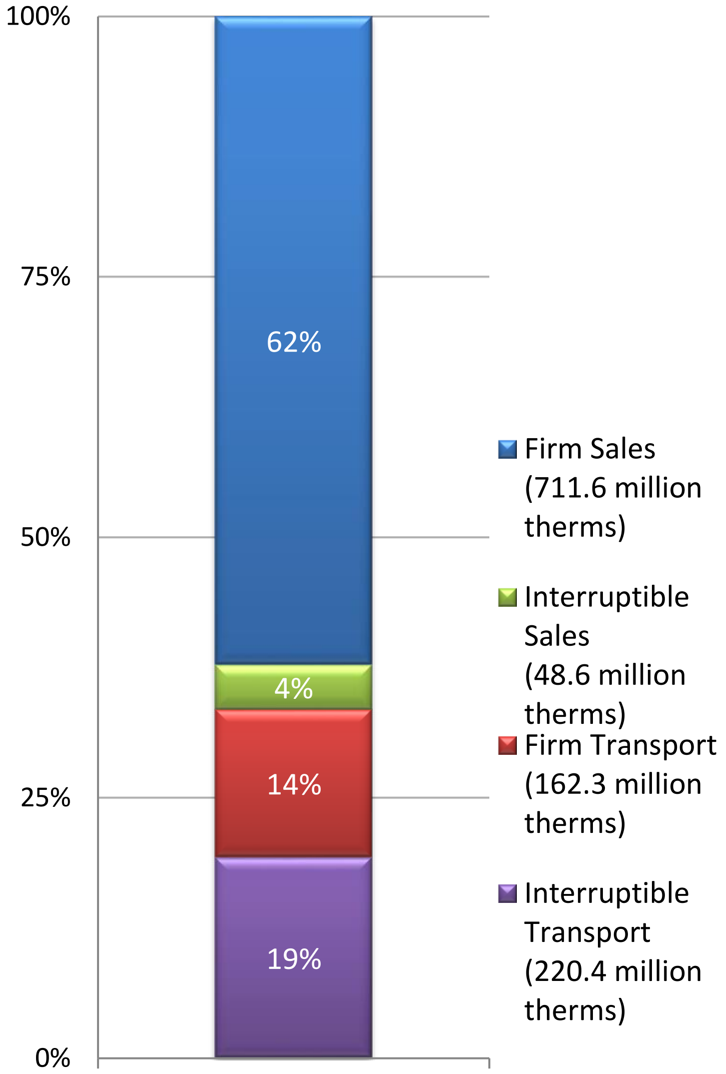
End of Energy Trust of Oregon Presentation

OR CPA for Transport Customers – Presented by AEG

NW Natural®

Customer Types and Resource Planning

Customer Category	System Capacity Resource Planning: Design Winter Weather Energy Requirements	System Capacity Resource Planning: Peak Day Capacity Requirements	System Capacity Resource Planning: Emission Compliance	Distribution System Planning: Peak Hour Capacity Requirements
Firm Sales	✓	✓	✓	✓
Interruptible Sales	✓		✓	
Firm Transport			✓	✓
Interruptible Transport			✓	

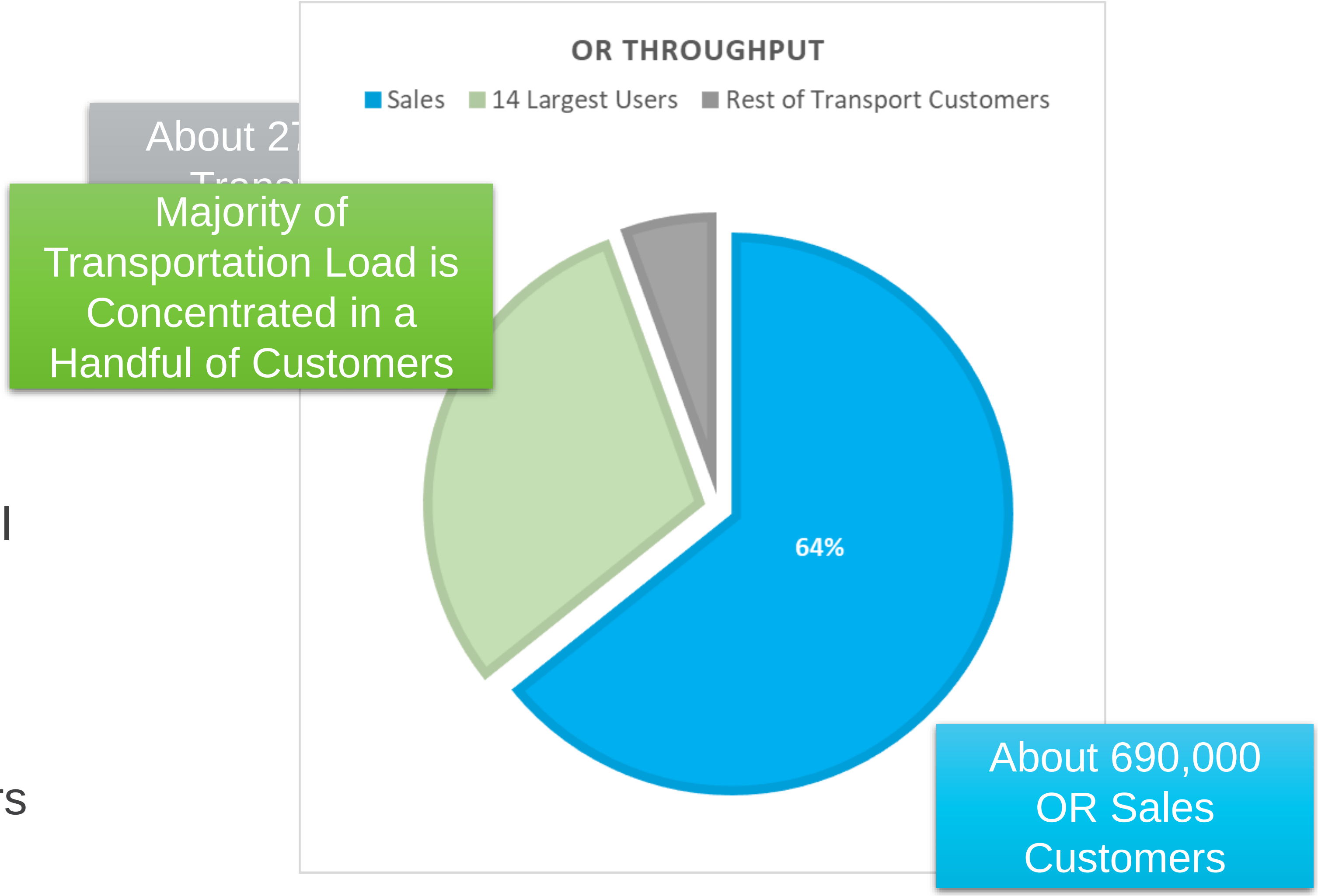


Percentage of YE Volume 2020 by Service Type

Note: Transport customers pay NW Natural to provide distribution services to *transport* the gas from the interstate pipeline to the customer's site location but are responsible for purchasing and upstream shipping of their gas.

Oregon Transportation Customers

- Customers who elect to be on a transportation rate schedule are typically large industrial users, with some large commercial users
- The mix of customers and how they use gas is different than our sales customers
- Emissions from these customers will fall under NW Natural’s compliance obligations under the CPP
- NW Natural hired AEG to conduct a CPA for OR transportation customers



Start of Presentation by AEG

AEG
APPLIED ENERGY GROUP

NW Natural OR Transport Customer Potential Study

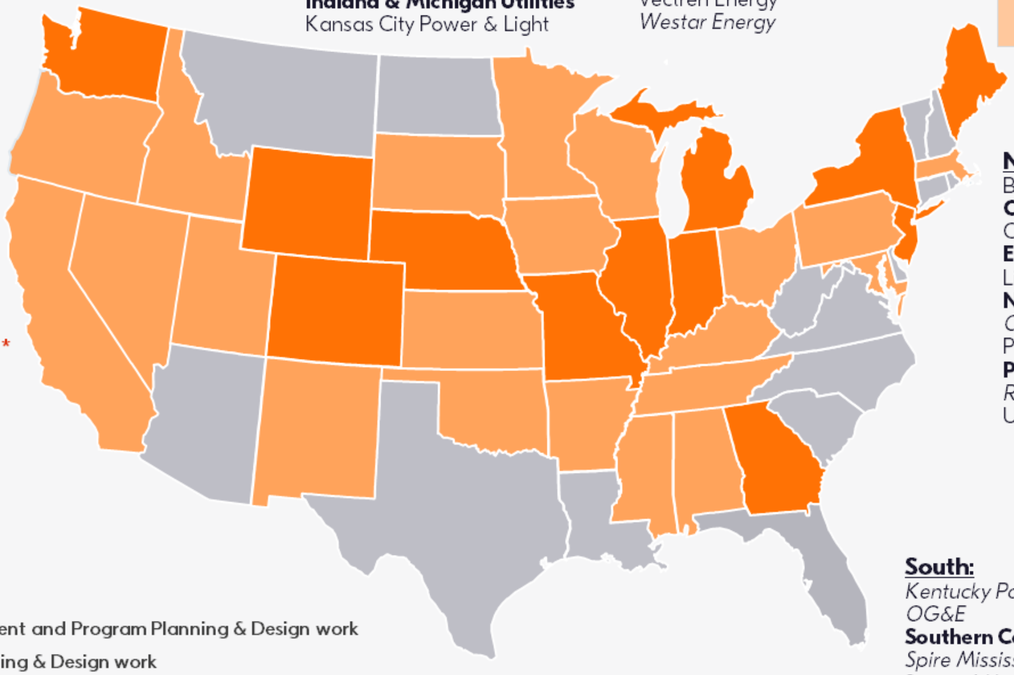
Date: April 14, 2022
Prepared for: NW Natural Technical Work Group

AEG Introduction


Eli Morris
Project Director


Neil Grigsby
Project Manager


Ken Walter
Analysis Lead



West:
Avista Energy *
BPA *
Cascade Natural Gas *
Chelan PUD
Cheyenne LFP *
Colorado Electric *
Cowlitz PUD *
HECO
Idaho Power *
Inland P&L *
LADWP
NV Energy
Oregon Trail EC
PacifiCorp *
PNGC
PG&E *
Portland General Electric
Public Service New Mexico *
Seattle City Light *
State of Hawaii *
State of New Mexico
Tacoma Power *
Xcel/SPS

Midwest:
Ameren Illinois *
Ameren Missouri *
Black Hills Power *
Citizens Energy
Empire District Electric *
Indianapolis P&L *
Indiana & Michigan Utilities
Kansas City Power & Light
MERC
NIPSCO *
Omaha Public Power District *
Peoples' Gas/ North Shore Gas *
Spire Missouri
State of Michigan
Sunflower Electric
Vectren Energy *
Westar Energy

Regional & National:
Midcontinent ISO *
EEI/IEE *
EPRI
FERC

Northeast:
Berkshire Gas
Central Hudson G&E *
Con Edison of NY *
Efficiency Maine *
Liberty Utilities *
New Jersey BPU
Orange & Rockland *
PECO Energy
PSEG Long Island
Rockland Electric
Unitil

South:
Kentucky Power *
OG&E
Southern Company / Georgia Power
Spire Mississippi
State of Maryland – EmPOWER *
TVA

Key
* Two or more studies
Bold = Both Market Assessment and Program Planning & Design work
Italics = Only Program Planning & Design work
As of January 2022

- 60 potential studies in last 5 years, many of these in the Pacific Northwest

Study Objectives

1. Assess the potential for energy efficiency to reduce energy consumption and on-site GHG emissions for NW Natural Oregon transport customers as a result of Oregon's Climate Protection Program (CPP).
2. Efficiently leverage information and assumptions from the potential study AEG performed for NW Natural's Washington service territory in 2021.
3. Incorporate NW Natural data and insights to understand how Oregon transport customers use natural gas and prioritize energy efficiency upgrades.

Methodology and Data Sources

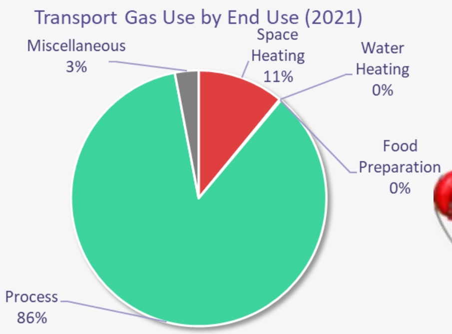
AEG's Modeling Approach

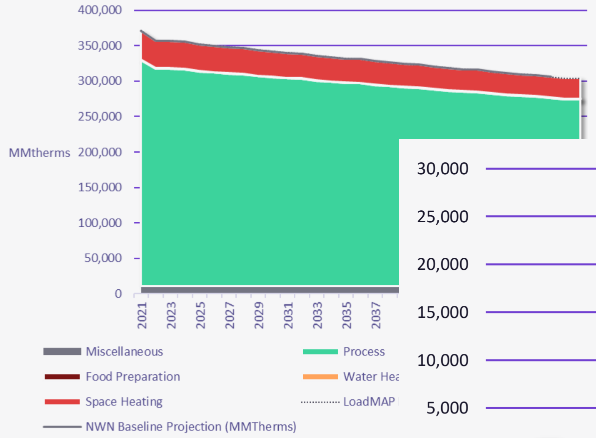
Market Characterization
- Baseline studies
- Utility data
- Secondary data

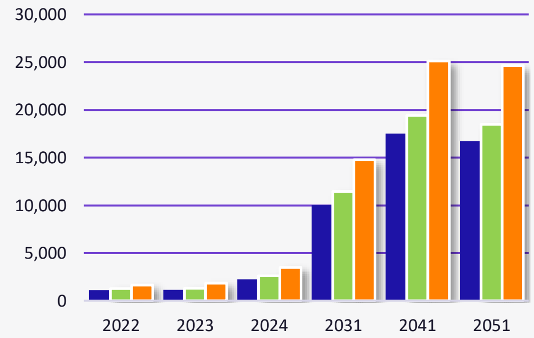
Identify Demand-Side Resources
- EE equipment
- EE measures
- Emerging tech.

Baseline Projection
- Utility forecasts
- Standards and building codes

Potential Estimation
- Technical
- Achievable Tech.
- Economic Achiev.







Key Data Sources

NW Natural Data

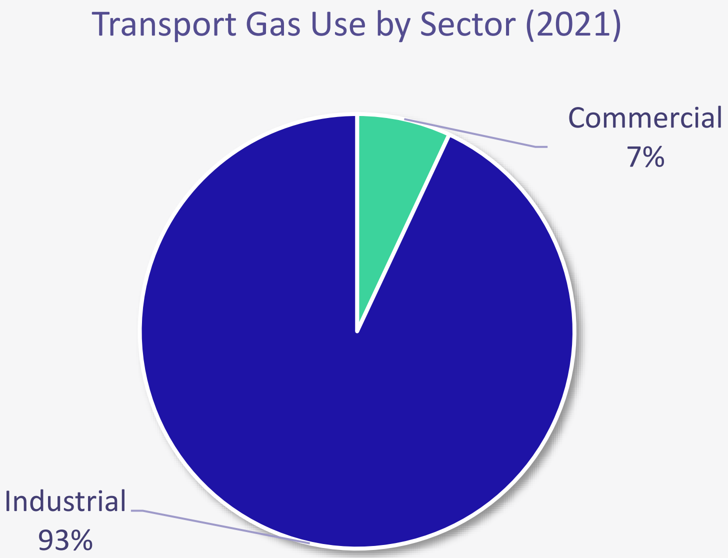
- Customer account data including SIC codes
- Customer equipment database including nameplate BTU
  - Vetted and adjusted by NW Natural field techs
- Transport customer class energy totals and forecast
- Washington CPA conducted by AEG served as a starting point for many measure characterizations and applicable market/adoption rate assumptions

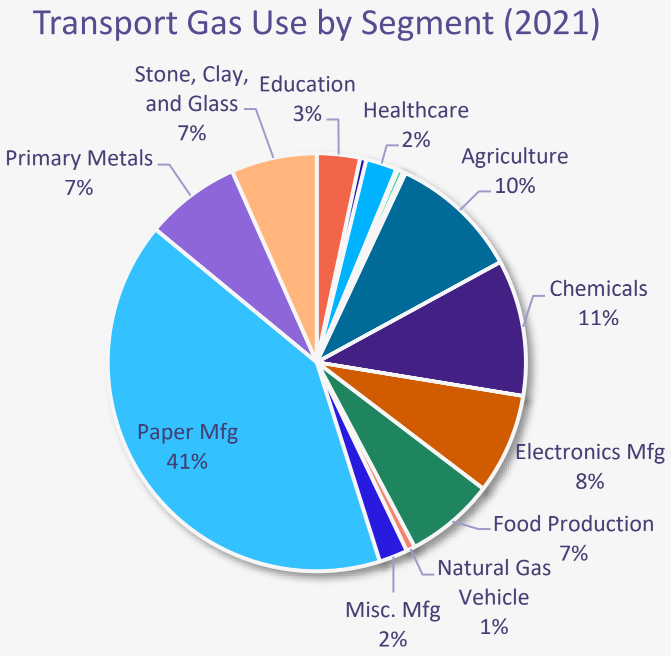
Additional Data Sources:

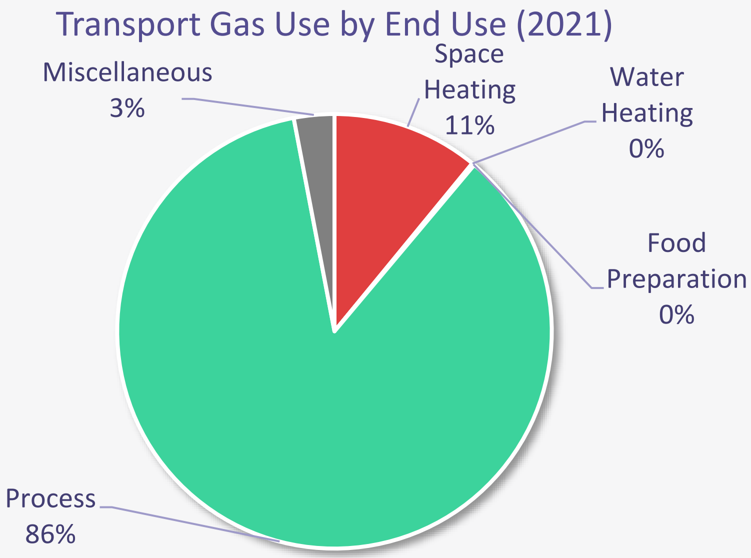
- Benchmarking/comparison:
  - NEEA's Commercial Building Stock Assessments (2014 and 2019)
  - US Energy Information Administration (EIA) Manufacturing Energy Consumption Survey (MECS)
- Projections
  - US EIA Annual Energy Outlook (AEO) reference case forecast (equipment stock turnover assumptions)
  - Northwest Power and Conservation Council measure adoption ramp rates

Market Characterization

- Define energy-consumption characteristics in the base year of the study (2021).
- Incorporates NW Natural's actual consumption and customer counts to develop "Control Totals" – values to which the model will be calibrated.
- Grounds the analysis in NW Natural data and provides enough detail to project assumptions forward to develop a baseline energy projection.
- After separating gas consumption into sectors and segments, it is allocated to specific end uses and technologies.







Applied Energy Group, Inc. | appliedenergygroup.com

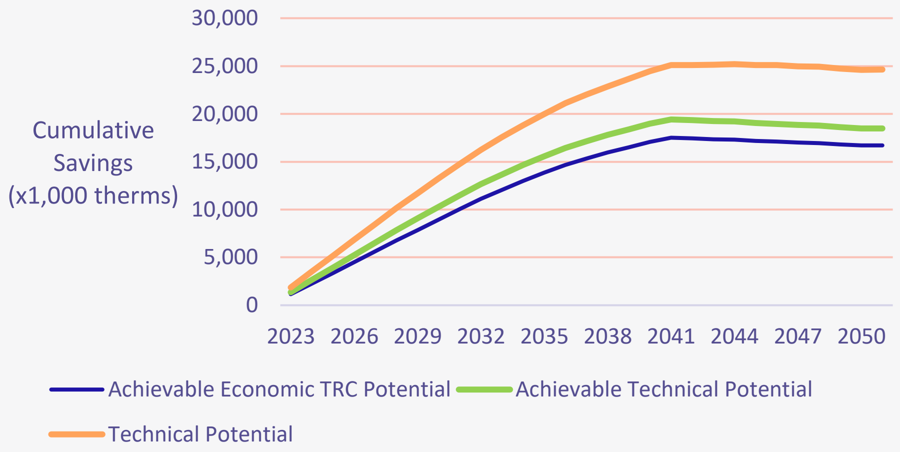
Considerations for this Analysis

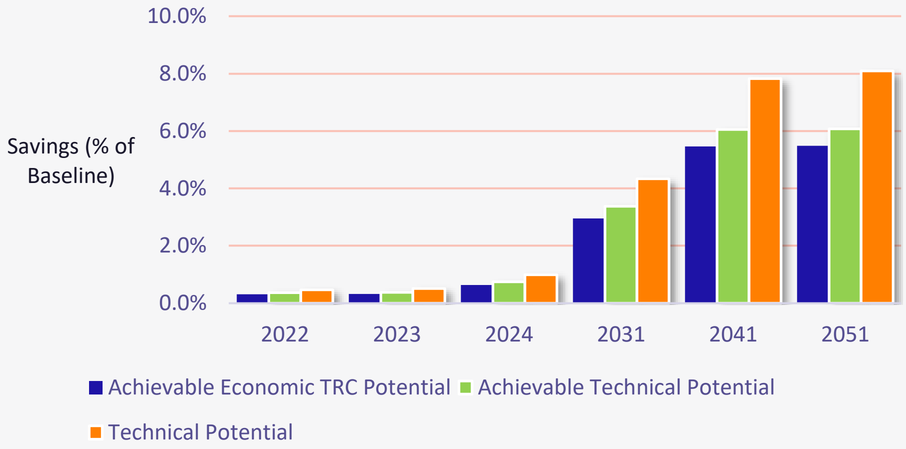
- Available potential is largely a function of baseline consumption – segments with the highest baseline consumption are likely to have the highest potential
- Potential studies rely on average information, which may not reflect conditions or opportunities for any single customer
  - This is particularly relevant for this study, where a small number of customers represent a large share of transport load
  - Ramp rates are derived from the Northwest Power and Conservation Council's 2021 Power Plan and reflect expected adoption across a broad set of customers. Actual adoption of energy efficiency for large transport customers may be lumpier based on cycles for implementing large capital projects
- Equipment data provided from NW Natural's system contain some uncertainty around frequency of use which could affect the actual impact of measures

Draft Potential Results

Cumulative Energy Efficiency Potential

- AEG assessed potential for technical, achievable technical, and achievable economic scenarios.
- Economic screening is from a Total Resource Cost (TRC) perspective, including the commodity cost of natural gas.
- Potential was estimated over a 30-year period, though most potential is assumed to be acquired within the first 20 years.
- Cumulative Achievable Technical Potential by 2031 is estimated at 11.4 million therms (3.4% of baseline sales), growing to 19.4 million therms (6.1%) by 2041.
- Most of the Achievable Technical Potential is expected to be cost-effective from a TRC perspective.
    - TRC Cost-effective potential is estimated at 10 million therms (3.0% of baseline) in 2031, growing to 17.5 million therms (5.5%) by 2041.



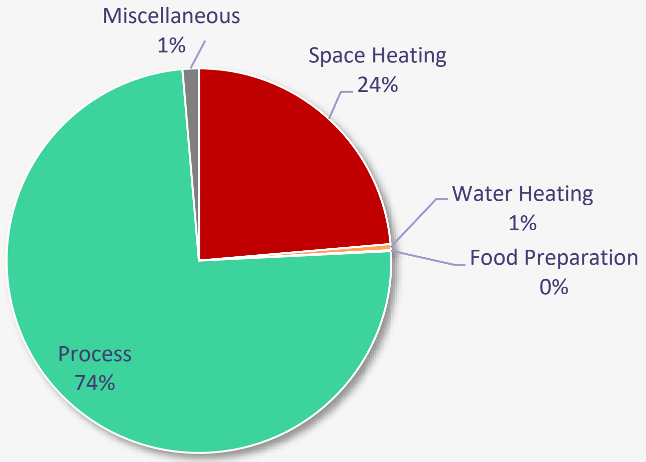


Cumulative Potential by End Use and Segment

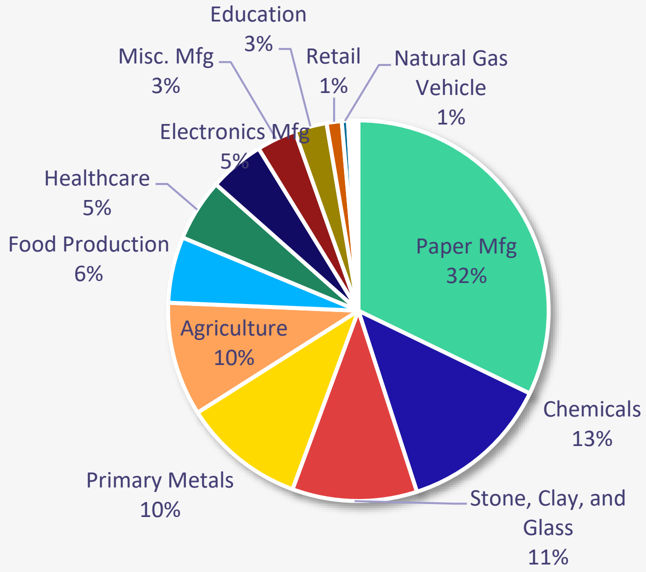
Achievable Economic Potential in 2041

- Savings are generally proportional to consumption in the base period
- Space heating savings come mainly from the commercial segments (Education and Healthcare) and have some easier/cheaper interventions compared to Process
- A large potion (32%) of potential comes from the Paper segment where there are only a few customers

2041 Savings by End Use



2041 Savings by Segment



Top Measures – Achievable Economic Potential

- Larger customers are likely using energy management and control systems with dedicated engineering staff.
- Deeper exploration needed to understand Gas Transport Customer participation in Energy Trust electric SEM program and any impact on gas savings.
- NW Natural customer representatives indicated that transport customers have expressed interest in energy efficiency opportunities and may be interested in participating in new programs.

Rank	Measure / Technology	2041 Achievable Economic TRC Potential Savings (000 therms)	% of Total
1	Strategic Energy Management	5,785	33.0%
2	Steam System Efficiency Improvements	2,562	14.6%
3	Gas Boiler - Insulate Hot Water Lines	2,190	12.5%
4	Insulation - Roof/Ceiling	1,604	9.2%
5	Gas Boiler - Hot Water Reset	824	4.7%
6	Process - Insulate Heated Process Fluids	819	4.7%
7	Gas Boiler - Stack Economizer	729	4.2%
8	Gas Boiler - Insulate Steam Lines/Condensate Tank	582	3.3%
9	Gas Boiler - Burner Control Optimization	576	3.3%
10	Unit Heater	489	2.8%
11	Boiler	485	2.8%
12	Gas Boiler - High Turndown	369	2.1%
13	Space Heating - Heat Recovery Ventilator	193	1.1%
14	Building Automation System	170	1.0%
15	Gas Boiler - Maintenance	148	0.8%
16	Kitchen Hood - DCV/MUA	104	0.6%
17	Thermostatic Radiator Valves	91	0.5%
18	Steam Trap Maintenance	82	0.5%
19	ENERGY STAR Connected Thermostat	71	0.4%
20	Furnace	60	0.3%
	Total of Top 20 Measures	**17,934**	**102.4%**
	Total Cumulative Savings	**17,506**	**100.0%**

Thank You.

Eli Morris
emorris@appliedenergygroup.com

Neil Grigsby
ngrigsby@appliedenergygroup.com

Ken Walter
kwalter@appliedenergygroup.com

Phone: 631-434-1414

AEG
APPLIED ENERGY GROUP

End of Presentation by AEG

WA CPA for Sales Customers

WA HB 1257

NW Natural

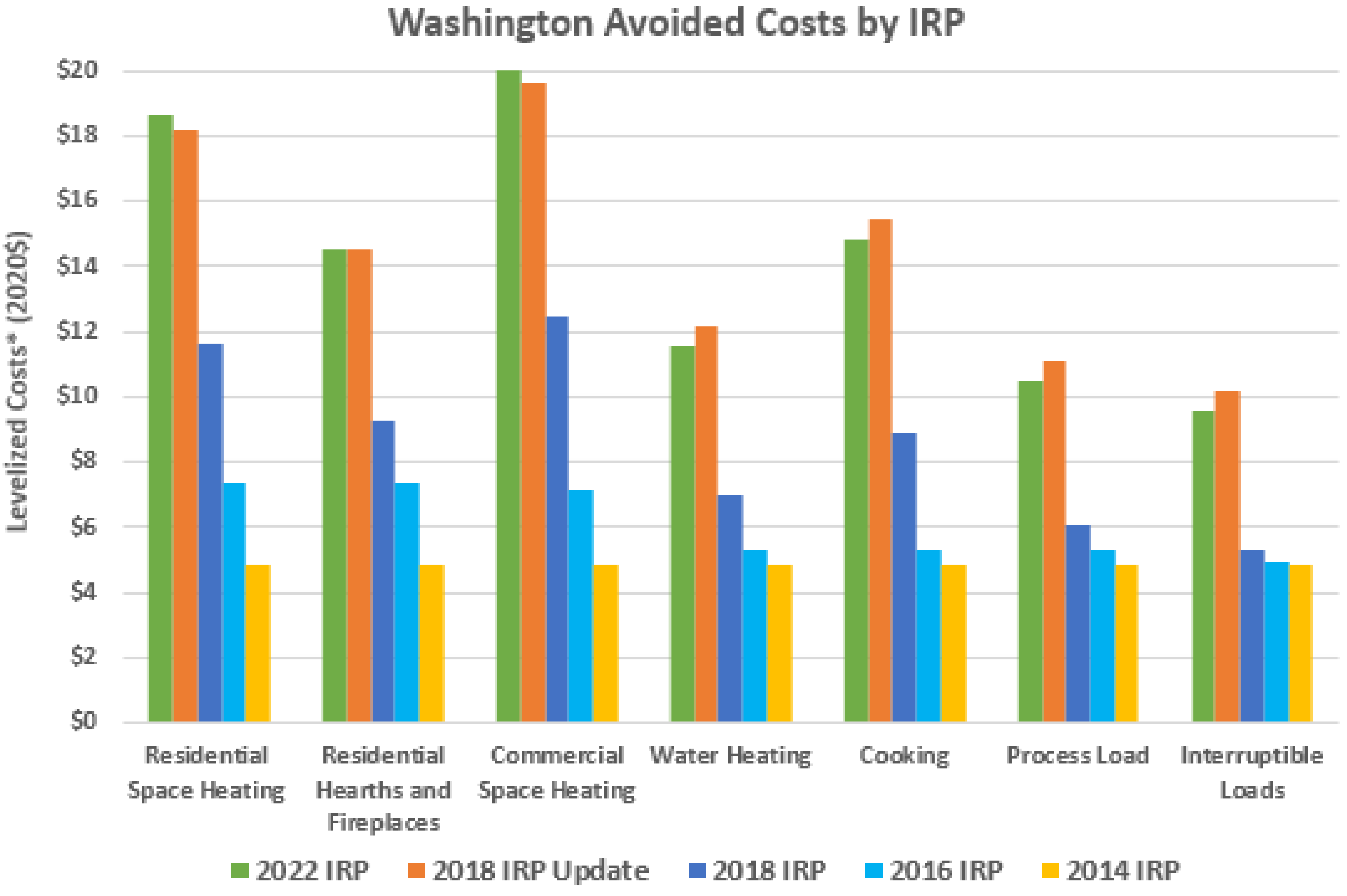
<u>NEW SECTION.</u> **Sec. 11.** A new section is added to chapter 80.28 RCW to read as follows:

Each gas company must identify and acquire all conservation measures that are available and cost-effective. Each company must establish an acquisition target every two years and must demonstrate that the target will result in the acquisition of all resources identified as available and cost-effective. The cost-effectiveness analysis required by this section must include the costs of greenhouse gas emissions established in section 15 of this act. The targets must be based on a conservation potential assessment prepared by an independent third party and approved by the commission. Conservation targets must be approved by order by the commission. The initial conservation target must take effect by 2022.

- NW Natural hired AEG as the independent 3rd party to conduct a CPA for WA sales customers
- This CPA informed NW Natural's Biennial Conservation Targets, which were approved by the WUTC for 2022 and 2023 (Docket UG-210773)
- Savings forecasted under the total resource cost test (TRC) from the CPA will feed back into the WA load forecast for the 2022 IRP – Link to CPA filed with WUTC

Avoided Costs Through Time-Washington

- The WA CPA used most of the same avoided costs as the 2018 IRP Update filed March 1, 2021
- The long-term gas price forecast was updated from the 2018 IRP Update for the WA CPA
- TWG on June 1, 2021, which reviewed the avoided costs



*2022 IRP and 2018 IRP Update are 30-year levelized figures where earlier figures are 20-year levelized figures

Summary of WA Savings Potential for Sales Customers

Table ES-1-1 Summary of Energy Efficiency Potential (mTherms)

Scenario	2022	2023	2024	2026	2031	2040	2050
Baseline Load Projection Absent Future Savings (mTherms)	80,831	82,581	84,282	87,530	95,229	109,312	125,747
Cumulative Savings (mTherms)							
TRC Achievable Economic Potential	354	725	1,036	1,827	4,390	9,345	11,392
UCT Achievable Economic Potential	477	992	1,470	2,671	6,523	13,936	16,818
Achievable Technical Potential	874	1,799	2,702	4,808	10,350	19,102	22,321
Technical Potential	2,033	4,189	6,160	10,491	20,957	35,383	42,373
Energy Savings (% of Baseline)							
TRC Achievable Economic Potential	0.4%	0.9%	1.2%	2.1%	4.6%	8.5%	9.1%
UCT Achievable Economic Potential	0.6%	1.2%	1.7%	3.1%	6.8%	12.7%	13.4%
Achievable Technical Potential	1.1%	2.2%	3.2%	5.5%	10.9%	17.5%	17.8%
Technical Potential	2.5%	5.1%	7.3%	12.0%	22.0%	32.4%	33.7%

Summary of WA Savings Potential for Sales Customers by sector

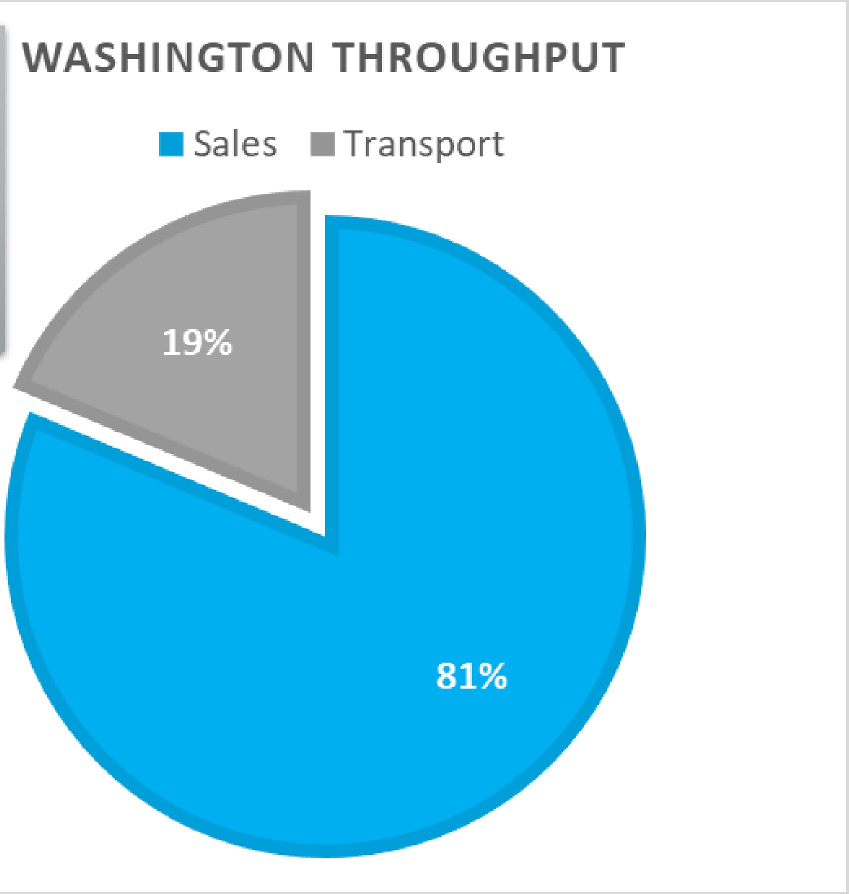
Table ES-1-2 Cumulative TRC Achievable Economic Potential (mTherms) by Sector

Sector	2022	2023	2024	2026	2031	2040	2050
Residential	182	369	478	837	2,250	5,380	6,612
Commercial	155	323	509	908	1,979	3,713	4,526
Industrial	16	33	49	82	162	253	254
Total	**354**	**725**	**1,036**	**1,827**	**4,390**	**9,3545**	**11,392**

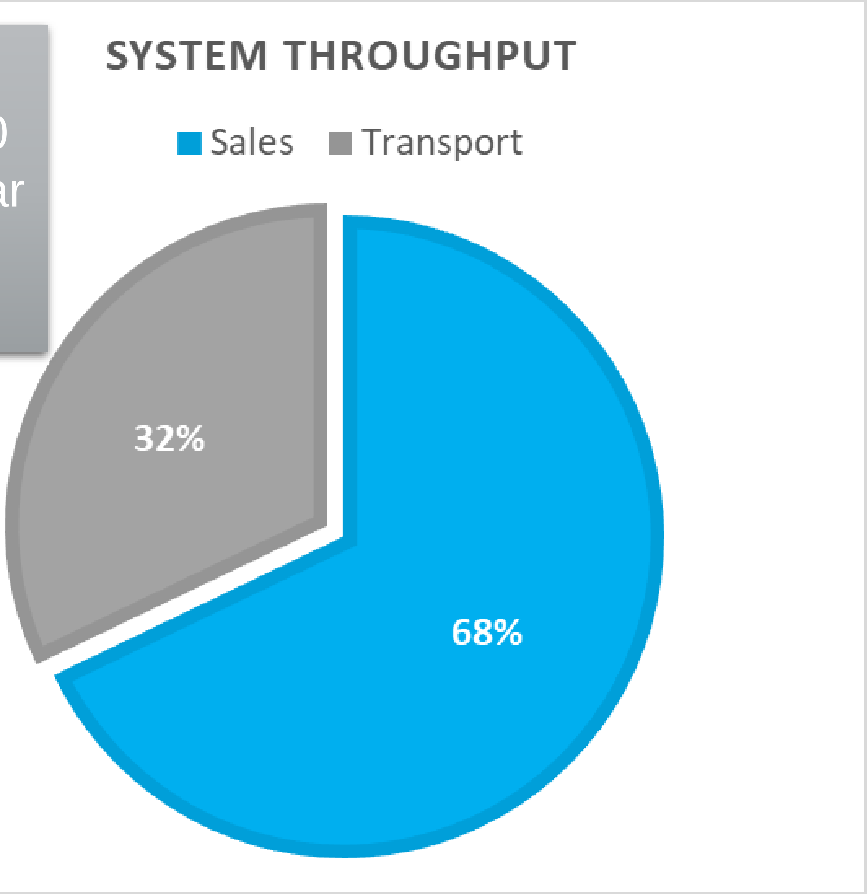
WA CPA for Transport Customers

WA Load Compared to System Load

About 20,000,000 Therms / Year and 30 Customers



About 380,000,000 Therms / Year and 300 Customers



WA Savings Potential for Transport Customers

- These results for transport were not filed with the CPA
  - At the time it was uncertain if NW Natural would be responsible for emissions compliance under the CCA for transportation customers
- Given the uncertainty around the policy NW Natural worked with AEG to run two sensitivity analysis for transportation customers to get a sense of the saving potential

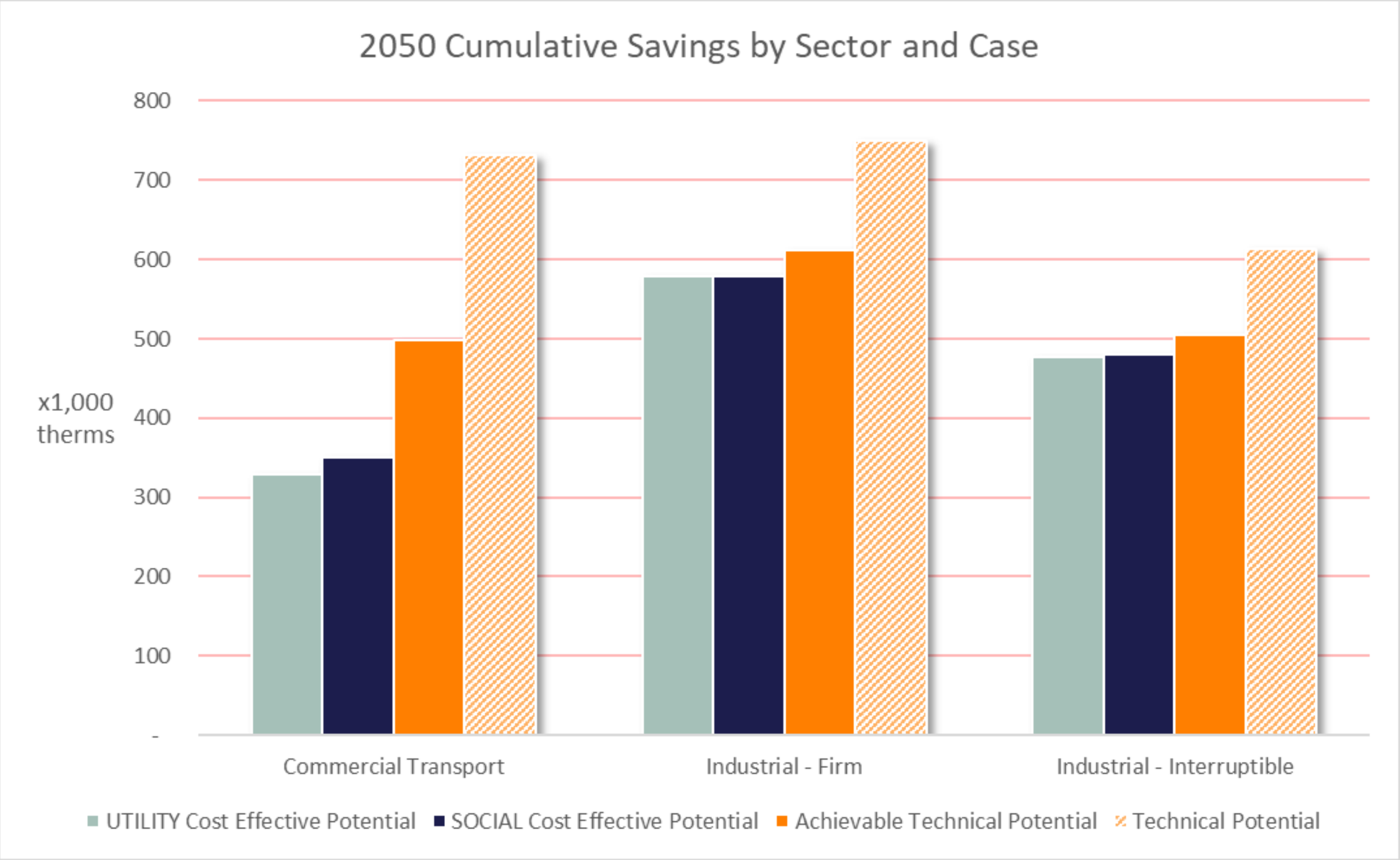
	Description
Social Perspective	**Includes all avoided costs to transport customers.**
Transport Interruptible	Gas costs, GHG Compliance, risk reduction value, 10% conservation credit
Transport Firm	Gas costs, GHG Compliance, capacity costs, risk reduction value, 10% conservation credit

	Description
Utility Perspective	**Includes only avoided costs to the utility.**
Transport Interruptible	GHG Compliance
Transport Firm	GHG Compliance, distribution capacity costs

- There are no existing programs for transport customers, so this is a starting point to assess the potential energy efficiency for transport customers at a high level

Summary of WA Savings Potential for Transport Customers

- The social perspective has higher avoided costs, but does not result in much of a difference in potential savings
- About 1/3 of these savings comes from Strategic Energy Management (SEM) measure
- These SEM savings are uncertain, and their savings potential will be unique to each customer given the small set of customers



Prepared for IRP Working Group- Not to be used for investment purposes.

Summary of WA Savings Potential for Transport Customers

- The social perspective has higher avoided costs, but does not result in much of a difference in potential savings
- About 1/3 of these savings comes from Strategic Energy Management (SEM) measure
- These SEM savings are uncertain, and their savings potential will be unique to each customer given the small set of customers

	Thousands of Therm Savings			
2050 Cumulative Savings by Sector	UTILITY Cost Effective Potential	SOCIAL Cost Effective Potential	Achievable Technical Potential	Technical Potential
Commercial Transport	328	350	499	731
Industrial - Firm	578	579	612	750
Industrial - Interruptible	477	481	505	614
Total	**1,384**	**1,410**	**1,615**	**2,095**

	Percentage of Forecasted 2050 WA Transportation Load			
2050 Cumulative Savings by Sector	UTILITY Cost Effective Potential	SOCIAL Cost Effective Potential	Achievable Technical Potential	Technical Potential
Commercial Transport	2%	2%	3%	4%
Industrial - Firm	3%	3%	4%	5%
Industrial - Interruptible	3%	3%	3%	4%
Total	**8%**	**9%**	**10%**	**13%**

Start of Presentation by GTI

gti®

Thermal (Gas) Heat Pumps

IRP Technical Working Group
April 13, 2022

Ryan Kerr
Senior Manager, Emerging Technologies
Rkerr@gti.energy

Presentation Outline

- GTI and Decarbonization Strategy
- Gas Heat Pumps- Why do we Care?
- Technology and Applications Overview
- Residential Combi Spotlight
- Commercial Market Overview
- Technology Readiness
- EE Program Development and Deployment

GTI Overview

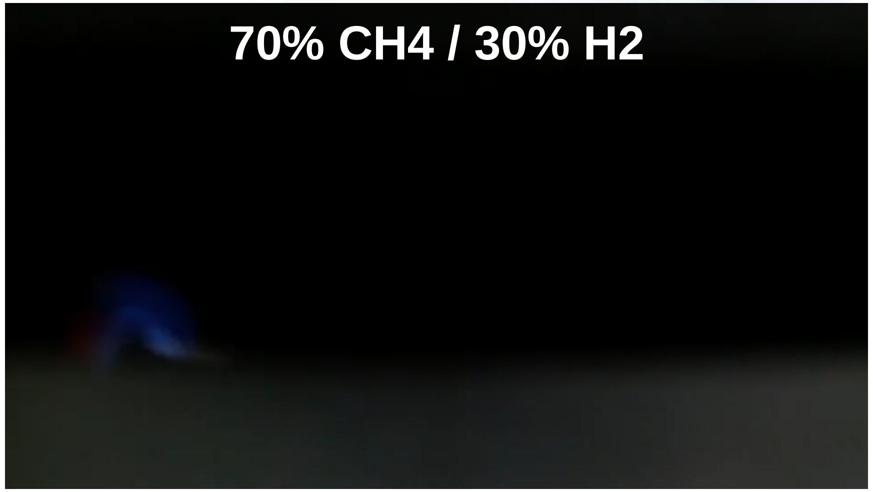
Serving the Industry 80 Years

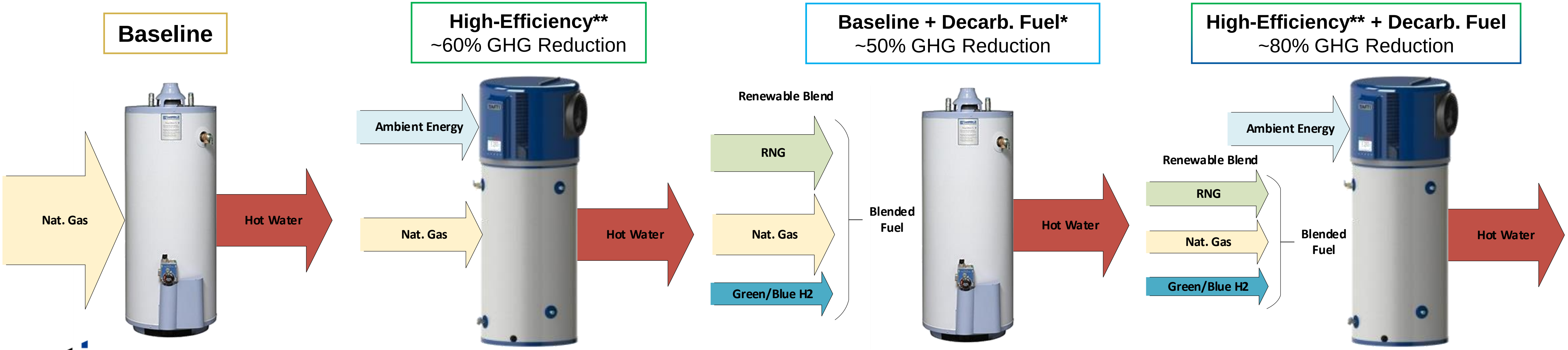
- Independent, 501(c)(3) not-for-profit
- GTI tackles tough energy challenges turning raw technology into practical solutions
- Client base spans private sector, state & federal government agencies, and utilities
- **Six buildings R&D laboratories**: appliances, envelope, renewables, emissions, IAQ, and micro/nano-grids

RESEARCH & DEVELOPMENT | PROGRAM MANAGEMENT | TECHNICAL/ ANALYTICAL | CONSULTING | TRAINING | COMMERCIALIZATION

Energy Efficiency + Decarbonized Fuels

- **Energy efficiency** coupled with **decarbonized fuels** can drive GHG reductions
- As a fuel, Hydrogen (H_2) emits no CO_2 and can be blended with natural gas or **biomethane** for standard products, or utilized directly (100% H_2) by **specially-designed equipment**
  - Used for **long duration**, mega-scale storage of renewable energy





gti®

*Assumes near-term achievable targets of H2 & RNG blending / ** Fuel-fired GHPWH performance assumptions from *Glanville, P., Fridlyand, A., Mensinger, M., Sweeney, M., Keinath, C. (2020) Integrated Gas-fired Heat Pump Water Heaters for Homes: Results of Field Demonstrations and System Modeling, ASHRAE Transactions; Vol. 126 325-332,* image source: SMTI.

Gas Heat Pumps: Motivation

> Best-in-class operating efficiency (primary basis)

> Good part-load performance and in cold climates

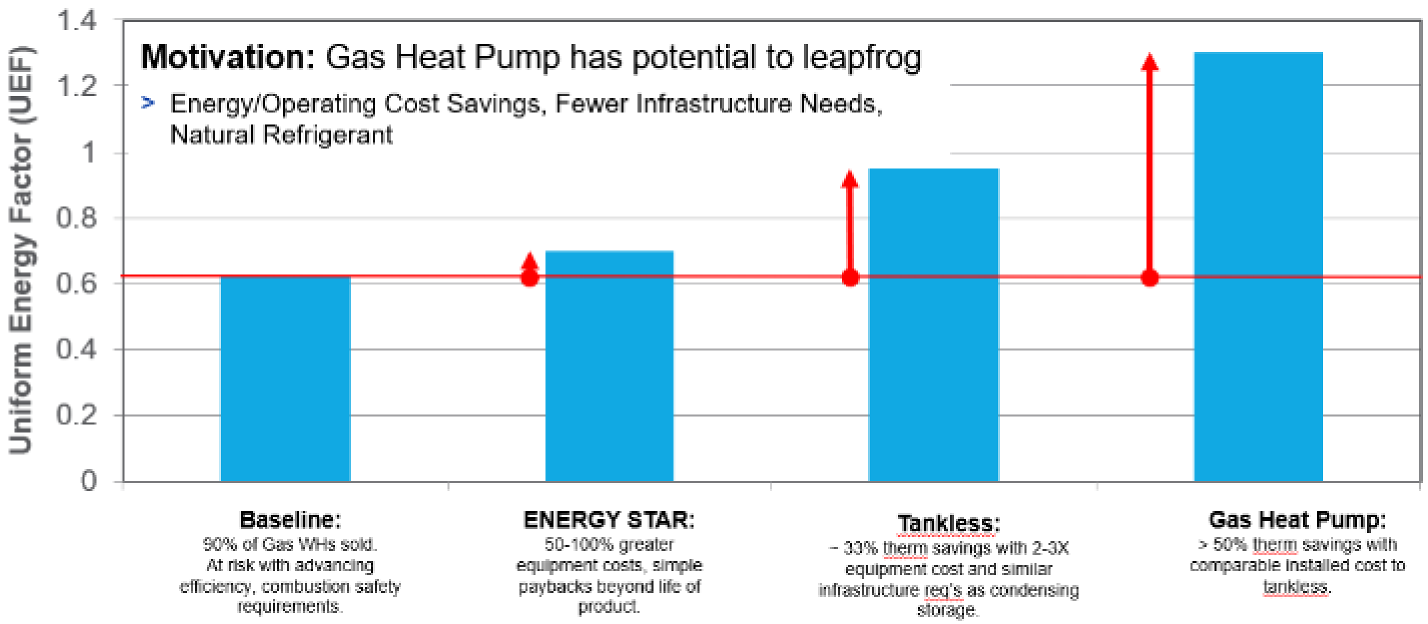
> Typically do not require backup heating and can continue operation during defrost

> Opportunities for peak load management

> Commonly use natural refrigerants/working fluids with low/no GWP/ODP

> NOx and GHG emissions are decreased by half or greater and combustion ‘sealed’ or occurs outdoors (IAQ & venting)

Residential Gas Water Heating - Efficiency



Source Material: GTI

Thermally-driven Gas Heat Pumps

Potential: Cut emissions and energy consumption by ***40% or greater*** with retrofit, potential for peak load management in winter/summer

THP

Vapor Compression


Aisin
Blue Mountain Energy
Yanmar
Tecogen
Panasonic
M-Trigen
LG / Daikin / Samsung

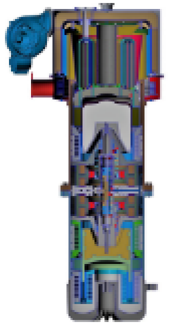
Sorption



Robur
SMTI
Vicot
Ariston
Fahrenheit
Oxicool
HeatAmp

Thermal Compression/ Thermoacoustic





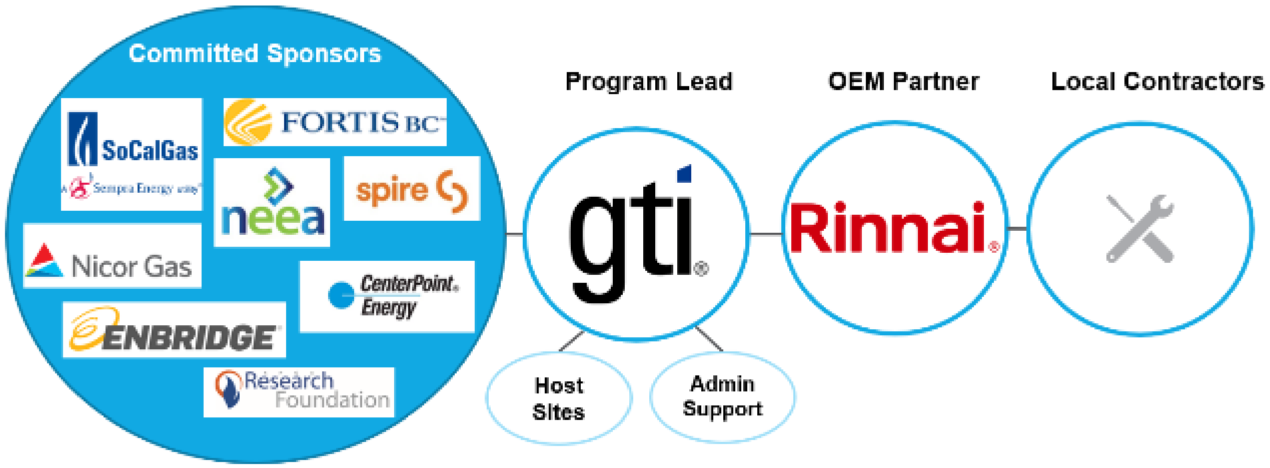
Thermolift
boostHEAT
Etalim

gti

Gas-fired Heat Pumps – On or Nearing Market

Residential Demonstration Summary:

- **Water Heater (50% energy savings):** More than ten years of technology and product development, demonstrations, and market development. 10+ programs/projects supported by DOE, CEC, and utilities.
- **Space Heating/“Combi” (>40% energy savings):** More than six years of technology and product development, demonstrations, and market development. 7+ programs/projects supported by the DOE and utilities. GTI leading several market transformation projects with advanced tankless driven combis to develop workforce



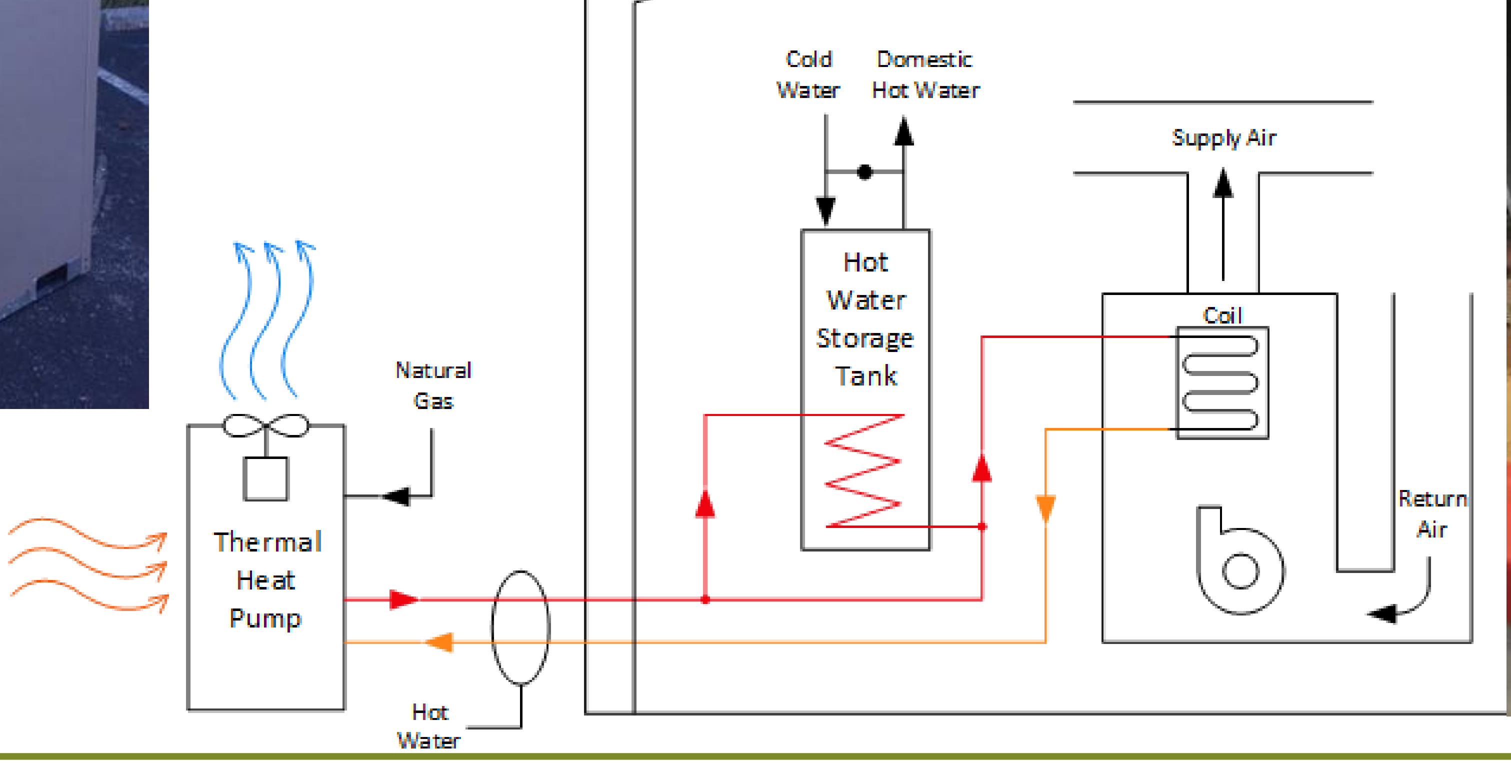
Commercial Demonstration Summary:

- **Commercial Hot Water/Boiler (>50% energy savings + optional cooling):** Multiple development/demonstration efforts in hot water and hydronic applications, with water heater and boiler manufacturing partners. Successful pilots in multifamily, restaurant, hospitality, and industrial applications supported by DOE, CEC, and utilities.
- **Commercial VRF and Packaged Rooftop Units (>40% energy savings + optional cooling):** Several demonstrations in different building types and climates supported by DOE, DOD, and utilities for VRF applications. GHP RTU installed in 2020 in Upstate NY, the cold-climate GHP integrated with RTU is supported by NYSERDA and DOE.

For more information: 1) Glanville, P.et al. (2020) Integrated Gas-fired Heat Pump Water Heaters for Homes: Results of Field Demonstrations and System Modeling, ASHRAE Transactions; Vol. 126 325-332.; 2) Glanville, P. et al. (2019) Demonstration and Simulation of Gas Heat Pump-Driven Residential Combination Space and Water Heating System Performance, ASHRAE Transactions; Vol. 125 264-272.; 3) Glanville, P. Innovative Applications of Thermal Heat Pumps in Multifamily Buildings and Restaurants, Presented at the ACEEE 2020 Hot Water Forum.; 4) GTI & Brio, Gas Heat Pump Technology and Market Roadmap, 2019.

Space AND Water Heating with GHPs

"Combi" system providing BOTH hot water and space heat



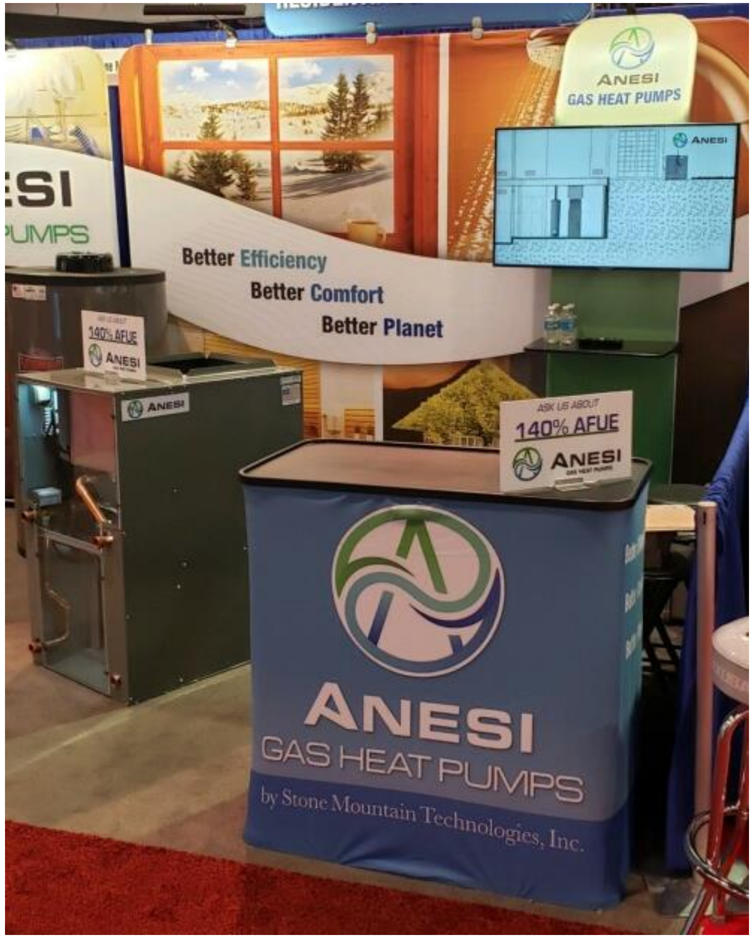
Indoors – Lessons from the Field

Simplify install with pre-assembled hydronic pumps and controls

GHP water heater

Residential SMTI Anesi 80k Lab Assessment

- In preparation for commercial launch and larger scale field deployments in 2022-23, GTI will be performing a lab evaluation of the new packaged Anesi GHP to:
  - Validate system efficiencies and performance
  - Evaluate thermostat and DHW controls
  - Perform full part-load evaluation of the integrated system to develop performance curves for model development and comparison to field operation



Residential GHP Lab Testing- Other Tech

- With support from numerous sponsors, GTI will be lab testing the latest near-market products from:
- HOMY/Vicot- Absorption GHP **~60-68 kBTU/h** (18-20kW) w/ **Hydronic AHU** as a packaged solution.
- Thermolift- heating and cooling thermal compression GHP **~75 kBTU/h, 3T Cooling**
- Robur- k18 absorption space/water heating GHP **65 kBTU/h** (commercially available in Europe)

ROBUR

VICOT

THERMOLIFT
The Future of Clean Energy

HOMY
BUILDING SOLUTIONS

THPs –Landscape for Commercial Sector

Heat /Cool — Power — WH — Heating only

OXICOOL (cooling only)

ThermoLift

Engine-driven Vapor Compression Heat Pumps

BME 11-RT Rooftop;
VRF Retrofit for RTU or Hydronic Sys

YOSHI®

Variable Refrigerant Flow (VRF)
2-pipe & 3-pipe Heat Recovery
8-RT (106 MBH) to 15-RT (189 MBH)
combined up to 300-RT

YANMAR

AISIN

BLUE MOUNTAIN ENERGY

* Panasonic, LG, Daikin, Samsung

Space Conditioning /
Power Gen

m-trigen Power Generation Systems Solutions

* Aisin GHP HiPOWER+

Water Source
Heat Pump /
Hydronic

Ilios High Efficiency Water Heater

Gas-fired Absorption Heat Pumps

BOOSTHEAT

HeatAmp

Air-to-water; Hybrid THP-boiler; THP/GWH
Applications high water heating demand: MF, CFS

Vicot 65 kW (220 MBH)

SMTI

(80 / 140 MBH)

ROBUR caring for the environment

(60 / 140 MBH)

Laboratory Stage — Field Demos / Scaling Up — Commercial / Emerging Tech

**Available outside North America*

Technology Readiness

Green: Commercially available in North America

Source: Enbridge, NEEA, GTI

Manufacturer	Type	Primary Applications	Primary Sectors	Technology Readiness for North America
ROBUR	Absorption	Space and DWH heating Cooling (possible)	• Commercial • Residential	• Commercial size unit commercially available • Residential unit available in Europe. Efforts underway to bring it to NA
YANMAR	Engine driven	Space heating and cooling	• Commercial	• Commercially available
SMTI / ANESI	Absorption	Space and DHW heating	• Residential • Small commercial	• Field trials of pre-production unit underway
VICOT	Absorption	Space and DHW heating	• Residential • Commercial	• Commercially available in China • Lab testing and field trials of production unit underway in NA
ThermoLift	Thermal compression	Space heating, cooling and DHW heating	• Residential • Small commercial	• Lab testing and field trials of pre-production unit underway
HeatAmp	Adsorption	Space and DHW heating	• Residential • Small commercial	• Lab testing in Europe
Rinnai	Absorption	DHW heating	• Residential	• Lab testing and field trials planned

Gas Heat Pump Cost Estimates

Application	Equipment Cost	Size	Notes
Residential (Absorption) **Water Heater**	$1,400 - $1,800		Projected
Residential (Absorption) **Space & Water Heat 'Combi'**	$5,000 (GHP only) $8,000 (w/ AHU and IST)	80,000 btu/hr	Projected
Commercial (Absorption) **Water Heat** **Space Heating/Cooling**	$8,500 $9,500	120,000 btu/hr 120,000 btu/hr, 5 ton	Available in PNW
Commercial (VRF) **Space Heating/Cooling**	$1,560/ton (GHP only) $21,840 for 14T system	189,000 btu/hr, 14 ton	Available in PNW

Equipment costs are engineering estimates with input from manufacturers

GHPs Update – Performance Standards

- **HVAC Applications**
  - GTI leading **ANSI Z21.40 update**, for all sizes of HVAC.
    - Seasonal metric (AFUE) used by CEE in draft spec., also steady ratings available (-10 F optional proposed)
    - AFUE neglects elec. power, be sure to incentivize elec. efficiency too!
  - Because test and operating conditions differ, **be careful** when comparing $AFUE_{furnace/boiler}$ to $AFUE_{THP}$
- **Water Heating**
  - ANSI/ASHRAE 118.1/118.2 adding THP coverage '21
  - UEFs and TEs will apply across product types, but represent single ambient/operating condition
- **Other Applications**
  - THPs added to the 2020 version of ANSI/ASHRAE 146 *Methods of Testing and Rating Pool Heaters*

CEE Gas-Fired Forced Hot Air Specification

Scope: Input rating <225,000 BTU/h
Optional distinction for units ≤40,000 BTU/h

Level	AFUE*
CEE Tier 1	≥ 92%
CEE Tier 2	≥ 95%
CEE Tier 3	≥ 97%

Level	AFUE**
Advanced Tier	≥ 120%

CEE Gas-Fired Boiler (Hydronic) Specification

Scope: Input rating <300,000 BTU/h

Level	AFUE*	Other Requirements
CEE Tier 1	≥ 90%	Thermal Load Management^
CEE Tier 2	≥ 95%*	

Scope: Input rating <225,000 BTU/h

Level	AFUE**	Other Requirements
Advanced Tier	≥ 120%	Thermal Load Management^

*10 CFR Appendix N to Subpart B of Part 430 - *Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers*
** ANSI Z21.40.4 *Performance Testing and Rating of Gas-Fired, Air Conditioning and Heat Pump Appliances*, designated for Region IV
^ May be met by incorporating outdoor reset control, indoor load reset, or thermal targeting strategies

CEE adding "Advanced Tiers" to Res. HVAC performance spec., other categories under development in consultation with utilities/GTI/industry

gti

Questions?

Gas Heat Pumps

IRP Technical Working Group
April 13, 2022

Ryan Kerr

Senior Manager, Emerging Technologies

Rkerr@gti.energy

End of Presentation by GTI

Start of Presentation by NEEA

NW Natural IRP Planning

Peter Christeleit

Manager, Natural Gas Portfolio & Strategy, NEEA

13 April, 2022

CLASSIFICATION LEVEL: PUBLIC

Agenda

- NEEA overview/fuel neutrality
- Gas MT programs
- Focus: Residential Water Heating
- Driving collaboration beyond the NW

Fuel Neutral Approach

Efficiency is the least-cost way to reduce the carbon impact of energy use… regardless of the source of that energy. That makes energy efficiency an important part of decarbonization and complements the region's efforts to diversify energy sources for a more sustainable future.

Market Transformation Portfolio, 2022

PRODUCTS

Consumer Products
- Retail Products Portfolio

Motor-Driven Products
- Extended Motors Products - Pumps
- Extended Motors Products – Fans*

Water Heating Products
- Heat Pump Water Heaters
- **Efficient Gas Water Heating* (natural gas)**

INTEGRATED SYSTEMS

HVAC Products
- High Performance HVAC
- Variable Speed Heat Pumps
- **Efficient Rooftop Units (natural gas)**

Lighting Products
- Luminaire Level Lighting Controls

Building Envelope
- Window Attachments
- **High Performance Windows (dual fuel)**

NEW CONST.

Codes & New Construction
- Commercial Code (dual fuel)
- Residential Code (dual fuel)
- Manufactured Homes

State and Federal Standards (dual fuel)

*Pending Concept Advancement

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Efficient Rooftop Units

Market Transformation Theory

RTUs are prevalent in low rise commercial buildings within our region ... Modeling work done by NEEA revealed several **low-cost opportunities to improve the efficiency of RTUs** not valued by the current metrics or widely used by manufacturers. **Current efficiency metrics and specifications focus on only some of the energy used by RTUs**… and does not consider fans, controls, insulation, damper leakage and performance in different climates. …a new efficient RTU national specifications and test procedures and associated QPL that reflect **whole system improvements from low-cost measures** that voluntary programs can reference, then manufacturers will change their standard product offerings to be more efficient.

High Performance Windows

Market Transformation Theory

New technology advancements in ultra-thin glass production and low-conductivity gasses have created the opportunity for a new form-factor for triple glazed window products. This new thinner, lighter weight form-factor allows triple-glazed insulated glass units (IGU) to **fit within existing window-frame** configurations without re-tooling by window installers. Designed to be the same width and virtually the same weight as existing double-glazed windows **avoids having to redesign the window sash and frame**, or possibly change the entire wall thickness, which would pose a significant installation cost obstacle.

Efficient Gas Water Heating - Overview

- Transforming the residential gas storage water heating market to a standard of UEF >1 can save our region more than 100MM annual therms by year 20.
- By overcoming barriers related to product development and supply chain adoption, NEEA can secure these savings and create lasting market change.
- Market transformation for residential gas water heating will focus on three primary areas:
  - Exploring opportunities for and value of increasing adoption of currently available efficient gas water heaters
  - Driving development and commercialization of GHPWH products
  - Collaborating with utilities throughout North America to enact mass deployment of GHPWH through a combination of traditional programs and innovative structures that would provide GHPWHs at low to no cost
- Collectively, these efforts will serve to influence federal standards mandating increasingly higher efficiencies, with UEF values >1 eventually becoming the minimum standard for residential gas storage water heaters larger than 35 gallons.

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Efficient Gas Water Heating - 2022

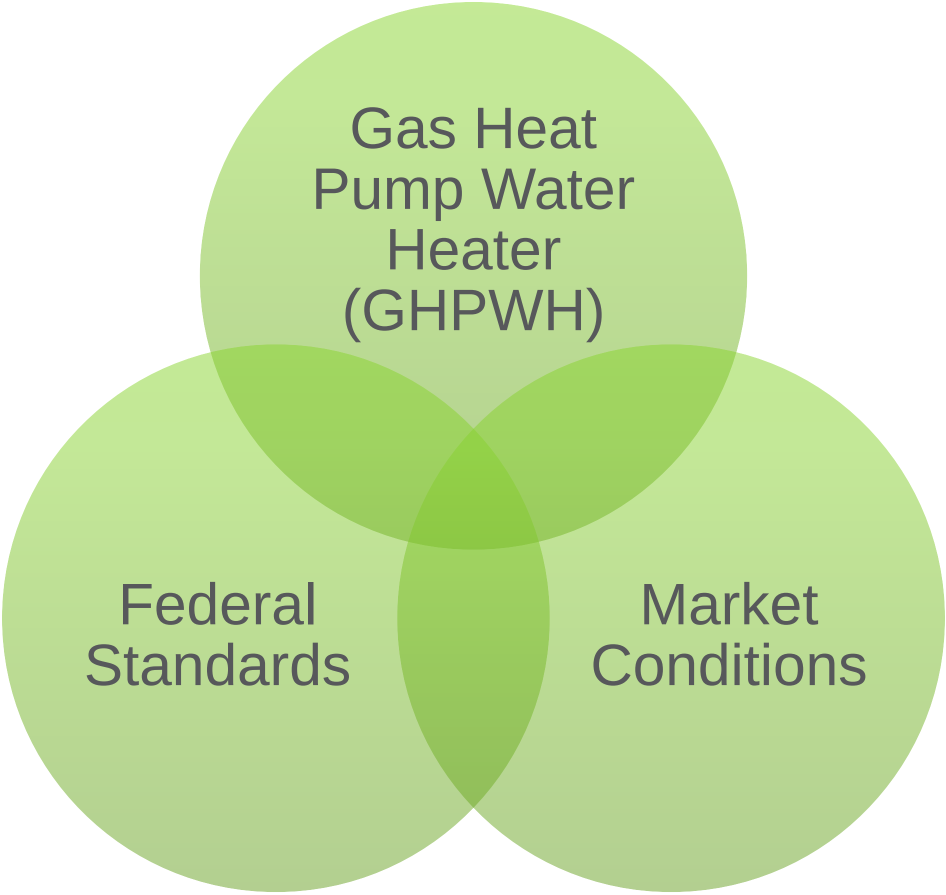
Focus Areas

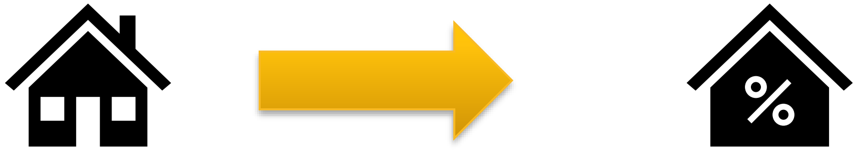
- Preparing for North American GHPWH Field Demonstration
- Additional technologies
- GHPWH Product launch strategic planning

Key Activities

- Supporting GHPWH manufacturer, finalizing testing strategy and timeline
- Accelerating product advancement and testing
- Partnering with NA GHP Collaborative to develop and implement aligned/enhanced programs

NW Opportunity – Residential Water Heating





1.7 million
Gas water heaters
Single family Homes

Doubling Efficiency
Technical Potential
exceeds 200 million therms/yr.

Barriers… and opportunity

- Lack of commercialized GHPWH product
- Change adverse supply chain
- Unclear value proposition
- Climate response

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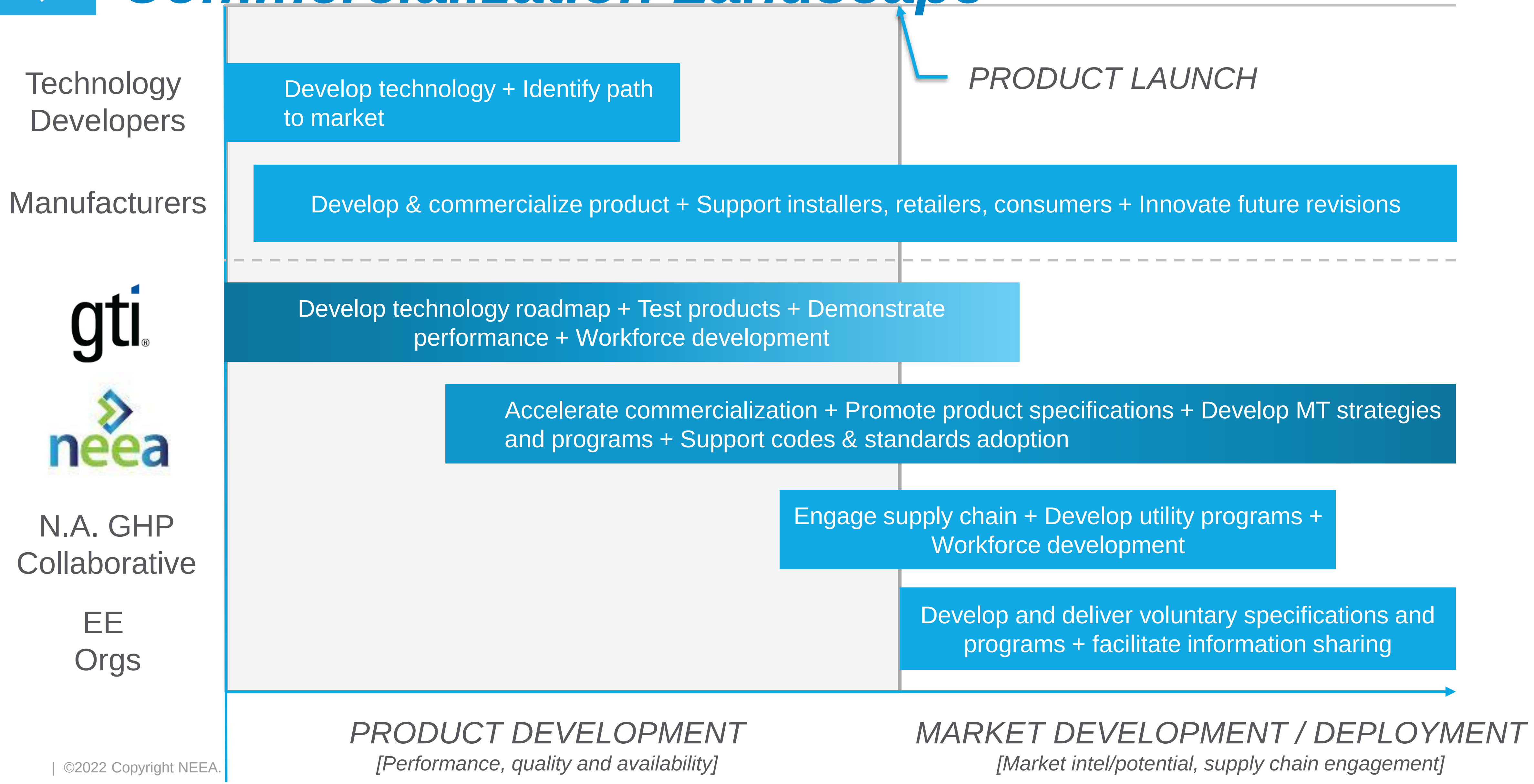
Commercialization Landscape

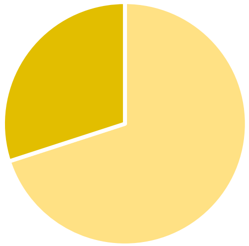


North American GHP Collaborative

North American Gas Heat Pump Collaborative
TECHNOLOGY FOR A CLEANER FUTURE

Developing and implementing activities to accelerate adoption of gas heat pump technologies

- Working with manufacturers to develop **product launch strategies**
- Conducting **market research** to inform supply chain business decisions and utility market interventions
- Adopting joint **product specifications** to ensure customer satisfaction and product performance
- Supporting **supply chain education** to prepare the market
- Offering **aligned incentives** on qualified products to drive adoption
- Working with standards-setting organizations to incorporate GHPs into **codes and standards**



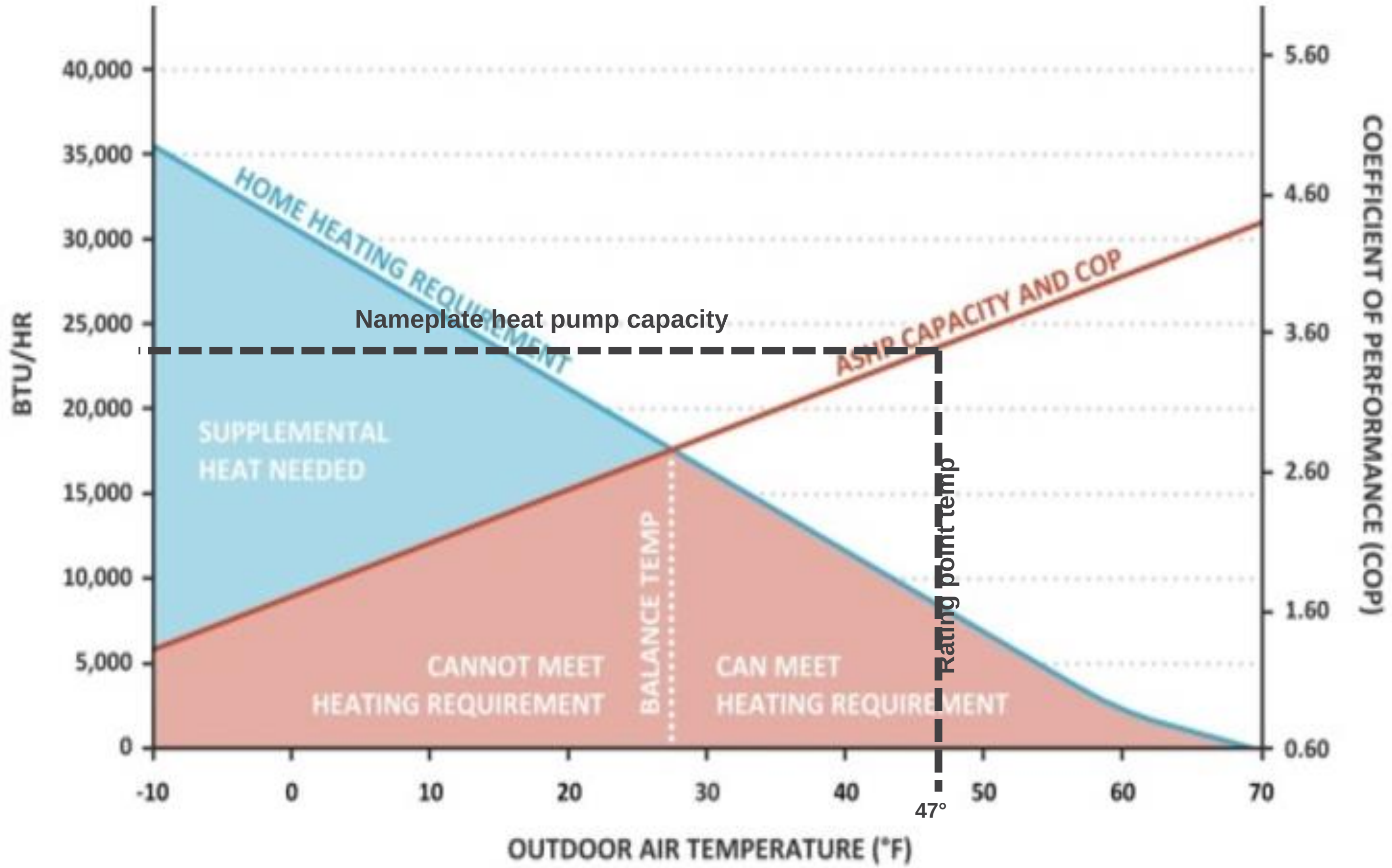
Representing >35% of US and Canadian households that use gas

End of Presentation by NEEA

Dual-Fuel (Hybrid) Heating Systems

Dual-Fuel (Hybrid) Heat Pumps-

Electric heat pump with direct use natural gas backup furnace for peak periods



- Electric heat pumps are efficient, but efficiencies decline as temperature decreases
- To maximize annual efficiency and maintain comfort electric heat pumps usually always have a backup system for cold temperatures – particularly ducted systems which are dominant in single-family homes
- An electric resistance furnace is the most common cold weather backup if a gas furnace is not used
- A system with electric resistance backup is inefficient during cold periods, which contributes large peaks to utility loads and is expensive for customers

Dual-Fuel (Hybrid) Heat Pumps

NW Natural®

Benefits:

- Helps energy system resource adequacy
  - Dual-fuel systems serve as demand response for the electric grid
- Allows existing seasonal storage infrastructure to serve peak needs in a region that is capacity constrained
- Are lower cost for customers to run, particularly during cold months
- Avoids use of inefficient electric resistance heating

Challenges:

- Regulatory structure may need modification to make the setup work for customers, installers, and utilities
- Current market structure does not value capacity services across the gas and electric grids
- Incentives to homeowners/business owners and HVAC contractors may need to be reconsidered
- Reduces gas usage within a home by roughly 80% in our climate

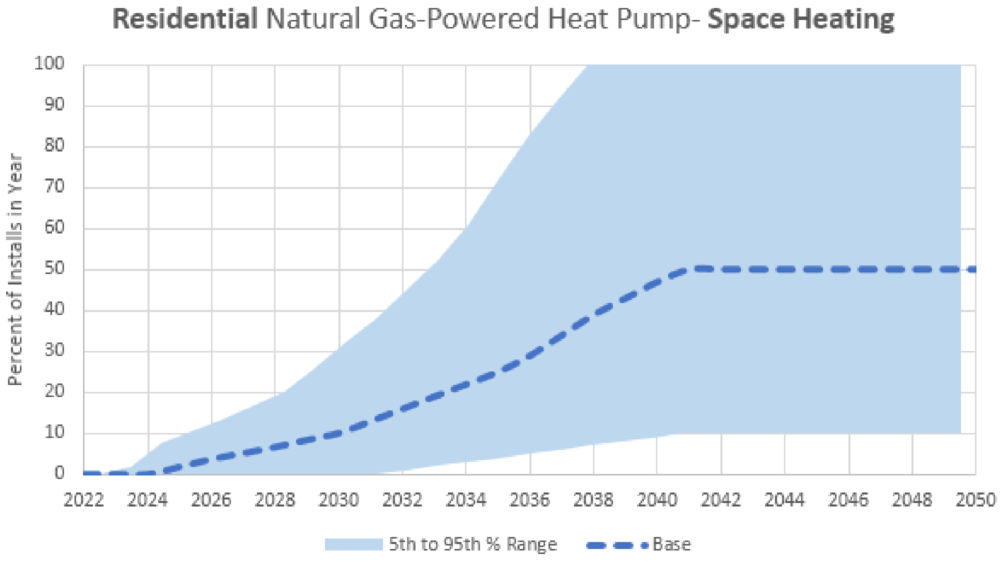
Demand-Side Assumptions Summary

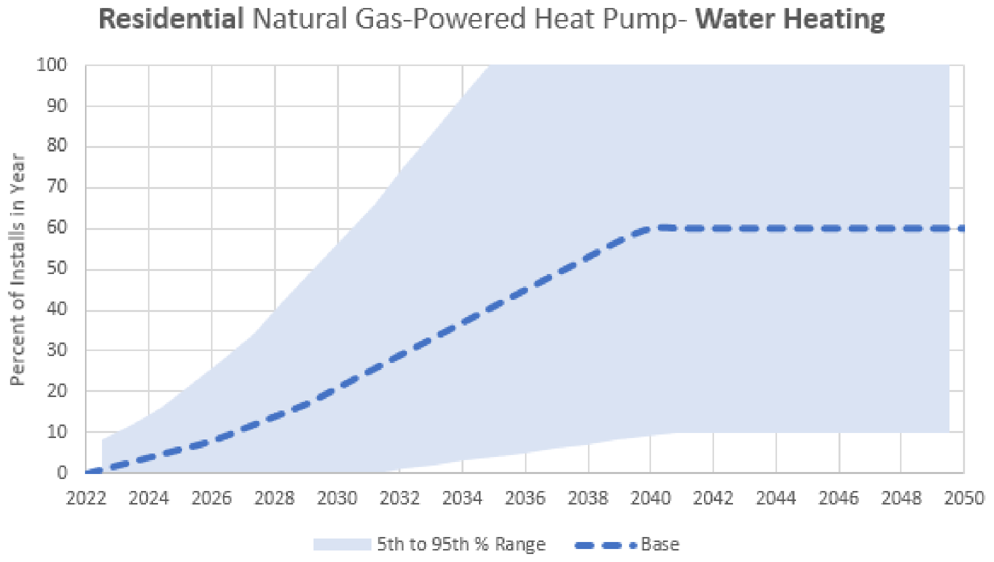
Key Demand-Side Input Assumptions

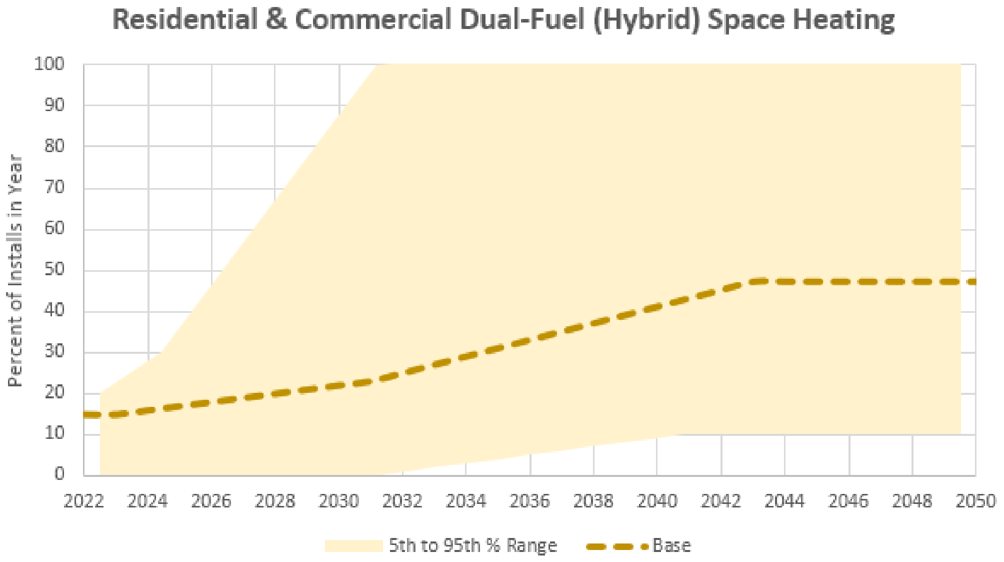
NW Natural®

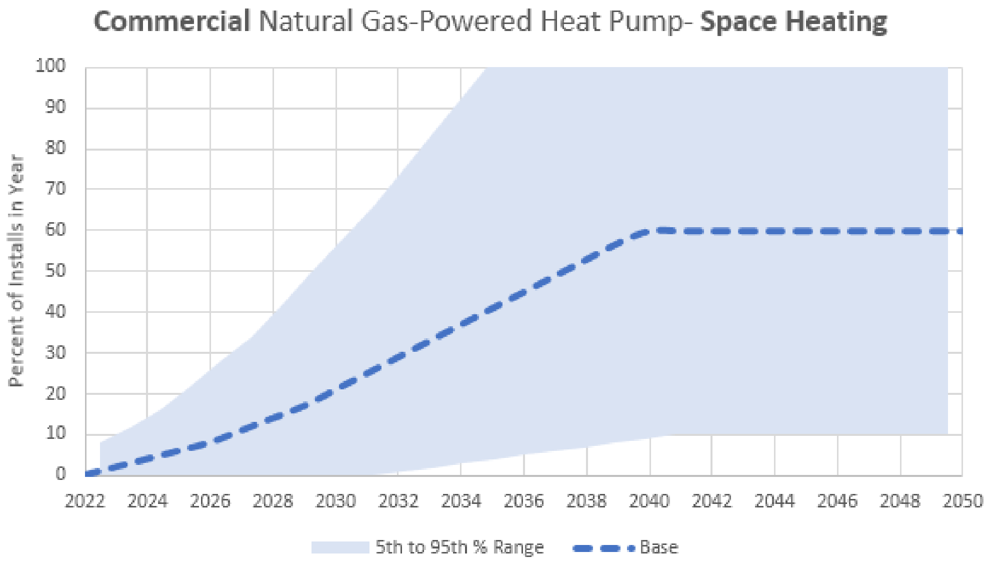
- Key driver of demand-side assumptions is forecasts from Energy Trust of Oregon and AEG
- We adjust our load forecasts for these projections (recognizing there is also energy efficiency included in our historical data used to train our load forecasting models)
- Roughly 20% reduction in load from reference case expected from programs for sales customers in 2050
- First transportation schedule load customer projection shows a roughly 10% reduction in transportation load from reference case in 2050
  - Transportation schedule energy efficiency programs assumed to begin in 2024
- Load sensitivities and simulation draws adjust for electrification assumptions so that savings are *not* being claimed from an energy need not being served by NW Natural

Key Demand-Side Assumptions- Emerging Technology Assumptions









Prepared for IRP Working Group- Not to be used for investment purposes.

Key Demand-Side Assumptions- Emerging Technology Assumptions

Incremental Demand-Side Measure Costs	Incentive	Total Cost to Utility	Cost Range (5th and 90th Percentile)
Residential Hybrid Heating Incremental Incentive (2020$/System Install)	$1,200	$1,600	+/- 30%
Residential Hybrid Heating Share of Incentive paid by non-CCI funds (%)	25%	$400	+/- 50%
Residential Gas Heat Pump Incentive (2020$/System Install)	$3,000	$4,000	+/- 40%
Residential Gas Heat Pump Water Heater Incentive (2020$/System Install)	$1,200	$1,600	+/- 40%
Commercial Hybrid Heating Incremental Incentive (2020$/System Install)	$3,000	$4,000	+/- 30%
Commercial Hybrid Heating Share of Incentive paid by non-CCI funds (%)	25%	$1,000	+/- 40%
Commercial Gas Heat Pump Incentive (2020$/System Install)	$10,000	$13,333	+/- 30%
First Year Transport Load Savings Cost (2020$/1st year therm saved)		$1.79	+/- 100%

Questions/Feedback

Please provide feedback on our resource option assumptions and analysis by May 4th

Strategic Planning | Integrated Resource Planning Team
irp@nwnatural.com