Cascade Natural Gas Corporation

Integrated Resource Plan
Technical Advisory Group Meeting #3

Thursday, Sept. 7th, 2017

Portland International Airport

Portland, OR

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
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Agenda

- **Introductions**
- **IRP Action Plan Update**
- **Walkthrough of Resource Assessment and Modeling**
- **Policies and Methodologies Informing DSM Outcome**
- **Acquisition of all Cost Effective DSM**
- **Oregon Low Income Energy Conservation (OLIEC) & Conservation Achievement Tariff (CAT) Programs**
- **Action Plan/Other Items**
- **SENDOUT® Modeling Update**
- **Preliminary Modeling Results**
- **Incremental GTN Capacity**
- **Upcoming Schedule**
- **Questions**

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IRP Action Plan Update

2014 IRP Action Item	Update
1. Cascade will improve its demand forecast by developing a report to track the issuance of corrected bills and reclassifying therms from corrected bills to the month those therms were used. In its next IRP, Cascade will use its new Statistical Analysis Software (SAS) to test non-linear weather effects on natural gas, to perform analysis on potential serial correlation problems, and to create a time series autoregressive integrated moving average (ARIMA) model for customer forecasting.	On June 26th Cascade's Gas Supply Oversight Committee (GSOC) met and was provided an update on the 2017 portfolio procurement plan, which included recent market intelligence and updated pricing. In TAG 3 the company will discuss its supplies of varying lengths and pricing alternatives.
2. Cascade will continue to monitor outside determinants of natural gas usage, such as legislative building code changes and electrical "Direct Use" campaigns as they are determined to significantly affect the Company's forecast.	Since the 2014 Action Plan, Cascade has monitored the following legislation, campaigns, and other external actions with the potential to influence natural gas use in the States of Washington and Oregon: - National standard practice manual, Portland renewable energy goals, gas to electric fuel switching, HB-2711 moratorium on hydraulic fracturing for oil and gas exploration and production, several Washington state bills on Carbon taxes, deep decarbonization, and the clean air rule.
3. Cascade will continue to monitor the effectiveness of the Oregon Public Purpose Fund to ensure the funds are adequate to capture significant portions of achievable therm savings in Oregon.	Since the 2014 IRP, Cascade has made two filings to increase its public purpose charge to ensure funding would be sufficient to acquire the therm savings target established in the IRP as a least cost resource: Advice No. O15-12-01 on December 11th, 2015 to increase its public purpose charge from 1.85% to 3.7% (reduced to 3.4% before Commission approval) and Advice No. O16-10-01 on October 31st, 2016, in which the Company asked to increase the Public Purpose Charge from 3.4% to 4.87%.
4. The company will continue to follow and analyze the impacts of the Western Climate Initiative and proposed carbon legislation at both the state and federal level as they pertain to natural gas conservation, as well as other such acts that may arise from these efforts. The company will continue to monitor the timing and the costs associated with carbon legislation and analyze the impacts on the company's overall portfolio costs. As specific carbon legislation is passed, the company will update its avoided cost calculations, conservation potential and make modifications to its DSM incentive programs as necessary.	The Company has continued to monitor the Western Climate Initiative and proposed carbon legislation since the 2014 Action Plan. While no significant action has been taken on the WCI with impacts to the Company, the Company is actively following the current legislation and is monitoring the potential impacts to portfolio costs.

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IRP Action Plan Update Cont'd

5. The company will continue to monitor the cost effectiveness of existing conservation measures and emerging technologies to ensure that the current mix of measures included in the Washington Conservation program is appropriate. Areas for further analysis include the impacts associated with modifications to building codes along with the cost effectiveness of newer technologies such as the next generation of high efficiency water heaters (.70 EF) and high-efficiency hybrid heat pumps. The applicability of these measures within Cascade's service territory will be analyzed and the company's Conservation Incentive Program will be modified as necessary.	Cascade continually monitors the region and natural gas industry on currently available technology advancements as part of our Washington incentive programs. We reevaluate the portfolio cost-effectiveness paired with current technology and update install costs to maintain viability and as robust of a program as feasible. The Company is also engaged with the Northwest Energy Efficiency Alliance market transformation collaborative in coordination with other local utilities and the Energy Trust of Oregon as well as the Gas Technology Institute's emerging technology program to stay abreast of new technologies and opportunities for additions and changes to the Company's offerings. The Company also maintains a Trade Ally network for our Washington programs and routinely connects with local contractors to gauge availability of product and costs associated with installs of rebate eligible equipment and measures. The landscape is constantly evolving and Cascade works with its partners and local agencies and builders (including home builder associations) to track building code updates as well as changes to industry standards.
6. The Company will continue to monitor the potential reporting, administrative and potential financial impacts of long term resources as a result of concerns surrounding fracking. In particular we are awaiting the EPA to reveal the results of their current study in alleged water contamination found in Wyoming as a result of fracking activities.	Cascade has included a slide in TAG 3 to address this action item. Additionally, Cascade has extended an invitation to NWIGU to discuss this item.

IRP Action Plan Update Cont'd

7. Cascade will continue to evaluate gas supply resources on an ongoing basis, including supplies of varying lengths (base, swing, peaking) and pricing alternatives. We will continue to analyze the uncertainties associated with supply and demand relationships.	Due to the robust nature of TAG 3, this will now be discussed in TAG 4.
8. The Company will continue to monitor the proposed pipeline expansion projects to access more supplies out of the Rockies. As cost estimates change, the company will analyze those resources under consideration to determine if modifications to the preferred portfolio are necessary.	NWP has provided an updated Wenatchee lateral expansion which is currently being considered for modeling.
9. As part of the Cascade's risk management policy and implementation, the Company will report on the status of the UM 1720 as well as related risk management policy enhancements to Cascade's risk management policy, at the first Purchased Gas Adjustment (PGA) quarterly meeting with OPUC Staff in early 2017. This docket is the Commission's Investigation into Long Term Hedging Policy.	Interested parties met on August 23rd, with the conclusion that an agreement could not be reached. The parties at this meeting (Staff, regional LDCs, NWIGU and CUB) will be requesting that this docket be closed. Cascade continues to work on enhancing its risk management policies in compliance with Washington's new hedging rules
10. The Company will continue to explore options to incorporate biogas into its portfolio, as specific projects are identified in our service territory. Price, location and gas quality considerations of the biogas supply will be evaluated.	Cascade has filed a Biomethane Reciept Services (Schedule 800) in Oregon to estabilsh biogas injection terms, conditions and gas quality requirements. Cascade continues to work with possible biomethane producers and evaluate those projects for possible future core supplies.
11. The Company will continue to monitor proposed LNG import facilities as information becomes available and will evaluate the various options that, if built, could result. Issues to monitor include specific cost, the availability of pipeline capacity and project timing.	Cascade is continuing to monitor the progress of import/export facilities such as the proposed Jordan Cove LNG terminal. The status of these projects are documented each month in Cascade's monthly internal market intelligence report
12. The Company will continue to monitor the futures market for price trends and will evaluate the effectiveness of its risk management policy. Implementation of Dodd- Frank in the coming year raises potential administrative challenges from a reporting standpoint; additionally it is unknown how the costs associated with the use of clearinghouses might impact prices of natural gas in the future.	Cascade has updated its price forecast to modify its weights based on a backcast of the accuracy of its sources. At this time the price impacts of Dodd-Frank and hedging related dockets such as UM 1720 and UG-132019 continues to be unknown. The Company will continue to provide updates in coming TAG meetings.

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Update on Fracking

- Cascade has reviewed the EPA document released in 2016 regarding Hydraulic Fracturing for Oil and Gas.
- Environmental impacts were documented but the results were overall inconclusive, included many data gaps, and any estimates contained high degrees of uncertainty.
- Cascade has determined that there are no immediate reporting, administrative and financial impacts of fracking that need to be addressed.

ETO/CNGC Joint DSM Presentation to Cascade Natural Gas Technical Advisory Group

TAG III Presentation

Thursday, September 7
Portland International Airport

Purpose

- To discuss the Company's Demand Side Management (DSM) strategy for the acquisition of all cost-effective conservation- in partnership with the Energy Trust of Oregon;
- Review of progress on adaptations based on OPUC order since last planning cycle; and
- Consideration of future DSM-focused action items to further strengthen & refine future analysis

OPUC Order Guidance

- Clearly show the plan to acquire all cost effective energy efficiency
- Provide complete conservation resource potential results and inputs specific to Cascade only, not including results of other Energy Trust territories or for measures that do not apply to Cascade territory
- Provide updated data and explanations for the policies and methodologies used to inform the DSM analysis
- Incorporate commercial market transformation savings similar to residential methods and include an explanation for how those assumptions are derived and applied within the IRP
- Clearly document assumptions behind capacity contribution of energy efficiency and how the capacity value is incorporated into resource planning
- Provide an explanation regarding how annual energy savings are translated into peak day demand and capacity resources

Today's Agenda

1. Walkthrough of Resource Assessment and Modeling
2. Policies and Methodologies Informing DSM Outcome
3. Acquisition of all Cost Effective DSM
4. Oregon Low Income Energy Conservation (OLIEC) & Conservation Achievement Tariff (CAT) Programs
5. Action Plan/Other Items

Energy Trust of Oregon

Energy Efficiency Resource Potential Study

September 7, 2017

EnergyTrust of Oregon

About

- Independent nonprofit
- Serving 1.5 million customers of Portland General Electric, Pacific Power,
  NW Natural and
  Cascade Natural Gas
- Providing access to affordable energy
- Generating homegrown, renewable power
- Building a stronger Oregon and SW Washington

Resource Assessment Overview

What is a resource assessment?

- Estimate of available, cost-effective efficiency available to be acquired in Cascade's service territory over 20 years

13

Resource Assessment Inputs:

Utility Service Territory Data

- Customer counts, 20-year load forecasts
- Avoided costs, discount rate

Demographic statistics

- Heating & hot water fuel splits, measure saturations
- Energy use intensity for Commercial

Measure assumptions

- Savings, costs, O&M, measure life, load profile, end use, baseline, technical applicability, achievability rates

Background – How is RA used?

- Energy Trust uses the resource assessment model for utility IRP work, strategic planning, and program planning
- Does not dictate what annual savings are acquired by programs
- Does not set incentive levels

Model Assumptions

- Factor in known codes & standards
- Utilize 3rd party research and survey work to inform saturation rates
- A more direct approach to quantifying RES & COM building stock as an input
- Incremental measure savings approach for potential instead of market shares
- New approach to emerging technologies

Measure Updates

Refreshed measure assumptions

- Updated measures across all Sectors (RES, COM, IND)
  - Residential New Home Construction packages
  - Residential Showerheads, aerators
  - New Homes Tankless Water Heaters

Added New Measures

- Commercial Strategic Energy Management (SEM) – Behavioral
- Commercial Cooking measures
- Residential Smart Thermostats

Cost-Effectiveness Screen

Total Resource Cost (TRC) test

- TRC benefit cost ratio (BCR) = NPV of Benefits / Total Resource Cost

Benefits

- Savings x Avoided Costs per therm
- Quantifiable non-energy benefits

Total Resource Measure Costs

- Full cost of EE measure or incremental cost of installing efficient measure over baseline measure

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 programs, sometimes with OPUC exception. Examples:

- Commercial Insulation and Windows
- Residential Furnaces
- New Homes Construction Pathways
- Residential Smart Thermostats
- Residential Windows
- Residential Insulation (ceiling, floor, wall)
- Residential Tank Water Heater

Emerging Technology

- New model includes savings potential from emerging technologies
- Factor in changing performance, cost over time
- Use risk factors to hedge against uncertainty

	ET Risk Factor Scorecard				
Risk Category	**10%**	**30%**	**50%**	**70%**	**90%**
Market Risk (25% weighting)	**High Risk:** • Requires new/changed business model • Start-up, or small manufacturer • Significant changes to infrastructure • Requires training of contractors. Consumer acceptance barriers exist.			**Low Risk:** • Trained contractors • Established business models • Already in U.S. Market • Manufacturer committed to commercialization	
Technical Risk (25% weighting)	**High Risk: Prototype in first field tests. A single or unknown approach**	**Low volume manufacturer. Limited experience**	**New product with broad commercial appeal**	**Proven technology in different application or different region**	**Low Risk: Proven technology in target application. Multiple potentially viable approaches.**
Data Source Risk (50% weighting)	**High Risk: Based only on manufacturer claims**	**Manufacturer case studies**	**Engineering assessment or lab test**	**Third party case study (real world installation)**	**Low Risk: Evaluation results or multiple third party case studies**

Emerging Technologies

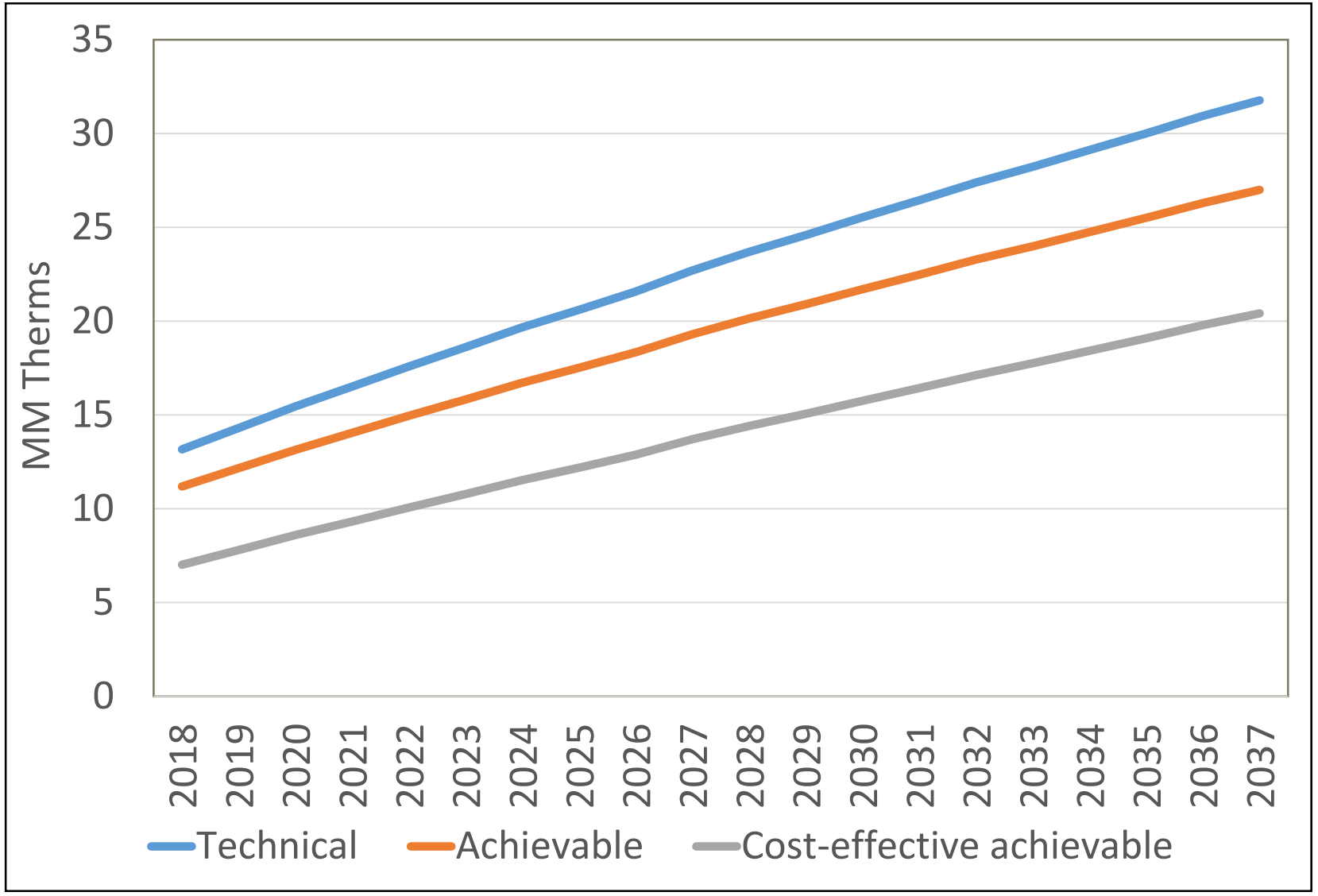
Residential	Commercial	Industrial
• Window Replacement (U<.20) • Advanced Insulation Technologies • Smart Devices Home Automation / Controls • Absorption Gas Heat Pump Water Heaters • AFUE 98/96 Furnace	• AC Heat Recovery, Hot Water • Advanced Ventilation Controls • Smart/Dynamic windows • Highly Insulated Windows • Energy Recovery Ventilator	• Gas-Fired Heat Pump Water Heaters • Wall Insulation

Outputs:

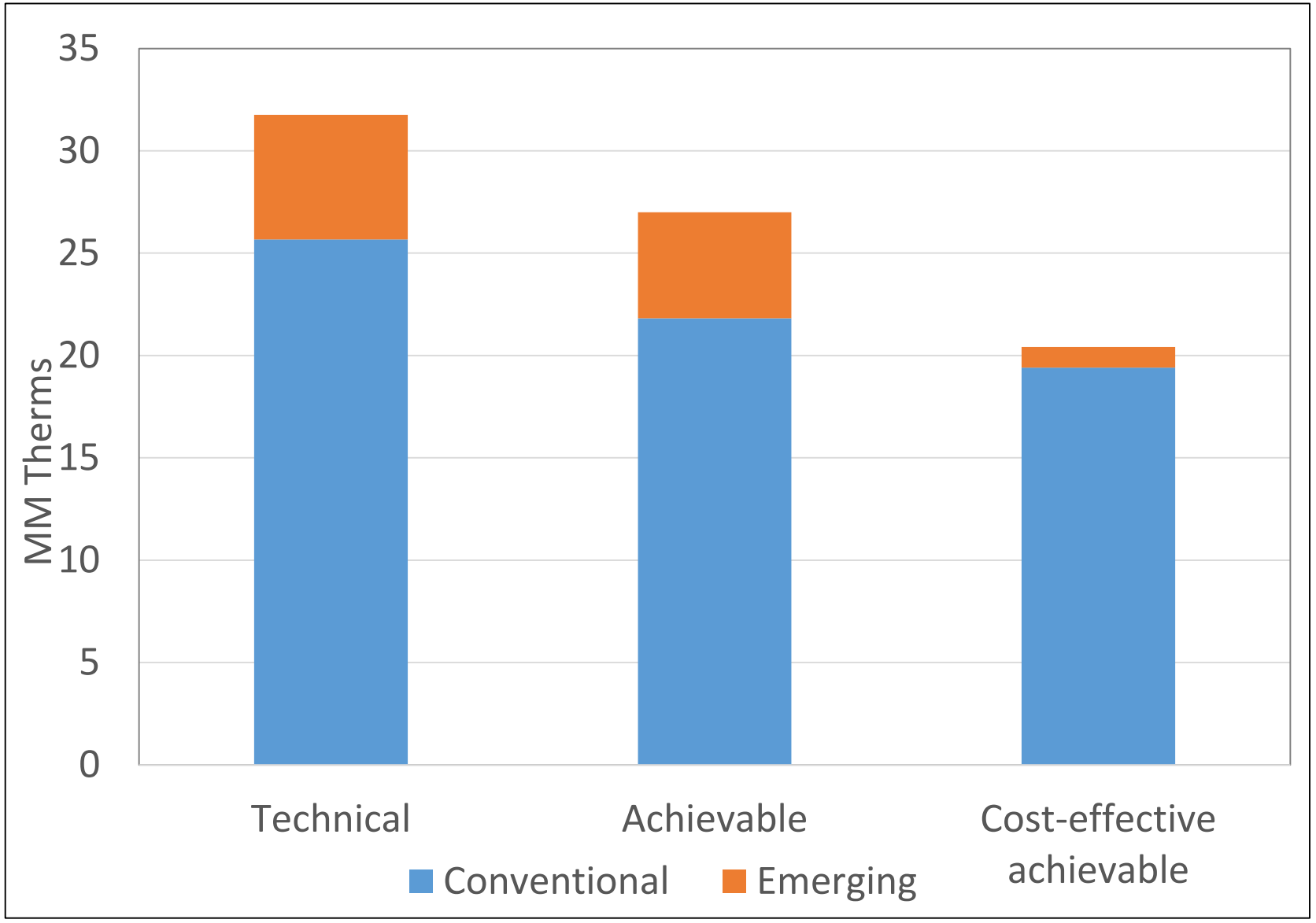
<table>
<tr><td>Not technically feasible</td><td colspan="3">Technical Potential</td></tr>
<tr><td>Not technically feasible</td><td>Market barriers</td><td colspan="2">Achievable Potential
85% of Technical</td></tr>
<tr><td>Not technically feasible</td><td>Market barriers</td><td>Not cost effective</td><td>Cost-Effective Potential</td></tr>
</table>

Results

Cumulative Potential by Type and Year



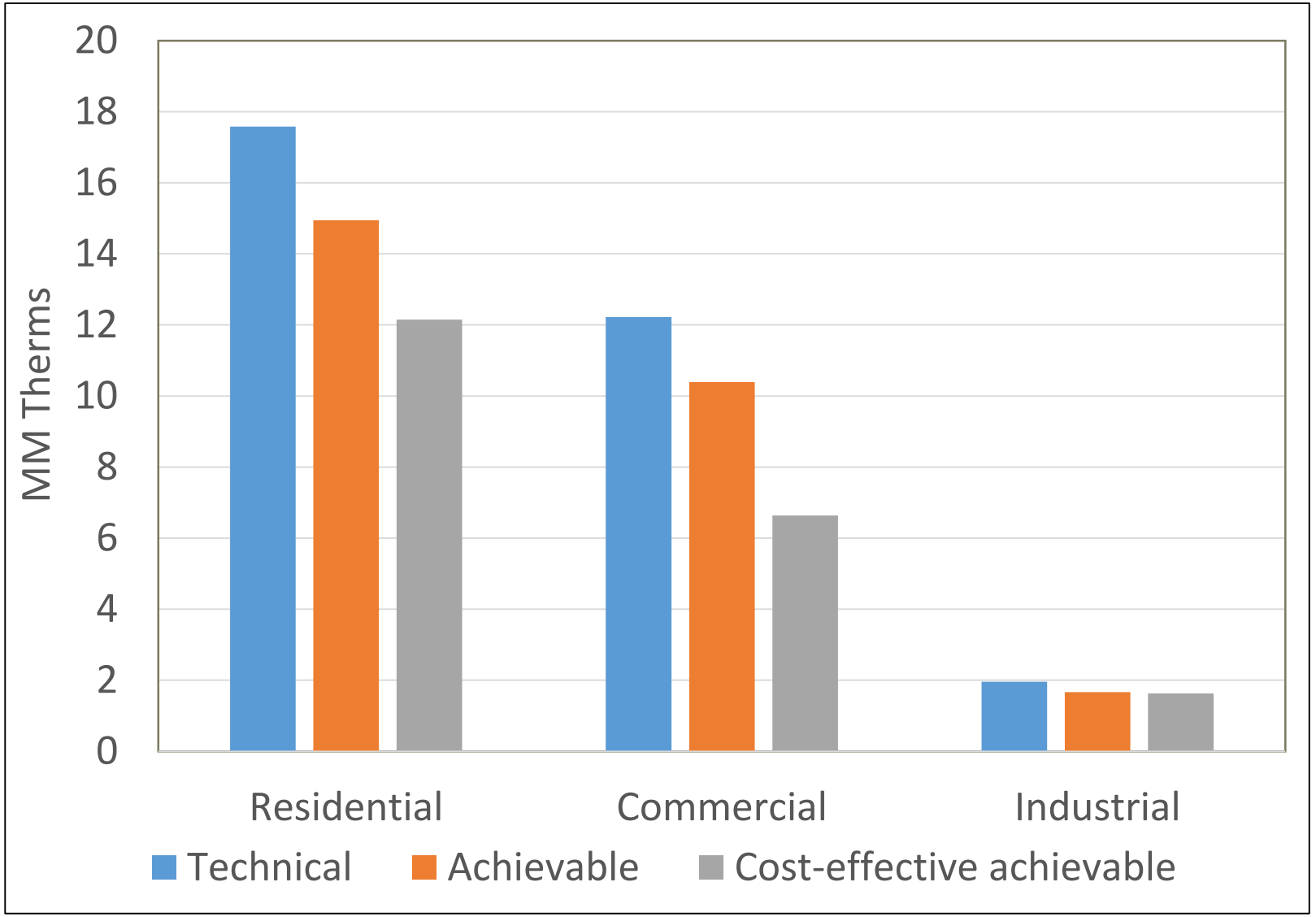
Cumulative Emerging Technology Contribution



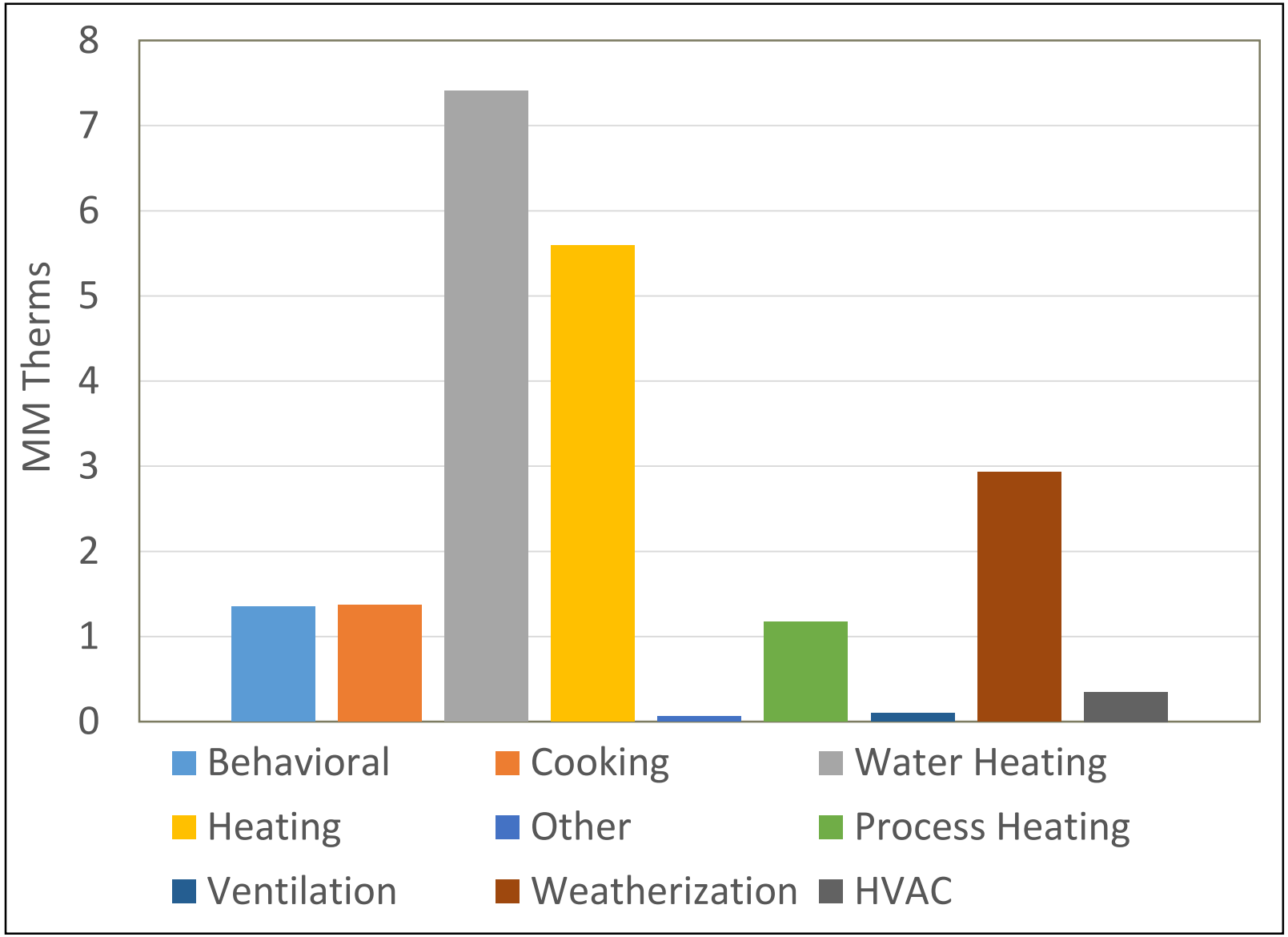
Cost-Effective Override – MM Therms

Sector	Yes CE Override	No CE Override	Difference
Residential	12.15	5.78	6.37
Commercial	6.64	6.47	0.17
Industrial	1.63	1.63	-
Total DSM:	**20.42**	**13.88**	**6.54**

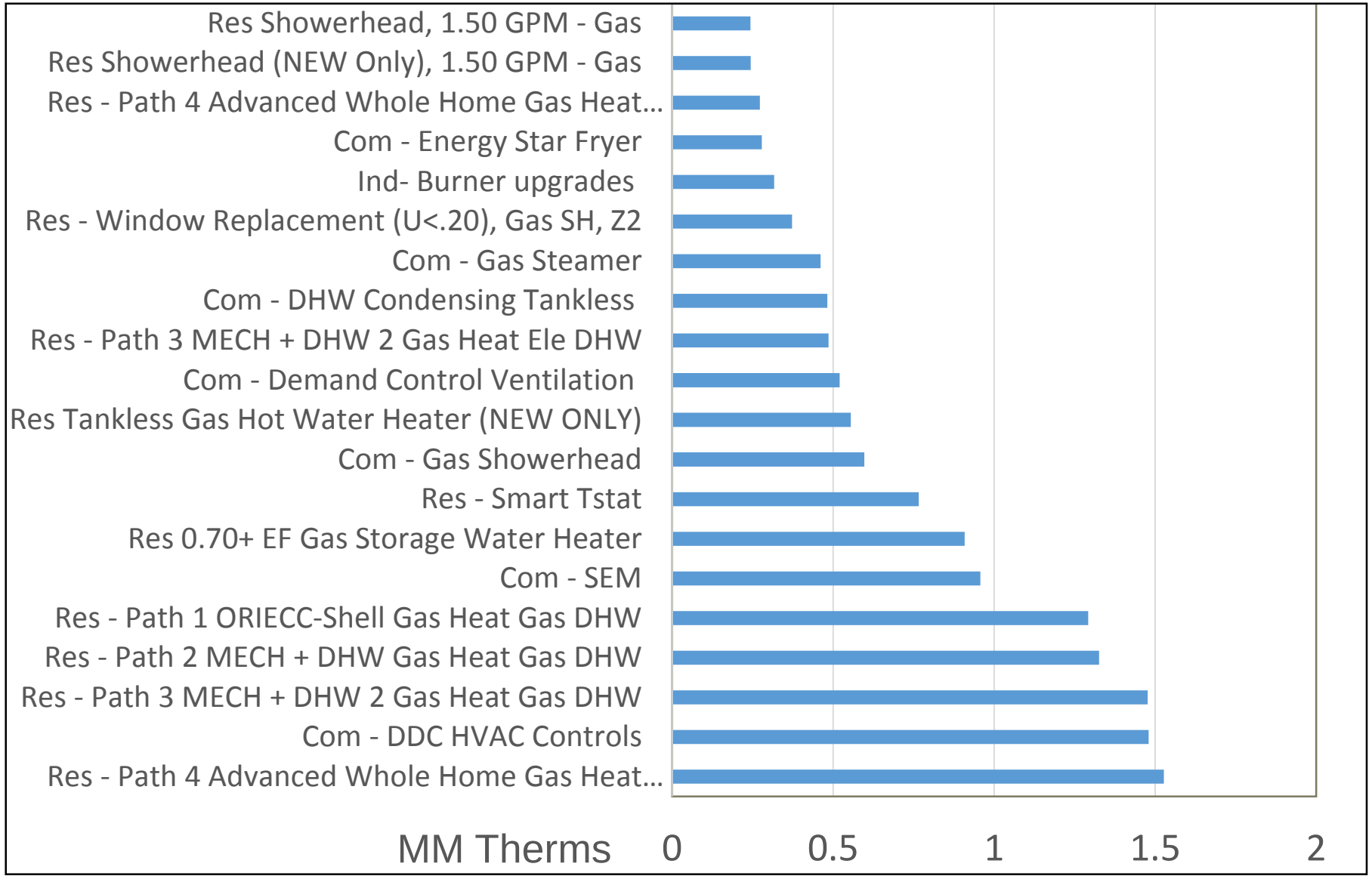
Cumulative Potential by Sector and Type



Cumulative Cost-effective Potential by End Use



Top-20 Measures – Cost-Effective Cumulative Potential

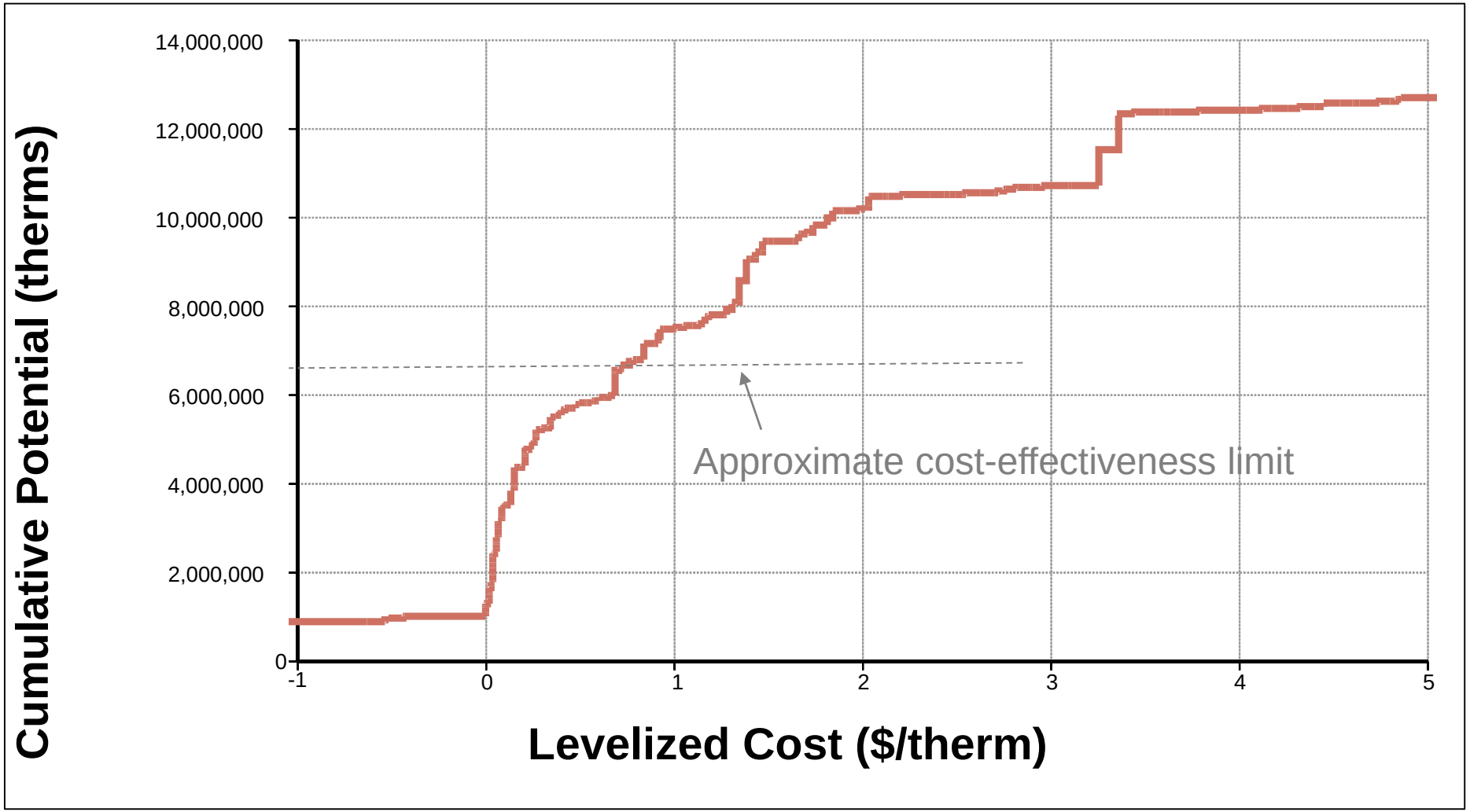


Market Transformation Savings Forecasts from Program Building Code Efforts

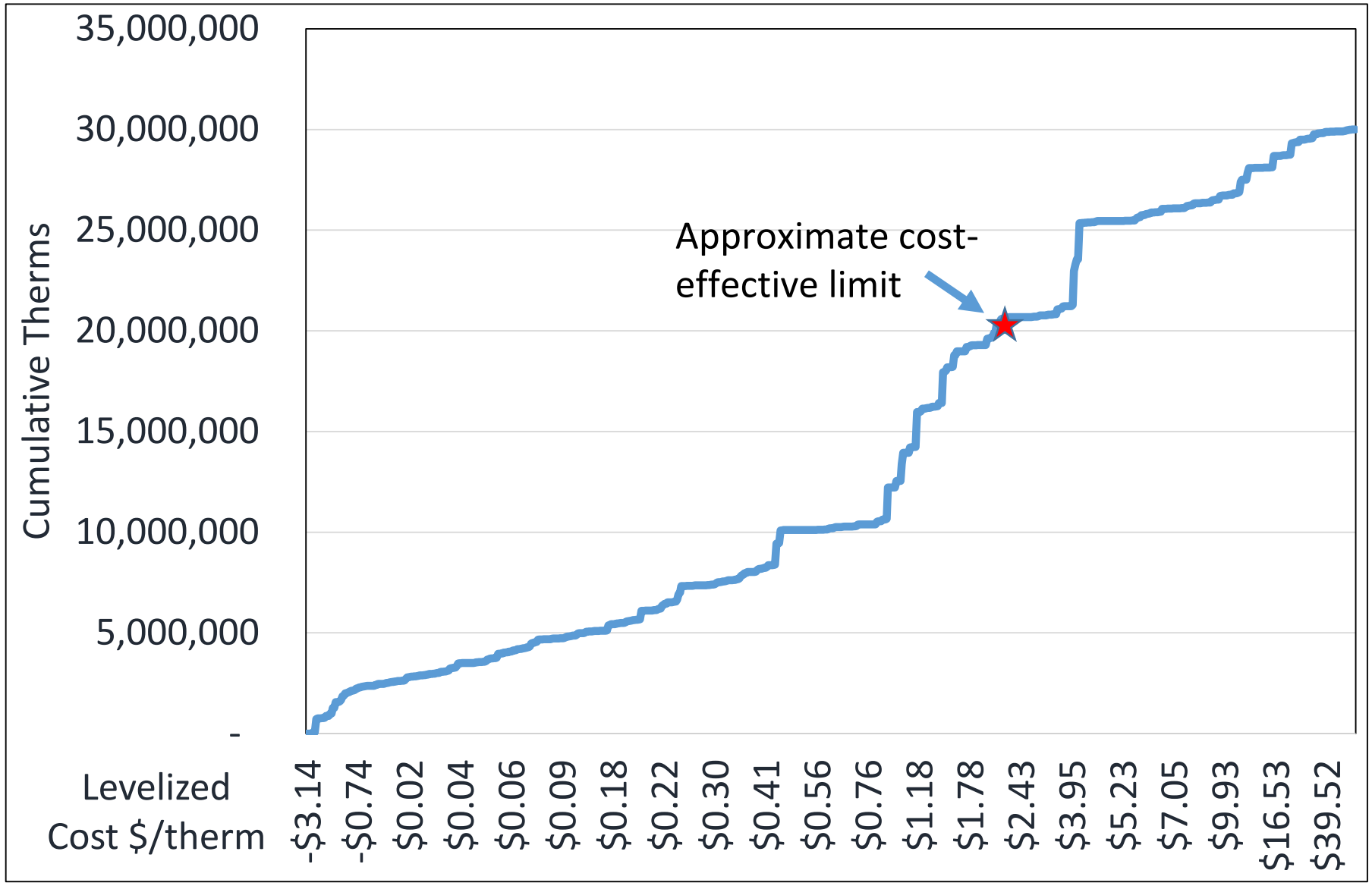
- New Home Construction Market Transformation:
  - 2018 Forecast of 54,335 therms
  - 2019 Forecast of 55,983 therms

- New Buildings Construction Market Transformation:
  - 2018 Forecast of 5,510 therms
  - 2019 Forecast of 5,510 therms

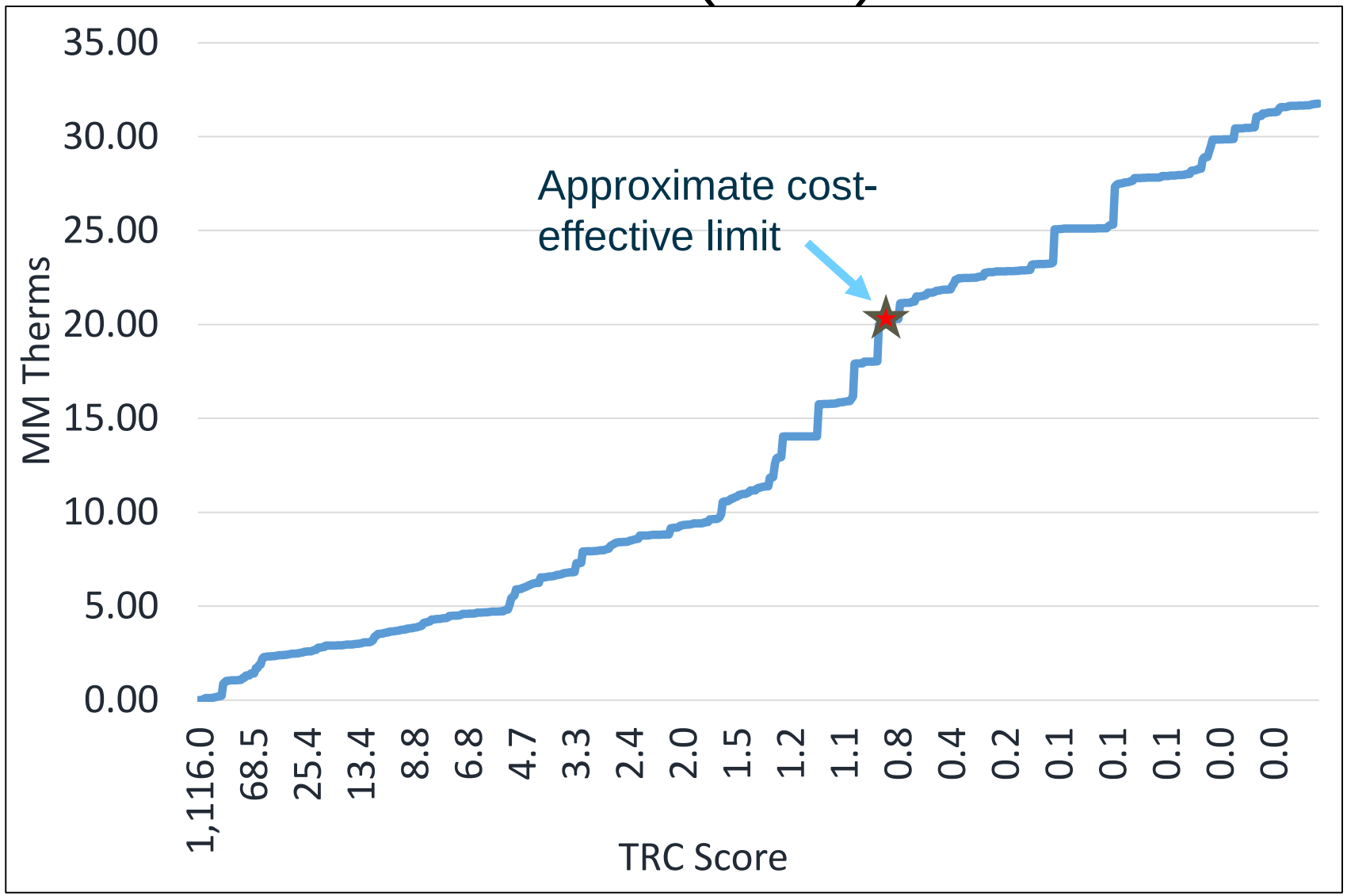
2015 Supply Curve – 20 Year Technical Potential



2018 Supply Curve – 20 Year Technical Potential by Levelized Cost of Energy



Supply Curve – 20 Year Cumulative Technical Potential by Total Resource Cost (TRC) Score



2018 IRP Projected Savings

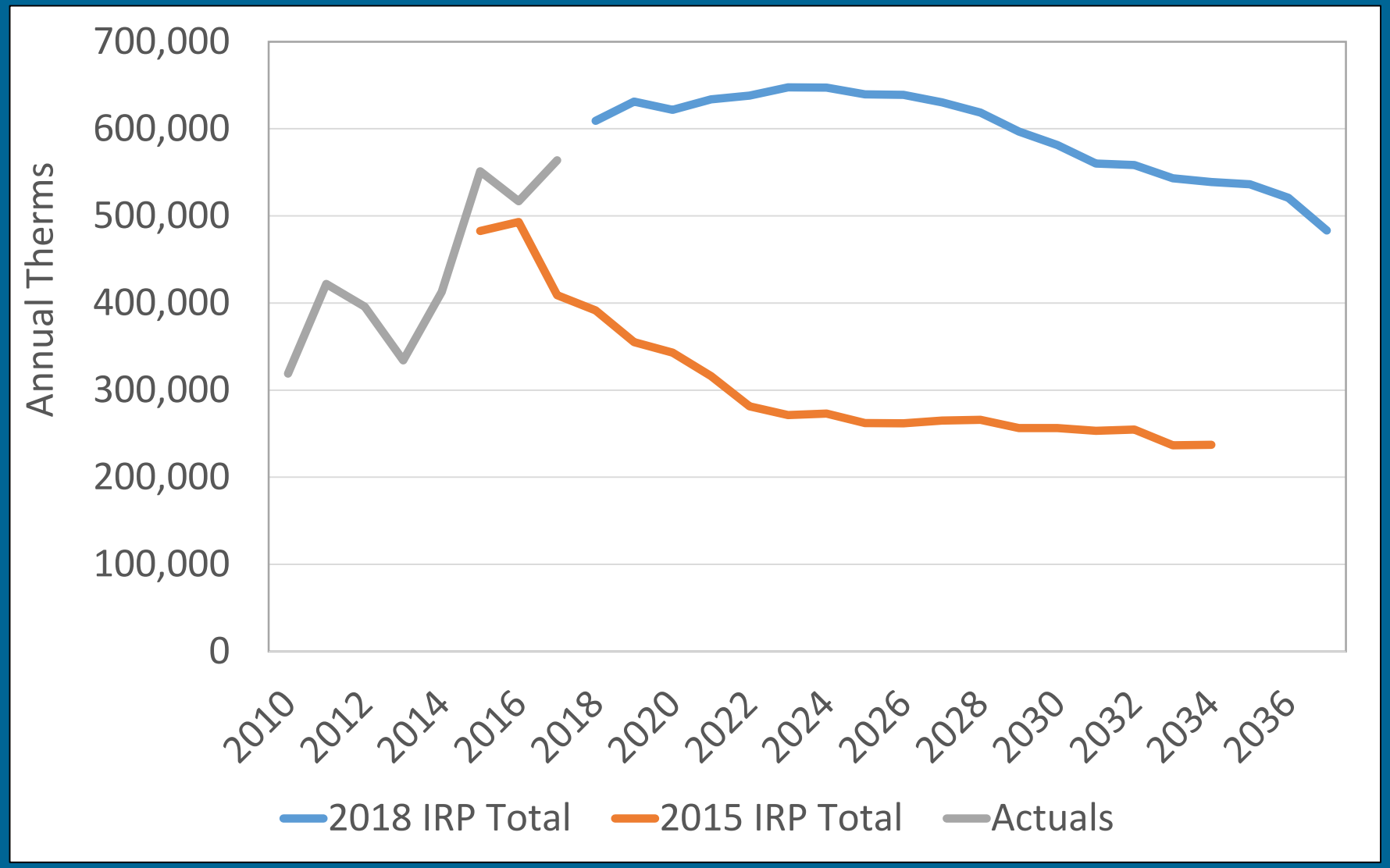
Types of Potential

<table>
<tr><td>Not technically feasible</td><td colspan="4">Technical Potential</td></tr>
<tr><td>Not technically feasible</td><td>Market barriers</td><td colspan="3">Achievable Potential</td></tr>
<tr><td>Not technically feasible</td><td>Market barriers</td><td>Not cost effective</td><td colspan="2">Cost Effective Potential</td></tr>
<tr><td>Not technically feasible</td><td>Market barriers</td><td>Not cost effective</td><td>Program design, market penetration</td><td>Program Savings Projection</td></tr>
</table>

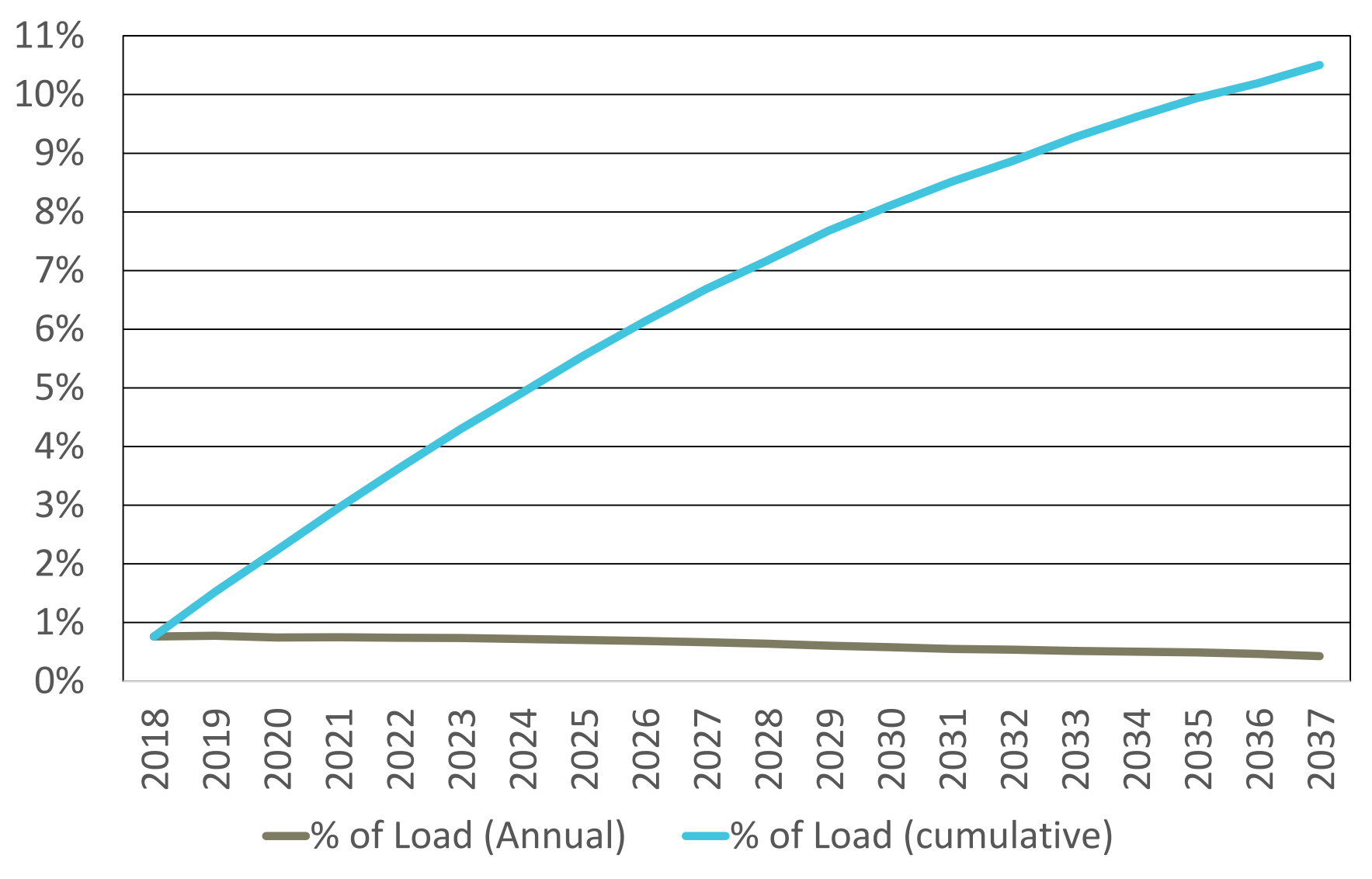
20-Year Potential by Type

	Technical	Achievable	Cost-effective	Energy Trust Savings Projection
Residential	17,580,928	14,943,789	12,148,348	4,344,727
Commercial	12,225,805	10,391,934	6,638,878	6,285,500
Industrial	1,957,048	1,663,491	1,627,931	1,245,219
All DSM	**31,763,780**	**26,999,213**	**20,415,156**	**11,875,446**

2015 vs. 2018 IRP Cost-Effective EE Savings Projections and Actuals



Annual Projected Savings as Percent of CNG's Annual and Cumulative Load Forecasts



Policies and Methodologies Informing DSM Outcome

Externalities

- Cascade evaluates the impacts of a range of environmental externalities
  - Price of carbon
  - Supply costs
  - Other associated adders
- Potential impacts on the cost of natural gas (carbon adders, etc.)
- Include code changes and cost-effectiveness methodologies
- To the best extent possible, these potential impacts have been incorporated into the Oregon DSM projections

Externalities Cont’d

- Carbon policy adder = price forecast x 10% to factor for environmental externalities
  - Per Northwest Power and Conservation Council

- After 10% added, Cascade converts $10/ton carbon tax into dollar value per MMBtu
  - Then added to commodity cost

Capacity Contribution and Value in Energy Efficiency

- Analysis at citygate level
- Demand reduced by the inputted level of EE before any optimization calculated
- Examining NWN approach
- Analysis will benefit from evolving conversation on capacity/avoided cost in Oregon

National

- National Standard Practice Manual
  - National Efficiency Screening Project, and E4TheFuture
  - Expands upon California Standard Practice Manual
  - Regulators select core costs/benefits for valuation of utility-run conservation

- Clean Power Plan
  - Requires existing fossil fuel-fired electric generating facilities to reduce carbon dioxide emissions
  - Currently being reevaluated by the EPA for consistency with the Executive Order on Promoting Energy Independence and Economic Growth

Oregon

- Renewable Energy Goals
  - Portland proposes to go 100% renewable energy by 2035, and 100% economy wide by 2050
  - Similar goals are under consideration in Hillsboro, Milwaukie, & Beaverton

- Gas to Electric Fuel-Switching
  - Ashland and Eugene have adopted energy action plans to reduce carbon emissions
  - Migration from direct use to gas-to-electric fuel switching
  - Cities plan use of renewables for electric generation as 1st phase

- HB3711 Moratorium on Hydraulic Fracturing for Oil and Gas Exploration and Production
  - Would prohibit hydraulic fracking in Oregon with moratorium until December 31, 2026
  - Exceptions for natural gas storage wells, geothermal wells/energy, & coal bed methane extraction wells
  - Passed through House, but not through Senate

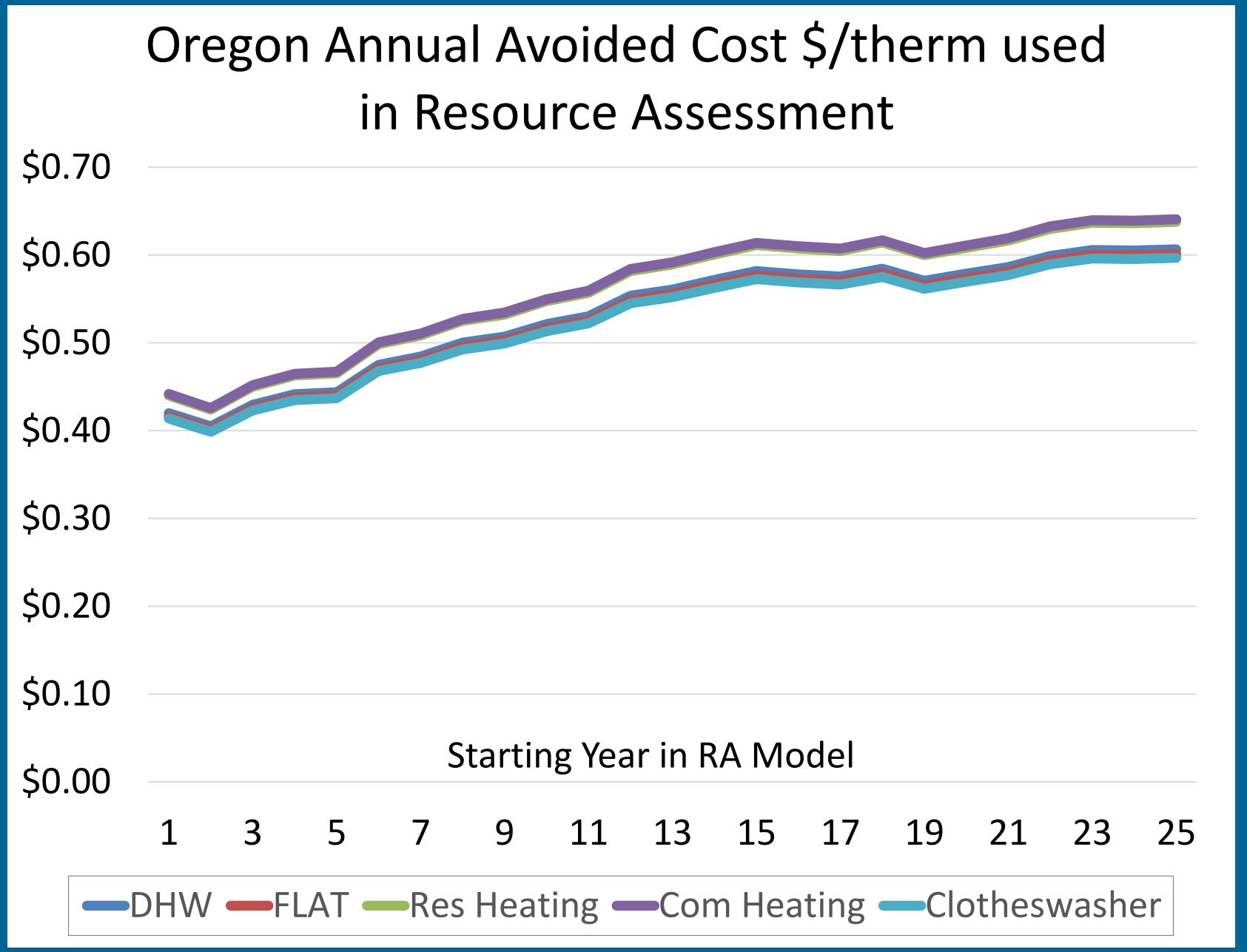
Washington

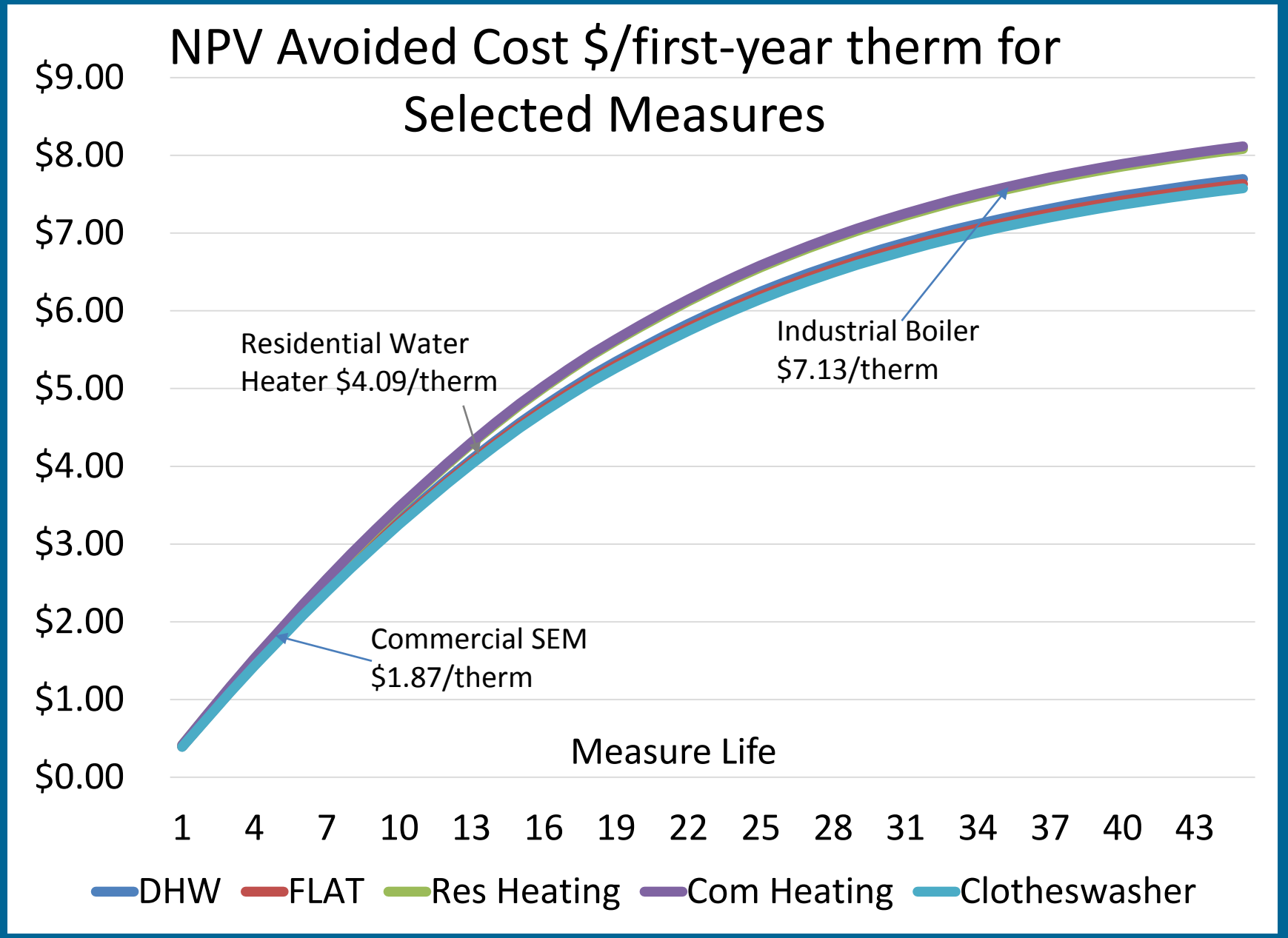
- Carbon Tax
  - Many bills circulated in the state of Washington
  - Ranges from $15/ton to $25/ton & increasing upwards over time
  - None passed, but watching closely
  - Movement by Alliance for Jobs and Clean Energy and The Natural Conservancy
    - Price on carbon- petroleum, natural gas electricity, stationary sources

- Deep Decarbonization
  - Governor Inslee's office released "deep decarbonization" study
  - Emissions reductions
  - Goal to curb global temperature increase below two degrees Celsius
  - Envisions replacing natural-gas with biomethane, synthetic natural gas & hydrogen

- Clean Air Rule
  - Cascade continues to evaluate options for compliance with the Clean Air Rule

Avoided Costs

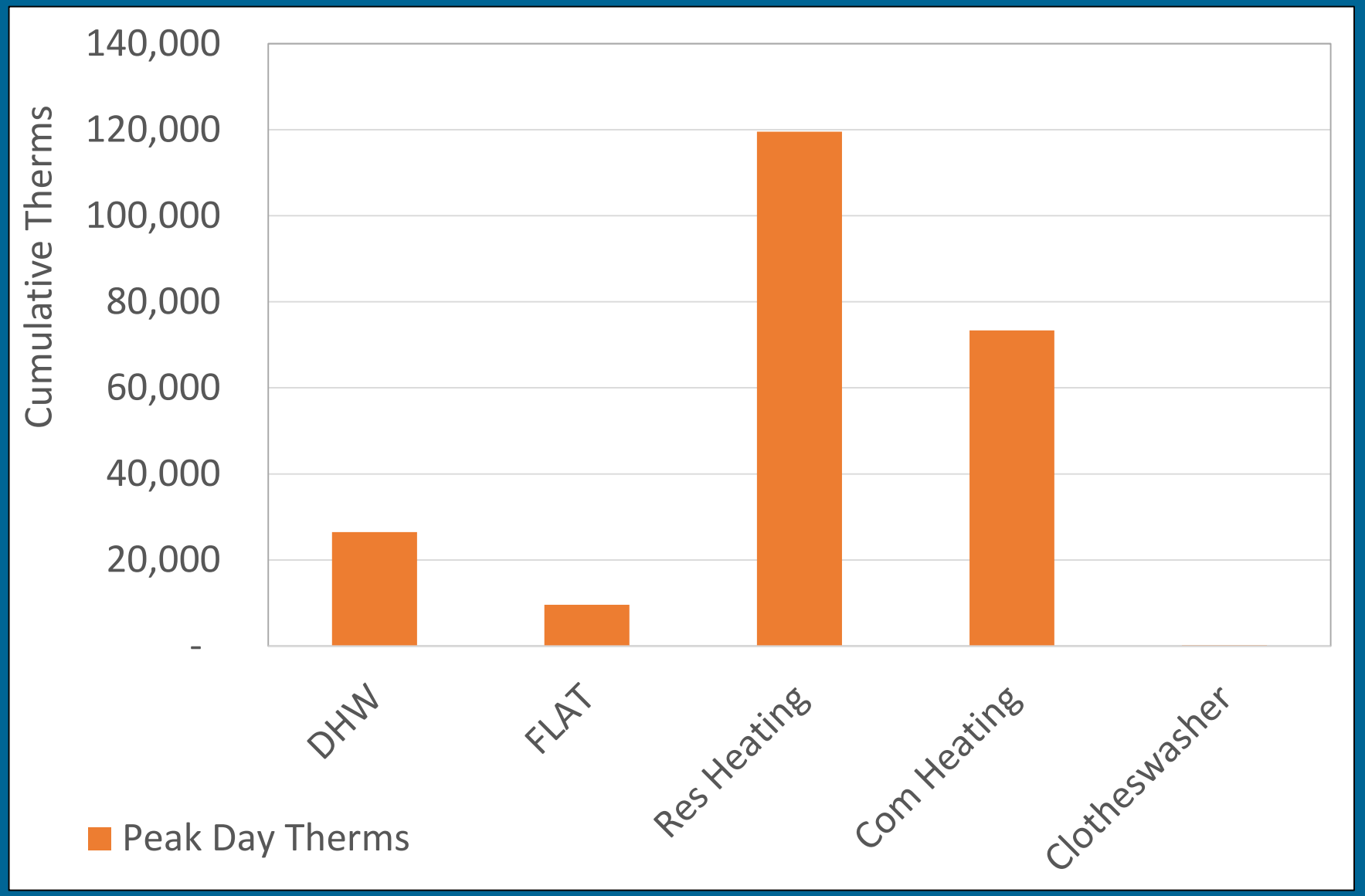

Oregon Annual Avoided Cost $/therm used in Resource Assessment
$0.70
$0.60
$0.50
$0.40
$0.30
$0.20
$0.10
$0.00
Starting Year in RA Model
1
3
5
7
9
11
13
15
17
19
21
23
25
DHW
FLAT
Res Heating
Com Heating
Clotheswasher


NPV Avoided Cost $/first-year therm for Selected Measures
$9.00
$8.00
$7.00
$6.00
$5.00
$4.00
$3.00
$2.00
$1.00
$0.00
Residential Water Heater $4.09/therm
Industrial Boiler $7.13/therm
Commercial SEM $1.87/therm
Measure Life
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43
DHW
FLAT
Res Heating
Com Heating
Clotheswasher

Peak-Day Savings

Peak Day/Annual Usage Savings Factors	
Load Profile	Peak Day Factor
DHW	0.4%
FLAT	0.3%
Res Heating	2.1%
Com Heating	1.8%
Clotheswasher	0.2%

Peak-Day Savings by Load Profile – 20 Year Potential



Acquisition of all Cost Effective DSM

2018 Programs – Pursuing all C/E Efficiency

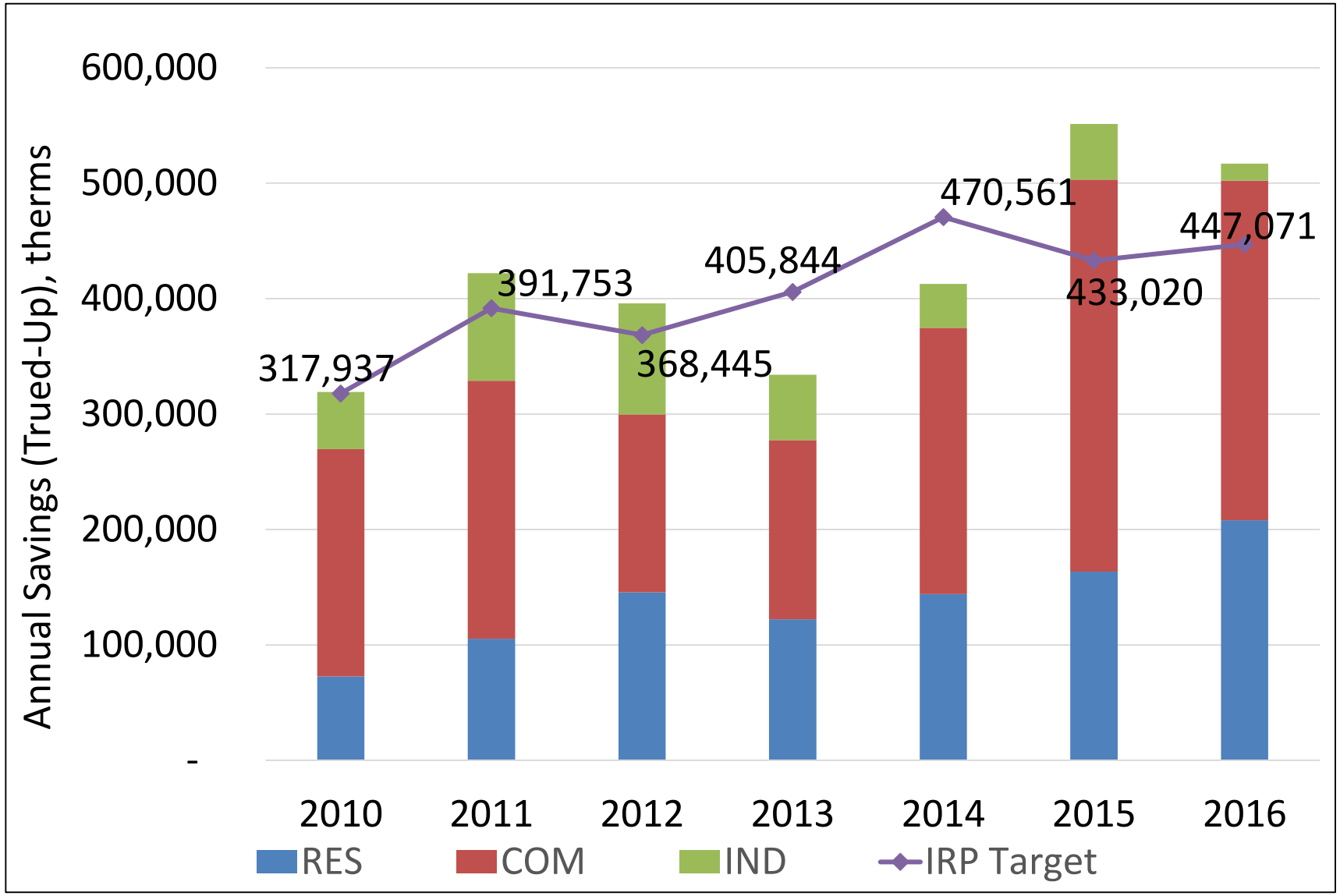
- Residential – Existing and New Home Construction
  - Single family, moderate income (SWR), manufactured homes
  - Weatherization (insulation, windows)
  - Gas fireplaces, furnaces for rentals and SWR
  - Water heaters, showerheads, aerators

- Commercial – Existing, New and multifamily in Oregon
  - Retail, offices, schools, groceries….all market segments
  - HVAC, controls, cooking equipment, water heating, windows, insulation

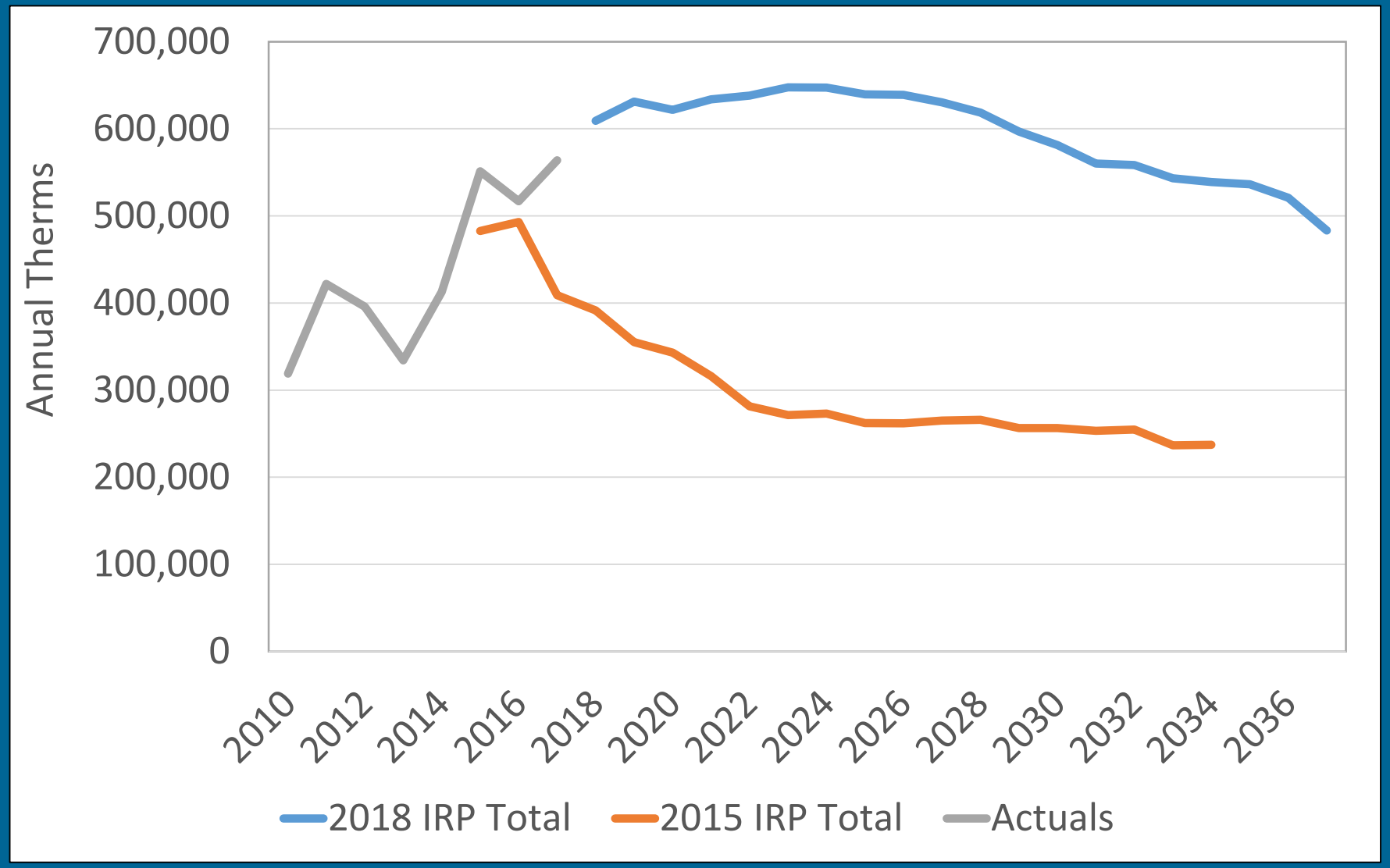
- Industrial & Agriculture in Oregon– Non transport sites
  - Manufacturing facilities, greenhouses
  - HVAC, O&M, process improvements

- Cascade Natural Gas & Energy Trust
  - Serving Oregon since 2006:
    - Served over 18,000 households, over 1,100 commercial sites and over 44 industrial sites

Historical Performance Against IRP Target



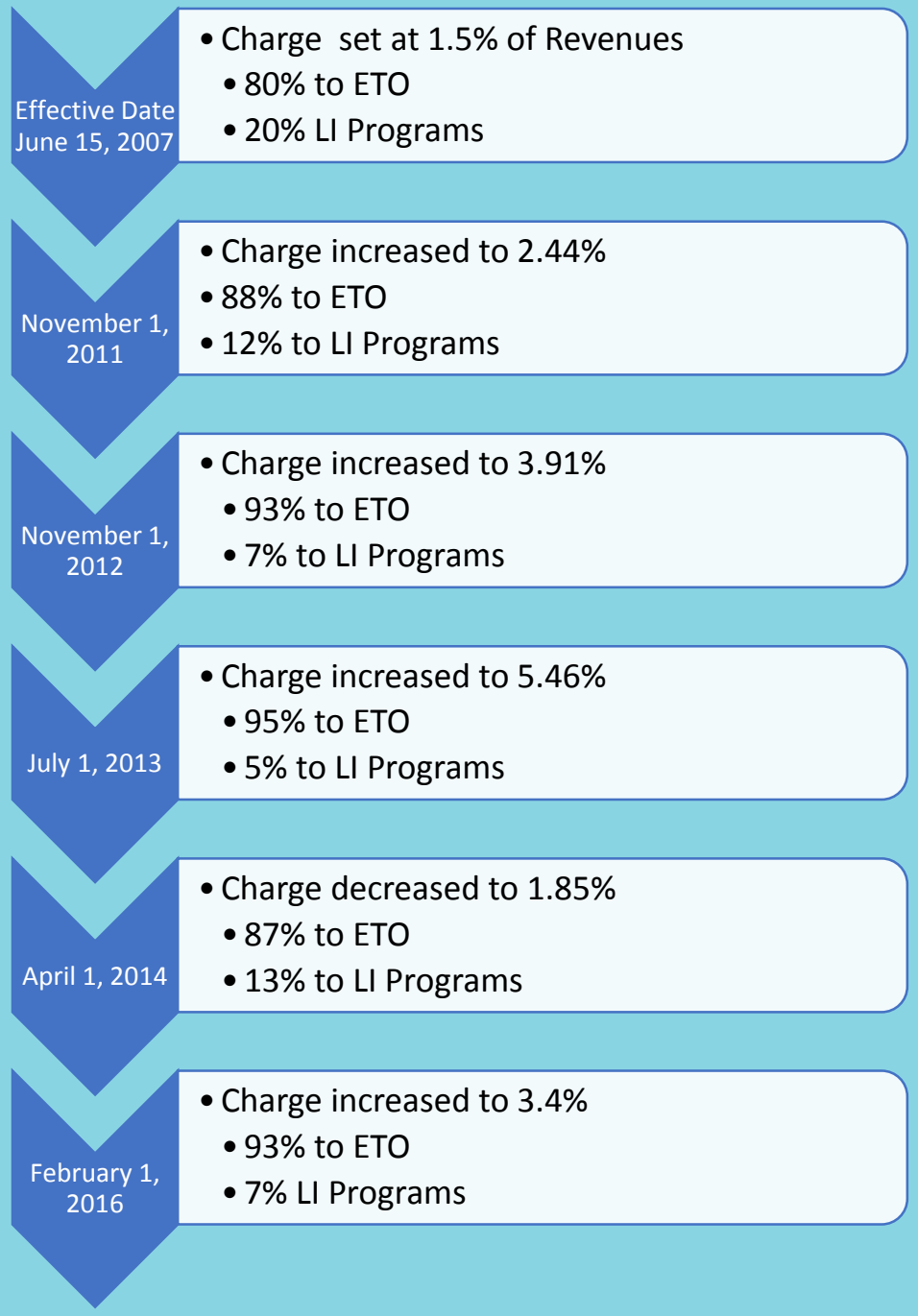
2015 vs. 2018 IRP Cost-Effective EE Savings Projections and Actuals



Program Funding

- Public Purpose Charge is established at a rate adequate to fund all cost-effective energy efficiency efforts identified with ETO
- OPUC Schedule No. 31, Public Purpose Funding
- Total PPC amount varies depending upon gas usage (weather-sensitive) and price
- Schedule 31 adjusted over time to align customer charges with program funding requirements

Adjustment History



- Revision to Schedule 31
  - Effective date of 12/1/2016
  - Increase to 4.87% with the intent of collecting $3,353,88
    - 88% was designated to the Energy Trust
      - $2,927,795 for the acquisition of 569,405 therm savings
    - 12% of funds directed towards Cascade's low income programs:
      - $50,000 to fund low income bill pay assistance
      - $361,627 for OLIEC and CAT

Oregon Low Income Energy Conservation (OLIEC) & Conservation Achievement Tariff (CAT) Programs

Cascade Community Action Partners
Serving Central & Eastern Oregon

- NeighborImpact
- Community Action Program East Central Oregon (CAPECO)
- Community Connection of NE Oregon (CCNO)
- Community In Action (CINA)
- Oregon Human Development Corporation

OLIEC

- Covers cost-effective portion of tariff approved measures
  - Ceiling, floor, wall and duct insulation
  - Duct sealing & infiltration system upgrades
  - High efficiency furnace installations, tune-up and filter replacement; and
  - High-efficiency water heaters
- New LI residential construction & individual custom efforts also eligible
- Additional $225 for admin & directly incurred program costs

Conservation Achievement Tariff

- Bridges gap between avoided cost & installed cost of qualified work
- Established as permanent program Dec 1, 2016 via Advice No. O16-10-02
- Funding equals .0625% of gross revenues
- Resulting 2017 OLIEC and CAT budget of $361,627
- $550 audit and $300 inspection fee to agency per job completed
- Total installed costs under OLIEC/CAT may not exceed $10,000

Achievements and Projections

- Since 2006:
  - **570** homes weatherized
  - **86,700** therms saved
  - **150** (approx.) therms per home on average
  - **$6,800** average per home cost

- Approximately **50** homes will be served each year (estimated **7,500** therms a year) if funds maintained near **$361,627** level

- Based on pilot activities, likely Agencies would be able to serve around **100** homes annually if funded at full capacity

Other Items

Future Action Plan Items (DSM)

- Coordination with ETO to achieve Geographically Targeted DSM
- Maintain holistic approach to planning & acquisition of demand side resources
- Integration of results deriving from OPUC Investigation into EE Avoided Costs
- Ongoing refinement of energy savings analysis to further align with capacity contribution and demand

Questions

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- Thank You

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EnergyTrust of Oregon

SENDOUT Modeling Update

Cascade Natural Gas Corporation
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SENDOUT® Model

- Cascade utilizes SENDOUT® for resource optimization.
- This model permits the Company to develop and analyze a variety of resource portfolios to help determine the type, size, and timing of resources best matched to forecast requirements.
- SENDOUT® is very powerful and complex. It operates by combining a series of existing and potential demand side and supply side resources and optimizes their utilization at the lowest net present cost over the entire planning period for a given demand forecast.

SENDOUT® Model Cont'd

- SENDOUT® utilizes a linear programming approach.
- The model knows the exact load and price for every day of the planning period based on the analyst's input and can therefore minimize costs in a way that would not be possible in the real world.
- Therefore, it is important to acknowledge that linear programming analysis provides helpful but not perfect information to guide decisions.

Portfolios

- Deterministic Optimal
- NWP Only
- NWP with Incremental Storage
- GTN Only
- GTN with Incremental Storage
- Incremental Storage Only

Supply Resource Optimization Process

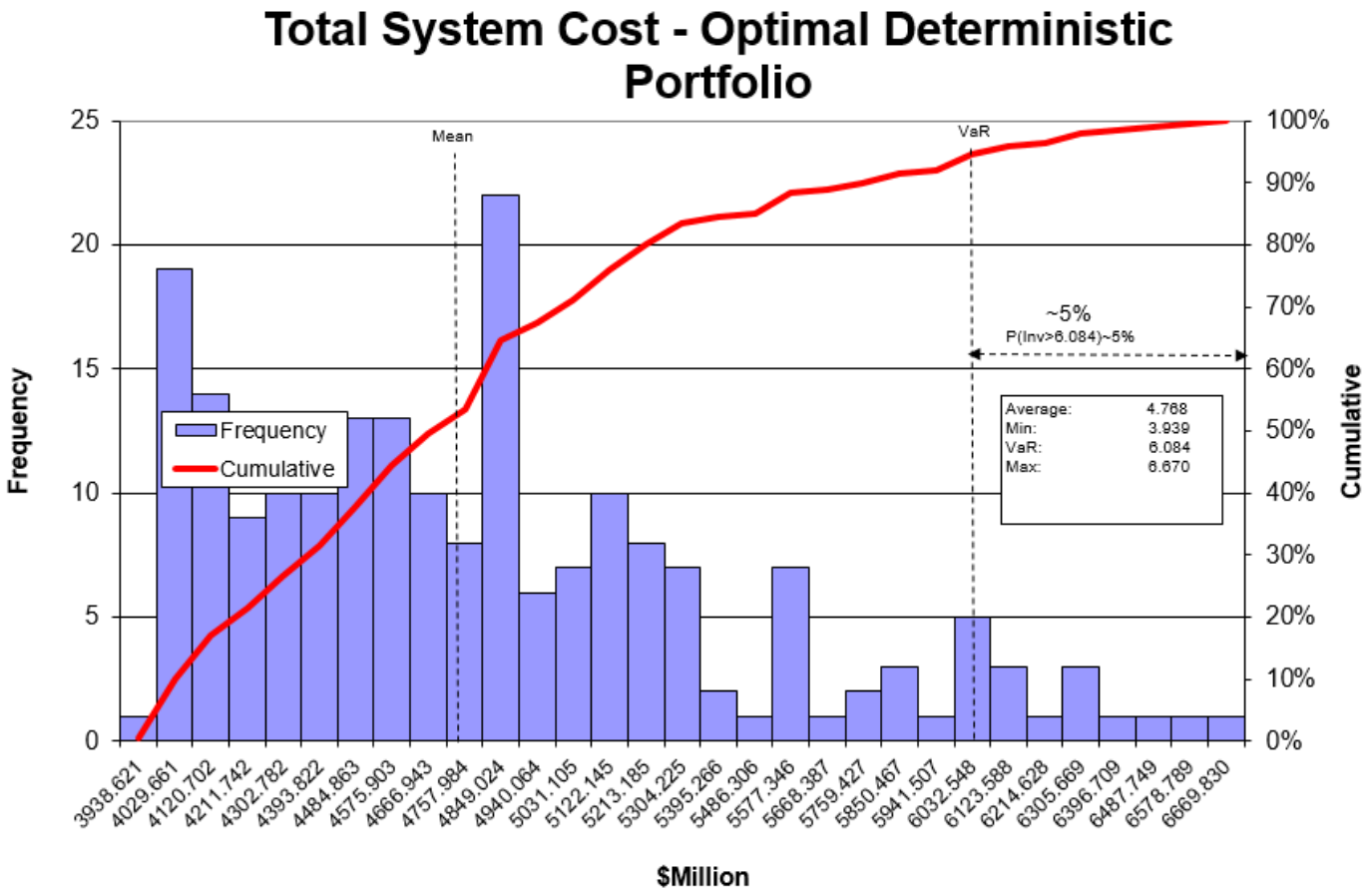
- **Step 1: As-Is Analysis**
  - Run a deterministic optimization of existing resources with a three-day peak event to uncover timing and quantity of resource deficiencies.
- **Step 2: Introduce Additional Resources**
  - Include incremental supply, storage, and transportation to derive a deterministic optimal portfolio, additional portfolios.
- **Step 3: Stochastic Analysis of All Portfolios Under Existing Conditions**
  - Run all portfolios through a Monte Carlo weather simulation, using expected growth, supply and storage accessibility. Record the probability distributions of total system costs for each portfolio.
- **Step 4: Ranking of Portfolios**
  - Determine the preferred portfolio based on mean total system cost and Value at Risk (VaR) of each portfolio. This resource mix will be the best combination of cost and risk for Cascade and its customers.

Supply Resource Optimization Process Cont'd.

- **Step 5: Stochastic Analysis of Preferred Portfolio**
  - Run Monte Carlo simulations of various scenarios on preferred portfolio; comparing Mean and VaR to a managerial limit.
- **Step 6: Analysis of Preferred Portfolio**
  - Review data to confirm total system costs did not exceed Mean and VaR limits in any scenario. If limit is exceeded, repeat step 5 with next highest ranked portfolio.
- **Step 7: Sensitivity of Preferred Portfolio**
  - Run the preferred portfolio through Monte Carlo simulations on price. Review results to determine if total system cost is within the Mean and VaR limits across all sensitivities.
- **Step 8: Re-evaluation of Preferred Portfolio**
  - If the total system costs fall outside of the Mean and VaR limits in sensitivity analysis, select the next most optimal portfolio to run scenario and sensitivity analysis on. Repeat as needed.

Preliminary Results

Preliminary Results



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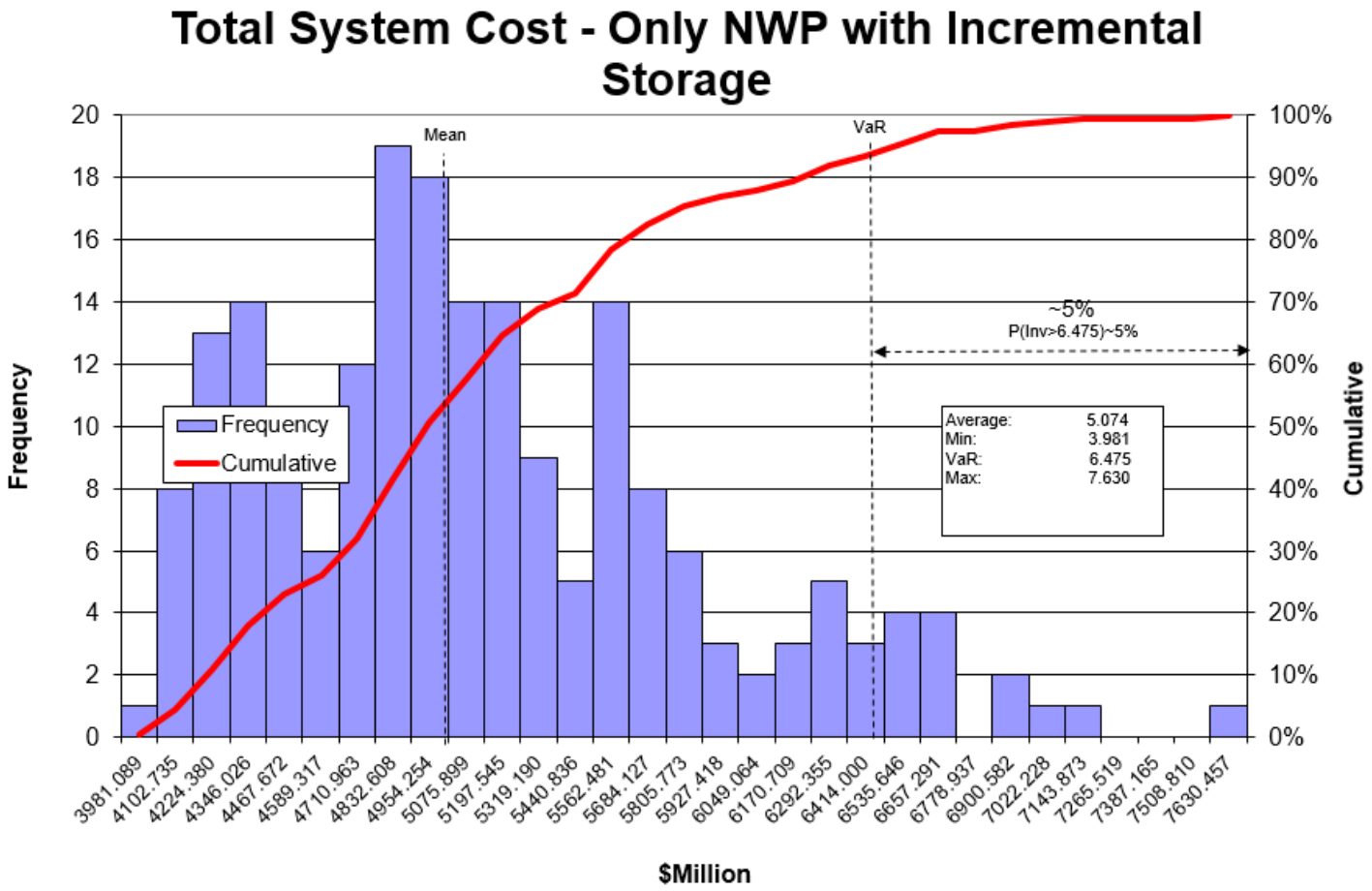
Preliminary Results



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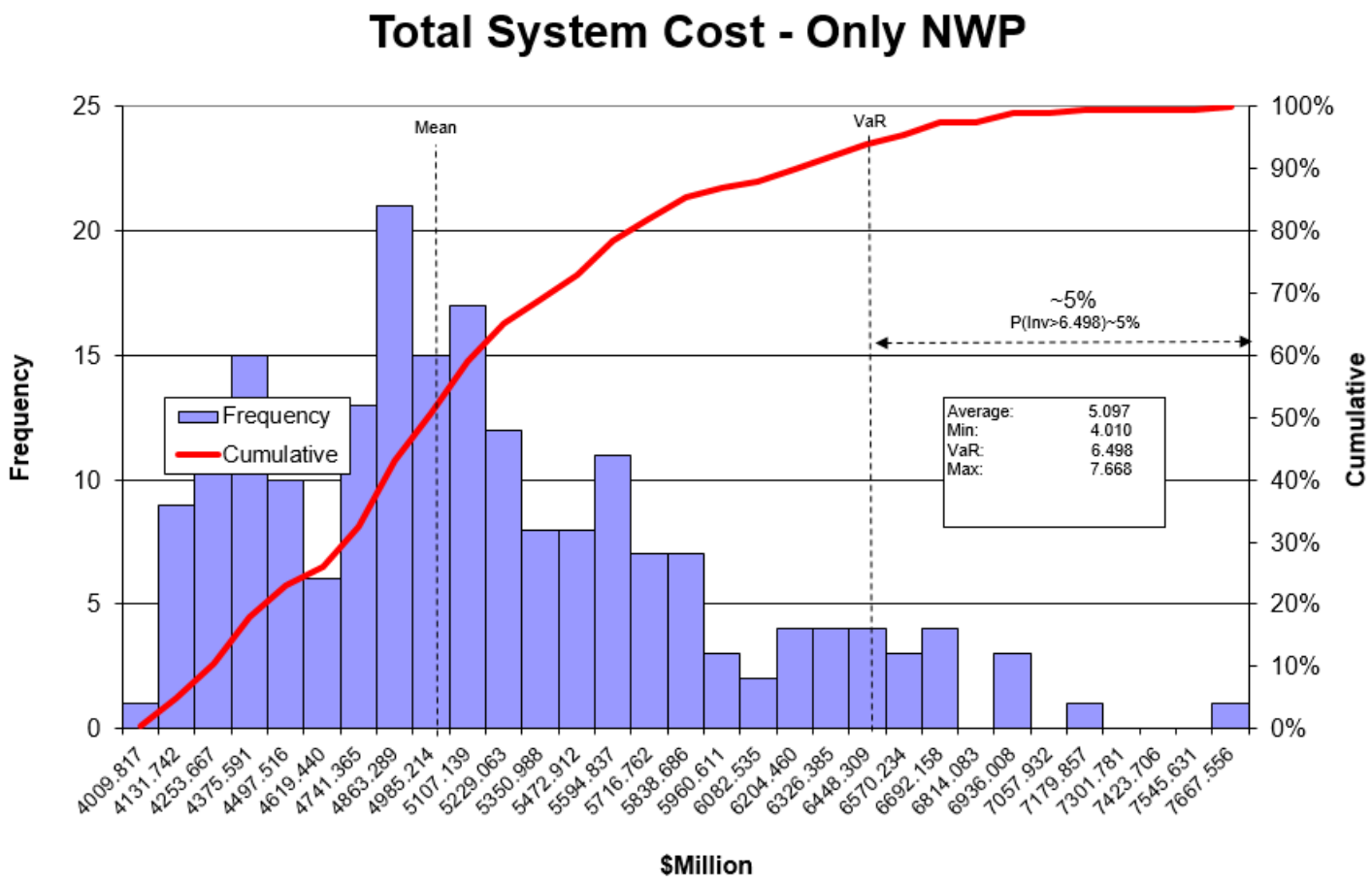

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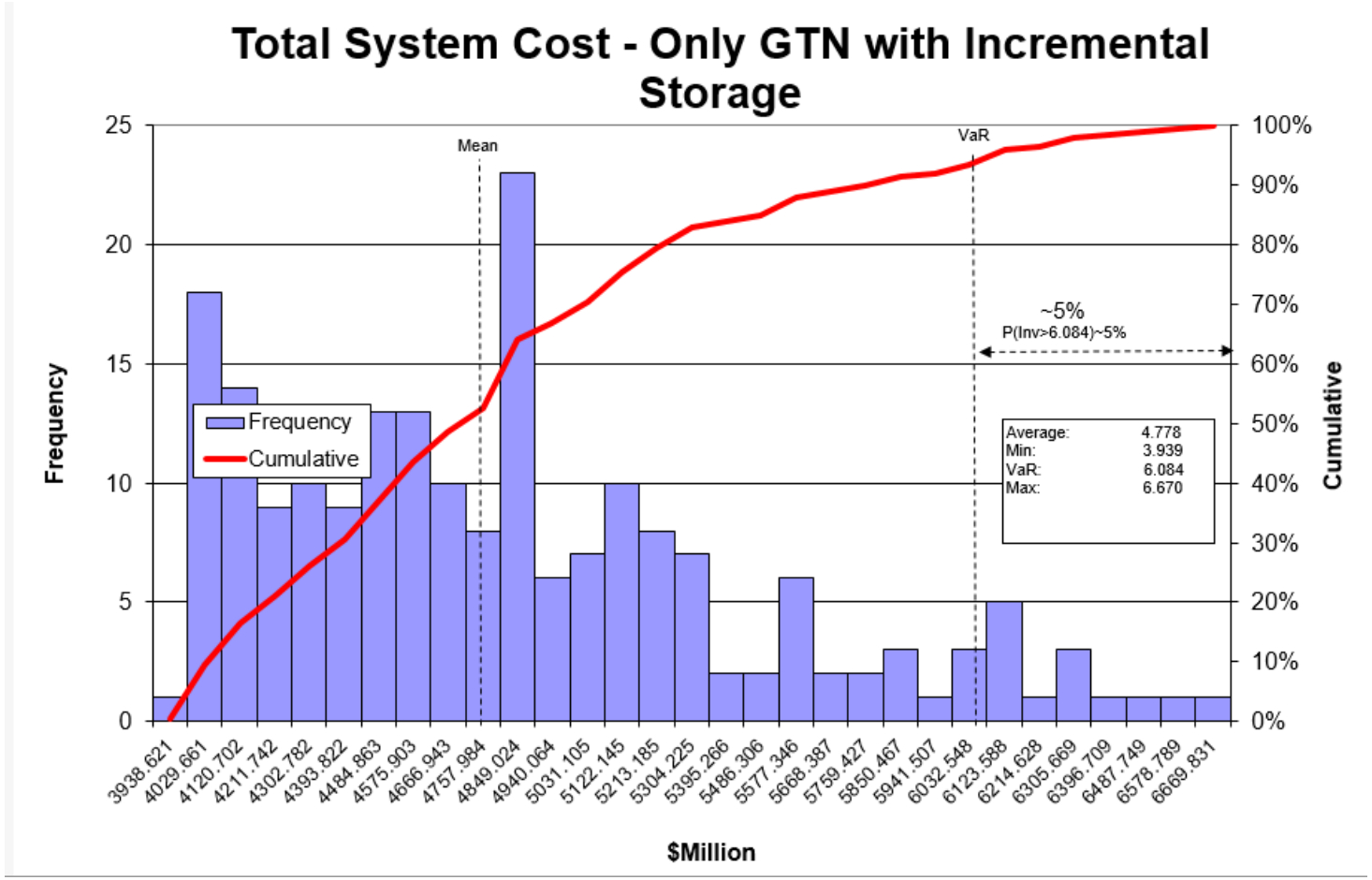

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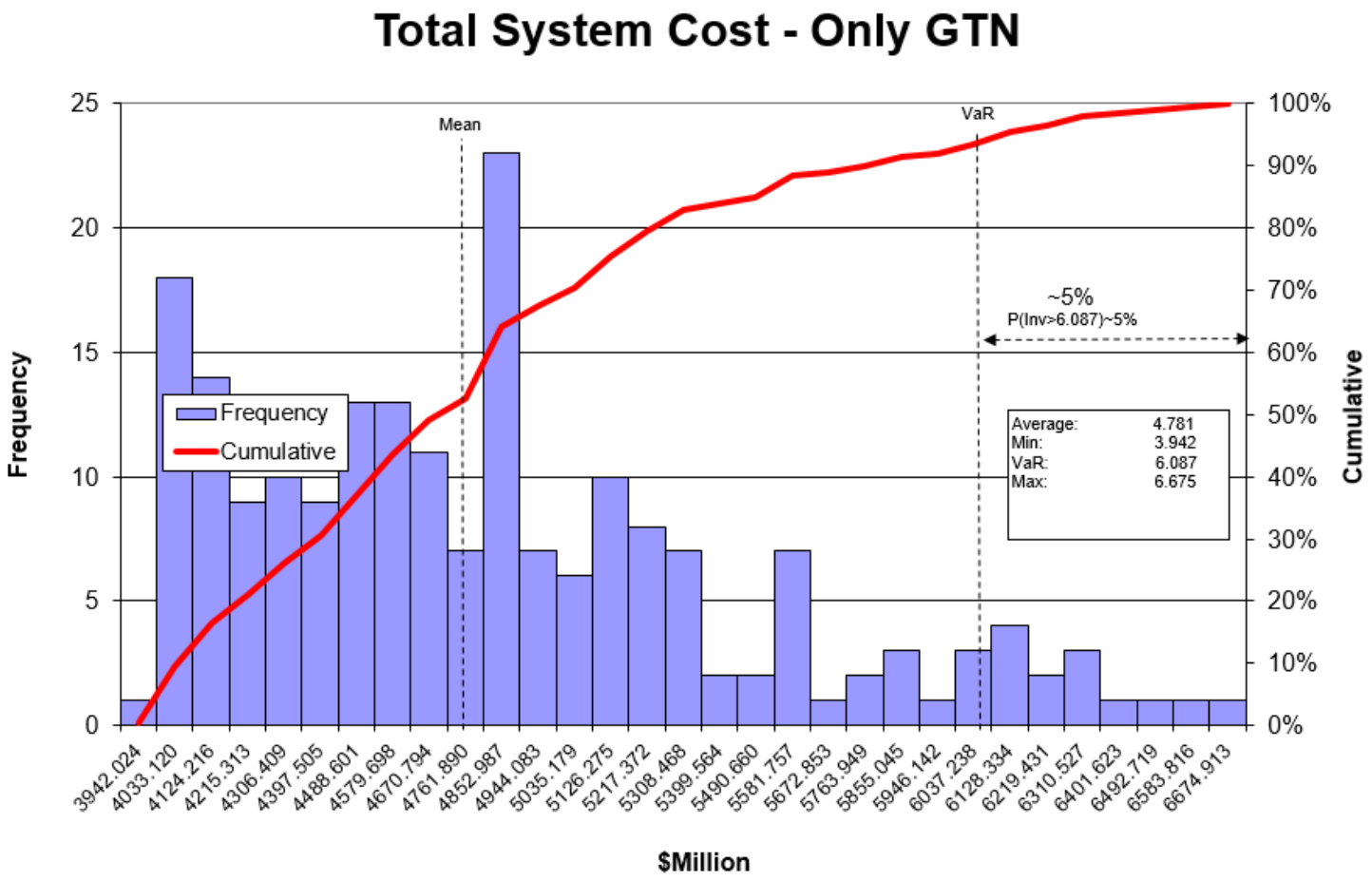

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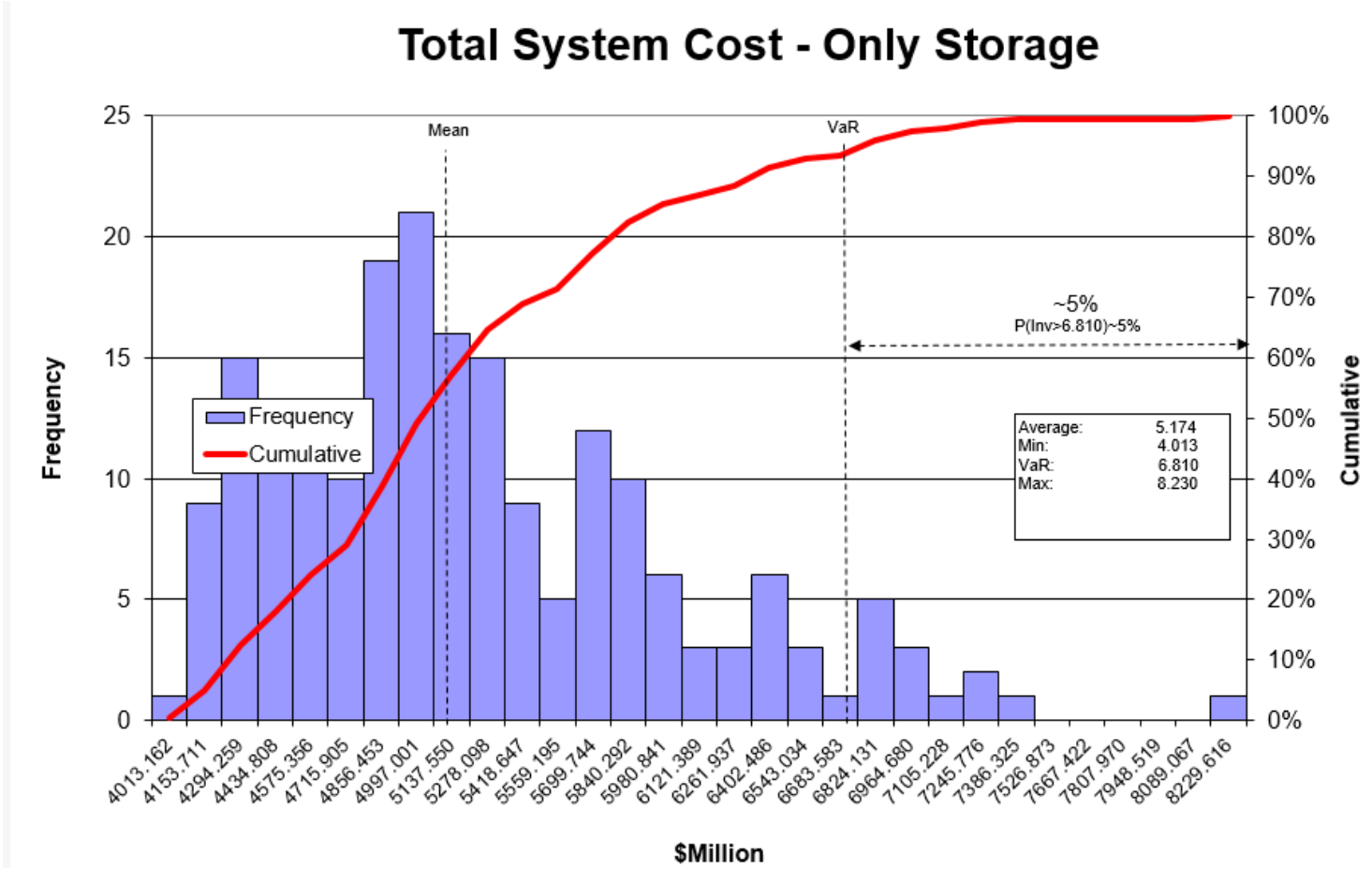

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Preliminary Results – Mean and VaR ($000)

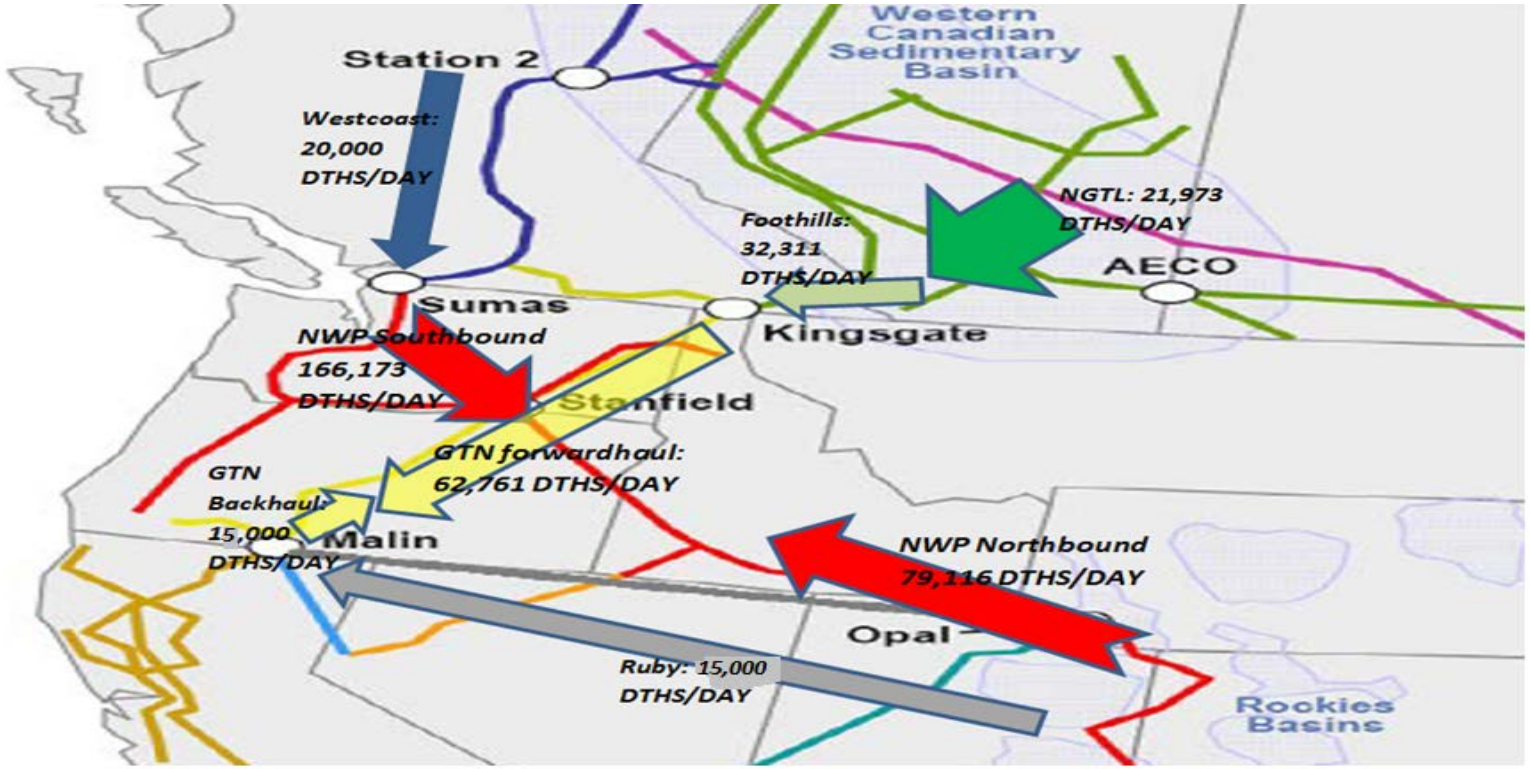
Portfolio	Mean	VaR
2018 IRP OPTIMUM DETERMINISTIC PORTFOLIO	4,767,939	6,083,974
2018 IRP ONLY GTN WITH STORAGE PORTFOLIO	4,778,447	6,083,974
2018 IRP ONLY GTN PORTFOLIO	4,781,488	6,086,634
2018 IRP ONLY NWP WITH STORAGE PORTFOLIO	5,073,169	6,474,956
2018 IRP ONLY NWP PORTFOLIO	5,097,485	6,498,092
2018 IRP ONLY STORAGE PORTFOLIO	5,173,884	6,810,359

Next Steps

- Continued discussions of VaR limits with senior management
- Stress test candidate portfolio in Monte Carlo scenarios
- Stress test candidate portfolio in Monte Carlo sensitivities
- Selection of Preferred Portfolio

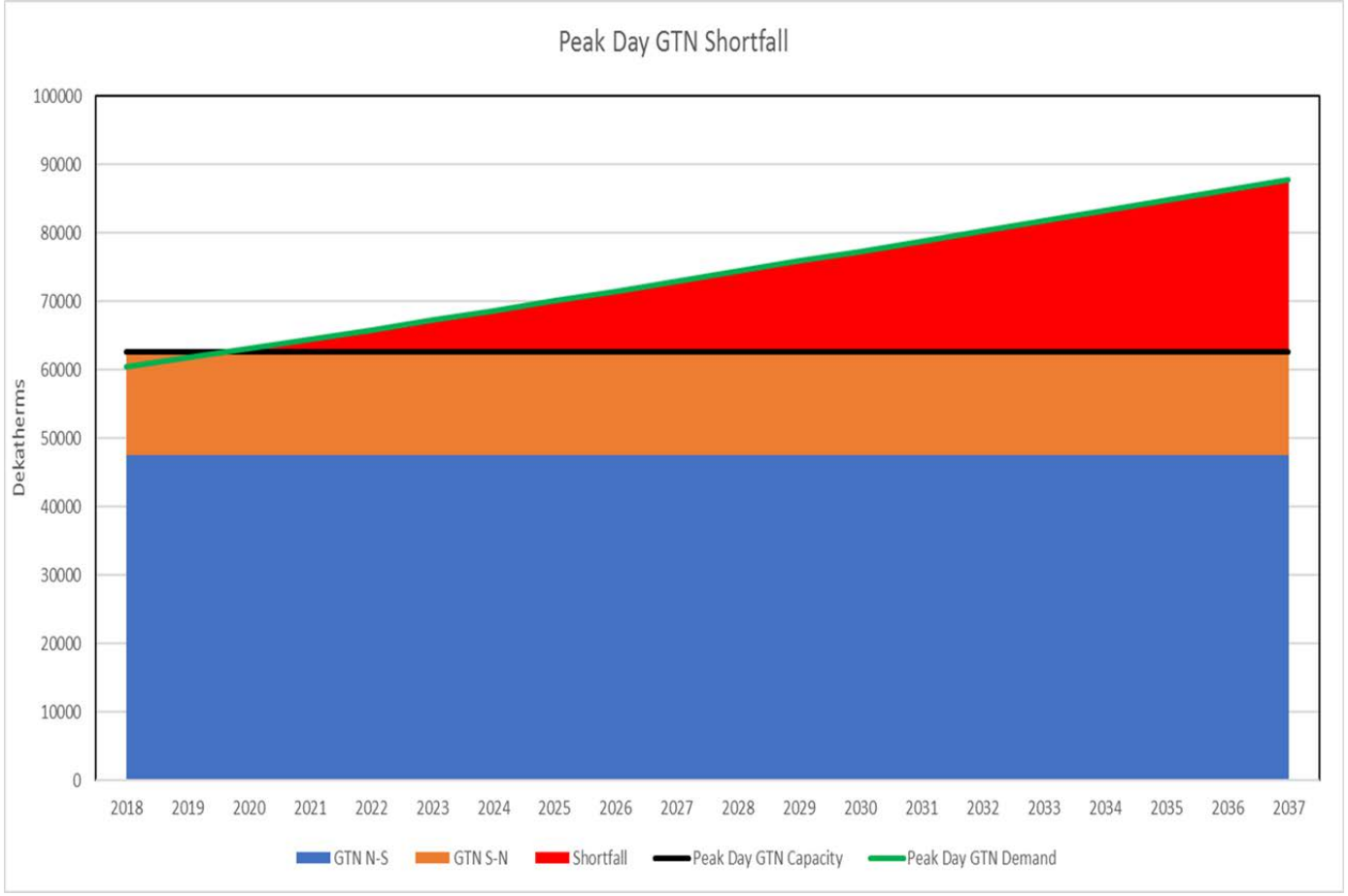
Incremental GTN Capacity

Pipeline transport flow



Upstream Pipeline Capacity Update - GTN

- As of July 28 IRP modeling:
  - Beginning in 2020 Cascade is short approximately 400 dths day of GTN capacity.
  - By the end of the 20 year horizon the shortfall is approximately 31,000.



Upstream Pipeline Capacity Update - GTN

- Cascade IRPs over at least the last 15 years have identified significant capacity shortfalls for Central Oregon in the 2020s.
- GTN has been significantly undersubscribed for years.
- Instead of picking up long-term, incremental GTN capacity, Cascade has relied on picking up capacity release on the day market if needed for peak day.
- Looks like will be changing around 2019 due to new projects.
- Many signs point to a probability that GTN will be fully contracted by 2020
  - NGTL and Foothills recently held an open season to eliminate the mismatch of capacity in the NGTL-Foothills-GTN pathway.
  - Most of the open season was acquired by Canadian producers at AECO.
  - This summer, Seven Generations Energy (7G) contracted delivery capacity to the Pacific Northwest and northern California on TransCanada's Foothills and GTN pipelines starting with modest volumes in November 2019, ramping up to about 90000 dths/day in 2020.
  - If a methanol plant or Coos Bay happens they will likely acquire GTN capacity, making GTN fully-subscribed.
  - Of the 400,000 dths/day of incremental Kingsgate capacity, only 80000 remains or that other utilities' IRPs also indicate a desire for the remaining capacity.

Upstream Pipeline Capacity Update – Incremental GTN capacity

- In September GTN is planning on filing with FERC to offer a firm hourly service, primarily targeted at gas-fired electric generation. Service will come from line pack, supported by reducing available excess capacity.
- If Cascade doesn't lock in the incremental GTN needs now, we risk not being available in 2019.
- AECO gas is critical to Cascade's long-term portfolio, particularly to Oregon

In accordance with past guidance from GSOC, Cascade has been negotiating with GTN to pick up a block of capacity to address our peak day needs. The initial offering was:

Path – Kingsgate to Malin
MDQ – 20000 dth/d annual (minimum, incremental quantity to qualify for the discount)
Term – 22 years, (thru 10/31/2039)
Start date – 11/1/2017 (required start date)

Rate – reservation based discount of $0.005 (1/2 cent) on the Kingsgate to Malin primary path) Approximately, $0.2952 per Dth

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Upstream Pipeline Capacity Update – Options

- Take the current offer from GTN for 20,000 dths/day at a discount effective Nov 2017
  - PGA demand costs will increase by approx. 2% (changing from $0.164 per therm to $0.167 per therm)

- Take 20,000 dths/day at recourse rates effective 2018

  - Bear in mind under GTN's tariff they are only obligated to accept this offer only six months prior to a effective date
  - Anyone requesting firm capacity for one year or more at recourse rates with an effective date six months from today would be awarded the capacity

- Offer to take as smaller quantity (as little as 10000 dths) for 15 years at the recourse rate recognizing the six month lead time issue

- Do nothing - continue to utilize capacity release to meet potential shortfalls until such time that GTN no longer has excess capacity

- If GTN becomes fully subscribed pursue an expansion, encourage Trail West pipeline

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Upstream Pipeline Capacity Update – Decision

- The discount is not material to the decision

- There is considerable risk that GTN may not have capacity available in 2020 when it is needed.

- However, 20000 dths/day for 22 years may be too aggressive a risk to take
  - Conservation impacts will affect load
  - Amount of shortfall may notably change
  - GTN might not become fully subscribed
  - Market conditions may change dramatically over 22 years

- Still--the shortfall does exists; Cascade will likely still be serving in 15 years

- Take some action now to provide reliability of service for several years out but continue to monitor both demand and market conditions via the IRP process.

- GSOC elected to secure 10000 dths/day for 15 years, beginning December 2017, at recourse rates with the right of first refusal.

- 10000 dths/day will satisfy peak day concerns through approximately 2028/2029, allowing time to observe outside impacts GTN's market, Cascade's demand and other operational factors

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2018 IRP Timeline

Date	Process Element	Location (Subject to change)
Friday, September 22, 2017	Tentative - Price Forecast Workshop	Skype
Wednesday, October 4, 2017	CAG Q4 Meeting	
Wednesday, October 11, 2017	TAG 4 slides distributed to stakeholders	
Thursday, October 19, 2017	**TAG 4: Final Integration Results, finalization of plan components**	**OPUC Offices Salem OR 9am-12pm**
Monday, November 6, 2017	Draft of 2018 IRP distributed	
Tuesday, December 5, 2017	Comments due on draft from all stakeholders	
Wednesday, December 20, 2017	TAG 5, if needed	WebEx Only
Monday, January 22, 2018	Executive Summary Presentation to Senior Management	Kennewick, WebEx
Thursday, January 25, 2018	IRP filing in Oregon	

NEXT STEPS?

Cascade Natural Gas Corporation

Integrated Resource Plan
Technical Advisory Group Meeting #3

Thursday, Sept. 7th, 2017

Portland International Airport

Portland, OR

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