Cascade Natural Gas Corporation

2020 Integrated Resource Plan

Technical Advisory Group Meeting #4

August 12th, 2020

Teleconference Only

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Agenda

- Introductions
- Safety Moment
- IRP Carbon Update and Assumptions
- DSM
- Renewable Natural Gas
- Discussion of RNG Cost Effectiveness Evaluation Tool
- Sendout Modeling
- Preliminary Resource Integration Results
- 2020 IRP Remaining Schedule
- Questions

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IRP Carbon Update and Assumptions

Devin McGreal

Abbie Krebsbach

August 12, 2020

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Topics to Cover Today

- Purpose
- Laying the Foundation
- GHG Emissions and Reducing Emissions
- GHG Policy Trends
  - The National Focus
  - The Regional Focus
  - Washington
  - Oregon
  - The Local Focus
- Types of CO_2 Adder Analyses
- Sensitivities and Impacts on Prices
- Next Steps and Conclusion

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Purpose

- GHG Policy Update
  - Provide insight into current national, regional/state and local policy activities that inform Cascade Natural Gas Corporation's IRP process.
  - Provide discussion on Cascade's actions to reduce methane leaks and fugitive emissions while ensuring safe, reliable and economic service, and utilizing natural resources efficiently to minimize environmental impact.
- Carbon Modeling Assumptions
  - To explain Cascade's approach in determining range of carbon dioxide emissions values and assumptions for calculating inputs to project a 20 year avoided cost of natural gas, with associated two-year action items.

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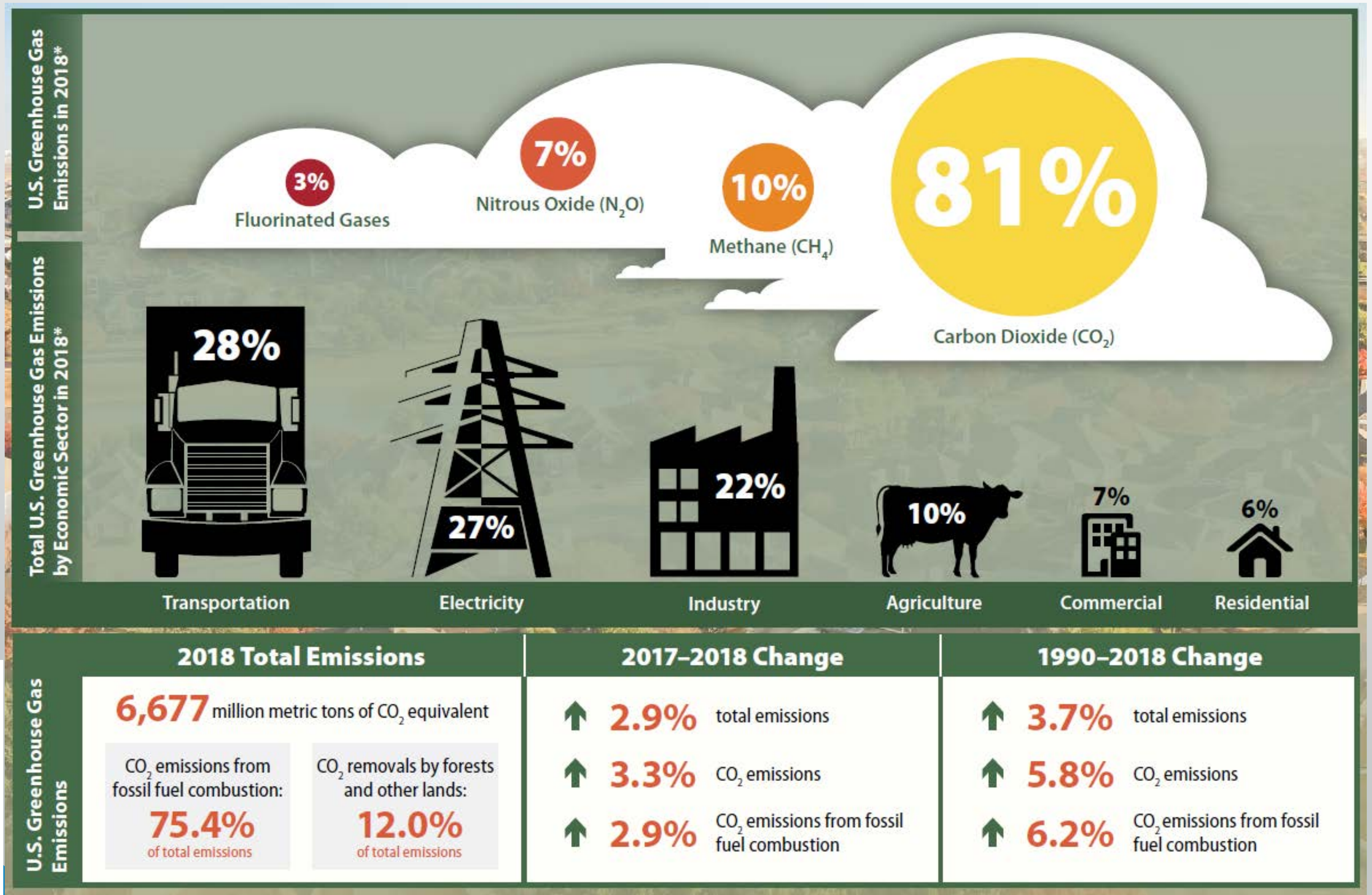
Laying the Foundation

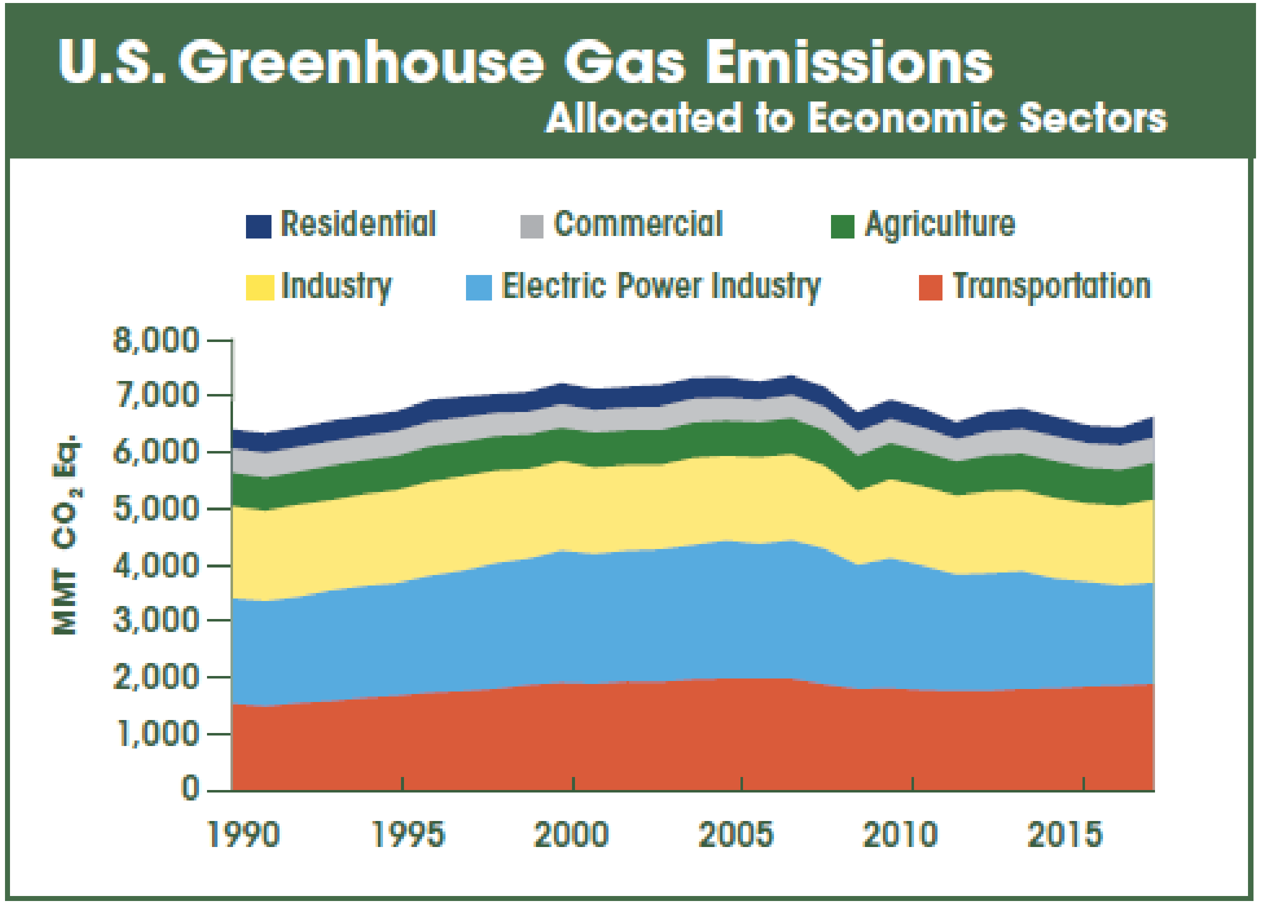
- Carbon dioxide (CO_2) is the primary greenhouse gas (GHG) emitted through human activities. Methane is second.



Figures and info from EPA Emissions and Sinks Fast Facts and Data Highlights webpage: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-fast-facts-and-data-highlights

Laying the Foundation

- Main sources of United States GHGs emitted from human activities:



Note: Does not include U.S. territories and LULUCF sector.

Figures and info from EPA Emissions and Sinks Fast Facts and Data Highlights webpage: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-fast-facts-and-data-highlights

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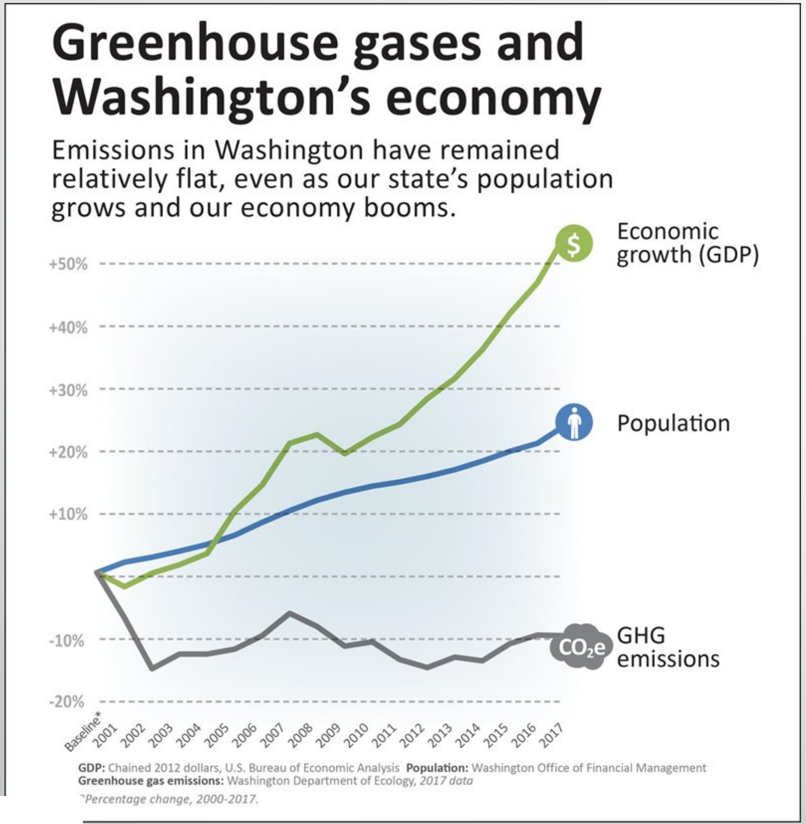
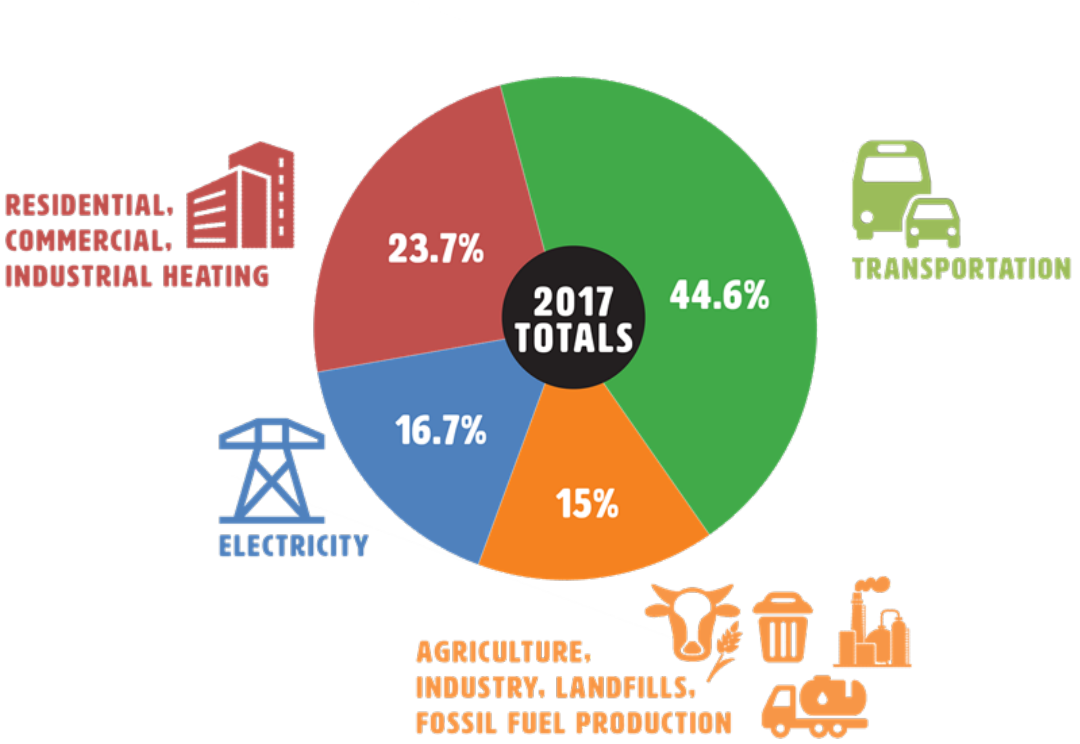
Laying the Foundation

Washington State GHG Emissions Trend



- Growth in emissions has significantly lagged economic and population growth in Washington, showing that the state's economy is much more efficient



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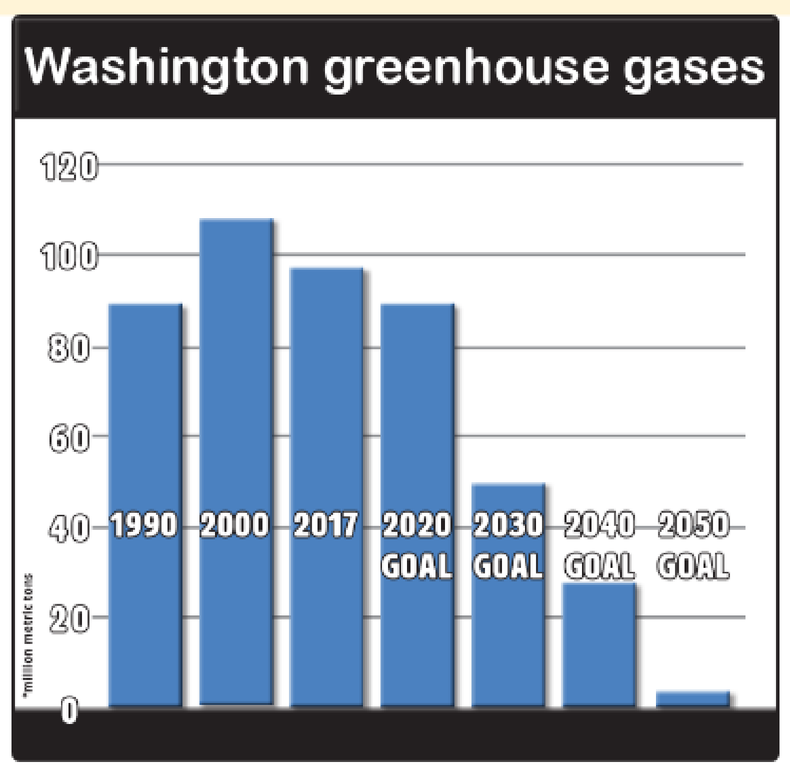
Figures and info from Washington Dept of Ecology website:https://ecology.wa.gov/Air-Climate/Climate-change/Greenhouse-gases/2017-greenhouse-gas-data

Laying the Foundation

Washington State GHG Reduction Targets



- In 2020, HB 2311 passed which revised the anthropogenic GHG reduction targets for the state to:
  - By 2020, achieve 1990 levels
  - By 2030, reduce state GHG emissions to 45% below 1990 levels
  - By 2040, reduce state GHG emissions to 70% below 1990 levels
  - By 2050, reduce state GHG emissions to 95% below 1990 levels

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Figures and info from Washington Dept of Ecology website:https://ecology.wa.gov/Air-Climate/Climate-change/Greenhouse-gases/2017-greenhouse-gas-data

GHG Emissions from Natural Gas

- Electric Generation Sector
  - Combustion emissions have dropped over time mainly due to transition from coal-fired electric generation to natural gas and renewable electric generation
- Oil and Gas Production and Exploration, Transmission, and Storage Sector
  - Fugitive methane emissions and equipment/facility combustion emissions
  - Continued debate on contribution of these emissions and how to consider emissions in total energy supply chain since emissions studies vary
- Northwest Power & Conservation Council's 7th Power Plan (2016 version)

  "…there is considerable uncertainty around such issues as whether its impacts compared to carbon dioxide are over or under-stated…and whether accounting for the methane emissions from coal production would also raise that fuel's full life-cycle climate impacts…"

  "…will likely draw on gas production new wells which have lower fugitive emissions…"

  "…unless new pipeline capacity is needed, fugitive emissions from pipeline leaks remain relatively constant…"

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GHG Emissions from Natural Gas (cont.)

- Natural Gas Distribution Facility Emissions
  - Fugitive methane emissions from pipeline infrastructure and CO_2 emissions from combustion equipment
    - Nationally about 4.1 percent of the oil and gas sector GHG emissions are from natural gas local distribution companies (EPA GHG inventory 2018 data)
    - Equating to about 0.5 percent of the total US GHG emissions from all human activities are from natural gas local distribution companies (EPA GHG inventory 2018 data)
    - Cascade's annual fugitive methane emissions and compressor emissions in Washington equal about 24,000 metric tons of CO_2e
    - Fugitive Methane Emission Rate for the company in our AGA Environmental, Social and Governance (ESG) Quantitative Report Template for 2019 was 0.07% (volume of methane emitted per methane throughput volume)

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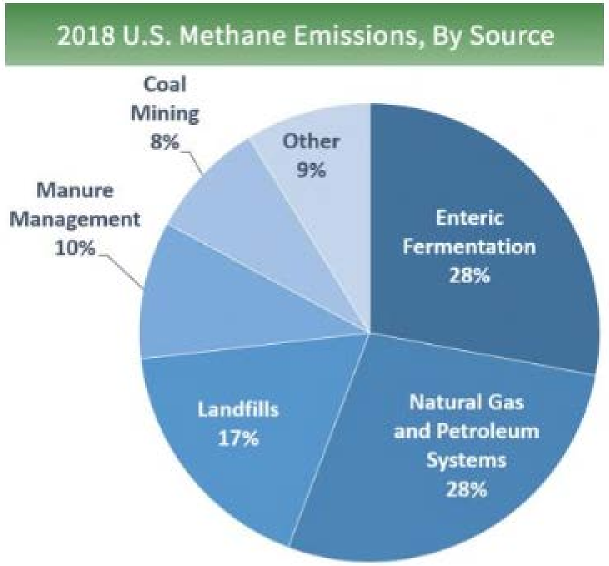
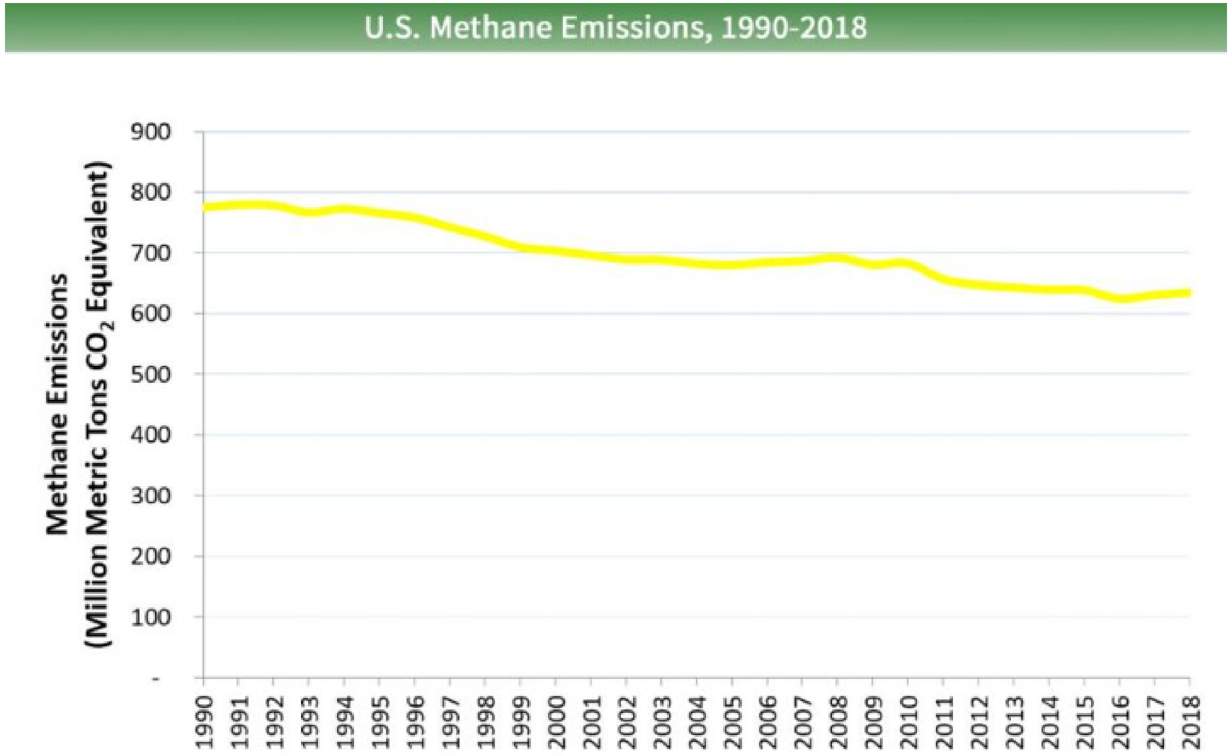
National Trend of GHG Emissions From Methane



Note: All emission estimates from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2018*.

Larger image to save or print



Note: All emission estimates from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018*. These estimates use a global warming potential for methane of 25, based on reporting requirements under the United Nations Framework Convention on Climate Change.

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GHG Emissions from Natural Gas (cont.)

- Natural Gas Distribution Customer Emissions
  - Cascade's customers emit CO_2 emissions from the combustion of natural gas
  - Natural gas sales have increased over time
  - Cascade's core customer emissions are currently in the range of about 1.4 million metric tons of CO_2e per year (about 25.5 million dekatherm annual gas sales).
  - Transport customer emissions are about 2.5 to 3 times higher
  - Energy efficiency programs currently provide emission reductions for our customers

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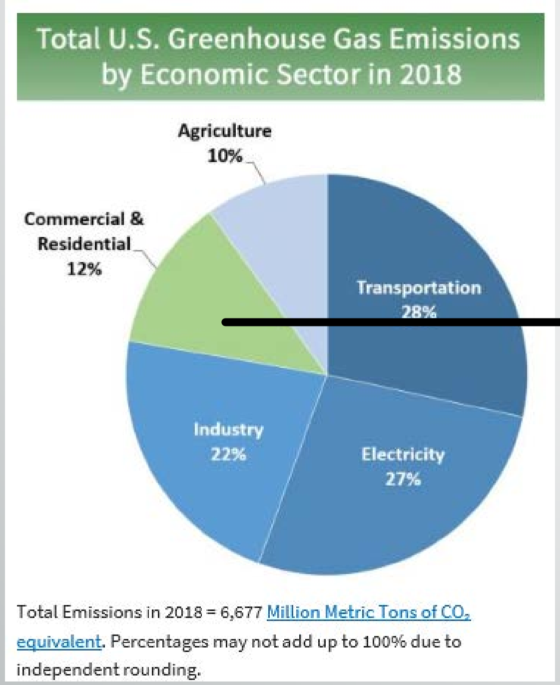
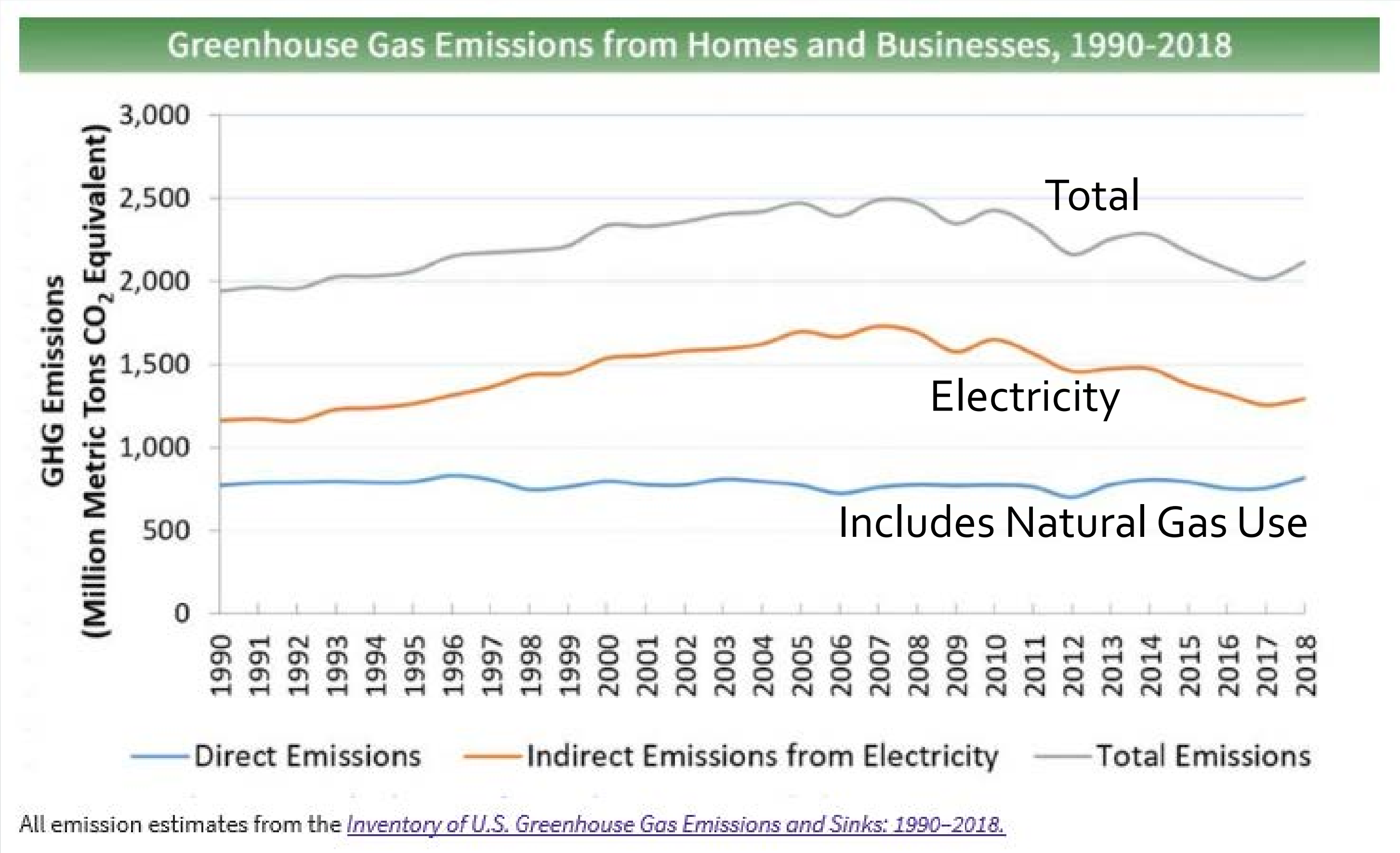
National Trend of GHG Emissions From Residential and Commercial





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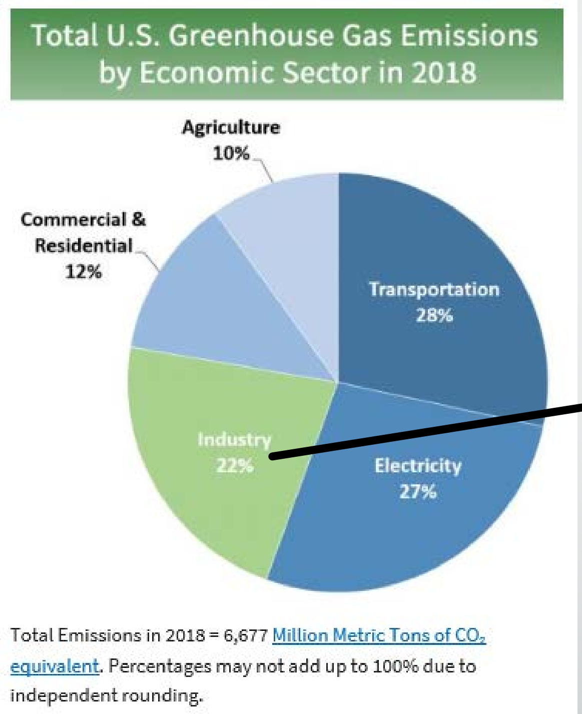
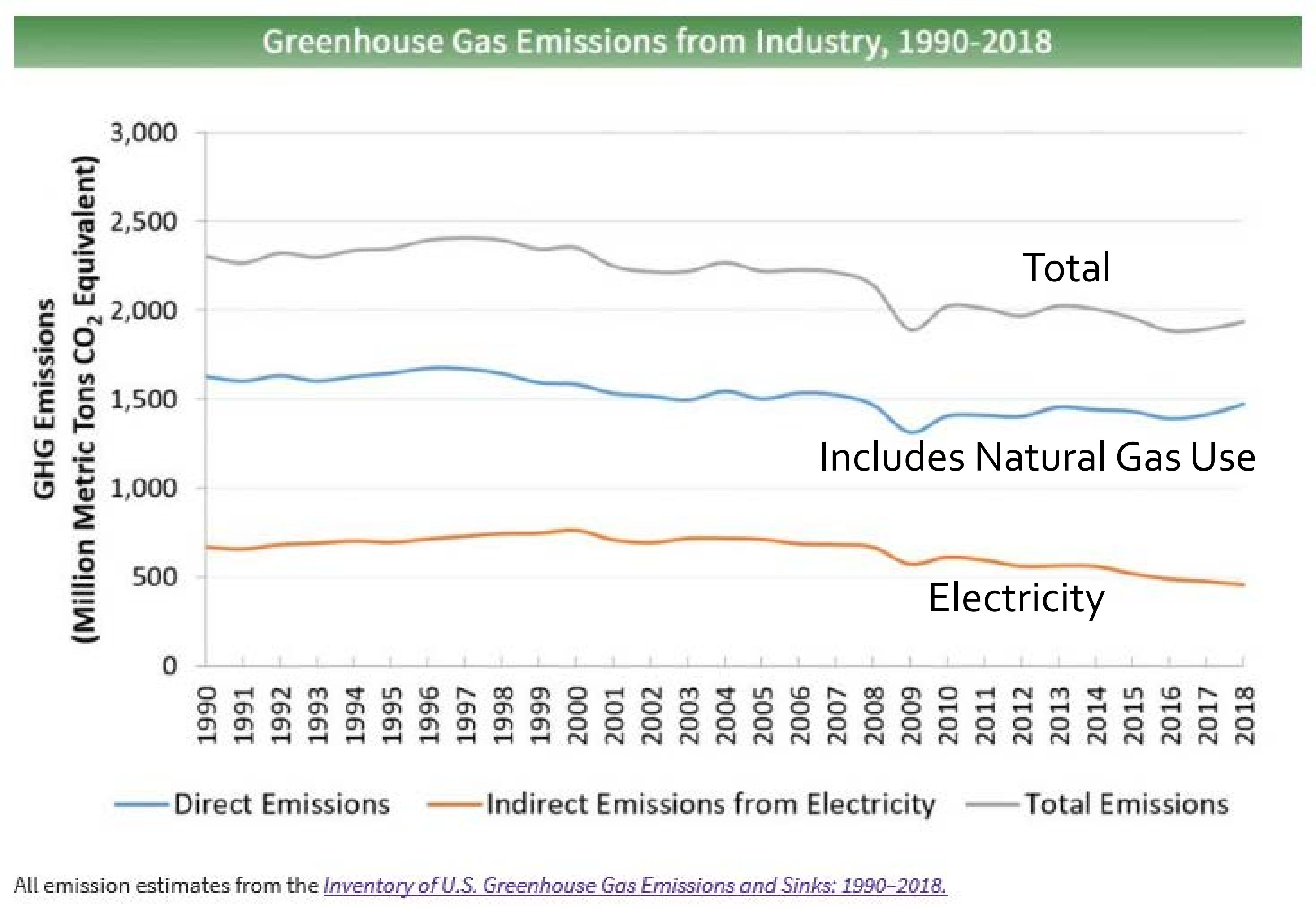
National Trend of GHG Emissions From Industrial





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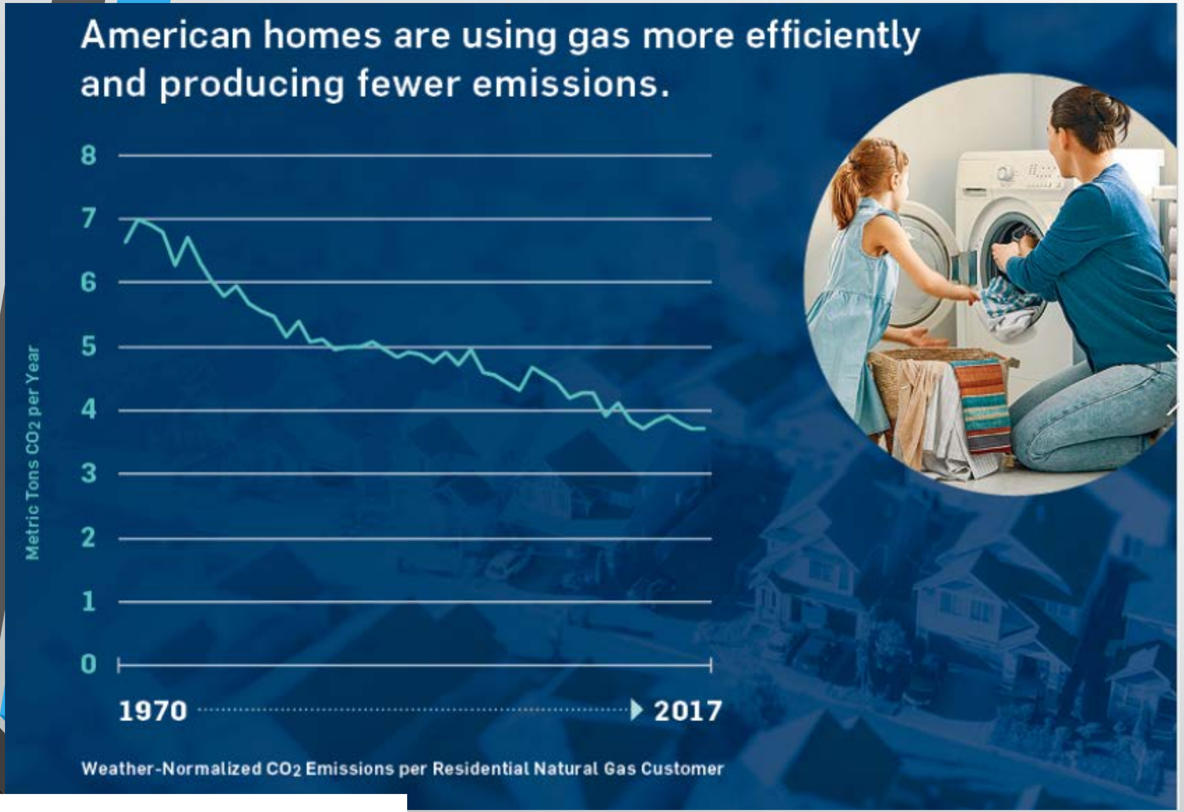
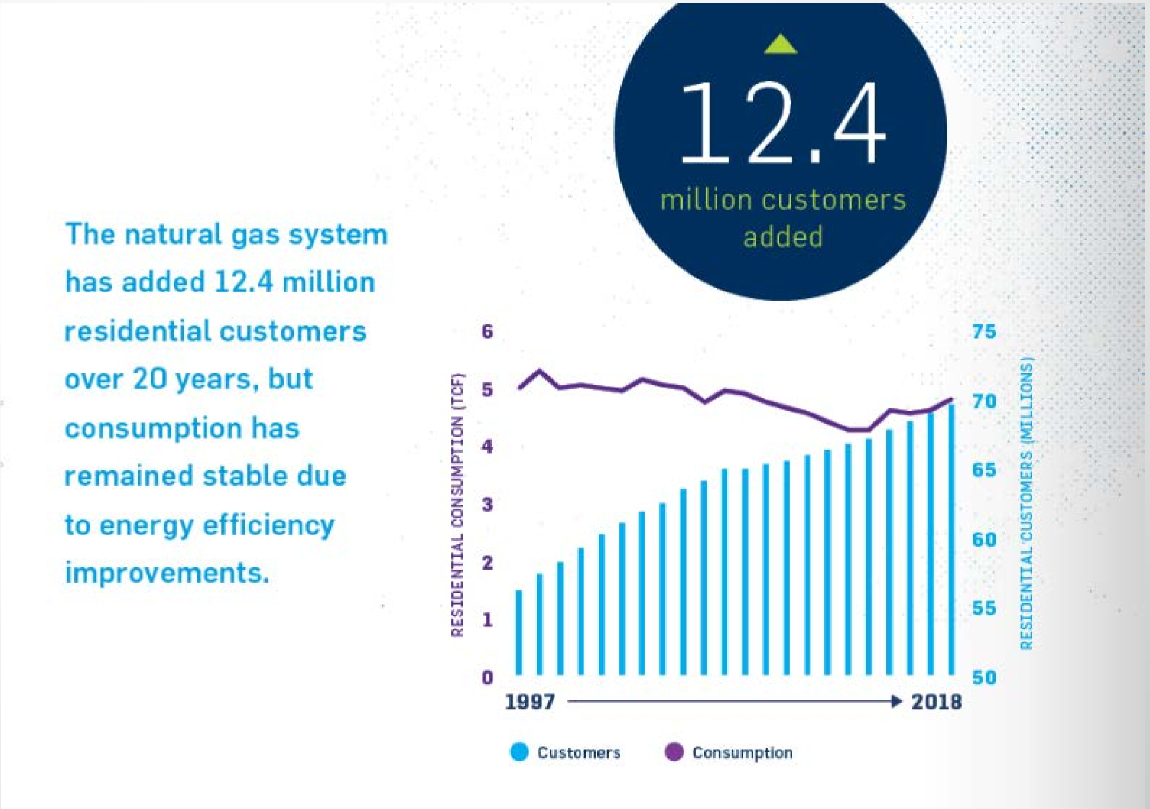
GHG Emissions From Natural Gas (Cont.)

Decreasing Trend for US Natural Gas Distribution Customer CO_2 Emissions





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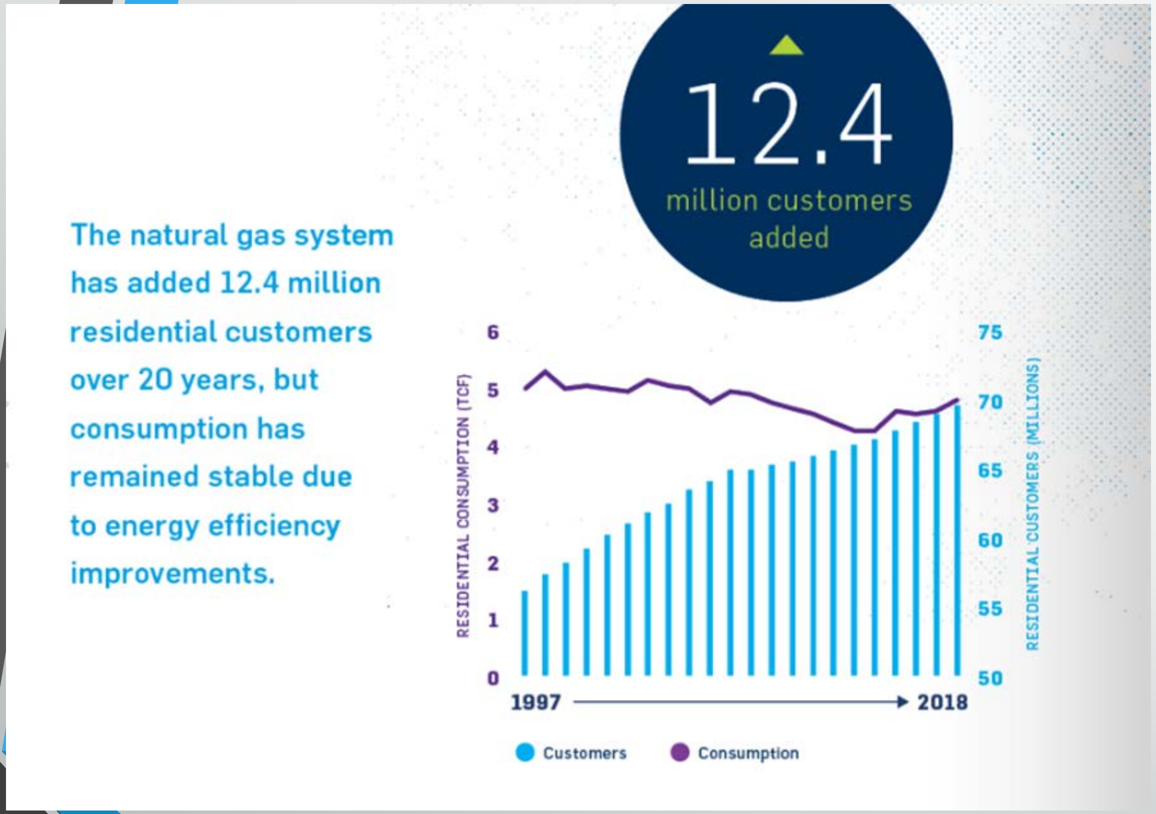
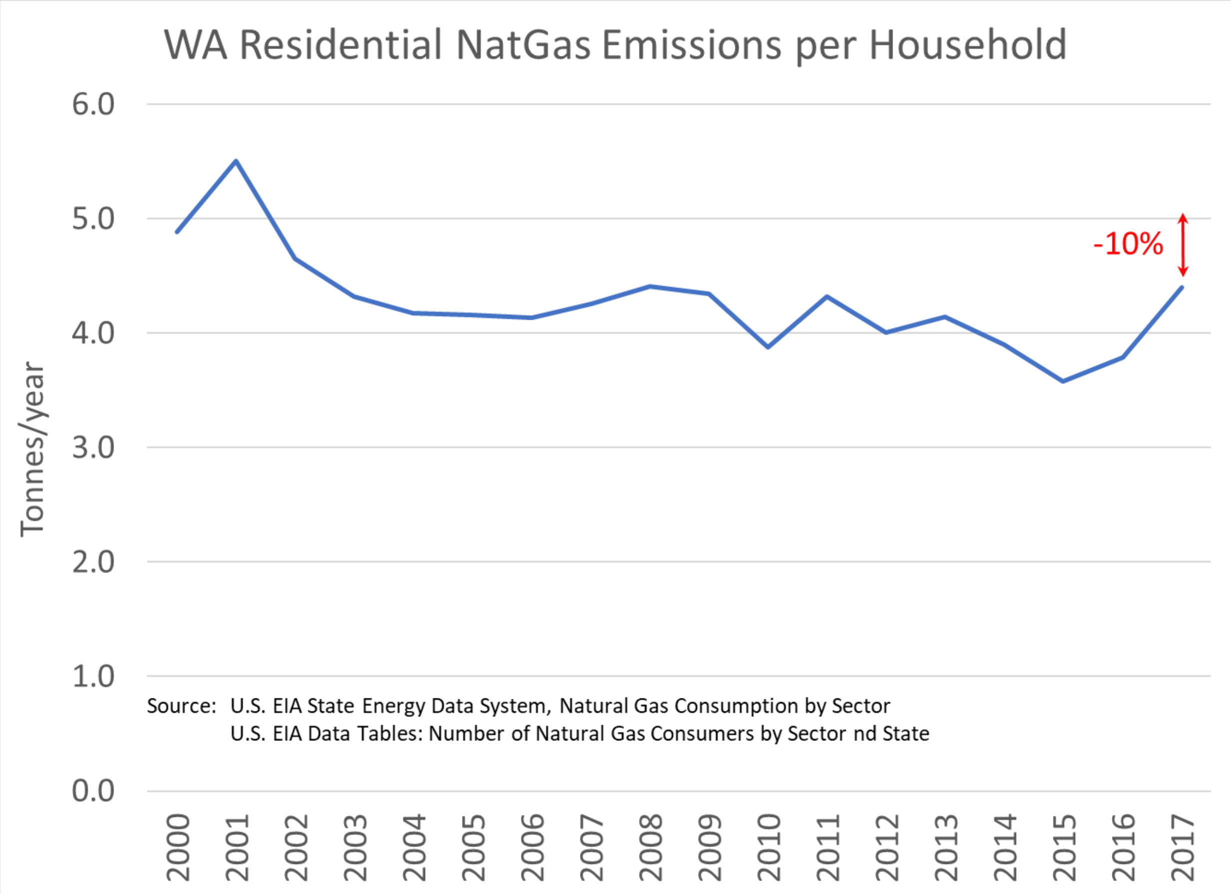
American Gas Association, Natural Gas: Our Clean Energy Future 2020 Playbook

Washington Emissions Trend Similar to National Trend



n, Natural Gas: Our Clean Energy Future 2020 Playbook



Courtesy of Northwest Gas Association

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Reducing Company Emissions

- Cascade has committed to GHG reductions from the following:

  - Methane fugitive emissions and leak reductions
    - Cascade became a founding member of EPA's Natural Gas Star Methane Challenge Program in March 2016
    - Participating in Excavation Damages Prevention
      - Created Public Awareness Coordinator position and implemented a Damage Prevention Program
      - Actively participating in 811, Common Ground Alliance, local underground utility coordinating councils, and damage complaint programs in Washington and Oregon.
      - Conduct incident analyses on excavation damages and report data to EPA

  - System Integrity Projects
    - Since 2012, Cascade has replaced over 75 miles of early vintage steel pipe with new steel or polyethylene pipe in Washington and over 25 miles in Oregon.
    - Cascade is better positioned than most US utilities as it has no unprotected steel pipeline and no cast iron pipe

- Streamlining emissions through demand management strategies including conservation and direct use

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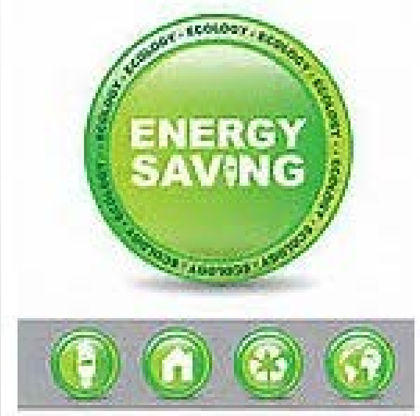
Reducing Customer Emissions Through Energy Efficiency

- Cascade is dedicated to expanding its EE efforts
  - Increasing focus on energy efficiency and benchmarking (HB-1257)
  - Increasing social media presence and providing virtual inspections
  - Commercial program adaptation to meet increased goals
  - Regional collaborative approach to market transformation
    - NEEA Board Member
    - Working with GTI on emerging technologies
  - Incorporation of NWPCC methodologies and are now funding regional technical forum
  - Focus on savings estimates for low income customers



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GHG Policy Trends

- National Focus
  - Current administration has focused less on required emissions reductions
  - In June 2017, the US withdrew from the Paris Agreement on climate change
- Regional Focus
  - Some states have been adopting emissions reduction requirements in lieu of, or in addition to, federal emission reduction requirements (ie. Washington, Oregon and California)
  - More state-level action
- Local
  - Seeing community-lead action
  - Some cities committing to 100% renewable energy through goals and referendums
    - Ready for 100% Renewables Energy and Go 100% Renewable Energy list some of these local commitments

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The National Focus

- EPA's Affordable Clean Energy Rule replaced Clean Power Plan
- Relaxing standards in other regulatory areas such as vehicle emissions standards and oil and gas methane emission rules
- 2019 – Raise Wages, Cut Carbon Act (HR 3966)
- 2019 - Climate Leadership and Environmental Action for our Nation's (CLEAN) Future Act discussion draft
- 2019 - American Energy Innovation Act (AEIA) (S.2657)
- 2020 - Clean Energy Innovation and Deployment Act (CEIDA)
- 2020 – Biden's "Build Back Better" Plan

The National Focus (cont.)

- FERC Review of Pipeline Projects
  - *Atlantic Coast Pipeline (ACP), LLC v. Cowpasture River Preservation Association.*
    - *FERC approved the pipeline project in Oct 2017, a joint venture between Dominion Energy, Duke Energy, and Southern Company. It was to be a 600 mi, 42" NG pipeline from WV to VA to NC.*
    - *12/14/2018 – 4th Circuit Court of Appeals, Richmond, VA, pulled the permits approved by the US Forest Service to cross 2 national forests and the Appalachian Trail, saying that the approval of the permits violated the National Forest Management Act and NEPA and that the USFS lacked the authority to authorize ROW and permits for the Appalachian Trail.*
    - *4/21/2020 – Nationwide Permit 12 vacated*
    - *6/25/2019 – ACP filed an appeal with the Supreme Court*
    - *6/15/2020 – The Supreme Court ruled in favor of ACP 7-2.*
    - *7/5/2020 - Dominion and Duke Energy cancelled the pipeline citing rising project costs beyond their budget forecast and legal uncertainties.*

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The Regional Focus

- The Northwest Power & Conservation Council published its 7th Power Plan in 2016
  - Significant discussion, analysis, and scenarios regarding CO2 contained in Chapters 3 and 15
  - In February 2019 the Council released its Midterm Assessment report on the Seventh Plan
  - Next plan is expected in 2021
    - Staff recommended a regional upstream methane emissions factor for 2021 Power Plan

SEVENTH NORTHWEST POWER PLAN

THE 2021 NORTHWEST POWER PLAN

Washington

- Clean Air Rule (CAR)
  - Washington Dept of Ecology issued final rule to reduce GHG emissions on September 15, 2016
  - Local distribution companies (LDC) would need to purchase emission reduction units ("ERUs") to demonstrate emissions reductions required by the rule considering LDC's obligation to serve customers
  - On September 27, 2016 and September 30, 2016, Cascade and three other natural gas distribution utilities jointly filed complaints in the United States District Court for the Eastern District of Washington and the State of Washington Thurston County Superior Court, respectively, challenging the legal underpinnings of CAR

Washington (cont.)

- Clean Air Rule (CAR) (cont.)
  - On December 15, 2017, Thurston County Superior Court invalidated CAR and Ecology suspended rule requirements in late December 2017
  - On May 16, 2018, Ecology filed an appeal with the Supreme Court of Washington
  - On Jan. 16, 2020, the Washington State Supreme Court ruled that Ecology exceeded its authority under the WA Clean Air Act by expanding the scope of emissions standards to non-emitters, such as natural gas distributors and fuel suppliers. The Supreme Court invalidated CAR for non-emitters and remanded the case to Thurston County Superior Court for further proceedings.
  - Parties have filed status reports with the court agreeing to delay proceedings. Ecology has expressed the desire to evaluate its position on whether additional regulatory changes may be needed, but needed additional time due to delays caused by COVID-19 and mandatory furloughs. The report is due by October 20, 2020.

Washington (cont.)

- 2019-2020 Legislation Passed
  - 2019 Clean Buildings Act - HB 1257 and Appliance Energy Efficiency HB 1444
    - Include standards to increase efficiency of new buildings and appliances and allows utility to develop a renewable natural gas program
  - 2019 HB 1070 renewable natural gas tax bill
  - 2020 HB 2311 – GHG reduction targets revised
  - 2020 HB 2518 – Safe and efficient transmission and distribution of natural gas
- Significant other state policy or regulation with GHG impacts
  - 2019 – Clean Energy Transformation Act - 100% fossil-free electricity to consumers by 2045
  - 2020 - Zero Emissions Vehicle Law
  - 2019 – Hydrofluorocarbon reductions
  - 2020 - GHG Assessment for Projects (GAP) rulemaking
- Legislation expected in 2021
  - Possible hybrid of cap and trade and clean transportation bill or carbon tax bill

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Oregon

- Executive Order No. 20-04
  - Issued March 10, 2020
  - 13 directives to multiple state agencies to take actions necessary to cap and reduce GHG emissions from:
    - Large stationary sources
    - Transportation fuels
    - Other liquid and gaseous fuels, including natural gas
  - Revises Oregon emissions reduction targets:
    - At least 45 percent below 1990 emissions levels by 2035; and
    - At least 80 percent below 1990 emissions levels by 2050
  - Draft rule expected in 2021
  - Cap and reduce program to commence by January 1, 2022

- Appliance Efficiency Standard and Code Changes
  - Cascade engaged in ODOE and Global Warming Commission workshops
  - Potential impacts on baseline equipment used for energy efficiency program design
  - Code discussion of efficiency focus vs. carbon reduction focus

Oregon (cont'd)

- Renewable Natural Gas
  - SB 98: RNG Bill (Sept 29, 2019)
    - Allows recovery of prudently incurred, qualified investments in RNG
    - Addresses recovery provisions for small and large utilities
  - UM 2030: Investigation into the use of Northwest Natural's RNG evaluation methodology
  - AR 632: Rulemaking regarding the 2019 SB 98 Renewable Natural Gas programs (Oct 1, 2019)
    - Designates that each large and small natural gas utility must include information relevant to the RNG market, prices, technology, and availability as part of IRP

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The Local Focus - City of Bellingham

- GHG Reduction and Renewables Energy Targets Resolution passed by Bellingham City Council in March 2018
  - Renewables and emissions reduction targets updated to:
    - Reduce municipal greenhouse gas emissions to 85% below 2000 levels by 2030 and 100% below 2000 levels by 2050
    - Reduce community emissions by 70% below 2000 levels by 2030 and 85% below 2000 levels by 2050
    - Obtain all energy from renewable sources and remove use of fossil fuels

- Climate Action Task Force
  - City Council created task force to explore and recommend 100% renewable energy city targets by 2050, taking into account technology, feasibility, costs and other impacts, funding mechanisms, as well as possible accelerated targets

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The Local Focus - City of Bellingham (cont.)

- Bellingham will be taking the Task Force recommendations and filtering them down to those most likely to be integrated successfully
  - Climate Action Plan will be amended based on this work.
- City staff intends to review the complete list of CATF recommendations; apply staff filters; and discuss the results with City Council
- Each measure will be assigned a score by staff and forwarded on. Then it will go through a triple bottom line assessment

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The Local Focus - City of Bellingham (cont.)

- The filter utilized by Bellingham is tiered as follows:
  - Tier 0: Complete or already ongoing measures
    - Adopted and appended to the Climate Action Plan
  - Tier 1: Ready for review and analysis. Ranked high with minimal unknowns
    - Reviewed by the public and Council and filtered onward
  - Tier 2: Additional research necessary. Moderate ranking and/or level of unknowns
    - Measures would undergo additional research on feasibility including the “triple bottom line plus” criteria
  - Tier 3: Table until annual update. Low ranking and high level of unknowns
    - Measures would undergo additional research on feasibility including the “triple bottom line plus” criteria

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The Local Focus - City of Bellingham (cont.)

- In the next 6 months, Council will amend the CAP, and staff will develop a Climate Implementation Plan. The Plan will be reviewed ongoing
- New projects would be vetted in 2021 and 2022
- Formal CAP review and update of goals would take place in 2023
- City will solicit public feedback to drive decision-making process

City of Bellingham Climate Action Plan Webpage https://www.cob.org/services/environment/climate/Pages/program.aspx

The Climate Action Task Force Final Report, December 2, 2019, is linked here.

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The Local Focus – Whatcom County

- Whatcom County – committed to the "Ready for 100" campaign
  - "Ready for 100" campaign website states the following goals, but participants can target less stringent goals:
    - 100% renewable electricity by 2035
    - 100% renewable all other energy sectors by 2050

  - Whatcom County commits to:
  - 100% renewable electricity for county operations and larger Whatcom County community by 2035
  - Established commitments in ordinance

- Whatcom County Climate Impact Advisory Committee
  - Provides review and recommendations to the Whatcom County Council and Executive on issues related to the preparation and adaptation for, and the prevention and mitigation of, impacts of climate change.
  - Ongoing meetings on climate and energy policy

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The Local Focus - City of Bend

- Council Resolution 3044 passed in 2016 established voluntary goals for City facilities and operations with the objective to:
  - Reduce community-wide fossil fuel use by 40% by 2030
  - Reduce community-wide fossil fuel use by 70% by 2050

- A Climate Action Steering Committee (CASC) convened from April '18 – December '19 to develop a **Community Climate Action Plan** to support these goals.
  - 13 individuals appointed, representing business, environmental, & youth communities, and local government.
  - Developed voluntary strategies and actions to guide Bend towards the fossil fuel reduction

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The Local Focus - City of Bend

- Community Climate Action Plan was approved by City Council on December 4, 2019.
- An Environment and Climate Committee (ECC) has been established for ramp up of the recently approved plan

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Types of CO_2 Adder Analyses

- Cascade will be using the Social Cost of Carbon forecast with a 2.5% discount rate, from the Interagency Working Group on the Social Cost of Greenhouse Gases, as per guidance received from the WUTC.

- Other methodologies were considered, and may be modeled as sensitivity analyses:
  - Cap and Trade Projections
  - House of Representatives Raise Wages, Cut Carbon Act
  - Stochastic blend of multiple approaches?

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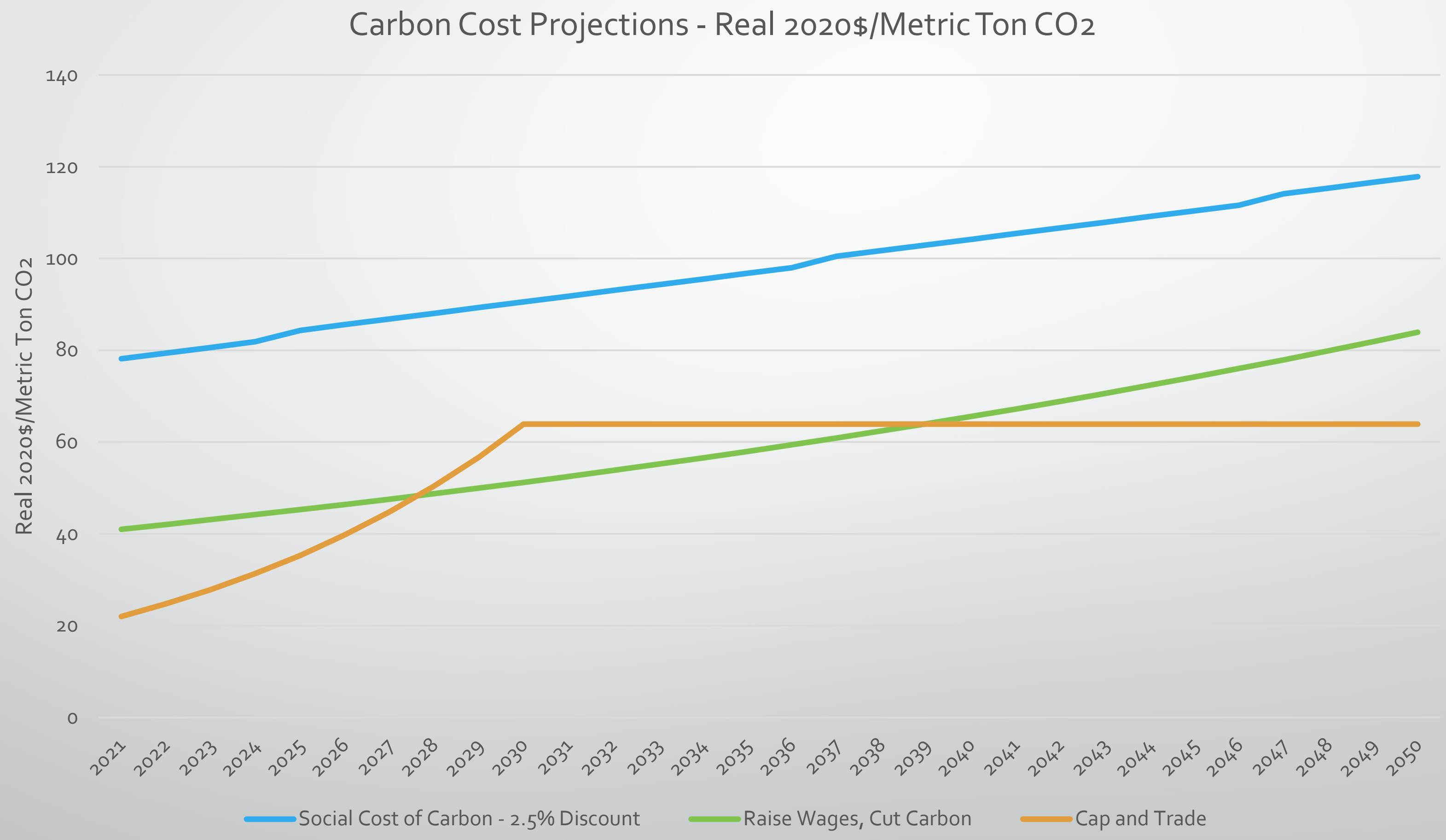
Comparing Carbon Cost Projections



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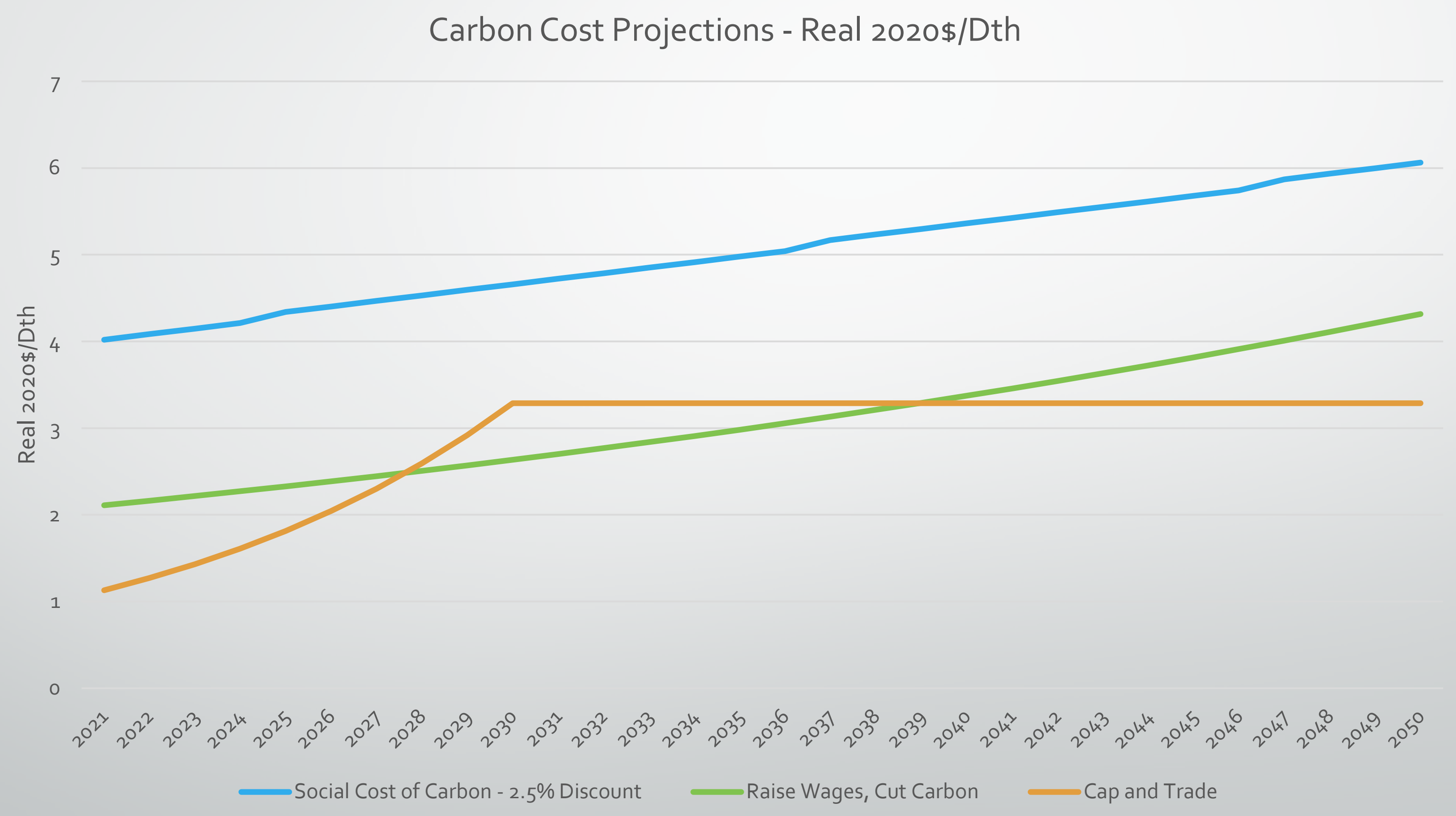
Comparing Carbon Cost Projections



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Types of CO_2 Adder Analyses (cont.)

- Analysis of potential carbon futures will impact:
  - Timing and quantity of demand side resources
  - Total system costs of candidate portfolio under stochastic conditions
  - Timing and quantity of viability of renewable natural gas

- Three additional sensitivity analyses will be performed:
  - 0% Environmental Adder
  - 20% Environmental Adder
  - 30% Environmental Adder

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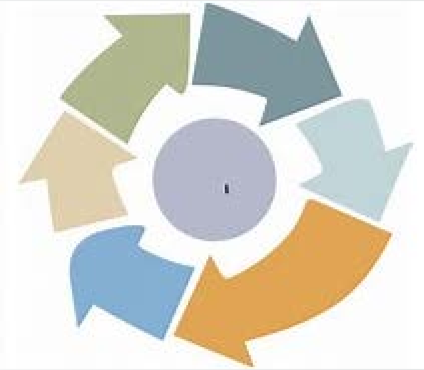

Next Steps and Conclusion

- Incorporate carbon planning assumptions into modeling
- Will provide a brief update of the modeling impacts at TAG 5
- Conclusion…
  - Regarding expectations, natural gas has a lesser impact on customers as compared to the electric utility industry
  - Cascade is paying close attention to National, Regional, and Local policies related to Carbon
  - Impact of ranges and sensitivity analyses will be presented to the TAG when modeling is performed

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Questions…

…and thank you

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DSM Forecast, 2020 IRP

Monica Cowlishaw & Phillip Hensyel

August 12th, 2020

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Topics to Cover Today

- Overview
  - Background
  - LoadMAP Modeling Tool
- Energy Efficiency 20-year Forecast
- Energy Efficiency Programs
  - Commercial and Industrial
  - Residential
    - Low Income
- Topics Outside DSM Potential

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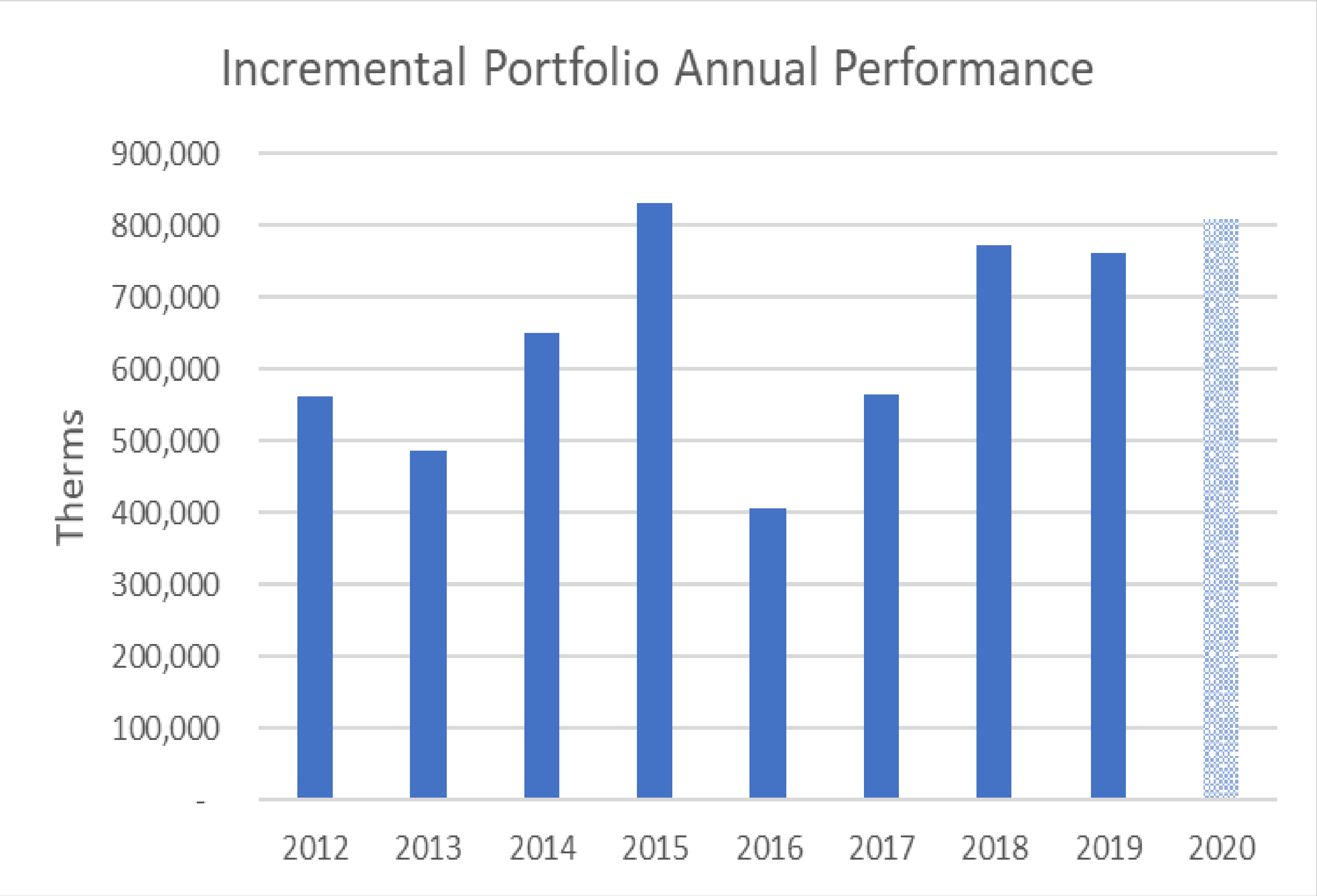
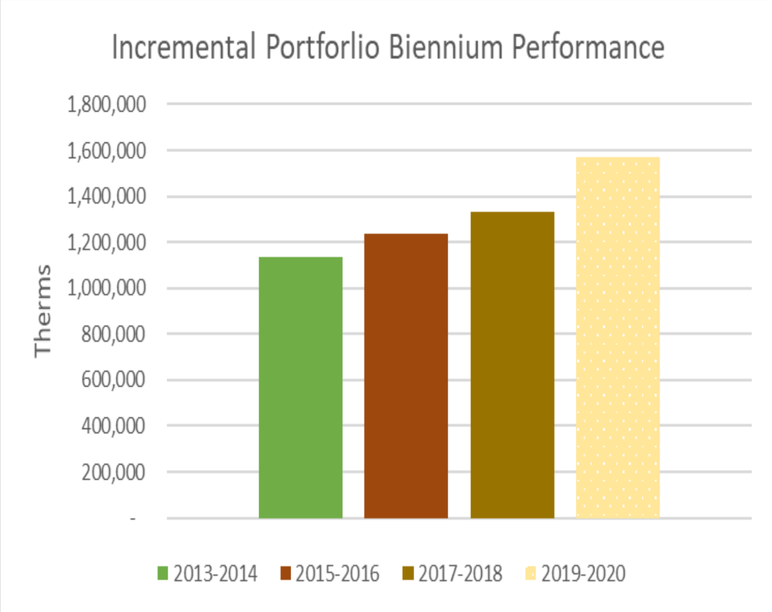
Overview



← ANNUAL PERFORMANCE



↑ BIENNIUM PERFORMANCE

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LoadMAP Sequence

Market Profile
- Customer Usage

Equipment
- Direct Gas Usage

Baseline Forecast
- End Use Demand compared to IRP Econometric

Non-Equipment
- Indirect Gas Usage

Potential
- Energy Efficiency Programs' Impacts

Final Results
- Incremental & Cumulative Annual Therm Savings

2020 Forecast Updates

2018

- Average Avoided Cost per therm ~$0.32
- Discount Rate 4.43%
- SCC Adder 3%

2020

- Average Avoided Cost per therm ~$0.57
- Discount Rate 3.40%
- SSC Adder 2.5%

Potential Increased

2.5% Social Cost of Carbon (SSC) Adder

~78% Increase in Avoided Costs on Average

~23% Decrease in Discount Rate

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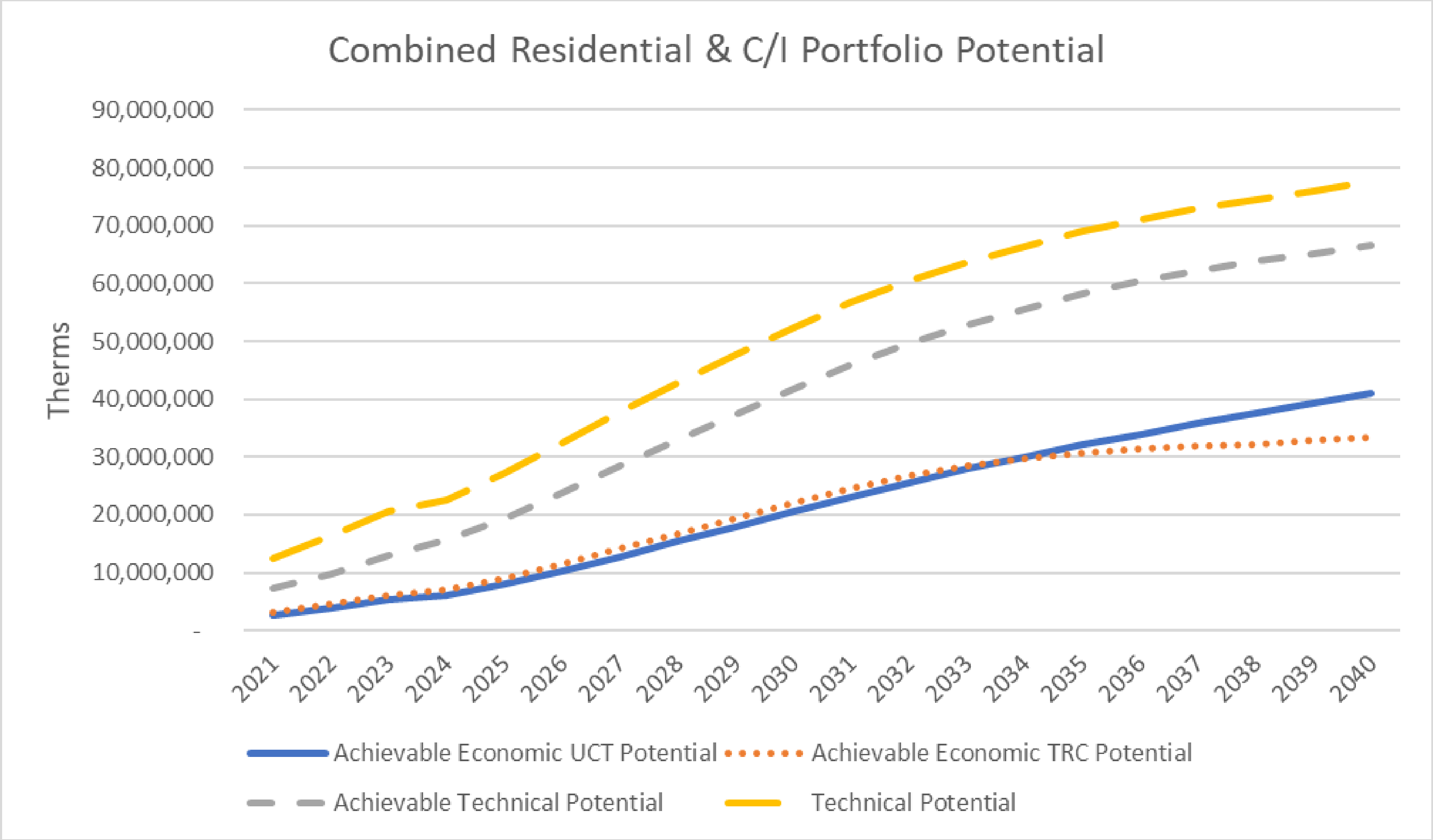
Energy Efficiency 20-year Cumulative Potential Forecast



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COMMERCIAL & INDUSTRIAL

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COMMERCIAL FORECAST SUMMARY

Summary of Energy Savings (MM therms), Selected Years	2021	2022	2023	2030	2040
Baseline Forecast (MMtherms)	105.864	106.520	107.171	112.523	122.356
Potential Forecasts (MMtherms)					
Achievable Economic UCT Potential	104.362	103.623	102.867	97.438	100.953
Achievable Economic TRC Potential	104.405	103.700	102.978	97.898	101.739
Achievable Technical Potential	104.344	103.596	102.830	97.347	100.801
Technical Potential	103.491	102.191	100.884	92.554	93.772
Cumulative Savings (MMtherms)					
Achievable Economic UCT Potential	1.501	2.896	4.304	15.084	21.403
Achievable Economic TRC Potential	1.458	2.819	4.193	14.625	20.617
Achievable Technical Potential	1.519	2.924	4.341	15.176	21.555
Technical Potential	2.373	4.328	6.287	19.969	28.584
Energy Savings (% of Baseline)					
Achievable Economic UCT Potential	1.4%	2.7%	4.0%	13.4%	17.5%
Achievable Economic TRC Potential	1.4%	2.6%	3.9%	13.0%	16.8%
Achievable Technical Potential	1.4%	2.7%	4.1%	13.5%	17.6%
Technical Potential	2.2%	4.1%	5.9%	17.7%	23.4%
Incremental Savings (MMtherms)					
Achievable Economic UCT Potential	1.501	1.410	1.439	1.540	0.751
Achievable Economic TRC Potential	1.458	1.376	1.404	1.482	0.693
Achievable Technical Potential	1.759	1.561	1.591	1.678	0.881
Technical Potential	2.373	1.990	1.996	1.908	1.138

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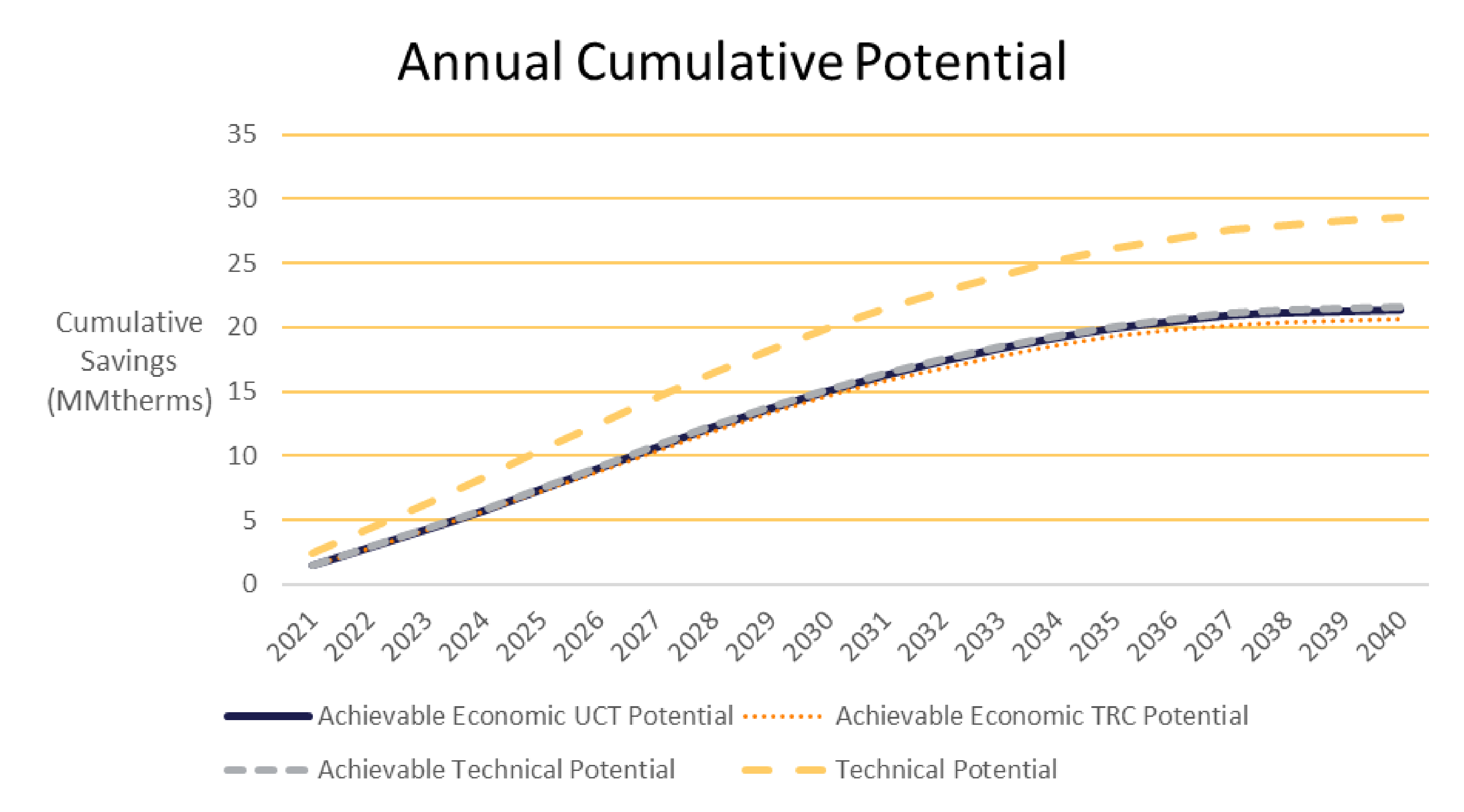
INDUSTRIAL FORECAST SUMMARY

Summary of Energy Savings (MM therms), Selected Years	2021	2022	2023	2030	2040
Baseline Forecast (MMtherms)	32.833	33.539	34.251	39.085	45.044
Potential Forecasts (MMtherms)					
Achievable Economic UCT Potential	32.753	33.382	33.995	38.012	43.305
Achievable Economic TRC Potential	32.758	33.393	34.024	38.130	43.442
Achievable Technical Potential	32.748	33.372	33.980	37.972	43.241
Technical Potential	32.667	33.255	33.826	37.581	42.707
Cumulative Savings (MMtherms)					
Achievable Economic UCT Potential	0.081	0.158	0.256	1.073	1.739
Achievable Economic TRC Potential	0.076	0.147	0.227	0.955	1.603
Achievable Technical Potential	0.086	0.168	0.270	1.114	1.803
Technical Potential	0.167	0.284	0.424	1.505	2.337
Energy Savings (% of Baseline)					
Achievable Economic UCT Potential	0.2%	0.5%	0.7%	2.7%	3.9%
Achievable Economic TRC Potential	0.2%	0.4%	0.7%	2.4%	3.6%
Achievable Technical Potential	0.3%	0.5%	0.8%	2.8%	4.0%
Technical Potential	0.5%	0.8%	1.2%	3.8%	5.2%
Incremental Savings (MMtherms)					
Achievable Economic UCT Potential	0.080617	0.077123	0.098242	0.114644	0.063250
Achievable Economic TRC Potential	0.075720	0.071092	0.080797	0.106231	0.060527
Achievable Technical Potential	0.092222	0.085160	0.106766	0.123404	0.070138
Technical Potential	0.166725	0.117709	0.141010	0.148716	0.085571

Energy Efficiency 20-year Cumulative Potential Forecast: Commercial/Industrial (C/I)



C/I Top Ten Measures

Rank	Measure / Technology	2021 Achievable Technical Potential Savings (therms)
1	*Water Heater - Solar System	480,716
2	*ENERGY STAR Connected Thermostat	154,268
3	Boiler	126,814
4	Water Heater	66,799
5	Insulation - Roof/Ceiling	58,181
6	Retrocommissioning - HVAC	55,268
7	Space Heating - Heat Recovery Ventilator	54,797
8	Insulation - Wall Cavity	48,061
9	Building Automation System	39,823
10	Furnace	43,364

* See Next Slide

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Water Heater – Solar and SMART Thermostat

Further research/review required for some measures by AEG

- Solar water heater measure –
  - It has too much overlap with the other equipment measure.
    - The model assumed in 2017 that 30% of the market would be using this measure.

- SMART thermostats –
  - Cascade did not have a commercial measure last time so the Company proxied the residential one.
    - The updated assumption for this measure saves between two and five times less.

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RESIDENTIAL

RESIDENTIAL FORECAST SUMMARY

Summary of Energy Savings (mmTherms), Selected Years	2021	2022	2023	2030	2040
Baseline Forecast (mmTherms)	124.029	125.349	127.214	135.725	150.521
Potential Forecasts (mmTherms)					
UCT Achievable Economic Potential	123.598	124.418	125.725	126.869	134.331
TRC Achievable Economic Potential	123.371	123.983	125.075	122.933	129.892
Achievable Technical Potential	123.112	123.400	124.110	116.357	116.511
Technical Potential	122.476	122.038	122.096	111.850	111.675
Cumulative Savings (mmTherms)					
UCT Achievable Economic Potential	0.430851	0.930947	1.488946	8.855369	16.190518
TRC Achievable Economic Potential	0.657872	1.365542	2.138726	12.791304	20.629579
Achievable Technical Potential	0.916665	1.948516	3.103777	19.367683	34.009791
Technical Potential	1.552597	3.310195	5.117903	23.874280	38.846217
Energy Savings (% of Baseline)					
UCT Achievable Economic Potential	0.3%	0.7%	1.2%	6.5%	10.8%
TRC Achievable Economic Potential	0.5%	1.1%	1.7%	9.4%	13.7%
Achievable Technical Potential	0.7%	1.6%	2.4%	14.3%	22.6%
Technical Potential	1.3%	2.6%	4.0%	17.6%	25.8%
Incremental Savings (mmTherms)					
UCT Achievable Economic Potential	0.430851	0.503824	0.563563	1.371870	0.396771
TRC Achievable Economic Potential	0.657872	0.714924	0.785228	2.004919	0.226056
Achievable Technical Potential	0.916665	1.042457	1.173012	3.076127	1.251017
Technical Potential	1.552597	1.774742	1.833045	3.502519	1.320842

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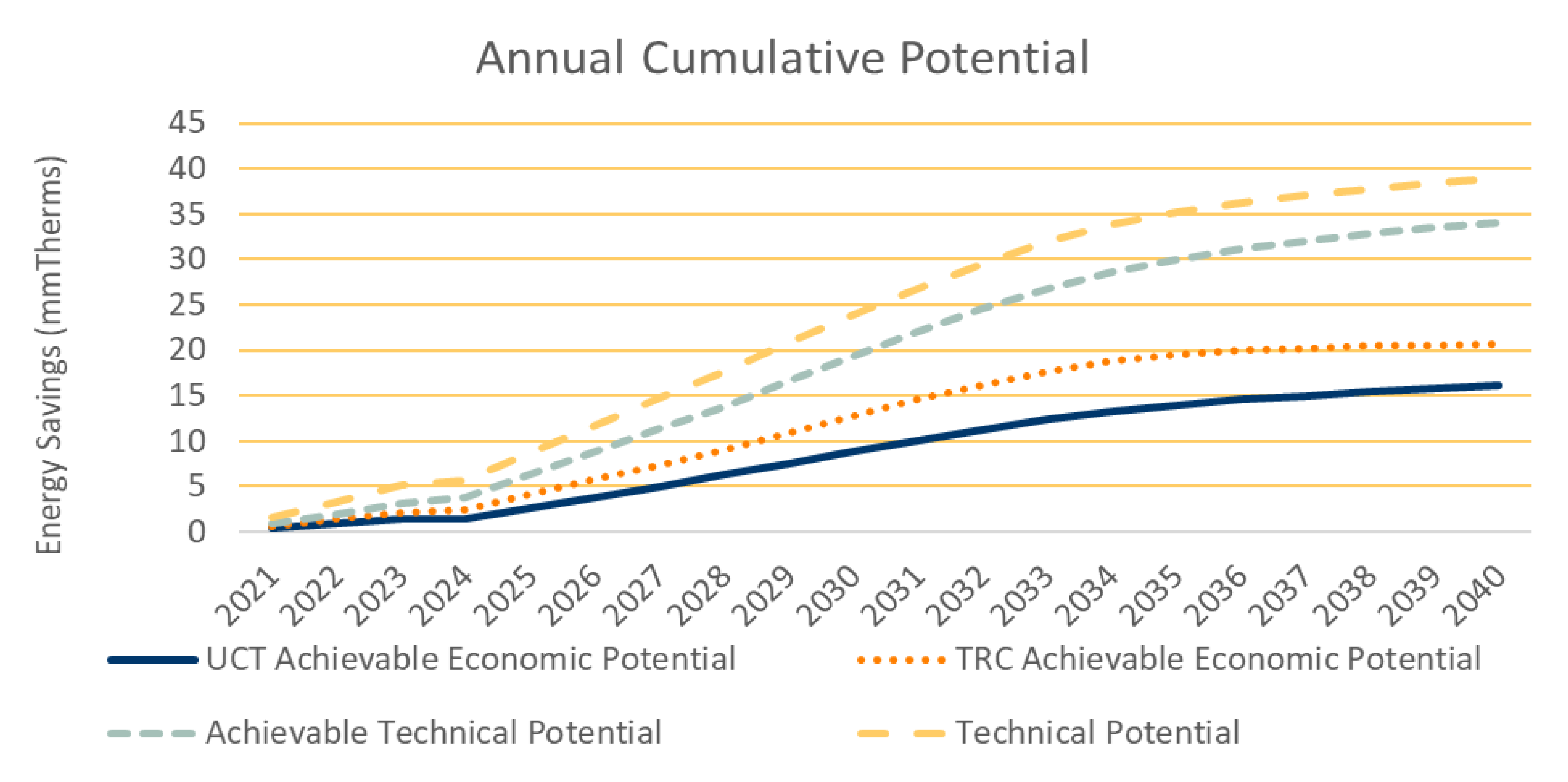
Energy Efficiency 20-year Cumulative Potential Forecast: Residential (RES)



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RES Top Ten Measures

Rank	Measure / Technology	2021 Achievable Economic UCT Potential Savings (therms)
1	Insulation - Floor/Crawlspace	111,398
2	*Water Heater - Solar System	62,455
3	Windows - High Efficiency	53,565
4	Insulation - Ceiling, Installation	34,773
5	Space Heating - Furnace - Direct Fuel	26,869
6	Insulation - Wall Cavity, Upgrade	25,268
7	Insulation - Wall Cavity, Installation	24,843
8	Insulation - Ceiling, Upgrade	22,292
9	Secondary Heating - Fireplace	12,083
10	Insulation - Basement Sidewall	12,030

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Additional EE Topics for the IRP

- CPA
  - August Focus
    - The new base year is 2019
    - Update Key Measures
    - Update Measure Ramp Rates
      - Reevaluate solar water heat to align with market availability
- HB 1257
- New Construction Code Changes
- Transition to Biannual Conservation Plan
- Timelines

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Questions…

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Renewable Natural Gas

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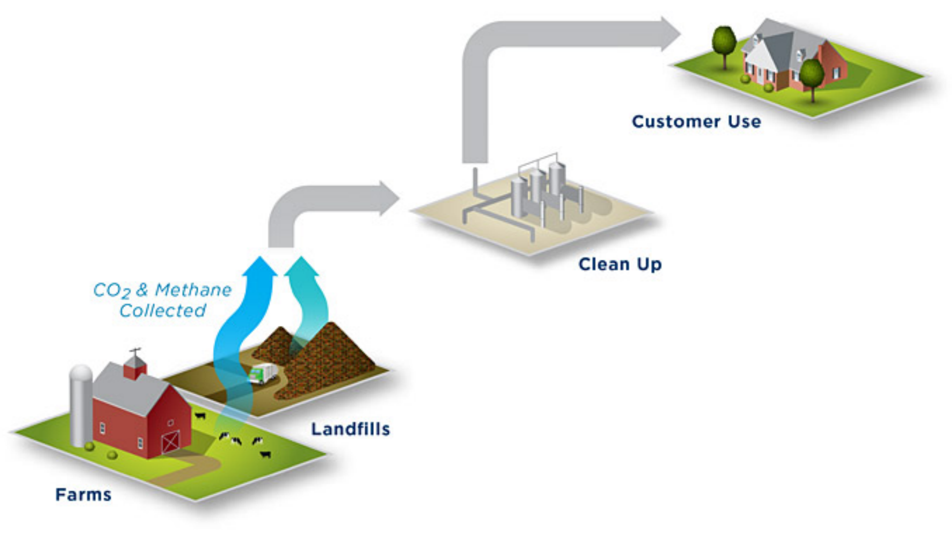
What is Renewable Natural Gas (RNG)?

- RNG is pipeline quality natural gas produced from various biomass sources through biochemical processes such as anaerobic digestion or gasification.[1]



[1] U.S. Department of Energy, Alternative Fuels Data Center, Renewable Natural Gas

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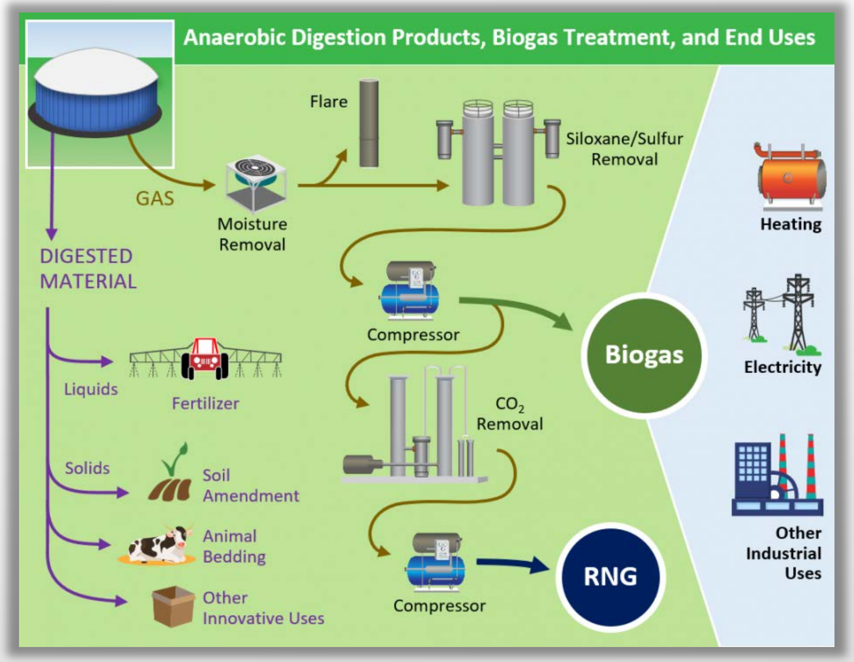
Renewable Natural Gas

- Examples:
  - Biogas from Landfills
    - Collect waste from residential, industrial, and commercial entities.
    - Digestion process takes place in the ground, rather than in a digester.
  - Biogas from Livestock Operations
    - Collects animal manure and delivers to anaerobic digester.
  - Biogas from Wastewater Treatment
    - Produced during digestion of solids that are removed during the wastewater treatment process.
  - Other sources include organic waste from food manufacturers and wholesalers, supermarkets, restaurants, hospitals, and more.[1]



[1] U.S. Department of Energy, Alternative Fuels Data Center, Renewable Natural Gas

Renewable Natural Gas

renewable natural gas

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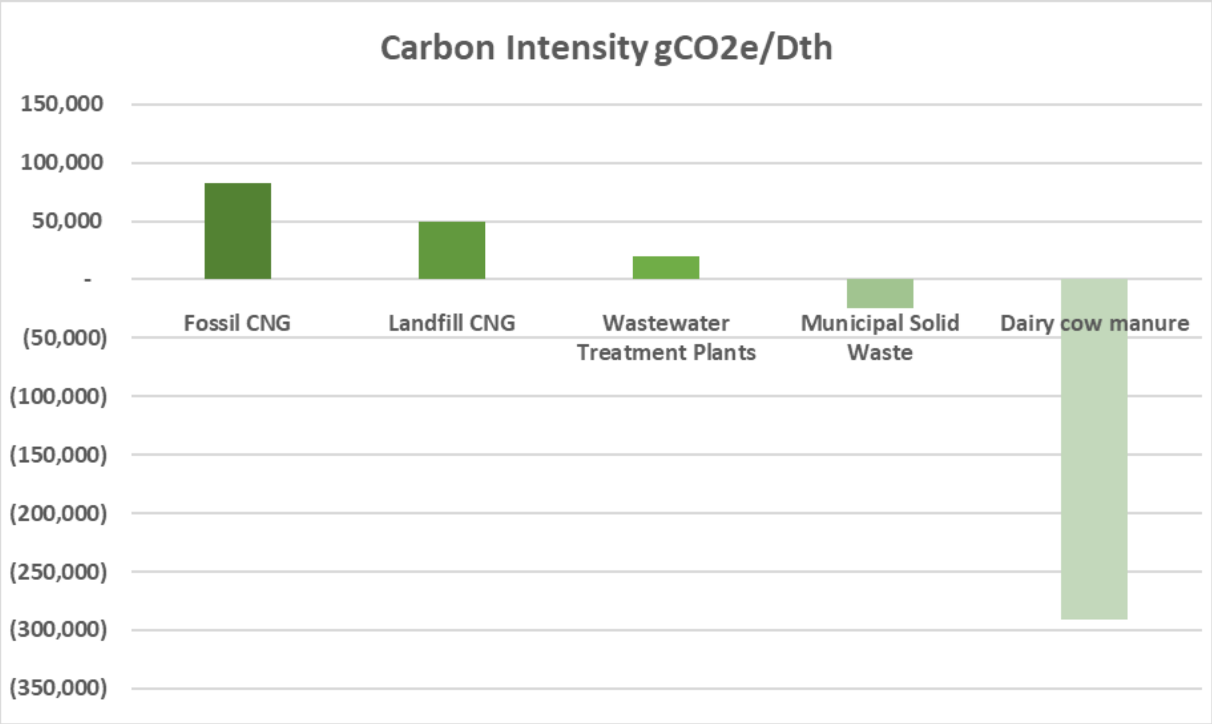
Carbon Intensity



Source: Institute of Transportation Studies at UC Davis, Research Report 16-20, June 2016.

Regulatory Matters Regarding RNG

- HB 1257 in Washington
  - HB 1257 Section 13 states that a natural gas company may propose a renewable natural gas program under which the company would supply renewable natural gas for a portion of the natural gas sold or delivered to its retail customers. Section 14 states that each gas company must offer by tariff a voluntary renewable natural gas service available to all customers to replace any portion of the natural gas that would otherwise be provided by the gas company.
- AR 632 and UM 2030
  - AR 632 is an open docket regarding RNG Rulemaking. Rules were filed on July 17, 2020. A few key points for IRPs:
    - IRPs should include an RNG-specific chapter.
    - Include information relevant to the RNG market, prices, technology, and availability that would otherwise be required under the Commission's IRP Guidelines.
  - UM 2030 is an open docket for determining the cost-effectiveness of RNG resources for Northwest Natural. Cascade has reviewed this docket and is an active participant.
- SB 98 in Oregon
  - SB 98 requires the Public Utility Commission to adopt by rule renewable natural gas program for natural gas utilities to recover prudently incurred qualified investments in meeting certain targets for including renewable natural gas in gas purchases for distribution to retail natural gas customers.

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Regulatory Matters Regarding RNG (Cont'd)

- Cascade is aware of the Washington State University Study on Renewable Natural Gas
  - A study around what RNG is and a possible roadmap of RNG in WA State.
- Treatment of Carbon Intensity
  - Cascade understands there are differing schools of thought for how to record Carbon Intensity of different sources of RNG and will continue to monitor the related legislative efforts.
- Any other items Cascade should be following?

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Cascade Market Research

- Options for securing RNG will involve purchase and/or participation in infrastructure.
- No "spot market" for RNG at this point due to long off-take commitments.
- Lead times on new RNG projects up to 36 months.
- Landfill projects are typically the largest RNG opportunity at 1,000-7,000 dth/day and usually require lowest capital investment.
- Digester projects, due to higher carbon intensity, do very well in the Renewable Identification Numbers (RINs) market and run 50-500 dth/day (expensive to operate).
- Food waste/wastewater treatment projects seen as an ideal option for utilities as they have low RINs and Low Carbon Fuel Standards (LCFS) potential.
- $10-$30/dth long-term off-take deals.

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Cascade Market Research (Cont'd)

- New landfill projects typically command $10-$19/dth with environmental attributes and facility investment recovery.
- Digesters need $15-$20/dth off-take deals.
- Dairy projects can be $25-$30/dth.
- Fortis B.C. has 9 Bcf/yr of RNG under contract.
- Some surveys have found customers will not pay more than $7/dth to natural gas.

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What is Cascade doing?

- **RNG planning**

Internal Attendees

  - Regulatory
  - Business Development – Oregon & Washington
  - Energy Efficiency
  - Public Affairs
  - Resource Planning Team
  - Gas Supply

External Attendees

  - Lobbyists
  - NWGA
  - Other LDC's located in Oregon & Washington

Climate Action Plan Support

  - Inclusion of biogas and offset program exploration as part of City of Bend's Climate Action Plan

Cascade's RNG Goals

- The Company's long-term view and approach to RNG
- Roles and Responsibilities
- RNG Policy – federal, state and local guidelines and requirements
  - Electrification and RNG parity
- Voluntary Programs/Offsets
- Energy Efficiency & RNG
- Future opportunities
- Standards

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Potential RNG Projects in Cascade's Service Territory

- Working with municipals, wastewater treatment plants, biodigesters with industrial customers, and landfills.

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Discussion of RNG Cost Effectiveness Evaluation Tool

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Top Level Discussion

- Cascade is in the process of developing a tool to evaluate the cost effectiveness of potential RNG projects.
- The Company's methodology follows guidance from OPUC AR 632 and UM 2030.
- Feedback is highly encouraged; this model is still evolving with input from internal and external stakeholders.

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Cascade Project Cost Effectiveness Evaluation Methodology

$$C_{RNG} = I_{RNG} - AC_U - AC_D + \sum_{T=1}^{365} (P_{RNG} + VC - CIF) * Q$$

$$C_{Conventional} = \sum_{T=1}^{365} (P_{Conventional} + VC) * Q$$

If $C_{Conventional} \geq C_{RNG}$, a project can be deemed cost effective under the inputs given, and should be considered for acquisition. If not, the project may still be considered under regulatory exceptions discussed earlier in this chapter.

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Model Notes

$\boldsymbol{C_{RNG}}$ = The all-inclusive annual cost of a proposed RNG project
$\boldsymbol{I_{RNG}}$ = The annual required investment to procure a proposed RNG resource. If Cascade is simply buying the gas and/or environmental attributes, this value is zero.
$\boldsymbol{AC_U}$ = Avoided upstream costs
AC_D = Avoided distribution system costs
P = Daily price of gas being evaluated
Q = Daily quantity of gas being evaluated
VC = Variable cost to move one dekatherm of gas to Cascade's distribution system. This value can be zero if a project connects directly to the Company's system.
CIF = Carbon Intensity Factor. This is calculated by multiplying the Company's expected carbon compliance cost by 1 minus the ratio of a proposed projects carbon intensity to conventional gas' carbon intensity.
$\boldsymbol{C_{Conventional}}$ = The all-inclusive annual cost of conventional natural gas.

Annual Required Investment

- Accounts for the upfront costs to build infrastructure needed to transport RNG from the source to either Cascade's distribution system or upstream pipeline
- Includes interconnect facilities, pipeline extensions, and applicable taxes and permitting charges
- Costs are amortized over the life of the project

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Avoided Costs

- Accounts for costs that are mitigated by the potential acquisition of RNG
- Upstream costs includes fixed, variable elements of incremental pipeline needed that can be offset by RNG
- Downstream costs include distribution system enhancements that can be replaced by RNG
- Avoided cost values come from most recently acknowledged IRP

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Cost of Gas

- Price of conventional gas derived as a demand weighted split of Cascade's 20-year price forecast at Sumas, Rockies, and AECO
- Price of RNG can be difficult to quantify as it is often a negotiated value
  - If a value cannot be provided, this can be optimized using Excel's solver functionality to derive the highest price that RNG from a project can be considered cost-effective

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Carbon Intensity Factor

- Quantifies the value of the environmental attributes associated with RNG
- Carbon impact is multiplied by the projected cost of carbon mitigation
- This element is one difference between Cascade's methodology and the methodology proposed in UM 2030
  - UM 2030 methodology calculates the carbon compliance cost for conventional gas, RNG separately
  - CNGC methodology calculates the ratio of the carbon impact RNG to that of conventional gas, uses this value to calculate the carbon compliance savings of RNG

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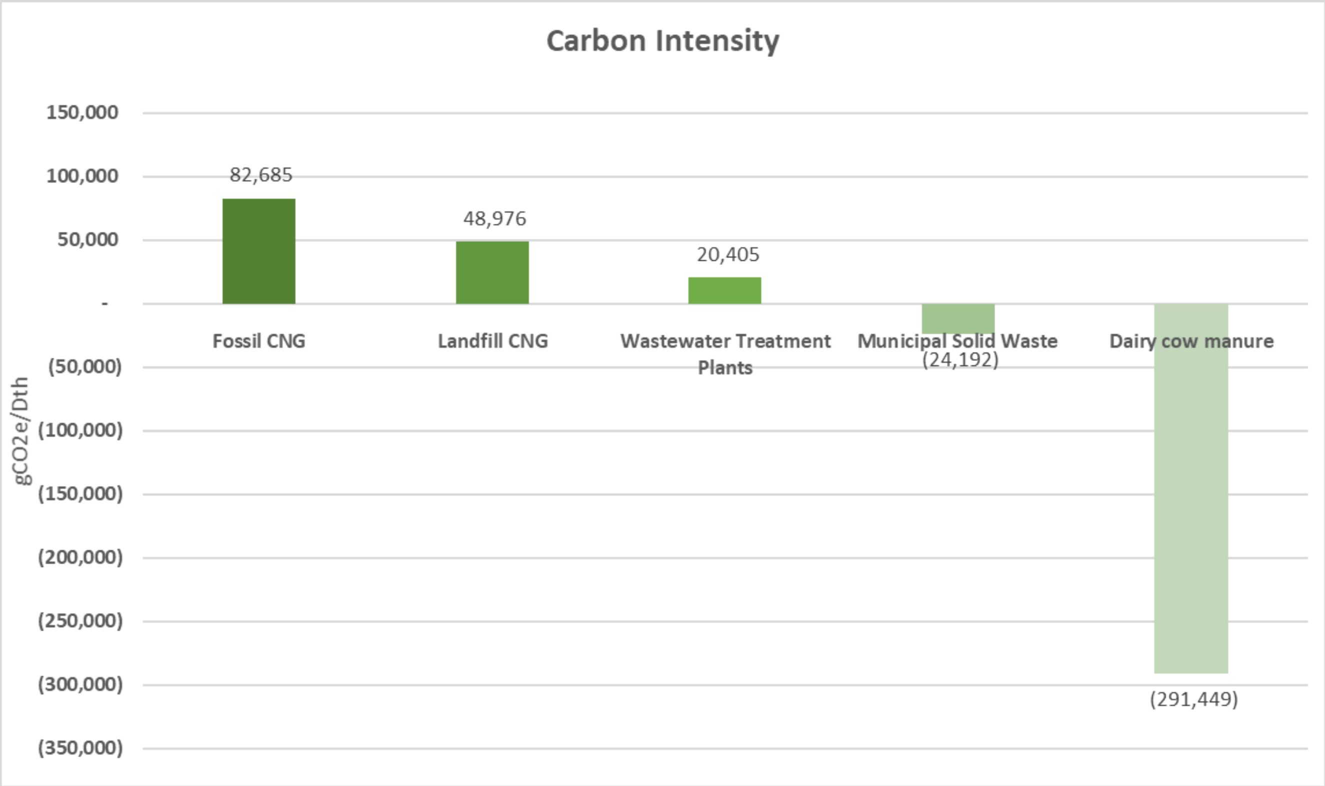
Jaffe 2016 Carbon Intensity Values



Source: Institute of Transportation Studies at UC Davis, Research Report 16-20, June 2016.

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An Example of Conventional Gas Vs. Landfill Gas

- Suppose the cost of carbon is $2/dth of conventional gas
- UM 2030 Methodology:
    - Cost of Conventional Gas = $2/dth
    - Cost of RNG = 48,976/82,685 * $2/dth, or approx. $1.185/dth
- Cascade Methodology:
    - Ratio of RNG to conventional gas = 48,976/82,865
    - 1-(48,976/82,865)*$2/dth = $.815/dth, which is equal to 2-1.185 in the example above

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Cost-Effectiveness Evaluation

- Levelized costs are evaluated for the projected lifespan of the RNG project. As discussed earlier, if the total cost of conventional gas exceeds that of RNG, the project may be deemed cost effective
  - Important to recognize that a model is only as good as its inputs; Without definitive answers for values like the cost of carbon compliance, price of gas, this cost-effectiveness determination should be used in conjunction with qualitative analysis from subject matter experts.

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If Not Cost-Effective…

- Cascade's model is able to project the impact to revenue requirement.
  - If under a certain threshold, a project may still be considered favorable to acquire
  - If not, the model will be able to calculate the price point needed to achieve that threshold
  - Projects may still be considered under a voluntary tariff

SENDOUT® Optimization Modeling

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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.

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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 recognize that linear programming analysis provides helpful but not perfect information to guide decisions.

Modeling Transportation In SENDOUT® is a Balancing Act

- Start with a point in time look at each jurisdiction’s resources
- Use the Nov19-Oct20 PGA portfolio
- Contracts –Receipt and Delivery Points
- We start with current transport contracts, using centralized receipts and approximately 67 delivery locations
- Rates - Current contractual, with CPI increase every 3 years
- Contractual vs. Operational
- Contractual can be overly restrictive
- Operational can be overly flexible
- Incorporating operational realities into our modeling can defer the need to acquire new resources.
- Gas Supply’s job is to get gas from the supply basin to the pipeline citygate
- IRP focus is on the core
- Operations job is to take gas from the pipeline gate to our customers
- Operations focus is on the system, not just the core
- Limiting factor is receipt quantity –how much can you bring into the system?

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Modeling Challenges

- Supply needs to get gas to the citygate.
- Many of Cascade's transport agreements were entered into decades ago, based on demand projections at that point in time.
- Sum of receipt quantity and aggregated delivery quantity can help identify resource deficiency depending on how rights are allocated.
- The aggregated look can mask individual citygate issues for looped sections, and the disaggregated look can create deficiencies where they don't exist.
- In many cases operational capacity is greater than contracted.
- SENDOUT® has perfect knowledge.

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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 candidate portfolio based on the mean and Value at Risk (VaR) of the total system cost and unserved demand of each portfolio. This resource mix will be the best combination of cost and risk for Cascade and its customers.

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Supply Resource Optimization Process (Cont'd)

- **Step 5: Stochastic Analysis of Candidate Portfolio**
  - Run Monte Carlo simulations of various scenarios on candidate portfolio; comparing Mean and VaR to a managerial limit.
- **Step 6: Analysis of Candidate 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 Candidate Portfolio**
  - Run the candidate 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 Candidate 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 until preferred portfolio is confirmed.

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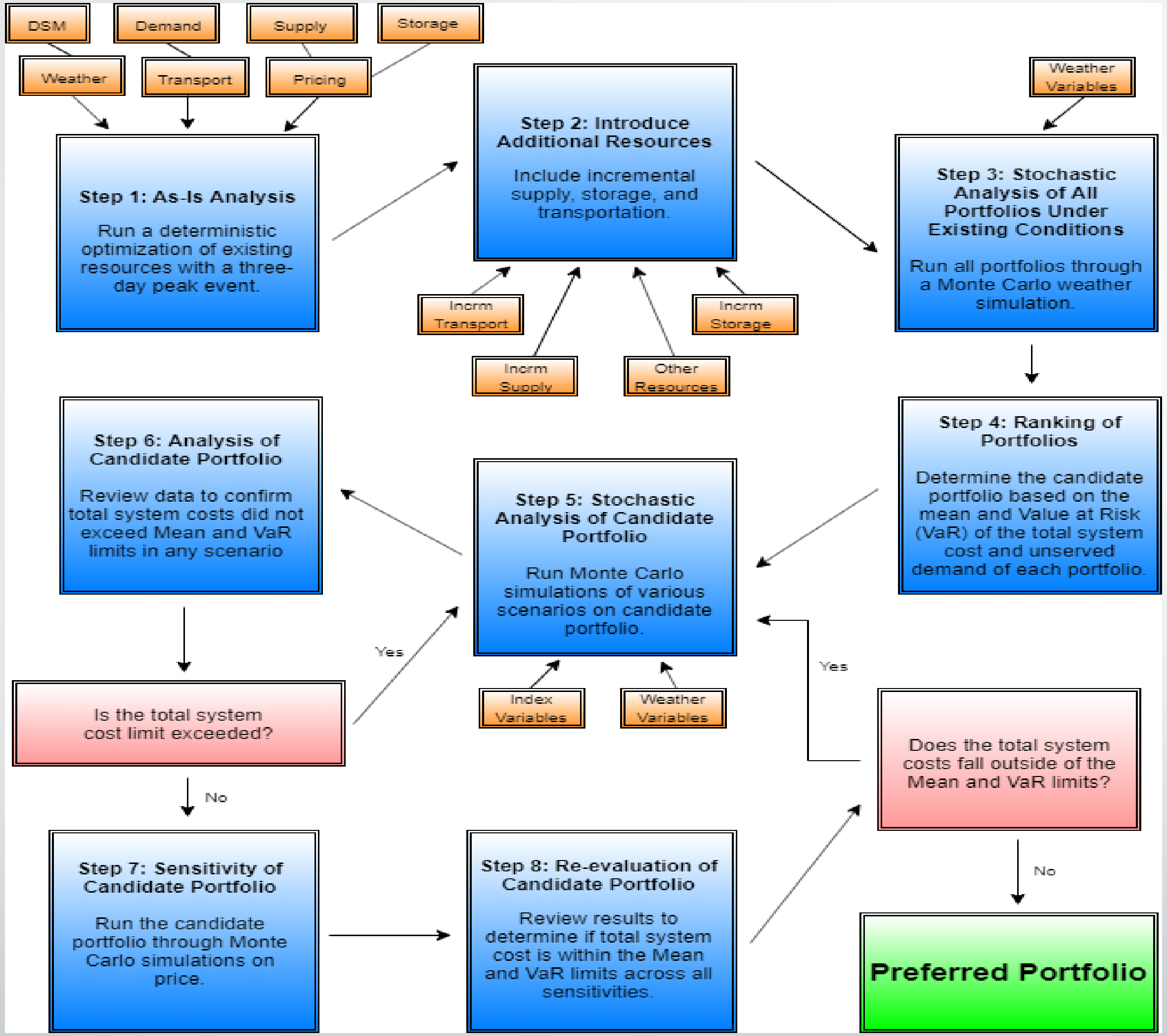


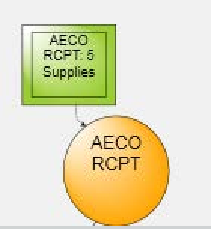
Supply Resource Optimization Process Flow Chart

Base Case Sendout Inputs

- Supply
- Storage
- Transportation
- Constraints
- Demand
- Weather
- Price Forecast

Supply

- Cascade can purchase gas at four markets; AECO, SUMAS, KINGSGATE and OPAL.
- At each market Cascade can purchase gas at different locations along the pipeline.
- For the first year, Cascade uses all current contracts for Supply inputs.
- For years 2-20, Cascade uses Base, Fixed, Winter base, Summer and Winter day gas, and Peak day incremental supplies as inputs.
- Over the planning horizon, the contracts are renewed in November and April.



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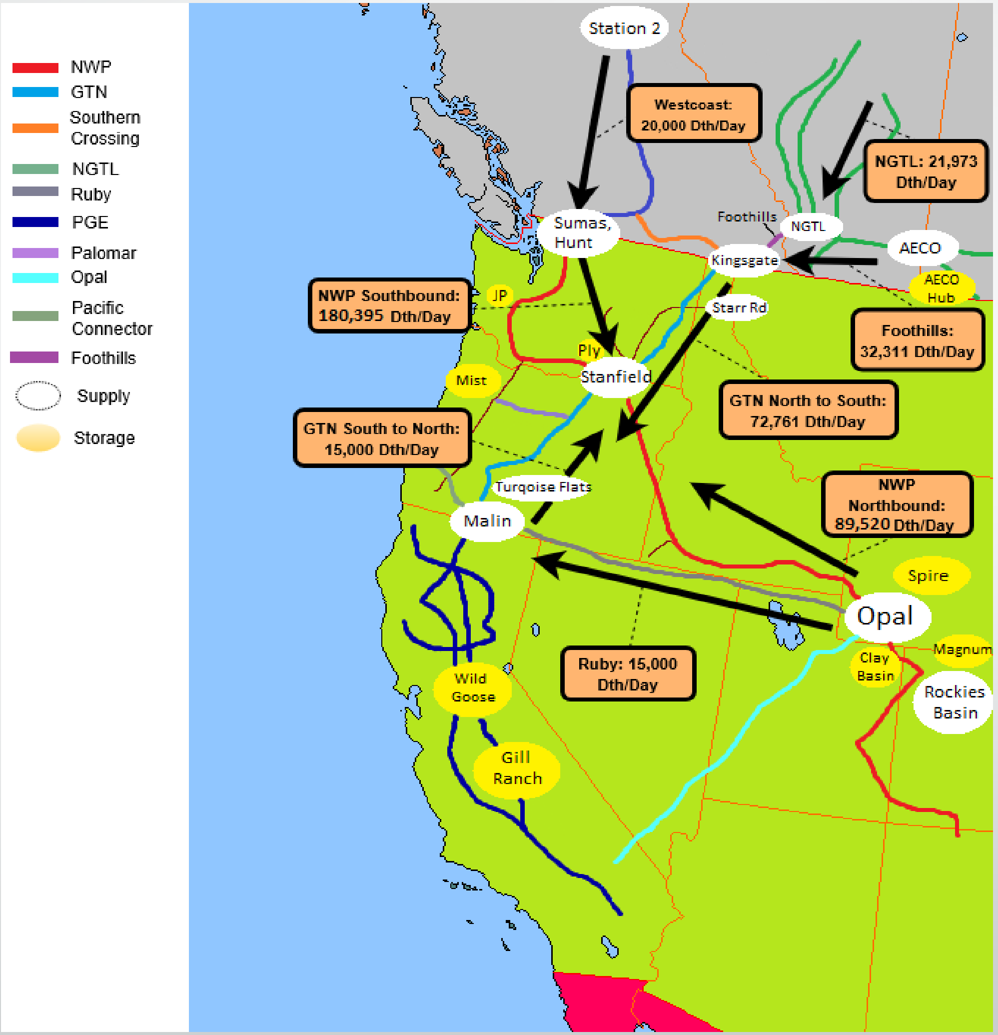
Supply


NWP
GTN
Southern Crossing
NGTL
Ruby
PGE
Palomar
Opal
Pacific Connector
Foothills
Supply
Storage
Station 2
Westcoast: 20,000 Dth/Day
NGTL: 21,973 Dth/Day
Sumas, Hunt
Foothills
NGTL
AECO
Kingsgate
AECO Hub
Starr Rd
NWP Southbound: 180,395 Dth/Day
JP
Foothills: 32,311 Dth/Day
Ply
Stanfield
Mist
GTN North to South: 72,761 Dth/Day
GTN South to North: 15,000 Dth/Day
Turqoise Flats
Malin
NWP Northbound: 89,520 Dth/Day
Spire
Opal
Magnum
Clay Basin
Ruby: 15,000 Dth/Day
Rockies Basin
Wild Goose
Gill Ranch

Supply Base and Fixed

- Supply Base and Fixed are the baseline supply contracts that are entered into every 12 months.
- A base contract has a basis rate. This is defined as the price of gas at a given market (i.e., AECO base is the expected cost of gas at NYMEX plus the basis for AECO, for a given month).
- A fixed contract has a fixed rate.
- A penalty is applied to each contract when the gas is not taken for a day. This type of penalty forces these types of contracts to only take the optimal amount of gas to serve the base demand.

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Supply Example

	JAN 2017	FEB 2017	MAR 2017	APR 2017	MAY 2017	JUN 2017	JUL 2017	AUG 2017	SEP 2017	Extension Option	Escalation Pattern	Monthly Multiplier	Index	Adder	Multiplier
*Daily MDQ	25000									Same					
*Daily Minimum Percent	100									Same					
Annual Maximum										Same					
Annual Minimum Percent										Same					
Monthly Maximum										Same					
Monthly Minimum Percent										Same					
Seasonal Maximum										Same					
Seasonal Minimum Percent										Same					
Known Take										Same					
*Rate - Commodity	2.5									Same	CPI				
Rate - Dispatch										Same					
Rate - Known Commodity Cost										Same					
Rate - Other Variable 1										Same					
Rate - Other Variable 2										Same					
Rate - Penalty Annual										Same					
Rate - Penalty Seasonal										Same					
Rate - Penalty Monthly										Same					
Rate - Penalty Daily	2.5									Same				-0.01	
Rate - D1										Same					
Rate - D2										Same					
Volume - D1 Volume										Same					
Volume - D2 Volume										Same					
Temp Cutoff Max Temperature										Same					
Available % Below Min/Above Max										Same					
Temp Cutoff Min Temperature										Same					
Apply Temperature Cutoff										Same					
Energy Conversion Factor										Same					
Process Indicator										Same					
Resource Mix Start\Stop Indicators	Start									Last Year					
Rmix MDQ Range Max	25000									Same					

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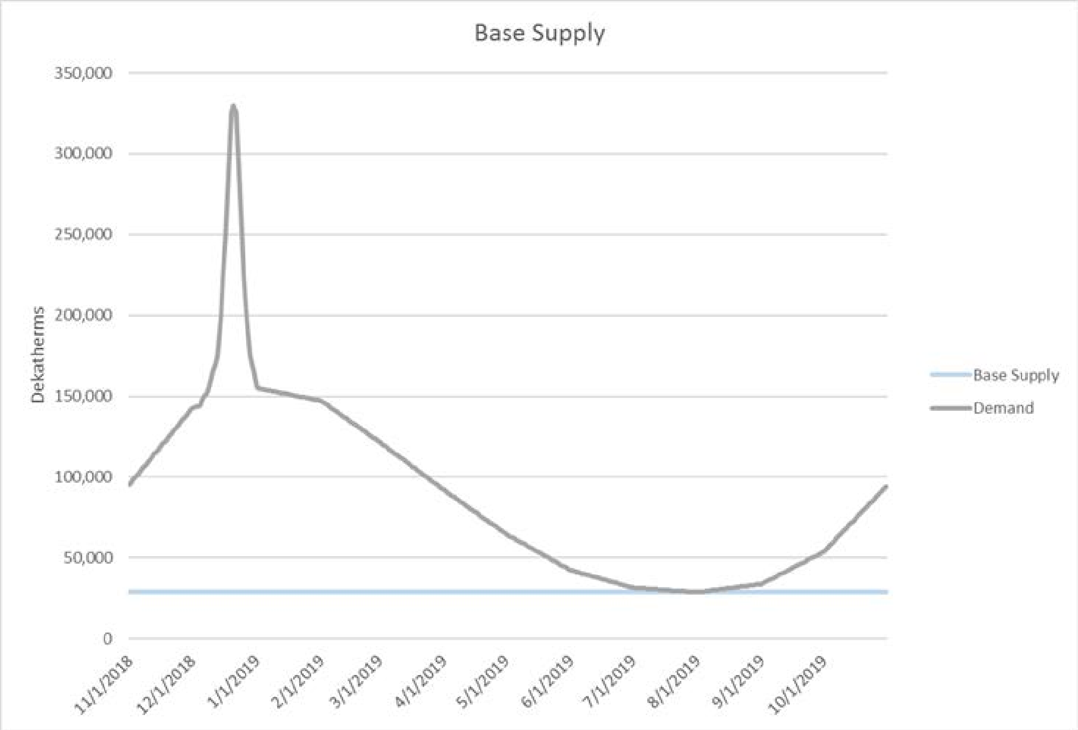
Base Supply (Cont'd)



Winter base Supply

- Winter base supply is contracted supply with a premium charge that is slightly higher than base gas.
- The Maximum Daily Quantity (MDQ) is optimally set by SENDOUT.
- Winter supply is renewed every November and completes at the end of March.
- Winter Supply is additional baseline supply on top of the base or fixed supplies for the winter months.
- There is a penalty associated to this contract to force SENDOUT to take the optimal amount of additional winter base gas.

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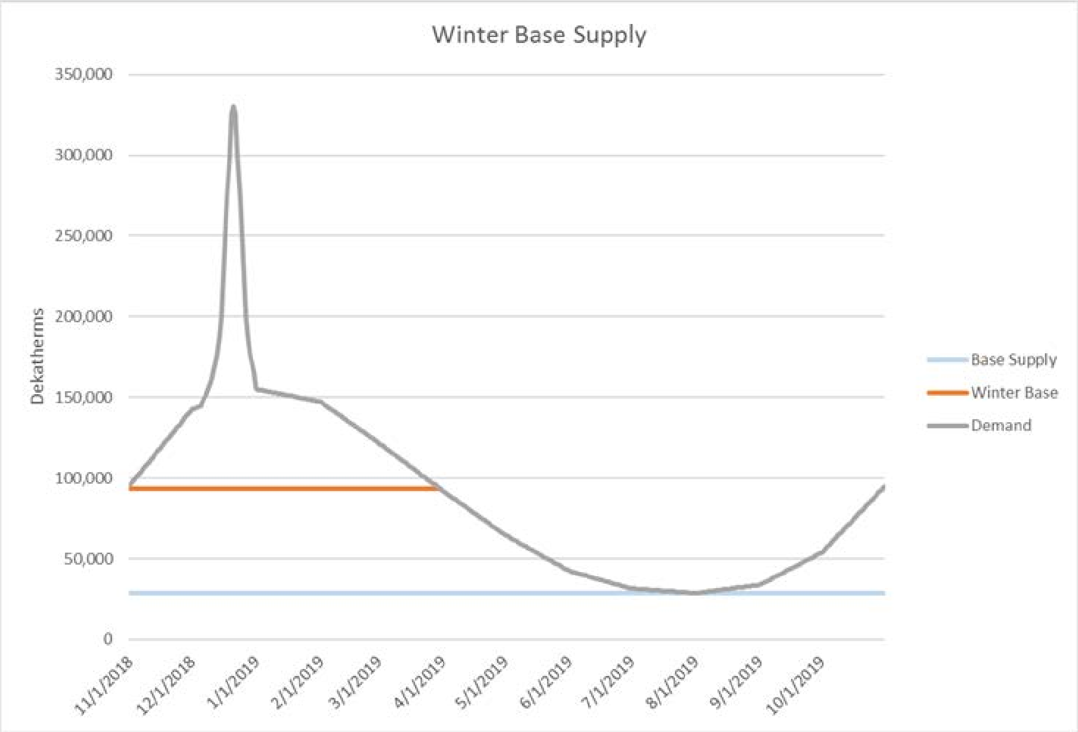
Winter Base Supply (Cont'd)



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Day Supply (Winter)

- Winter Day supply is gas that is R-mixed at the beginning of November each year.
- The R-mix function takes into account the fixed and variable costs of a resource to determine the proper amount to take in a given period.
- Winter day gas has an MDQ cap but is not a must take supply.
- If a winter day supply has an MDQ of 10,000 dth then it can take anywhere from 0 to 10,000 dth of gas on any given day in the winter.
- Winter day supply has a slightly higher premium than winter base supply and it can be contracted from November to April.

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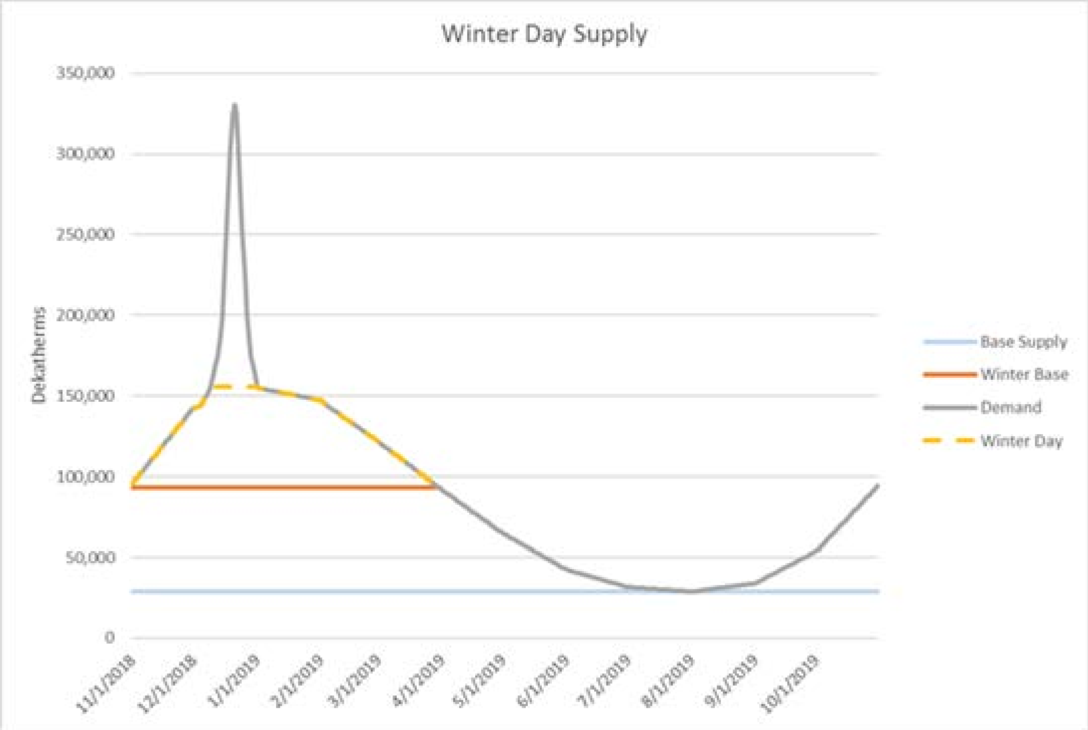
Winter Day Supply (Cont'd)



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Day Supply (Summer)

- Summer day supply is gas that is R-mixed at the beginning of April each year.
- Summer day gas has an MDQ cap but is not a must take supply.
- If a summer day supply has an MDQ of 10,000 dth then it can take anywhere from 0 to 10,000 dth of gas on any given day in the summer.
- Summer day supply has a slightly higher cost than base supply and it can be contracted from April to November.

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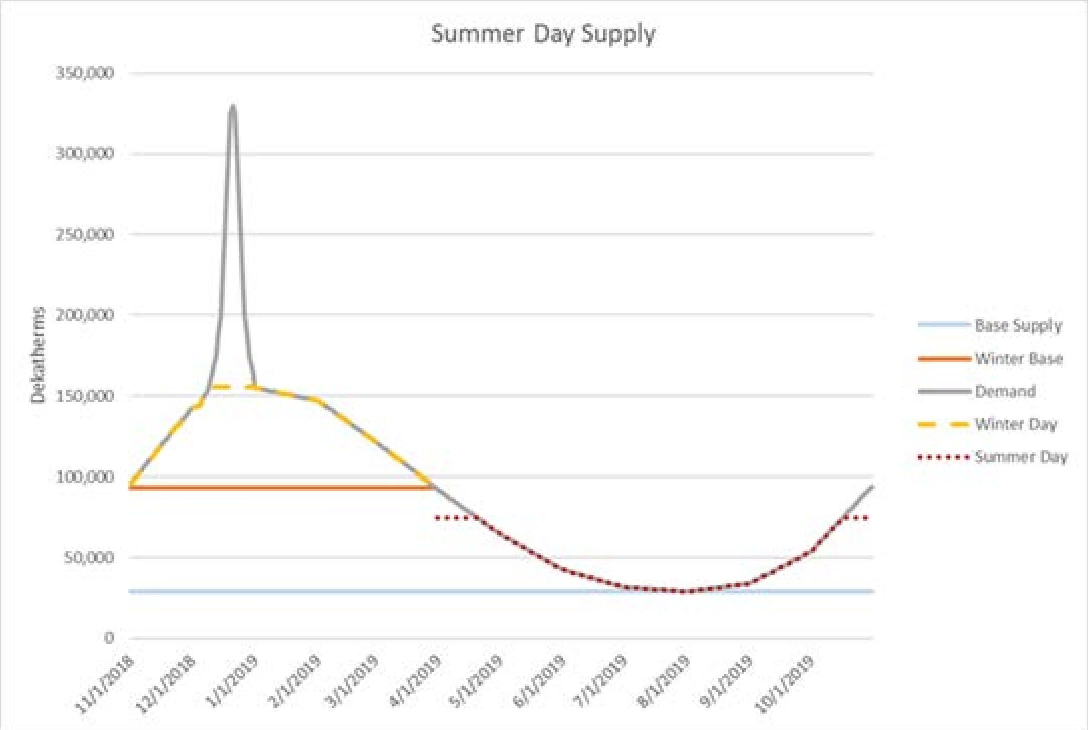
Day Supply (Summer)



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Peak Supply

- Peak supply is gas purchased on high demand days where base, index, winter base, or day supply cannot accommodate.
- Peak supply has a slightly higher premium to buy than day supply.
- As long as Cascade has the transport capacity or can utilize a third party's transport capacity, we can purchase as much peak supply as needed to meet peak demand.

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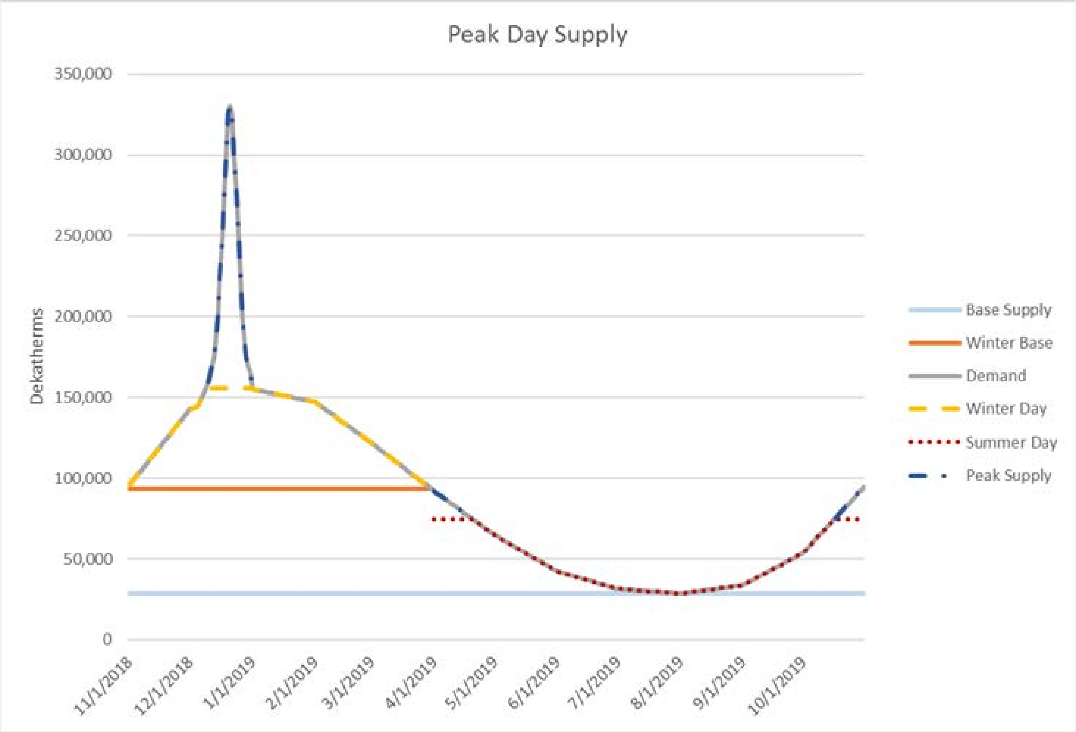
Total Supply



Storage

- Cascade leases storage at 3 locations: Jackson Prairie (JP), Plymouth (Ply), and Mist.
- Cascade has 4 storage contracts with JP, 2 contracts with Plymouth, and 1 with Mist.
- Storage injections targets are set at 35% by the end of June, 80% by the end of August, and 100% by the end of September.
- These targets are set by upstream pipelines' tariffs.
- Cascade can withdrawal approximately 56,000 dth per day from JP, 78,000 dth per day from Plymouth, and 30,000 Dth per day from Mist for a total of approximately 164,000 dth per day.

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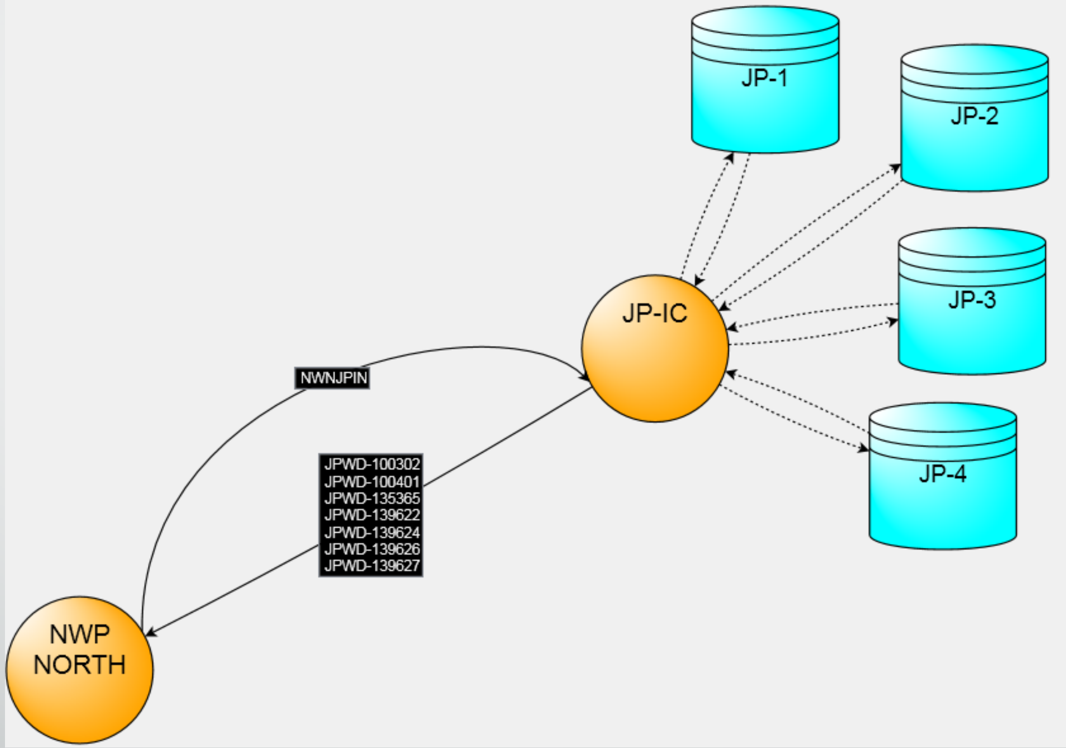
Storage Example



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Storage Example 2

	JAN 2017	FEB 2017	MAR 2017	APR 2017	MAY 2017	JUN 2017	JUL 2017	AUG 2017	SEP 2017	Extension Option	Escalation Pattern	Monthly Multiplier
Process Indicator										Same		
Inventory Maximum Physical Capacity	604351									Same		
Inventory Minimum Physical Percent										Same		
*Target Inv - End of Period Max Pct										Same		
*Target Inv - End of Period Min Pct						35		80	100	First Yeai		
*Inventory Adjustment - Value per Unit										Same		
*Inventory Adjustment - Volume										Same		
*Injection Daily MDQ				16789						First Yeai		
*Injection Daily Min Percent										Same		
*Withdrawal Daily MDQ				0						Last Yeai		
*Withdrawal Daily Min Percent										Same		
Fuel - Injection	0.15									Same		
Fuel - Withdrawal	0.15									Same		
Rate - Carry										Same		
Rate - Injection										Same		
Rate - Withdrawal										Same		
Rate - Other Injection										Same		
Rate - Other Withdrawal										Same		
Rate - Volume Charge										Same		
Rate - D1	.01558									Same		DaysInMontł
Rate - D2	.00057									Same		DaysInMontł
Volume - D1 Volume	16789									Same		
Volume - D2 Volume										Same		
Storage Ratchets Table	JP									Same		
Starting Inv Layer 1 Value per Unit	3									Same		
Starting Inv Layer 1 Volume	604351									Same		
Energy Conversion Factor										Same		
Injection Costing List - Transport										Same		
Injection Costing List - Source										Same		

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Transportation

- Transportation contracts are the means of how Cascade gets the gas from the supplier to the end user.
- Cascade has multiple types of transportation:
  - A single delivery point.
  - Multiple delivery points.
- The multiple delivery point contracts gives Cascade the flexibility to move the gas where it's most needed.
- On NWP, transportation goes to the zonal level because MDDO's can be reallocated within a zone to the citygate. Additionally, NWP typically issues constraint concerns at the zonal level.
- On GTN, transportation goes to the citygate level as MDDO's cannot be reallocated within the GTN zone.

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Transportation (Cont'd)

- Transportation has an MDQ, a D1 rate, a transportation rate, and a fuel loss percentage.
- A maximum delivery quantity (MDQ) which is the maximum amount of gas Cascade can move on the pipeline on a single day.
- A D1 rate which is the reservation rate to have the ability to move the MDQ amount on the pipeline.
- A transportation rate which is the rate per dekatherm that is actually moved on the pipeline.
- The fuel loss percentage is the statutory percent of gas based on the tariff from the pipeline that is lost and unaccounted for from the point of where the gas was purchased to the citygate.

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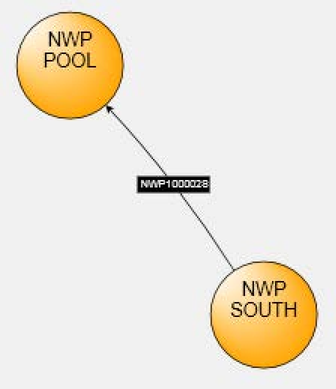
Transport Example



Transport Example

	JAN 2017	FEB 2017	MAR 2017	APR 2017	MAY 2017	JUN 2017	JUL 2017	AUG 2017	SEP 2017	Extension Option	Escalation Pattern	Monthly Multiplier
*Daily MDQ	116866									Same		
*Daily Minimum Percent										Same		
Fuel	1.28									Same		
Rate - Transportation	0.03									Same		
Rate - Other Variable										Same		
Rate - D1 Rate	0.39249									Same		DaysInMontl

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Delivery Rights vs Receipt Rights

- Cascade has more Delivery Rights than Receipt Rights.
- Approximately 457,000 Dth of Delivery Rights.
- Approximately 360,000 Dth of Receipt Rights.
- The excess Delivery Rights allow Cascade to be flexible with the 360,000 Dth of Receipt Rights.

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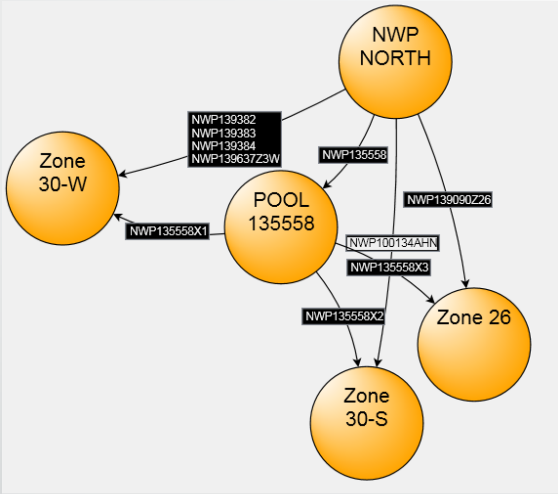
Example of delivery right flexibility



All of the following must be true

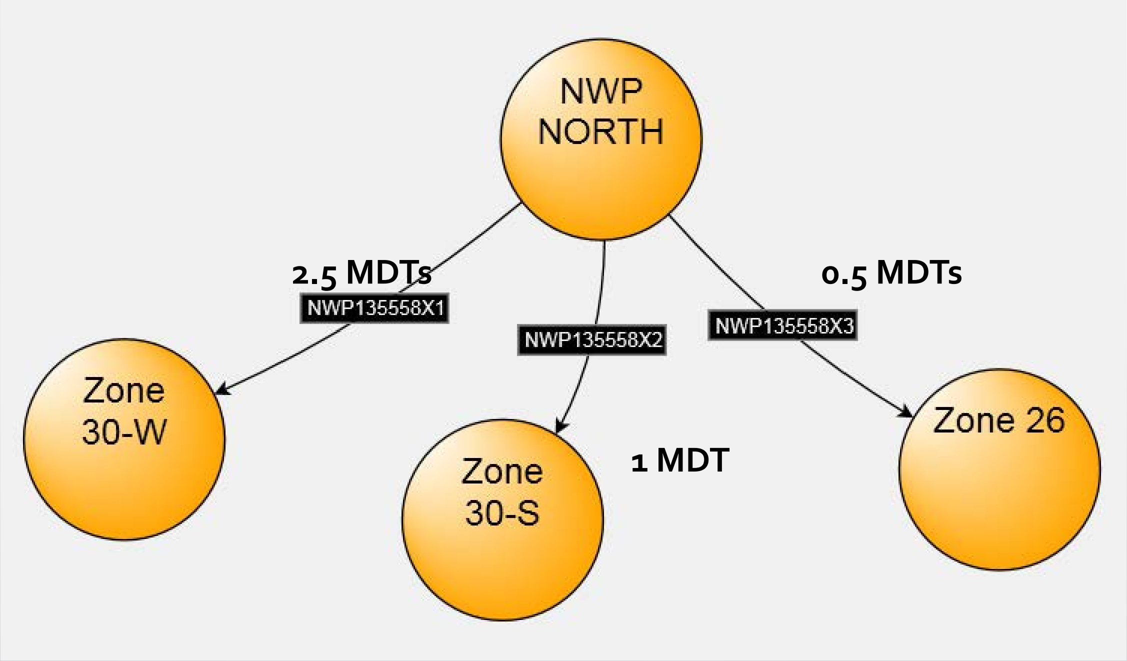
$$X1 \leq 4\text{MDTs}$$

$$X2 \leq 4\text{MDTs}$$

$$X3 \leq 4MDTs$$

$$X1 + X2 + X3 \leq 4MDTs$$

Example of delivery right inflexibility



Transport Constraints

- To simplify modeling in SENDOUT®, the software allows the user to group multiple paths of one contract into a constraint group.
- This tells SENDOUT® to allow each path to take up to X Dekatherms, but not to exceed X Dekatherms for all paths of the contract.
- The analyst identifies which contracts should be in the group and assigns an MDQ for the constraint group.

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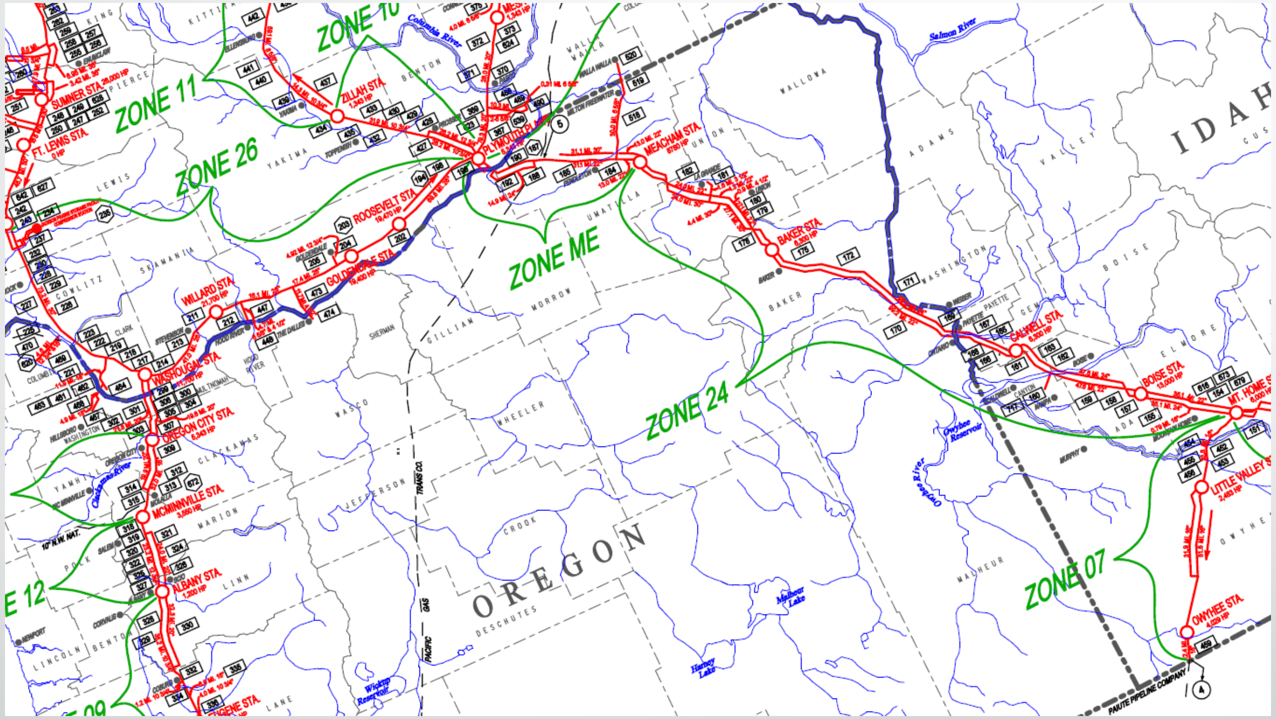
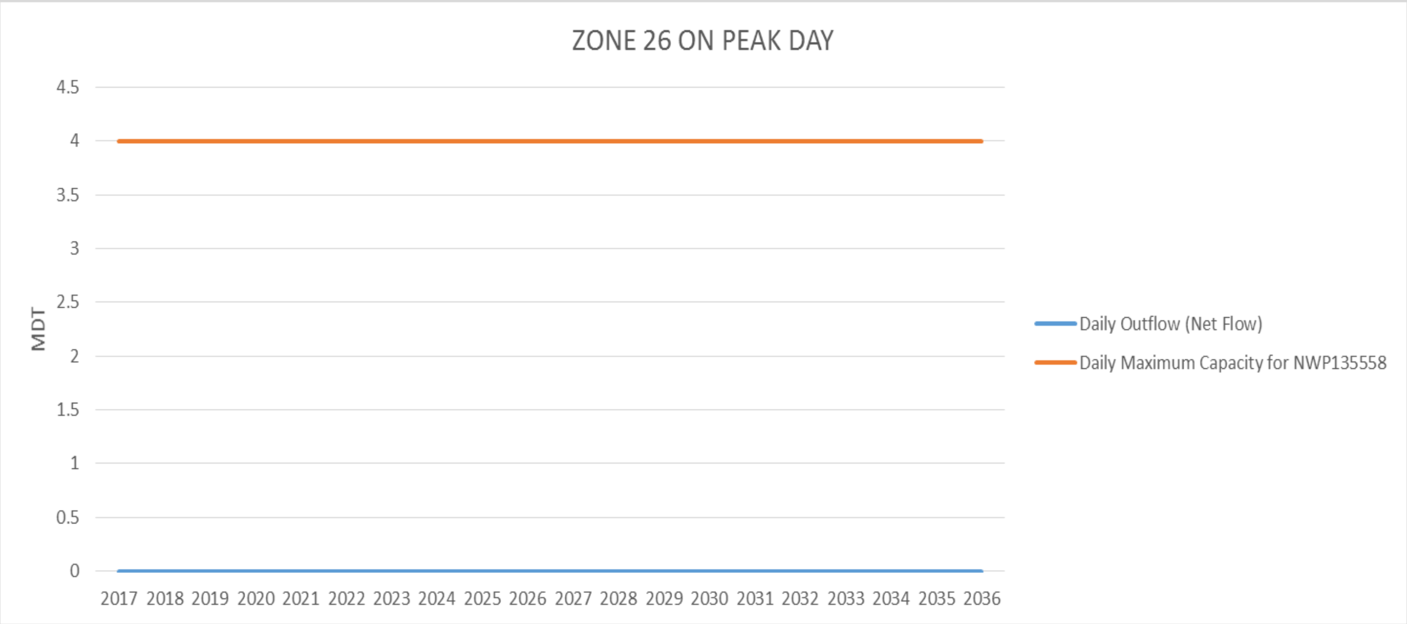
Transport Constraints Example

	JAN 2017	FEB 2017	MAR 2017	APR 2017	MAY 2017	JUN 2017	JUL 2017	AUG 2017	SEP 2017	Extension Option
Annual Max										Same
Annual Min Percent										Same
Seasonal Max										Same
Seasonal Min Percent										Same
Monthly Max										Same
Monthly Min Percent										Same
*Daily Max	47603									Same
*Daily Min Percent										Same
Resource Mix Start\Stop Indicators										Same
RMIX MDQ Max										Same
RMIX MDQ Min										Same
Fixed Rate										Same
Demand Annual Max Percent										Same
Demand Annual Min Percent										Same
Demand Seasonal Max Percent										Same
Demand Seasonal Min Percent										Same
Demand Monthly Max Percent										Same
Demand Monthly Min Percent										Same
*Demand Daily Max Percent										Same
*Demand Daily Min Percent										Same

Location of Zones (Source: NWP)



Zone 26 on Peak Day for Transport 135558



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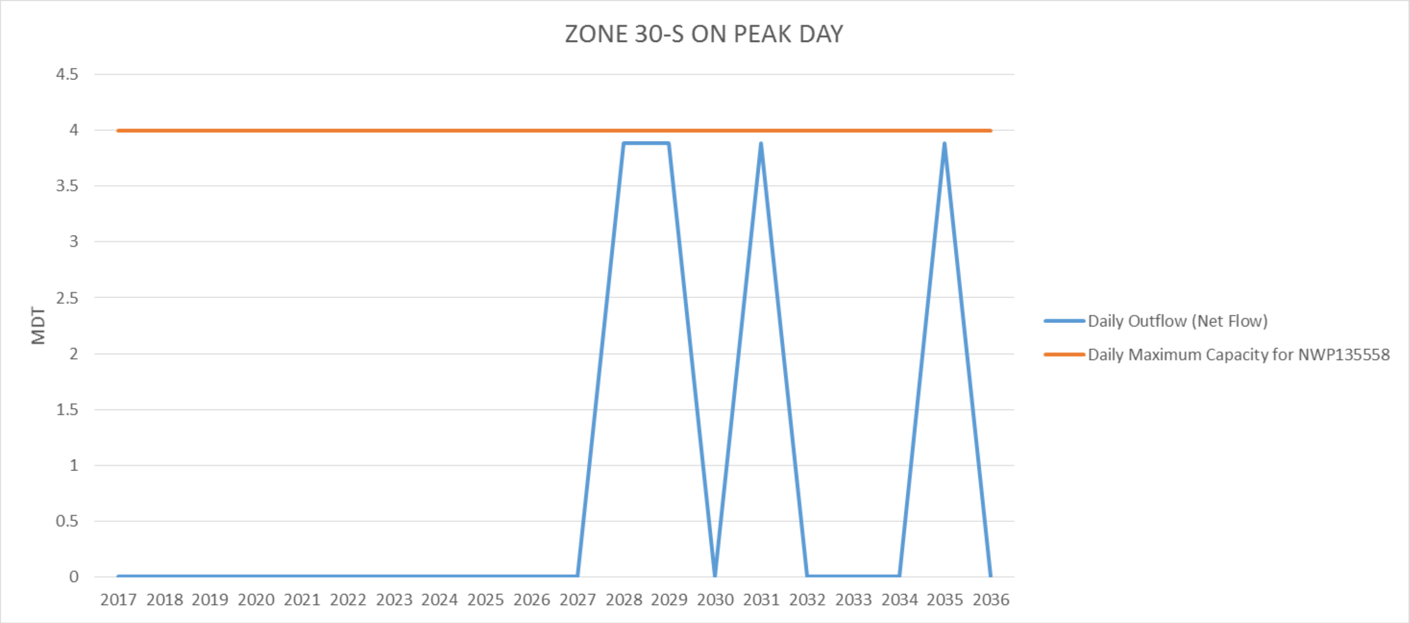
Zone 30-S on Peak Day for Transport 135558



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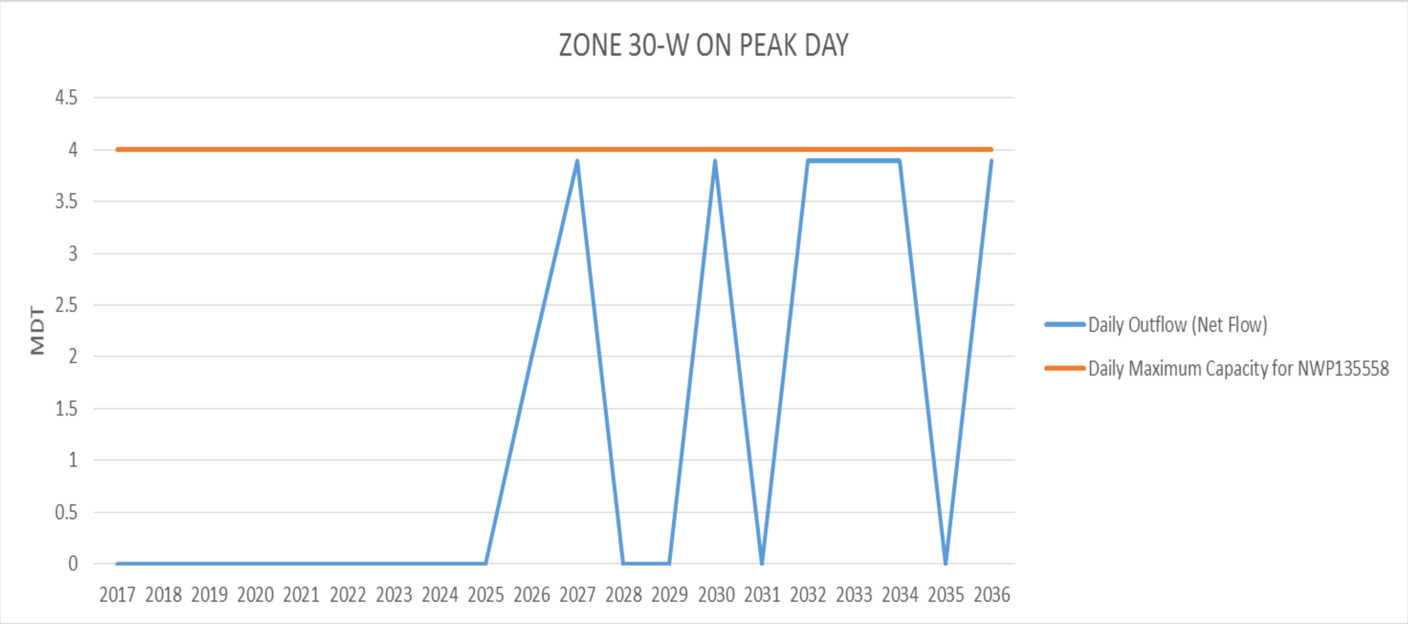
Zone 30-W on Peak Day for Transport 135558



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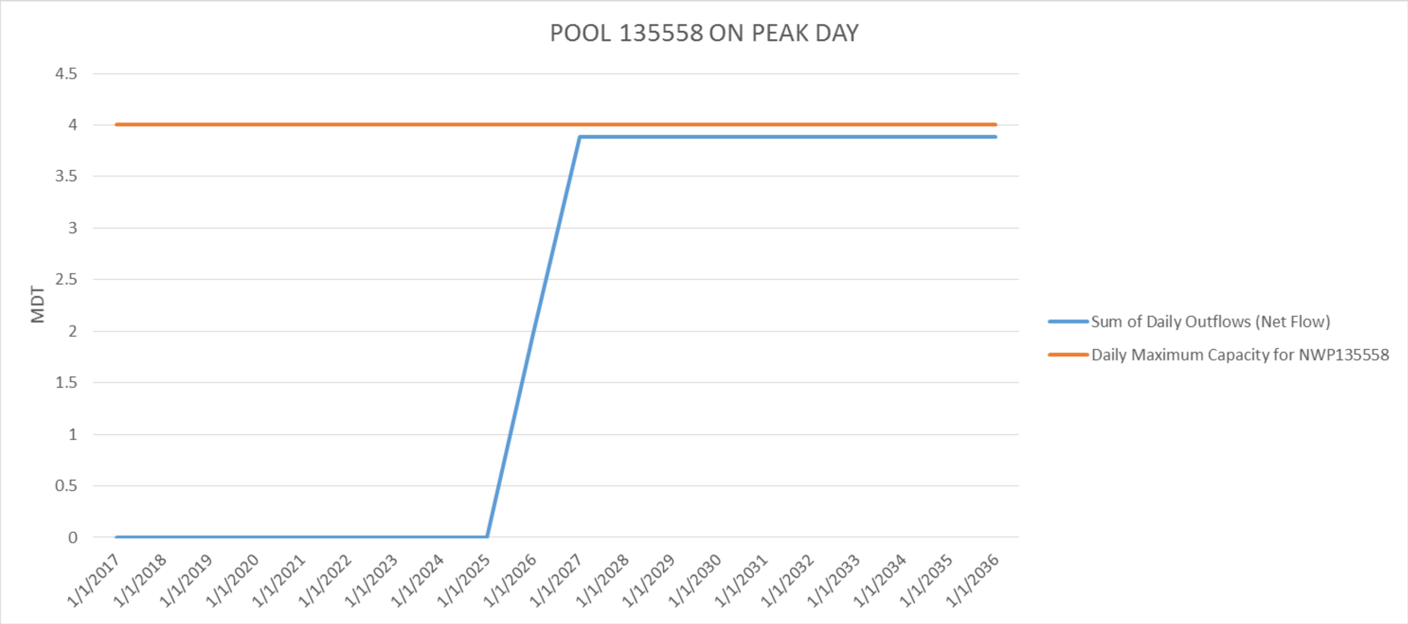
Transport Contract 135558 on Peak Day



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Demand Behind the Gate

- Cascade has strived over the last several years to enhance the IRP forecast and resource analysis to get to as granular a level as possible using the available data.
- Attempts to forecast demand behind the gate using existing forecasting methodology has been challenging.
- Customer billing data does not have daily meter reads for core customers making regression analysis on use per HDD per customer difficult.
- Some towns can be served by multiple pipelines and the mix can change over time.

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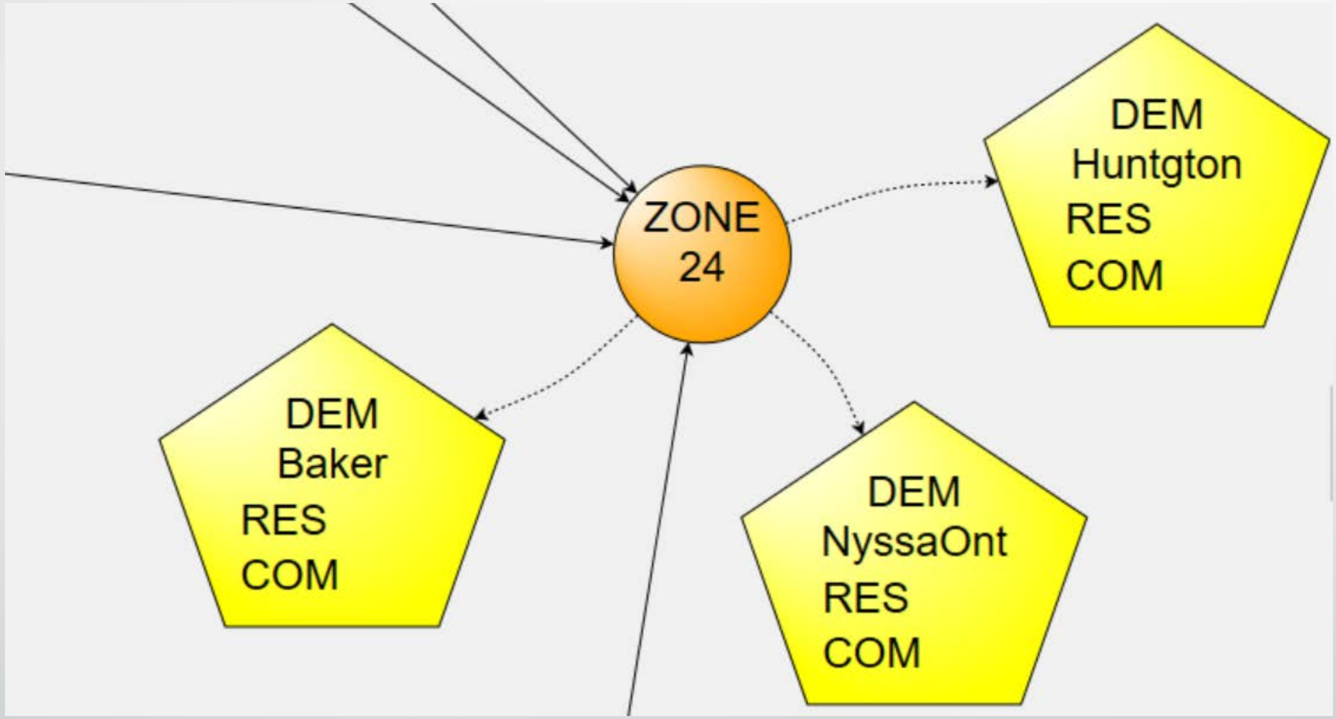
Demand

- Demand is forecasted at the citygate level by rate schedule.
- For NWP, each citygate's demand is associated with the zone.
- For GTN, each citygate's demand is associated with it's respective citygate interconnect.
- Demand Inputs
  - Forecast type (Monthly amount or Regressions).
  - Monthly projected customers for 20 years.
  - Regression coefficients if using the Regression forecast type.
  - If using a monthly number, it is the 2020 demand for that month with a growth factor.

Demand Example



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Demand Example 2

	JAN 2017	FEB 2017	MAR 2017	APR 2017	MAY 2017	JUN 2017	JUL 2017	AUG 2017	SEP 2017	Extension Option	Escalation Pattern	Monthly Multiplier	Index	Adder	Multiplier
Forecast Method	Usage Fac									Same					
Customers	28347	28386	28429	28435	28456	28442	28450	28469	28489	Same					
*Demand - Daily										Same					
Demand - Monthly Base										Same					
Demand - Monthly Heat										Same					
Demand - Monthly Total										Same					
Demand - Percent Factor - non P non Q										Same					
Demand - Percent Factor - non Q										Same					
Usage Factors - Weekday Base	0.1919	0.1659	0.1396	0.0979	0.0741	0.0625	0.0589	0.0581	0.06	First Year					
Usage Factors - Weekday Heat	0.007448									Same					
Usage Factors - Weekend Base	0.186298	0.160298	0.133998	0.092298	0.068498	0.056898	0.053298	0.052498	0.054398	First Year					
Usage Factors - Weekend Heat	0.007448									Same					
*Rate - Unserved Dispatch (Pri 1)										Same					
*Rate - Unserved (Pri 2)	960									Same					

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Weather

- Weather inputs for SENDOUT include:
  - Monte Carlo
  - Historical
  - Normal
- Monte Carlo inputs include mean, standard deviation, max, minimum, and distribution.
- Historical data is used to build weather profiles for Monte Carlo.
- Normal weather is the daily average of the 30-year most recent history (1989-2019).

Weather Example – Monte Carlo

	JAN 2014	FEB 2014	MAR 2014	APR 2014	MAY 2014	JUN 2014	JUL 2014
HDD Mean	1031.8	804.1	639.6	453.9	254.2	92.6	10.3
HDD Std Dev	145.4	133.1	84.4	93.0	72.2	40.4	15.2
HDD Distribution	Normal						
HDD Max	1291	1242	841	641	426	170	75
HDD Min	772	568	448	254	92	19	0
CDD Mean							
CDD Std Dev							
CDD Distribution							
CDD Max							
CDD Min							
Scaling Year	Best Match						

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Preliminary Resource Integration Results

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Preliminary Results

- Cascade has finalized its load forecast for the 2020 WA IRP.
- All of Cascade's existing resources have been run through SENDOUT® to complete the Company's As-is analysis as discussed in Step 1 of the Supply Resource Optimization Process.
  - Assuming contracts evergreen.
  - These preliminary results do not include the impacts of DSM as discussed earlier.
- Cascade has identified no potential shortfalls.

Next Steps

- Cascade will still perform the portfolio analysis as detailed early to identify if a particular resource mix provides a more optimal, least cost/least risk solution.
- Even without current shortfalls, the top ranking candidate portfolio will need to undergo scenario/sensitivity analyses to ensure test its performance under a number of externalities.
- The results of this analysis will be presented in TAG 5

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Remaining Schedule

Date (Subject to change)	State	Process Element	Location (Subject to change)	Notes
Wednesday, September 16, 2020	WA	TAG 5 slides distributed to stakeholders		
Wednesday, September 23, 2020	**WA**	**TAG 5: Final Integration Results, finalization of plan components, Proposed new 4-year Action Plan.**	**SeaTac Airport - 9 am to 12 pm**	
Tuesday, November 17, 2020	WA	Draft of 2020 WA IRP distributed		
Wednesday, December 23, 2020	WA	Comments due on draft from all stakeholders		
Wednesday, January 27, 2021	WA	TAG 6, if needed	WebEx Only	
Friday, February 26, 2021	WA	IRP filing in Washington		

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ADDITIONAL QUESTIONS?

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Bruce Folsom - Consultant

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Cascade Natural Gas Corporation

2020 Integrated Resource Plan

Technical Advisory Group Meeting #4

August 12th, 2020

Teleconference Only

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