Cascade Natural Gas Corporation

2018 Integrated Resource Plan
Technical Advisory Group Meeting #4

August 23rd, 2018

Seattle-Tacoma International Airport

Seattle, WA

CASCADE NATURAL GAS CORPORATION

A Subsidiary of MDU Resources Group, Inc.

In the Community to Serve®

Agenda

- Introductions
- Safety Moment
- Organization Changes
- TAG 2/3 Recap
- Carbon Impacts
- Avoided Cost
- DSM Forecast
- Bio-Natural Gas
- Sendout Modeling
- Preliminary Resource Integration Results
- 2018 IRP Remaining Schedule
- Questions

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

TAG 2/3 Recap

- Cascade values and appreciates the feedback received from stakeholders.
- Responses to stakeholder questions were sent out with the slide deck.
- Additional questions?

Cascade Natural Gas Corporation®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

IRP Carbon Update and Assumptions

Devin McGreal

Andy McDonald

August 23rd, 2018

Topics to Cover Today

- Purpose
- Laying the Foundation
- Reducing Emissions
- The National Focus
- The Regional Focus
- Washington
- Oregon
- The Local Focus
- Types of CO2 Adder Analyses
- Washington and Oregon Commission-Jurisdictional Planning Treatment
- Sensitivities and Impacts on Prices
- Proposed Direction
- Next Steps and Conclusion

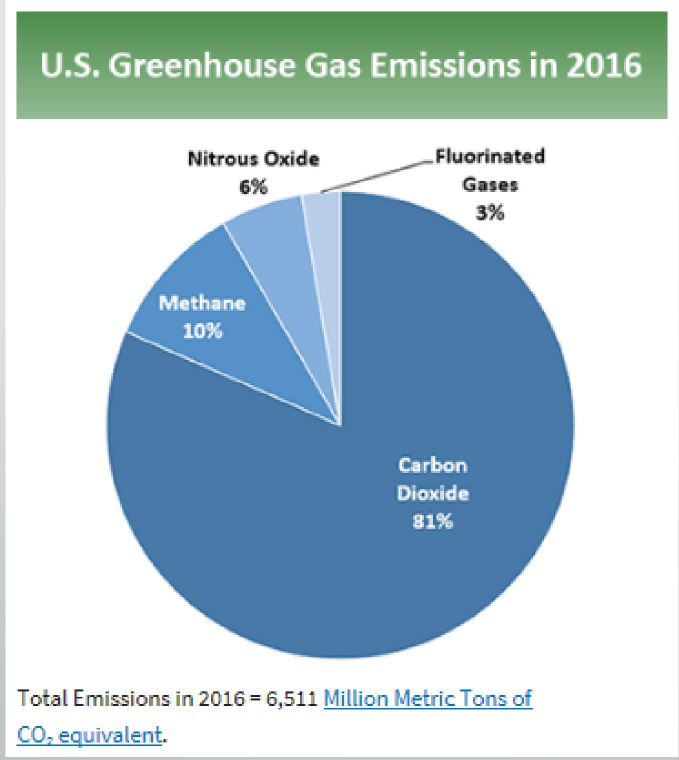
Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Purpose

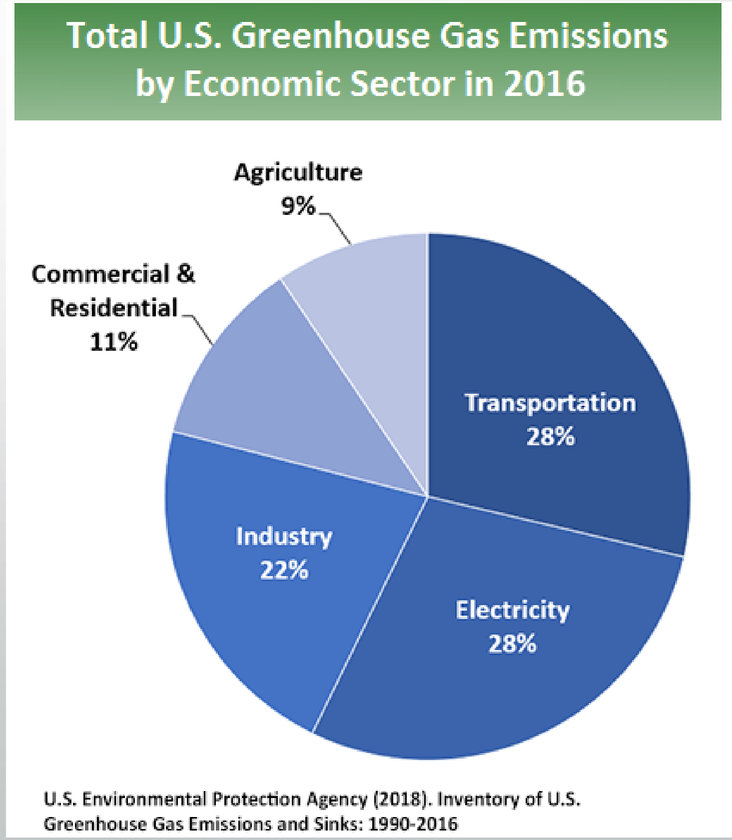
- GHG Policy Update
  - Provide insight into current national, regional/state and local policy activities that inform Cascade Natural Gas Corporation's IRP process.
  - Provide discussion on Cascade's actions to reduce methane leaks and fugitive emissions while ensuring safe, reliable and economic service, 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.

Laying the Foundation

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

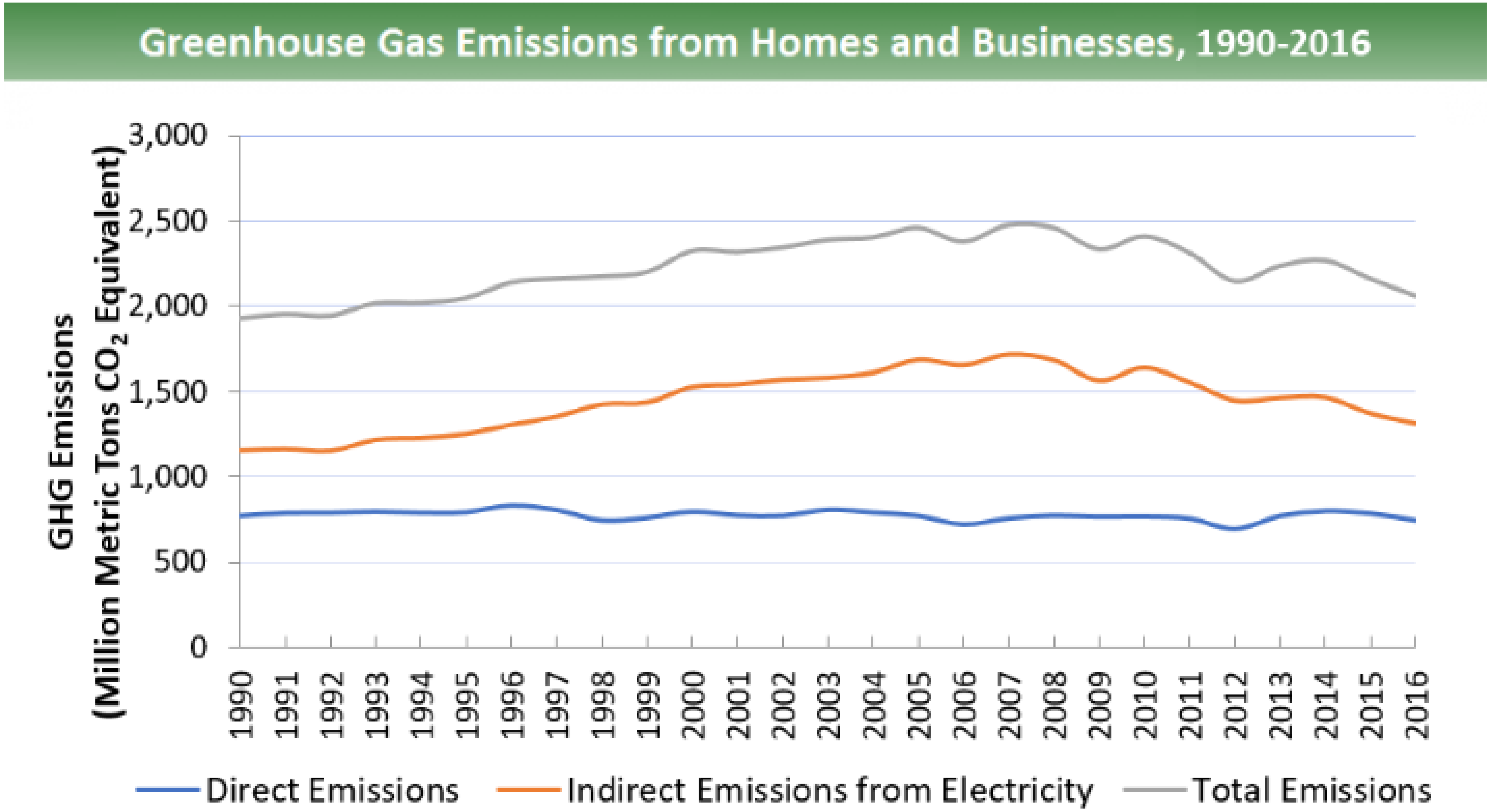


- Main sources of United States GHGs emitted from human activities:



CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

EPA Shows Decreasing Nationwide GHG Emissions Trends in Many Sectors



U.S. Environmental Protection Agency (2018). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2016

All emission estimates from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2016*.

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve

GHG Emissions from Natural Gas

- Electric Generation Sector
  - Combustion emissions have dropped over time and transition to natural gas has helped achieve GHG reductions.

- Oil and Gas Production and Exploration, Transmission, and Storage Sector
  - Fugitive methane emissions and equipment/facility combustion emission.
  - 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…"

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve

GHG Emissions from Natural Gas (cont.)

- Natural Gas Distribution Facility Emissions
  - Fugitive methane emissions from pipeline infrastructure and CO_2 emissions from combustion equipment
    - About 5 percent of oil and gas sector GHG emissions are from natural gas local distribution companies (based on EPA GHG inventory 2016 data)
    - About 0.5 percent of the total US GHG emissions from human activities are from natural gas local distribution companies (based on EPA GHG inventory 2016 data)
    - Cascade's annual facility emissions in Washington are about 27,000 metric tons of CO_2

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

GHG Emissions from Natural Gas (cont.)

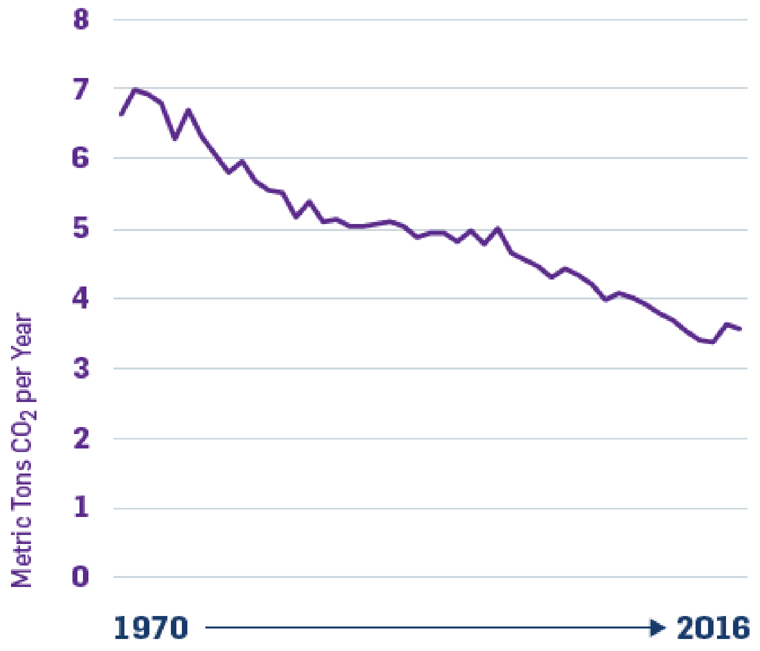
- Natural Gas Distribution Customer Emissions
  - Cascade's customers emit CO_2 emissions from the combustion of natural gas
  - Natural gas sales have increased overtime
  - Cascade's core customer emissions are in the range of about 2 to 2.5 million metric tons of CO_2 per year
  - Energy efficiency programs currently provide targeted emission reductions

Cascade Natural Gas Corporation®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Decreasing Trend for US Natural Gas Distribution Customer CO_2 Emissions

Residential Natural Gas Customers Have Led the Nation in Reducing Emissions for 40 Years

- Since 1970, gas utilities have added 30 million more residential customers with virtually no increases in emissions
- Utilities budgeted $1.5 billion in efficiency programs for 2018
- Utilities helped customers reduce 12.4 million metric tons of carbon dioxide emissions in 2016



Weather- Normalized CO_2 Emissions per Residential Natural Gas Customer

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

American Gas Association, A Thoughtful Pathway 2018

Reducing 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
      - In 2014, created the Public Awareness position
      - 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.
  - System Integrity Projects
    - From 2012-2018, nearly 91 miles of early vintage steel pipe, ranging from service lines up to 12-inch mains, have been replaced with new steel or polyethylene pipe.
    - Cascade is better positioned than most US utilities as it has no unprotected steel pipeline and none of the potentially leak-prone cast iron pipe seen elsewhere
- Streamlining emissions through demand management strategies including conservation and direct use

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Reducing Emissions Through Energy Efficiency

- Cascade is dedicated to expanding its EE efforts
  - Increased conservation goals and targets
  - Residential program step increases
  - Commercial/Industrial program outreach & marketing
  - Regional collaborative approach to market transformation
  - Incorporation of NWPCC methodologies and regional technical forum
  - Emerging technology scanning and support
  - Supporting Wood Fireplace changeout programs
  - Coordination with state and local conservation initiatives

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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, expected due to less national focus
- Local
  - Now seeing city-level action due to less national focus
  - 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

Cascade Natural Gas Corporation®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

The National Focus

- EPA's Clean Power Plan (CPP)
  - Final CCP in August 2015 requiring state-specific reductions in CO_2 emissions from electric sector and did not directly impact natural gas local distribution companies
  - Supreme Court granted stay of the CPP in February 2015 until DC Circuit Court of Appeals issues decision
  - Court has not issued a decision. Court has granted EPA's ongoing requests to hold the case in abeyance and for the abeyance to remain in place until 30 days after the conclusion of EPA's review and future rulemaking.
  - EPA proposed a "CPP Repeal" rule and requested comment in early 2018.
  - EPA's proposed "CPP Replacement" rule is currently being reviewed by Office of Management and Budget (OMB) and is expected to be published in the near future.
  - "CPP Replacement" rule is expected to limit GHG reductions to what is achievable "inside the fence" of a power plant facility.

Cascade Natural Gas Corporation®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

The National Focus (cont.)

- NSPS OOOOa – 40 CFR Part 60 Subpart OOOOa Standards of Performance for Crude Oil and Natural Gas Facilities
  - Reduces methane leaks at new, modified or reconstructed oil and oil and natural gas facilities.
  - Most natural gas local distribution companies are not significantly impacted by this rule.
- Market Choice Act
  - Proposed on July 23rd 2018 in the US House of Representatives as a national carbon tax of $24 per metric ton starting in 2020.
  - Unlikely to move past the House, but important to monitor.
- Vehicle Emissions Standards
  - EPA recently proposed a rule lessening the stringency of fuel economy standards for years 2012- 2026 new cars, SUVs and light duty trucks, citing concerns with maintaining the safety and affordability of vehicles, while also achieving lower pollution.

The National Focus (cont.)

- FERC Review of Pipeline Projects
  - *Sierra Club v. FERC*
    - On August 22, 2017 DC Circuit Court of Appeals held FERC is obligated to consider downstream GHG emissions
    - Remanded FERC's approval of the Southeast Market's Sabal Trail pipeline project for further review of downstream GHG emissions
    - No challenge was made to the US Supreme Court
    - Downstream GHG emissions were quantified, but FERC chose not to use Social Cost of Carbon in determining impacts
    - Permit was approved
  - FERC recently requested public input on implementing GHG/climate change impacts in their NEPA reviews

The Regional Focus

- The Northwest Power & Conservation Council (NWPCC or Council) recently published its 7th Power Plan
  - Most recent release May 2016
  - Significant discussion, analysis, and scenarios regarding CO_2 contained in Chapters 3 and 15
  - Next version draft expected October 2018, final mid-term report on January 2019

- Considerable prior regional collaboration regarding GHG
  - Such as the proposed cap and trade program of the Western Climate Initiative

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.)
  - Natural gas utilities argued CAR should be invalidated due to:
    1. Ecology does not have authority to regulate non-emitting sources for their customers' emissions
    2. Ecology does not have authority to implement a program to limit statewide greenhouse gas emissions, particularly a trading program based on ERUs
  - 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
  - Briefing is in progress. It is unknown when a decision on appeal will be issued, but is not expected before IRP filing

Washington (continued)

- Initiative 1631 (I-1631) – Washington Carbon Emissions Fee and Revenue Allocation Initiative
  - Charges a carbon tax of $15 per ton of carbon dioxide in 2020
  - Increases $2 per ton per year plus inflation
  - By 2030, price would be about $40 per ton and may increase further depending on whether the state is expected to meet its statutory greenhouse gas targets
  - By 2045, price would be about $85 per ton
- 2018 Legislation Considered but Not Passed
  - SB 6335 (Hobbs) $15 per ton in 2019, $25 per ton in 2024
  - SB 6096 (Ranker) $15 per ton in 2019 with $2.50 annual escalation until $30 per ton in 2025
  - SB 6203 (Inslee/Carlyle) $12 per ton in 2020 with $1.80 annual escalation and $30 per ton cap
- More legislation expected in 2019
- Significant other state policies with CO2 impacts
  - SHB 2580 – Promoting Renewable Natural Gas
  - Electric Vehicle Action Plan
  - Potential Residential Energy Code Changes in 2019

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Oregon

- Executive Order No. 17-20
  - Zero energy ready buildings & high performance energy targets for existing state buildings
  - Appliance efficiency standards review
  - ETO Pilot Programs
- SB344 – Inventory of Biogas and Renewable Natural Gas in Oregon
- 2018 Legislation Considered but Not Passed
  - GHG Cap and trade program bills – HB 4001, SB 1507
- Additional cap and trade proposals may be introduced in the 2019 legislative session
  - Joint Interim Committee on Carbon Reductions
- VW Settlement Funds
  - DEQ authorized to fund school bus projects
  - Treatment of at least 450 diesel powered buses
  - 20 buses qualified in CNGC service territory

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.

Cascade Natural Gas Corporation®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

The Local Focus - City of Bellingham (cont.)

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

	2012 *Target*	2015 *Actual Emissions*	2020 *Target*	2030 *Target*	2050 *Target*
Municipal **reduction measures:** 3 completed, 20 long-term ongoing	-64% emissions from 2000 *exceeded (-69.5%)*	-68.3% from 2000	-70% from 2000	-85% from 2000	-100% from 2000
Community **reduction measures:** 5 completed, 43 long-term ongoing	-7% emissions from 2000 *exceeded (-17%)*	-10.4% from 2000	70% -[illegible]% from 2000	-40% from 2000	-85% from 2000

TABLE 1. *Municipal (city government operations) and community (within city limits) progress toward climate targets (which include green power purchases).*

Climate Protection Action Plan 2018 Update (51MB)

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

The Local Focus - City of Bend

- Council Resolution 3044 passed by City of Bend in 2016
  - Established voluntary goals for City facilities and operations
    - 40% reduction of 2010 baseline year emissions by 2030
    - 70% reduction of 2010 baseline year emissions by 2050
    - May determine to use more recent years for baseline
  - May establish same voluntary goals community-wide
- Council Resolution 3099 created an ad hoc Climate Action Steering Committee (CASC)
    - Meeting in 2017-2019 to provide recommended action to City Council that encourage and incentivize voluntary efforts to reduce GHG emissions and fossil fuel use
  - Community Climate Action Plan (C-CAP)
    - CASC will recommend a set of strategies in the plan to guide both the City and the community in achieving the goals

Cascade Natural Gas Corporation®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Types of CO_2 Adder Analyses

- Cascade will be using the Social Cost of Carbon forecast with a 3% discount rate, from the Interagency Working Group on the Social Cost of Greenhouse Gases, as per guidance received from stakeholders in prior workshops.
- Other methodologies were considered, and may be modeled as sensitivity analyses:
  - I-1631 Ballot Initiative
  - Gov. Inslee proposed tax
  - House of Representatives Market Choice
  - Expected Value blend of multiple approaches?

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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

Washington and Oregon Commission-Jurisdictional Planning Treatment of CO_2 Emissions

- In their acknowledgment of many recent regional IRPs, the WUTC has indicated a strong desire for LDCs to use SCC as their baseline for carbon analysis
- Local Distribution Company acknowledgments:
  - PSE
    - UE-160918 and UG-160919
  - Pacific Power
    - UE-160353
  - Avista
    - UE-161036
- Cascade is not using ERU costs as a carbon adder due to Thurston County Court invalidating CAR

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Questions…

…and thank you

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Avoided Cost Methodology and Calculation

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Avoided Cost Overview

- As part of the IRP process, Cascade produces a 20-year price forecast and 45 years of avoided costs.
- The avoided cost is an estimated cost to serve the next unit of demand with a supply side resource option at a point in time. This incremental cost to serve represents the cost that could be avoided through energy conservation.
- The avoided cost forecast can be used as a guideline for comparing energy conservation with the cost of acquiring and transporting natural gas to meet demand.

Cascade Natural Gas Corporation®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Avoided Cost Overview

- For the 2018 IRP, Cascade has revamped its avoided cost formula to create a more transparent and intuitive final number.
- Cascade evaluates the impact that a range of environmental externalities, including CO_2 emission prices, would have on the avoided costs in terms of cost adders and supply costs.
- The Company produces an expected avoided cost case based on peak day for each of four climate zones.

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Avoided Cost Formula

The components that go into Cascade's avoided cost calculation are as follows:

$$AC_{nominal} = TC_F + TC_v + SC_v + ((CC + C_{tax}) * E_{adder}) + DSC + RP$$

Where

- $AC_{nominal}$ = The nominal avoided cost for a given year. To put this into real dollars you must apply the following: Avoided Cost/(1+discount rate)^Years from the reference year.
- TC_F = Incremental Fixed Transportation Costs
- TC_v = Variable Transportation Costs
- SC_v = Variable Storage Costs
- CC = Commodity Costs
- C_{tax} = Carbon Tax
- E_{adder} = Environmental Adder, as recommended by the Northwest Power and Conservation Council
- DSC = Distribution System Costs
- RP = Risk Premium

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Incremental Fixed Transportation Costs

- Cascade identifies when its shortfalls would begin in a pre-DSM environment and takes the simple average of all cost effective solutions for its fixed transportation costs.
- Only costs for incremental transportation is included because current fixed costs are not avoidable.
- These costs typically account for about 0-8% of avoided costs in a given year.

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Variable Transportation Costs

- Cascade takes the simple average of current transportation costs pre-shortfalls, and the simple average of incremental transportation costs post shortfalls, for its variable transportation costs.
- Since variable costs are only charged on therms that flow through the upstream pipeline these are avoidable for existing contracts.
- These cost typically account for less then 1% of the avoided cost.

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Storage Costs

- These would be the costs associated with a storage contract that would be used to solve for some or all of Cascade's peak day shortfalls, such as on system storage.
- Currently Cascade has no on system storage, such as Mist, and does not foresee on system storage as being part of the Company's preferred portfolio, so these costs are zero.

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Commodity Costs

- Commodity Costs are derived from Cascade's price forecast for the AECO, Rockies and Sumas basins.
- Cascade uses SENDOUT to calculate how each basin should be weighted in each climate zone.
- Avoided costs are run using peak pricing versus annual pricing.
- Commodity Costs are one of the major factors of Cascade's avoided cost calculation, accounting for 40-80% of the total avoided cost

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Carbon Tax

- New to this IRP in Washington, Cascade will be modeling the impact of a carbon tax by analyzing the impact of a number of actual proposed carbon futures.
- As per guidance from stakeholders in previous workshops, Cascade's base case carbon forecast will be based on the Social Cost of Carbon with a 3% discount rate.
- Using this forecast, these costs account for 0-45% of avoided costs.

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Environmental Adder

- Cascade modifies its commodity and carbon compliance costs by a 10% adder, as recommended by the NWPCC.
- There is some debate as to whether this is double counting the costs of the carbon compliance. Cascade will continue to use this adder but will look to the next power plan and regional best practices for guidance.

Distribution System Costs

- New to this IRP cycle, Cascade will include avoided distribution system costs in its final calculation.
- These are calculated by taking Cascade's margin for each rate class, and deriving a one day system weighted margin figure, which is assumed to grow by inflation each year.
- These costs account for approximate 15-35% of Cascade's avoided cost

Risk Premium

- Cascade's avoided cost formula allows for an additional adder to account for a premium associated with the uncertainty around the other factors of the avoided cost versus the relative certainty of energy efficiency programs.
- With gas prices so low and volatility very low, Cascade does not believe there is a material risk premium in this year's avoided cost calculation, so this factor is zero.

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

DSM FORECAST, 2018 IRP

TAG 4, Thursday, August 23rd, 2018

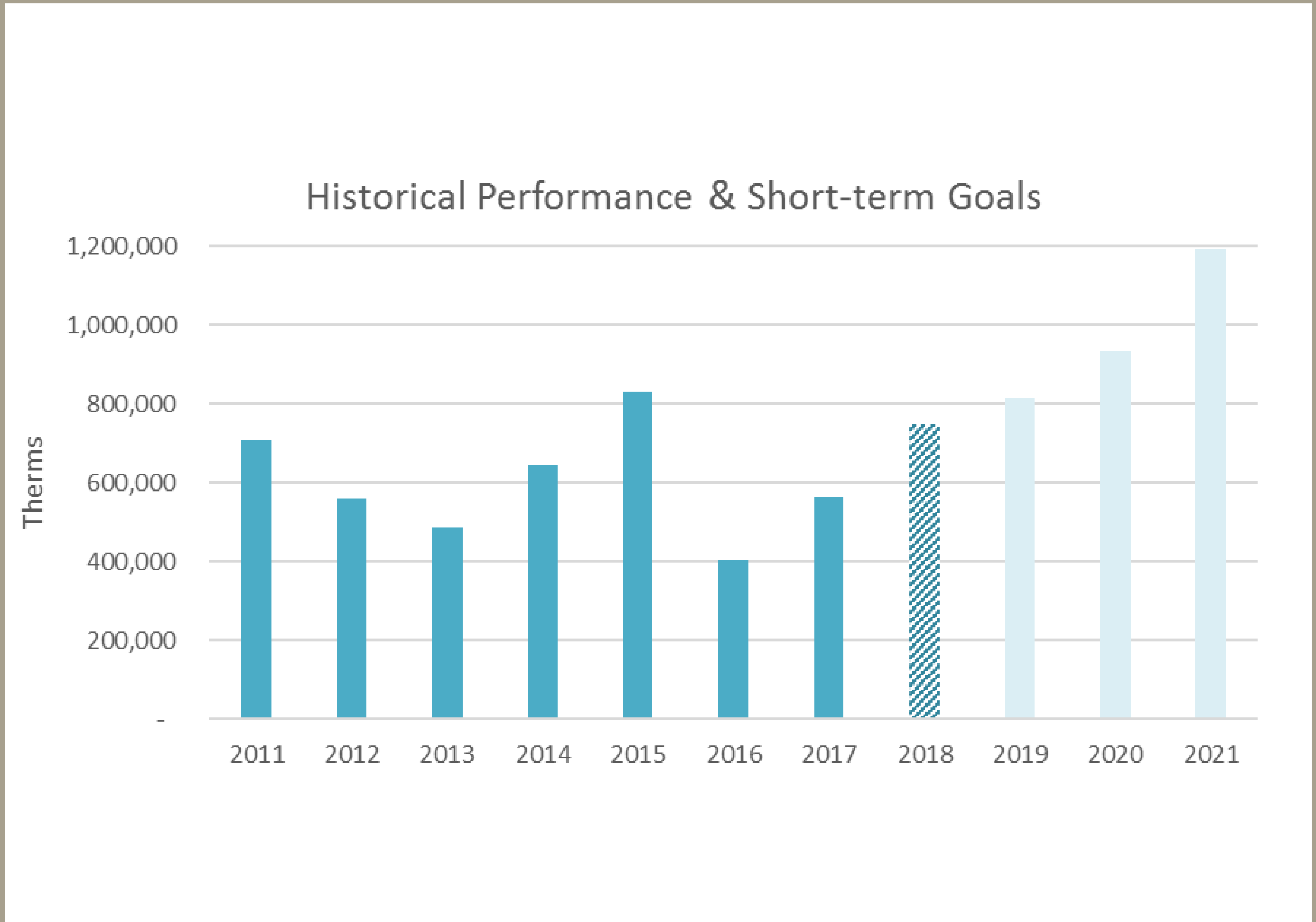
Monica Cowlishaw & Amanda Sargent

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

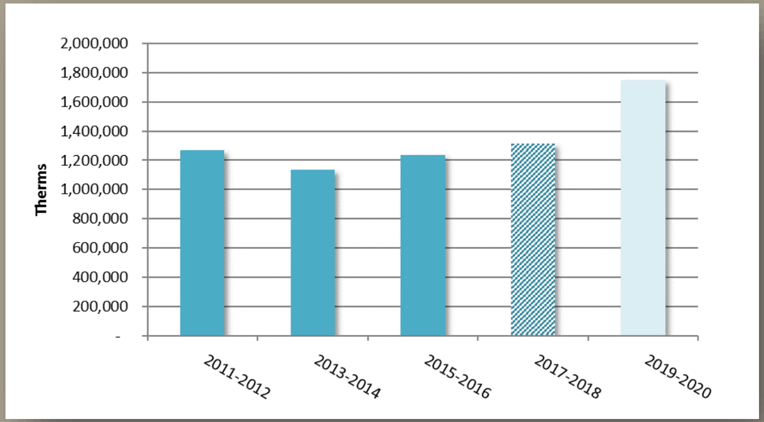
In the Community to Serve®

ELEMENTS OF THE DSM CHAPTER

- Overview
  - 2016 Deliverables
    - New Conservation Potential Assessment (included in Appendix)
    - NWPCC forecast methodology and ramp rate alignment
  - Historic Program Performance



← ANNUAL PERFORMANCE



↑ BIENNIUM PERFORMANCE

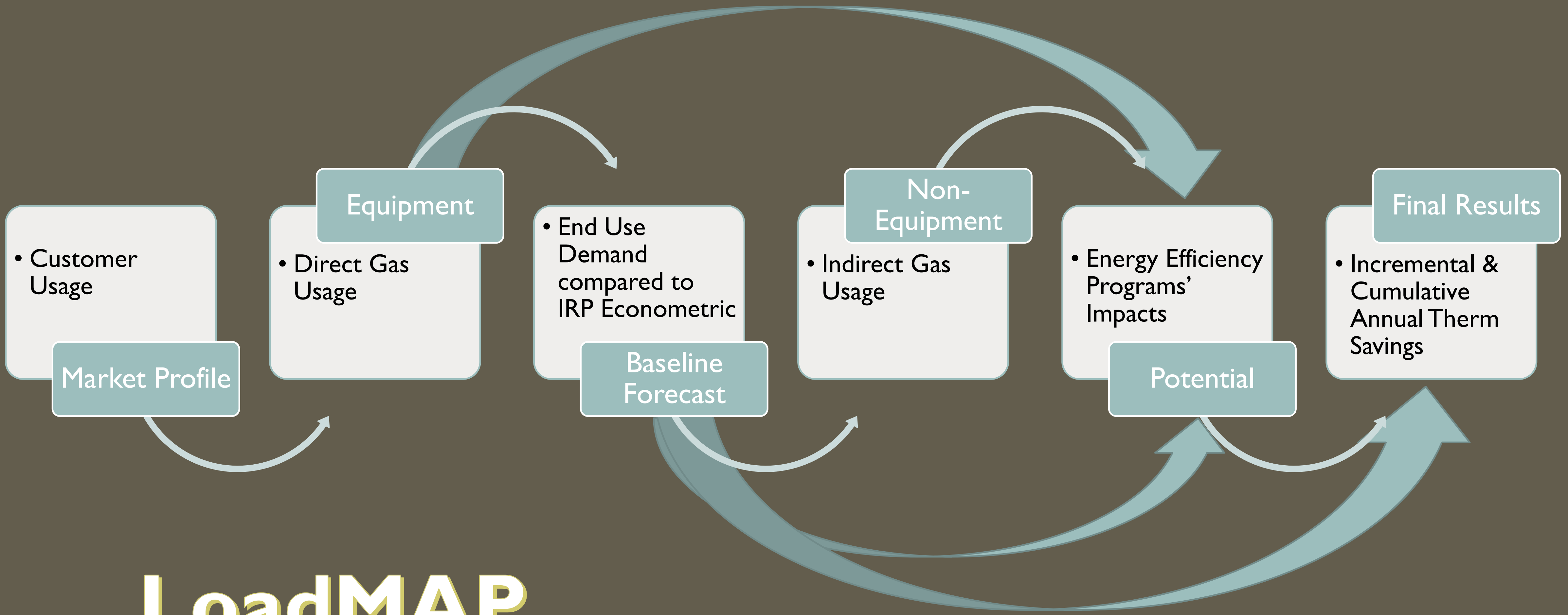
ANNUAL SHORT TERM GOALS

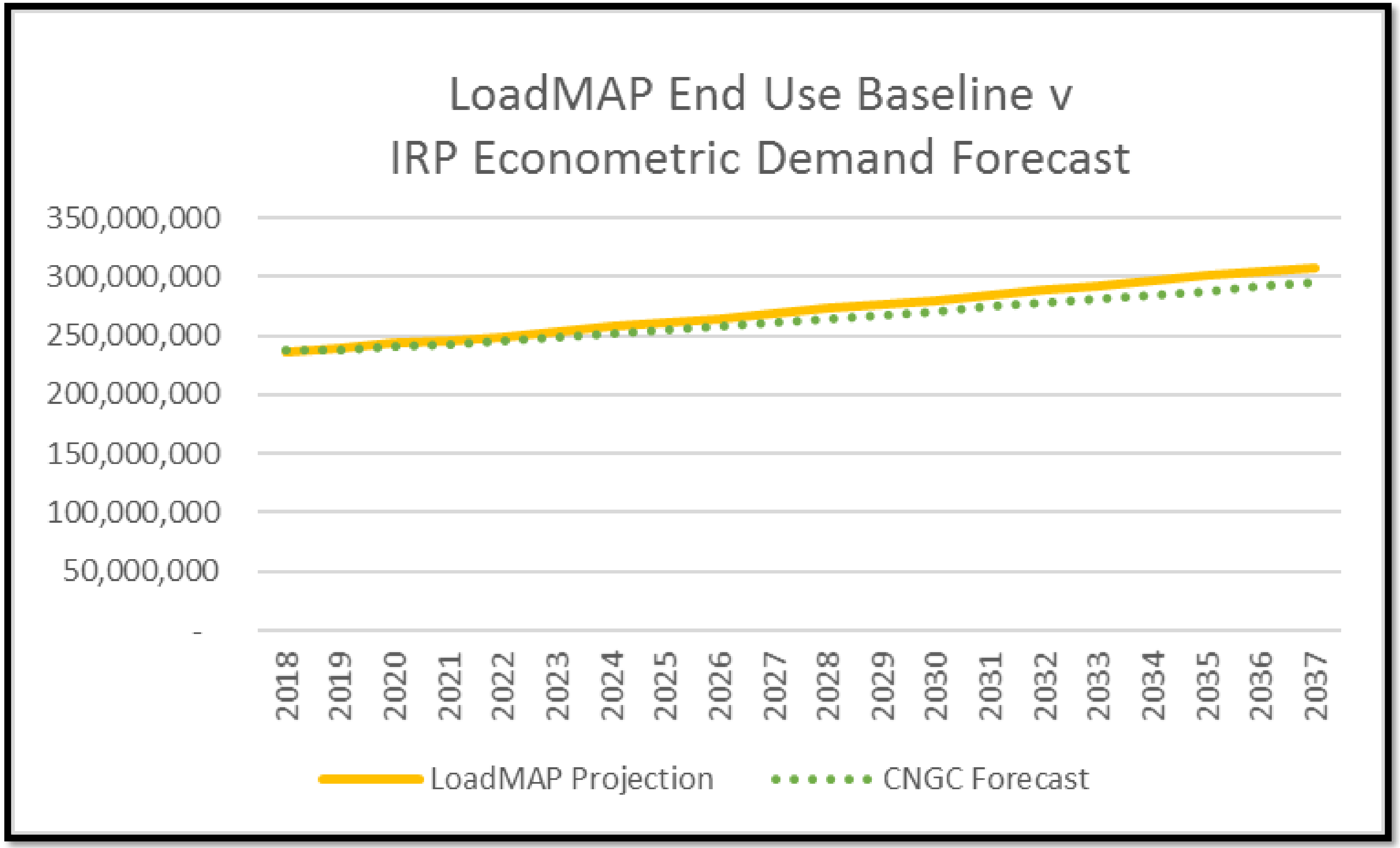
	2018	2019	2020
C&I	328,807	415,266	479,323
RES	363,319	401,117	455,251

ELEMENTS OF THE DSM CHAPTER

- Conservation Planning
  - Prospective Portfolio Updates
  - Pathways to achieve 10 year goals
- Goals and Budget Estimates
- Benefit Cost Test Analysis
- 2018 Energy Efficiency Two Year Action Plan
  - Outreach & Messaging
    - Community Partnerships & Targeted Outreach

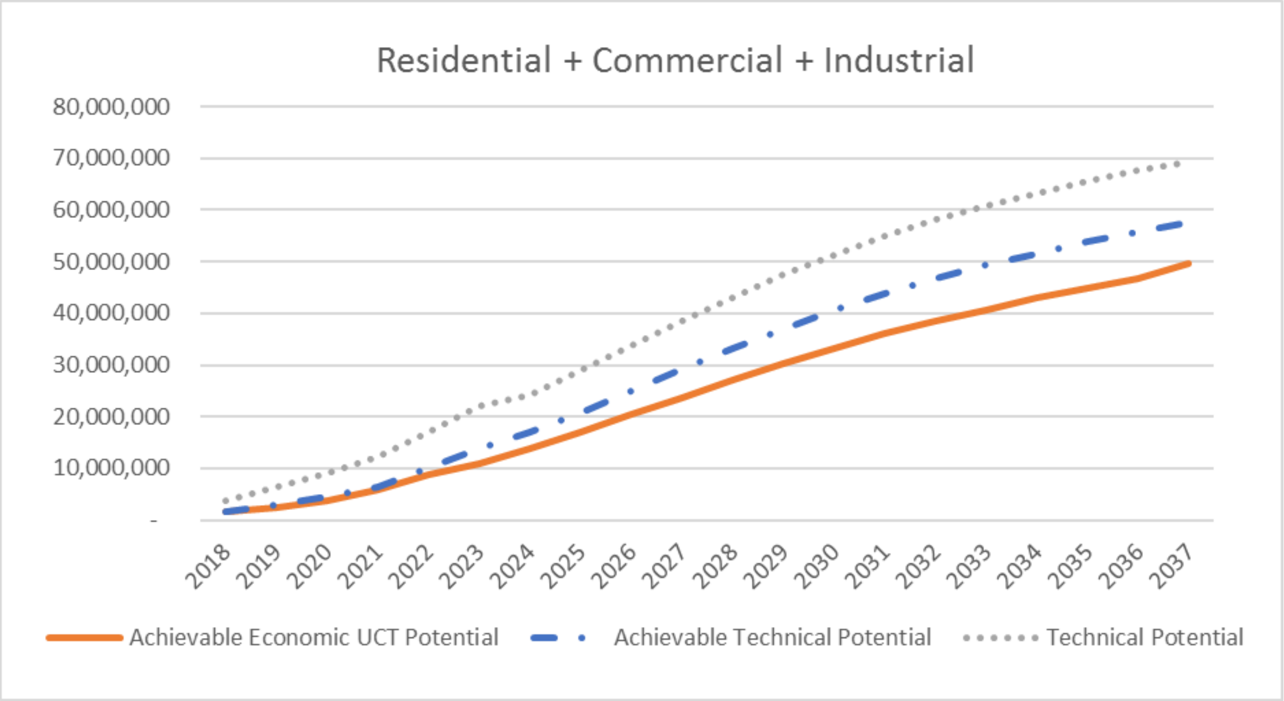
LoadMAP Sequence



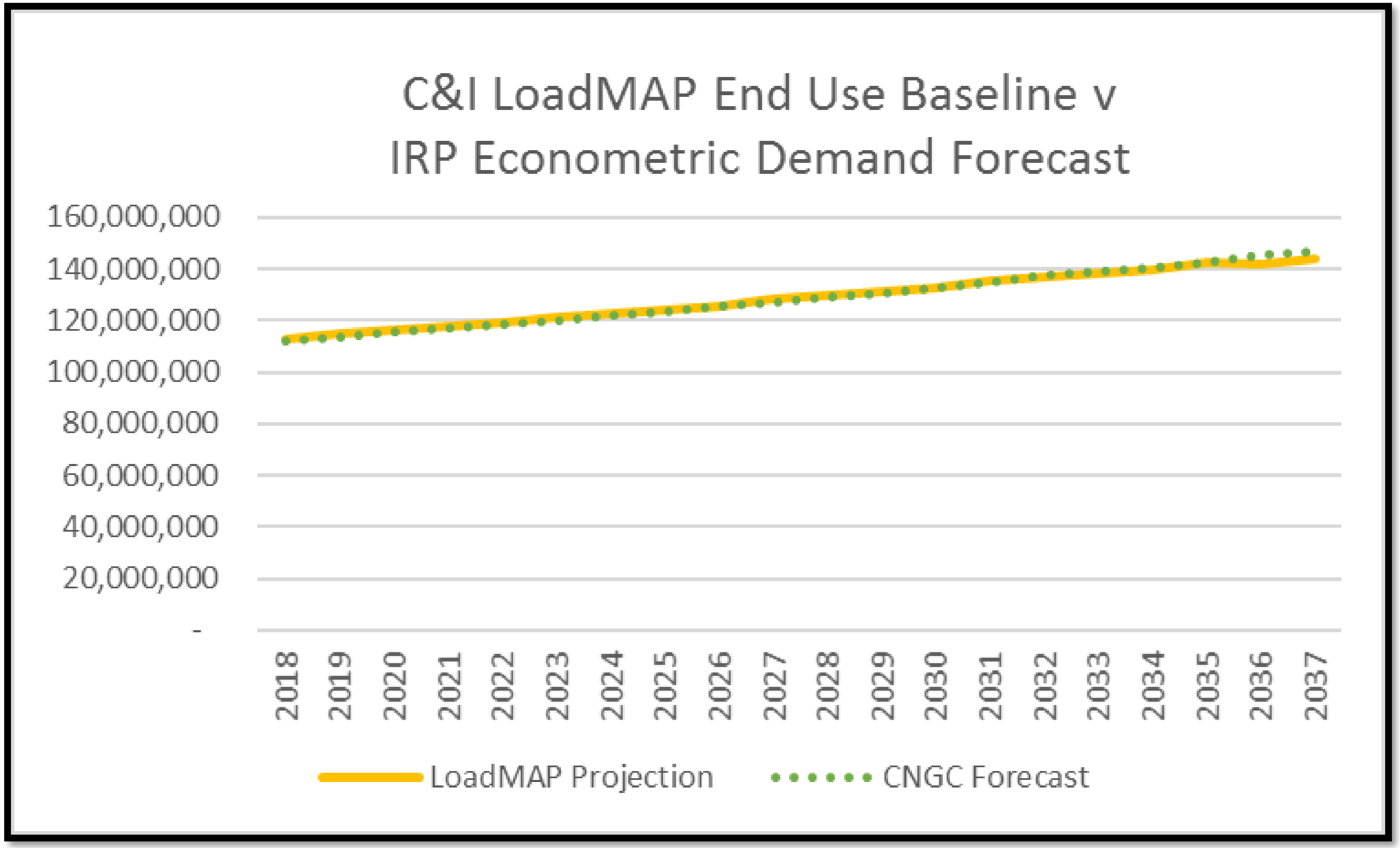


FORECAST COMPARISON

CUMULATIVE POTENTIAL DSM FORECAST



COMMERCIAL & INDUSTRIAL



C&I BASELINE COMPARISON

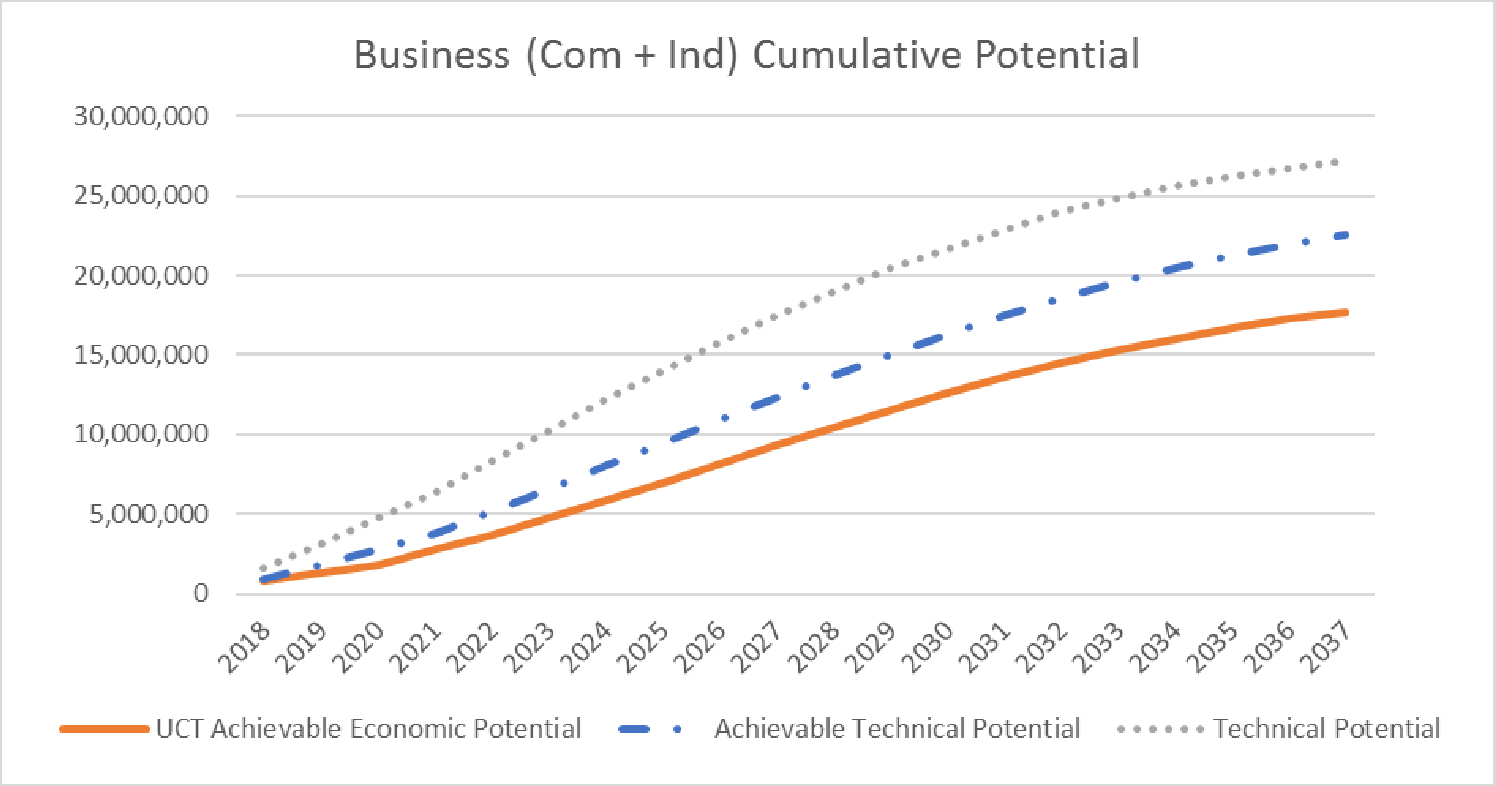
COMMERCIAL FORECAST SUMMARY

Summary of Energy Savings (therms), Selected Years	2018	2019	2020	2022	2028	2038
Baseline Forecast (therms)	88,483,161	90,091,358	91,205,068	93,684,393	102,242,675	130,660,356
Potential Forecasts (therms)						
UCT Achievable Economic Potential	88,154,354	89,409,245	90,110,833	91,290,596	93,951,450	114,567,443
TRC Achievable Economic Potential	88,223,772	89,554,255	90,339,363	91,717,094	95,139,028	116,884,352
Achievable Technical Potential	87,647,752	88,409,501	88,628,509	88,886,010	89,630,200	109,456,837
Technical Potential	87,005,599	87,136,887	86,750,093	85,873,696	84,596,621	105,187,379
Cumulative Savings (therms)						
UCT Achievable Economic Potential	328,807	682,113	1,094,235	2,393,797	8,291,225	16,092,913
TRC Achievable Economic Potential	259,389	537,103	865,704	1,967,299	7,103,647	13,776,004
Achievable Technical Potential	835,409	1,681,857	2,576,558	4,798,383	12,612,475	21,203,518
Technical Potential	1,477,562	2,954,471	4,454,974	7,810,697	17,646,054	25,472,977
Energy Savings (% of Baseline)						
UCT Achievable Economic Potential	0.4%	0.8%	1.2%	2.6%	8.1%	12.3%
TRC Achievable Economic Potential	0.3%	0.6%	0.9%	2.1%	6.9%	10.5%
Achievable Technical Potential	0.9%	1.9%	2.8%	5.1%	12.3%	16.2%
Technical Potential	1.7%	3.3%	4.9%	8.3%	17.3%	19.5%
Incremental Savings (therms)						
UCT Achievable Economic Potential	328,807	354,891	415,598	825,719	1,104,473	888,630
TRC Achievable Economic Potential	259,389	278,779	330,974	717,786	963,972	775,707
Achievable Technical Potential	835,409	854,631	911,577	1,301,446	1,412,237	960,026
Technical Potential	1,477,562	1,488,445	1,523,723	1,876,154	1,691,119	1,158,787

INDUSTRIAL FORECAST SUMMARY

Summary of Energy Savings (therms), Selected Years	2018	2019	2020	2022	2028
Baseline Forecast (mmTherms)	24,136,140	24,778,429	24,988,671	25,279,998	27,322,555
Potential Forecasts (mmTherms)					
UCT Achievable Economic Potential	24,076,166	24,658,182	24,804,912	24,914,869	26,304,750
TRC Achievable Economic Potential	24,079,851	24,666,546	24,818,858	24,941,526	26,372,329
Achievable Technical Potential	24,069,346	24,645,139	24,785,898	24,884,901	26,250,889
Technical Potential	24,042,048	24,592,175	24,708,611	24,755,724	25,992,179
Cumulative Savings (mmTherms)					
UCT Achievable Economic Potential	59,974	120,247	183,759	365,129	1,017,806
TRC Achievable Economic Potential	56,288	111,883	169,813	338,472	950,227
Achievable Technical Potential	66,794	133,290	202,773	395,097	1,071,667
Technical Potential	94,092	186,254	280,060	524,274	1,330,376
Energy Savings (% of Baseline)					
UCT Achievable Economic Potential	0.2%	0.5%	0.7%	1.4%	3.7%
TRC Achievable Economic Potential	0.2%	0.5%	0.7%	1.3%	3.5%
Achievable Technical Potential	0.3%	0.5%	0.8%	1.6%	3.9%
Technical Potential	0.4%	0.8%	1.1%	2.1%	4.9%
Incremental Savings (mmTherms)					
UCT Achievable Economic Potential	59,973.8	60,375.1	63,725.1	114,016.4	104,139.8
TRC Achievable Economic Potential	56,288.2	55,689.5	58,124.8	107,524.4	96,946.3
Achievable Technical Potential	66,793.8	66,647.5	69,798.9	119,530.7	108,159.3
Technical Potential	94,091.8	92,389.7	94,275.9	148,767.1	127,341.6

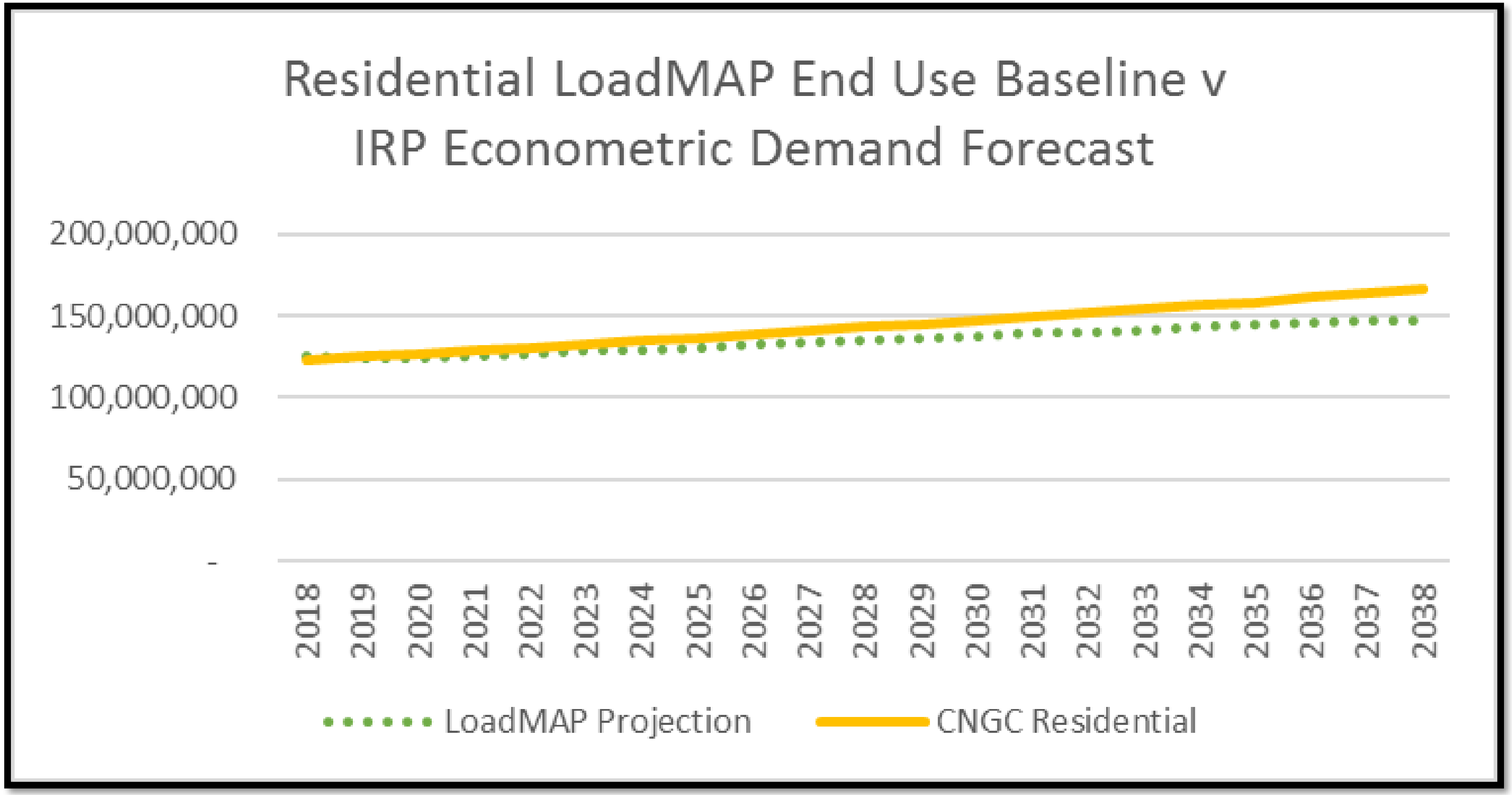
BUSINESS
20 YEAR DSM



TOP TEN MEASURES

Measure
Boiler - AFUE 98%
Fryer - ENERGY STAR
Insulation - Roof/Ceiling - R-38
HVAC - Demand Controlled Ventilation - DCV enabled
Insulation - Wall Cavity - R-21
Gas Boiler - Insulate Steam Lines/Condensate Tank - Lines and condenstate tank
Water Heater - TE 0.94
Retrocommissioning - HVAC - Optimized HVAC flow and controls
Furnace - AFUE 95%
Space Heating - Heat Recovery Ventilator - HRV installed

RESIDENTIAL

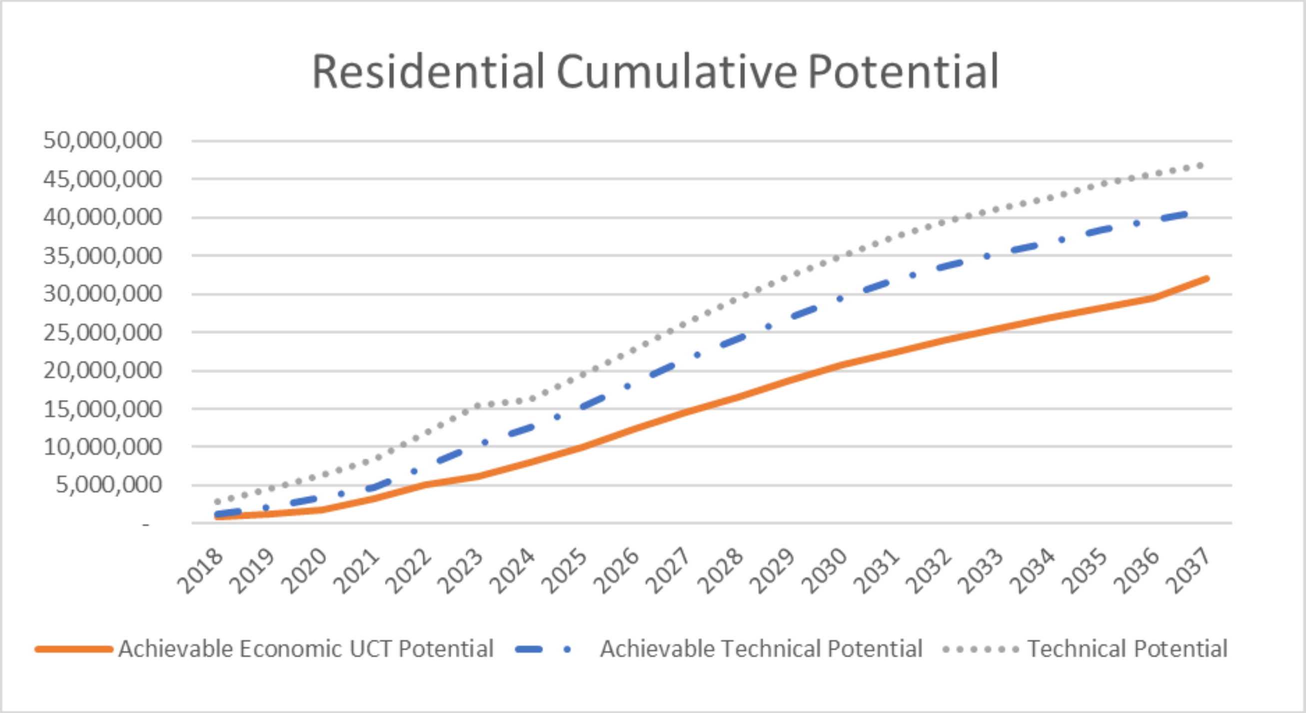


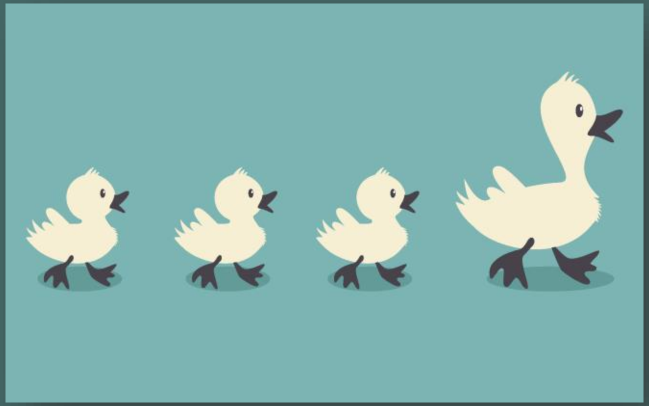
RESIDENTIAL BASELINE COMPARISON

FORECAST SUMMARY

Summary of Natural Gas Savings (therms), Selected Years	2018	2019	2020	2022	2028	2038
Baseline Forecast (therms)	125,132,034	123,592,607	124,383,336	126,802,750	134,762,905	147,070,239
Cumulative Savings (therms)						
UCT Achievable Economic Potential	401,017	794,418	1,250,899	3,234,259	14,448,057	45,729,170
Achievable Technical Potential	1,192,971	2,207,715	3,343,924	7,503,967	24,243,313	53,055,480
Technical Potential	2,876,398	4,540,572	6,282,242	11,862,187	29,429,050	61,341,343
Energy Savings (% of Baseline)						
UCT Achievable Economic Potential	0.3%	0.6%	1.0%	2.6%	10.7%	31.1%
Achievable Technical Potential	1.0%	1.8%	2.7%	5.9%	18.0%	36.1%
Technical Potential	2.3%	3.7%	5.1%	9.4%	21.8%	41.7%
Incremental Savings (therms)						
UCT Achievable Economic Potential	363,319	401,117	455,251	1,375,977	2,357,378	2,560,114
Achievable Technical Potential	1,075,090	1,039,784	1,137,091	2,825,441	3,257,000	2,504,871
Technical Potential	2,064,443	1,719,169	1,735,923	3,602,268	3,671,603	2,722,813

20 YEAR CUMULATIVE





TOP TEN RESIDENTIAL MEASURES

Measure
Furnace - Direct Fuel - AFUE 95%
Insulation - Ceiling, Installation - R-38 (Retro only)
Built Green homes - Built Green spec (NC Only)
Insulation - Wall Cavity, Installation - R-11
Insulation - Floor/Crawlspace - R-30
Water Heater - Solar System - 40 sq ft supplemental solar system installed
Thermostat - Programmable - Programmed thermostat
Thermostat - Wi-Fi/Interactive - Interactive/learning thermostat (ie, NEST)
Fireplace - Tier 1 (70% FE Rating)
Water Heater > 55 gal. - Condensing (UEF 0.82)

QUESTIONS?

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.

In the Community to Serve®

Monica.Cowlishaw@cngc.com

Amanda.Sargent@cngc.com

Kent.Crouse@cngc.com

Bio-Natural Gas

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Role of RNG in the IRP

- New to the 2018 WA IRP, Cascade will evaluate the potential of including Renewable Natural Gas (RNG) as a part of its preferred resource mix.
- Most of Cascade's discussions are preliminary, so modeling will mostly be used to determine optimal price points for certain projects under various scenarios and sensitivities.
- Currently Cascade is focused on two projects in WA: Biogas from the City of Richland Landfill and two bio digestors from Andgar in Bellingham.

Cascade Natural Gas Corporation®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

City of Richland Landfill

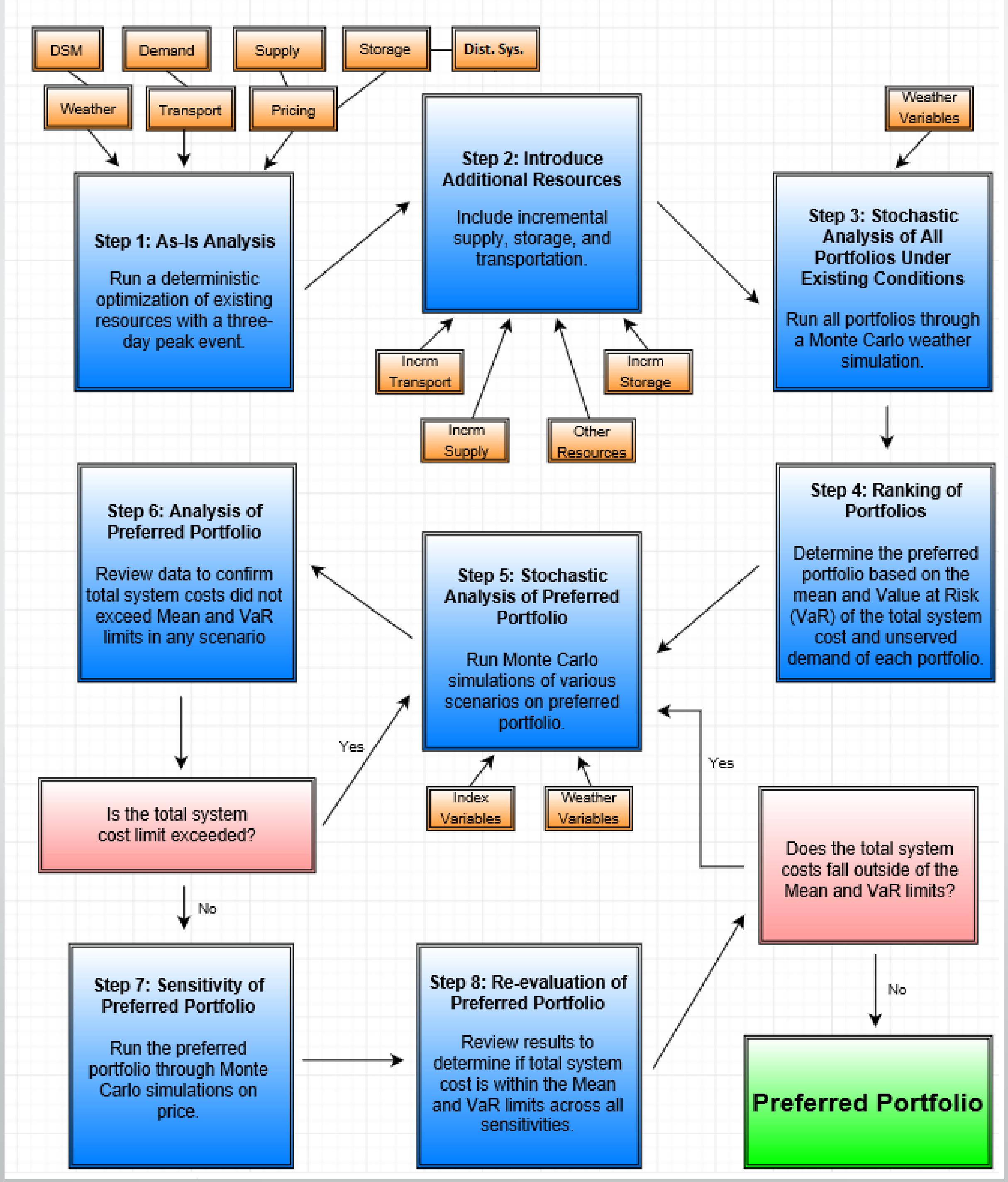
- The city has hired a consultant to investigate the likelihood of pulling biogas from the Richland Landfill.
- The project is estimated to produce 504 dekatherms per day, and would connect to Cascade's North Richland distribution system.
- The developer is planning on keeping the environmental attributes (RINs) but have not had any further discussions on who would be using the physical gas.

Andgar

- Developer that currently feeds an electric generation facility in the Bellingham area with two bio digesters.
- With the devaluation of REC's, Andgar is investigating re-routing their biogas into Cascade's North Whatcom distribution system and selling the environmental attributes into the open market.
- They have had some early discussions with Fortis BC and Cascade has also expressed interest in buying both the physical gas and environmental attributes.
- The project is estimated to produce 3,000 dekatherms per day. An estimate for an interconnect has been provided however, no further discussions has taken place.

SENDOUT® Optimization Modeling

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®



Supply Resource Optimization Process Flow Chart

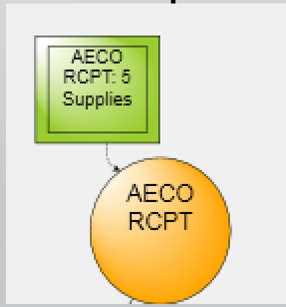
Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Base Case Sendout Inputs

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

Supply

- Cascade models the purchase of 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 or index), Winter base, Summer and Winter day gas, and Peak day incremental supplies as inputs.
- Base contracts for years 2-20 are renewed in November and April.



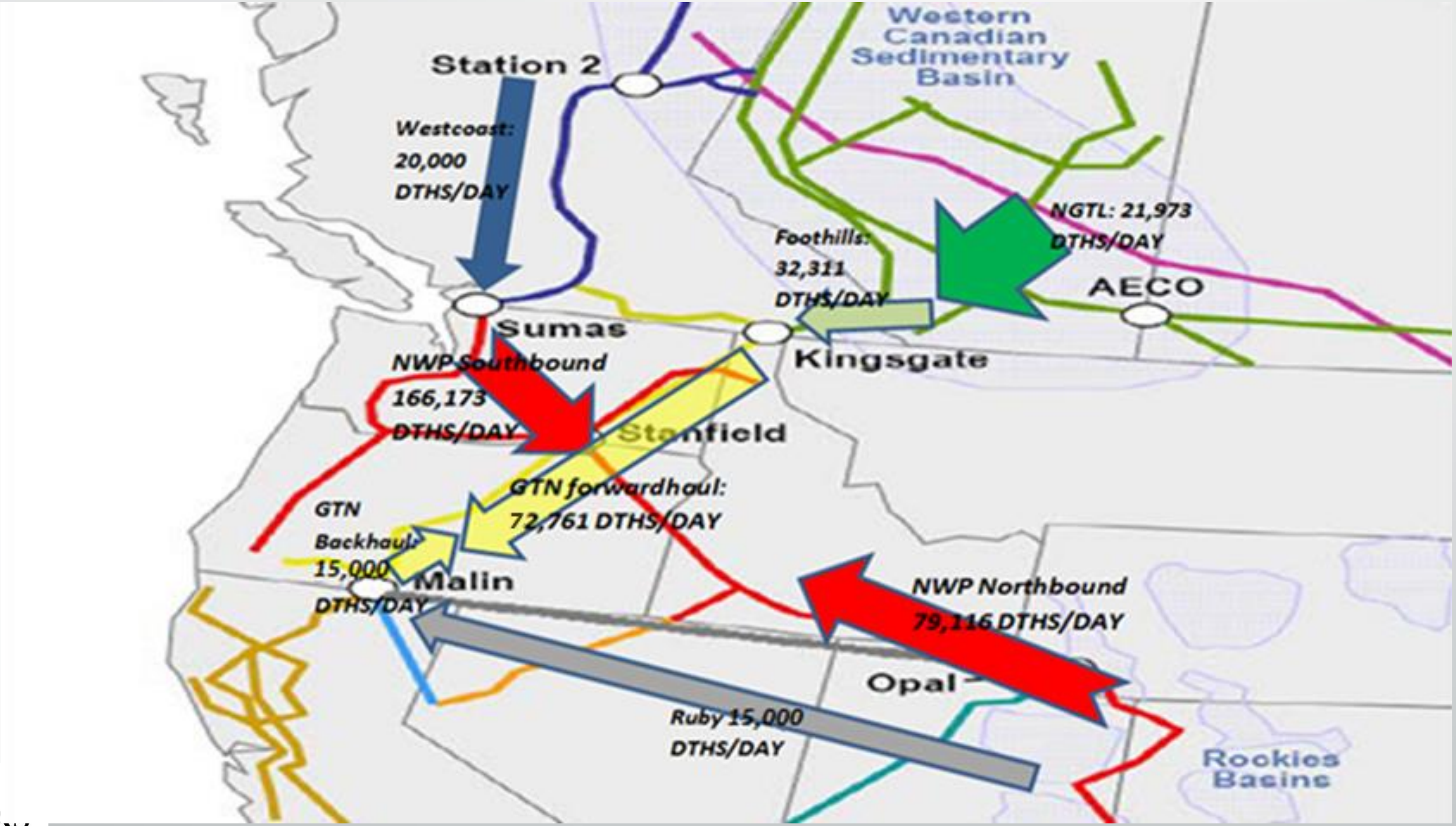
CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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					

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve

Supply

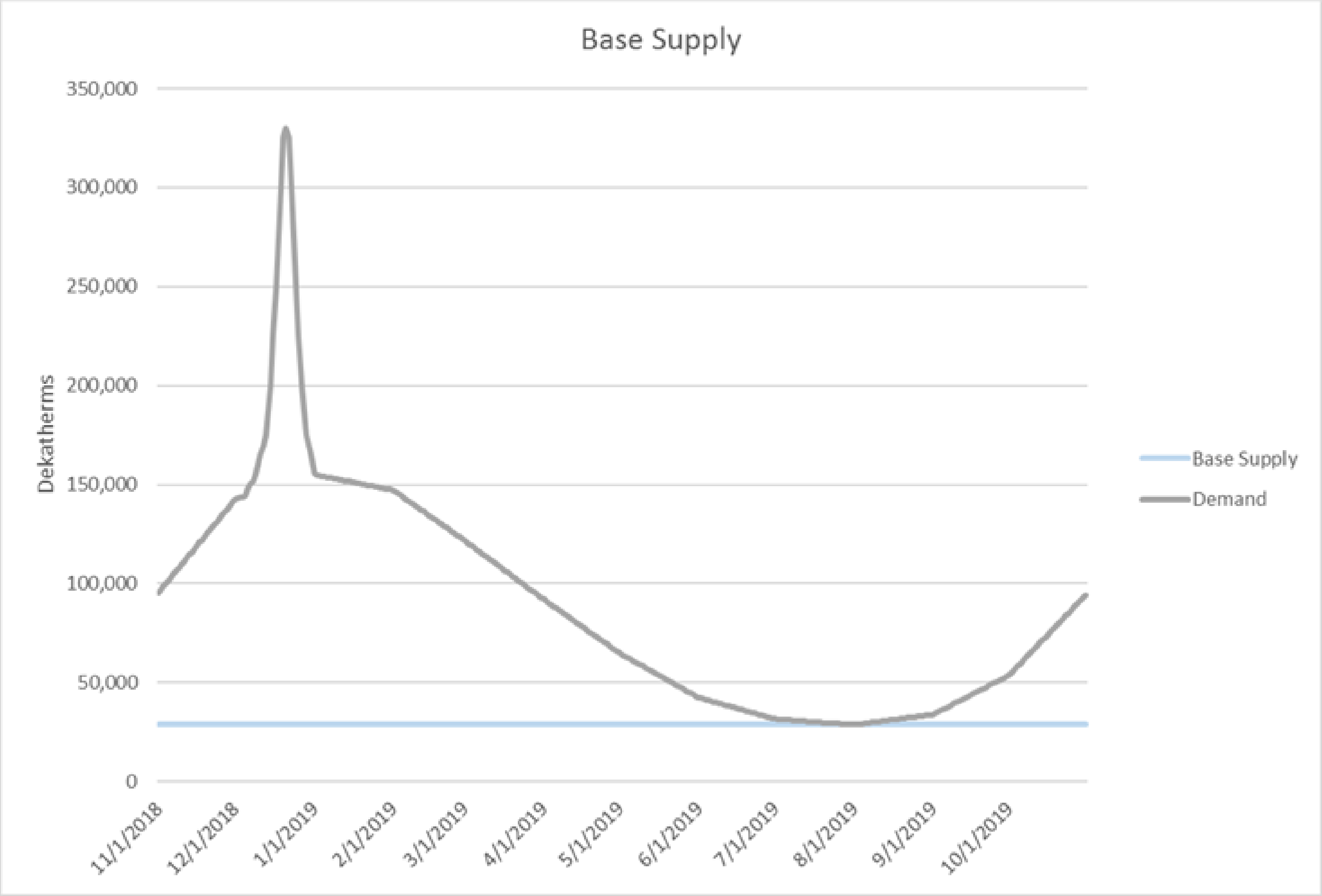


CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Supply Base

- Supply Base is the baseline supply contracts that are entered into every 12 months.
- An index contract has a basis rate. This is defined as the floating price of gas at a given market (ie, AECO index is the forecasted 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 forces SENDOUT® to only take the optimal amount of gas to serve the base demand.

Base Supply cont'd



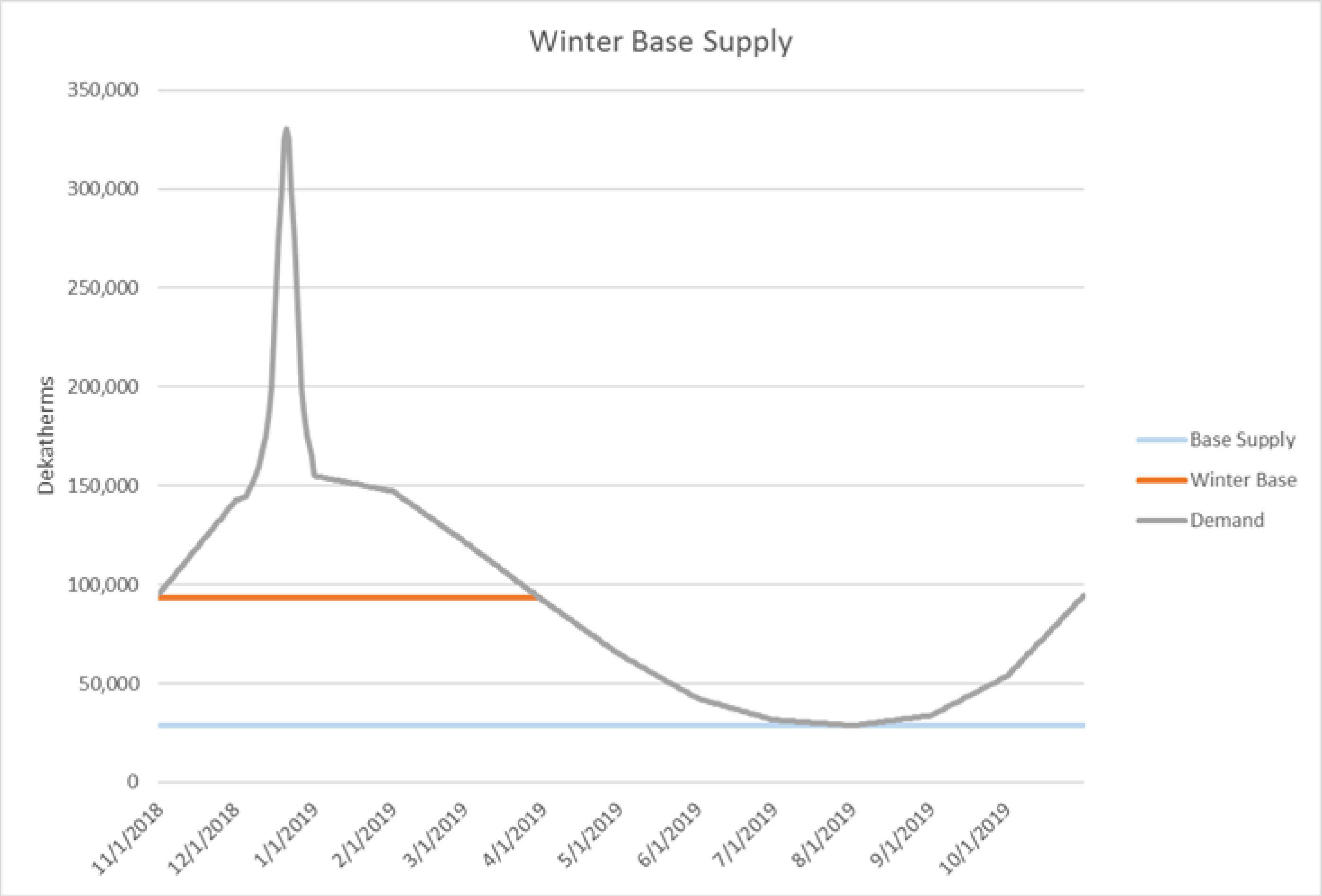
Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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.

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Winter base Supply cont'd

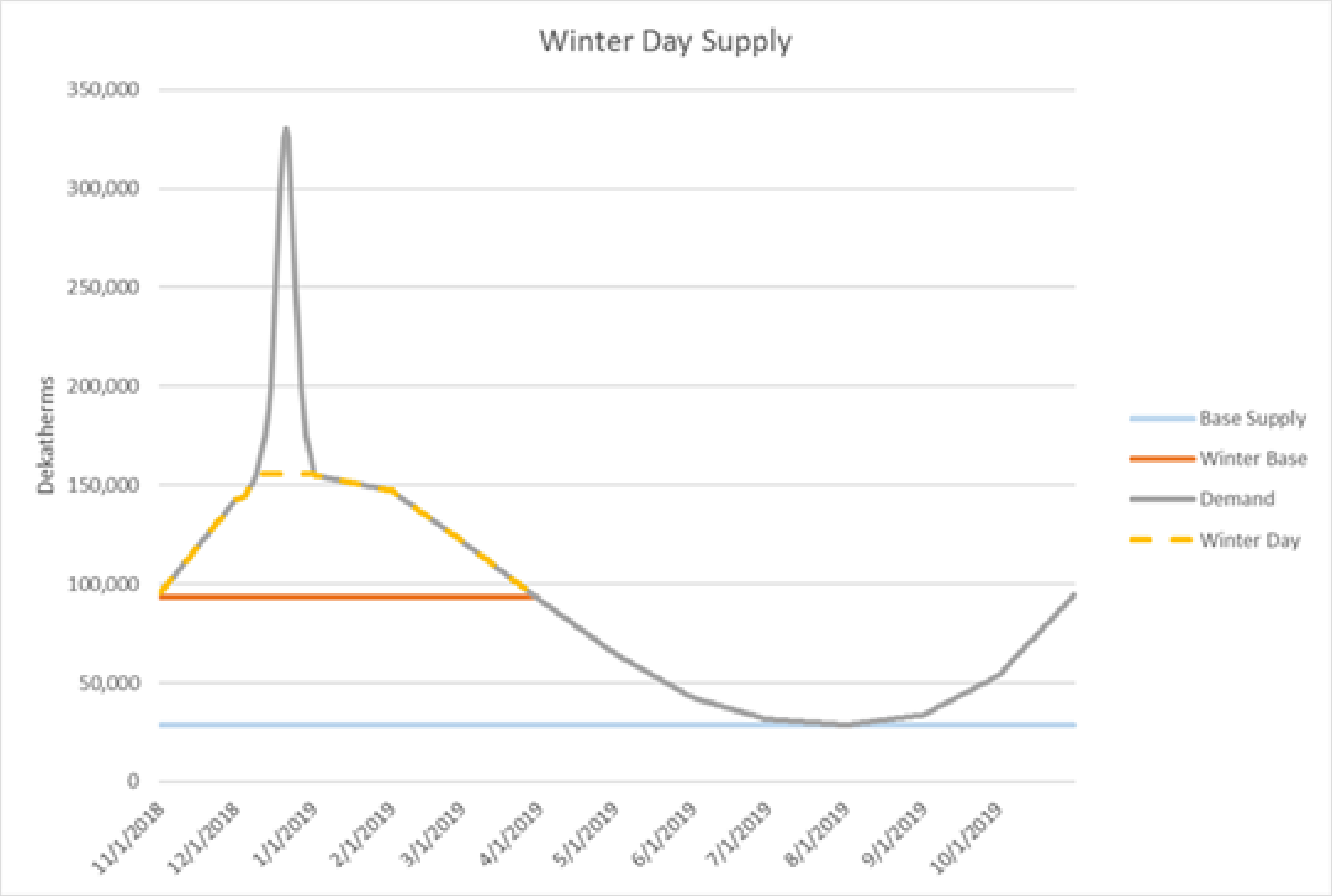


Day Supply (Winter)

- 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 a MDQ cap but is not a must take supply.
- If a winter day supply has an MDQ of 10000 dth then it can take anywhere from 0 to 10000 dth's 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.

Cascade Natural Gas Corporation®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

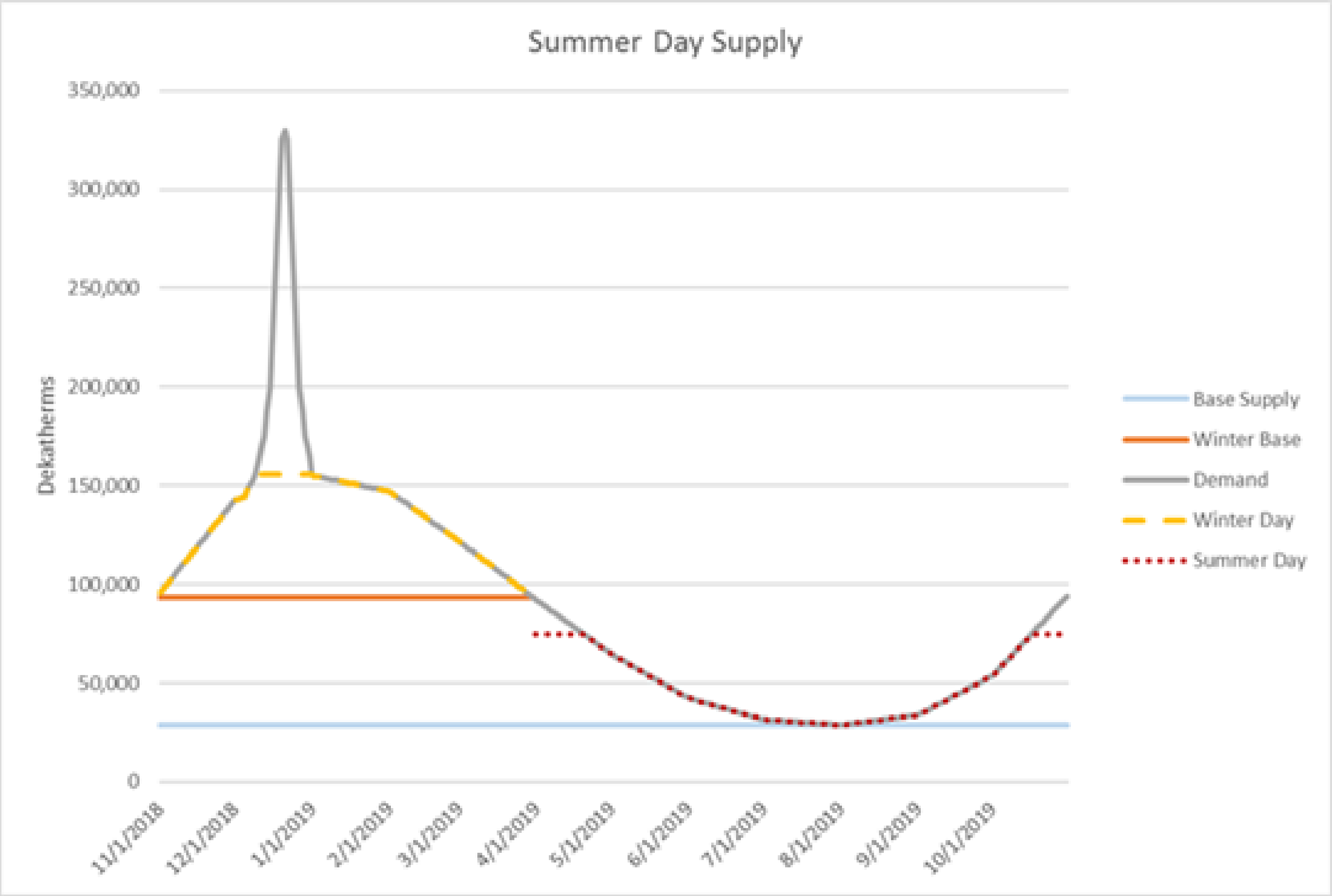
Day Supply (Winter) cont'd



Day Supply (Summer)

- Summer day supply is gas that is R-mixed at the beginning of April each year.
- Summer day gas has a MDQ cap but is not a must take supply.
- If a summer day supply has an MDQ of 10000 dth then it can take anywhere from 0 to 10000 dth's 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.

Day Supply (Summer)



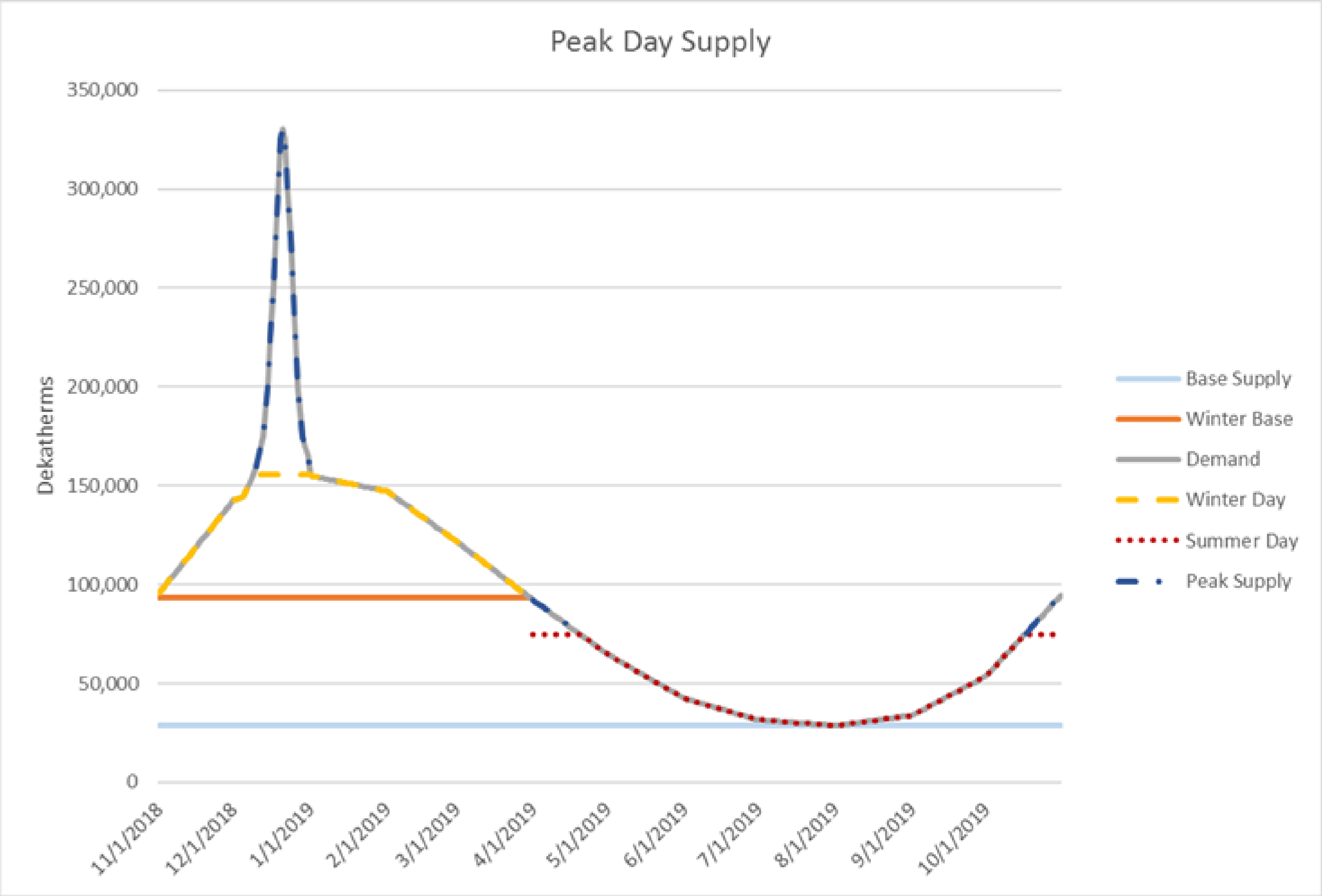
CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Peak Supply

- Peak supply is gas purchased on high demand days where base, winter base, or day supply cannot accommodate.
- Peak supply has the highest premium to buy.
- 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.

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Total Supply

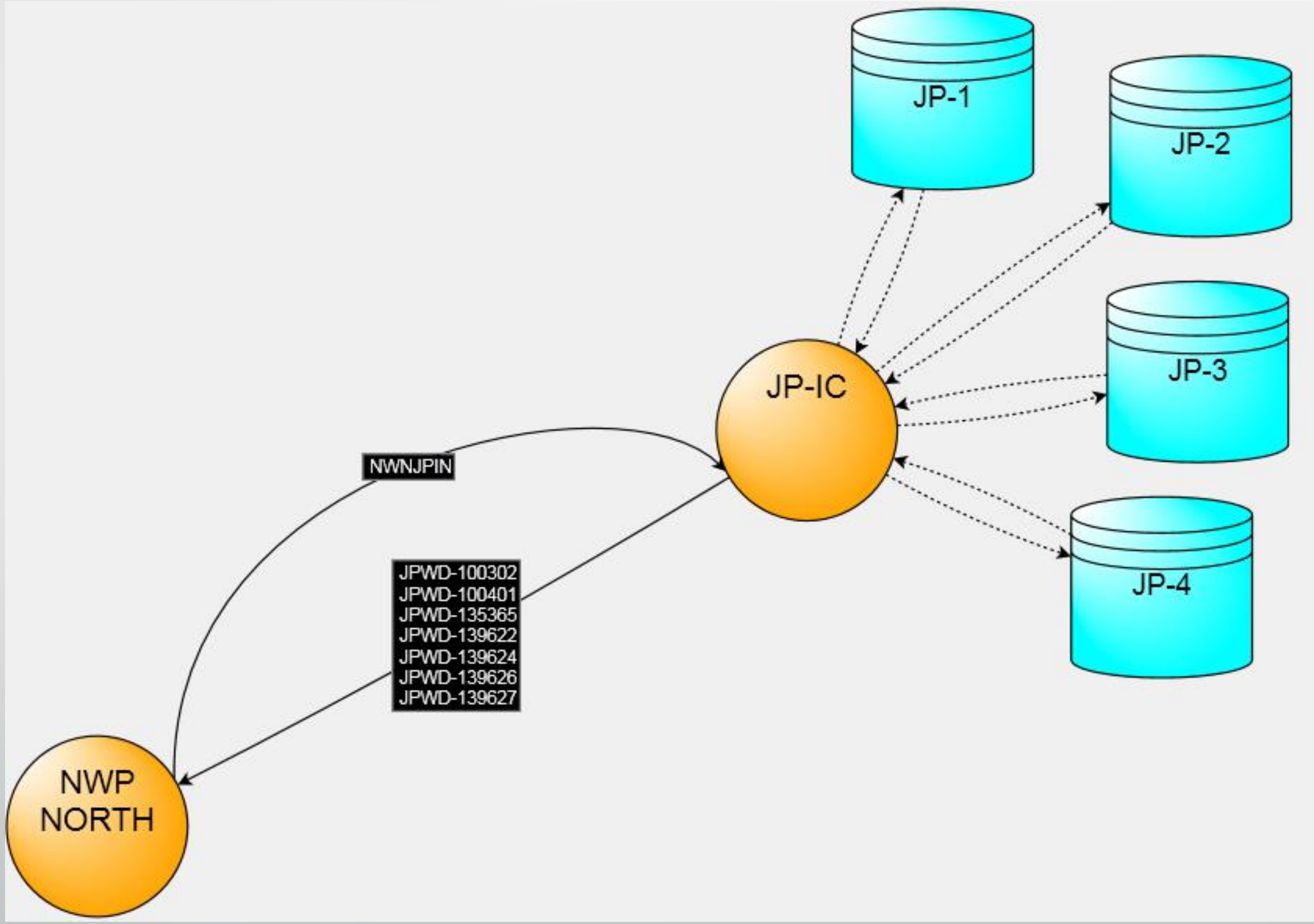


CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Storage

- Cascade leases storage at 2 locations: Jackson Prairie (JP) and Plymouth.
- Cascade has 4 storage contracts with JP and 2 contracts with Plymouth.
- 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 Pipeline tariffs.
- Cascade can withdrawal approximately 56,000 dth's per day from JP and 78,000 dth's per day from Plymouth for a total of approximately 134,000 dth's per day.

Storage Example



CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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 Year		
*Inventory Adjustment - Value per Unit										Same		
*Inventory Adjustment - Volume										Same		
*Injection Daily MDQ				16789						First Year		
*Injection Daily Min Percent										Same		
*Withdrawal Daily MDQ				0						Last Year		
*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		DaysInMonth
Rate - D2	.00057									Same		DaysInMonth
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		

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Transportation

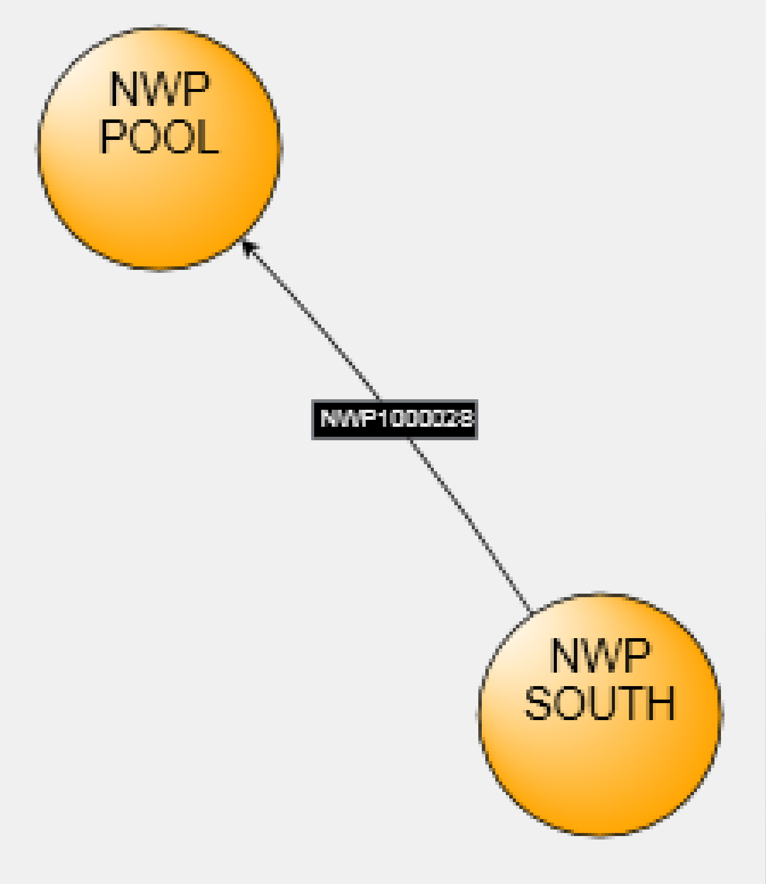
- Transportation contracts are the means of how Cascade gets the gas from the supplier to the end user.
- Cascade has multiple types of transportation:
    - A single delivery point.
    - Multiple delivery points.
- The multiple delivery point contracts gives Cascade the flexibility to move the gas 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.

Transportation cont'd

- Transportation has an MDQ, a D1 rate, a transportation rate, and a fuel loss percentage.
- A maximum delivery quantity (MDQ) is the maximum amount of gas Cascade can move on the contract on a single day.
- A D1 rate is the reservation rate to have the ability to move the MDQ amount on the pipeline.
- A transportation rate 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.

Cascade Natural Gas Corporation®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Transport Example



CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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		DaysInMonth

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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.

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Example of delivery right flexibility

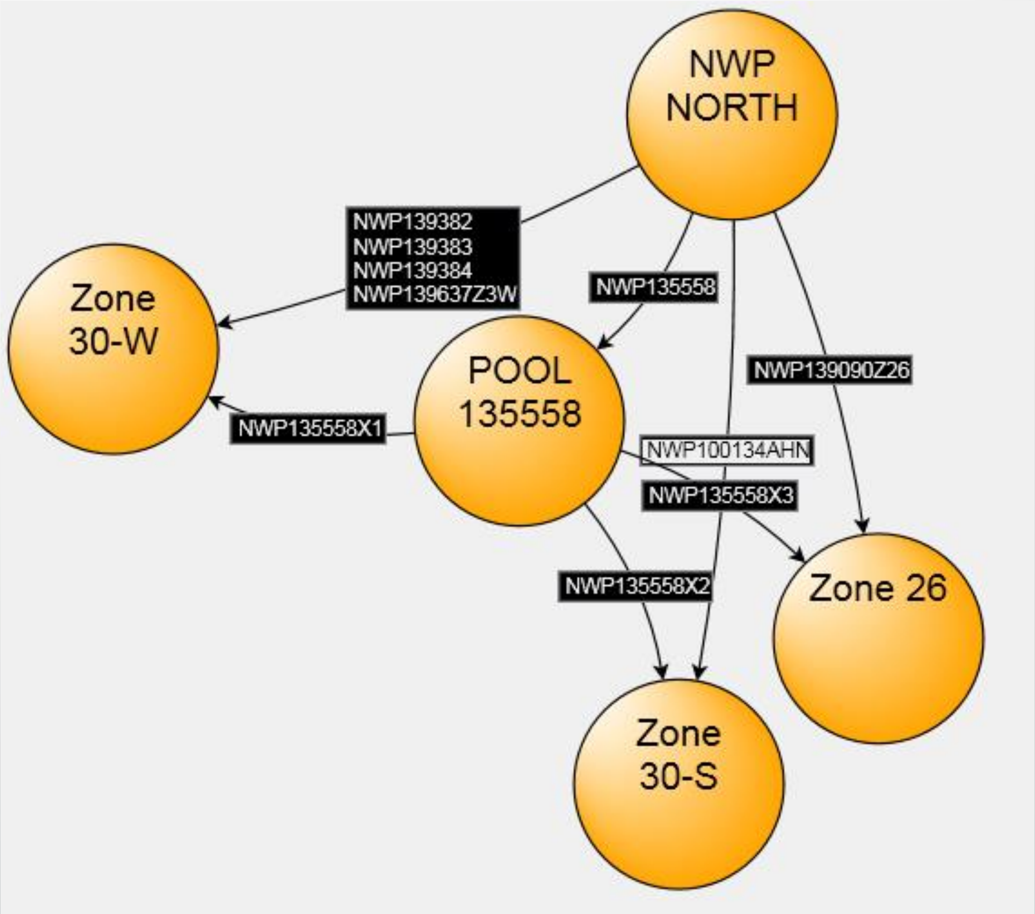
All of the following must be true

$X1 \leq 4\text{MDTs}$

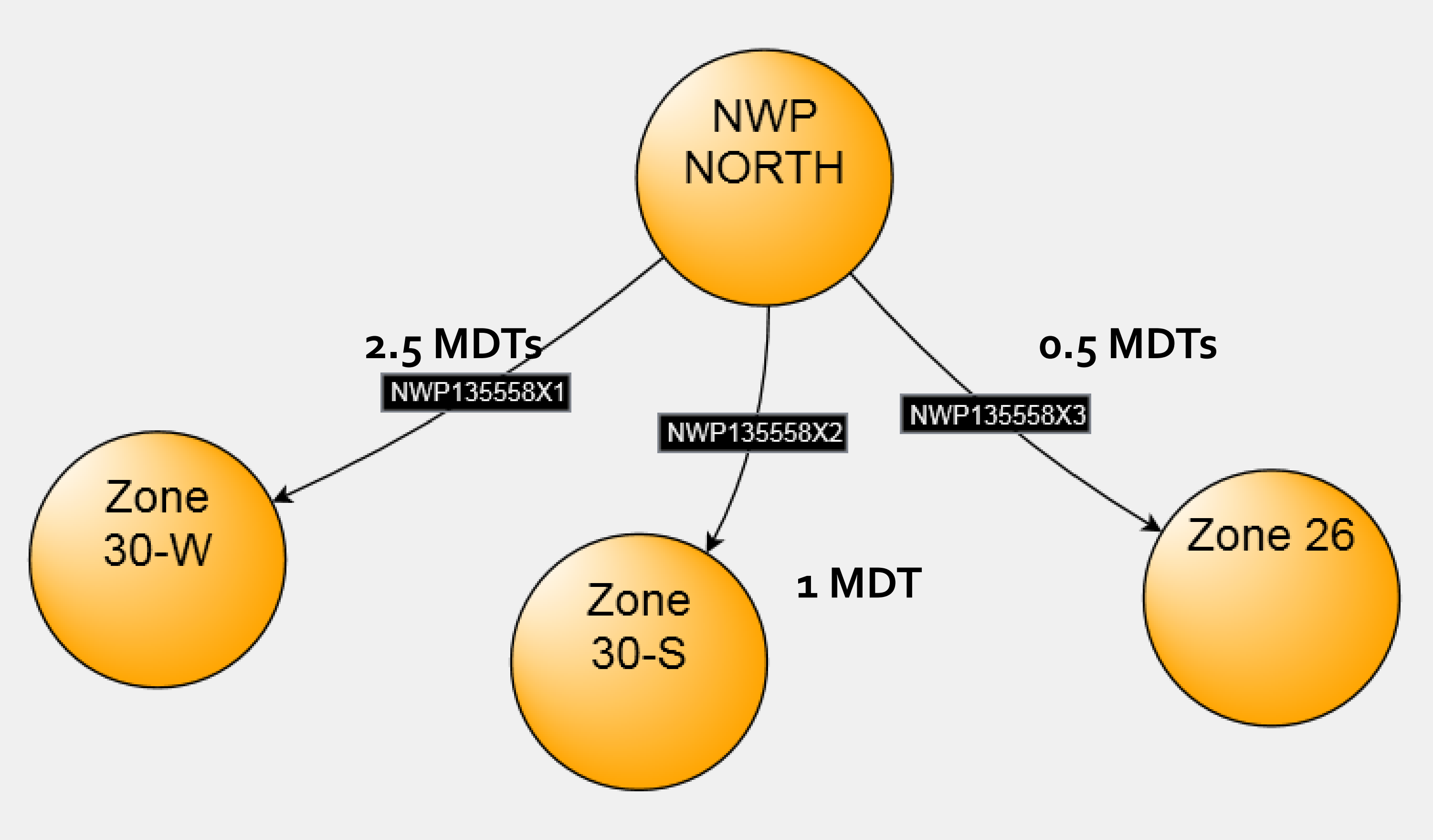
$X2 \leq 4\text{MDTs}$

$X3 \leq 4MDTs$

$X1 + X2 + X3 \leq 4MDTs$



Example of delivery right inflexibility



CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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 the contract MDQ for the constraint group.

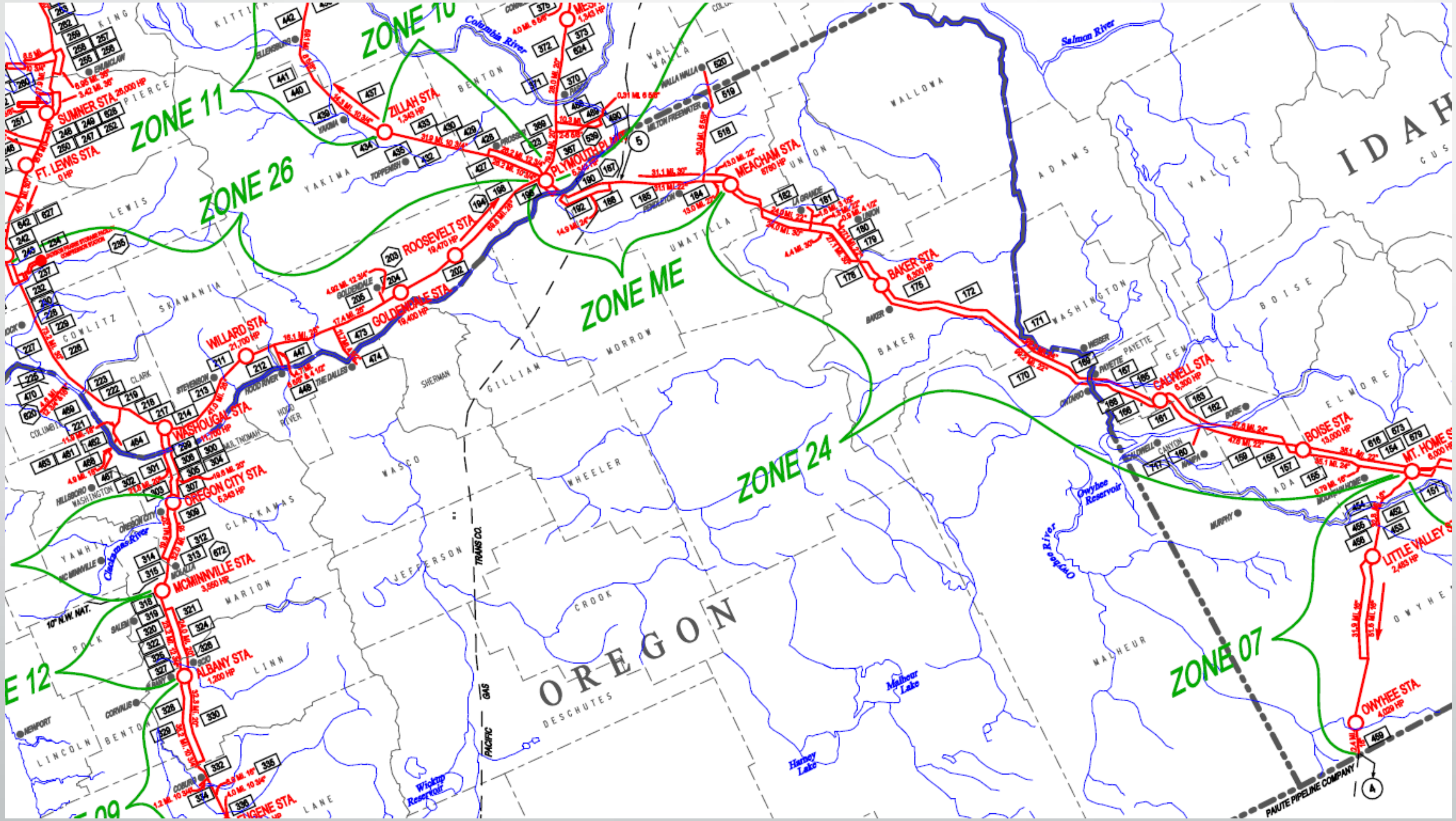
CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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

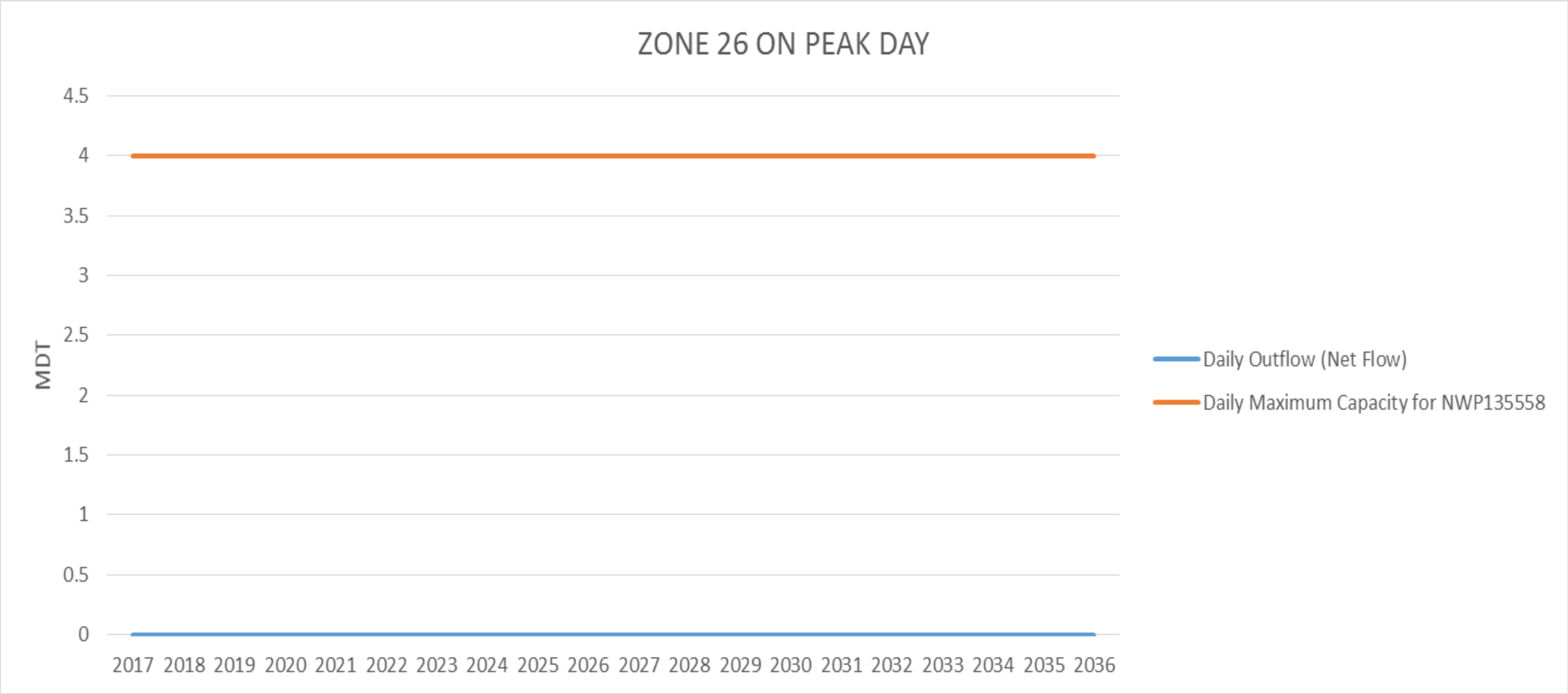
CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Location of Zones (Source: NWP)



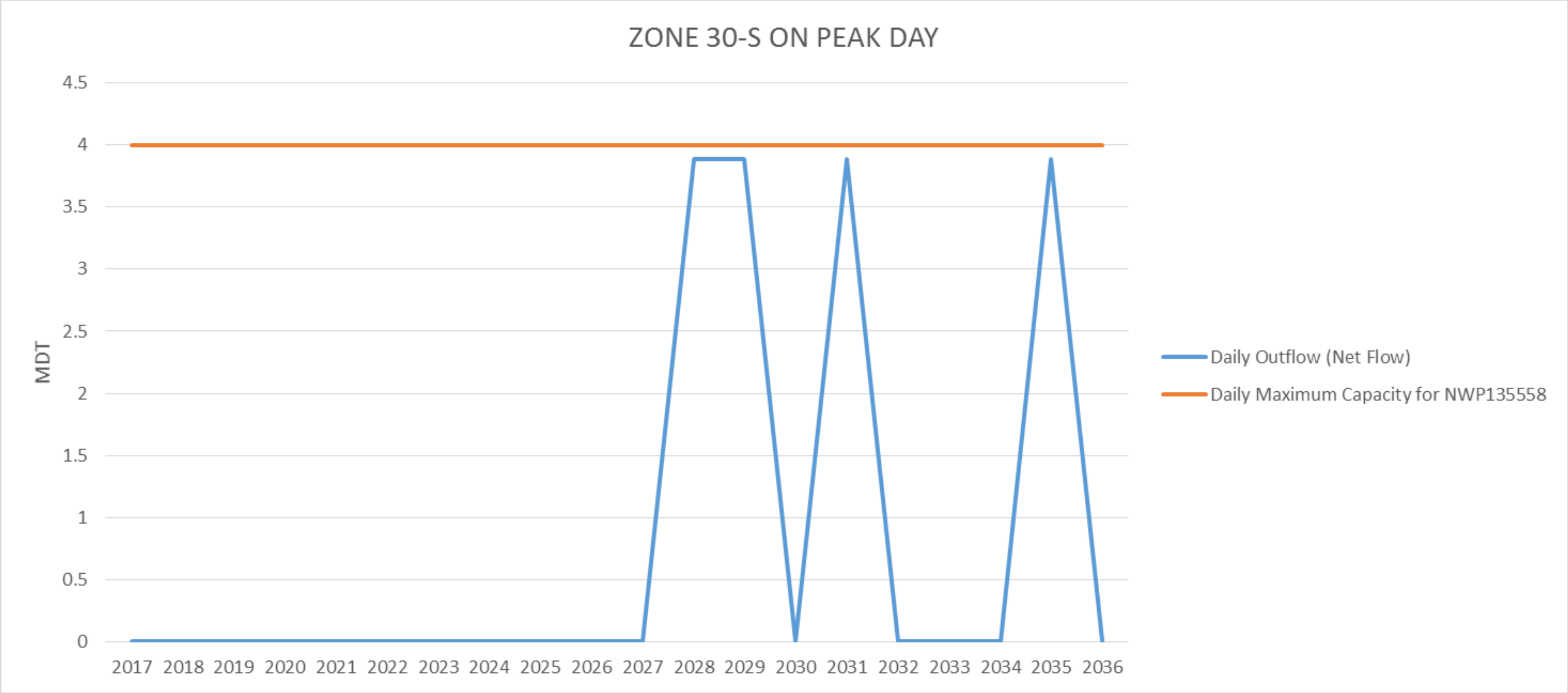
CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Zone 26 on Peak Day for Transport 135558



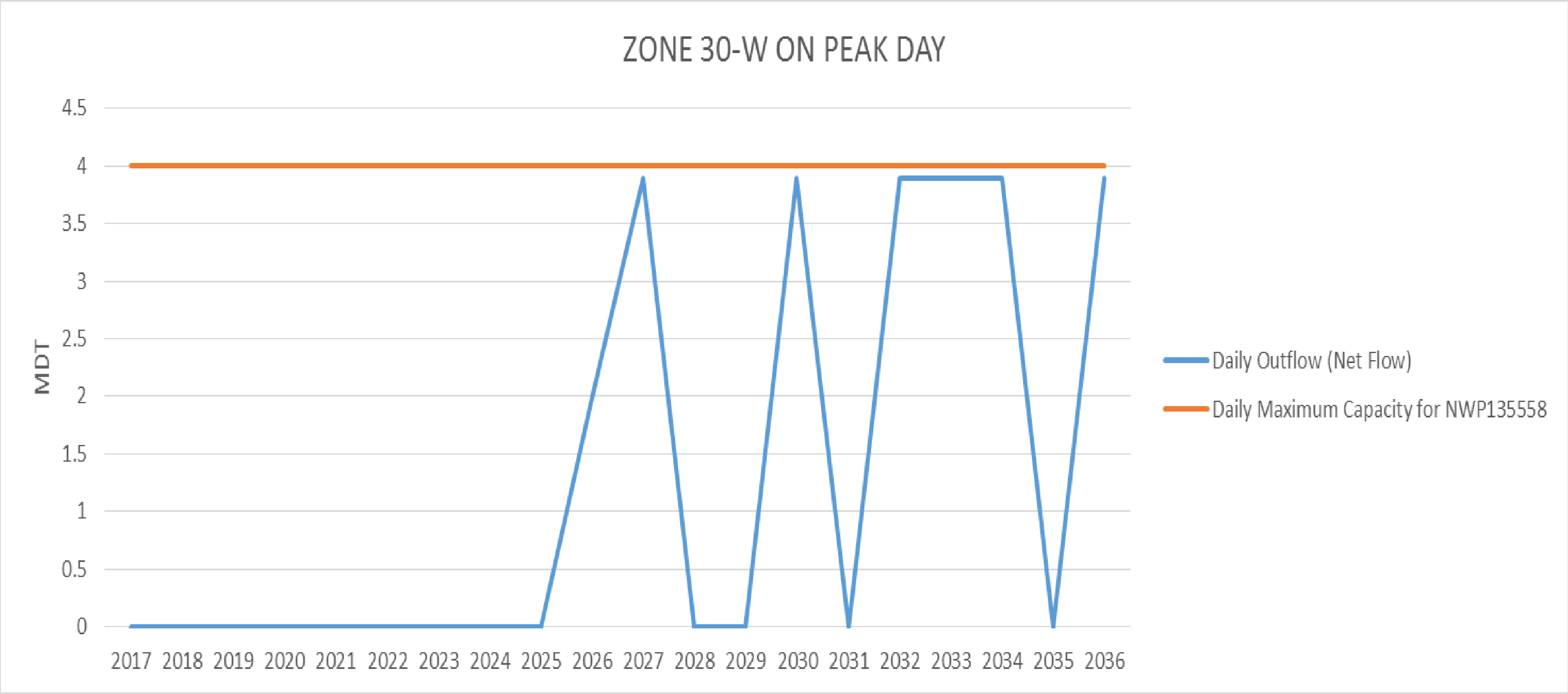
Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Zone 30-S on Peak Day for Transport 135558



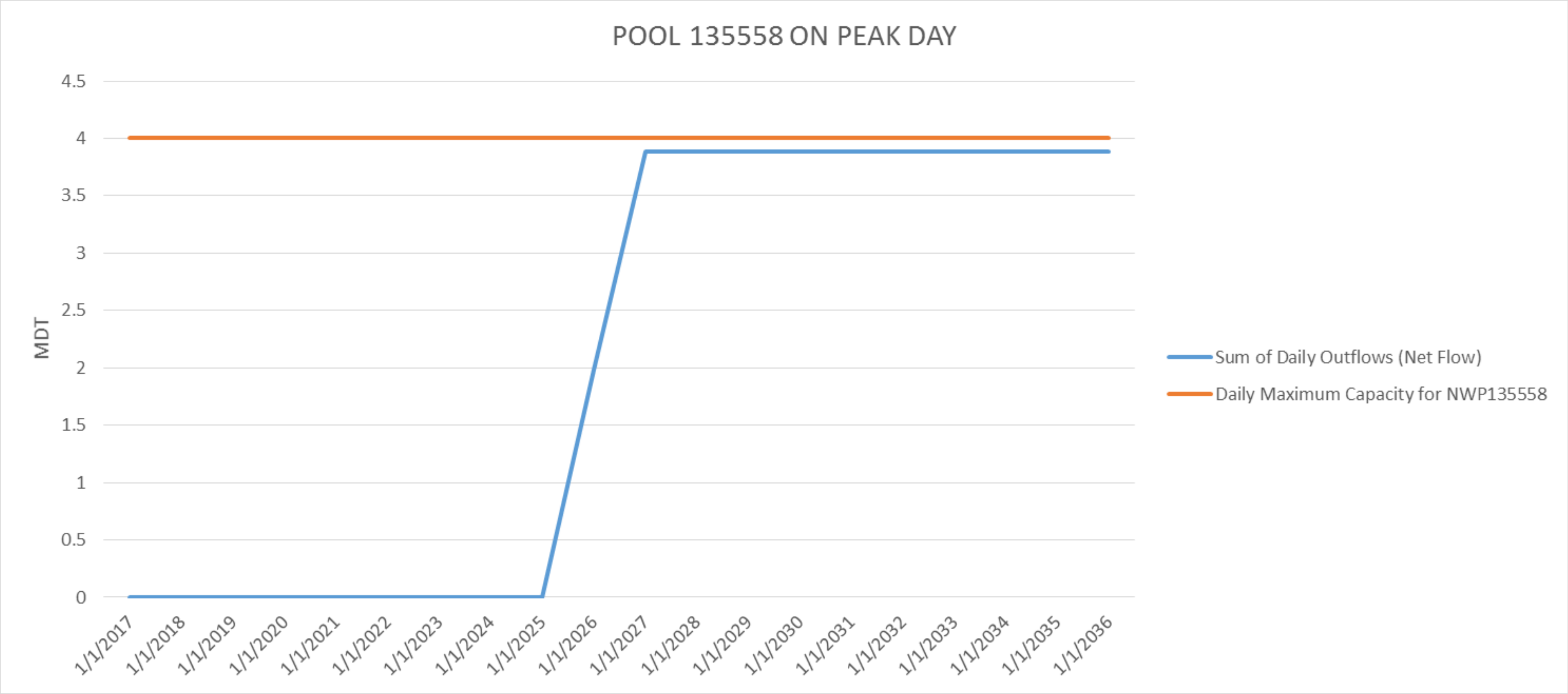
Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Zone 30-W on Peak Day for Transport 135558



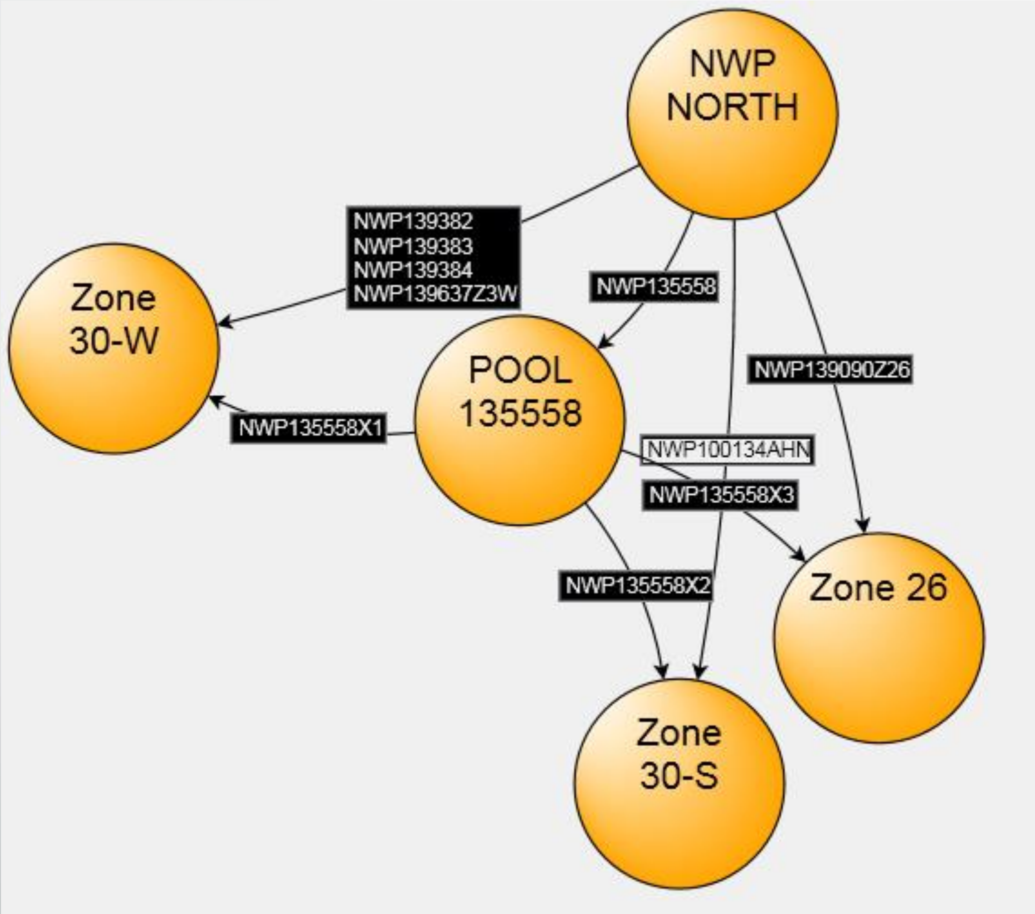
Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Transport Contract 135558 on Peak Day



CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Example of delivery right flexibility



Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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 a use per HDD per customer difficult.
- Some towns can be served by multiple pipelines and the mix can change over time.

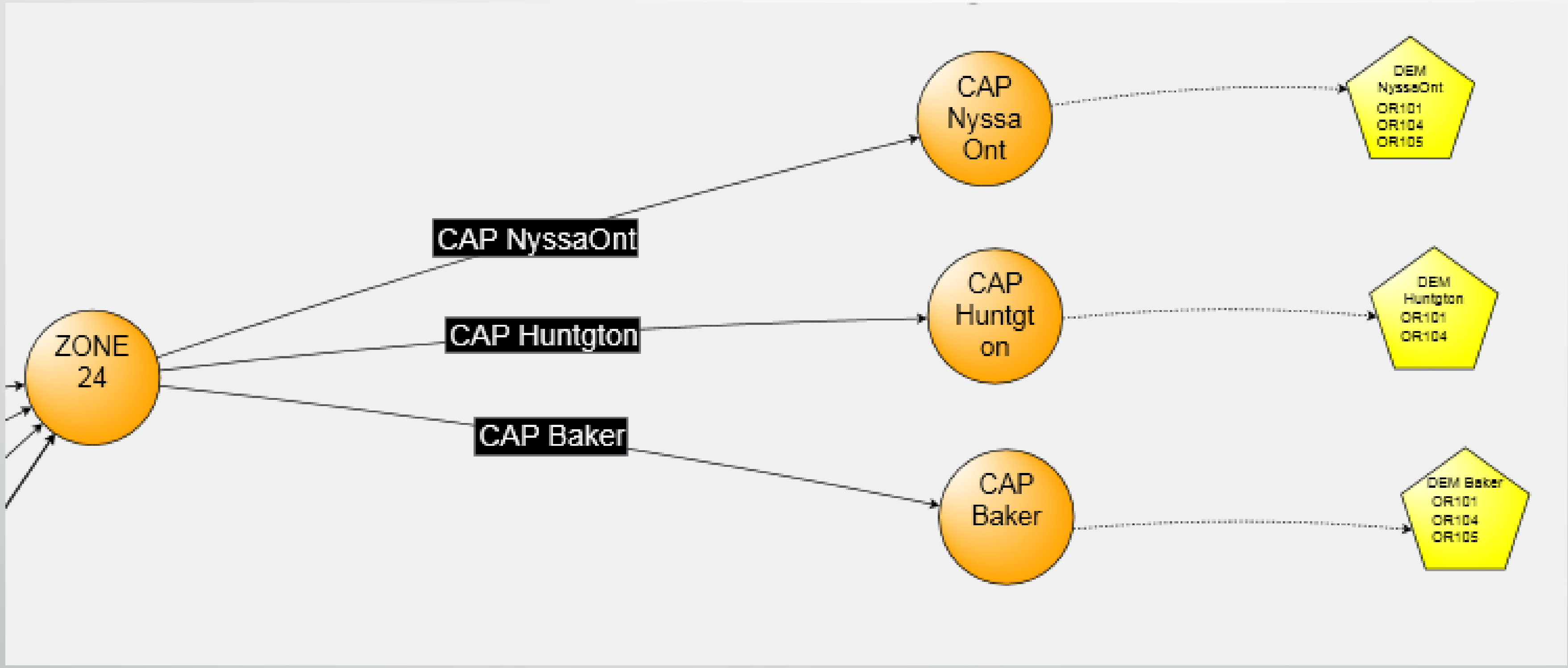
Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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.

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Demand Example



Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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 Yeai					
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 Yeai					
Usage Factors - Weekend Heat	0.007448									Same					
*Rate - Unserved Dispatch (Pri 1)										Same					
*Rate - Unserved (Pri 2)	960									Same					

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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 (1988-2017).

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

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						

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Long Range Price Forecast

- Cascade's long-term planning price forecast is based on a blend of current market pricing along with long-term fundamental price forecasts.
- The fundamental forecasts include Wood Mackenzie, EIA, the Northwest Power Planning Council (NPPC), Bentek and the Financial Forecast Center's long term price forecasts.
- While not a guarantee of where the market will ultimately finish, Henry Hub NYMEX is the most current information that provides some direction as to future market prices.
- Wood Mackenzie's long-term forecast is at a monthly level by basin. Cascade uses this to help shape the forecast's monthly basis pricing.
- The Company also relies on EIA's forecast; however, it has its limitations since it is not always as current as the most recent market activity. Further, the EIA forecast provides monthly breakdowns in the short-term, but longer term forecasts are only by year.

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Long Range Price Forecast Cont'd

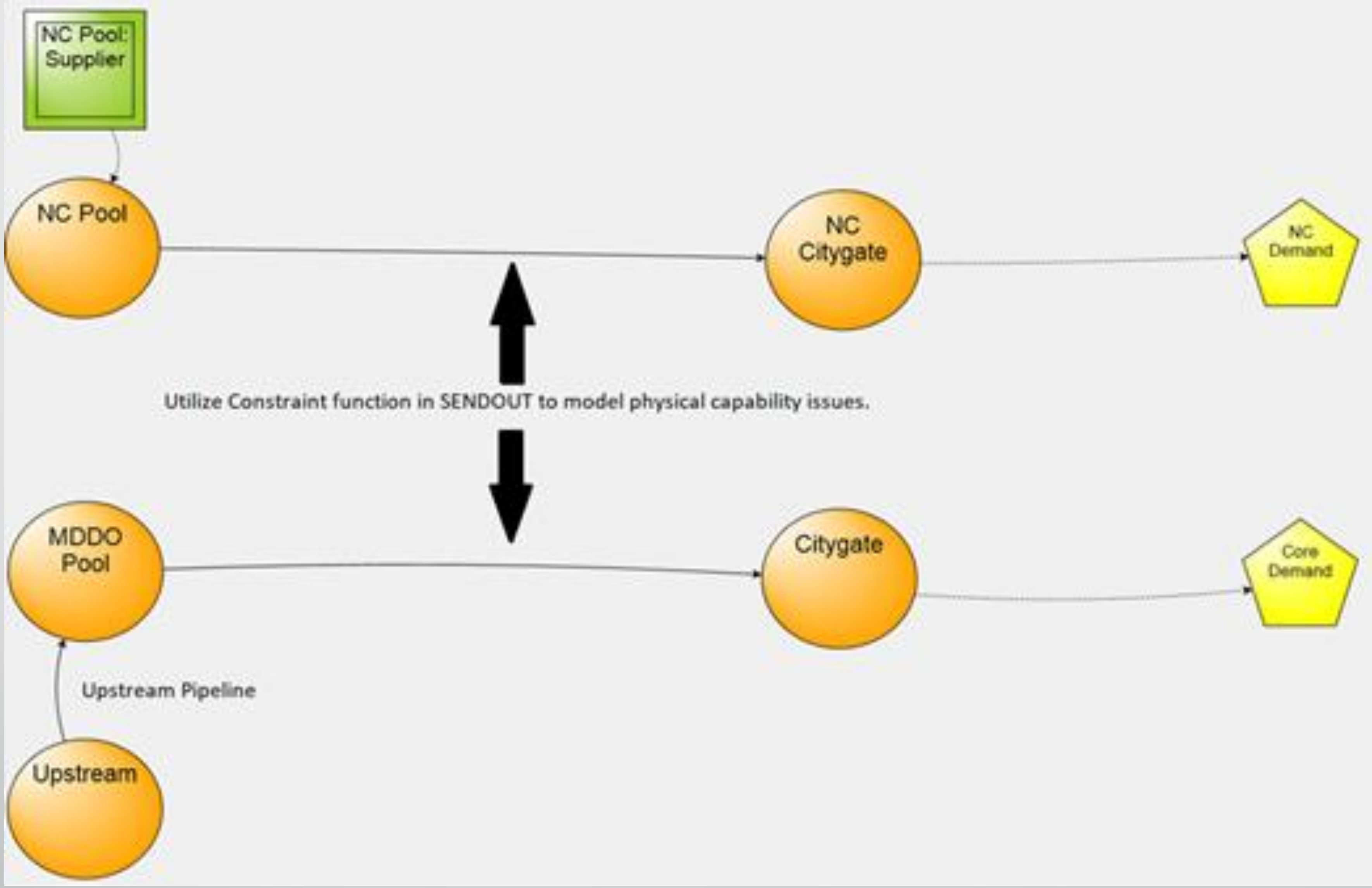
- CNGC assigns a weight to each source to develop the monthly Henry Hub price forecast for the 20-year planning horizon.
- Although it is impossible to accurately estimate the future, for trading purposes the most recent period has been the best indicator of the direction of the market. However, Cascade also considers other factors (historical constraints) which can lead to minor adjustments to the final long range forecast.

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Distribution System Planning in SENDOUT®

- New modeling technique in SENDOUT®.
- Models physical constraints at the citygate level.
- Does not impact the upstream modeling for core customers.
- Can show any citygate physical constraints over the next 20-years.
- Can be used to compare similar results from Engineering.
- Cascade has identified 5 citygates that need an upgrade in the next 1-2 years. 3 in Washington and 2 in Oregon:
  - Arlington, Walla Walla, Yakima, Bend, Prineville
- Cascade has also identified several other citygates which may need an upgrade in the next 2-5 years.

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®



CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Step 1: As-is Analysis

- Model Cascade's current system under expected conditions with a 3-day peak inserted each year.
- Record timing and location of potential shortfalls.
- Identifies the problems that incremental resources will solve for.

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Step 2: Introduce Additional Resources

- Cascade uses it's market intelligence to identify potential solutions to shortfalls previously identified in the As-is.
- These can be in the form of incremental transport, incremental supplies, incremental storage, and other resources.
- Once included, Cascade runs the optimizer and records the timing and quantity of resources selected.
- This forms the deterministic preferred portfolio; one of six portfolios to be evaluated under stochastic conditions.
- The other 5 portfolios are derived by running the optimizer on a modified list of resource availability.

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Step 2: Introduce Additional Resources

- Deterministic Preferred Portfolio
- GTN Only Portfolio
- GTN + Storage Portfolio
- NWP Only Portfolio
- NWP + Storage Portfolio
- Storage Only

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Step 3: Stochastic Analysis of All Portfolios Under Existing Conditions

- Each of the 6 portfolios is run through a Monte Carlo simulation on weather.
- Cascade records the mean and 95th percentile value-at-risk (VaR) of the total system cost and unserved demand of each portfolio.
- This allows Cascade to evaluate the portfolios' intrinsic and extrinsic values.

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Step 4: Ranking of Portfolios

- Portfolios are ranked primarily on unserved demand and secondarily on total system cost.
- Cascade uses regional best practices to weight the deterministic and stochastic components.
- Ultimately, the portfolio that performs best under expected conditions will be deemed the first candidate portfolio.

Cascade Natural Gas Corporation®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Step 5: Stochastic Analysis of Candidate Portfolio

- Cascade runs Monte Carlo analysis on the candidate portfolio under a variety of scenarios.
- Scenarios allow Cascade to evaluate a portfolio under a number of load impacting externalities.
- Cascade expects to run the simulations on both price and weather.
- Cascade records mean and VaR of total system cost under each scenario.

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Step 6: Analysis of Candidate Portfolio

- Cascade compares the 95th percentile VaR under each scenario to a predetermined VaR limit.
  - The VaR limit is a risk and cost ceiling determined by Cascade's GSOC.
- If costs exceed the VaR limit in any scenario tested, Cascade may reject the candidate portfolio and begin testing the next ranking portfolio from step 4.
- If costs do not exceed the VaR limit, the candidate portfolio moves to sensitivity testing.

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Step 7: Sensitivity Analysis of Candidate Portfolio

- Cascade runs Monte Carlo analysis on the candidate portfolio under a variety of sensitivities.
- Sensitivities allow Cascade to evaluate a portfolio under a number of price impacting externalities.
- Cascade expects to run the simulations on both price and weather.
- Cascade records mean and VaR of total system cost under each sensitivity.

Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Step 8: Re-evaluation of Candidate Portfolio

- Cascade compares the 95th percentile VaR under each sensitivity to a predetermined VaR limit.
- If costs exceed the VaR limit in any sensitivity tested, Cascade may reject the candidate portfolio and begin testing the next ranking portfolio from step 4.
- If costs do not exceed the VaR limit, the candidate portfolio becomes Cascade's preferred portfolio.

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Preliminary Resource Integration Results

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Preliminary Results

- Cascade has finalized its load forecast for the 2018 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 potential shortfalls in its GTN citygates starting in 2023.

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Discussion of Shortfalls

- Current modeling does not identify any shortfalls in Washington.
  - This assumes all deterministic conditions, and all contracts evergreening over the 20-year planning horizon.
- Cascade is running scenario and sensitivity analyses to evaluate the viability of options specific to Washington citygates, such as the Bremerton expansion.

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Discussion of Shortfalls (cont.)

- Shortfalls in the citygates served by GTN are consistent with Cascade's modeling in years past.
- Additionally, this is corroborated by Cascade's market intelligence, which identifies Bend, OR as a major growth center on Cascade's system.
- The next step is for Cascade to perform its Supply Resource Optimization Process which will determine the optimal solutions for any identified deterministic shortfalls.

Cascade Natural Gas Corporation®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Remaining Schedule

Date	Process Element	Location (Subject to change)
Tuesday, September 11, 2018	TAG 5 slides distributed to stakeholders	
Tuesday, September 18, 2018	**TAG 5: Final Integration Results, finalization of plan components.**	**Seattle-Tacoma International Airport Conference Center 9am-12pm**
Friday, October 5, 2018	Draft of 2018 IRP distributed	
Friday, November 2, 2018	Comments due on draft from all stakeholders	
Wednesday, November 14, 2018	TAG 6, if needed	WebEx Only
Friday, December 14, 2018	IRP filing in Washington	

CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

ADDITIONAL QUESTIONS?

Mark Sellers-Vaughn – Manager, Resource Planning: (509) 734-4589
mark.sellers-vaughn@cngc.com

Brian Robertson – Senior Resource Planning Analyst: (509) 734-4546
brian.robertson@cngc.com

Devin McGreal – Resource Planning Analyst II: (509) 734-4681
devin.mcgreal@cngc.com

Ashton Davis – Resource Planning Analyst I: (509) 734-4520
ashton.davis@cngc.com

Bruce Folsom - Consultant

CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Cascade Natural Gas Corporation

2018 Integrated Resource Plan

Technical Advisory Group Meeting #4

August 23rd, 2018

Seattle-Tacoma International Airport

Seattle, WA

CASCADE NATURAL GAS CORPORATION

A Subsidiary of MDU Resources Group, Inc.

In the Community to Serve®