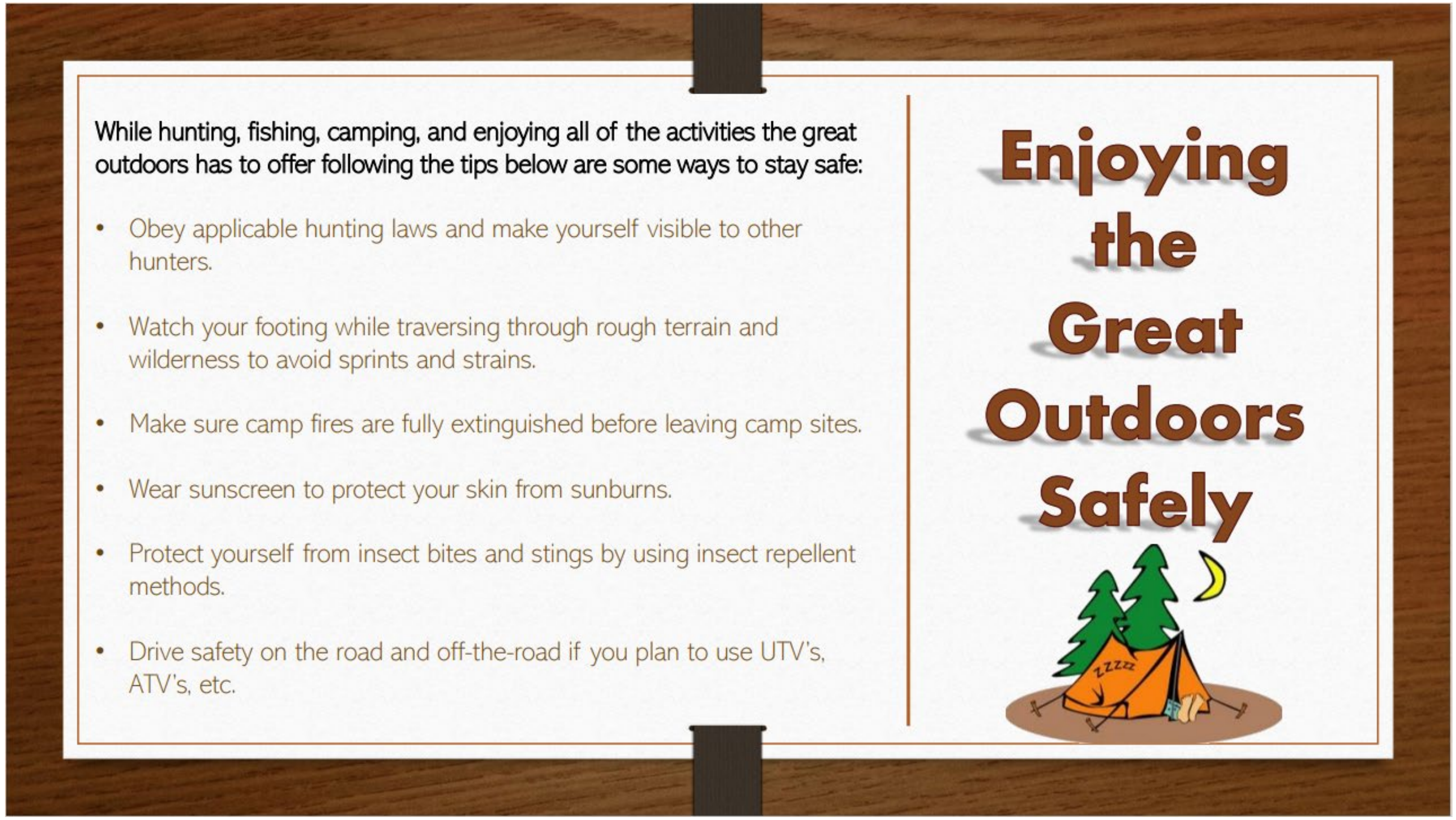
Integrated Resource Plan Technical Advisory Group Meeting #2

MAY 18, 2022

MICROSOFT TEAMS/TELECONFERENCE

Agenda

Introductions → Safety Moment → Public Outreach Plan → Stakeholder Engagement → Demand Forecast → Customer Forecast → Forecast Results → Weather Normals and Climate Change Impacts → Non-Core Outlook → Market Outlook and Long-Range Price Forecast → 2023 IRP Timelines → Next Steps



Safety Moment

Public Outreach Plan

- The Company identifies five general segments of stakeholders
  - Commission Staffs
  - Customer representatives
  - Community-based organizations
  - Expert Public
  - General Public
- Cascade notifies these segments in several ways, perhaps bill inserts, media releases to broadcast and print outlets, social media (Facebook and Twitter), meetings throughout service territory, web page, Commission web page.
- Cascade has a dedicated Internet webpage where customers and interested parties can view the IRP timeline, TAG presentations and minutes, as well as current and past IRPs.
- The Company believes that customers and interested parties were made aware of Cascade's IRP meetings, opportunity to participate, as well as availability of CNGC personnel to address any related issues. Additionally, Cascade hosts the Conservation Advisory Group (CAG) to receive regular input on energy efficiency issues.

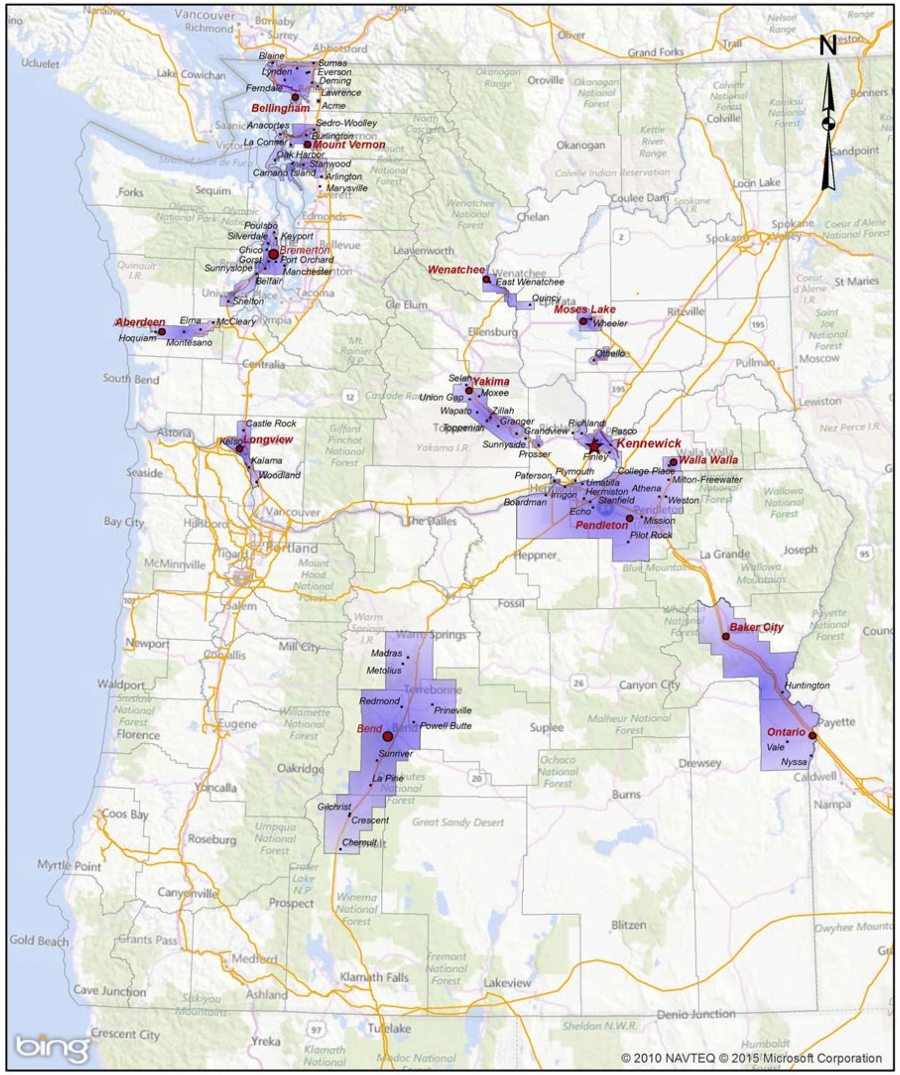
Stakeholder Engagement

- For attendance at meetings, in an effort to further clarify roles and responsibilities for the Company as well as stakeholders, Cascade follows a Stakeholder Engagement Design Document, presented in TAG1.

- In the past decades, “rules of the road” for participation in Pacific Northwest utility advisory groups and collaboratives have ranged from full informality to specific charters. The latter has taken significant time for crafting and agreement by all parties. Cascade’s Stakeholder Design Document attempts to capture the best from each approach.

- Cascade’s meetings are informal so either unmuting or raising your hand, or even typing questions into chat is fine with Cascade.

Demand Forecast



CASCADE NATURAL GAS CORPORATION

In the Community to Serve

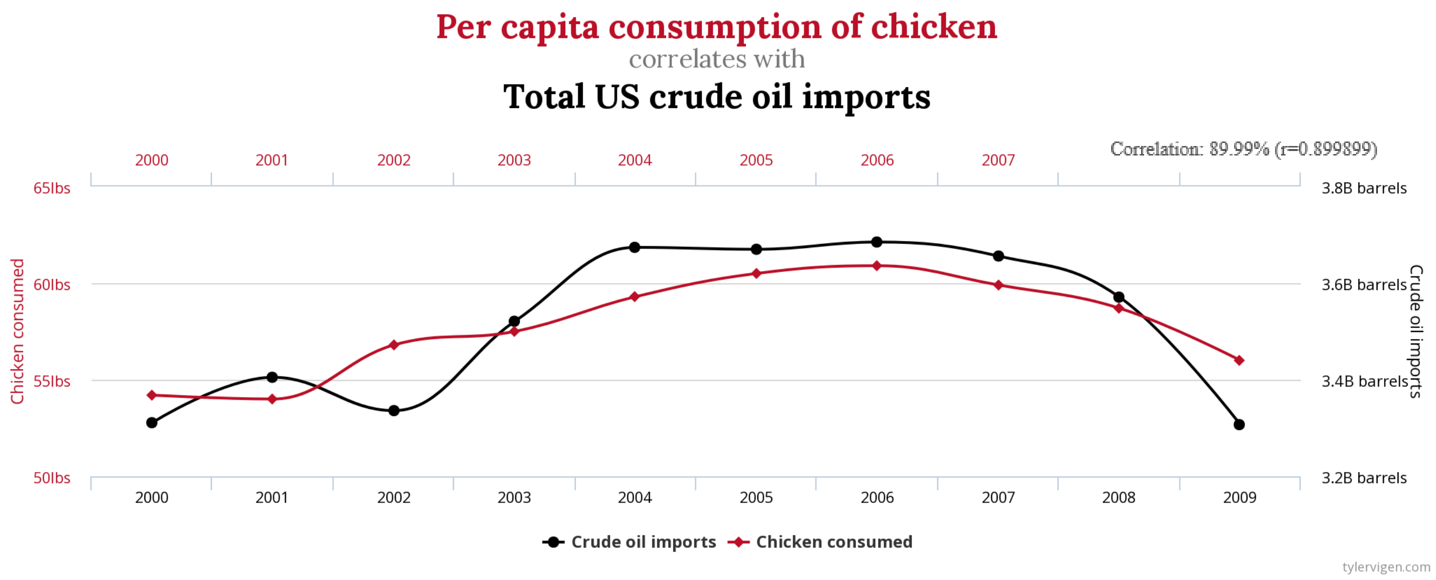
Service Boundaries

Communities
- N
- District Office
- Region Office
- General Office

Document Path: G:\Dept\Mapping\SYSTEM MAP\System Map.mxd /Date: 11/13/2015

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

A Little Fun with Spurious Correlations…



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

Demand Forecast

- The Cascade demand forecast developed for the IRP is a forecast of core customers and their usage, including peak demand, for the next 20+ years.
- Demand is forecasted at:
  - the citygate and citygate loop level;
  - the rate schedule level;
  - the daily level; and
  - forecasted out to 2050 for decarbonization planning.

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

Key Definitions

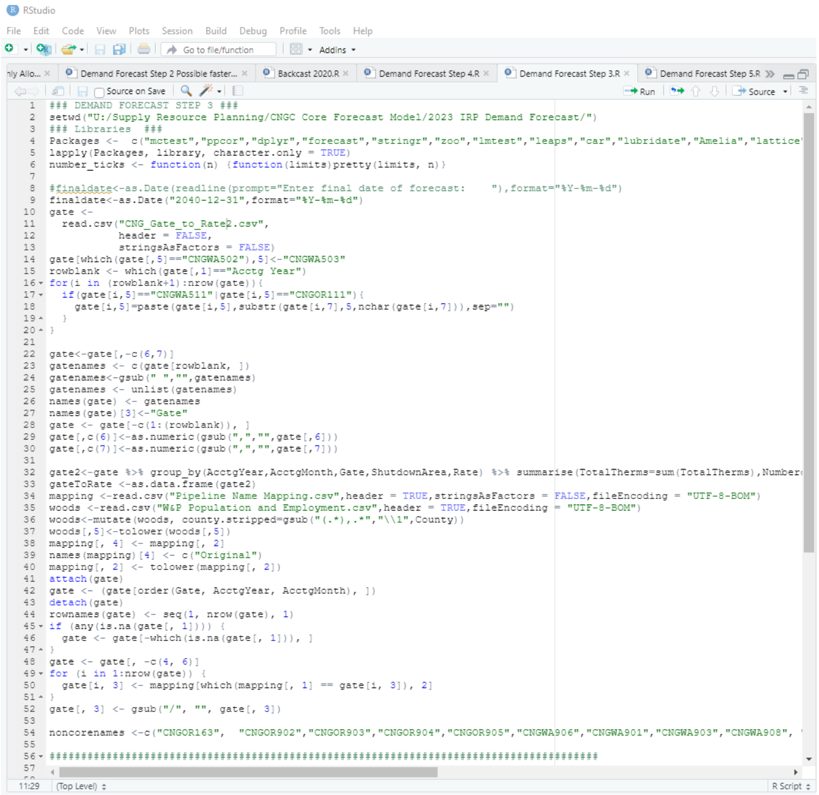
- AIC: The Akaike information criterion (AIC)
  - A measure of the relative quality of statistical models for a given set of data. Given a collection of models for the data, AIC estimates the quality of each model, relative to each of the other models. Hence, AIC provides a means for model selection.
- ARIMA: Auto-Regressive Integrated Moving Average
  - Type of model that is fitted to time series data.
  - When doing regressions using time series variables, it is common for the errors (or residuals) to have a time series structure. This could mean there is a predictable structure to the errors, meaning they can also be modeled. This is where the ARIMA term comes in.
- Fourier Terms
  - The decomposition of a time series into a set of sine-waves (or cosine-waves) with differing amplitudes, frequencies, and phase angles. Essentially, these terms help find seasonalities within a time series that wasn’t accounted for by regressors.
- Weather in terms of HDDs (Heating Degree Day), referencing 60 degrees.
- Wind is average daily wind speed.
- Citygate loops are a group of citygates that service a similar area that are forecasted together due to pipeline operations.

R Software

R is a free software environment for statistical computing and graphics.

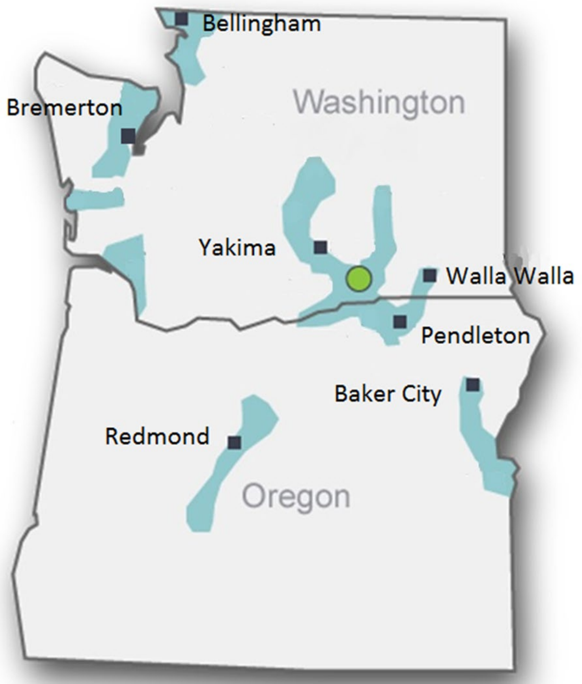
Thousands of packages: A package bundles together code, data, documentation, and tests, and is easy to share with others.

Allows for large number of complex calculations in reasonable amount of time (i.e., Monte Carlo simulations, entire load forecast, etc…).



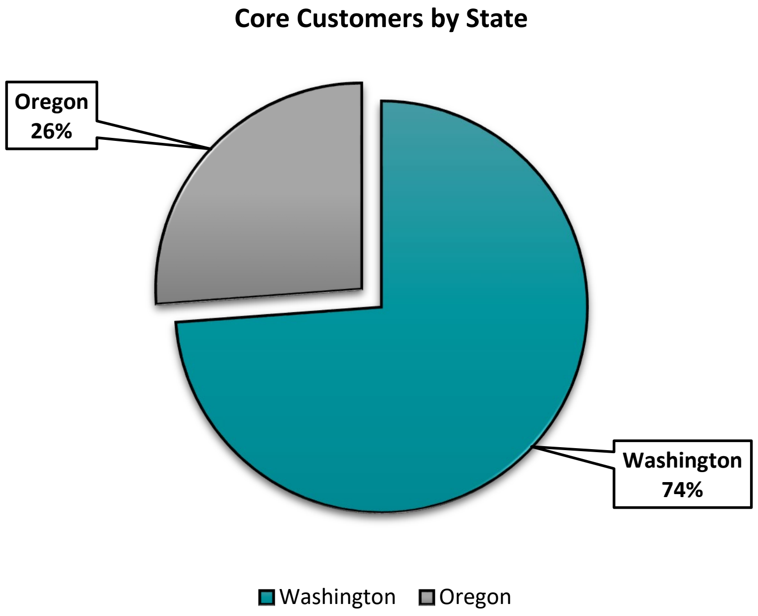
CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

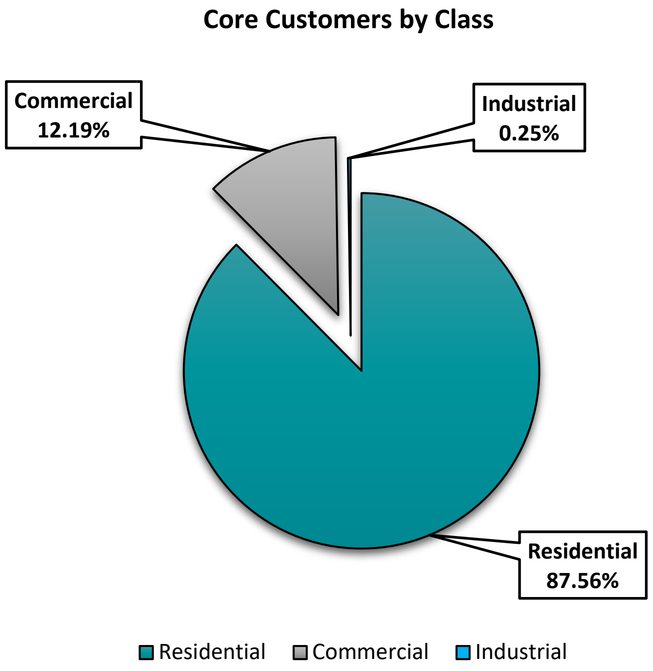
Weather Stations

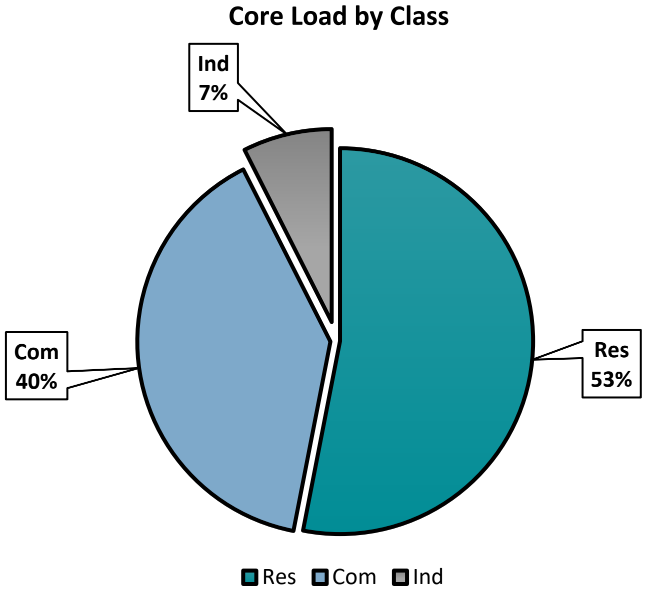


- The seven weather stations are shown on the map.
- Cascade's service territory is shaded in aqua.
- Each citygate and loop is assigned to a weather station.

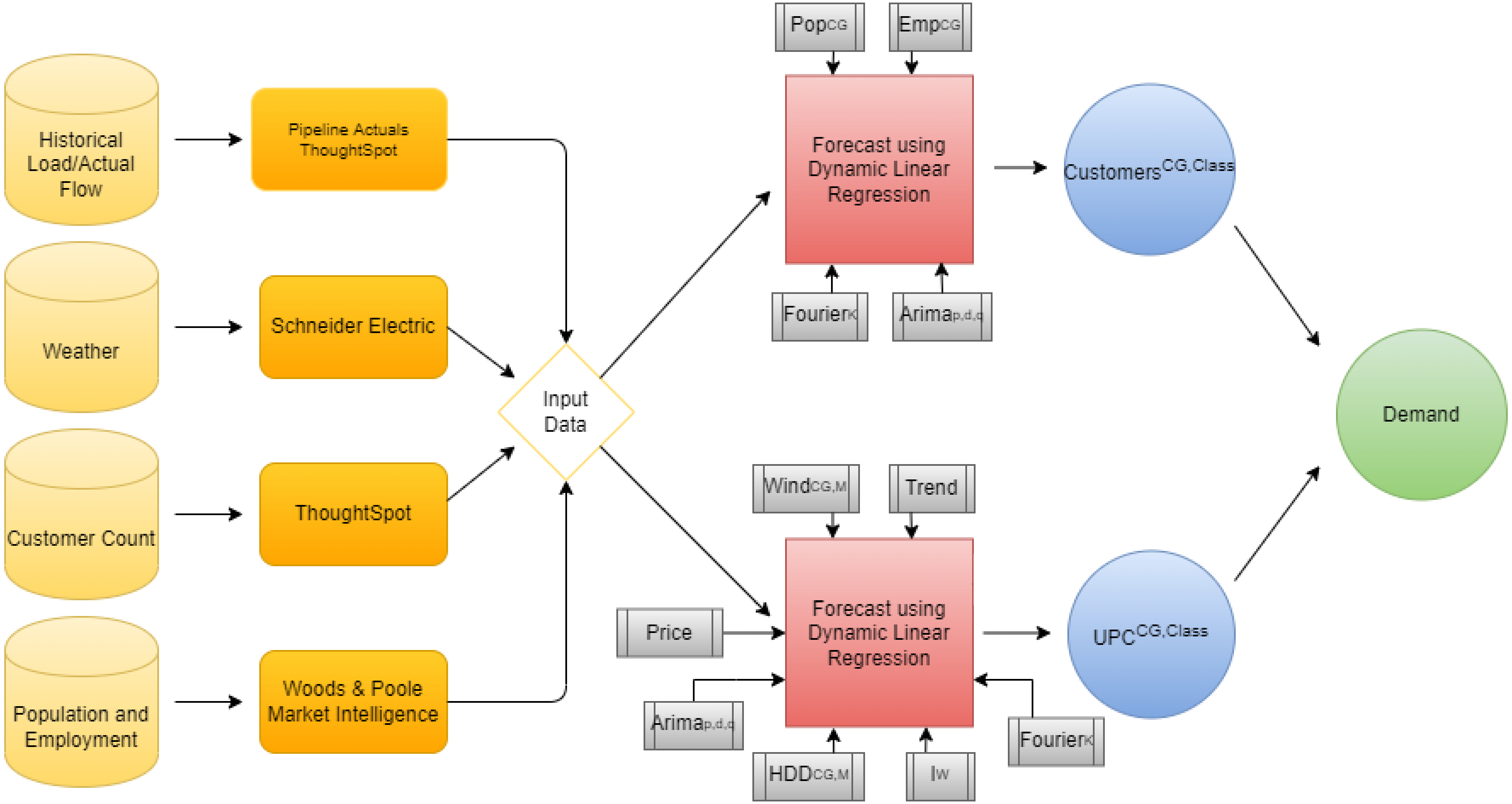
Core Customers/Load Breakdown - 2021



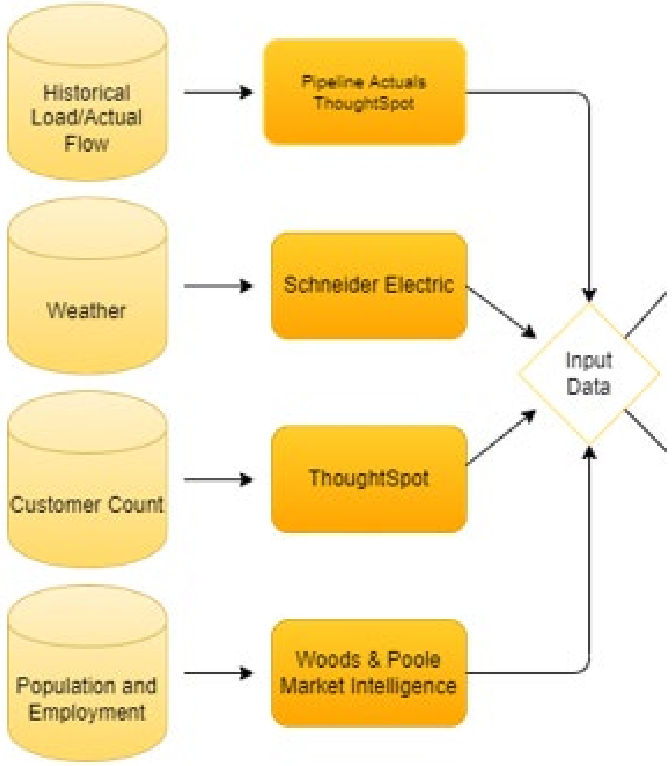




Process



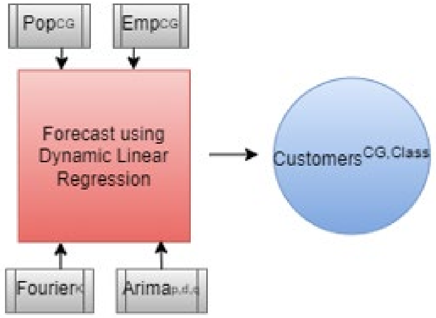
Cascade Natural Gas Corporation
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®



Inputs

- Cascade uses data from various sources:
  - Pipeline actuals at daily/Citygate level.
  - Woods & Poole at county level.
  - ThoughtSpot citygate/monthly allocations
- Market intelligence monthly.
- Unifying inputs is an important part of the forecasting process.

Customer Forecast



Customer Forecast

$C^{CG,Class} = \alpha_0 + \alpha_1 Pop^{CG} + \alpha_2 Emp^{CG} + Fourier(k) + ARIMA \in (p,d,q)$

Model Notes:

- C = Customers; CG = Citygate; Class = Residential, Commercial, Industrial, or Interruptible; ARIMA∈(p,d,q) = Indicates that the model has p autoregressive terms, d difference terms, and q moving average terms; Pop = Population; Emp = Employment; Fourier(k) = Captures seasonality of k number of seasons.

Start with Linear Model

Some are Naïve models

Tests for any collinearity

Customer Forecast Inputs

Woods & Poole Data

County		Populatio	Employme
ALBANY-LEBANON	OR	70.221	29.329
ASTORIA	OR	27.905	12.293
BAKER	OR	15.219	6.517
BEND	OR	29.726	12.947
BEND-PRINEVILLE	OR	39.554	17.551
BENTON	OR	51.491	19.344
BROOKINGS	OR	13.18	4.988
CLACKAMAS	OR	156.015	47.703

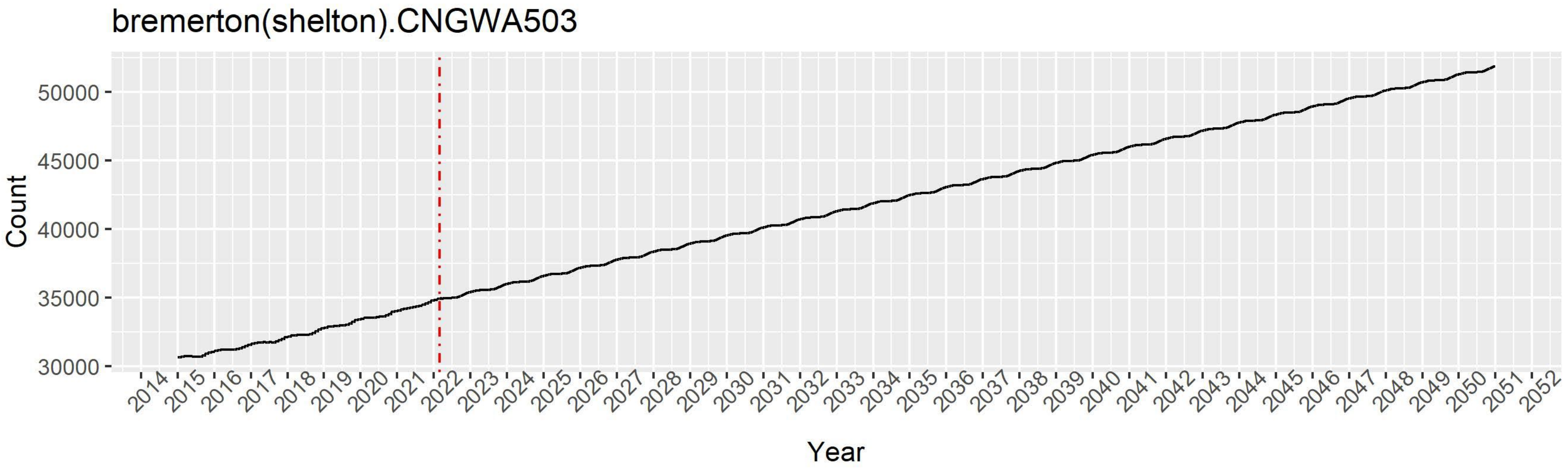
ThoughtSpot Data

3	Acctg Year	Acctg Month	Gate (Loop)	Shutdown Area	Rate	MR Cycle	SP Type	Total Therms	Number of Prem ID
4	2020	1	Umatilla	56-H011	CNGO11LV	CA00	CNGG-IND	0	1
5	2021	1	Umatilla	56-H011	CNGO11LV	CA00	CNGG-IND	0	1
6	2022	1	Umatilla	56-H011	CNGO11LV	CA00	CNGG-IND	0	1
7	2015	1	Athena	56-H008	CNGOR101	CA06	CNGG-RES	708	3
8	2015	1	Athena	56-I033	CNGOR101	CA06	CNGG-RES	31331	316
9	2015	1	Athena	56-I038	CNGOR101	CA06	CNGG-RES	16611	171
10	2016	1	Athena	56-I033	CNGOR101	CA06	CNGG-RES	27992	321
11	2016	1	Athena	56-H008	CNGOR101	CA06	CNGG-RES	599	3
12	2016	1	Athena	56-I038	CNGOR101	CA06	CNGG-RES	14858	171
13	2017	1	Athena	56-H008	CNGOR101	CA06	CNGG-RES	947	3
14	2017	1	Athena	56-I038	CNGOR101	CA06	CNGG-RES	22870	173

Pipeline Data

	A	B	C	D	E	F	G	H	I	J	K
1	Aggregated Locations	Loop		Year	Month	Day	Year-Month-Day	Date	Actual Dth	None Core	Core
38	ABERDEEN/HOQUIAM/MCCLEARY			2015	1	1	1/1/2015	Thursday	6,315	2,819	3,496
39	ABERDEEN/HOQUIAM/MCCLEARY			2015	2	1	2/1/2015	Sunday	3,243	1,083	2,160
40	ABERDEEN/HOQUIAM/MCCLEARY			2015	3	1	3/1/2015	Sunday	4,424	2,335	2,089
41	ABERDEEN/HOQUIAM/MCCLEARY			2015	4	1	4/1/2015	Wednesday	5,725	3,560	2,165
42	ABERDEEN/HOQUIAM/MCCLEARY			2015	5	1	5/1/2015	Friday	3,721	2,472	1,250
43	ABERDEEN/HOQUIAM/MCCLEARY			2015	6	1	6/1/2015	Monday	4,827	3,748	1,079
44	ABERDEEN/HOQUIAM/MCCLEARY			2015	7	1	7/1/2015	Wednesday	4,076	3,500	576.3
45	ABERDEEN/HOQUIAM/MCCLEARY			2015	8	1	8/1/2015	Saturday	3,106	2,589	517
46	ABERDEEN/HOQUIAM/MCCLEARY			2015	9	1	9/1/2015	Tuesday	4,067	3,393	674.3
47	ABERDEEN/HOQUIAM/MCCLEARY			2015	10	1	10/1/2015	Thursday	4,598	3,705	893.2
48	ABERDEEN/HOQUIAM/MCCLEARY			2015	11	1	11/1/2015	Sunday	4,074	2,752	1,322
49	ABERDEEN/HOQUIAM/MCCLEARY			2015	12	1	12/1/2015	Tuesday	3,444	2,078	1,366
50	ACME			2015	1	1	1/1/2015	Thursday	51	0	51
51	ACME			2015	2	1	2/1/2015	Sunday	29	0	29
52	ACME			2015	3	1	3/1/2015	Sunday	31	0	31
53	ACME			2015	4	1	4/1/2015	Wednesday	28	0	28
54	ACME			2015	5	1	5/1/2015	Friday	12	0	12
55	ACME			2015	6	1	6/1/2015	Monday	6	0	6
56	ACME			2015	7	1	7/1/2015	Wednesday	5	0	5
57	ACME			2015	8	1	8/1/2015	Saturday	6	0	6
58	ACME			2015	9	1	9/1/2015	Tuesday	12	0	12

Customer Forecast

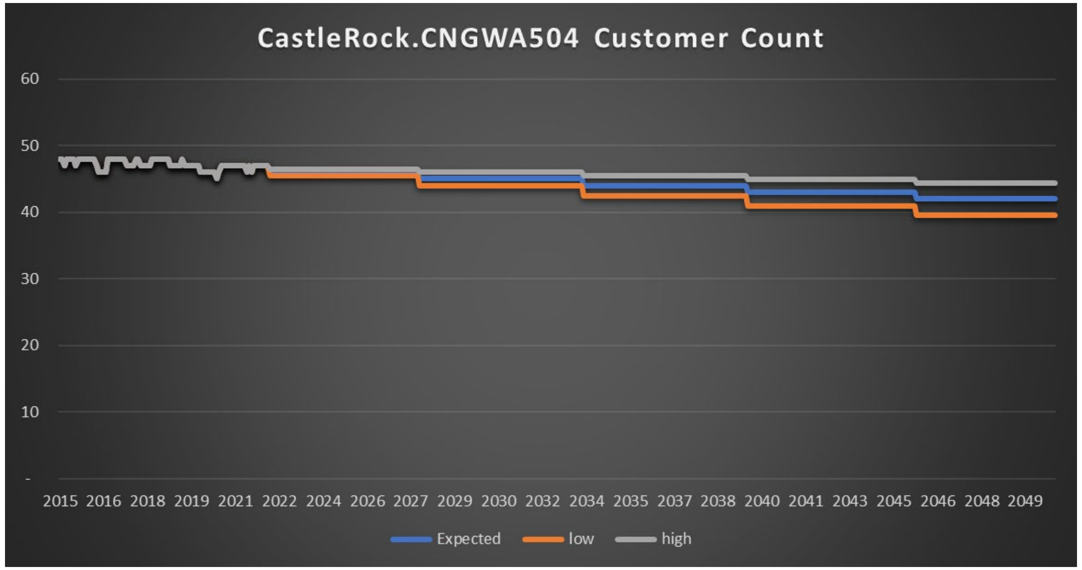


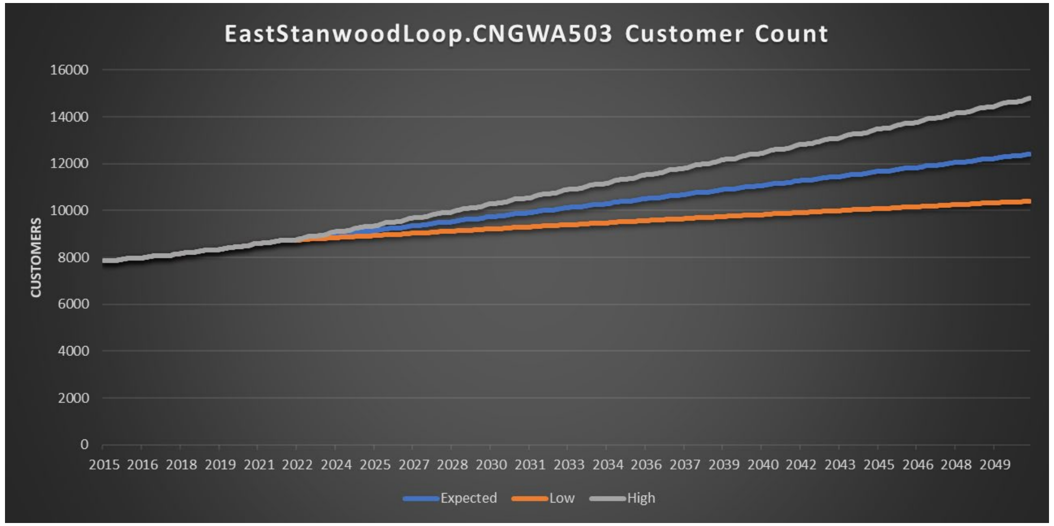
Model Selection

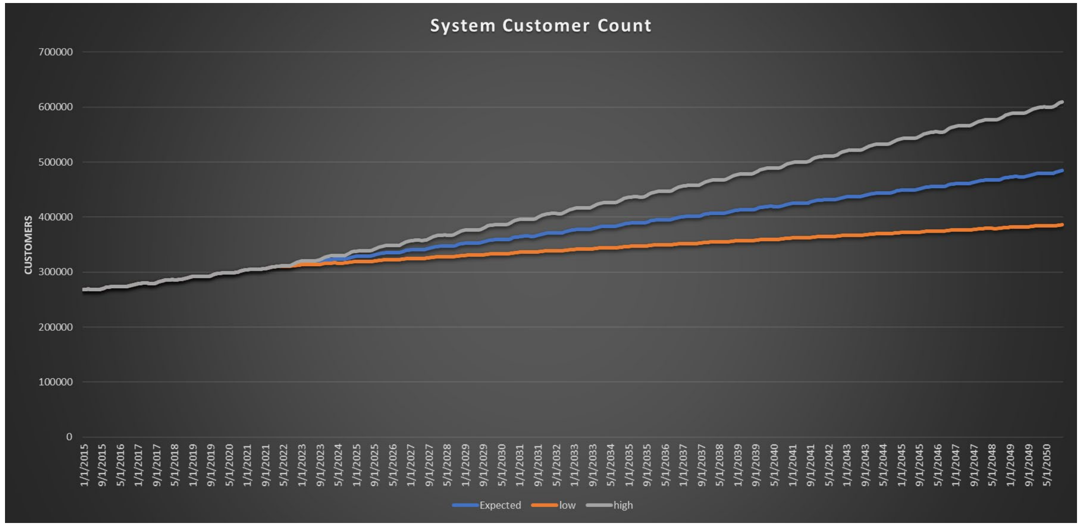
Xregs	AICc
Fourier	1505.389
Population + Fourier	1506.871
Employment + Fourier	1507.519
Employment	1562.932
Population	1566.24
Employment + Population + Fourier	1568.108
Arima Only	1597.354

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

Customer Forecast - High and Low Growth







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

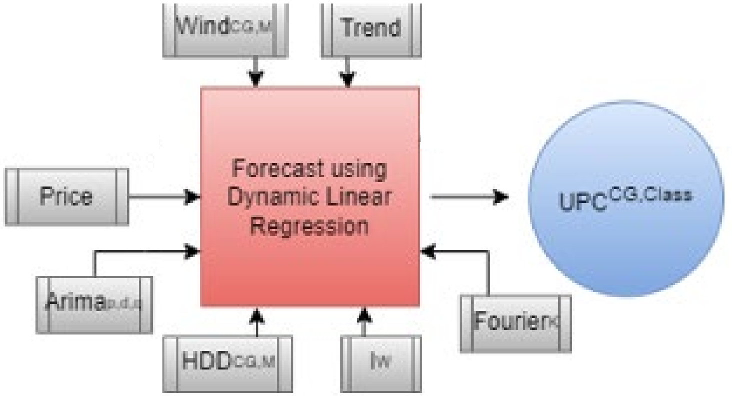
Customer Growth Rates

System	High	Base-Case	Low
Residential	2.33%	1.56%	0.75%
Commercial	1.90%	1.28%	0.62%
Industrial	2.22%	1.47%	0.66%
Total	**2.28%**	**1.52%**	**0.74%**

WA	High	Base-Case	Low
Residential	2.12%	1.42%	0.69%
Commercial	1.95%	1.31%	0.64%
Industrial	1.87%	1.27%	0.58%
Total	**2.10%**	**1.41%**	**0.68%**

OR	High	Base-Case	Low
Residential	1.78%	1.19%	0.58%
Commercial	1.78%	1.19%	0.58%
Industrial	3.08%	2.02%	0.91%
Total	**2.73%**	**1.83%**	**0.88%**

Use Per Customer Forecast



Therms/C^{CG,Class} = $\alpha_0 + \alpha_1 HDD^{CG,\,M} + \alpha_2 I_w + \alpha_4 WIND^{CG,\,M}$ + Price + Trend + Fourier(k) + ARIMA$\in$(p,d,q)

Model Notes:

- Therms/C = Therms per customer; CG = Citygate; Class = Residential, Commercial, Industrial, or Interruptible; HDD = Heating Degree Days; M= Month; I_w = Indicator Variable set to 1 if it is a weekend; T = Trend Variable increasing by 1 for each day forecasted; WIND = Daily average wind speed; Price is FOM pricing.

Start with linear model

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

Use Per Customer Forecast Inputs

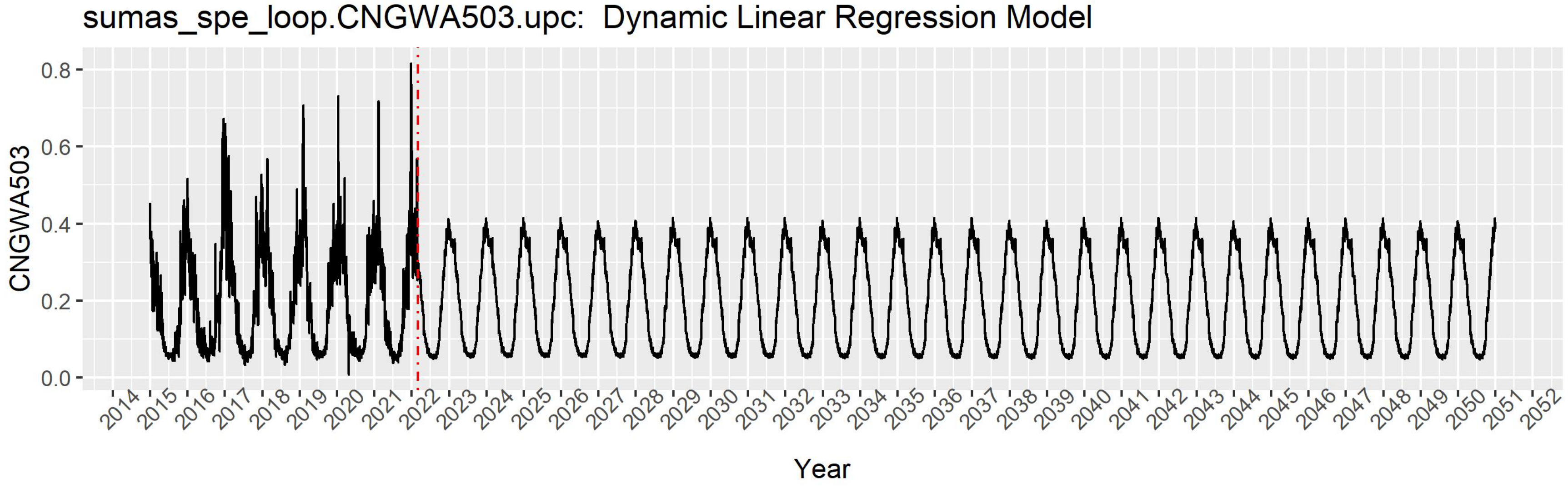
$$\text{Therms/C}^{CG,Class} = \alpha_0 + \alpha_1 \text{HDD}^{CG,\,M} + \alpha_2 I_w + \alpha_4 \text{WIND}^{CG,\,M} + \text{Price} + \text{Trend} + \text{Fourier}(k) + \text{ARIMA} \in (p,d,q)$$

Aggregated.Locations	CNGOR101	weekend	jan.hdd	feb.hdd	mar.hdd	apr.hdd	may.hdd	jun.hdd	jul.hdd	aug.hdd	sep.hdd	oct.hdd	nov.hdd	dec.hdd	jan.wind	feb.wind	mar.wind	apr.wind	may.wind	jun.wind	jul.wind	aug.wind	sep.wind	oct.wind	nov.wind	dec.wind	price.temp
south hermiston	137	0	29	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3.095990165

UPC Forecast Results

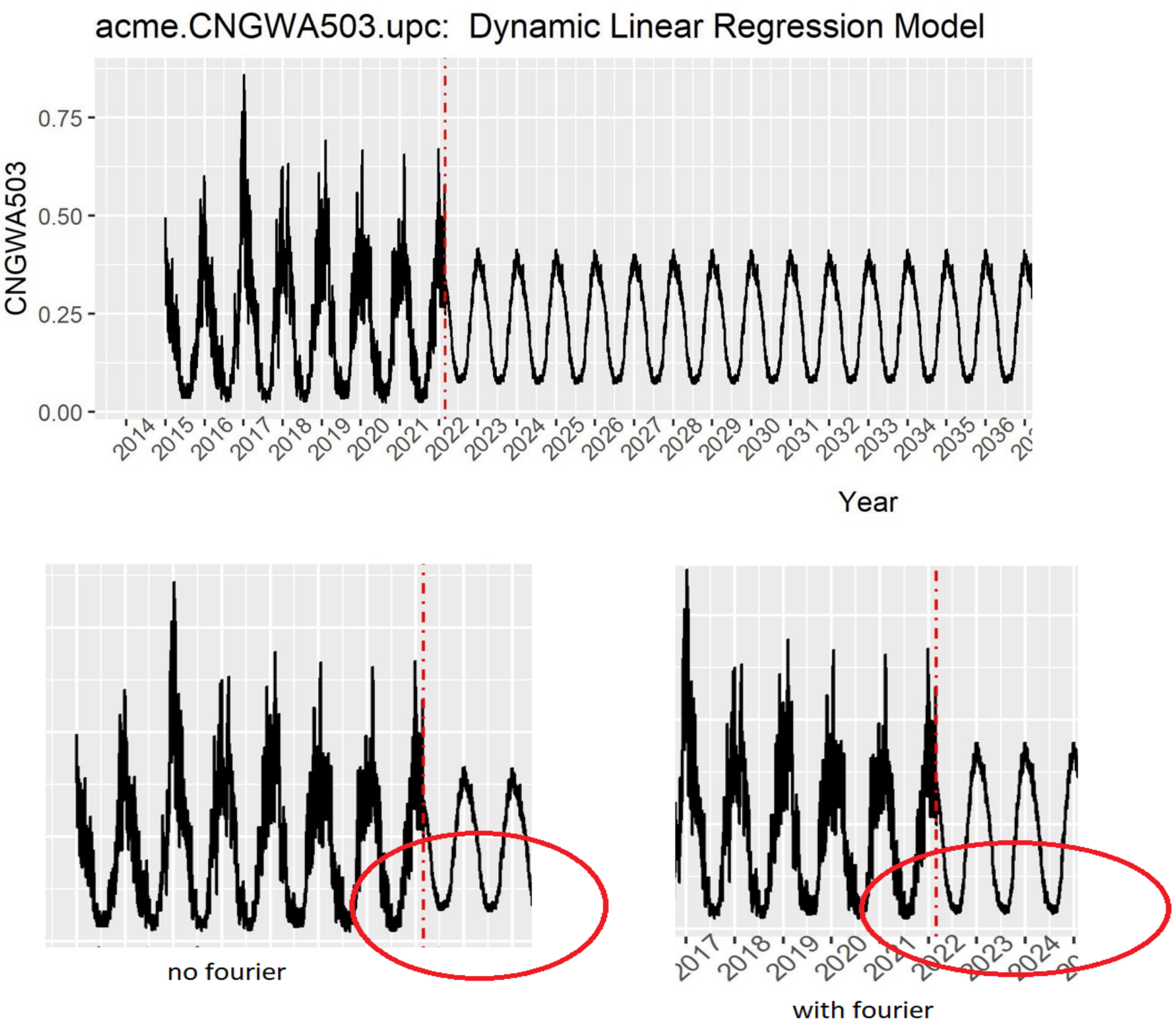
ar1	ar2	ar3	ma1	ma2	ma3	ma4	intercept	weekend	jan.hdd	feb.hdd	mar.hdd	apr.hdd	may.hdd	jun.hdd	jul.hdd	aug.hdd	sep.hdd	oct.hdd	nov.hdd
0.072517433	0.202667228	0.564950142	0.178551246	-0.067482619	-0.51394553	-0.047368441	0.084391666	-0.008088873	0.011839269	0.011870203	0.010491619	0.009235327	0.006505575	0.005502497	0.005191624	0.004315505	0.005899139	0.009113726	0.010875138

dec.hdd	jan.wind	feb.wind	mar.wind	apr.wind	may.wind	jun.wind	jul.wind	aug.wind	sep.wind	oct.wind	nov.wind	dec.wind	price	S1-365	C1-365	S2-365	C2-365	S3-365	C3-365
0.011958002	0.004857669	0.004504779	0.004358709	0.002700278	0.000552336	-0.000246139	-0.000274343	0.00029844	0.001779977	0.003644867	0.004009029	0.004188376	-0.002184843	0.016337025	0.009787113	0.006171567	0.001279059	0.000465429	0.001946981



Fourier terms

What do they do exactly?

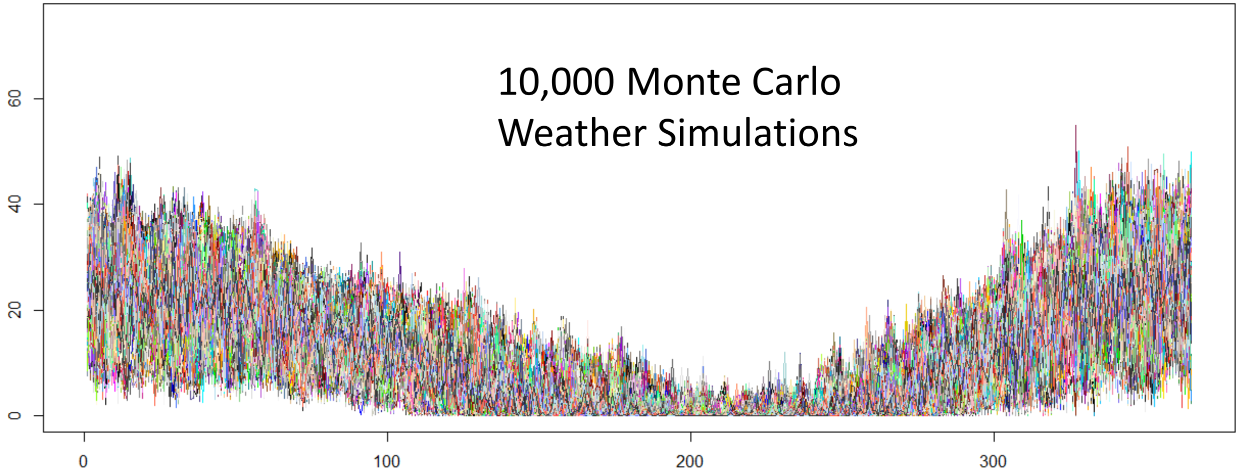


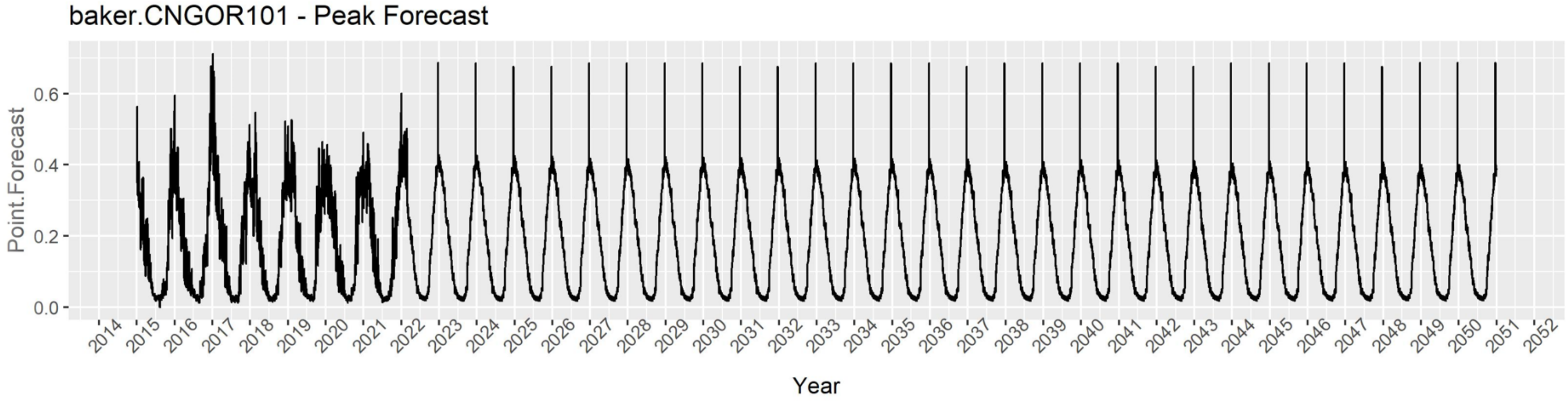
Peak Day Use-Per-Customer

10,000 simulations ran on each of Cascade's seven weather zones along with a system-wide weighted simulation.

Found 95th, 99th, and 100th percentile of each weather location.

99th percentile lined up with previous peak day values.





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

Methodology Changes

- Added price as a regressor
- Shifted customer class:

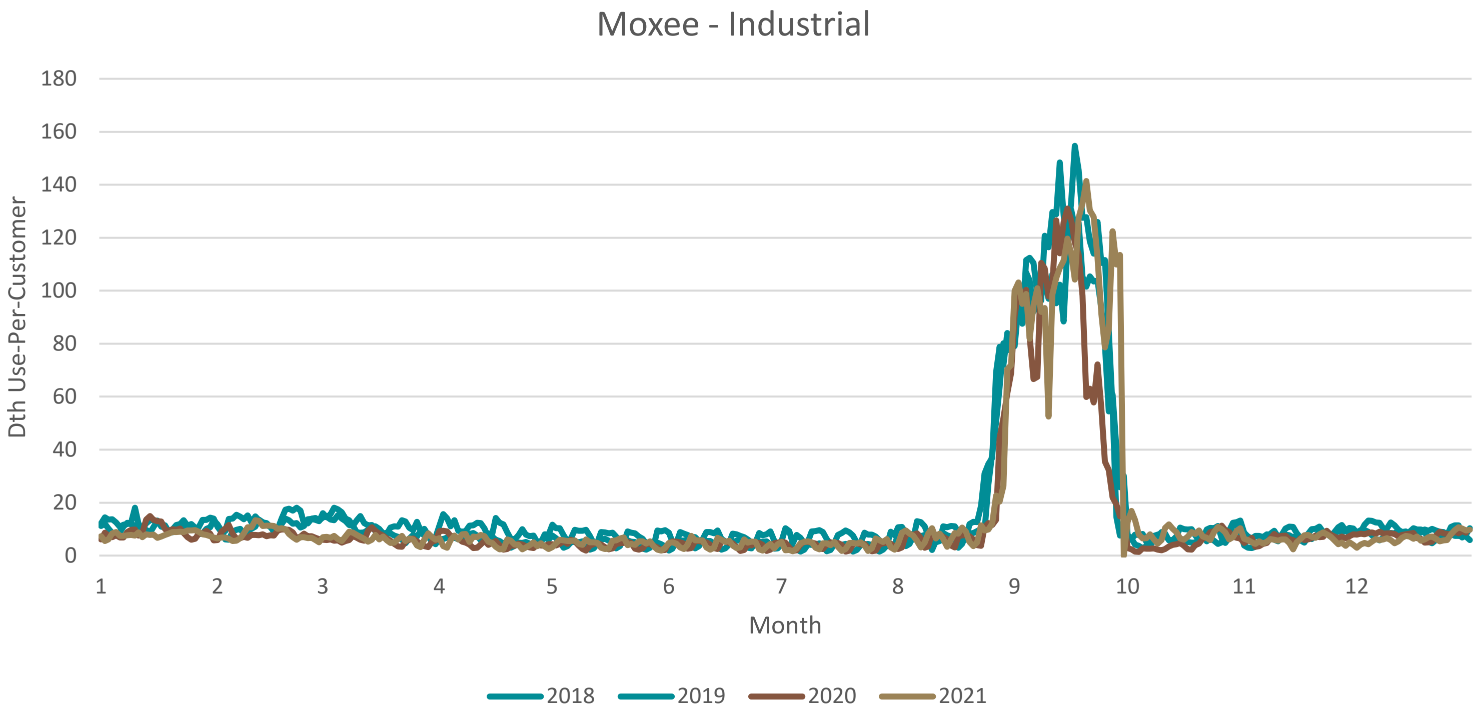
3	Acctg Year	Acctg Month	Gate (Loop)	Shutdown Area	Rate	MR Cycle	SP Type	Total Therms	Number of Prem ID
4	2020	1	Umatilla	56-H011	CNGO11LV	CA00	CNGG-IND	0	1
5	2021	1	Umatilla	56-H011	CNGO11LV	CA00	CNGG-IND	0	1
6	2022	1	Umatilla	56-H011	CNGO11LV	CA00	CNGG-IND	0	1
7	2015	1	Athena	56-H008	CNGOR101	CA06	CNGG-RES	708	3
8	2015	1	Athena	56-I033	CNGOR101	CA06	CNGG-RES	31331	316
9	2015	1	Athena	56-I038	CNGOR101	CA06	CNGG-RES	16611	171
10	2016	1	Athena	56-I033	CNGOR101	CA06	CNGG-RES	27992	321
11	2016	1	Athena	56-H008	CNGOR101	CA06	CNGG-RES	599	3
12	2016	1	Athena	56-I038	CNGOR101	CA06	CNGG-RES	14858	171
13	2017	1	Athena	56-H008	CNGOR101	CA06	CNGG-RES	947	3
14	2017	1	Athena	56-I038	CNGOR101	CA06	CNGG-RES	22870	173

- Compared to pipeline data, CA01-CA14 need to be shifted back 1 month
- Peak day: Coldest in 30 years to Monte Carlo simulations

Non-Weather Dependent Demand

- Demand that is not influenced by weather.
- Typically caused by a customer who ramps up production based on the time of season.
- Cascade's models can accurately capture this type of demand.

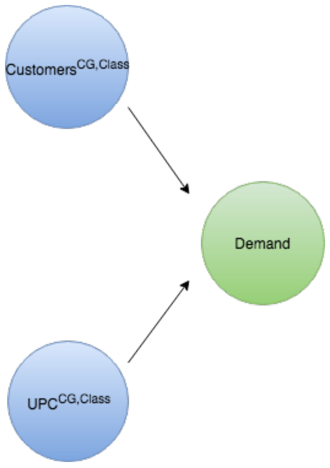
Moxee

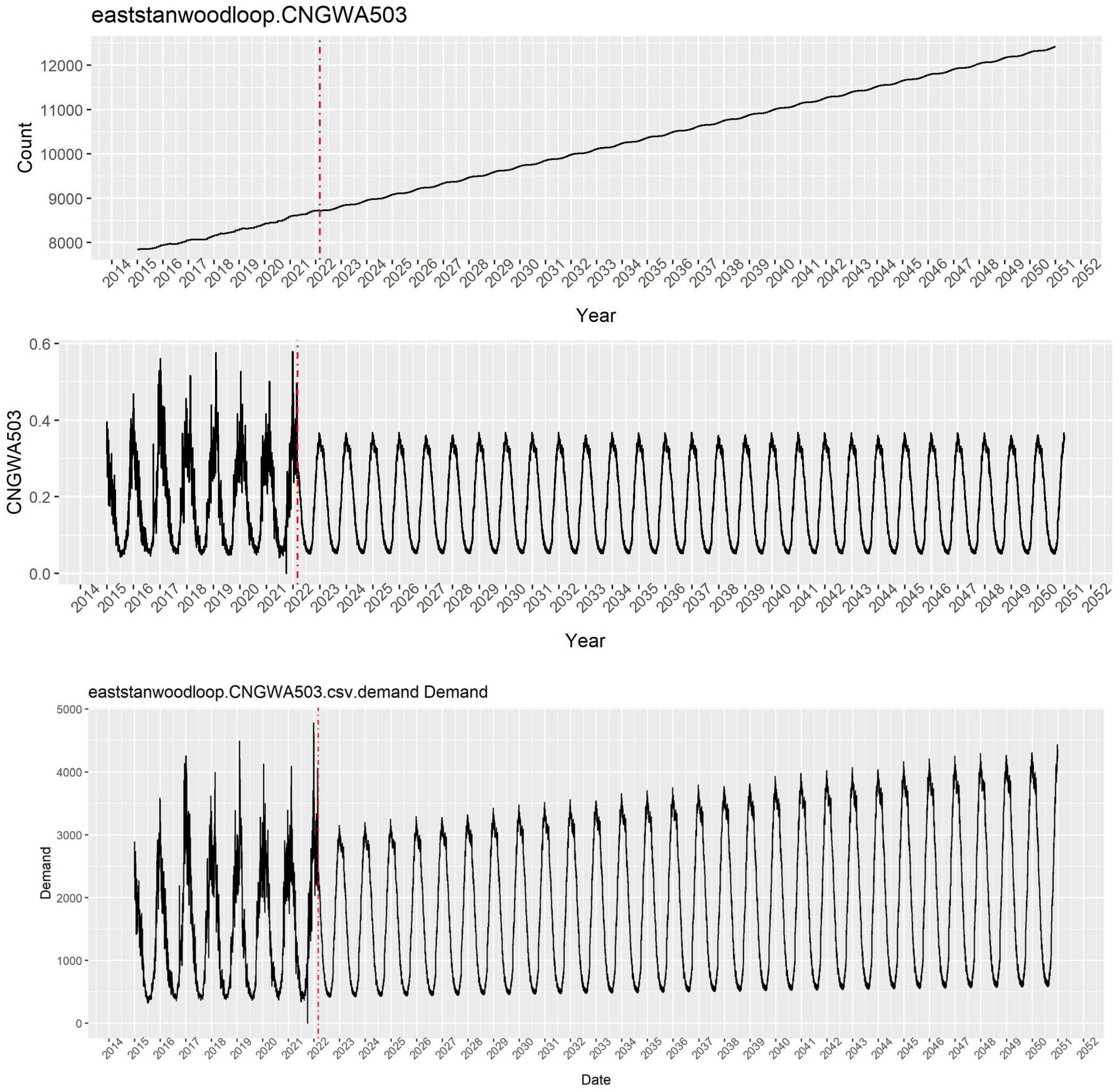


CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

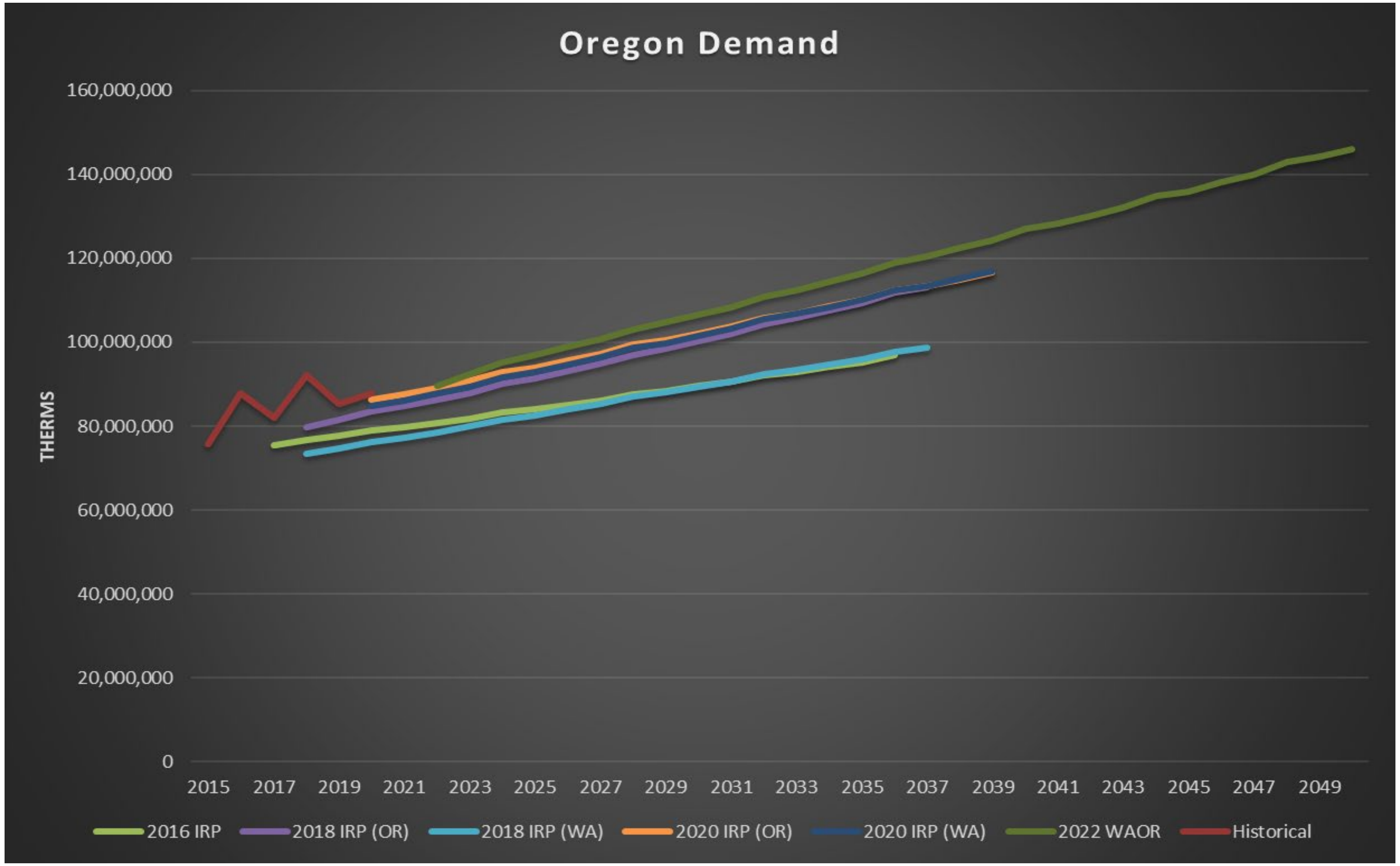
Forecast Results

Final Demand Calculation



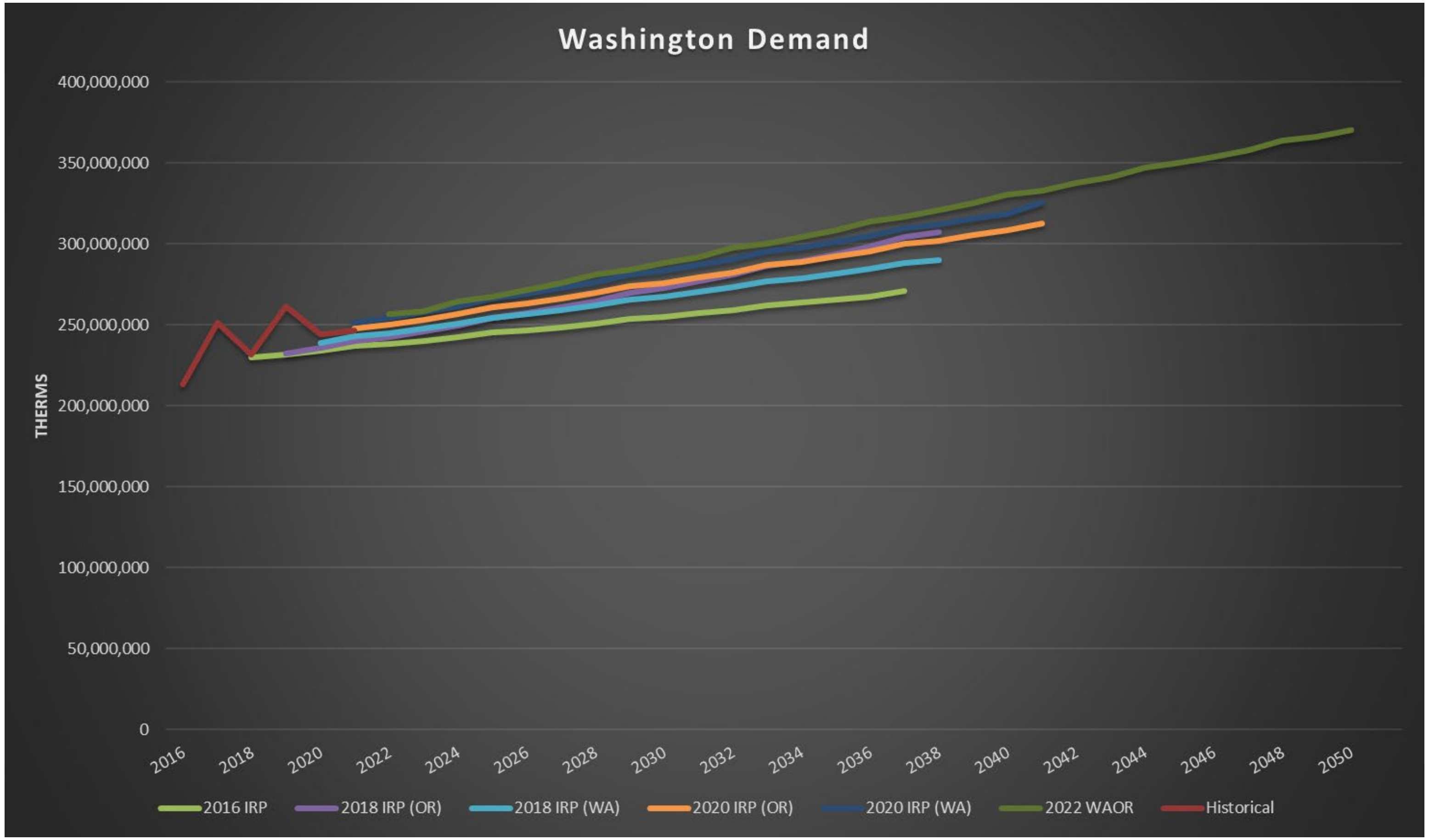


Oregon Demand



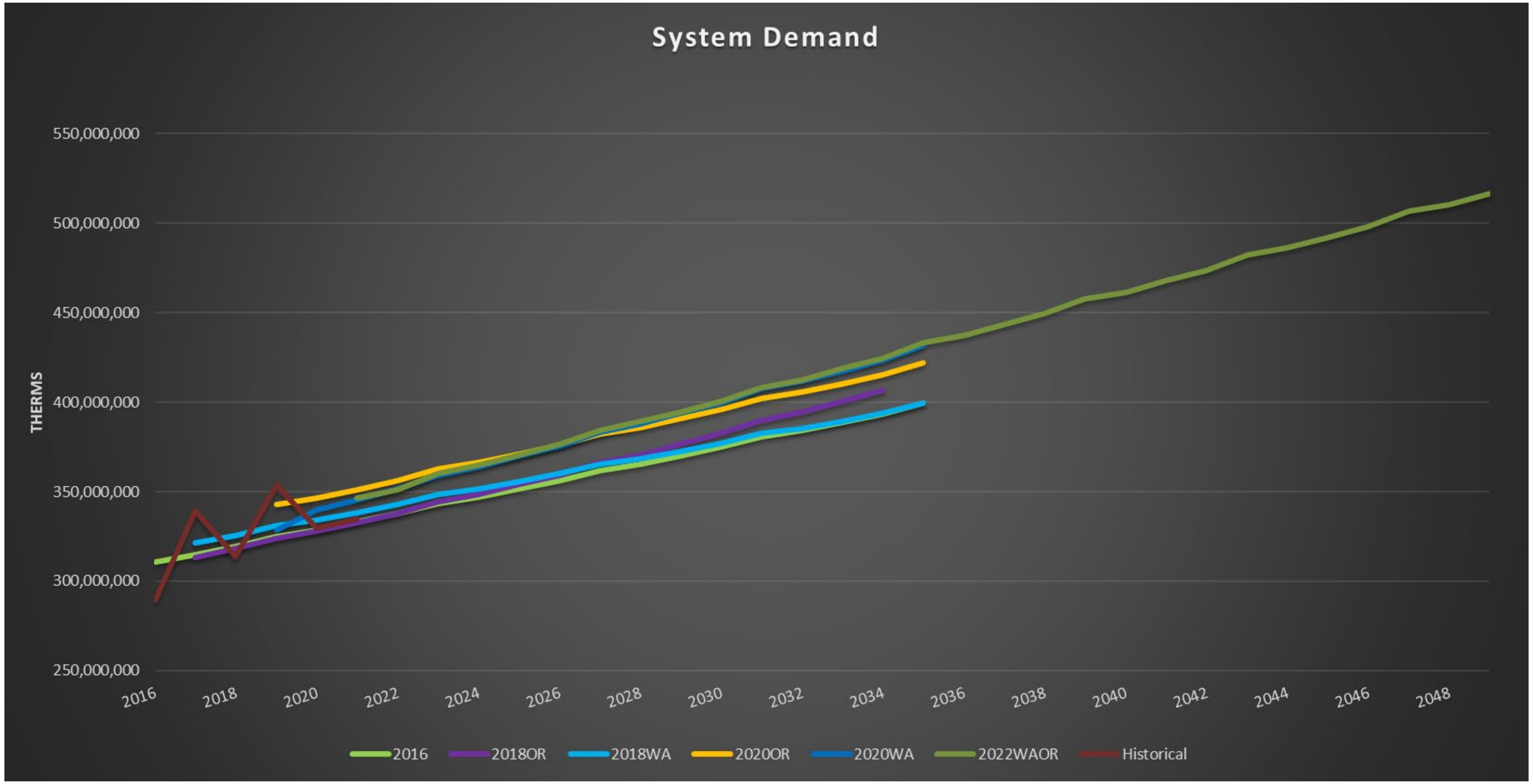
CASCADE NATURAL GAS CORPORATION
A Subsidiary of MDU Resources Group, Inc.
In the Community to Serve®

Washington Demand



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

Total System Demand



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

Weather Normals and Climate Change Impacts

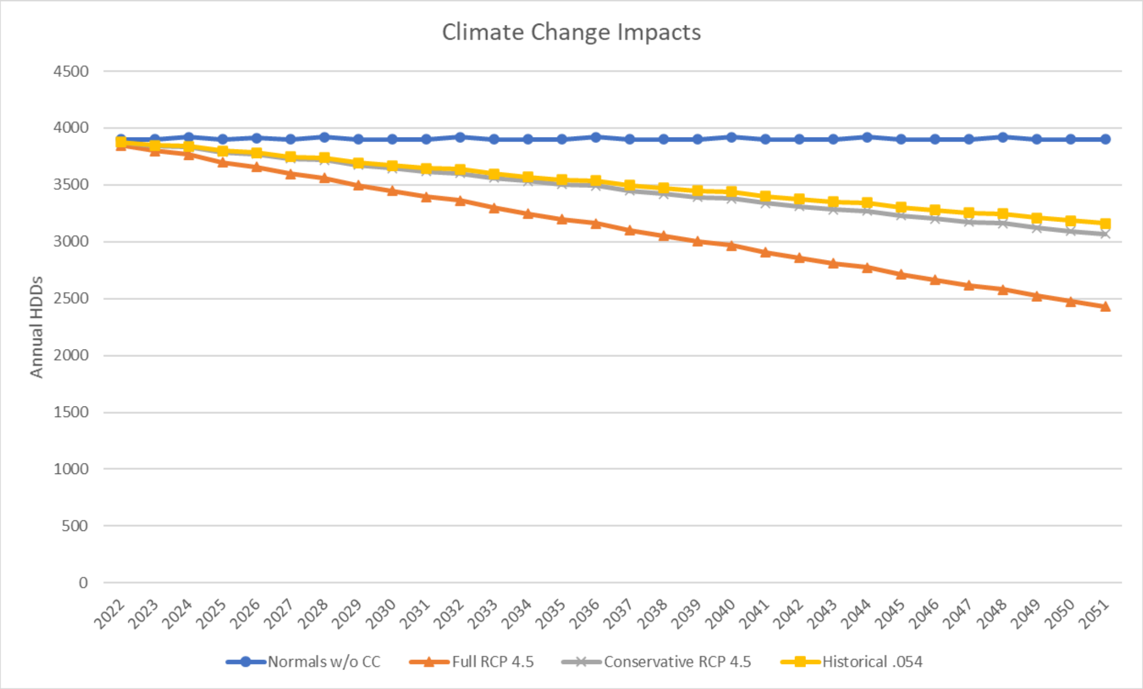
Weather Normals

Historically, Cascade has used the average weather from the past 30 years for weather normals.

As Cascade is looking at Climate Change impacts, the Company has provided several different ranges of weather normals.

Scenario	Historical Range	Peak HDD	Avg Annual
Previous IRP	1990-2019	55.7	4012
30-year	1992-2021	49.9	4025
20-year	2002-2021	49.9	4037
15-year	2007-2021	46.7	4038
10-year	2012-2021	46.7	3872

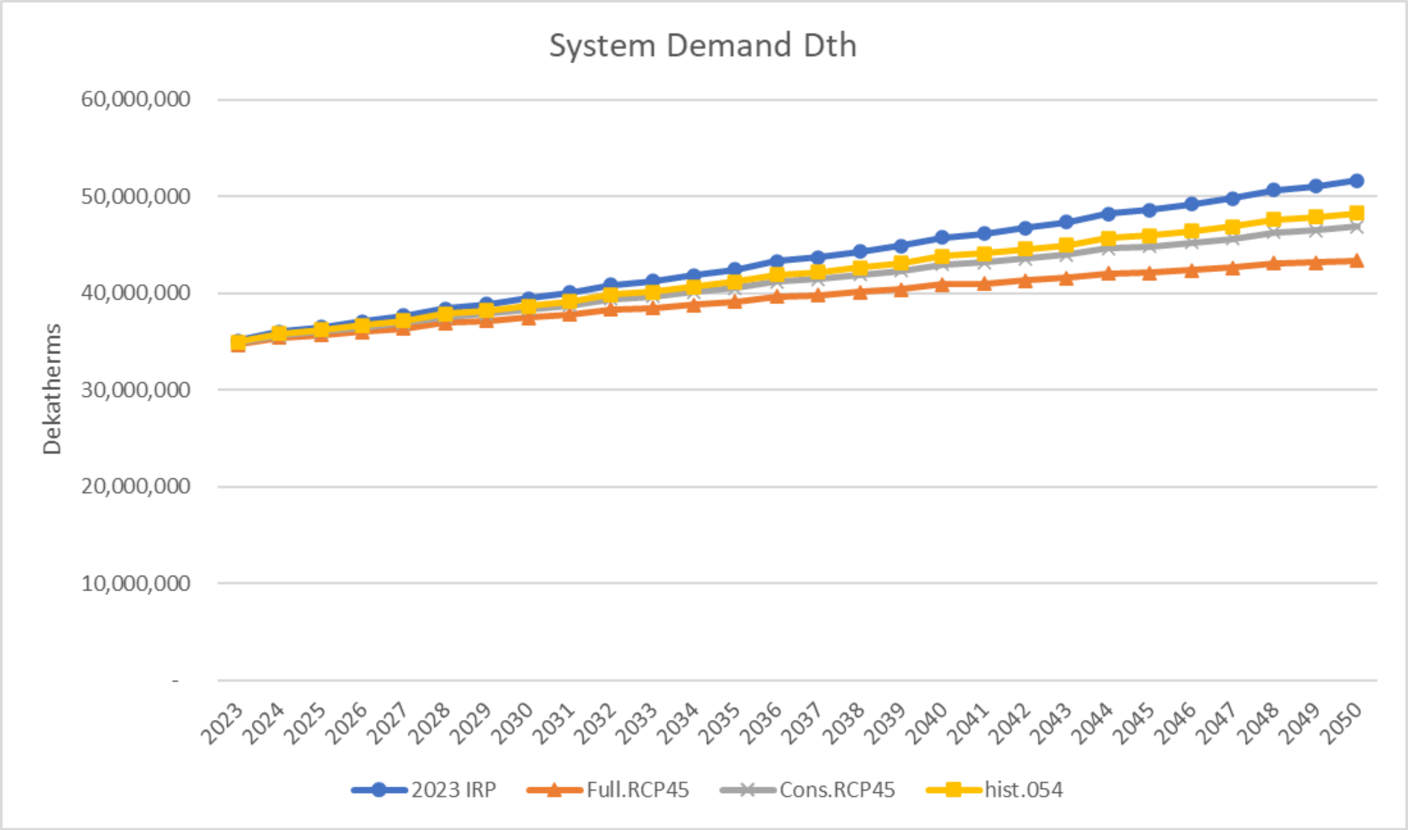
Climate Change Impacts



- Cascade utilized Climate Change data from the Intergovernmental Panel on Climate Change.[1]
- Cascade used the Coupled Model Intercomparison Project Phase 4 (CMIP5) with the RCP 4.5 scenario which included 36 different models.
- Cascade chose this scenario as it best represents the Western North America emission goals and was labeled as the most probable baseline scenario.[2]
- Cascade also modeled using the 18 most conservative models as well as the Environmental Protection Agency's noted historical temperature change (.54°F per decade since 1979).[3]

1 HTTPS://IPCC-BROWSER.IPCC-DATA.ORG/BROWSER/SEARCH?FORMAT
2 REPRESENTATIVE CONCENTRATION PATHWAY – WIKIPEDIA
3 CLIMATE CHANGE INDICATORS: U.S. AND GLOBAL TEMPERATURE | US EPA

Climate Change Impacts



Non-Core Outlook

Non-Core Outlook

- Cascade forecasts the non-core out to 2050.
- Unlike the core, non-core (or transportation) customers are customers who schedule and purchase their own gas, generally through a marketer, to get gas to the citygate. The customer then uses Cascade's distribution system to receive the gas.
- Cascade's transportation customers include all types of industrial customers. It includes farms that may not use any gas during the winter to food manufacturers that average 800,000 therms per month throughout the year.
- Cascade also serves five electric generation customers in Washington and one in Oregon. Those six customers project to use approximately 419,000,000 therms in 2023.

Transportation Customers

- Cascade's transportation customer forecast increased from the previous forecast. The current forecast projects the customer count to be 245 in 2023, up from 234 customers from the previous forecast, with plans to bring on several new customers over the next five years. Cascade's industrial managers are working closely with potential industrial customers.
- Cascade's projection increased by 12 million therms from the previous forecast. The increase is mainly a direct result from the new customers the Company added.
- Cascade projects the transportation customers in Washington and Oregon to consume approximately 598 million therms in 2023.

Non-Core Forecast Results

Transportation customers in Washington forecast to use 537 million therms in 2023.

Transportation customers in Oregon forecast to use 61 million therms in 2023.

Electric Generation customers forecast to use 419 million therms in 2023.

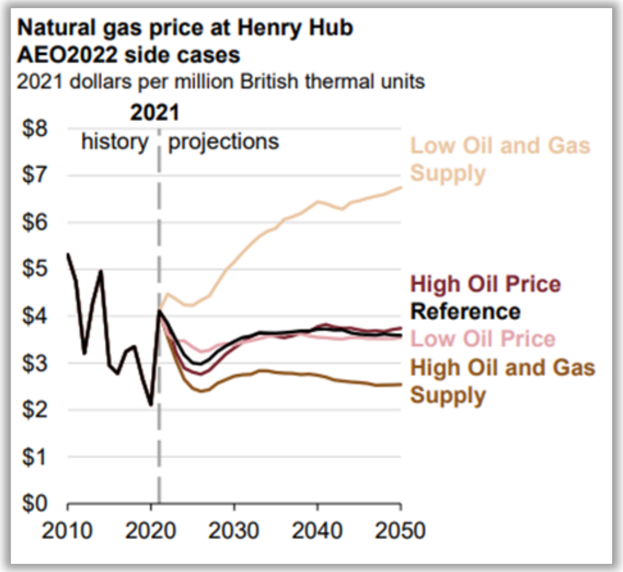
Non-Core total forecast for 2023 is approximately 1.017 billion therms.

Market Outlook and Long-Range Price Forecast

Long Range Market Outlook

Despite LNG export growth and increased domestic demand for natural gas, EIA projects that the Henry Hub price will remain below $4/MMBtu throughout the projection period in most cases. Amid growth in LNG exports, the natural gas spot price at the Henry Hub faces upward pressure from the mid-2020s through the early 2040s across all cases except the High Oil and Gas Supply case.

Steady growth in natural gas demand in the industrial sector and growing electric power sector demand for natural gas after 2035 also put upward pressure on the Henry Hub price during this time.[1]



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

[1] EIA's Annual Energy Outlook 2022

Coronavirus, the Economy, and Natural Gas

Declining Demand

- EIA's April *Short-Term Energy Outlook* (STEO) forecasts decreased total U.S. natural gas consumption in 2021 and 2022 following a decline in 2020. Consumption in 2020 was 1.9 billion cubic feet per day (Bcf/d) lower than the all-time high of 85.1 Bcf/d set in 2019. Total consumption declined as a result of the economic slowdown associated with the COVID-19 pandemic and lower heating demand amid milder temperatures. [1]
- Both Cascade's FERC form 2 and MDUR's 2021 Annual Report imply there was no material impact to operations or revenues from Covid-19.

Price Volatility Impacting Demand

- The impact of high and volatile prices is leading to much bigger reductions for gas and LNG. Last week, Wood Mackenzie cut forecast gas demand in Europe by 4% for 2022 and 5% for 2023 compared with July 2021 (the outlook before the winter rise in gas prices
- Asian LNG demand to come in at around 270 mmtpa, flat versus 2021, and down 4.5% on Wood Mackenzie's prior forecasts of 283 mmtpa. As global LNG prices moderate next year, Wood Mackenzie expects demand to rise to 280 mmtpa in 2023.)[2]

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

[1] EIA April 2021 STEO
[2] The Edge: How the war is choking energy demand

Price Forecast Calculation Process

1. Update Source Data
2. Calculate Source Weights
3. Interpolate Source Weights
4. Apply Age Dampening Mechanism (if applicable)
5. Apply Weights to Sources to Calculate Forecast

Long Range Price Forecast - Sources

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 consider sources such as Wood Mackenzie, EIA, the Northwest Power and Conservation Council (NWPCC), S&P Global, the Intercontinental Exchange (ICE), and various third-party 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.

Sources Continued

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.

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.

Price Forecast Weights

Considerations in weight assignments:

- Cascade produces a weighting system based on an analysis of the symmetric mean absolute percentage error (SMAPE) of its sources since 2010;
- Some sources produce forecasts daily, while others are far less frequent.
    - Cascade uses an age dampening mechanism to account for this in its price forecast, reducing the impact of forecasts that do not account for more current market information.

SMAPE to Weights

SMAPE = |(Actual – Forecast)/((Actual + Forecast)/2)|

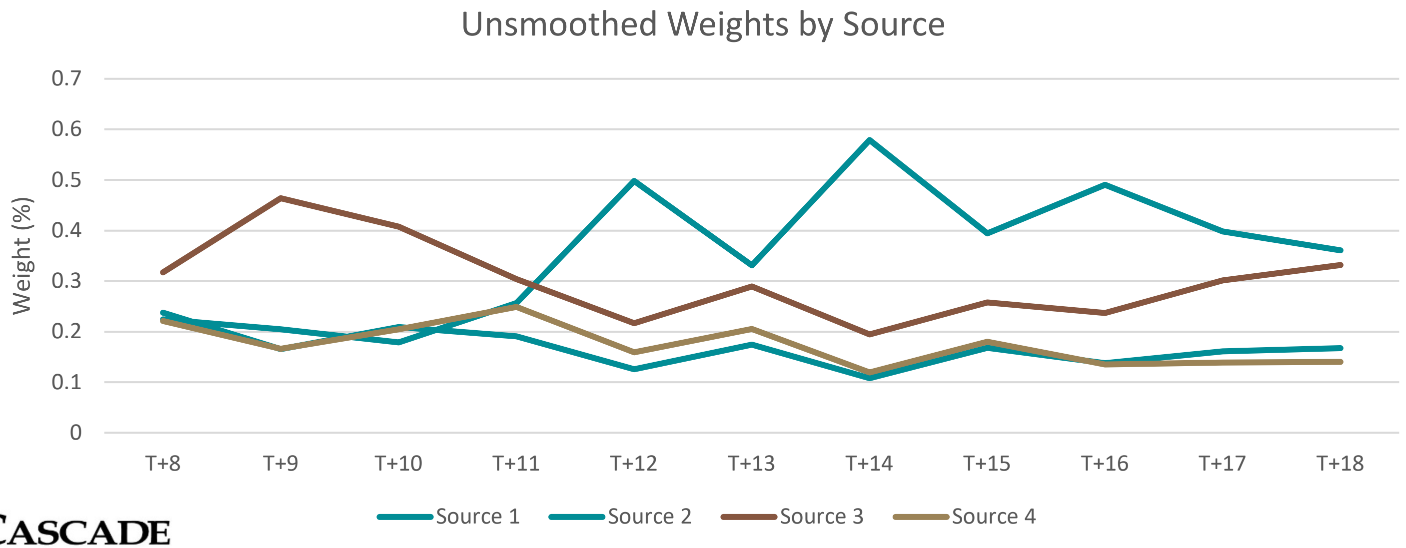
Cascade calculates the weight of the inverse of the SMAPEs of each source, which are then smoothed using Holt-Winters smoothing.

	Weight		Interval
Rank (order of severity)	Source 1	Source 2	
MSE	0.605111033	0.394888967	0.210222067
MAE	0.563119545	0.436880455	0.12623909
MAPE	0.562986465	0.437013535	0.12597293
RMSE	0.553149363	0.446850637	0.106298727
MAAPE	0.546818641	0.453181359	0.093637282
SMAPE	0.546045931	0.453954069	0.092091861

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

Example of Unsmoothed Weight Calculations by Source

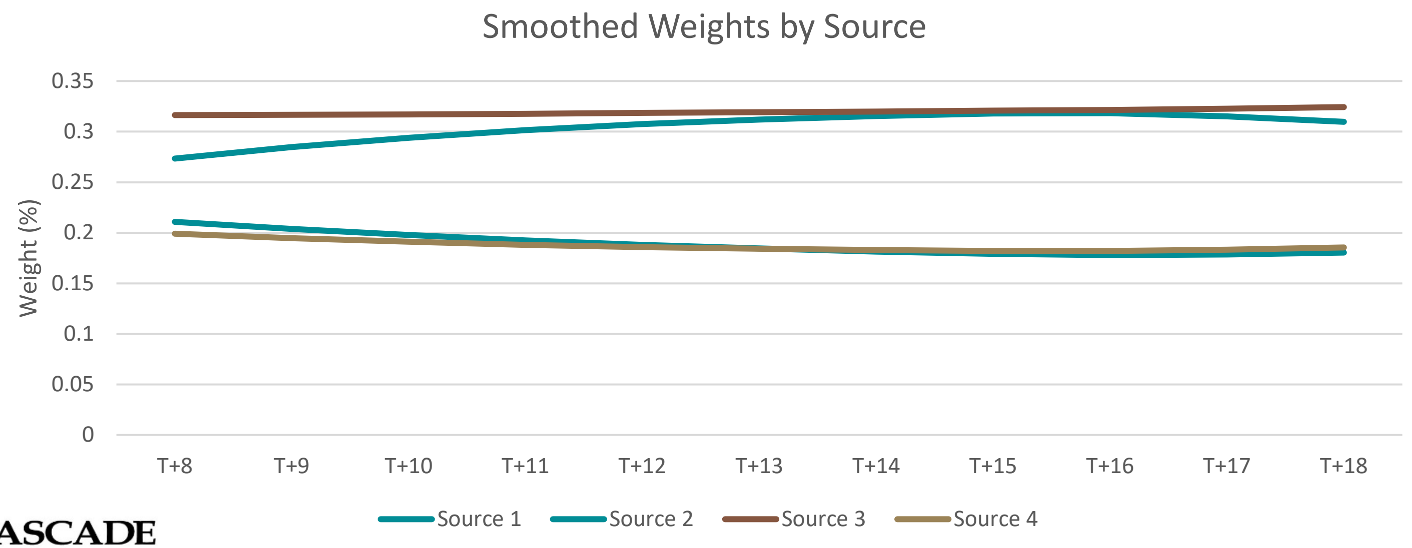
	Source 1	Source 2	Source 3	Source 4
T+8	0.237316542	0.224109939	0.317405756	0.221167763
T+9	0.165516016	0.204743885	0.463881136	0.165858963
T+10	0.2092634	0.178375551	0.407479269	0.20488178
T+11	0.190493321	0.256691958	0.30400596	0.248808761
T+12	0.125623842	0.498275448	0.216825417	0.159275292
T+13	0.174170781	0.331083637	0.289279079	0.205466503
T+14	0.107674741	0.578677045	0.194447694	0.11920052
T+15	0.168128627	0.39434101	0.257778228	0.179752135
T+16	0.137570017	0.490453841	0.236754446	0.135221696
T+17	0.16124735	0.398220835	0.301492422	0.139039393
T+18	0.167346294	0.36071593	0.331817645	0.140120131



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

Example of Smoothed Weight Calculations by Source

	Source 1	Source 2	Source 3	Source 4
T+8	0.210945514	0.273340067	0.316566729	0.199147689
T+9	0.203808917	0.284713928	0.316745954	0.194731201
T+10	0.197699412	0.294028366	0.317166229	0.191105994
T+11	0.192517021	0.301522286	0.317766021	0.188194672
T+12	0.188161769	0.307434596	0.318483797	0.185919839
T+13	0.184533679	0.312004199	0.319258024	0.184204098
T+14	0.181532775	0.315470003	0.320027169	0.182970053
T+15	0.179059082	0.318070912	0.320729698	0.182140308
T+16	0.177871605	0.318363025	0.321577606	0.182187764
T+17	0.178493366	0.315293759	0.322759839	0.183453036
T+18	0.18047041	0.309688996	0.324180298	0.185660296



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

Price Forecast Weight Adjustments

In Months T+1 to T+12, Cascade uses NYMEX Forward pricing for all locations exclusively;

- For short term forecasting, the marketplace is ideal because forward prices should reflect all current events that impact the forecast (weather, storage, etc.)
- Long term forecasting is more concerned about the fundamental market intelligence, which is reflected in the analysis of Cascade's sources.

Months T+13 to T+48 are used to interpolate the weights from exclusively NYMEX to the weights calculated from each source's SMAPE.

Months T+49 onward use the age dampened (if applicable) weights of each source.

Example Weights Price Forecast For 2023 IRP (Not Interpolated)

	Source 1	Source 2	Source 3	Source 4
May-23	100.000%	0.000%	0.000%	0.000%
Jun-23	18.453%	31.200%	31.926%	18.420%
Jul-23	18.153%	31.547%	32.003%	18.297%
Aug-23	17.906%	31.807%	32.073%	18.214%
Sep-23	17.787%	31.836%	32.158%	18.219%
Oct-23	17.849%	31.529%	32.276%	18.345%
Nov-23	18.047%	30.969%	32.418%	18.566%
Dec-23	18.335%	30.237%	32.574%	18.853%
Jan-24	18.667%	29.418%	32.735%	19.180%
Feb-24	18.999%	28.592%	32.891%	19.518%
Mar-24	19.285%	27.843%	33.032%	19.839%
Apr-24	19.622%	26.890%	33.243%	20.245%

Example Weights Price Forecast For 2023 IRP (Interpolated)

	Source 1	Source 2	Source 3	Source 4
May-23	100.000%	0.000%	0.000%	0.000%
Jun-23	97.917%	0.797%	0.816%	0.471%
Jul-23	95.833%	1.606%	1.629%	0.931%
Aug-23	93.750%	2.422%	2.442%	1.387%
Sep-23	91.667%	3.227%	3.260%	1.847%
Oct-23	89.583%	3.998%	4.093%	2.326%
Nov-23	87.500%	4.724%	4.945%	2.832%
Dec-23	85.417%	5.400%	5.817%	3.367%
Jan-24	83.333%	6.028%	6.708%	3.930%
Feb-24	81.250%	6.618%	7.614%	4.518%
Mar-24	79.167%	7.187%	8.526%	5.121%
Apr-24	77.083%	7.667%	9.478%	5.772%

Price Forecast Age Dampening Mechanism

With gas markets as volatile as they are, it has never been more important to ensure that data is as current as possible for forecasting.

- Stale data may be missing key factors that impact the price forecast.
- Long term forecasting is somewhat more insulated against this, so we don't want to discount older sources too heavily or exclude them entirely.

If any source is more than eleven months old, all outdated sources are decremented by the ratio of how many months old they are to the aggregate number of stale months.

Decremented weights are then added back to the sources proportionate to how current their data is.

Example Weights Price Forecast For 2023 IRP

No Age Dampening			
Age (Months)			
0	16	5	2
Source 1	Source 2	Source 3	Source 4
0.000%	37.212%	35.045%	27.743%

Age Dampened			
Age (Months)			
0	16	5	2
Source 1	Source 2	Source 3	Source 4
0.000%	17.673%	42.799%	39.528%

2023 IRP Remaining Schedule

Process Items	Process Elements	Date
TAG 3 (WA)	Distribution System Planning, Alternative Resources, Price Forecast, Avoided Costs, Current Supply Resources, Transport Issues.	6/29/2022
TAG 3 (OR)	Distribution System Planning, Alternative Resources, Price Forecast, Avoided Costs, Current Supply Resources, Transport Issues.	7/14/2022
TAG 4 (WA)	Carbon Impacts, Energy Efficiency, Bio-Natural Gas, Preliminary Resource Integration Results.	8/10/2022
TAG 4 (OR)	Carbon Impacts, Energy Efficiency (ETO), Bio-Natural Gas, Preliminary Resource Integration Results.	9/20/2022
TAG 5 (WA)	Final Integration Results, finalization of plan components, Proposed new 2- to 4-year Action Plan.	9/28/2022
TAG 5 (OR)	Final Integration Results, finalization of plan components, Proposed new 4-year Action Plan.	11/9/2022
Draft of 2022 IRP distributed (WA)	Filing of Draft IRP	11/24/2022
Draft of 2022 IRP distributed (OR)	Filing of Draft IRP	1/5/2023
Comments due on draft from all stakeholders (WA)	Comments due from Stakeholders	1/13/2023
Comments due on draft from all stakeholders (OR)	Comments due from Stakeholders	2/24/2023
TAG 6, if needed (WA)	An additional TAG if needed based on comments from Stakholders	2/1/2023
TAG 6, if needed (OR)	An additional TAG if needed based on comments from Stakholders	3/15/2023
IRP filing (WA)	IRP Final Filing	2/24/2023
IRP filing (OR)	IRP Final Filing	4/14/2023

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

Questions/Next Steps

Review Plans for TAG 3 Discussion

- Distribution System Planning
- Alternative Resources
- Price Forecast
- Avoided Cost
- Current Supply Resources
- Transport Issues
- Next WA TAG is Wednesday, June 29
- Next OR TAG is Thursday, July 14

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

Contact Information

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

Brian Robertson – Supervisor, Resource Planning: (509) 221-9808
brian.robertson@cngc.com

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

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

Cascade IRP email – irp@cngc.com

Cascade Natural Gas Corporation

A Subsidiary of MDU Resources Group, Inc.

In the Community to Serve®

Integrated Resource Plan Technical Advisory Group Meeting #2

MAY 18, 2022

MICROSOFT TEAMS/TELECONFERENCE

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