

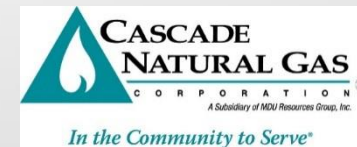
Cascade Natural Gas Corporation

2016 Integrated Resource Plan Update
Workshop with OPUC Staff and Stakeholders

Monday, March 27, 2017

OPUC

Salem, OR



AGENDA

- Opening Remarks
- Item 1 – Modeling
- Item 2&3 – Shortfalls
- Item 5 – Staffing
- Closing Remarks
- Questions

Item 1 - Modeling

- In your ARIMA models for customer forecasting, will you distinguish between long term and short term forecasting? If so, what will the differences between the models be?
 - Cascade uses uniform ARIMA modeling for its customer forecasting over the 20 year planning horizon of the IRP.

Item 1 - Modeling

- In your ARIMA models for customer forecasting, will you distinguish between residential and business customers? If so, what will the differences between the models be?
 - Cascade does distinguish by residential, commercial, and industrial customers. When modeling, we started with the same parameters for each model, which will be discussed in the next slide. We then test all parameters for statistical significance, ultimately settling on a unique model for each class of each county that best represents that county's behavior.

Item 1 - Modeling

- What variables will be included in your customer forecasting models?
 - $C^{CG,Class} = \alpha_0 + \alpha_1 Pop^{CG} + \alpha_2 Emp^{CG} + \alpha_m I_m + ARIMA \in (p,d,q)$
 - Model Notes:
 - C = Customers, CG = Citygate, Class = Residential, Commercial, or Industrial, M = Month, I = Indicator Variable, where 1 if the month indicated, 0 otherwise, $ARIMA \in (p,d,q)$ = Indicates that the model has p autoregressive terms, d difference terms, and q moving average terms, Pop = Population, Emp = Employment.
 - C are forecasted at a monthly level

Item 1 - Modeling

- What will your autoregressive; moving average; and difference terms be in the model?
 - This is unique to each class for each county. First, we observe the data for stationarity. If it is non-stationary we difference it to achieve stationarity. We then observe the ACF and PACF values calculated by SAS to determine if any autoregressive or moving average terms need to be added to the model. This is done by looking for terms that fall outside of the statistically significant range calculated by SAS.

Item 1 - Modeling

- What quantitative method for analyzing forecast error will be employed? Please provide relevant formula or detailed description of the methods.
 - $AIC = 2k + n \log(RSS/n)$ Where $K = \#$ of model parameters $RSS =$ Residual Sum of Squares and $N =$ Number of Observations
 - $MAPE = 100/n \sum |(A-F)/A|$ Where $N =$ number of observations $A =$ Actual Value and $F =$ Forecasted Value
 - Cascade looks at the Akaike information criterion (AIC) calculated by SAS. This is a tool to compare the relative significance of any changes to the model used for a given county and class. A decrease in AIC tends to indicate a more accurate model. Additionally, for each variable provided on the previous slides, including the Autoregressive and Moving Average terms, Cascade analyzes the P-Values to ensure they are significant at the alpha of .05. Variables that are shown not to be significant are removed one at a time, starting with the highest p-value. This should lower the AIC. If it does not, the variable is placed back into the model, which more often than not happens with the Monthly Indicator Variable. Furthermore, Cascade uses backcasting methodology to calculate the Mean Absolute Percentage Error (MAPE) at each phase of testing a model, to ensure that the MAPE is decreasing with each incremental change to the model. Ultimately, Cascade looks at the final forecast and determines whether it makes sense.

Item 1 - Modeling

- What are your data sources for the model? What steps have you taken to ensure these are the most robust data available for forecasting purposes?
 - Customers – Cascade’s Customer Care & Billing (CC&B) system
 - Class – Cascade’s Tariff’s
 - Population – Woods & Poole, provided at a county level, forecasted to 2050. Woods & Poole is a trusted industry source for population and employment growth, but Cascade does make sure to validate information they provide. An example of this would be an unusually high growth rate reported in Bend, OR. Cascade researched this further and discovered that Bend is in the middle of an urban growth expansion, which would lend to an increase in both population and employment
 - Employment - Woods & Poole, provided at a county level, forecasted to 2050
 - Housing Starts – Cascade explored the possibility of including data related to new housing starts in its forecast. Cascade was unable to find this data at the county level, and data at the national level proved not to be statistically significant in Cascade’s regression. Because of this housing starts were excluded from the models.

Items 2 and 3 Questions: Shortfall

- For your citygate study, what are your data sources and what empirical and/or modeling strategies are you employing?
 - Pipeline flow data, historical SCADA flow data (hourly, daily), weather, billing data, Synergi[®] modeling, IRP demand forecast modeling (which includes considerations for DSM, weather, population, employment, housing, etc.)

Items 2 and 3 Questions: Shortfall

- Have you received responses from any of the pipeline companies yet on GTN capacity or other matters?
 - As of last week GTN is working on a proposal for a ten year or twenty year Kingsgate to Malin capacity, with an effective date in 2018.
 - We have reviewed recent station upgrades in Oregon and will be looking at other potential upgrades following completion of the Citygate/Load study
 - We have discussed issues related to supply availability at AECO, A/BC Foothills and Kingsgate.
 - We hold periodic discussions with NWP every few weeks to discuss the progress of their analysis, provide updated information regarding supply source, loads, etc. Most recent discussions were held on March 7 and March 24.

Items 2 and 3 Questions: Shortfall

- Please describe the “continuous modeling” work being done using Synergi. Please employ qualitative and quantitative descriptions in your response.
 - Synergi® is the successor to the GasWorks models that were built years ago and have been upgraded as needed. Cascade’s philosophy is that every couple of years the models should be rebuilt and recalibrated to represent the system more accurately. Synergi® is more advanced than GasWorks and much more user friendly. Synergi® is also the modeling software of choice for many other LDCs.

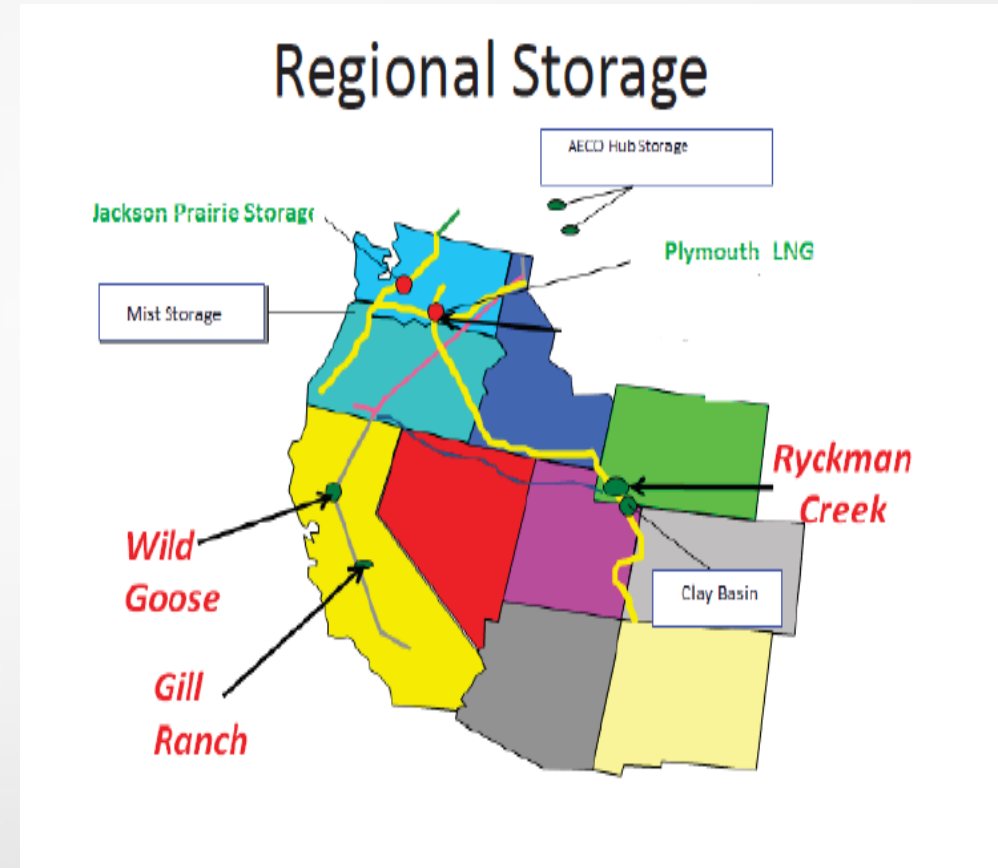
Synergi modeling (cont.)



- Distribution system network design fundamentals anticipate demand requirements and identify potential constraints. Company has been upgrading from Gas Works to SYNERGI—expected to be complete this summer.
- Cascade utilizes its internal GIS environment (pipe size, material, date of install, operating pressure) and other input data (i.e. SCADA data, market intelligence from districts, growth analysis from IRP, considerations of pipeline flow data, weather, etc. to create system models through the use of Synergi® software.
- Distribution system enhancements include analyses of approximately 6,348 miles pipelines (4,744 miles in Washington, 1,604 miles in Oregon with pressures ranging from 200-900 psi), regulators, and compressor stations.
- Impacts of proposed conservation resources on anticipated distribution constraints are reviewed.
- Analyses are performed on every system at design day conditions to identify areas where potential outages may occur.

Items 2 and 3 Questions: Shortfall

- Have you identified any storage fields or infrastructure that will be viable options?
 - During 2016, as part of the 2016 IRP Cascade considered the following storage facilities as potential resource options:
 - AECO Hub, Jackson Prairie, Plymouth LNG, Ryckman Creek, Clay Basin, Wild Goose, Gill Ranch, Mist, Satellite LNG
 - Ryckman Creek, Gill Ranch, Wild Goose, AECO Hub – No incremental storage was selected – none of the storage facilities modeled were cost effective, or led to an increase in served demand. The primary reason appears to be that each storage facility modeled required long-term incremental transportation, as in the case of AECO Hub, no incremental NOVA capacity is available at this time.
 - The Company will receive updated information regarding these facilities and will model as part of the 2018 IRP.
 - Additionally, the Company will model a new storage facility that is currently being developed by Magnum Gas Storage around the Rocky Mountain region, and is projected to be operational starting in 2020. Analysis of the viability of this facility will be included in the 2018 IRP.



Items 5 Questions: Staffing

- Have you begun interviews for the open position?
 - We have completed the analysis of the 31 applications received by March 3. Interviews are currently scheduled for the first week of April.
 - It's important to recognize this is Cascades' third attempt in the past year to fill this vacancy. The Company has encountered difficulties attracting qualified candidates for varying reasons, often related to location.

Items 5 Questions: Staffing

- Do you feel additional staffing or expertise is needed to meet the next IRP cycle goals?
 - One of the reasons the Company secured the services of an IRP consultant was to ensure we have the expertise and staffing to meet the needs of the 2018 IRP cycle.
 - Particularly important as we still have one analytical vacancy to fill, and the new staff is developing their skills and expertise.
 - The creation of the IRP Steering Committee has given the Company an improved management structure to ensure active participation across the multiple departments that have a role in the development of the IRP.
 - The Company is committed to continuously evaluating the staffing levels of the Resource Planning Group, particularly as the requirements of the IRP continue to evolve (e.g. WUTC's IRP guideline docket, advancement of carbon policies in OR and WA, additional supporting analysis on forecasts, etc.)



Questions?