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November 19, 2018

VIA ELECTRONIC FILING

Public Utility Commission of Oregon
201 High Street SE Suite 100
Post Office Box 1088
Salem, Oregon 97308-1088

Attn: Filing Center

Re: **LC 71: NW Natural's 2018 Integrated Resource Plan Reply Comments**

Northwest Natural Gas Company, dba NW Natural (NW Natural or Company), files herewith its Reply Comments on NW Natural's 2018 Integrated Resource Plan.

Please address correspondence on this matter to me with copies to the following:

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Sincerely,

NW NATURAL

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BEFORE THE PUBLIC UTILITY COMMISSION OF OREGON LC 71
IN THE MATTER OF
NW NATURAL'S 2018 INTEGRATED RESOURCE PLAN

NW NATURAL'S REPLY COMMENTS

1. INTRODUCTION

Northwest Natural Gas Company (NW Natural or the Company) files these Reply Comments in response to the Opening Comments submitted in this docket by the Public Utility Commission of Oregon (OPUC), Staff, the Alliance of Western Energy Consumers (AWEC) and the Oregon Citizens' Utility Board (CUB).

Prior to addressing Staff's, AWEC's and CUB's specific comments, NW Natural would like to thank all participants in its Integrated Resource Planning (IRP or Plan) process for their engagement, comments and general spirit of collaboration.

NW Natural's Reply Comments are organized generally along the same lines as Staff's Comments. Responses by Energy Trust are shown in red.

2. NEW TECHNOLOGIES

Staff points out, "*According to NEEA the first three new technologies listed above[1] represent 'a long-term energy savings resource capable of delivering over 280 million therms annually to the Northwest region at a weighted average total resource cost (TRC) of $0.28/Therm.'"*

Staff also requests that in future IRPs, NW Natural provide the TRC test and the utility cost test (UCT) for new technologies identified in the IRP. While NW Natural provides avoided costs, which are used for cost-effectiveness, NW Natural does not calculate either the TRC or UCT for energy efficiency measures. The TRC for conventional and emerging technology measures is calculated by the Energy Trust in order to identify cost-effective conventional and emerging technology measures over a 20-year forecast period.

The Northwest Energy Efficiency Alliance (NEEA) performs early cost/benefit estimates to ascertain the viability of long-term market transformation potential for new or emerging technologies. NEEA calculates a TRC as technology advances and inputs are more certain to ensure cost-effectiveness before advancing through full deployment. Note that the TRC calculated by NEEA is not used as a cost-effectiveness test for energy efficiency measures deployed by Energy Trust.

NW Natural did examine long-term potential load impacts from the adoption of gas-fired heat pumps and gas-fired heat pump water heaters for two different sensitivities in the risk analysis section of the IRP.[2] The IRP does not evaluate the success or failure of these technologies, but only considers technology adoption and its potential to impact natural gas load. In the future, NW Natural will continue to coordinate with NEEA and Energy Trust to monitor and evaluate these emerging technologies.

[1] The technologies are:
1. Efficient Gas Water Heaters
2. Combination Space and Water Heating Systems,
3. Hearth Products

[2] Chapter Seven, section 8.

2.1. RESPONSE BY ENERGY TRUST SHOWN IN RED

Energy Trust can provide the TRC test score on a year-by-year basis for each of the emerging technology measures included in the energy efficiency potential over the 20-year forecast period. Energy Trust can also provide associated annual savings for each emerging technology measure as either cost-effective achievable potential and/or deployed cost-effective achievable potential.

Energy Trust's current modeling process does not include incentive amounts that would allow Energy Trust to calculate a UCT score. Incentive inputs are not part of Energy Trust's modeling process because they are undetermined for future years. This is because it is not possible to know what incentives will be necessary to move customers to implement measures over the 20-year forecast period, especially for emerging technologies.

Energy Trust can provide the risk adjustment assessment for each emerging technology measure according to the methodology described in footnote 7 on page 5.8 in Chapter Five of NW Natural's 2018 IRP.

Please note that Energy Trust includes emerging technology measures in energy efficiency resource projections in order to be as comprehensive as possible in forecasting future potential. However, assumptions for emerging technology measures are based on the best estimates that we have available at the time of our modeling. Due to their nature, there is more uncertainty surrounding emerging technology measures. Consequently, current assumptions for emerging technology measures are, on average, subject to more significant future variations than assumptions associated with conventional measures.

3. LOAD FORECAST

In their initial comments, Staff indicated that they are examining the details of NW Natural's load forecasts presented in the 2018 IRP. NW Natural appreciates Staff's thorough efforts to this end and hopes to continue to provide any data or information needed for the examination. Below are several topics referenced by Staff in their comments. Most of Staff's comments on these topics did not include explicit requests, however the Company welcomes the opportunity to discuss its methodologies.

Expert Panel Customer Forecast

Staff indicates that they were reviewing a minor change to the method NW Natural uses to blend its shorter-term subject matter expert (SME) panel forecast of customers with its longer-term econometric forecast. As Staff notes, this blending method was used in NW Natural's prior IRP; for the 2018 IRP, the Company performed analysis that indicated that blending the two forecasts one year later than it did for the 2016 IRP (i.e., blending in year 4, rather than 3 of the

forecasts) resulted in an overall forecast that performed better, and has provided Staff with data and statistical program files to support this conclusion.[3] The results of this analysis are presented in Chapter Three, section 2.3 and summarized in Table 3.4 of the IRP. The Company will provide any additional information that Staff requires for its examination. The Company will continue to evaluate this methodology in future IRPs.

Commercial Load Growth Forecast

Staff notes that estimated commercial new construction customer usage has increased considerably over previous IRPs. There are many variables which effect commercial customer usage including building square footage, equipment penetration and business sector. These and other variables may have changed over time which could explain a higher usage estimate in the 2018 IRP. At this time, NW Natural has not performed an analysis of its forecast to determine what variables had the largest influence on the commercial load growth forecast.

Interaction Effects Utilized in the Daily System Load Model

Staff notes that adding interaction effects to the daily system load model may be overfitting the model given the number of observations. In statistics, this concern emerges in regard to a model's "degrees-of-freedom." Models with lower degrees-of-freedom are less likely to forecast accurately. In econometric models, degrees-of-freedom are calculated as the number of observations minus the number of regressors. Although including additional interaction terms increases the number of regressors (23 regressors), NW Natural is also able to include far more observations into the daily system load model (2170 observations).[4] This actually increases the degrees-of-freedom relative to prior models. In addition, how out-of-sample forecasts perform is used as a criteria for evaluating models.[5]

Capacity Planning Standard

NW Natural appreciates the time Staff has taken to better understand the new capacity planning standard methodology. NW Natural agrees with Staff that changes to the temperature pattern over time are important to consider. In regards to NW Natural's planning standard methodology, the relevant questions to answer are:

1) What is the distribution of the lowest heating season temperature in the first planning year?
2) How does the distribution of the lowest heating season temperature change over the planning horizon?

[3] Please see NW Natural's response to Staff's data requests 43 and 44.
[4] By using interaction effects NW Natural can expand the range of daily observations as measured by daily average temperatures used in the daily system load model to estimate peak requirements. The model with the interaction effects uses all days with a system weighted average daily temperature less than 59°F.
[5] See Tables 3.9 and 3.10 in the 2018 IRP for model comparison.

While Staff's suggestion of using 50 years or fewer of weather data as one approach to changing temperature patterns, the Company is concerned that this type of approach may unnecessarily add instability in the planning standard (though there would still be far less instability than using the "coldest-in-30 years" methodology). It might also either understate or overstate longer-term temperature trends. NW Natural would like to continue to work with Staff to find an acceptable methodology which uses the full available historical temperature record, accounts for long-term trends in the temperature distribution and is stable when additional data is included in the model.

Allocation of Annual Customer Forecasts to Monthly Values to Facilitate Peak Load Forecasting

Staff notes that it has worked with NW Natural to explore the Company's method for transforming annual forecasts into monthly forecasts and will work with the Company to explore whether "alternative historical data sources" exist that could improve the Company's annual-to-monthly transformations.

NW Natural provided extensive documentation and supporting data for the statistical models that accomplish this transformation through responses to Staff's data requests[6] and detailed its models in Appendix C of the 2018 IRP. The Company looks forward to additional discussion with Staff if necessary.

Econometric Modeling Approach to Customer Count Forecasts

Staff indicates that they will be reviewing the work that NW Natural performed to develop its econometric customer forecast models, including the Company's exploration of Staff's suggestion of load-center-level forecasting from the 2016 IRP. NW Natural has provided Staff with extensive documentation, input data and statistical tests to support its model specifications, which are detailed in Chapter Three, section 2 of the 2018 IRP. The Company welcomes any additional discussion that Staff deems necessary on this topic.

Annual Use per Customer Trend – Incentivized Demand-side Resources

NW Natural is happy to continue to work with Staff to answer any questions they have regarding the forecasted trends in use per customer.

Load Implications of Climate Analysis

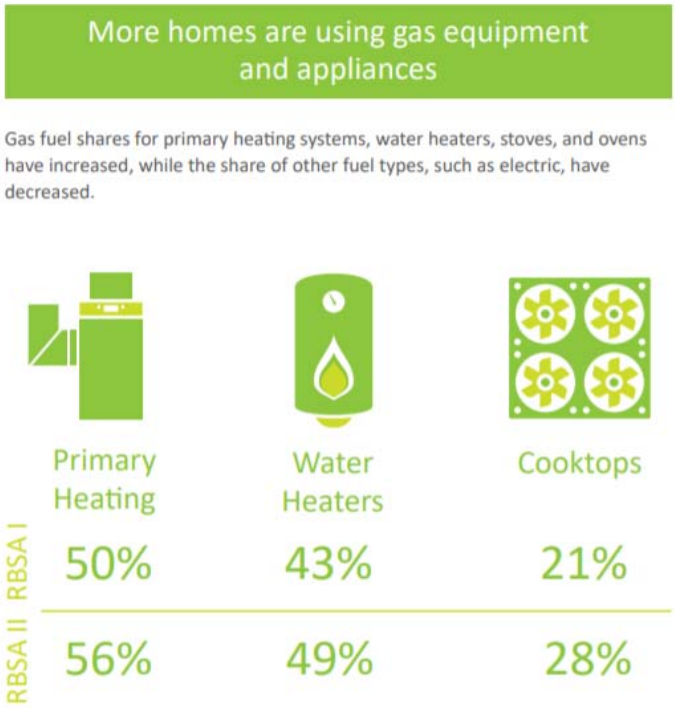
NW Natural appreciates CUB's view that NW Natural's environmental policy analysis in its 2018 IRP is at the forefront of natural gas utility resource planning regionally and nationally. However, CUB states, "NW Natural's discussion of climate and carbon fails to adequately discuss and analyze the amount of fuel switching away from natural gas that is likely to take place in response to concerns that it is a fossil fuel and its use adds carbon emissions to the atmosphere," and that NW Natural "needs to include a forecast of fuel switching in future IRPs."

[6] See NW Natural's response to Staff's data request 39.

The Company's base case load forecasts incorporate all trends that are occurring, including fuel switching, as all trends are included in the data that is used to project future loads. While these trends may change in the future, the Company does not have evidence to demonstrate that current trends are changing or will change dramatically in the near-term (please note that CUB does not provide evidence that fuel switching is occurring, just anecdotal assumptions that it might). NW Natural's current load forecasting methods use strictly calibrated models driven by hard data on customer decisions and are evaluated on their ability to accurately forecast.

The Company will address the issue of fuel switching and distribution system projects in the specific context of the North Eugene Reinforcement project in Section 8, Distribution System Planning, though this issue, relative to load forecasting, is discussed here. First it is important to note that the most recent data available suggests natural gas space heating in NW Natural's service territory is increasing rather than decreasing, and this is also true of the Pacific Northwest as a whole (see Figure 1).

Figure 1: NEEA 2016-17 Residential Building Stock Assessment (RBSA II) in Comparison to 2011-12 (RBSA I): Single Family Homes[7]



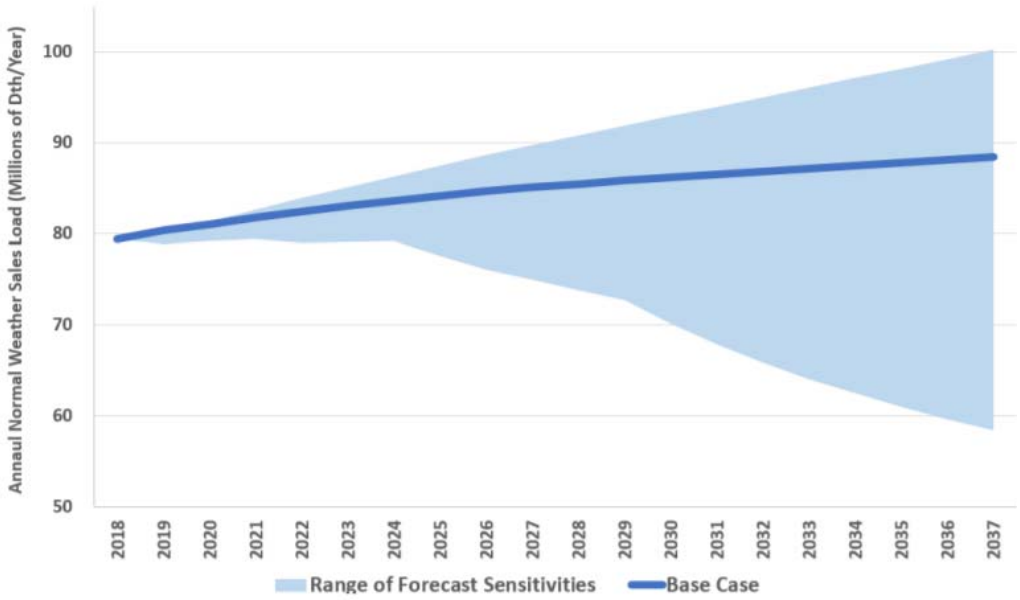
This consumer choice decision is embedded within the Company's customer count and customer usage data that is used to forecast load.

Additionally, while recent trends are to forecast the base case load, NW Natural evaluated a wide range of load forecasts around its base case forecast to better understand the impact on

[7] Figure from the Northwest Energy Efficiency Alliance's Residential Building Stock Assessment Single Family Report Executive Summary (https://neea.org/img/uploads/Single-Family-Web-Version.pdf. See page 5).

its resource planning should load trends deviate from their current trajectory. NW Natural analyzed six additional load forecasts in its sensitivity analysis included in Chapter 7; and four of those sensitivities revolve around different environmental policy worlds. Each of these four sensitivities, which make up a large share of the analysis in the IRP related to climate, start with a load forecast that does not primarily start with an econometric forecast using historical data. These assumptions resulted in a wide range of potential load forecasts that were evaluated in the 2018 IRP (see Figure 2).

Figure 2 Range of Annual Load Forecasts[8]



The underlying assumptions driving each of the forecasts were presented at the Company's technical working group meetings. At that time, NW Natural solicited feedback about potential additional sensitivities to analyze as part of the 2018 IRP and did not receive feedback from CUB (or other stakeholders) that a sensitivity with a lower load forecast should be considered. The Company notes that from a resource planning perspective, the reason for a particular load forecast does not impact least cost and least risk resource planning to serve that load,[9] and given the historical load the Company has served, the load forecast sensitivities that show a steeply declining load over the IRP planning horizon represent a major departure in trend from the growing load that NW Natural has experienced over many decades.

As CUB points out, as part of the sensitivities designed to evaluate different potential policy environments, NW Natural evaluated a sensitivity where no new direct-use gas hookups are allowed starting in 2025.[10] However, CUB incorrectly states that the sensitivity does not take into consideration the possibility of existing customers deciding to fuel switch away from natural

[8] See Figure 1.9 of the 2018 IRP. Also see Figures 7.21 and 7.22 for the load forecast of each sensitivity.
[9] Two identical load forecasts that resulted from a different set of assumptions or methodologies would show the same resources to serve that load as least cost/least risk.
[10] The results of the IRP suggest this would be a poor policy choice in terms of reducing societal emissions. See Chapter Seven, section 8.5.

gas. Per the IRP, Sensitivity 9, the New Direct Use Natural Gas Customer Moratorium Starting in 2025 sensitivity, "assumes NW Natural does not add any new customers starting in 2025 *and the historical rate of customer losses due to building structure demolition and fuel switching away from natural gas continues over the planning horizon*."[11] NW Natural currently serves more than 70% of new single-family homes in its service territory and this number has not declined in recent years.[12] Additionally, roughly one-quarter of the customers NW Natural adds in a given year represent existing buildings that fuel switch to natural gas. Changing both of these figures to 0% (per the moratorium assumption) represents fuel switching on a very large scale and an extreme potential future prospect for the Company's load. NW Natural maintains that this sensitivity presents a reasonable lower bound of the load forecasts to consider for resource planning. Furthermore, to reiterate, the action items in the IRP represent required near-term actions that do not depend on continued growth over the long-term to be necessary to continue to provide safe and reliable service to our customers.

CUB additionally recommends that NW Natural begin to use a trended annual weather forecast to account for climate change. NW Natural agrees with CUB that this should be included in the next IRP. Because the methodology for peak planning only considers the coldest temperature recorded in a heating season, accounting for the overall annual trend in temperatures in the annual demand forecast will not have any impact on peak capacity needs. It could, as CUB stated, impact the longer-term value of storage capacity versus pipeline capacity.

4. AVOIDED COSTS AND DEMAND-SIDE RESOURCES

Before addressing each of the issues raised regarding avoided costs and demand-side resources (DSM) in the stakeholder comments, please note that Staff has requested many things from NW Natural that are not provided by the Company, but rather provided by either Energy Trust or the NEEA. NW Natural is happy to work with Energy Trust and NEEA to provide the appropriate responses and has indicated where Energy Trust or NEEA responded to Staff's comments. Additionally, the Company has updated a couple of slides it presented at a technical working group meeting to show what NW Natural, Energy Trust and NEEA do regarding avoided costs and projecting energy efficiency savings (see Figure 3) and how the energy efficiency savings projection is part of the broader IRP process (see Figure 4). NW Natural would like to thank these organizations for the great work they do on behalf of the Company's customers.

[11] Emphasis added.
[12] This includes homes that are built in NW Natural's service territory but are not near the Company's pipes, so the figure is higher for new homes built where natural gas service is more readily available.

Figure 3: EE Savings Projection Key Inputs and Processes

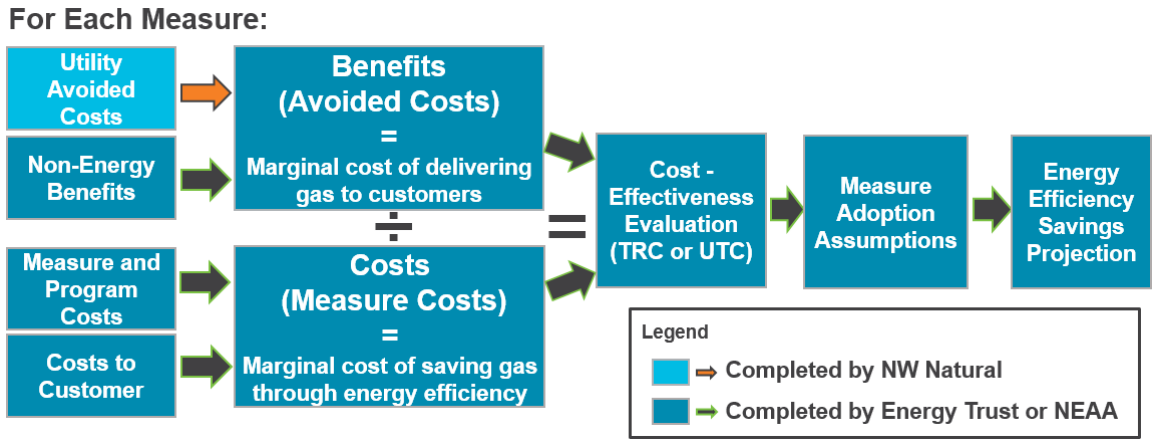
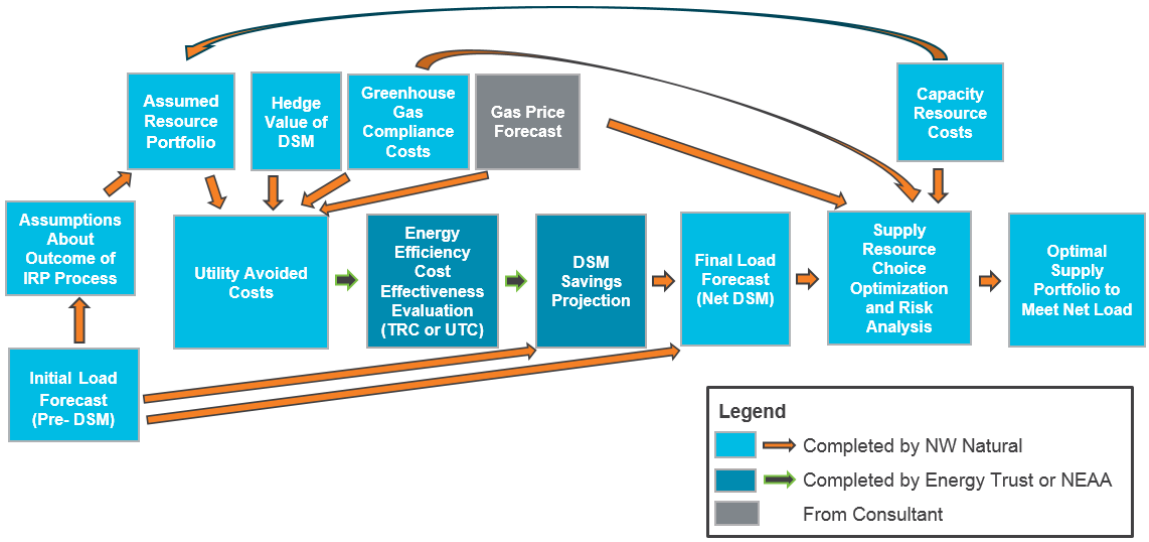


Figure 4: EE Savings Projection and the Broader IRP Process



Differences in Avoided Costs from 2016 IRP

Staff points out three differences between the avoided costs presented in the 2016 IRP and the 2018 IRP[13]:

- The lack of a base load estimate of avoided costs
- Carbon policy assumptions that are broken out differently between IRPs
- The change in hedge value from $.07 to $.00 cents.

[13] NW Natural summarizes the key avoided cost methodological differences between the 2018 and 2016 IRPs on page 4.2 of the 2018 IRP.

First, the base load estimate of avoided costs presented in the 2016 IRP was further subdivided into water heating, cooking and process load for the 2018 IRP. Table 1, presented at the third technical working group meeting, illustrates this breakdown.

Table 1: Avoided Costs End Uses by IRP

<table>
<tr><th>2014 IRP</th><th>2016 IRP</th><th>2018 IRP</th></tr>
<tr><td rowspan="7">No Distinction by End Use</td><td rowspan="2">Residential Space Heating</td><td>Residential Space Heating</td></tr>
<tr><td>Residential Hearths and Fireplaces</td></tr>
<tr><td>Commercial Space Heating</td><td>Commercial Space Heating</td></tr>
<tr><td rowspan="3">Base Load</td><td>Water Heating</td></tr>
<tr><td>Cooking</td></tr>
<tr><td>Process Load</td></tr>
<tr><td>Interruptible Load</td><td>Interruptible Load</td></tr>
</table>

Staff also ponders how these additional end uses were developed and the difference between peak load impacts for the new end uses relative to the old breakdown. All end uses employ the same general methodology, so in a general sense the new end uses are developed in the same way as the old end uses. In the 2016 IRP, all base load measures were assumed to be flat loads, though that is no longer assumed for water heating and cooking loads. NW Natural is happy to provide any additional material or meetings to explain its avoided cost calculations.

Regarding Staff's second avoided cost issue, the difference in the expected greenhouse gas (GHG) emissions compliance costs used as a proxy for carbon policy are shown in Chapter Two of the 2018 IRP in Figure 2.17. Note that these expected compliance costs use the same methodology as the 2016 IRP, though the values have changed as expectations of potential policies that would require compliance obligations have evolved.

Regarding the third issue, while the values have been updated, the same methodology that was reviewed in UM 1622 and the 2016 IRP is used to calculate the price risk reduction ("hedge") in the 2018.[14] Per the outcome of UM 1622, a zero cost hedge value is used in lieu of negative values. Additionally, a decrease from $.07 to $.00 per dekatherm borders on what might be considered material, given that $.07 represents between 0.8% and 1.4% of the total value of demand-side avoided costs.[15]

Avoided Costs for Process and Interruptible Loads

Staff notes that interruptible load and process load have the lowest avoided cost and states that the Company's "methodology on infrastructure avoided costs appears to discount the infrastructure avoided cost benefits of industrial energy savings." Staff additionally states, "Staff

[14] See OPUC docket No. UM 1622 for a lengthy discussion of the hedge value of DSM in avoided costs. Also, see page 10 and Appendix 1 of NW Natural's reply comments in the Company's 2016 IRP proceeding (OPUC docket No. LC 64) for a detailed history on how the hedge value of DSM came to be included in the NW Natural's avoided costs starting with the 2016 IRP. (https://edocs.puc.state.or.us/efdocs/HAC/lc64hac115929.pdf).

[15] For residential space heating and interruptible loads, respectively.

appreciates the inclusion of gas megaprojects and must learn more. Staff is concerned that these megaprojects may be undervalued using the Company's updated avoided cost methodology. Large-scale and permanent reductions of industrial gas use leave capacity available at all times, including peak times."

NW Natural recognizes that its infrastructure avoided costs are higher than other utilities in the region and the Company stands by both its methodology for calculating those costs and the cost estimates for the end uses evaluated in the IRP – including for industrial load.

Per the IRP, "infrastructure needs are driven by peak loads. Consequently, the extent to which resources reduce or supply energy on peak determines the infrastructure costs they avoid."[16] The IRP also describes the reason why infrastructure-related avoided costs are not applied to interruptible customers;

> *"A significant share of the energy savings achieved through Energy Trust programs come from large industrial customers, though many of these customers elect to be on interruptible schedules.[17] These customers are interrupted during peak events, so they do not contribute to peak load or the infrastructure designed to serve it. Therefore, savings acquired for interruptible customers avoid commodity related costs, but do not avoid infrastructure related costs related to peak planning."[18]*

As is described in the IRP, none of the load from customers on interruptible schedules is included in NW Natural's peak load forecasts. Interruptible load is a demand response resource that the Company would deploy (i.e. interruptible customers would be interrupted) in the event of peak weather conditions. If a "megaproject" is conducted for an interruptible customer, Staff's assertion that "large-scale and permanent reductions of industrial gas use leave capacity available at all times, including peak times"is not correct in respect to peak loads. In future IRPs, NW Natural will consider showing loads inclusive of interruptible loads and show the reduction in load from these customers on peak as part of demand response so the impact of interruptible customers is more apparent.

Second, process load is assumed to be flat load (i.e., does not increase when the weather becomes cold). Therefore; the contribution of process load to the Company's peak load for which the system is designed to meet is relatively small compared to other end uses that are temperature sensitive and therefore larger contributors to peak. Tables 4.2 and 4.3 in the 2018 IRP detail the relatively small usage factors for process load during a peak day and peak hour, respectively. Due to the relative small contribution of process load to peak load, the avoided infrastructure costs are correspondingly smaller for process load.

[16] See page 4.4 of the NW Natural 2018 IRP.
[17] Note that interruptible customers pay a lower rate than firm customers, with the difference in rate being the estimated infrastructure costs that are saved by interrupting customers during peak events.
[18] Chapter Four, section 2.2 of the NW Natural 2018 IRP.

Application of Avoided Costs to Supply-side Resources

Staff points out that it "wishes to understand more about the application of avoided costs to supply-side resources. Is this a matter of rearranging resource costs that were used in the past, or additional cost applied to these resources?"

The same avoided costs methodologies for each type of cost that can be avoided ("avoided costs components") are applied consistently for all resources, be they demand-side resources or supply-side resources. Table 4.1 in Chapter Four of the 2018 IRP shows which types of costs are avoided for each resource type. For example, whether a non-traditional supply resource (like renewable natural gas) supplies one unit of natural gas to the system or a demand-side resource (like energy efficiency) saves one unit of natural gas from being delivered, the gas and transport costs assumed avoided are the same.

Response to Request for Working Papers

Staff requests that NW Natural provide work papers detailing the Company's methodology for peak load incorporation, new end uses and changes to distribution system values. A workshop on avoided costs with Staff is scheduled for November 29, 2018 to take Staff through the material presented at the third technical working group meeting and additional material of interest. The Company provided work papers to Staff regarding its avoided costs calculations in advance of this meeting.

5. DEMAND-SIDE RESOURCES

Targeted DSM

While the targeted DSM pilot (now referred to as Geo TEE) was not addressed in the 2018 IRP, NW Natural and Energy Trust continue to work on defining the pilot and have scheduled a workshop with stakeholders for December 3, 2018.

5.1. RESPONSE BY ENERGY TRUST SHOWN IN RED

Staff must gain to learn more information from the Company about the role of new technologies in the DSM forecast, for example: to what extent do the ten emerging technologies in Section 5 overlap with the new technologies listed in Chapter 2?

Energy Trust has prepared a comparison table to answer Staff's question about overlap between new (emerging) technology measures modeled by Energy Trust and discussed in Chapter Five of the 2018 IRP, compared with NEEA emerging technologies described in Chapter Two. The color-coded cells indicate measures where technologies overlap. For the next IRP, Energy Trust and NW Natural will engage with each other on this topic earlier in order to coordinate assumptions around emerging technology measures and the timeline in which they are expected to become cost effective.

Table 2: Comparison of Emerging Technologies[19]

Emerging Technology Measures - Unique Measure Name (Full List)	Energy Trust Modeled 20-year Cumulative Cost-Effective Potential (therms)	NW Natural's chapter 2 measures
Com - AC Heat Recovery, HW	385,032	Gas-fired HP Water Heaters
Com - Advanced Ventilation Controls	888,759	Combo systems – gas fired heat pump space and water heating
Com - DHW Circulation Pump	382,664	Hearth products – eliminate standing pilot lights and low-capacity hearth using half the therms for the same aesthetic flame presence
Com - DOAS/HRV - GAS SH	3,058,027	Condensing Rooftop units
Com - Energy Recovery Ventilator - Gas Heating	-	Efficient gas dryers
Com - Gas-fired HP HW	-	
Com - Gas-fired HP, Heating	251,173	
Com - Highly Insulated Windows (NEW)	-	
Com - Highly Insulated Windows (RET)	-	
Com - Secondary Windows Glazing	-	
Com - VIP, R-35 wall (NEW)	-	
Com - VIP, R-35 wall (RET-no insl'n)	-	
Com - VIP, R-35 wall (RET-R-11)	-	
Com - ZNE	6,828,548	
Ind - Gas-fired HP Water Heater	223,816	
Ind - Wall Insulation- VIP, R0-R35	109,809	
Res - AFUE 98/96 Furnace, Z1	-	
Res - AFUE 98/96 Furnace, Z1 - SF	-	
Res - AFUE 98/96 Furnace, Z2	-	
Res - AFUE 98/96 Furnace, Z2 - SF	-	
Res - Behavior Competitions	29,678	
Res - Behavior Competitions (NEW only)	3,970	
Res - Gas Absorption Heat Pump Water Heater	-	
Res - Gas Absorption Heat Pump Water Heater (NEW Only)	-	
Res - Insulating Window Attachments (Gas SH) Z1	-	
Res - Insulating Window Attachments (Gas SH) Z2	-	
Res - New MH - HPMH Gas Z1	-	
Res - New MH - HPMH Gas Z2	-	
Res - Path 5 Emerging Super Efficient Whole Home Ele Heat Gas DHW	10,957	
Res - Path 5 Emerging Super Efficient Whole Home Gas Heat Ele DHW	263,834	
Res - Path 5 Emerging Super Efficient Whole Home Gas Heat Gas DHW	6,966,071	
Res - Window Replacement (U<.20), Gas MF	3,596	
Res - Window Replacement (U<.20), Gas MH	465	
Res - Window Replacement (U<.20), Gas SF	322,739	
Res - Wx insulation (ceiling), NEW, ET, Gas SH, Z1	-	
Res - Wx insulation (ceiling), NEW, ET, Gas SH, Z2	-	
Res - Wx insulation (ceiling), RET, ET, Gas SH, Z1	-	
Res - Wx insulation (ceiling), RET, ET, Gas SH, Z2	-	
Res - Wx insulation (wall), NEW, ET, Gas SH, Z1	-	
Res - Wx insulation (wall), NEW, ET, Gas SH, Z2	-	
Res - Wx insulation (wall), RET, ET, Gas SH, Z1	-	
Res - Wx insulation (wall), RET, ET, Gas SH, Z2	-	

Further, how much of the increased savings seen in the 2018 IRP reflect market transformation activities?

[19] Yellow represents Emerging Technology Water Heating Measure and Orange represents Emerging Technology Space Heating Measure.

Energy Trust ramped its annual deployed savings (final savings projection) to 100% over the 20-year forecast period (aligning with NW Power and Conservation Council methodology) under the assumption that we believe these savings will occur either through Energy Trust programs or by code changes, standards or other market transformation mechanisms. Energy Trust is unable to disaggregate whether savings will come through Energy Trust programs or other market transformation mechanisms for most of these savings categories because it is unclear how exactly savings will materialize in the 5-20 year time period. However, in some instances, Energy Trust did specifically identify certain market transformation savings that we expect our New Buildings and New Homes programs will claim annually. These gas savings, which are the result of building code improvements worked on by NEEA and Energy Trust (but not claimed by NEEA due to NEEA's historical electric-only focus) have been claimed by Energy Trust to date. The table below shows the total 20-year deployed savings potential forecasted in the 2016 and 2018 IRPs, along with the increase in potential that can be seen from 2016 to 2018. The relatively large increase in savings from 2016 to 2018 is due to a methodology change to reflect what will come off the system regardless of whether Energy Trust will claim them or whether they occur via naturally occurring market transformation.

Table 3: Total Market Transformation Savings from New Buildings and New Homes Code Improvements

	2016 IRP	2018 IRP	Increase in therms between IRPs
New Buildings MT	132,102	1,105,624	973,522
New Homes MT	869,560	3,245,138	2,375,578
Total:	1,001,662	4,350,762	3,349,100

Staff is also interested in the mix of energy efficiency end uses for the newly cost-effective technologies. Figure 8 shows the impact of an increased avoided cost on the quantity of savings and how many measures will become cost-effective as a result of the change in avoided cost. Staff will look further into what kinds of measures are affected and at what costs.

The supply curve Energy Trust provided in Staff's Comments Figure 8[20] shows the levelized costs of all of the technical potential identified by Energy Trust's Resource Assessment model. The levelized cost cutoff shown on the supply curve is the point on the supply curve that coincides with the total cost-effective achievable potential identified by the model. Therefore, the levelized cost cutoff is an approximation of cost-effectiveness, but it is not directly correlated with cost-effectiveness. That is, there may be cost-effective savings that have a higher levelized cost than represented by the threshold, and there may be savings that are not cost-effective that have a lower levelized cost than represented by the threshold.

[20] NW Natural's 2018 IRP, Figure 5.7 at 5.17

Energy Trust provided table 5.6 in the 2018 IRP to identify the key drivers of the change in potential between the 2016 and 2018 IRPs, as shown below:

Table 4: Key Drivers of the Change in Potential Between the 2016 and 2018 IRPs

Change Component	Change in DSM Savings (Millions of Therms) from 2016 to 2018	% of Total
Measure Exceptions	(7.00)	-8%
Emerging Technology	9.02	10%
RES Smart T-Stats	13.81	15%
Change in Avoided Costs	26.10	29%
Change in Model Assumptions	49.63	54%
Total Change from 2016 to 2018 IRP	91.57	100%

The following table shows the measures and corresponding amount of cost-effective potential that became cost-effective in the 2018 IRP, due solely to the change in avoided costs. Energy Trust produced this data set by running the 2018 resource assessment model with the 2016 IRP's avoided costs and comparing this new data set with the list produced from the 2018 model with 2018 avoided costs. (Note that some of the cost-effective achievable potential values are negative. The reason is that with the new higher avoided costs, some measures that compete with one another within competition groups were reorganized because measures that were not previously cost-effective became cost-effective and outcompeted the measures that were cost-effective in the prior modeling.)

Table 5: Cost-effective Potential in the 2018 IRP Due Solely to Change in Avoided Costs

	Cost-effective achievable
Com - AC Heat Recovery, HW	239,437
Com - DDC HVAC Controls	32,024
Com - DOAS/HRV - GAS SH	288,342
Com - Gas-fired HP, Heating	251,173
Com - Gas Conv. Oven	451,920
Com - Gas Griddle	730,466
Com - HVAC System Commissioning	45,412
Com - Steam Balance	34,952
Com - Windows Upgrade (New)	140,327
Com - ZNE	504,771
Res - 0.67/0.69 EF Gas Storage Water Heater	(1,145,613)
Res - 0.70+ EF Gas Storage Water Heater	1,426,357
Res - Behavior Savings (NEW)	91,189
Res - Ceiling insulation - stacked GAS SPHT R49	17,962
Res - Duct Sealing, Gas SH, Z1	2,511,560
Res - Duct Sealing, Gas SH, Z2	25,369
Res - New MH - Eco Gas Z1	106,495
Res - New MH - Eco Gas Z2	381
Res - Path 1 ORIECC-Shell Gas Heat Gas DHW	2,100,760
Res - Path 4 Advanced Whole Home Ele Heat Gas DHW	10,320
Res - Path 4 Advanced Whole Home Gas Heat Ele DHW	3,963,646
Res - Path 4 Advanced Whole Home Gas Heat Gas DHW	11,245,663
Res - Path 5 Emerging Super Efficient Whole Home Ele Heat Gas DHW	(5,485)
Res - Path 5 Emerging Super Efficient Whole Home Gas Heat Ele DHW	76,858
Res - Path 5 Emerging Super Efficient Whole Home Gas Heat Gas DHW	2,958,246
Total	26,102,530

Staff appreciates the inclusion of gas megaprojects and must learn more. Staff is concerned that these megaprojects may be undervalued using the Company's updated avoided cost methodology. Large-scale and permanent reductions of industrial gas use leave capacity available at all times, including at peak times. Staff would like to see a list of the past five megaprojects and their corresponding annual reduction in gas use.

Energy Trust included "Megaprojects" in the energy efficiency forecast to represent large, unexpected projects that may not otherwise be identified in the forecast. These megaprojects

were added to Energy Trust's final savings projection exogenously to the resource assessment model during the deployment phase. These projects were given a flat load profile when assessing peak impact because it is not possible to identify the specific end uses that may be associated with these projects. Using the flat load profile does result in reductions to the Company's peak load as these projects are assumed to run at all times. Thus, the assumed peak impact is the annual savings amount multiplied by the flat load profile's peak hour coincident factor of 1/8760. Practically speaking, this capacity impact will likely overestimate or underestimate the impact on capacity depending on whether the end uses from these projects actually have a load coincidence factor that is lower or higher during NW Natural's forecasted peak period.

Energy Trust reviewed the largest gas projects per year from the prior seven years in order to determine an estimated savings value that comes from these large, unexpected projects. The megaproject value included in the 2018 IRP is based on the median savings value of 189,723 therms, which was calculated from the seven projects listed in the table below that occurred over the previous seven years (Energy Trust chooses median savings because the one very large project would have resulted in a skewed average value). These projects were used to determine the megaproject adder to use in the 2018 IRP forecast. Energy Trust has since realized that the term megaproject is probably not ideal for this purpose because megaprojects are a formal project definition associated with a project that receives >$500,000 in incentives and requires Energy Trust board approval. Consequently, Energy Trust is shifting to calling these projects "large, unexpected projects."

Table 6: Megaproject Projects - Sector, Measure, and Net Therms

Year	Sector	Measure Description	Net Therms
2010	Industrial	Custom Primary Process	189,723
2011	Industrial	Custom Heat Recovery	141,251
2011	Industrial	Custom O & M	133,650
2012	Commercial	Custom Boiler	134,420
2015	Industrial	Custom Air Abatement	1,283,576
2016	Industrial	Custom Controls	363,055
2016	Commercial	Custom Heat Recovery	265,788

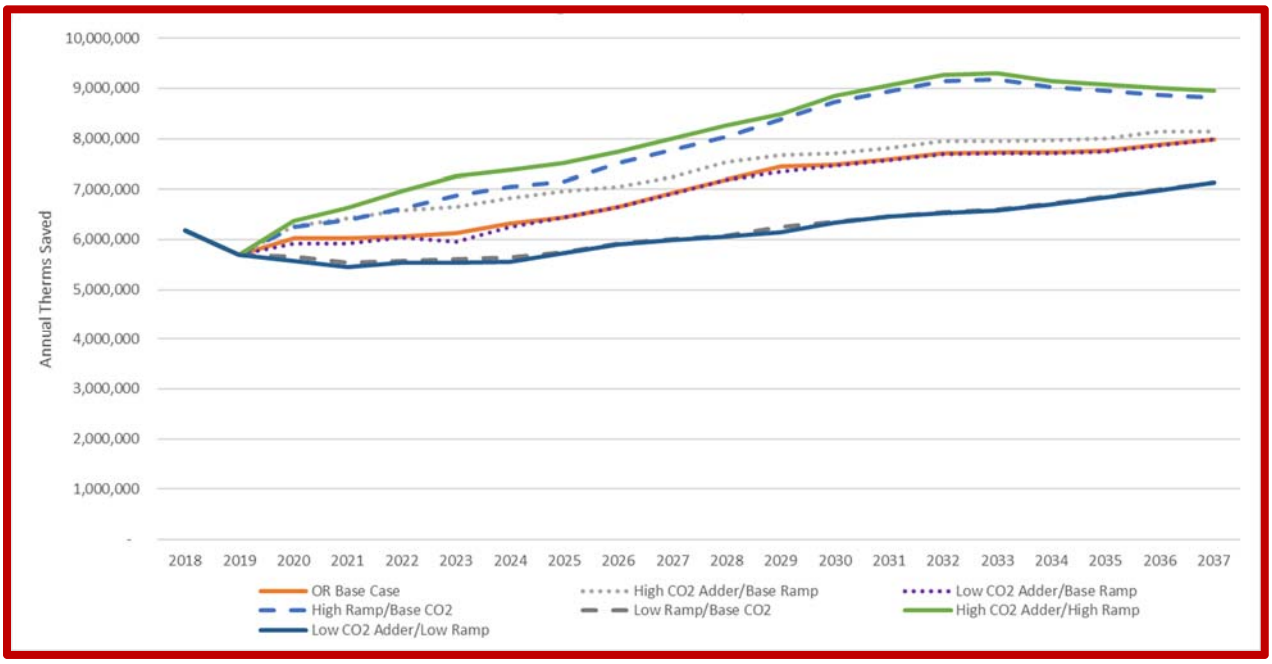
Regarding the scenarios for sensitivity analysis, Staff would like to know what led to the choices of these scenarios for energy efficiency sensitivities. Staff would have expected to see the ramp rate scenarios and carbon scenarios to be combined, but they are not. Staff also notes that low ramp rates appear unlikely given Energy Trust's past performance, which led the Company to request changes to mitigate the underestimation of savings acquisition in the 2018 IRP.

Energy Trust decided to limit the number of scenario iterations it conducted and to focus on what it thought might be most useful. In response to Staffs' comment, Energy Trust has run two additional scenarios, as shown below:

- High CO2 adder with high ramp rates
- Low CO2 adder with low ramp rates

These two scenarios effectively capture the highest and lowest possible boundaries of the numerous iterations possible, putting jaws on the range.

Figure 5: NW Natural Oregon Scenario Comparison



Staff Request(s) for NW Natural: The Company submit a list of past megaprojects and their corresponding annual reduction in gas use.

Please see table 6 and the discuss about megaprojects above.

Staff also notes that the end uses in Figure 5.528 of the 2018 IRP do not correspond to the end uses in the Avoided Cost chapter and therefore requires additional Company discussions about how the end use information in Chapter Four will be used to direct DSM acquisitions.

This issue seems to be a result of similar terminology being used in two different ways. In Chapter Four, NW Natural is using terminology related to load shape end uses and Energy Trust's Figure 5.5 is using similar terminology related to the end use of measure equipment. An alternative way to describe Energy Trust's application of this terminology is "measure categories." Generally speaking, the terminology used to describe end uses of measures and load shapes are often similar (ex. water heating) but there are distinctions like having heating as an end use, which will be used for both commercial and residential measures. In comparison, the load shape discussed by NW Natural is directly referencing the end use and sector (ex. residential space heating and commercial space heating).

6. SUPPLY SIDE RESOURCES

Heat Content

Staff mentioned on page 17 of its Comments that it was investigating the heat content factors used in the analysis and had issued an information request. Hopefully the Company's response to that request[21] provided all the needed information, which in short was that the heat content of gas plays a very limited role in the 2018 IRP since customer demand and most of the Company's resources (e.g., interstate pipeline transportation contracts) are calculated or stated directly in energy units without regard to the heat content of the gas, but where heat content is applicable (e.g., storage plant capacities), the same heat content values were used consistently throughout the analysis in the IRP.

Jackson Prairie

Staff also mentioned on page 17 of its Comments that it would like to better understand the modeling of Jackson Prairie storage. To that end, the Company provided further information verbally and through a data request[22] to clarify the cost-effectiveness of Jackson Prairie storage and the firming up of a small portion (13,525 Dth/day) of the Northwest Pipeline capacity used to transport Jackson Prairie withdrawals, as discussed in greater detail in Chapter Six, section 3.2 (specifically pages 6.11-6.12) of the IRP.

Portland LNG Plant (Gasco)

NW Natural appreciates the time Staff has taken to better understand potential projects at the Portland LNG Plant. Investments in the facility are not included in the 2018 IRP Action Plan as NW Natural is currently in the process of evaluating all alternatives to the liquefaction and pretreatment systems at the Portland LNG Plant. NW Natural would like clarify that the analysis is ongoing and at this point in time, no preferred course of action has been selected. Once this study is complete, NW Natural will decide on the appropriate steps to take relative to the IRP process. Additionally, NW Natural is not opposed to including an action item relative to the Portland LNG Plant and is willing to work with Staff on the appropriate wording.

Miller Station Compressors

NW Natural appreciates the time Staff has taken to better understand the study to determine the best solutions to address the issue with the reciprocating compressors at Miller Station that are now inefficiently sized to serve current flow conditions and operations at Mist. NW Natural is planning to conduct this study in 2019 to help determine the most cost-effective plan for future compressor operations at Miller Station. Once this study is complete, NW Natural will decide on the appropriate steps to take relative to the IRP process.

[21] See response to LC 71 OPUC DR 59.
[22] See response to LC 71 OPUC DR 60.

The study to evaluate compression at Miller Station is being done in the ordinary course of business. NW Natural performs many similar studies in which third-party expertise is used to help inform critical infrastructure investment decisions before those decisions are made. NW Natural does not believe it is necessary for these informational studies to be acknowledged in an IRP prior to deciding whether or not to pursue the study. These types of studies are used to inform the infrastructure investments or other activities which would ultimately become an item in the Action Plan in future IRPs. The Company though is not opposed to including an action item with regard to the Miller Station Compressor study.

Renewable Natural Gas

In its initial comments and data requests, Staff sought to understand how the RNG scenarios considered in the IRP were developed and how the RNG market is currently impacting the consideration of RNG resources. NW Natural sought to evaluate RNG resources that were most similar to the types of RNG resources we understand to be available now or in the near future in our service territory. We have gathered information about three large wastewater treatment plants, many area landfills and multiple dairies to better understand the cost associated with production of RNG on these sites. The wastewater treatment plant scenarios – which only differ across scenarios by considering the sale of the environmental credits in different ways – reflect the equipment selection, operating expenses and other considerations we have learned about by reaching out to wastewater treatment plants considering RNG production in our region. It is important to note that the scenarios discussed in the IRP were chosen to be illustrative and informative examples based on our current understanding of RNG markets. Actual projects will be analyzed based on their specific attributes when they become available.

Of the three RNG projects expected to physically interconnect to our distribution system in the next 1-2 years, two are large scale municipally-owned wastewater treatment plants. The wastewater treatment plant scenarios evaluated in the IRP reflect, to the best of our knowledge, what procurement of RNG from resources such as those would look like for our customers.

Similarly, we have spoken with multiple dairies that are interested in producing RNG and are evaluating potential RNG development projects. Some of these dairies are located very near our distribution infrastructure, while others are located very far away. Thus, we evaluated two different dairy-based RNG scenarios, reflecting the costs we understand would be likely given the different sizes, makeups and types of dairies that might produce RNG. We have spoken with individual RNG project developers to ascertain the unique challenges and opportunities in the dairy RNG markets today.

Finally, we also evaluated the purchase of RNG from a landfill. We have sought high-level information from individual landfills as well as third-party marketers of RNG to understand the market characteristics that would impact a contract for landfill RNG today. We considered the availability of landfill RNG based on our current understanding of which regional landfills are producing RNG, or may produce in the near future, and determined a representative price for landfill RNG based on our understanding of what different landfills are considering selling their RNG for and on what terms.

Staff notes that the credit markets for RNG environmental credits change daily. While this is true, it is important to understand that longer-term contracts for RNG, which are the types of contracts that the Company would seek if it were ever to acquire RNG, can lock in set prices for RNG that will not fluctuate day to day. Indeed, such contracts and arrangements are desirable to RNG project developers and financers, who are not comfortable financing projects based solely on highly volatile credit markets that are subject to political uncertainty. As more stable contracts are desirable in order to ensure long-term revenue certainty, RNG project developers are motivated to offer sale of their RNG at prices below current market trading values, provided the buyer is interested in a longer-term contract and reliable pricing.

RNG Pilot

CUB notes that the Company should consider proposing a RNG pilot program that would identify sources, technologies and best practice that might be required to bring this RNG onto NW Natural's system. RNG is a proven technology and in fact, there are 51 operational RNG projects in the US that are interconnected with natural gas pipelines today. That said though, the Company is open to the idea of a targeted RNG pilot, such as the deployment of small-scale digester technology for smaller farms that are not typical targets for RNG project developers currently. Smaller dairies, such as the size typically found in Oregon, are not being targeted for RNG project development because developers have been much more focused on the largest dairies in the country. Oregon has many smaller dairy farms that produce manure that is held in large lagoons, emitting methane directly to the atmosphere. New technology is potentially available to more cost-effectively produce RNG from smaller dairies and potentially aggregate manures from multiple diaries to be processed with one set of conditioning equipment. For instance, a pilot project that helped to cover the costs of the digester and/or gas cleaning equipment may help some of those dairies move toward beneficial capture and use of their manure-based biogas.

Power-to-Gas

In its initial comments and data requests, Staff expressed interest in continuing to discuss the Company's examination of power-to-gas (P2G) resources in its 2018 IRP, particularly the power cost assumptions driving the illustrative examples presented in section 8.4 of Chapter Six. NW Natural has committed to rigorously evaluating renewable resources, including P2G, as nascent markets continue to develop in the region.

At present, no actual P2G resources are available to evaluate for purposes of the Company's integrated resource planning and P2G resources do not appear in the Company's base case portfolio (P2G only appears in one sensitivity listed in Chapter Seven). In the interest of fully understanding the potential role of these resources in its portfolio, the Company has performed preliminary analyses using assumptions based on available cost estimates and expectations of future market conditions. In Chapter Six, section 8.4, the company summarizes the economics

of potential P2G facilities,[23] holding electricity costs constant at zero. This assumption is derived from recurrent periods of over-generation in the Pacific Northwest, when the regional hydro system faces spring runoff and relatively low electricity demand.[24] As additional non-dispatchable renewables enter the system over time, these periods are expected to continue and potentially become more prevalent.[25] The Company is in early conversations with several owners of different intermittent renewable electricity resources who are interested in exploring ways to produce greater value from their assets during times of low- or zero-priced electricity.

It is important to note that the Company's analyses of P2G are necessarily preliminary at this time, any actual potential resources will be analyzed based on their specific economics as opportunities arise in the future, and no past or proposed resource decisions have been driven by the early work presented in Chapter Six. Moving forward, NW Natural will continue to investigate the details of potential resources and share its findings with Staff as they materialize over future IRP processes.

7. PORTFOLIO SELECTION

Estimation of RNG Resources

NW Natural's previous internal estimates of RNG potential were in line with the estimates recently published by the Oregon Department of Energy (ODOE),[26] which is why we indicated to Staff that the new ODOE information is unlikely to change the modeling of RNG in the 2018 IRP. The Company welcomes Staff inquiry into our RNG estimation process, which is directly informed in part by direct relationships with a variety of would-be RNG producers, such as wastewater treatment plants, large dairies and large landfills in our service territory with whom we already often have existing relationships since they are NW Natural customers. The ODOE report found that there was well over twice the 3,000 Dth/day[27] modeled in this IRP that is technically available in Oregon at existing dairies. It is clear that the model of potentially trucking RNG to a centralized injection site is one that can work in the field and thus we assume any available dairy RNG developed in the state could potentially be injected onto our system.

SENDOUT Workshop

NW Natural held a SENDOUT workshop on November 15, 2018 to show staff how inputs are provided into SENDOUT and how the optimization software is used to select resources.

[23] See Figures 6.10 and 6.11 and accompanying discussion.
[24] See Figure 6.12, illustrating data from EIA's Mid-C Peak electric price series, and accompanying discussion.
[25] As discussed in Chapter Six, section 8.2, "Power-to-Gas and the Need for Seasonal Energy Storage."
[26] The study was published on September 13, 2018.
[27] The technically available amount in the ODOE study included both on- and off-system RNG. We are working to better understand how much would be available for on-system injections.

8. DISTRIBUTION SYSTEM PLANNING

Distribution system planning is a critical part of NW Natural's operations. Potential disruptions on local natural gas systems present logistical[28] and financial challenges that can be greater than the familiar blackouts of the electrical grid. The Company has continuously worked to improve its system planning in order to maintain a properly working system for its customers in the least cost, least risk manner.

In its initial comments, Staff expressed a general need to better understand NW Natural's distribution planning process and several specific areas of interest relative to the distribution reinforcement projects included in the 2018 IRP Action Plan. NW Natural recognizes the complexity of distribution system planning relative to supply-side planning, as well as the increased attention on utility distribution system planning. The Company has been working with Staff since the conclusion of its technical working group sessions in summer 2018 to ensure that all parties have all necessary data and information necessary to review these planned projects. This has included three additional work sessions with Staff and in-depth documentation and narratives provided through responses to Staff's data requests.

Below, the Company addresses the issues raised by Staff in its initial comments, summarizing the detailed information provided via data request[29] regarding each of the six distribution projects in the 2018 Action Plan. The Company has now provided the requested detailed and comprehensive data and will continue to work with Staff if it has any remaining questions or concerns.

Additionally, CUB recommended Commission acknowledgement of all of the Action Plan distribution projects except the North Eugene Reinforcement, citing potential fuel switching spurred by the City of Eugene's climate plan and temporary incentives advertised on Eugene Water and Electic Board's (EWEB) website with regards to the latter. NW Natural appreciates CUB's engagement on this topic, its recognition of the evidence presented for reinforcement in the Company's distribution system and its concerns regarding potential fuel switching. As described below, the North Eugene project addresses a current and growing risk to customers in the local system, and the Company believes it would be imprudent and unsafe to postpone reinforcement due to unsupported claims of future fuel switching in that particular area.

Hood River Reinforcement Project

The Hood River distribution system serves approximately 2,500 customers in the town of Hood River and the surrounding area. The current configuration of the local system makes it vulnerable to low pressures as customer demand increases, as evidenced by customer outages and violations of NW Natural's system reinforcement standards in January 2017. System modeling validates that problematic pressures will continue to occur under similar conditions, which were less severe than the Company's design peak conditions.

[28] For example, relighting pilot lights on equipment, manually bypassing district regulator stations, etc.
[29] See NW Natural's response to OPUC DR 52, which includes detailed narratives and data related to each project.

An alternative analysis for this project evaluated alternate configurations, as well as pipeline uprates, satellite LNG and targeted interruptible agreements with customers in the area. None of the alternatives were found to be both viable and more cost-effective than the proposed project.

Sandy Feeder Reinforcement Project

The Sandy River pipeline serves approximately 2,000 customers in the town of Sandy and surrounding area. The performance of the Sandy distribution system is wholly dependent on the ability of this single high pressure pipeline to deliver gas from the Sandy Gate Station to the local system. The current configuration of the pipeline significantly violates our system reinforcement criteria, as demonstrated by very large pressure drops in January 2017. System modeling and field observation validates that problematic pressures will continue to occur under similar conditions, which were less severe than the Company's design peak conditions. Marginally higher demand than what was experienced during the 2017 event would result in malfunction and customer outages.

An alternative analysis for this project evaluated alternate configurations, and well as pipeline uprates, satellite LNG and targeted interruptible agreements with customers in the area. None of the alternatives were found to be both viable and more cost-effective than the proposed project.

South Oregon City Reinforcement Project

The Oregon City distribution system serves approximately 4,000 customers in the town of Oregon City and the surrounding area. Like the case of Hood River, cold temperatures in January 2017 resulted in customer outages and widespread low pressures in violation of system reinforcement standards in the area. These temperatures were not anomalous for the area, and system modeling validates that unacceptable pressures and customer outages will occur under similar or colder conditions.

An alternative analysis for this project evaluated alternate configurations, as well as pipeline uprates, satellite LNG and targeted interruptible agreements with customers in the area. None of the alternatives were found to be both viable and more cost-effective than the proposed project.

Happy Valley Reinforcement Project

The distribution system in the Happy Valley area serves approximately 2,500 customers and has been a cold weather concern to the Company for many years. Several main extensions and small system reinforcement projects have occurred over time to meet growing demand in this area.

NW Natural monitors pressures in the large residential interior of Happy Valley through system modeling, using data captured at nearby locations to calibrate the models and estimate conditions therein. Pressure drops recorded nearby validate system modeling that shows very low pressures have and will continue to occur during cold weather, in violation of the Company's system reinforcement standards.

An alternative analysis for this project evaluated alternate configurations, as well as pipeline uprates, satellite LNG and targeted interruptible agreements with customers in the area. None of the alternatives were found to be both viable and more cost-effective than the proposed project.

Kuebler Road Reinforcement Project

Load growth in the Salem area has resulted in inadequate pressure on the local high pressure distribution system during cold weather, as demonstrated recently by significant pressure drops in January 2017, violating system reinforcement standards under cold but not uncommon temperatures. System modeling and field observation validates that the system will continue to experience unacceptable pressures under cold temperatures and that marginally higher demands than were experienced in 2017 would result in customer outages.

An alternative analysis for this project evaluated alternate configurations, as well as pipeline uprates, satellite LNG and targeted interruptible agreements with customers in the area. None of the alternatives were found to be both viable and more cost-effective than the proposed project.

North Eugene Reinforcement Project

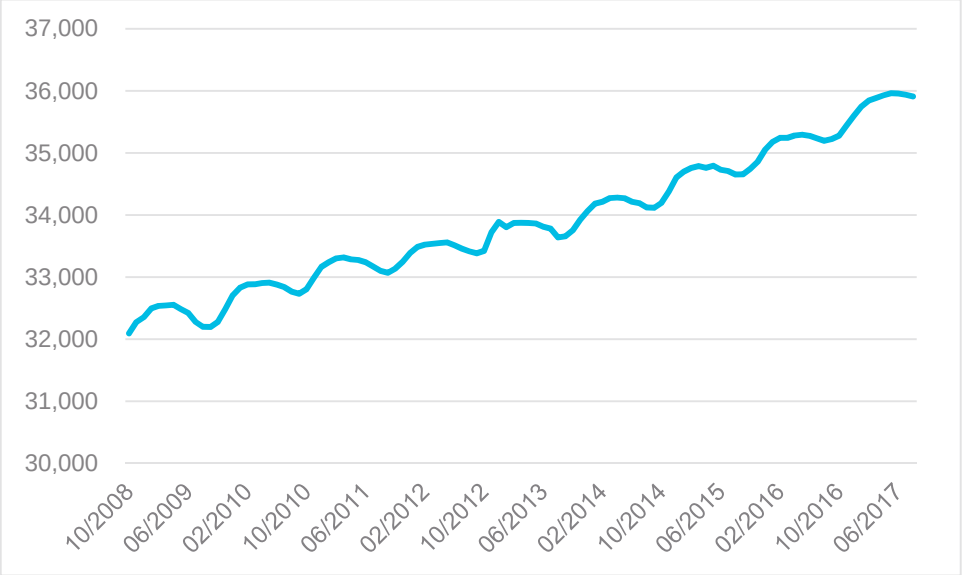
The distribution system in the North Eugene area of River Road serves approximately 1,500 customers. Significant residential growth in the area has required several main extension projects to meet increased customer demand. This growth has again resulted in modeled pressures that fail to meet system reinforcement standards.

NW Natural estimates the expected impact of peak hour customer demand on the distribution system in this area of North Eugene through system modeling. These models have proven to be reliable indicators of distribution system performance. Models for this specific system use current piping configurations and are tuned based on expected peak demand conditions and current customer counts in the load center. Modeling indicates that under the current configuration of the system, peak hour load conditions would result in inadequate pipeline pressures to reliably deliver gas to existing customers on the system.

As noted above, CUB recommended that the Commission not acknowledge this reinforcement project in its initial comments, based on the potential for fuel switching in Eugene spurred by the city's climate goals and incentives advertised on EWEB's website. It is important to reiterate that this reinforcement project is required to serve current customers and does not require further customer growth to be necessary. NW Natural's data does not suggest that large-scale fuel

switching is occurring in Eugene. We have recorded positive customer growth and increasing cold weather load in this area that has coincided with the availability of fuel switching to customers in the area. Figure 6 below summarizes the Company's firm customer growth in Eugene to date. As detailed in Chapter Three, table 3.7 of the 2018 IRP, the company forecasts average residential customer growth in Eugene of 1.4% over the IRP horizon.

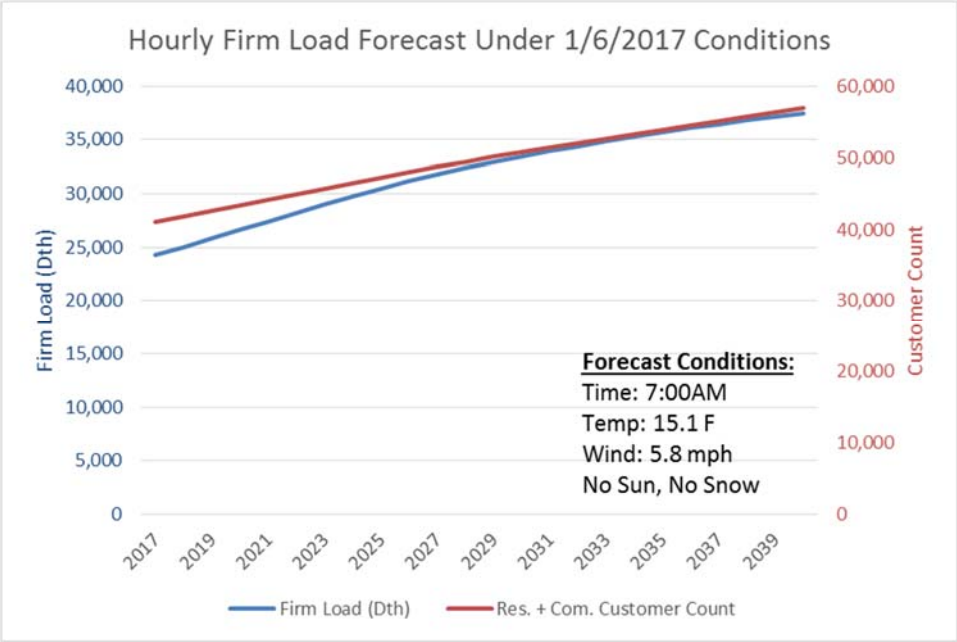
Figure 6: Residential Customers, Eugene Load Center



The Company's customer forecast for Eugene appropriately follows this upward trend. Although the Company has established declining use per residential customer,[30] loads under recently experienced cold temperature conditions currently violate system reinforcement standards and are forecast to continue to grow for Eugene (Figure 7, below).)

[30] NW Natural 2018 IRP, Chapter Three, Figure 3.17

Figure 7: Hourly Firm Load Forecast Under 1/6/17 Conditions



The North Eugene reinforcement project is necessary to address the needs of current customers. The Company believes that forgoing system reinforcement in light of speculative forecast assumptions such as fuel switching to be unsafe and imprudent.

Staff's Requests Related to Distribution Planning

NW Natural appreciates the specificity of Staff's questions and comments regarding the Distribution Planning analysis in the 2018 IRP. The Company strives to strike an appropriate balance between producing accessible documentation of its planning processes for stakeholders and providing adequately granular detail for the Commission's review. We have now provided Staff with all requested information related to the distribution projects in the Action Plan, including distribution system modeling, service call logs, system pressure charts, historical weather readings and detailed engineering summaries of project histories that support the justification laid out in the IRP itself. As always, the Company welcomes any additional requests or questions from Staff related to these projects and will work to include such detail directly in the body of future IRP filings.

9. RENEWABLE NATURAL GAS EVALUATION METHODOLOGY

NW Natural greatly appreciates the thoughtful engagement and helpful feedback from Staff and CUB relative to its proposed RNG evaluation methodology during the Company's technical working group meetings,[31] in their opening comments and in two subsequent workshops and

[31] The RNG material supporting the evaluation methodology were presented during multiple technical working group meetings. The materials from these workshops have been combined and is attached as Attachment A

one additional meeting with Staff where this topic was discussed in greater detail.[32,33] We will now respond to Staff's and CUB's comments on the evaluation methodology action item by topic.

IRP Guidelines Require Evaluation of All Resources and Prospective Compliance Costs

Staff notes that "the Company has not provided sufficient explanation of why it seeks to acquire RNG when there are currently no regulations in place or proposed that mandate such a requirement, or how the Company plans to account for any risks associated with the timeframe of actual greenhouse gas regulation versus the predicted date of such regulation."

NW Natural interprets the OPUC IRP Guidelines as requiring the Company to evaluate RNG resources regardless of whether there is a specific mandate or requirement to procure RNG. IRP Guideline 1(a) states:

All resources must be evaluated on a consistent and comparable basis.

- *All known resources for meeting the utility's load should be considered, including supply-side options which focus on the generation, purchase and transmission of power – or gas purchases, transportation, and storage – and demand-side options which focus on conservation and demand response.*

NW Natural has complied with Guideline 1(a), which requires the Company to evaluate all known resources, of which RNG is included.

Additionally, the OPUC's IRP Guidelines state the Company has an obligation to consider environmental compliance regulations or mandates that are not currently in place, as Guideline 8(a)[34] states:

> *"The utility should construct a base-case scenario to reflect what it considers to be the most likely regulatory compliance future for carbon dioxide (CO2), nitrogen oxides, sulfur oxides, and mercury emissions. The utility also should develop several compliance scenarios ranging from the present CO2 regulatory level to the upper reaches of credible proposals by governing entities."*

Environmental policy is the largest uncertainty impacting resource planning in this IRP, and while the Company does not currently have GHG compliance obligations that impose significant costs, we do expect significant compliance obligations relative to GHG emissions over the IRP planning horizon. In Chapter Two, the Company describes its assumptions and explanation

[32] One meeting held on October 10, 2018 and an RNG evaluation methodology-specific workshop on November 16, 2018, in addition to a webex meeting on November 5, 2018.
[33] Before proceeding, NW Natural would like respond to a mistake in Staff's comments that states, "this specific Action Plan item was not discussed during any of the technical workshops." Action Item 2 related to the Company's proposed RNG evaluation methodology was discussed in detail during Technical Working Group Six. (see Attachment A).
[34] Order No. 08-339 in Docket UM 1302.

used in developing the GHG ("carbon") compliance cost sensitivities in the IRP; how the Company is evaluating uncertainty around GHG regulation for all resources through risk analysis is discussed in Chapter Seven.[35] While GHG policy expectations are a crucial piece to evaluating RNG, they are a global assumption that applies consistently to all resources evaluated in the IRP – including RNG, energy efficiency and conventional supply. Furthermore, this consistent treatment of resources is required by IRP Guideline 1(a) which states, "all resources must be evaluated on a consistent and comparable basis."

In summary, it is the Company's view that 1) the OPUC's IRP guidelines require a consideration of RNG resources and the inclusion of expected GHG compliance costs; and 2) a review of the Company's expected GHG compliance costs should be a review on its own terms where the result will apply to all resources and not be linked specifically to our proposed RNG evaluation methodology.

The Proposed RNG Evaluation Methodology and Coordination with Other Policies

The purpose of the Company's proposed RNG evaluation methodology is detailed in the IRP's Appendix H in the following manner:

> *Enabled by new information and expertise gained since completing the last IRP, NW Natural evaluated low carbon gas resources in a much more detailed and comprehensive manner in the 2018 IRP. This methodology applies the current least cost and least risk planning standard to RNG resources; it is not meant to expand the scope of integrated resource planning or serve as a policy statement regarding RNG. The methodology and process presented in this appendix is meant to be flexible so that as new policies are enacted they can be incorporated into the analysis.*

Relative to what this means about how the methodology interacts with potential and existing policies, NW Natural sees a distinction between policies that are requirements or mandates and those that are voluntary to encourage action beyond standard resource planning. The proposed methodology is compatible with both voluntary policy avenues and mandatory compliance obligations :

1) For voluntary policy avenues (such as SB 844 or pilot programs), the proposed methodology would set the cost-effectiveness baseline for policies that encourage resource procurement beyond the current least cost and least risk framework.
2) For mandatory compliance obligations (such as cap-and-trade or emissions taxes), the proposed methodology is meant to be able to easily fold these policies into the evaluation if they are enacted.

[35] See NW Natural's 2018 IRP, pages 2.15-2.25 for the sensitivities considered, pages 7.15-7.23 for how these sensitivities are applied to all resource options through the Company's risk analysis, and pages 7.22-7.23 for how the Company selects among portfolios in terms of the least cost and least risk framework, and pages H.12- H.13 for how these are applied in the RNG evaluation methodology.

Staff also encourages NW Natural to consider "the potential for NW Natural to propose RNG projects through the process laid out in Senate Bill 844 as a means to test new methods to enter into this market with potentially fewer long-term risks to ratepayers." NW Natural would first caution that the avenue through which a project is acquired does not necessarily impact the cost or risk customers undertake for that project. More importantly, the proposed methodology is seeking to determine which RNG resources the Company should procure within the current least cost/least risk resource planning framework and IRP Guidelines.

The primary salient aspect of SB 844 is that it is meant as an avenue to bring forth voluntary carbon emission reduction projects that go above and beyond the "ordinary course of business."[36] The proposed RNG methodology would be used to *set the ordinary course of business* for resources evaluated in detail for the first time in this IRP. As such, it is NW Natural's intent that procuring RNG projects that show as cost-effective under this methodology would constitute normal utility operations, whereas projects that do not pencil as cost-effective using the proposed methodology would be eligible for consideration as SB 844 or pilot projects. NW Natural understands Staff seeking clarity on this point, and has adjusted its RNG project evaluation and procurement process diagram to better show this distinction (see Attachment B for the updated version of this process diagram with the change highlighted in red).

All-in Costs Represents an Apples-to Apples-Comparison

Staff's comments state that "Staff plans to work with the Company in verifying whether this plan fits within the guidelines of least cost, least risk planning before considering a recommendation for acknowledgement." NW Natural looks forward to this collaboration,[37] and would point out that this is exactly what the action item related to our proposed RNG evaluation methodology is seeking: is the proposed methodology an appropriate application of the least cost and least risk framework?[38]

"All-in costs" are presented as a way to describe this apples-to-apples comparison between gas resources with different carbon intensities and infrastructure needs. This concept has been referred to in other contexts as "stacking the values" to allow a consistent comparison. Per the Company's RNG evaluation methodology appendix:

> *All-in cost refers to the total cost to deliver a unit of natural gas to a customer on NW Natural's system, inclusive of infrastructure requirements to deliver that gas and emissions compliance costs. All-in costs can be substantially more or less than the cost of the commodity itself.*

Note that the price of RNG in transportation markets includes the environmental benefits of that gas (in other words the environmental compliance benefits are included in the price), whereas

[36] ORS 757.539(3)(d).
[37] NW Natural has conducted an additional workshop with Staff to discuss in more detail its proposed evaluation methodology.
[38] Note that the first sentence of the appendix detailing the proposed methodology states that it "presents an application of the existing least cost and least risk resource planning framework to evaluate low carbon gas resources on an apples-to-apples basis against conventional gas resources."

the price of conventional gas does not include any potential emissions compliance costs associated with its use. Additionally, some RNG is locally sourced and would be injected directly onto NW Natural's pipeline grid, avoiding the costs required upstream of NW Natural's system to bring conventional gas to the Company's customers from the supply basins where it is purchased.[39] As such, comparing the market price of RNG with the market price of conventional gas is a poor representation of the total relative cost and risk customers pay for each type of gas supply. Therefore, NW Natural feels Staff mischaracterizes the Company's proposal when it states:

> *NW Natural's 2018 IRP notes that project developers can command ten times (or greater) the price of conventional gas in the current RNG market and the Company is looking to use their proposed evaluation methodology in order to offer more competitive prices. These prices would be above what the Company currently pays for conventional gas resources in order to secure RNG.*

The Company believes a more accurate characterization of its proposal is:

> *When all costs and risks are considered, RNG is more competitive relative to conventional gas than market prices suggest. NW Natural is proposing a methodology that evaluates if particular RNG resources are lower cost and lower risk compared to conventional gas using the traditional resource planning framework.*

The methodology does not recommend procuring RNG that is a higher cost and higher risk resource in comparison to conventional gas.

RNG Project Procurement Structures are Likely to be Diverse

There are numerous procurement structures that potential RNG projects could take, depending on ownership structure, whether the project is new or has been operating for some time, and the risk profile of the project owner. In Table 7, we summarize some of the various structures that the Company would be likely to encounter when considering procurement of RNG.

[39] Using the same avoided cost methodology applied to all "on-system" resources, including demand-side resources like energy efficiency. See Chapter Four of the 2018 IRP.

Table 7: Possible Structures Encountered When Considering RNG Procurement

Type of Structure	Ownership of biogas production	Ownership of conditioning and cleanup equipment and/or pipeline interconnection	Cost basis for consideration of cost-effectiveness
1. RNG commodity-only purchase	3rd party	3rd party	Flat $/Dth contract for delivery of gas over a set time period
2. Investment in gas conditioning and/or pipeline interconnection	3rd party	NW Natural	Capital costs of investment in gas cleanup/ interconnection, minus some payment to 3rd party for raw biogas
3. Investment in full RNG project development	NW Natural	NW Natural	Capital costs of gas production and gas cleanup/interconnection

Based on NW Natural's understanding of the current RNG market, the most likely project structures are either number 1 or 2, above. Whether the cost basis is a contract for delivered RNG, as in number 1, or an assessment of capital costs we assess via a cost-of-service financial model, the Company does not view RNG resource procurement as necessitating a change to the currently employed avenues for cost recovery. We believe that RNG resources can be evaluated through the Purchased Gas Adjustment (PGA) process for scenarios like number 1; through a general rate proceeding for scenarios like number 3; and a combination of the PGA and general rate for scenarios like number 2 (where the commodity costs would be evaluated in the PGA and the capital costs evaluated in a general rate case). The proposed methodology does, however, incorporate all costs for a given project – whether they are commodity costs, capital costs or both – into the project evaluation so that cost-competitiveness is fairly evaluated against conventional gas resources. The methodology is also flexible enough that it should be able to evaluate all potential project structures we currently anticipate.

NW Natural's Proposed Methodology is not Seeking Pre-Approval

NW Natural does not believe that acknowledgment of its action item related to evaluating RNG would constitute pre-approval of RNG procurement. The Company understands that "a decision to acknowledge or not acknowledge an action item does not constitute ratemaking" and that capital investments are ultimately evaluated for prudency in a subsequent rate proceeding. The Company fully agrees with Staff that "acknowledgement in an IRP of a methodology is not a pre-approval nor a determination of prudence, but would only indicate whether the Commission sees the proposed methodology as a reasonable way to proceed." This indication of whether the Company's methodology is a reasonable application of the current planning framework is what NW Natural is seeking by asking for acknowledgement of the methodology, and it

recognizes that this would not constitute pre-approval of the procurement of any RNG project or contract.

10. GENERAL COMMENTS

Enbridge Pipeline Rupture Analysis

The Enbridge pipeline rupture that occurred on October 9, 2018 led to this request from AWEC in its comments:

> *"AWEC urges NW Natural to supplement the 2018 IRP with a special analysis of how the system performed during the days immediately following the rupture and loss of service from Sumas. The analysis should include an in-depth analysis of how curtailments of industrial loads kept NW Natural's system from losing pressure or having to interrupt core customers. The analysis should also include a scenario where this type of event happened in winter, where it would not have been possible to interrupt natural gas fired electric generation, including the effect on both gas and electric service."*

The interruption of industrial customers on interruptible service agreements, along with the voluntary actions of regional electric generators to interrupt their natural gas usage, were indeed two of the key steps in helping to avoid potential large-scale outages of firm customers during the period that began on the evening of October 9 and ended on the morning of October 11, 2018. Unfortunately, the analysis that AWEC has requested goes well beyond the scope of NW Natural's IRP. For example, AWEC asks that the analysis include the effects on electric service, which is clearly outside NW Natural's expertise. Also, the impacts of the Enbridge event have been felt by numerous utilities, pipelines and direct connect customers well outside NW Natural's service territory. Accordingly, any analysis would be woefully incomplete if it did not consider the broader regional impacts since gas service has some similarities to the electric grid in that a resource deficiency in one area will eventually lead to deficiencies in other areas if not alleviated in time. Finally, it should be noted that the Enbridge disruption is still ongoing and only about half of the Enbridge system capacity has been restored to date.

CONCLUSION

NW Natural's 2018 IRP complies with the guidelines established for IRPs and the Company requests the Commission's acknowledgement of its Plan as filed.

ATTACHMENT A

RNG TECHNICAL WORKING GROUPS RECAP

FORWARD LOOKING STATEMENT

This and other presentations made by NW Natural from time to time, may contain forward-looking statements within the meaning of the U.S. Private Securities Litigation Reform Act of 1995. Forward-looking statements can be identified by words such as “anticipates,” “intends,” “plans,” “seeks,” “believes,” “estimates,” “expects” and similar references to future periods. Examples of forward-looking statements include, but are not limited to, statements regarding the following: including regional third-party projects, storage, pipeline and other infrastructure investments, commodity costs, competitive advantage, customer service, customer and business growth, conversion potential, multifamily development, business risk, efficiency of business operations, regulatory recovery, business development and new business initiatives, environmental remediation recoveries, gas storage markets and business opportunities, gas storage development, costs, timing or returns related thereto, financial positions and performance, economic and housing market trends and performance shareholder return and value, capital expenditures, liquidity, strategic goals, carbon savings, supplies and characteristics of the same, avoided costs, resource options, renewable natural gas, power to gas, carbon reductions, gas reserves and investments and regulatory recoveries related thereto, hedge efficacy, cash flows and adequacy thereof, return on equity, capital structure, return on invested capital, revenues and earnings and timing thereof, margins, operations and maintenance expense, dividends, credit ratings and profile, the regulatory environment, effects of regulatory disallowance, timing or effects of future regulatory proceedings or future regulatory approvals, regulatory prudence reviews, effects of regulatory mechanisms, including, but not limited to, SRRM and the Company’s infrastructure investments, effects of legislation, including but not limited to bonus depreciation and PHMSA regulations, and other statements that are other than statements of historical facts.

Forward-looking statements are based on our current expectations and assumptions regarding our business, the economy and other future conditions. Because forward-looking statements relate to the future, they are subject to inherent uncertainties, risks and changes in circumstances that are difficult to predict. Our actual results may differ materially from those contemplated by the forward-looking statements, so we caution you against relying on any of these forward-looking statements. They are neither statements of historical fact nor guarantees or assurances of future performance. Important factors that could cause actual results to differ materially from those in the forward-looking statements are discussed by reference to the factors described in Part I, Item 1A “Risk Factors,” and Part II, Item 7 and Item 7A “Management’s Discussion and Analysis of Financial Condition and Results of Operations,” and “Quantitative and Qualitative Disclosure about Market Risk” in the Company’s most recent Annual Report on Form 10-K, and in Part I, Items 2 and 3 “Management’s Discussion and Analysis of Financial Condition and Results of Operations” and “Quantitative and Qualitative Disclosures About Market Risk”, and Part II, Item 1A, “Risk Factors”, in the Company’s quarterly reports filed thereafter.

All forward-looking statements made in this presentation and all subsequent forward-looking statements, whether written or oral and whether made by or on behalf of the Company, are expressly qualified by these cautionary statements. Any forward-looking statement speaks only as of the date on which such statement is made, and we undertake no obligation to publicly update any forward-looking statement, whether as a result of new information, future developments or otherwise, except as may be required by law.

TWG 3

Key Takeaways

- NW Natural will evaluate four different RNG scenarios in 2018 IRP
- Buying RNG on the market is likely more expensive than producing it ourselves and/or negotiating long-term contracts
- Statewide RNG technical potential analyses currently underway in Oregon and Washington; to be finalized by end of 2018
- NW Natural considering how to bring lower cost RNG to customers in the future

Renewable Natural Gas (RNG)

Photo source Portland Tribune

RNG is *pipeline-quality gas* derived by cleaning up the biogases emitted as organic material chemically breaks down. Material such as:

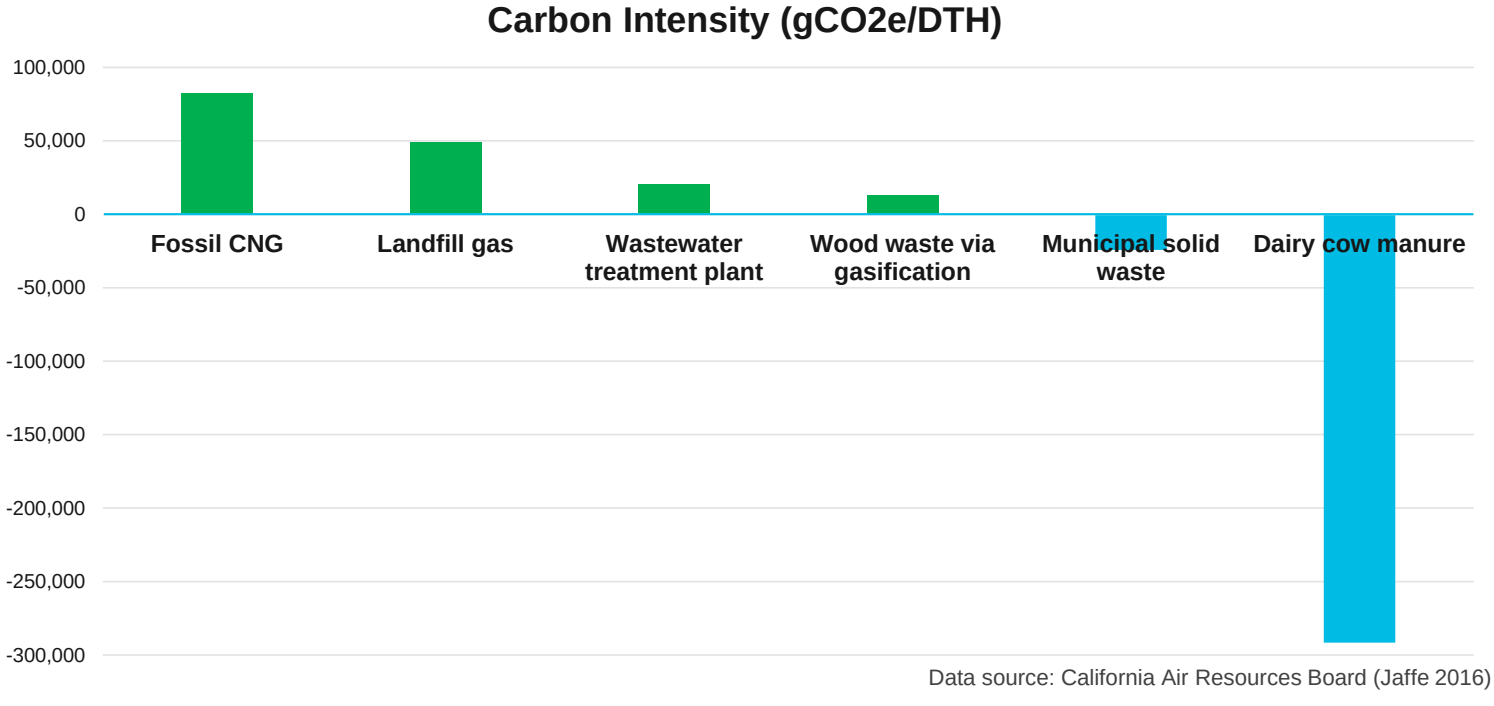
- Food waste
- Wastewater treatment plants
- Landfills
- Dairy and other manures
- Mill and forest residues

Why Consider RNG?

- RNG reduces CO_2 emissions, whether used directly in appliances or in vehicles
  - NW Natural assumes some future cost of carbon in all resource planning scenarios
- RNG production turns costly waste products into revenue generators for cities and businesses
- Local RNG resources produce direct economic benefits
- On-system RNG potentially reduces infrastructure requirements

Eugene-Springfield Water Pollution Control Facility
Photo source City of Eugene

RNG: Carbon Reduction Benefits



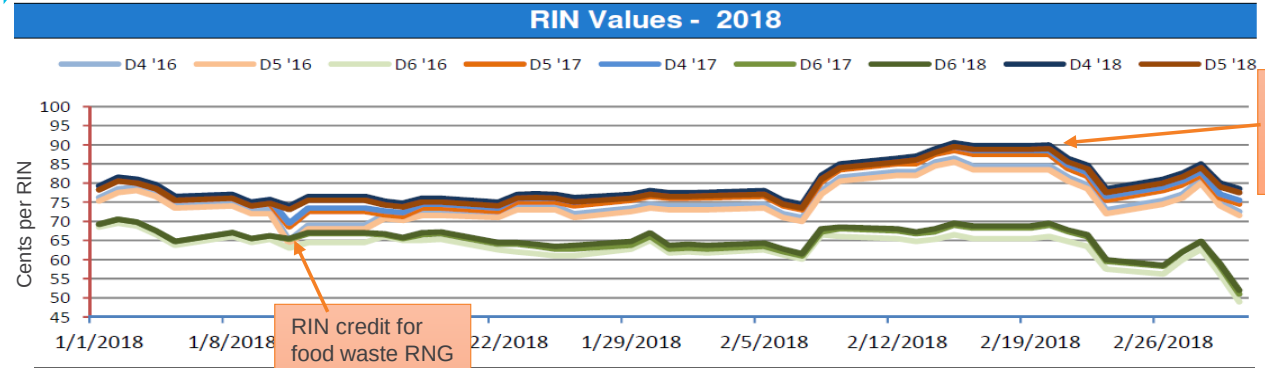
Data source: California Air Resources Board (Jaffe 2016)

RNG as a Resource

Current RNG market:

- Must compete with market-altering transportation credits
  - Too expensive to buy RNG today on the open market for our customers
- Expect significant growth in number of RNG projects in U.S. throughout 2018
- ODOE technical potential and report to legislature: Fall 2018
- NWN considering how to secure lower-cost RNG for customers

RNG as a Resource



Transportation fuel credits for RNG: lucrative but volatile:

- Federal: Renewable Identification Number (RIN)
- California: Low-Carbon Fuel Standard (LCFS)
- Oregon: Clean Fuels Program (CFP)

Prepared for IRP Working Group - Not to be used for investment purposes.

RNG as a Resource

RNG on NWN system:

- City of Portland Columbia Boulevard Wastewater Treatment Plant → in process
- Four other projects (wastewater treatment plants/food waste facilities) → likely in 2018/2019

Columbia Boulevard Wastewater Treatment Plant
Photo source Eli Duke, via Flickr via NextCity

RNG as a Resource

- This region has a wide array of potential RNG resources
- For the 2018 IRP, we will model four that represent possible near-term potential resources:
  1. Purchase RNG on market today
  2. Sign contract now for delivery of RNG in years 2023-2033
  3. Utility-owned equipment to capture and process RNG
  4. Utility-owned equipment to capture and process RNG with near-term monetization of transportation fuel credits

We assume for all projects:

- 100,000 Dth annual RNG production in all scenarios
- Transportation fuel credits for RNG decrease after 2022

RNG as a Resource

	Scenario	Source of biogas	Ratepayers invest in	Estimated Cost/Dth[1]	Capital expenses	Annual operating expenses	On-system resource benefits	Estimated Percent CO_2 reduction compared to conventional gas	Estimated Cost ($) per metric ton of CO_2 avoided
1	Buy RNG on market today	Landfill	--	$30.25	--	--		41%	$889.71
2	Enter into contract for RNG for 2023-2033	Dairy	--	$14.00	--	--	x	452%	$34.14
3	Develop RNG plant	Wastewater	Cleanup, compression, interconnect	$12.65	$8 million	$600,000	x	75%	$186.45
4	Develop RNG plant and monetize transportation fuel credits in years 1-5	Wastewater	Cleanup, compression, interconnect	$8.10	$8 million	$600,000	x	75%	$130.65

[1] Cost/Dth in Scenarios 1 and 2 derived from market knowledge; Scenarios 3 and 4 through cost-of-service modeling

RNG as a Resource-Scenario One

- Scenario One: Purchase of RNG on market
  - Portion of landfill output
  - Have to compete against lucrative transportation offtake market
  - Working with RNG marketers to understand market dynamics

Roosevelt Regional Landfill
Photo source Klickitat PUD

RNG as a Resource-Scenario Two

- Scenario Two: Sign contract for RNG to be delivered in years 2023-2033
  - Of interest to project developers because transportation credit market in later years is very uncertain
  - Project is located at a dairy that can earn higher carbon-based program credits

Photo source Chronicle.co.zw

RNG as a Resource-Scenario Three

- Scenario Three: Investment at wastewater treatment plant
  - Reflective of regional capital and operating costs
  - Assume no monetization of transportation fuel credits
  - Assume existing wastewater treatment plant with digesters already in place
  - Assumed capital investment includes:
    - Gas conditioning
    - Gas compression
    - Pipeline extension
    - Interconnection equipment (monitoring, metering, etc.)

Fats, Oils, and Greases (FOG) tanks at Gresham Wastewater Treatment Plant
Photo source NW Natural

RNG as a Resource-Scenario Four

- Scenario Four: Investment at wastewater treatment plant
  - Reflective of regional capital and operating costs
  - NWN customers take delivery of physical gas upon facility completion
  - Environmental attributes sold into transportation markets first five years; all environmental attributes kept for NWN customers starting in year six
  - Assume existing wastewater treatment plant with digesters already in place
  - Assumed capital investment includes:
    - Gas conditioning
    - Gas compression
    - Pipeline extension
    - Interconnection equipment (monitoring, metering, etc.)

Anaerobic Digester Eggs at Newtown Creek
Photo source NYC.gov

TWG 4

New Resources

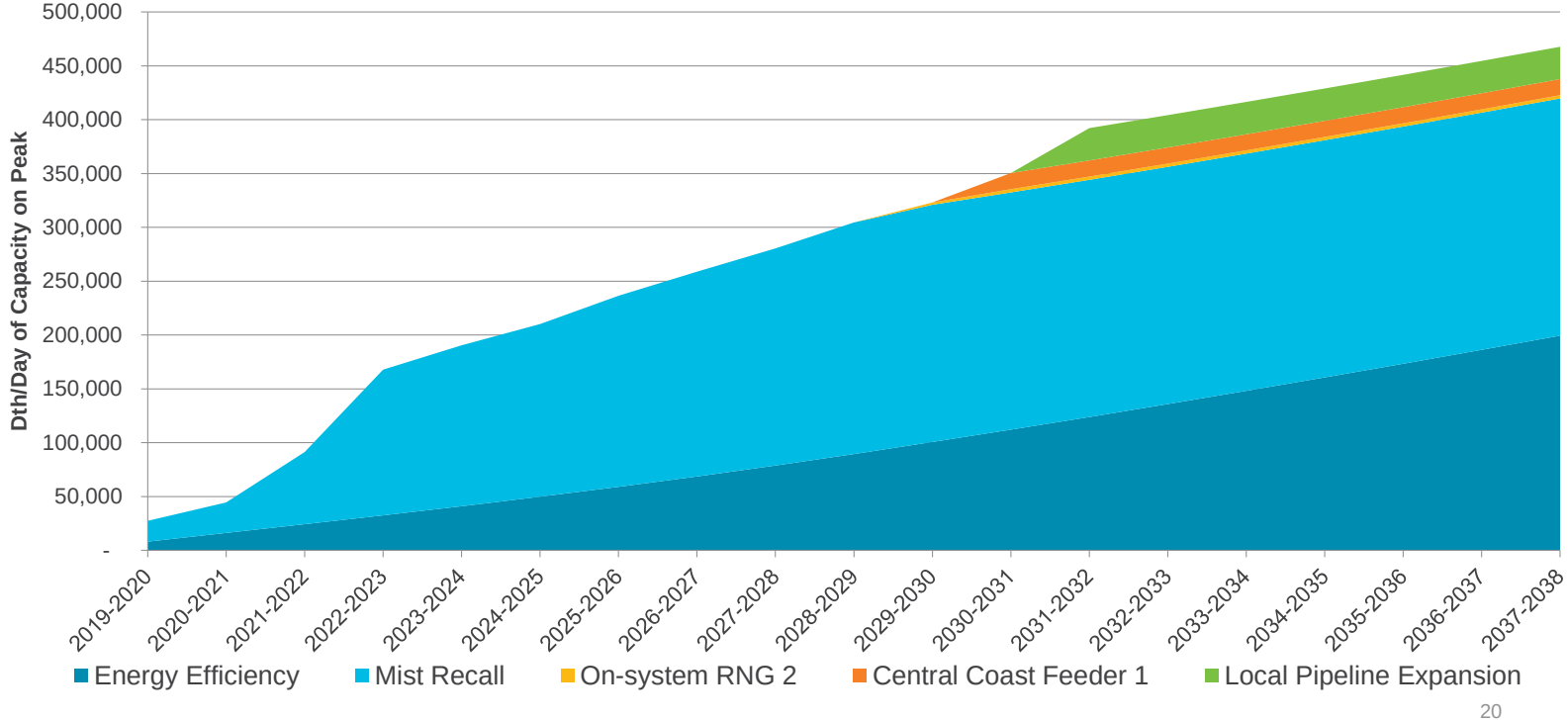
Resources	Description	Commodity Cost ($/Dth)	Estimated Percent CO_2 reduction compared to conventional gas
RNG 1 : Landfill Gas*	Purchase RNG at market value inclusive of the environmental attributes and have delivered along NWP	30.25	41%
RNG 2 : On-system Dairy Gas	Contract with on-system dairy farmers to purchase their dairy digester biogas	14.00	452%
RNG 3 : Waste Water	Develop an RNG facility at a wastewater treatment plant to clean and capture methane	12.65	75%
RNG 4 : Waste Water with Monetized RINs	Develop an RNG facility at a wastewater treatment plant to clean and capture methane, but monetize transportation fuel credits in years 1-5 to offset some costs	8.10	75%
RNG 5 : Off-system Dairy*	Contract with off-system dairy farmers to purchase their dairy digester biogas.	14.00	452%
Power-to-Gas	Build a power to gas facility at Mist to blend in produced hydrogen into natural gas	67.52-20.26	100%

Notes: *RNG 1 & 5 are not a capacity resources. Power-to-Gas cost are assumed to be declining over time.

Expected Demand Portfolios – Key Takeaways

- If no regional pipeline comes online during the planning horizon:
  - NW Natural exhausts Mist Recall in 2029-2030 gas year
  - On-system RNG from dairy farms becomes cost effective in 2029-2030 gas year after Mist Recall is exhausted
  - The Central Coast Feeder 1 is required to serve customers in Salem and Albany load centers 2030-2031
  - A local pipeline expansion (NW Natural specific) would be required in the 2031-2032 gas year
- If a regional pipeline expansion comes online in 2025, it would be cost effective for NW Natural to subscribe to roughly 30,000 Dth/day of pipeline capacity
- Off-system RNG becomes cost effective in 2036-2037 gas year and displaces conventional gas supply

No Regional Pipeline Expansion



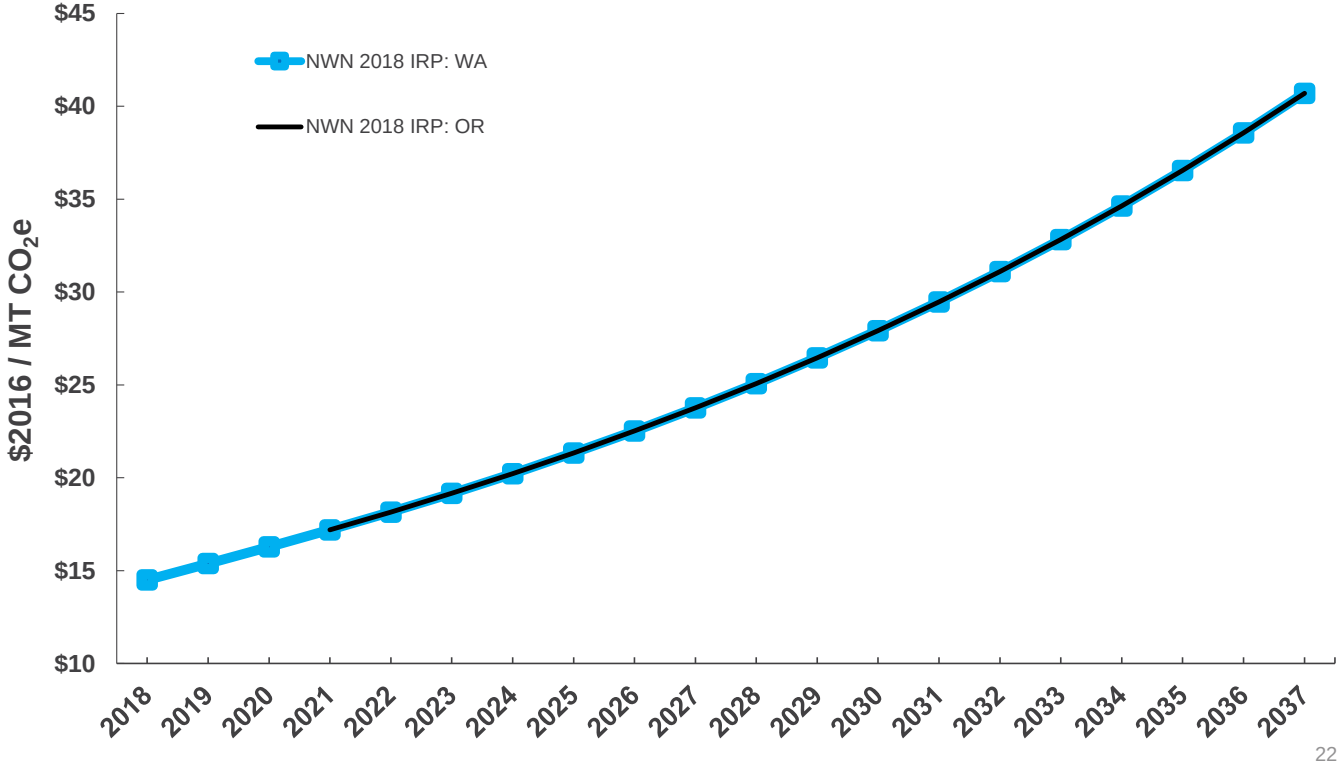
RNG as a Least Cost Option

- On-system RNG from dairy farms is the least cost option to serve load once Mist Recall is exhausted

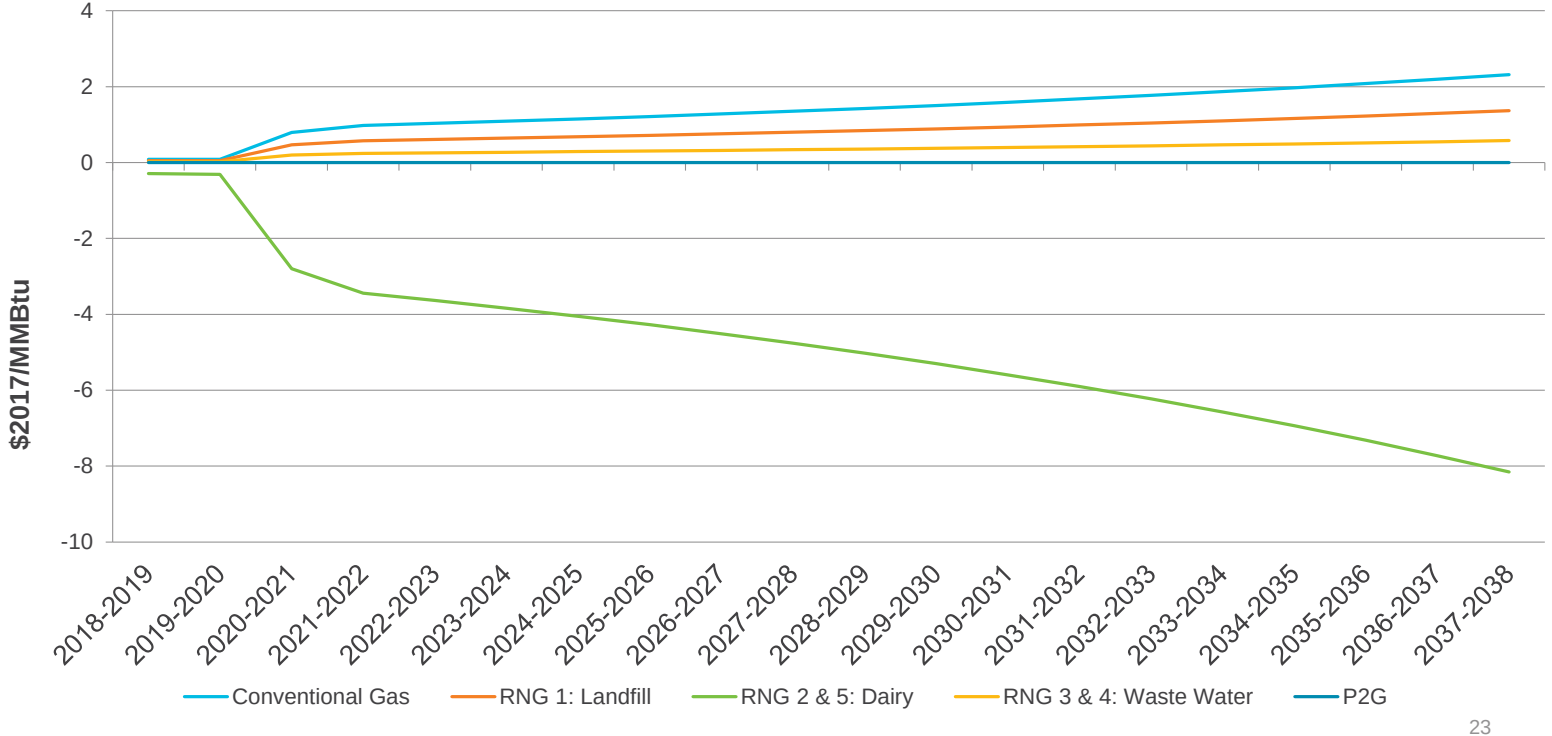
On-System RNG	Off-System RNG
Avoided Costs • Compliance Costs • Upstream transmission costs • System reinforcement costs	Avoided Costs • Compliance Costs
Shows up in the supply stack as a resource	Does NOT show up in the supply stack
On-system dairy: limited to 3,000 Dth/Day*	Off-system dairy: limited to 6,000 Dth/Day*

*NW Natural will continue to study and refine the amount of RNG available to customers in future IRPs and will be greatly informed by the completion of ODOE's study on RNG.

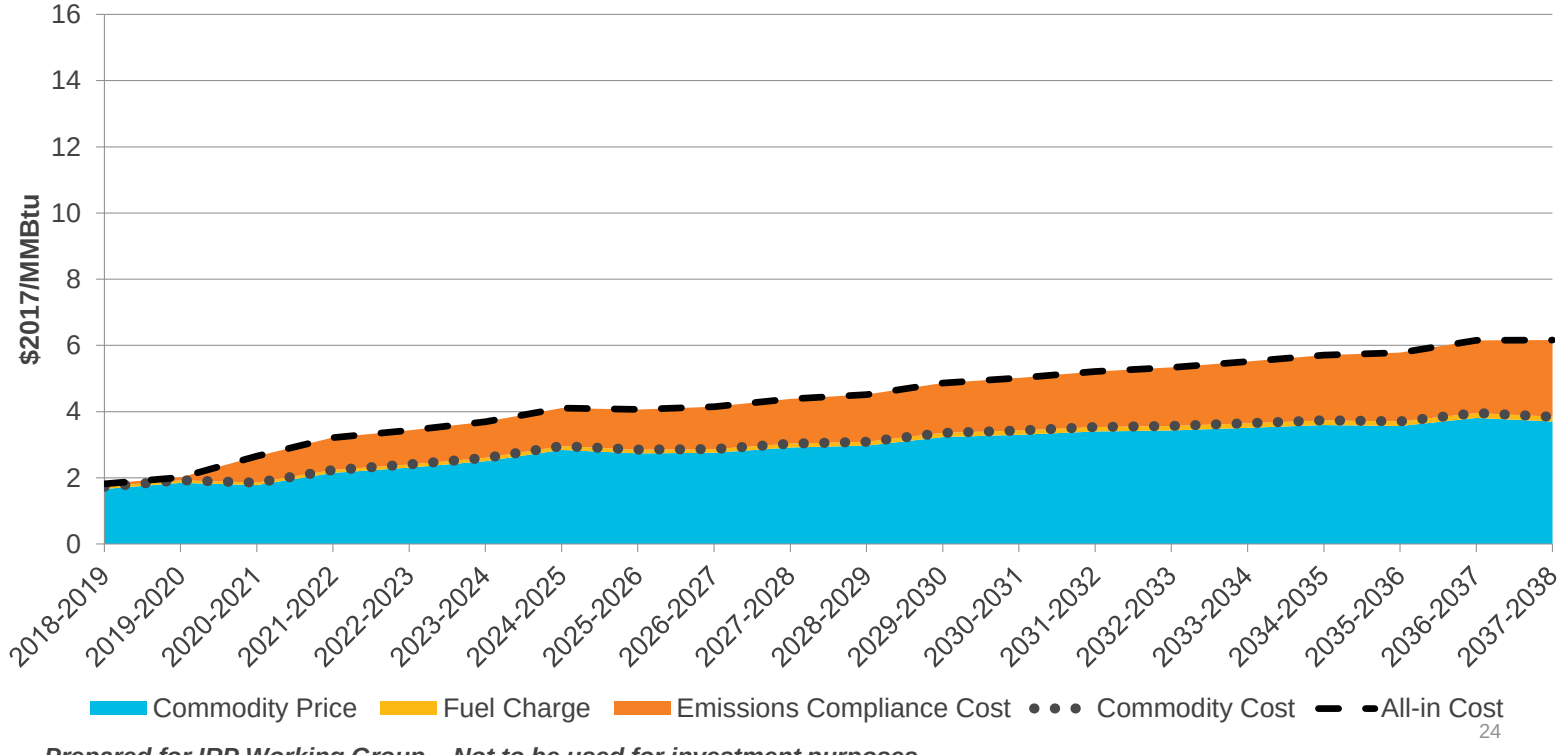
Expected GHG Compliance Costs



GHG Compliance Costs by Gas Source

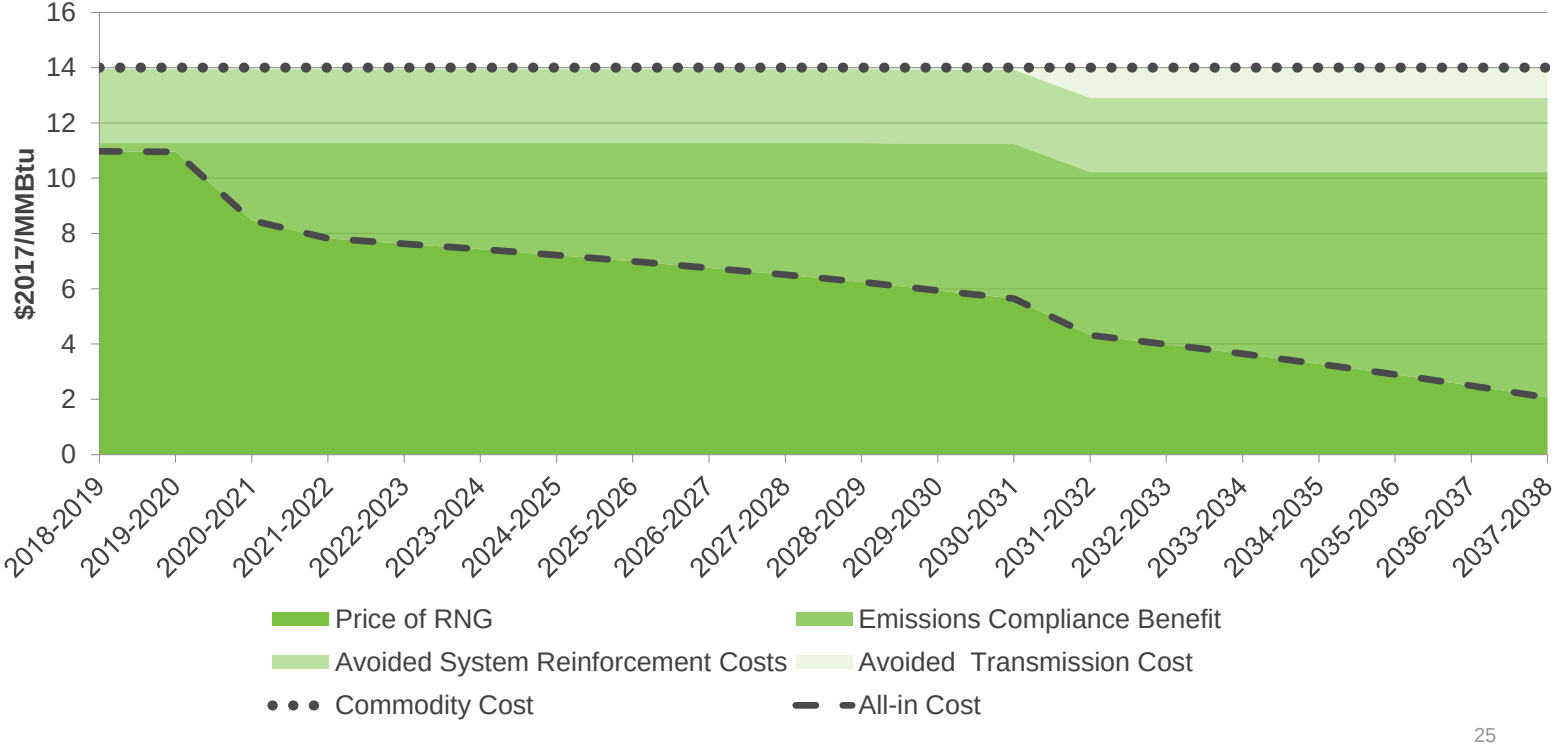


Conventional Gas All-in Cost

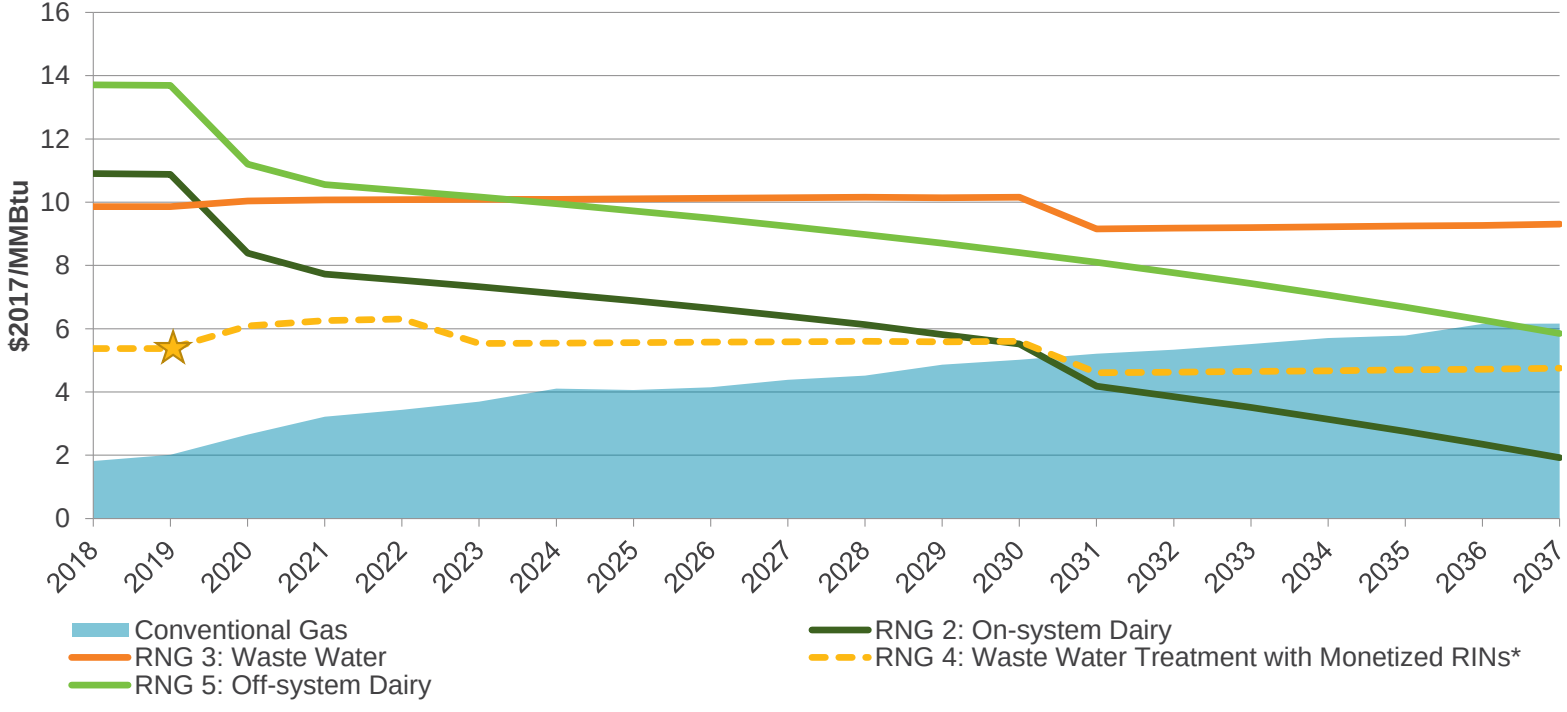


Prepared for IRP Working Group - Not to be used for investment purposes.

RNG 2 : On-system Dairy All-in Cost



All-in Gas Cost by Source

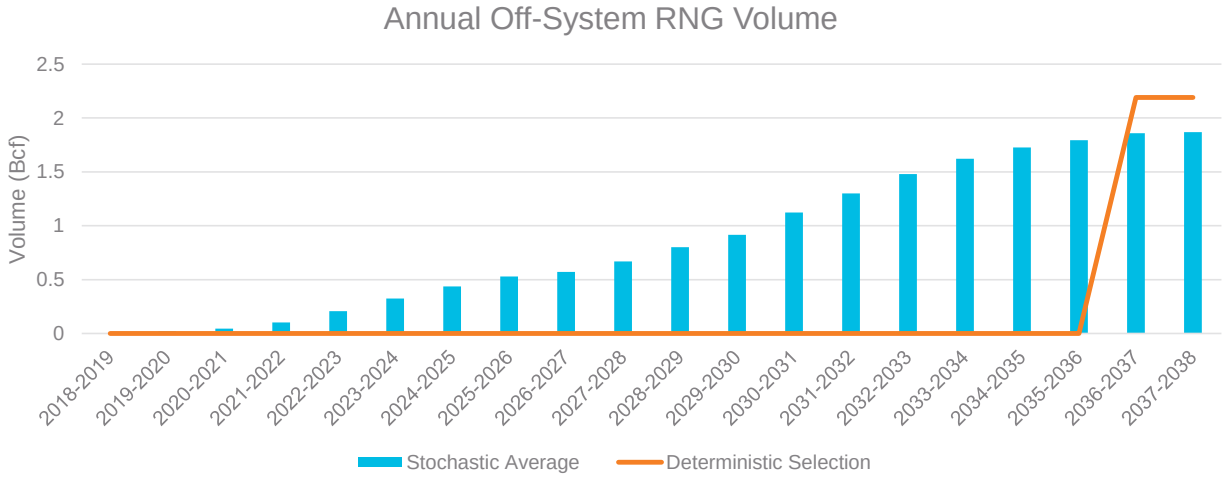


*RNG 4 option is only available if selected today in order to monetize the RIN value over the next 5 years and kept over the planning horizon. Other options are available at any time.

TWG 5

Impact of Carbon Policy and Commodity Price Risk on RNG

RNG is often taken much earlier in the stochastic analysis compared to the deterministic case



IRP Sensitivities

		Supply Infrastructure Sensitivities			Economic Growth Sensitivities		Environmental Policy Sensitivities			
		1	2	3	4	5	6	7	8	9
		Base Case - No New Regional Pipeline	New Regional Pipeline in 2025 - Fully Subscribed	New Regional Pipeline in 2025 - Excess Capacity	High Customer Growth	Low Customer Growth	Use Social Cost of Carbon in Resource Planning	Deep Decarbonization	CNG Adoption in Medium- and Heavy-Duty Transportation	New Direct Use Gas Customer Moratorium in 2025
Demand-Side Assumptions	Customer Growth	Expected (Statistical Trend Continuation)			High 90% Confidence Interval	Low 90% Confidence Interval	Expected (Statistical Trend Continuation)		Expected Res and High Comm and Ind CNG	No new direct use customers allowed after 2025
	Space Heat Equipment	Expected (Trend Continuation Plus Adjustment for Energy Trust Energy Efficiency Savings Projection)			Expected (Trend Continuation Plus Adjustment for Energy Trust Energy Efficiency Savings Projection)		Newly installed units 25% Natural Gas Powered Heat Pumps in 2025 and 50% in 2030	Newly installed units 50% Natural Gas Powered Heat Pumps in 2025 and 100% GHP in 2030	Trend Continuation Plus EE Savings Projection	Trend Continuation Plus EE Savings Projection for Existing Customers
	Water Heating Equipment						New units 25% Nat Gas Heat Pump WH in 2025 and 50% GHPWH in 2030	New units 50% Nat Gas Heat Pump WH in 2025 and 100% GHPWH in 2030	Trend Continuation Plus Adjustment for Energy Trust Energy Efficiency Savings Projection	
	Industrial Load Efficiency						25% Increase in Industrial Efficiency	50% Increase in Industrial Use Efficiency	Trend Continuation	
	Building Shell Improvement	Shell Related Savings in Energy Trust Energy Efficiency Savings Projection			Shell Related Savings in Energy Trust Energy Efficiency Savings Projection		High CO2 Price Sensitivity Energy Efficiency Savings	Aggressive Shell Savings	Shell Related Savings in Energy Trust Energy Efficiency Savings Projection	
Supply-Side Assumptions	Regional Interstate Pipeline Expansion	No new regional interstate pipeline in Planning Horizon	Regional Pipeline Project in 2025 - Fully Subscribed	Regional Pipeline Project in 2025 - Excess Capacity	No new regional interstate pipeline in Planning Horizon		No new regional interstate pipeline in Planning Horizon			
	Renewable Natural Gas	Base Case Assumptions			Base Case Assumptions		Base Case Assumptions	Policy, Market, and Costs Attractive for Direct Use RNG	Continuation of Federal Transportation RNG Policy	Base Case Assumptions
	Power-to-Gas Hydrogen							Policy, Market, and Costs Attractive for PtG	Base Case Assumptions	
	Carbon Pricing						Social Cost of Carbon	High Sensitivity		

Portfolio Results: Incremental Peak Capacity by Sensitivity

		Supply Infrastructure Sensitivities			Economic Growth Sensitivities		Environmental Policy Sensitivities			
		No New Regional Pipeline	New Regional Pipeline in 2025- Fully Subscribed	New Regional Pipeline in 2025- Excess Capacity	High Customer Growth	Low Customer Growth	Use Social Cost of Carbon in Resource Planning	Deep Decarbonization	CNG Adoption in Medium- and Heavy-Duty Transportation	New Direct Use Gas Customer Moratorium in 2025
Peak Load 2037-2038 Gas Year (Dth/Day)		1,181,833	1,181,833	1,181,833	1,355,499	1,003,112	1,134,772	1,055,316	1,209,482	982,655
Incremental Resource Capacity Contribution to Peak		Resource Timing								
Resource	Dth/Day									
Exhaust Mist Recall	220,300	2029	2037	2029	2037	-	-	-	2037	-
Pipeline	Varied by Sensitivity →	Local 30,000 2031	Regional 30,000 2025	Regional 30,000 2031	Local 100,000 2024	- - -	- - -	- - -	Local 40,000 2029	- - -
Central Coast Feeder 1	15,000	2030	2031	2030	2031	-	2034	-	2028	-
Mist Expansion (II & III)	100,000	-	-	-	2033	-	-	-	-	-
RNG 2 : On-System Dairy	3,000	2029	2030	2029	2029	2029	2019	2021	2027	2031
RNG 3: On-System Waste Water	5,000	-	-	-	-	-	-	2034	-	-
RNG 4: On-System Waste Water with Monatized RIN Values	1,500	-	-	-	2019	-	2019	2019	2019	-
P2G: Power-to-Gas (No Methanation)	21,900	-	-	-	-	-	-	2036	-	-

Cost-Effective RNG by Sensitivity

		Supply Infrastructure Sensitivities			Economic Growth Sensitivities		Environmental Policy Sensitivities			
		Base Case- No New Regional Pipeline	New Regional Pipeline in 2025- Fully Subscribed	New Regional Pipeline in 2025- Excess Capacity	High Customer Growth	Low Customer Growth	Use Social Cost of Carbon in Resource Planning	Deep Decarbonization	CNG Adoption in Medium- and Heavy-Duty Transportation	New Direct Use Gas Customer Moratorium in 2025
First Year Renewable Resource Option Chosen	RNG1- Off-System Landfill	-	-	-	-	-	-	-	-	-
	RNG2- On-System Dairy	2029	2030	2029	2030	2029	2019	2021	2027	2031
	RNG3- On-System WWTP	-	-	-	-	-	-	2034	2037	-
	RNG4- On-System WWTP w/ RIN sales	-	-	-	2019	-	2019	2019	2019	-
	RNG5- Off-System Dairy	2036	2036	2036	2036	2036	2019	2023	2036	2036
	P2G- Power to Gas Hydrogen	-	-	-	-	-	-	2036	-	-
Share of Sales Load in Renewables in 2037		3.7%	3.7%	3.7%	3.8%	4.2%	5.3%	21.0%	5.1%	4.4%
Share of Sales Emissions Reduced in 2037		16.8%	16.8%	16.8%	15.2%	18.9%	21.1%	38.7%	15.9%	20.1%
Metric Tons CO2e Reduced in 2037		787,999	787,999	787,999	809,791	787,999	809,791	1,306,650	846,635	787,999
Metric Tons CO2e Reduced Over 20 Year Horizon		3,301,058	3,101,547	3,301,058	3,479,989	3,328,308	15,221,541	13,216,113	4,238,085	2,802,975

TWG 6

RNG Results by Sensitivity

First Year RNG Resource Option Chosen	Supply Infrastructure Sensitivities			Economic Growth Sensitivities		Environmental Policy Sensitivities			
	Base Case - No New Regional Pipeline	New Regional Pipeline in 2025- Fully Subscribed	New Regional Pipeline in 2025- Excess Capacity	High Customer Growth	Low Customer Growth	Use Social Cost of Carbon in Resource Planning	Deep Decorbonization	CNG Adoption in Medium- and Heavy-Duty Transportation	New Direct Use Gas Customer Moratorium in 2025
RNG1- Off-System Landfill	-	-	-	-	-	-	-	-	-
RNG2- On-System Dairy	2029	2030	2029	2030	2029	2019	2021	2027	2031
RNG3- On-System WWTP	-	-	-	-	-	-	2034	2037	-
RNG4- On-System WWTP w/ RIN sales	-	-	-	2019	-	2019	2019	2019	-
RNG5- Off-System Dairy	2036	2036	2036	2036	2036	2019	2023	2036	2036
P2G- Power to Gas Hydrogen	-	-	-	-	-	-	2036	-	-
f Sales Load in Renewables in 2037	3.7%	3.7%	3.7%	3.8%	4.2%	5.3%	21.0%	5.1%	4.4%
Sales Emissions Reduced in 2037	16.8%	16.8%	16.8%	15.2%	18.9%	21.1%	38.7%	15.9%	20.1%
tric Tons CO2e Reduced in 2037	787,999	787,999	787,999	809,791	787,999	809,791	1,306,650	846,635	787,999
s CO2e Reduced Over 20 Year Horizon	3,301,058	3,101,547	3,301,058	3,479,989	3,328,308	15,221,541	13,216,113	4,238,085	2,802,975

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RNG Results by Sensitivity

		Supply Infrastructure Sensitivities			Economic Growth Sensitivities		Environmental Policy Sensitivities			
		Base Case- No New Regional Pipeline	New Regional Pipeline in 2025- Fully Subscribed	New Regional Pipeline in 2025- Excess Capacity	High Customer Growth	Low Customer Growth	Use Social Cost of Carbon in Resource Planning	Deep Decarbonization	CNG Adoption in Medium- and Heavy-Duty Transportation	New Direct Use Gas Customer Moratorium in 2025
First Year Renewable Resource Option Chosen	RNG1- Off-System Landfill	-	-	-	-	-	-	-	-	-
	RNG2- On-System Dairy	2029	2030	2029	2030	2029	2019	2021	2027	2031
	RNG3- On-System WWTP	-	-	-	-	-	-	2034	2037	-
	RNG4- On-System WWTP w/ RIN sales	-	-	-	2019	-	2019	2019	2019	-
	RNG5- Off-System Dairy	2036	2036	2036	2036	2036	2019	2023	2036	2036
	P2G- Power to Gas Hydrogen	-	-	-	-	-	-	2036	-	-
Share of Sales Load in Renewables in 2037		3.7%	3.7%	3.7%	3.8%	4.2%	5.3%	21.0%	5.1%	4.4%
Share of Sales Emissions Reduced in 2037		16.8%	16.8%	16.8%	15.2%	18.9%	21.1%	38.7%	15.9%	20.1%
Metric Tons CO2e Reduced in 2037		787,999	787,999	787,999	809,791	787,999	809,791	1,306,650	846,635	787,999
Metric Tons CO2e Reduced Over 20 Year Horizon		3,301,058	3,101,547	3,301,058	3,479,989	3,328,308	15,221,541	13,216,113	4,238,085	2,802,975

RNG Evaluation and Procurement Action Item

Use the methodology detailed in Appendix 10 to evaluate renewable natural gas resources against conventional sources based upon “all-in costs,” where all-in costs are defined as:

All-in costs = Net Present Value ([cost for delivered gas] +

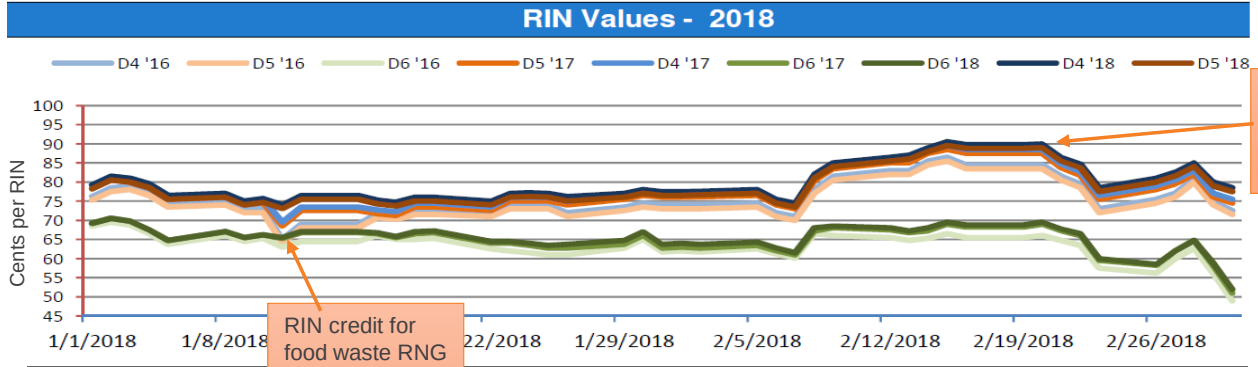
*[net GHG emissions intensity*Cost of GHG Emissions Compliance]*

– [avoided supply capacity costs] – [avoided distribution capacity costs])

Why Include a RNG Action Item?

- RNG has multiple stacked values; currently NWN has no way to bundle these stacked values into a clear offer to take to the market to procure RNG
- There are many RNG projects interested in securing long-term offtake agreements at prices far below RINs/LCFS/CFP credit prices
- There are finite RNG resources in Oregon; there are projects being developed today that may be cost-effective resources for our customers. Waiting to bring each project through an IRP process means we may lose access to the most cost-effective RNG resources. In order to provide our customers with the most cost-effective RNG resources NWN needs to be nimble and able to negotiate on price

RNG Market Driven by Transportation Policy



Transportation fuel credits for RNG: lucrative but volatile:

- Federal: Renewable Identification Number (RIN)
- California: Low-Carbon Fuel Standard (LCFS)
- Oregon: Clean Fuels Program (CFP)

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Why this RNG Action Item?

- The RNG options presented in the IRP are hypothetical resource options based upon general expectations about different types of potential RNG projects
- The proposed methodology would be used to evaluate specific low carbon resource projects on an apples-to-apples basis relative to conventional gas resources
- Using this methodology NW Natural can proactively approach RNG producers with terms and conditions that benefit customers
- Gives NW Natural an avenue to evaluate RNG projects as they arise in order to not miss out on cost-effective opportunities for customers

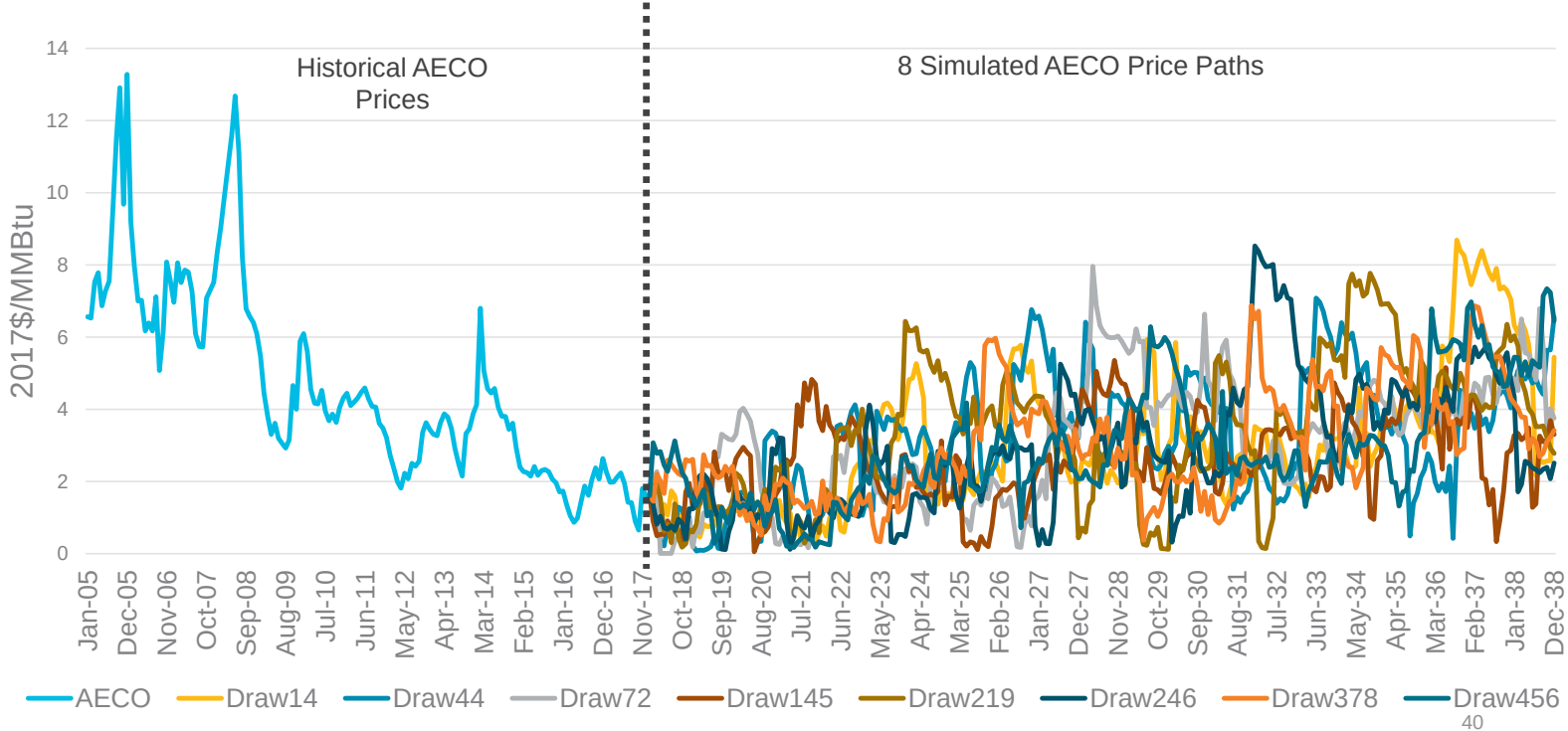
RNG Evaluation Methodology

RNG project evaluation should take relative risks into account given uncertainty in natural gas prices, potential compliance costs, weather and capital expenditures:

Methodology Mechanics:

1. Run deterministic and Monte Carlo simulations for 2 portfolios using supply resource planning model (SENDOUT):
   Simulation 1: Portfolio with proposed RNG project.
   Simulation 2: Portfolio without proposed RNG project
2. Compare cost distributions of the two portfolios using Risk-Adjusted Present Value of Revenue Requirement (rPVRR)
3. Determine the maximum risk-adjusted cost customers would be willing to pay for the RNG resource under consideration

Commodity Price Forecast Distribution (AECO)



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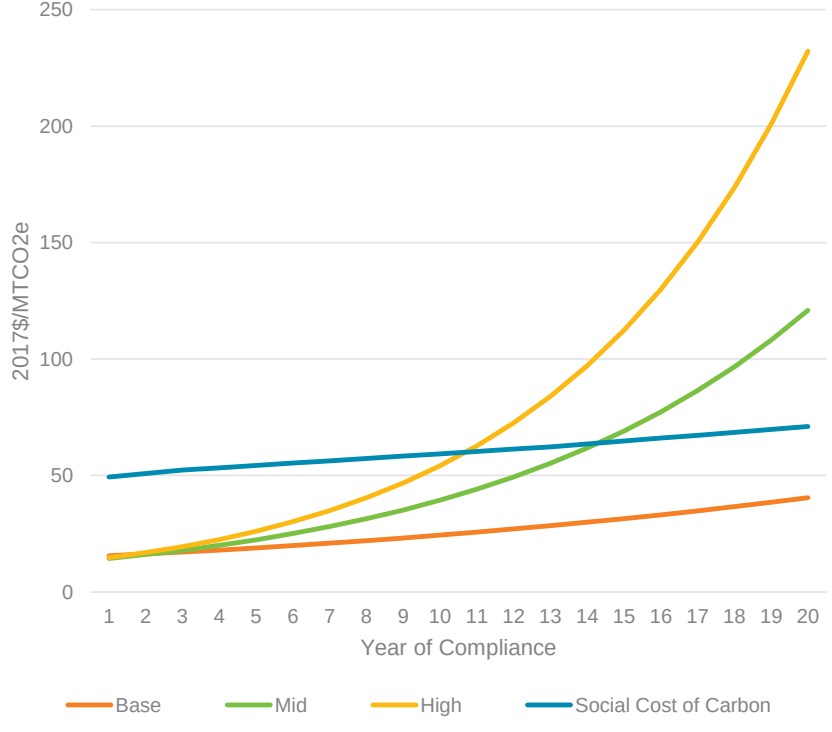
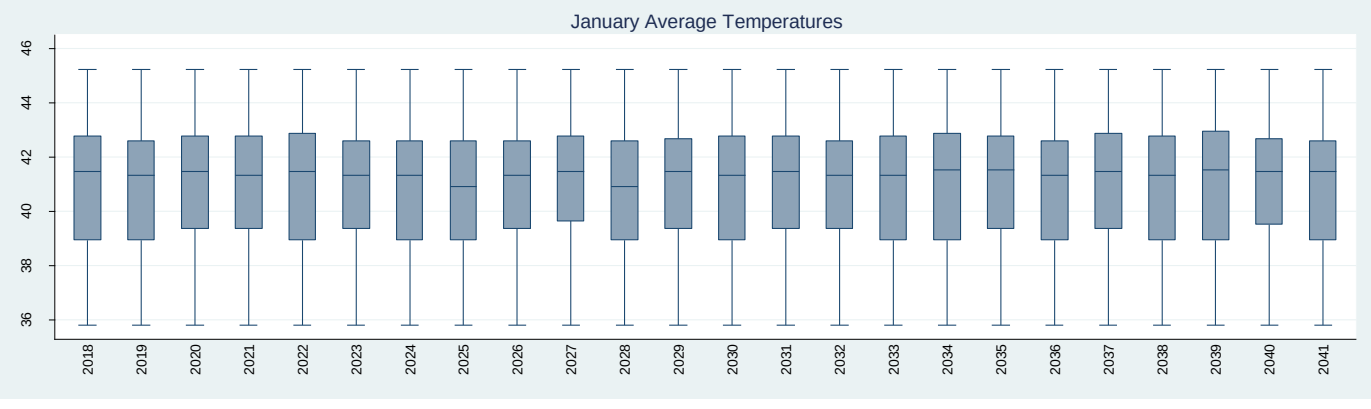
Compliance Cost Distribution



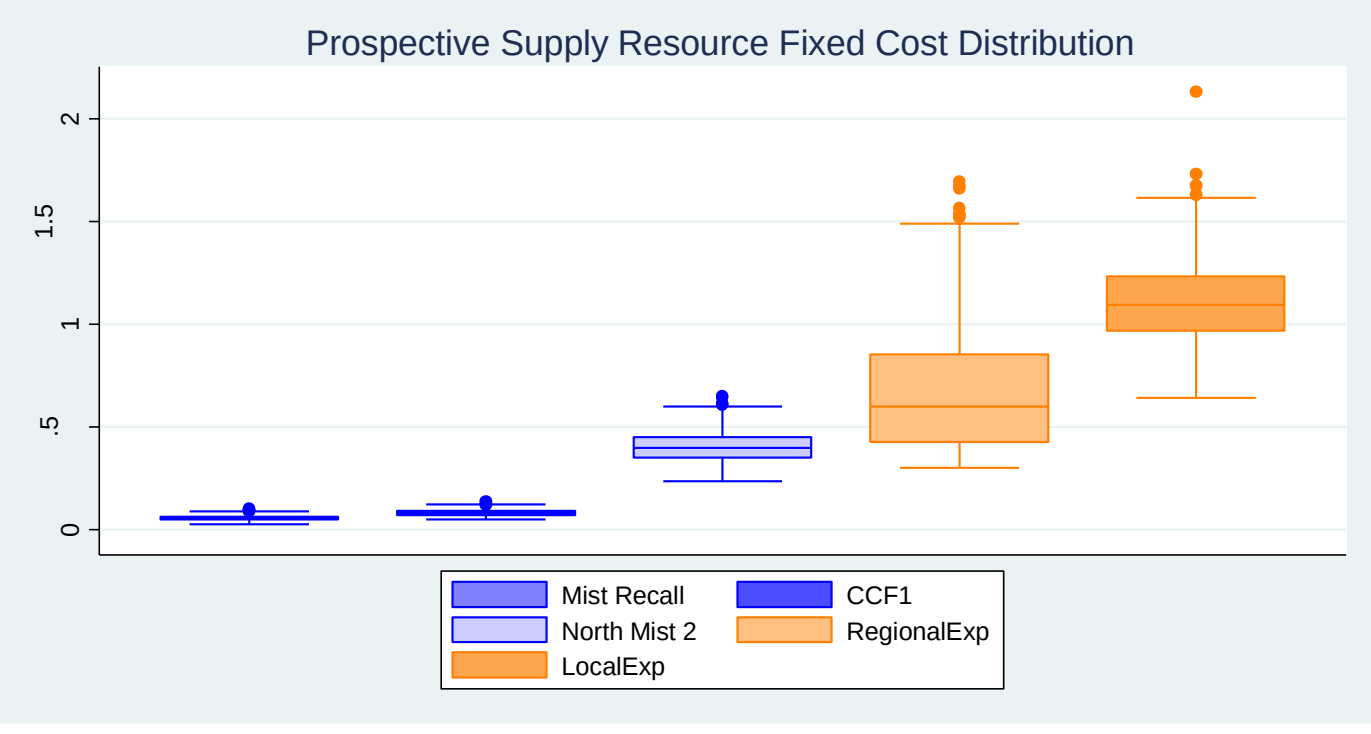
- Four possible compliance price paths
- Each path has an equal probability of occurring
- A carbon policy must start by January 2026, but has an equal probability of starting each year until 2026
- Once a policy starts it begins on this trajectory path starting at Year 1 cost levels
- For example, draw 246 chose the high sensitivity, but starts in 2024

Weather Distribution

Monthly daily temperature draws are created by randomly selecting a month of actual temperatures from a 35-year history



Resource Cost Distribution



On-system RNG vs. Off-system RNG

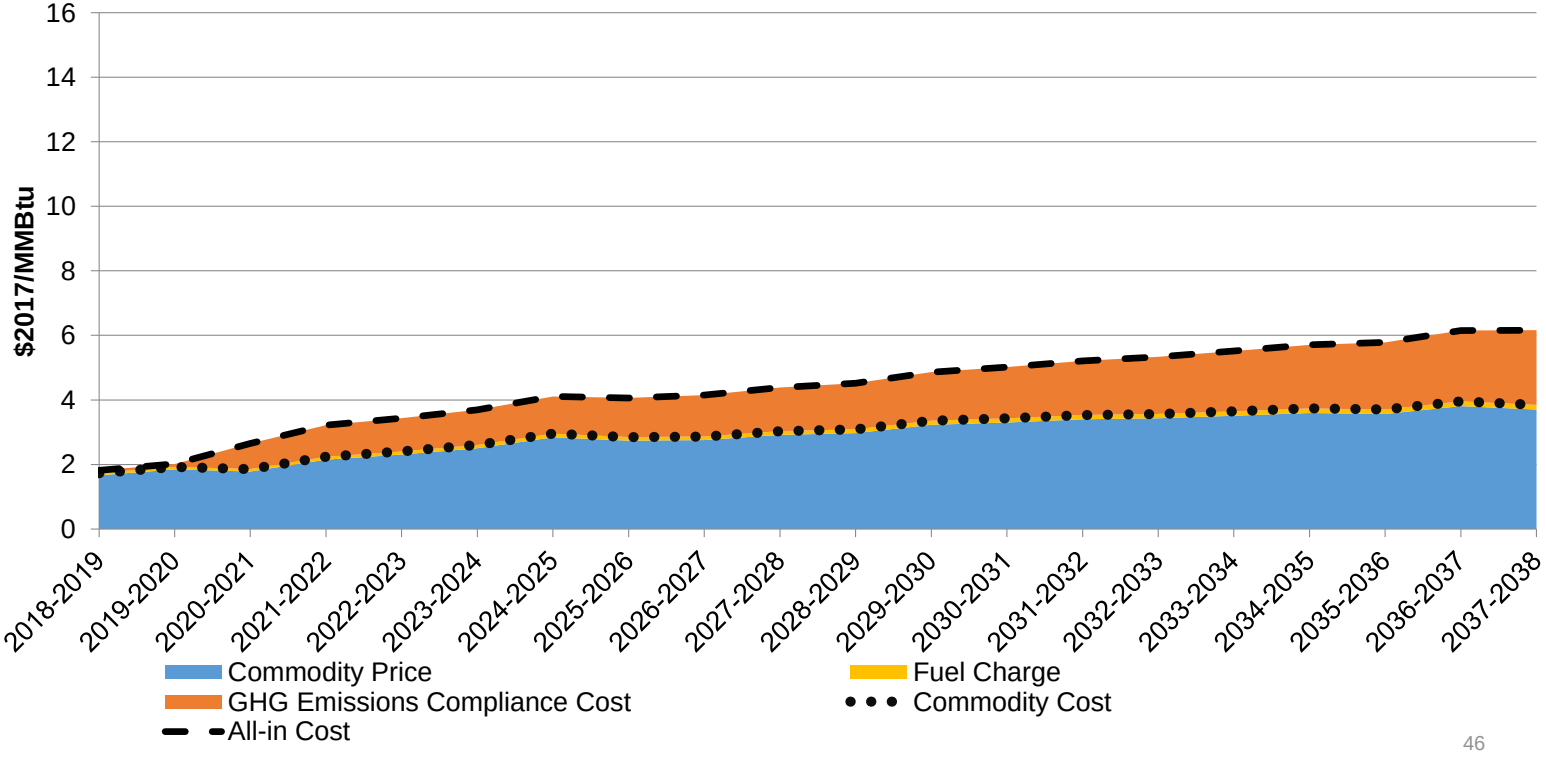
On-system RNG	Off-system RNG
Avoided costs • GHG Emissions Compliance costs • Supply capacity costs • Distribution capacity costs	Avoided costs • GHG Emissions Compliance costs
Shows up as a supply resource contributing to the peak supply portfolio	Does NOT contribute to peak supply portfolio
Injected on to the distribution system and can help prop up pressure along the distribution pipelines	Needs upstream pipeline capacity to bring the RNG to our system
Uses full equation to stack the benefits	Uses full equations, but: *avoided supply capacity costs = 0* *avoided distribution capacity costs = 0*

*NPV of All-in costs = Net Present Value ([cost for delivered gas] + [net GHG emissions intensity*Cost of GHG Emissions Compliance] – [avoided supply capacity costs] – [avoided distribution capacity costs])*

All-in Components

	All-in Component	Cost Calculation	Price Discovery
Cost for Delivered Gas	Commodity Contract Price	Project Specific	Varied for Price Discovery
	Levelized Capital Expenditures	Project Specific	Fixed Distribution
	Avoided Supply Capacity Cost	System-wide Calculation	Fixed Path Over Time
	Avoided Distribution Capacity Cost	State-wide Calculation	Fixed
GHG Emissions Compliance Cost	Carbon Intensity	Project Specific	Fixed
	Carbon Price	State-wide Calculation	Fixed Distribution

Conventional Gas All-in Cost



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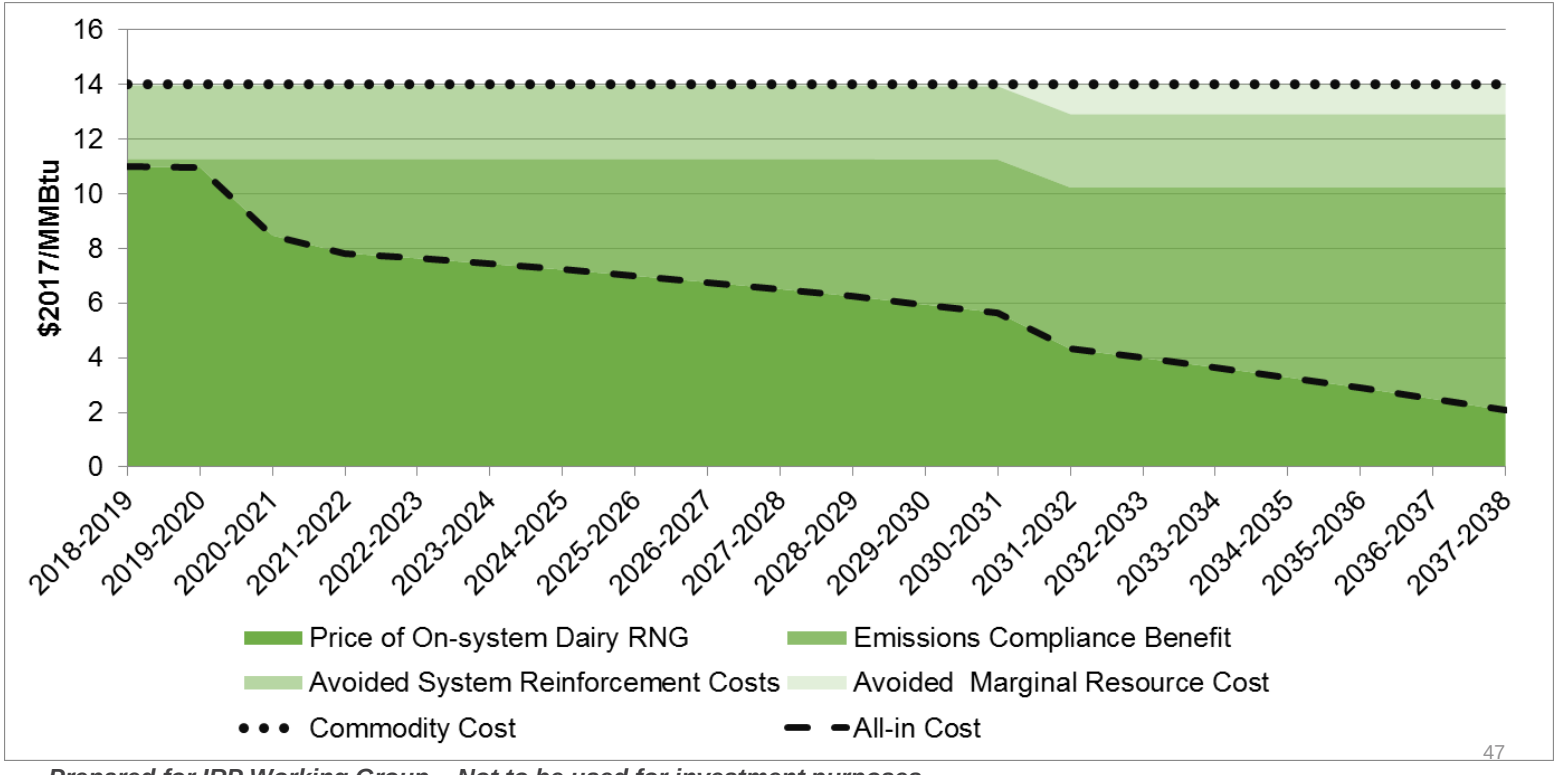
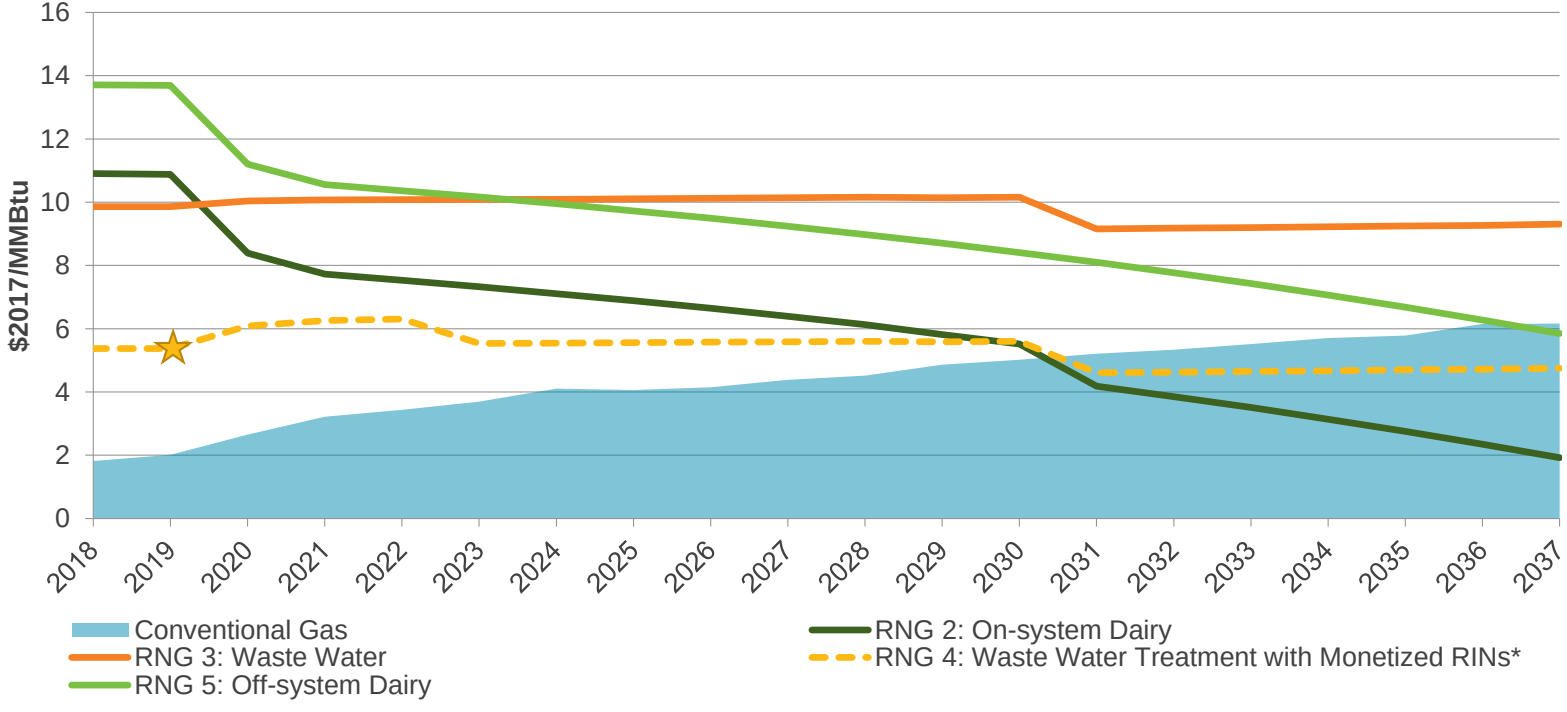
RNG 2 : On-system Dairy All-in Cost



All-in Gas Cost by Source



*RNG 4 option is only available if selected today in order to monetize the RIN value over the next 5 years and kept over the planning horizon. Other options are available at any time.

Risk-Adjusted NPV Average Cost

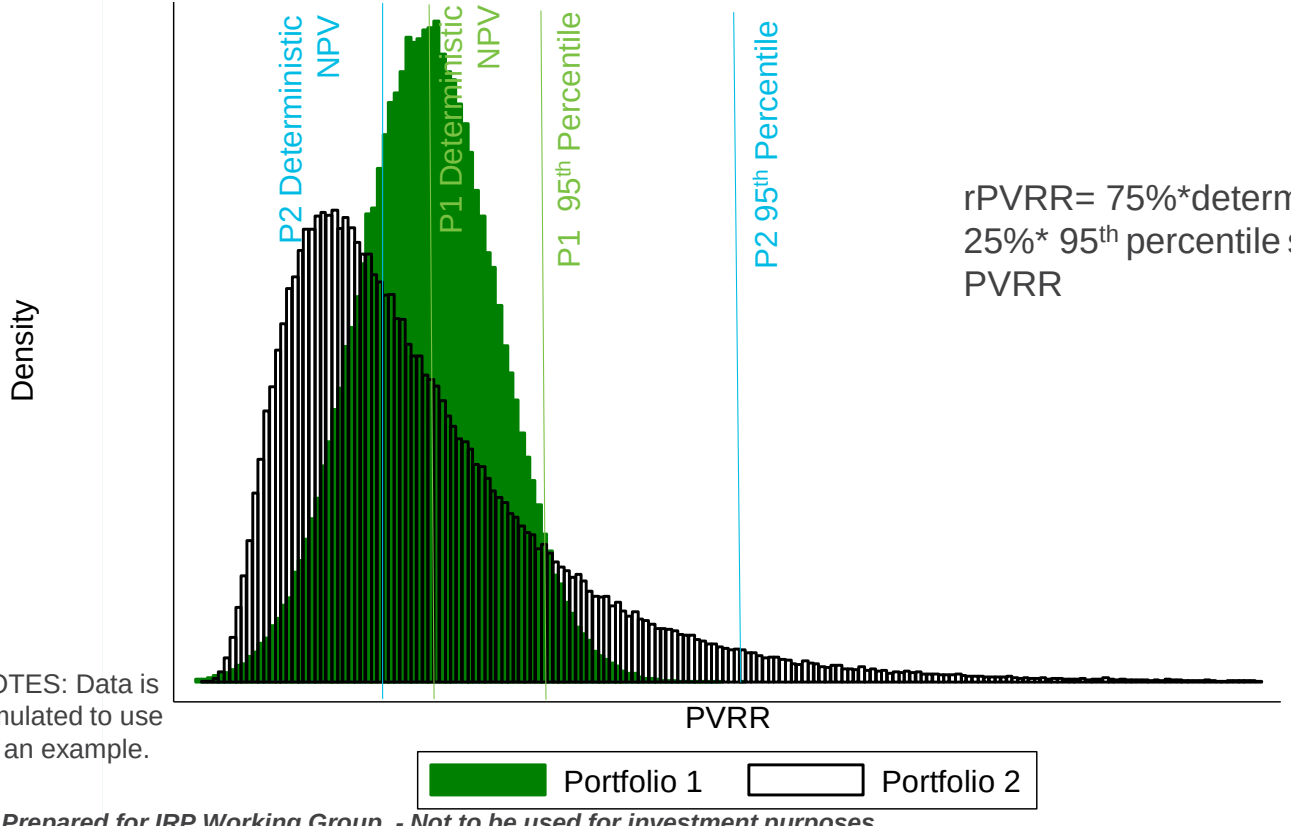
Each portfolio will have cost distribution from the Monte Carlo.

These distributions will be evaluated for both least cost and least risk based on the risk-adjusted PVRR.

Risk-adjusted PVRR (rPVRR)

$$rPVRR = 75\% * \text{deterministic PVRR} + \underbrace{25\% * 95^{th} \text{ percentile stochastic PVRR}}_{\text{Risk Premium}}$$

Risk-Adjusted NPV Average Cost



rPVRR= 75%*deterministic NPV+ 25%* 95th percentile stochastic PVRR

NOTES: Data is simulated to use as an example.

ATTACHMENT B

RNG EVALUATION PROCESS

1. NW NATURAL RENEWABLE NATURAL GAS (RNG) PROJECT EVALUATION PROCESS