APPENDIX H

RENEWABLE GAS SUPPLY RESOURCE EVALUATION METHODOLOGY

1. PURPOSE AND OVERVIEW

This appendix details and expands upon the analysis included in Chapter 7 of the IRP and presents an application of the existing least-cost/least-risk resource planning framework to evaluate low carbon gas resources on an apples-to-apples basis against conventional gas resources. As stated in NW Natural's Action Plan, the Company is seeking acknowledgment to use this methodology to evaluate, and if supportable, secure potential RNG resources.

Enabled by new information and expertise gained since completing its 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/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.

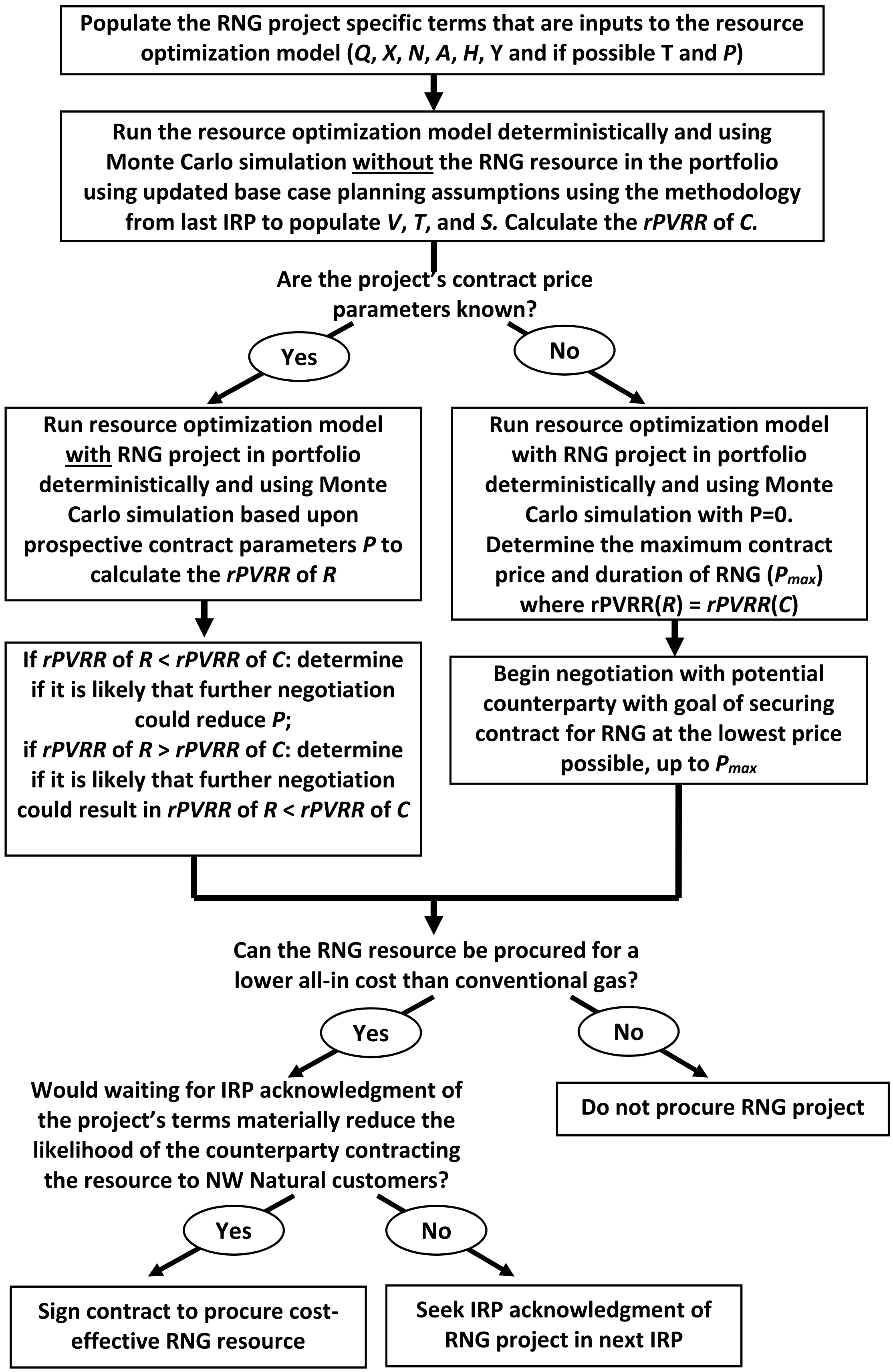
The methodology and process presented in this Appendix is meant to be flexible so that as new policies are enacted they can be incorporated into the analysis. While the RNG resources evaluated in the 2018 IRP are representative projects rather than actual resource options, their parameters are based upon the best available information and show RNG resources have the potential to be cost-effective resources for customers in both the near and long-term. This result – and the potential for missed opportunities to procure cost-effective RNG resources for our customers – serves as the motivation for the inclusion of Action Item 2 in the 2018 IRP.

The following represents the methodology and procurement process of which NW Natural is seeking acknowledgment:

- NW Natural Renewable Natural Gas Project Evaluation and Procurement Process;
- NW Natural Renewable Natural Gas Project Evaluation Criteria and Calculations;
- NW Natural Renewable Natural Gas Project Evaluation Component Descriptions; and
- NW Natural Renewable Natural Gas Project Evaluation Component Definition Fill-in Sheet

The remainder of this Appendix (Sections 2 through 6) provides a detailed explanation of terms and the rationale for the proposed evaluation process.

NW Natural Renewable Natural Gas Project Evaluation and Procurement Process



NW Natural Renewable Natural Gas Project Evaluation Criteria and Calculations

Annual all-in cost of RNG (R) =
Cost of methane (M) + Emissions compliance costs (E) – Avoided infrastructure costs (I)

Or: $$R_T = M_T + E_T - I_T$$

Where:

$$M_T = X_T + \sum_{t=1}^{365} [P_{T,t} + Y_{T,t}^{RNG}] Q_{T,t}$$

$$E_T = \sum_{t=1}^{365} N^{RNG} G_T Q_{T,t}$$

$$I_T = S_T A_T + DH_T$$

Substituting leaves the annual all-in cost of RNG as:

$$R_T = X_T - S_T A_T - DH_T + \sum_{t=1}^{365} \left[P_{T,t} + Y_{T,t}^{RNG} + N^{RNG} G_T\right] Q_{T,t}$$

Where the annual all-in cost of the conventional natural gas alternative (C) is:

$$C_T = \sum_{t=1}^{365} \left[V_{T,t} + Y_{T,t}^{CONV} + N^{CONV} G_T\right] Q_{T,t}$$

The present value of revenue requirement of all relevant years is used for evaluation where:

$$PVRR(R) = \sum_{T=k}^{T=k+z} \frac{R_T}{[1+d]^T}$$

$$PVRR(C) = \sum_{T=k}^{T=k+z} \frac{C_T}{[1+d]^T}$$

This is risk-adjusted to account for uncertainty in long-term forecasting where:

$$rPVRR(R) = 0.75 * \text{deterministic } PVRR(R) + 0.25 * \text{95th Percentile Stochastic } PVRR(R)$$

$$rPVRR(C) = 0.75 * \text{deterministic } PVRR(C) + 0.25 * \text{95th Percential Stochastic } PVRR(C)$$

The RNG project is a least cost/least risk resource to acquire if:

$$rPVRR(R) \leq rPVRR(C)$$

NW Natural Renewable Natural Gas Project Evaluation Component Descriptions

Term	Units	Description	Source	Project Specific?	Input or Output of Optimization?	Treated as Uncertain?
R	$/Year	Annual all-in cost of prospective renewable natural gas (RNG) project	Output of RNG evaluation process	Yes	Output	Yes
C	$/Year	Annual all-in cost of conventional natural gas alternative	Output of RNG evaluation process	Yes	Output	Yes
M	$/Year	Annual costs of natural gas and the associated facilities and operations to access it	Output of RNG evaluation process	Yes	Output	Yes
E	$/Year	Annual greenhouse gas emissions compliance costs	Output of RNG evaluation process	Yes	Output	Yes
I	$/Year	Annual infrastructure costs avoided with on-system supply	Output of RNG evaluation process	Yes	Output	Yes
Q	Dth	Expected or contracted daily quantity of RNG supplied by project	Project evaluation or RNG supplier counterparty	Yes	Input	If no contractual obligation
P	$/Dth	Contracted or expected volumetric price of RNG	Project evaluation or RNG supplier counterparty; Max cost-effective price determined in SENDOUT if NWN initiating negotiations	Yes	Input if responding to offer, Output if NWN making offer	If no contractual obligation
T	Year	Year relative to current year, where the current year T = 0, next year T = 1, etc.	Project evaluation or RNG supplier counterparty	Yes	Input if responding to offer, Output if NWN making offer	If no contractual obligation
k	Year	When the RNG purhcase starts in # of years in the future; k = RNG start year - current year	Project evaluation or RNG supplier counterparty	Yes	Input if responding to offer, Output if NWN making offer	If no contractual obligation
z	Years	Duration of RNG purchase in years	Project evaluation or RNG supplier counterparty	Yes	Input if responding to offer, Output if NWN making offer	If no contractual obligation
t	Days	Day number in year ***T*** from 1 to 365	N/A	No	Input	No
V	$/Dth	Price of conventional gas that would be displaced by RNG project	Average price of last ***Q*** quantity of conventional gas dispatched in SENDOUT run without RNG project	Yes	Output	Yes
Y	$/Dth	Variable transport costs to deliver gas to NWN's system	*For off-system RNG* - based upon geographic location of project; *For conventional gas* - determined from last gas dispatched in SENDOUT	Yes	Output	No
X	$/Year	Annual revenue requirement of capital costs to access resource	Engineering project evaluation or RNG supplier counterparty	Yes	Input	If no contractual obligation
N	TonsCO_2e /Dth	Greenhouse gas intensity of natural gas being considered	From actual project certification if available, from California Air & Resources Board by biogas type if no certification has been completed	Yes	Input	No
G	$ /TonCO_2e	Volumetric Greenhouse gas emissions compliance costs/price	Expected greenhouse gas compliance costs from the most recently acknowledged IRP	No	Input	Yes
S	$/Dth	System supply capacity cost to serve one Dth of peak DAY load	Calculated within SENDOUT based upon marginal supply capacity resource that is being deferred using Base Case resource availability from the last IRP	No	Output	Yes
A	Dth	Minimum natural gas supplied on a peak DAY by project	Project evaluation or contractual obligation from RNG supplier counterparty	Yes	Input	If no contractual obligation
D	$/Dth	Distribution system capacity cost to serve one DTH of peak HOUR load	Distribution system cost to serve peak hour load from avoided costs in most recently acknowledged IRP	No	Input	No
H	Dth	Minimum natural gas supplied on a peak HOUR by project	Project evaluation or contractual obligation from RNG supplier counterparty	Yes	Input	If no contractual obligation
d	% rate	Discount Rate	Discount rate from most recently acknowledged IRP	No	Input	No

NW Natural Renewable Natural Gas Project-Specific Component Definition Fill-In Sheet

Term	#	Question	Project Parameter	
Q: RNG Output	1	How much RNG is the project expected to sell to NW Natural annually?		Dth
	2	Is this volume expected to vary by season, day of the week, or any other factor? If so, provide the expected variation on a separate spreadsheet		
	3	Is there a minimum daily, monthly, or annual quantity included/expected to be included in the prospective contract? If so, what is the minimum daily volume?		Dth per
T: Timing of RNG Purchase	4	Is the duration and timing of the RNG purchase known?		
	5	If Yes, when does the RNG purchase begin?	Date	
	6	If Yes, when does the RNG purchase end?	Date	
	7	If No, when does the RNG purchase begin?	Date	
P: Price of RNG	8	Is the volumetric pricing arrangement for the RNG known?		
	9	If Yes, and it is it a fixed price arrangement, what is the proposed price NW Natural will pay for the RNG? If fixed, but varying through time attach separate spreadsheet and enter average for duration of contract to the right:	$	per Dth
	10	If Yes and it is not a fixed price arrangment, please provide the formula for pricing on a separate spreadsheet and enter average expected price for the duration of the contract to the right:	$	per Dth
X: Required Capital Investment	11	What (if any) is the total annual revenue requirement of any equipment and facilities in which NW Natural needs to invest to access the RNG from the project?	$	per Year
	12	If there is a fixed non-volumetric payment to the RNG supplier as part of the contract, what is the annual payment?	$	per Year
N: GHG Emissions Intensity	13	If the project has already been assessed a greenhouse gas intensity from the EPA or ODEQ, what is the carbon intensity of the RNG?		Metric Tons CO2e/Dth
	14	If the project has not already been assessed a carbon intensity, what is the average GHG intensity for the projects biogas type from the Low Carbon Fuel Standards work done by the California Air & Resources Board		Metric Tons CO2e/Dth
On-System?	15	Will the project inject the RNG onto NW Natural's distribution system?		
	16	Where will NW Natural take custody of the RNG?		
		If the answer to *Question 15* is **YES** fill-in **Zero** on *Question 17*		
Y: Variable Transport	17	What are the total variable volumetric transport charges that would be required to bring the off-system RNG to NW Natural's system?	$	per Dth
		If the answer to *Question 15* is **NO** fill in **Zero** for the remaining questions		
A: Peak Day Supply	18	What is the mininum daily amount of methane the project would inject into NW Natural during a cold weather event?		Dth per Day
	19	Is this amount a contractual obligation?		
H: Peak Hour Supply	20	What is the minimum amount of methane the project would inject into NW Natural's system during the 7am hour of a cold weather event?		Dth per Hour
	21	Is this amount a contractual obligation		

2. WHY SEEK ACKNOWLEDGMENT OF A METHODOLOGY?

This section provides background on the salient factors driving the RNG market today as well as an explanation for why NW Natural would need to be able to make decisions on RNG projects along a timeframe more compressed and uncertain than the biennial schedule of IRPs. It is preferred by NW Natural that RNG opportunities be reviewed on a project-by-project basis through the IRP process. However, RNG market characteristics dictate that waiting for IRP acknowledgement for specific projects may lead to lost cost-effective RNG procurement opportunities for NW Natural's customers. Consequently, NW Natural is seeking acknowledgement of an evaluation methodology and process that would allow us to use the key assumptions detailed and reviewed in the most recent IRP to evaluate and procure cost-effective RNG within a timeframe acceptable to RNG suppliers.

2.1 The Current Market for RNG

The RNG market has seen tremendous growth over the past few years, due mostly to the strong economic incentive associated with developing RNG for use in the CNG market. Under a federal program (the Renewable Fuel Standard) and two state programs (California's Low-Carbon Fuel Standard and Oregon's Clean Fuels Program) RNG resources that are ultimately sold for use in CNG vehicles can command prices much higher than that of conventional natural gas. Under these programs, parties with compliance obligations, including petroleum product refiners and producers, purchase the credits (the "green attributes" of the renewable resource) to meet annual obligations set by the program administrators.

To illustrate the significance of these credit values to the RNG industry, Figure H.1 below shows the trend in the value of credits derived from dairy-based RNG sold into the California market for CNG vehicle fuel. In 2015 the average value for such a credit was $23.20 per MMBtu-equivalent sold. The value of these credits has steadily risen in the past few years, and currently is trading near historically peak prices. Throughout June 2018, the value of the credits continued to rise, reaching $69/MMBtu-equivalent. This credit is one component of the overall revenue stream available to RNG sold into the market today, and would be coupled with both a revenue associated with the federal Renewable Fuel Standard as well as the sale of the underlying gas commodity.

Figure H.1: Historical dairy-based RNG Low-Carbon Fuel Standard credit value

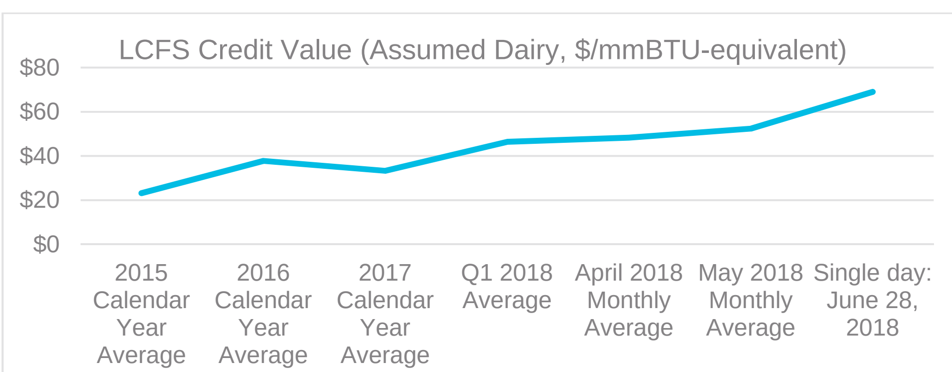


Figure data source: California Air Resources Board

It is clear that the value of selling RNG into these markets is significant. However, these markets are highly volatile and the value of credits can change dramatically from day to day. For instance, Figure H.2 shows 14 different individual trades within the Low-Carbon Fuel Standard over the course of five days in June 2018. One contract traded at $37.41/MMBtu-equivalent price, while another the day before traded at $68.09/MMBtu-equivalent. Additionally, all of these environmental credit programs are potentially subject to political changes and are not guaranteed in perpetuity.

Figure H.2: Low Carbon Fuel Standard Credit 5 Day Trading Value

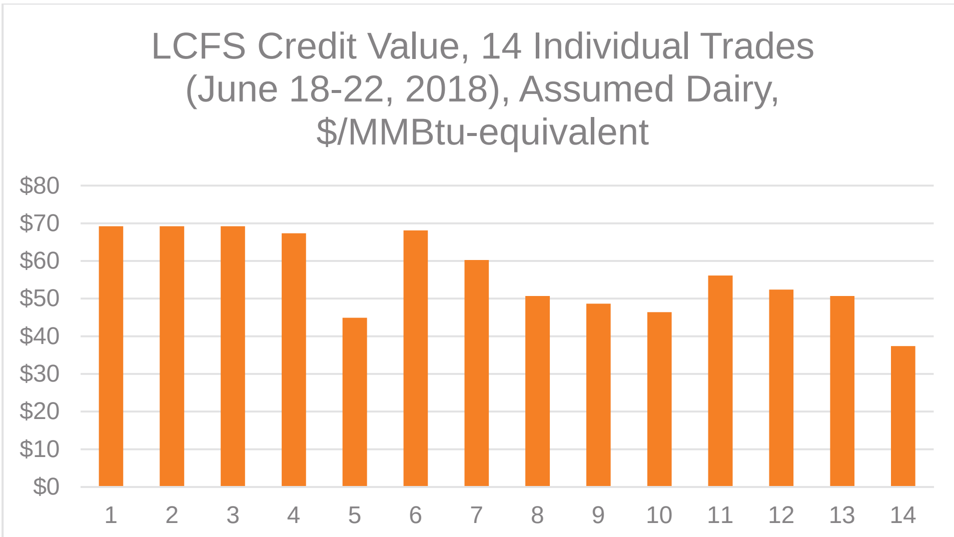


Table data source: California Air Resources Board

A typical contract structure for these environmental credits will be a multi-year (1-3 years) off-take by a party that is obligated to acquire these credits within the program. Payment under these contracts will typically be some percentage of the credit trading price, adjusted to reflect daily or monthly trading values. The longer the contract term, the lower the percentage paid to RNG producers, to reduce the exposure of the obligated parties to rising credit prices.

These wide variations in credit value and the risk that these programs are not renewed mean that many RNG producers are interested in hedging their bets on environmental credit markets and reducing their risk exposure. Thus, many are interested in securing long-term contracts for all or part of their RNG, perhaps after a period during which they hope to benefit from high credit prices. For instance, NW Natural has observed RNG projects that enter into an off-take for environmental credits at 80% of the credit value price over three years, and then in year four enter into contracts with a guaranteed floor price that is well below the trading price of the credits.

Despite the environmental credit volatility and inherent risk in investing in major capital projects predicated on future political support of the programs, the RNG industry has seen rapid growth in the last few years, and especially the last year. The environmental credits available to RNG project developers have been significant enough to drive major capital investment around the country. Between 1982 and 2014, 41 individual RNG projects were built in the U.S. and Canada. Today there are 77 RNG projects operating in the U.S. and Canada, with at least 40 additional projects now in development. The environmental credits available to RNG projects are the clear driver for this tremendous growth, and have helped the RNG market both grow and mature significantly in recent years. This growth and maturation is reflected in the different treatment of RNG in this IRP compared to the IRP developed just two years ago.

2.2 The Need for a Flexible RNG Procurement Process

As the RNG market grows and develops, the markets for gas purchases and environmental credit purchases are becoming more sophisticated. RNG producers typically ask for bids from a variety of potential RNG and environmental credit purchasers as the project is being developed, before the project is operating but after the projected volume and carbon intensity of the gas has been finalized. They then consider the multiple bids received during one “off-taker” contract evaluation process. A typical time period between when a request for bid is issued and when the offers are evaluated is about 30-60 days. This means that for any given RNG project, there is a short window during which any bid to purchase the RNG produced will be evaluated. RNG producers will evaluate the risk, revenue opportunities, and other characteristics of each bid during that time. As NW Natural considers its interest in potentially acquiring RNG for our customers, we recognize that there are regional RNG projects that will ask us to bid for their RNG within such a window. Indeed, NW Natural has already been approached by several Oregon-based RNG project developers to indicate our interest in offering a bid for the RNG from projects they are developing.

To date we have only offered the price we pay for conventional gas resources to RNG project developers given the uncertainty in the prudency criteria for evaluating on-system and/or lower carbon intensity sources of natural gas. This lower price is usually of little interest to RNG project developers who can command ten times – or greater – that price in the current market. The work in this IRP shows that NW Natural could pay more for RNG than the price of conventional natural gas depending on its carbon intensity and whether it would be injected directly into our distribution system grid, though the cost-effective price for NW Natural customers is still much below what can be obtained in the transportation incentive market in the near term. However, after about 2021, when the uncertainty around incentives in the transportation market grows, RNG suppliers may find the price shown as cost-effective by the methodology laid out in this Appendix to be high enough to make sense to them on a risk-adjusted basis.

An approach that allows NW Natural to apply this methodology on a project-specific basis by evaluating the volume, carbon intensity, location, and other aspects of in-development RNG resources to quickly determine the price we could pay for such resources would allow us to adequately respond to requests for offers to bid for RNG and potentially be competitive to procure the renewable resources our customers prefer at a lower expected price than conventional gas resources. The methodology discussed herein would establish a “ceiling” price, reflecting the highest price we could pay before the RNG becomes not cost-effective for our customers. However, NW Natural recognizes its duty to procure resources for its customers at the lowest price possible, so we would offer/bid a price lower than the ceiling price if we believe that price may be attractive to the RNG producer.

As new RNG projects are developed, NW Natural will need to be nimble to act on potential opportunities to procure RNG. As a practical matter, the Company will need to make decisions at the pace that the RNG market dictates, which is likely faster than the Company could bring individual projects for acknowledgment in the IRP. As a result of these market dynamics, NW Natural is proposing to utilize this methodology and process plan to evaluate projects so that the Company can quickly respond to potential cost-effective resources. In the event that our methodology or process changes, the Company will update the Commission so that there is full transparency into our decision-making process around these resources.

2.3 Potential Contract Structures

RNG producers could potentially benefit from setting up a fixed price contract to sell their gas to NW Natural, especially for producers – such as publicly-owned entities – that are trying to reduce their overall risk exposure in their RNG project development. These contracts can take several different forms and will be unique to each project. For example, an RNG producer may wish to interconnect with NW Natural's distribution system to take advantage of the lucrative RIN market. As long as this producer is participating in the RIN market, and selling to CNG vehicles somewhere in the U.S., NW Natural does not receive the green attributes associated with the RNG. The RNG producer may wish to plan to sell into the RIN and LCFS credit markets for four years. However, beginning in year five, they may wish to "lock in" a long-term fixed-price contract that is not susceptible to the volatility of the environmental credit markets. NW Natural could offer a long-term fixed price contract for delivery of RNG beginning in Year 5, at which point the RNG producer would sell the RNG – including all of its environmental attributes – to NW Natural. NW Natural would then claim the emissions savings associated with that project's RNG production. A fixed price contract can offer price certainty for these producers, while providing a low-carbon intensive resource for NW Natural's customers.

3. "ALL-IN" COST COMPONENTS

The all-in cost refers to the total cost to deliver a unit of natural gas to a customer on the Company'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. The calculation for all-in costs that is provided in Section 1, where this section will describe in more detail the components that make up the all-in cost of gas for both RNG and the conventional gas alternative. This section is organized into three subsections based upon the three broad components that make up all-in costs (commodity costs, infrastructure costs, and emissions compliance costs) and details all the components in the equations in Section 1.

3.1 Cost of the natural gas Commodity (Methane (M))

For the conventional natural gas alternative, this is the price of natural gas (***V***) plus the variable costs associated with transporting the gas to the Company's pipeline network (Y^{CONV}).[1] The variable costs are quite small relative to the price of natural gas paid at the supply basins where NW Natural purchases gas and include variable payments to interstate pipeline operators and line losses" (the amount of gas that is used to deliver gas from where it is purchased to where it is consumed by a NW Natural customer).

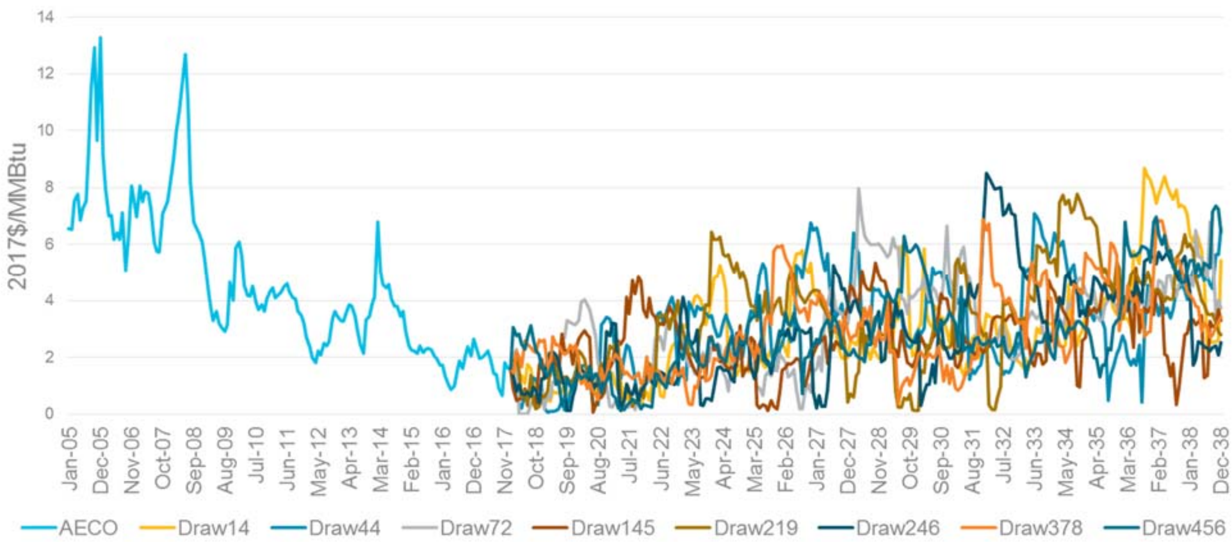
$$M_T^{CONV} = X_T + \sum_{t=1}^{365} [V_{T,t} + Y_{T,t}^{CONV}] Q_{T,t}$$

On any given day (***t*** in Year ***T***) in the timeframe over which the RNG project is expected to be part of NW Natural's gas supply the gas and transport costs of the conventional alternative represent the average cost of the last (***Q***) units of gas expected to be procured during that particular day,[2] as this is the amount of gas that would be displaced if the RNG project were in the portfolio. This daily gas price and the associated transport costs come from the SENDOUT® optimization run without the potential RNG project in the portfolio and are therefore the result of production cost modeling dispatch. These units of potentially displaced gas are from a spot purchase at one or more of the supply hubs NW Natural purchases gas or from a storage withdrawal (or a combination thereof) depending on the load that needs to be served and gas prices on that day (and throughout the year).

The deterministic resource optimization run for this evaluation will use the most recent forecast from NW Natural's third party consultant. Additionally, given that gas prices are uncertain they are varied in the risk analysis. As such, the process to determine the commodity costs of the conventional alternative will use the Monte Carlo simulation process presented in Chapter Seven. Figure H.4 shows eight representative stochastic draws for AECO gas prices. Simulations for weather, resource costs, and GHG compliance costs as described in Chapter Seven are also applied within this methodology and will impact the commodity portion of the conventional gas alternative's costs in each of the draws in the simulation.

[1] Variable costs for transporting gas on interstate pipelines include fuel charges and variable charges. For example, NW Pipelines charges 1% in fuel charges and 0.8 cents ($0.008) per dekatherm in variable charges. In comparison these variables costs are very small compared to the commodity cost.
[2] Which by cost minimization protocols is the most expensive unit of gas purchased that day

Figure H.4: Stochastic Commodity Price Forecast (AECO)



For the prospective RNG project the commodity cost portion of all-in costs is more complex and may be unknown when beginning the analysis process. If it is known (the typical situation for this would be NW Natural responding to a contract offer) each of the components that make up the commodity cost portion of all-in costs will be inputs to the optimizations described in the next section. More likely, however, these costs will be unknown (the typical situation when NW Natural is responding to a bid solicitation or is approaching a biogas supplier with an offer for RNG), making the process more involved. In this case the primary purpose of the analysis is to determine the breakeven RNG commodity price where the prospective renewable project becomes more expensive than the conventional gas alternative- i.e. to determine the maximum price where RNG is a least-cost/least risk resource for customers ($\boldsymbol{P^{MAX}}$).

$$\boldsymbol{M_T^{RNG} = X_T + \sum_{t=1}^{365} [P_{T,t} + Y_{T,t}^{RNG}] Q_{T,t}}$$

Additionally, for RNG projects the total commodity costs (***M***) can also include the net revenue requirement associated with constructing and maintaining the equipment owned by NW Natural that allows the project to be accessed and connected to the Company's system (***X***) in addition to the RNG commodity contract price (***P***). While for on-system RNG equipment will always be necessary to process, connect, and inject RNG into our distribution system, NW Natural could own all, part, or none of that equipment depending on the arrangement. Typically, when this equipment is owned and operated by the counterparty these costs will be included in the commodity price of RNG, whereas it will need to be added if there is additional revenue requirement from NW Natural ownership and maintenance of assets to access the RNG. In addition to the capital outlay, variable costs (e.g., O&M expenses), financing costs, taxes and other loadings are incorporated into a net annual revenue requirement that is levelized over an asset's depreciable life.

The contract price for the RNG commodity could take many different forms as it could be fixed over some time frame (be it monthly, yearly, or multiyear), determined by a formula, a combination of both, and many other setups.

Additionally, if the prospective RNG project will not be injecting gas directly onto NW Natural's distribution system it is necessary to utilize the Company's interstate pipeline capacity to bring the gas to our system. In this case, the RNG project will have variable transport costs ($\boldsymbol{Y^{RNG}}$), where the exact amount is dependent upon the location NW Natural will need to transport the gas from.

3.2 Emissions Compliance costs (or benefits)

The per unit emissions compliance costs are net GHG emissions intensity (***N***) multiplied by the cost of GHG emissions compliance (otherwise referred to as the "carbon price") (***G***).

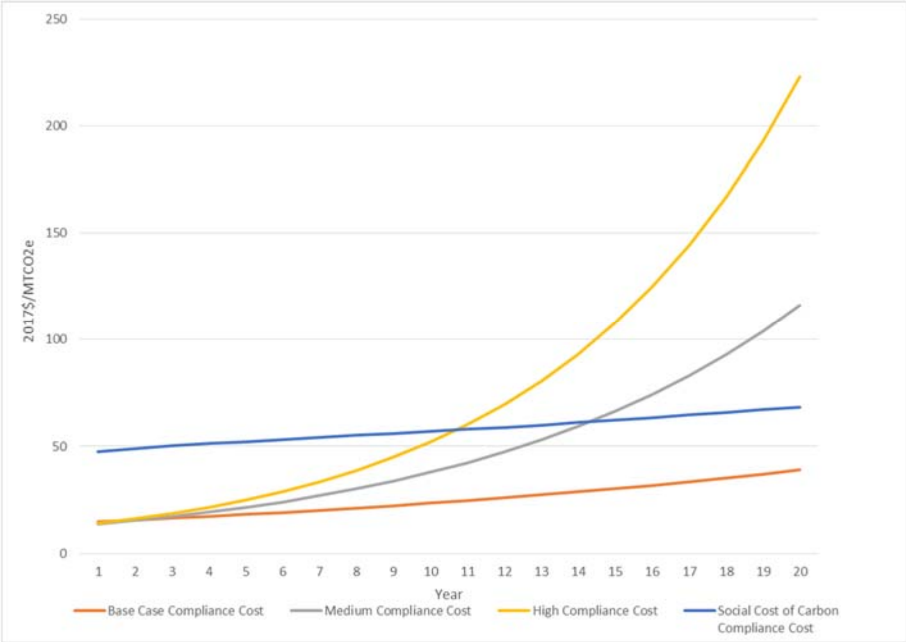
$$\boldsymbol{E_T = \sum_{t=1}^{365} N G_T Q_{T,t}}$$

The policy driven expected emissions compliance price (***N***) is constant across all sources of gas, though can vary through time. For the deterministic case the base case carbon price from the previous IRP will be used (as is detailed in Chapter Two in the 2018 IRP). There is currently significant uncertainty about what emissions compliance costs will be for the direct use of natural gas going forward, though there is a growing likelihood that both states will implement GHG reduction policies that include compliance obligations for natural gas LDCs. However, the policy tool is currently unknown and even if a policy is implemented the actual compliance price in any given year may not be known.

The Company will take the same approach as presented in Chapter Seven where the carbon price is an input into the stochastic modeling when the price is uncertain. The distribution of potential carbon prices is based on four potential carbon price paths shown by Figure H.5. Three of the paths are based on forecasts from the California Energy Commission and the fourth is the social cost of carbon.[3] Forecasting both the type of policy and timing of the policy is very difficult and uncertain. In order to model this for the stochastic analysis the simulation creates 500 draws from these possible paths.

[3] The social cost of carbon price forecast is pulled from EPA's-mid price of the social cost of carbon based on a 2% discount rate. The three ramping price paths are allowance price forecasts for the cap-and-trade market administered under the California Air and Resource Board. Low, medium and high forecasts are produced by the California Energy Commission through 2030. The low price path is used for the Company's base case assumptions.

Figure H.5 Potential Carbon Price Paths



Each path has an equal probability of occurring. The policy must start by January of 2026, but has an equal probability of starting each year leading up to 2026. Once a policy starts it begins on the trajectory path starting as year 1 cost levels.

The carbon intensity (***N***), on the other hand, will vary between the prospective RNG project and the conventional alternative. Furthermore, there is substantial difference in carbon intensities across RNG resources. The carbon intensities presented in Chapter Six and Seven are average intensities published by the California Air and Resource Board (CARB) for different types of RNG resources. When RNG producers choose to sell credits into the federal or state-level programs, they must have their carbon intensity verified by the administrating agency. Depending on the credit market, this will include the U.S. Environmental Protection Agency, the California Air Resources Board, or the Oregon Department of Environmental Quality. These agencies all have extensive processes for reviewing and vetting an individual project's carbon intensity. NW Natural will use the verified carbon intensity evaluation of the potential project if available. The Company will then use these site-specific carbon intensities to calculate the emissions compliance cost, which is a negative cost for sources with negative carbon intensities. If these carbon intensities have not been previously developed, the Company will refer to the Oregon Department of Environmental Quality, which administers the Oregon Clean Fuels Program, for assistance in identifying the most appropriate carbon intensity value to use.

3.3 Avoided Infrastructure Capacity Costs

Infrastructure needs are driven by peak loads. On-system resources that supply gas during peak periods reduce the amount that needs to be supplied from off-system and avoids infrastructure costs (***I***).[4] In order to estimate infrastructure costs avoided for any resource there are two pieces that need to be calculated:

1) The incremental cost of serving additional peak load (***S*** and ***D***); and
2) The amount of energy that would be saved or supplied during peak (***A*** and ***H***)

Note that the incremental cost of serving additional peak load is the same for all resources but the energy supplied or saved on peak is resource specific. There are two infrastructure related avoided costs components–supply capacity avoided costs and distribution system avoided costs.

$$\boldsymbol{I_T = S_T A_T + D H_T}$$

Supply capacity resources are the resources NW Natural uses to get gas onto our system of pipelines and are primarily interstate pipeline capacity and storage resources. Distribution system resources are the assets, primarily smaller pipelines, on NW Natural's system that distribute the gas that arrives at NW Natural's system via its supply resources to customers as it is demanded.

As peak load grows the Company must increase the deliverability of gas onto our system and the best currently available option is Mist Recall. Each guaranteed dekatherm supplied from RNG on a peak day contributes to NW Natural's portfolio of capacity resources it holds to ensure it can meet customers' peak needs and avoids having to recall a dekatherm of Mist Recall. Once Mist Recall is exhausted, an on-system RNG project would avoid the cost of the next best alternative.[5] This avoided cost is a benefit that is determined within the supply resource planning optimization (i.e., SENDOUT).

The avoided distribution capacity costs (***D***) applied to on-system supply resources (in this instance RNG) will be consistent with the methodology used for energy efficiency; see the discussion in Chapter Four. As load within its service area grows NW Natural must reinforce its distribution system to alleviate bottlenecks where the Company sees pressure drops or other indications of insufficient pressure (Chapter Six). If these on-system resources inject gas on the correct side of the bottleneck on the peak hour the additional gas props up the pressure in the system, which can delay or avoid a system reinforcement project.

If the amount of RNG that is injected during a peak hour (***H***) or day (***A***) can be estimated, or better yet contractually guaranteed, these volumes will be used for evaluation. If this is not estimated or guaranteed, NW Natural will assume RNG supply is constant across all hours in a year.

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[4] For off-system resources there are no avoided infrastructure capacity costs (i.e., $\boldsymbol{I_T = 0}$).
[5] The term best is used instead of cheapest since the marginal resource might be selected based on its deliverability profile and not strictly based on its costs.

4. PORTFOLIO EVALUATION CRITERIA

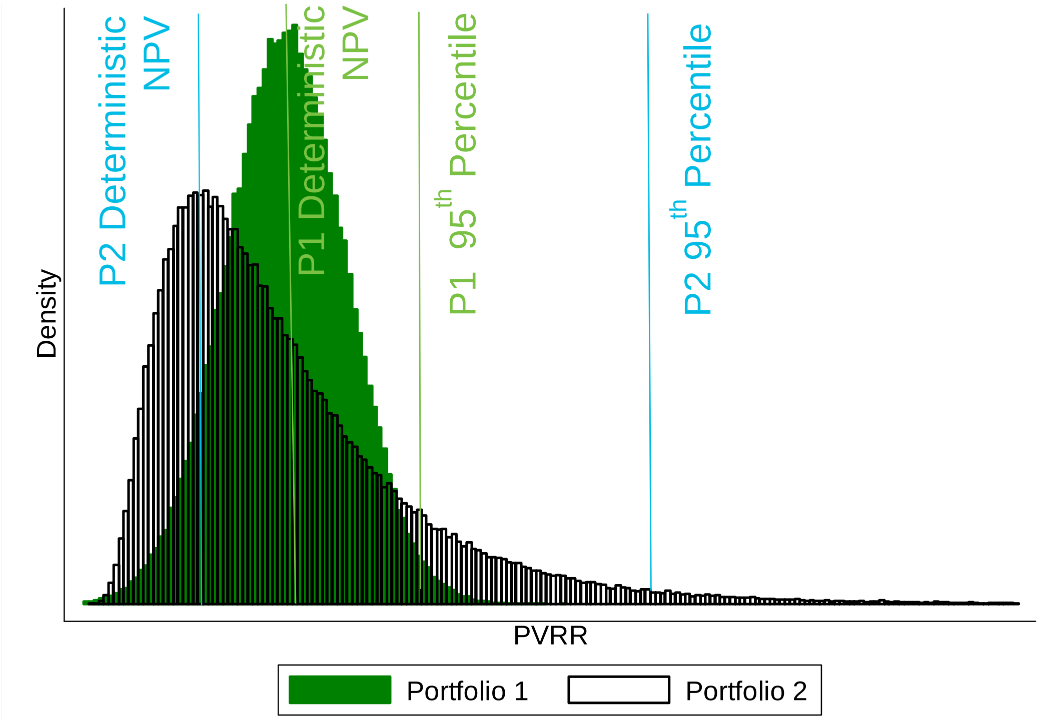
Projects will be evaluated based on a risk-adjusted present value of revenue requirements (rPVRR) calculated from the supply resource planning model (SENDOUT) where rPVRR is defined as:

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

The rPVRR criteria is developed to balance overall expected cost and the downside cost risk to customers when evaluating portfolios. The deterministic cost, which is the primary component of the rPVRR, represents the Company's expectations of the future and takes as input the base case gas price forecast, expected resource costs, and normal weather. The 95th percentile adjusts the criteria for the potential high cost risk and is estimated based on a Monte Carlo simulation (as detailed in Chapter 7) where the distributions of gas prices, emissions costs, resource costs, and weather are accounted for.

The cost distribution from the stochastic analysis can vary widely depending on the RNG source (i.e., landfills, waste water treatment plants, or dairy farms) and the specific contract structure. Figure H.3 gives an example of two cost distributions and demonstrates the trade-off of least cost and least risk between two portfolios. In this example Portfolio 1 has a higher deterministic cost, but a lower downside cost risk, as indicated by the 95th percentile. In this example case, after applying the 75/25 weighting Portfolio 1 results in a lower rPVRR despite the expected cost being higher than Portfolio 2.

Figure H.3: Portfolio Cost Distribution Example



5. PORTFOLIO EVALUATION PROCESS

The decision to execute RNG projects should account for uncertainties related to natural gas prices, weather, carbon policies, and capital expenditure cost estimates. Using the stochastic analysis described in Chapter Seven, NW Natural can incorporate these uncertainties into the decision process.

If NW Natural were presented with specific contract terms from an RNG producer the Company would evaluate the proposal through the following process:

1. Run deterministic and Monte Carlo simulations for two portfolios using supply resource planning model (SENDOUT):

   Portfolio 1: with proposed RNG project

   Portfolio 2: without proposed RNG project

2. Compare cost distributions of the two portfolios using Risk-Adjusted Present Value of Revenue Requirement (rPVRR)

The PVRR result of the deterministic portfolio runs are weighted by 0.75. The 95th percentile is estimated from the stochastic simulations and is weighted by 0.25. The proposed RNG contract terms could be accepted if the rPVRR of the RNG portfolio is less than or equal to a portfolio without the RNG.

Alternatively NW Natural may proactively approach RNG producers with terms and conditions, which will be negotiated with the counter-party. In this circumstance the process requires a third step to find the maximum contract price the Company can offer where the project is still considered cost-effective for customers.

3. Based on equating the rPVRR between simulation 1 and 2; determine the maximum risk-adjusted commodity contract price customers would be willing to pay for the RNG resource under consideration.

6. EXAMPLE PROJECT EVALUATION

Placeholder for Final IRP