Appendices

NW Natural®

Appendices Table of Contents

Appendices Table of Figures

Appendices Table of Tables

Appendix A: IRP Requirements and Updates

A.1 NW Natural's 2022 IRP - Oregon Compliance

NW Natural's 2022 IRP - Oregon Compliance			
Citation	Requirement	NW Natural Compliance	Chapter
Order No. 07-047			
Guideline 1(a)	All resources must be evaluated on a consistent and comparable basis.	NW Natural uses a site-specific cost of service model to estimate the PVRR of NW Natural owned resources. Existing non-NW Natural owned resources use their current tariff rates and future resource costs are developed using estimates from the owner of those facilities. Additionally, new to the 2018 IRP, NW Natural developed a methodology for a consistent and comparable basis for evaluating renewable resources. This methodology has been updated and is included as an appendix to this IRP. NW Natural uses avoided costs to evaluate the cost effectiveness of Demand-side resources.	4, 5, 6, 7, 8
	Utilities should compare different resource fuel types, technologies, lead times, in-service dates, durations and locations in portfolio risk modeling.	Chapters Five and Six focus on supply-side and compliance resources, and demand-side resources, respectively. The supply-side options considered in Chapter Six range from existing and proposed interstate pipeline capacity from multiple providers and NW Natural's Mist underground storage to various types of renewable natural gas, and imported LNG, and includes satellite LNG facilities sited at various locations within NW Natural's service territory. For those resources evaluated as being sufficiently viable to be included in resource portfolio optimization, NW Natural clearly defines each resource's in-service date before which the respective resource is unavailable for selection as part of a resource portfolio. Because NW Natural identified unserved demand occurring in all areas of its service	2, 3, 5, 6, and 7

		territory within the planning horizon in the absence of supply-side resource acquisition, the Company considered a variety of supply-side options to meet local, regional, and system-wide demand. These options included satellite LNG, on- and off-system renewable resources, NW Natural pipeline enhancements, and interstate pipeline expansions. The in-service dates of prospective resources range from short-term, such as Mist recall supplies to longer-term resources such as new interstate pipelines. NW Natural also performed analyses varying the in-service dates of different resources. NW Natural's analysis considers all prospective supply-side resources to be available, as of assumed in-service dates, throughout the remainder of the planning horizon. Meeting compliance obligations in both Oregon and Washington over the planning horizon is a major focus for this IRP. Compliance obligations and resources are discussed in Chapter Three and Six, respectively. NW Natural has additionally considered technologies which are not currently available but have been identified for continued monitoring and future assessment.	
	Consistent assumptions and methods should be used for evaluation of all resources.	NW Natural uses a site-specific cost of service model to estimate the PVRR of NW Natural owned resources. Existing non-NW Natural owned resources use their current tariff rates and future resources costs are developed using estimates from the owner of those facilities. NW Natural uses avoided costs to evaluate the cost effectiveness of Demand-side resources (energy efficiency and demand response) and supply-side resources (most notably the low carbon gas evaluation methodology). Compliance resources are also evaluated on a PVRR basis.	7

	The after-tax marginal weighted-average cost of capital (WACC) should be used to discount all future resource costs.	NW Natural uses a real after-tax discount rate of 3.4 percent in this IRP, which it derives using the currently authorized values associated with its cost of capital in Oregon. The Company incorporates a 2.86 percent annual rate of inflation, which it estimated using methods with which the Commission is familiar. Note that a real after-tax discount rate of 3.83 percent was used by ETO and AEG in their DSM savings potential analyses included Chapter Five. As discussed in Chapter Four of this IRP, ETO and AEG's energy savings forecasts need to be completed prior to NW Natural's resource optimization analysis. Therefore, NW Natural provided the 3.83 percent discount rate to ETO and AEG in 2021 and updated the discount rate to 3.4 percent in May 2022 and used it in resource optimization to reflect of the influence of the recent dynamic economic environment.	5, 6, 7, and Appendix A
Guideline 1(b)	Risk and Uncertainty must be considered.		
1.b.2 (note that 1.b.1 applies to electric utilities)	At a minimum, utilities should address the following sources of risk and uncertainty: Natural gas utilities: demand (peak, swing, and base load), commodity supply and price, transportation availability and price, and cost to comply with any regulation of greenhouse gas emissions.	Risk and uncertainty are intrinsic characteristics in long-term planning and NW Natural performed a risk analysis including both a stochastic analysis and a wide range of sensitivities to evaluate the impact of risk and uncertainty. More specifically, NW Natural analyzed demand uncertainty (peak, swing, and baseload) by using deterministic load forecasts. The Company analyzed weather uncertainty, gas price uncertainty, cost of compliance uncertainty, load, and resource-costs uncertainty in its stochastic analysis. Due to the degree of uncertainty of loads, policy, costs, and resources, for this IRP rather than developing a base case, NW Natural uses the range of cases, stochastic simulation, and risk analysis	2, 3, 4, 5, 6, and 7

		to inform this IRP. Finally, NW Natural discusses the impacts of complying with recently passed GHG emissions regulation and the uncertainty associated with the levels of the cost of compliance and potential emissions reduction alternatives. Chapter Seven contains the discussion of the Company's risk analysis, assumptions, and results.	
	Utilities should identify in their plans any additional sources of risk and uncertainty.	In addition to the uncertainties mentioned above, NW Natural has also modeled different sources of renewable resources. Not only does this take carbon compliance into consideration, but also tests the robustness of the plan given different renewable resources with different costs and different carbon attributes.	6, 7
Guideline 1(c)	The primary goal must be the selection of a portfolio of resources with the best combination of expected costs and associated risks and uncertainties for the utility and its customers. The planning horizon for analyzing resource choices should be at least 20 years and account for end effects. Utilities should consider all costs with a reasonable likelihood of being included in rates over the long term, which extends beyond the planning horizon and the life of the resource.	The primary goal of this IRP is the selection of a portfolio of resources with the best combination of expected costs and risks over the planning horizon. In this IRP, the portfolio selected depends upon the prospective development of a number of renewable natural gas projects. The analysis considers all costs that could reasonably be included in rates over the long-term, which extends beyond the planning horizon and the life of the resource. The robustness of the expected costs was evaluated in the stochastic risk analysis found in Chapter Seven.	7

	Utilities should use present value of revenue requirement (PVRR) as the key cost metric. The plan should include analysis of current and estimated future costs for all long-lived resources such as power plants, gas storage facilities, and pipelines, as well as all short-lived resources such as gas supply and short-term power purchases.	NW Natural uses PVRR as the key cost metric in this IRP and includes analysis of current and estimated future costs of both long- and short-lived resources.	7
	To address risk, the plan should include, at a minimum:		
1.c.1	Two measures of PVRR risk: one that measures the variability of costs and one that measures the severity of bad outcomes.	NW Natural assesses both the variability of costs and the severity of bad outcomes in the risk analysis which includes both a stochastic and sensitivity analysis in Chapter Seven.	7
1.c.2	Discussion of the proposed use and impact on costs and risks of physical and financial hedging.	NW Natural provides retail customers with a bundled gas product including gas storage by aggregating load and acquiring gas supplies through wholesale market physical purchases that may be hedged using physical storage or financial transactions. The following goals guide the physical or financial hedging of gas prices: 1) reliability; 2) lowest reasonable cost; 3) rate stability; 4) cost recovery; and 5) environmental stewardship.	Appendix E
	The utility should explain in its plan how its resource choices appropriately balance cost and risk.	NW Natural uses a probabilistic peak planning standard to accurately capture risk in its resource selection. Further, the Company augments its deterministic least cost portfolio optimization with a rigorous risk analysis, and its underlying	1, 3, 4, 6, and 7

		forecasts of weather and gas price variables with stochastic elements. NW Natural considered not only the strictly economic data in its assessment of resource options, but also the likelihood of alternative resources being available, analysis of demand and price forecasting, and the reliability benefits associated with certain resources. NW Natural uses this same process to balance costs and risks for compliance resources.	
Guideline 1(d)	The plan must be consistent with the long-run public interest as expressed in Oregon and federal energy policies.	This IRP includes compliance plans to meet Oregon's Climate Protection Plan and other policies that promote GHG emissions reductions. The Company's underlying gas price forecast provided by an outside consultant includes the cost of compliance with most known environmental regulations. The Company includes an emissions forecast associated with the considered resource portfolios, and explicitly models the outcomes of disparate policy futures including deep decarbonization of the natural gas system and an outright moratorium on new natural gas customer growth. As always, NW Natural works closely with Energy Trust of Oregon to acquire all cost-effective energy savings available for customers and continues to work to fully value the system benefits of demand-side resources.	2, 4, 5, 6, and 7

Guideline 2(a)	The public, which includes other utilities, should be allowed significant involvement in the preparation of the IRP. Involvement includes opportunities to contribute information and ideas, as well as to receive information. Parties must have an opportunity to make relevant inquiries of the utility formulating the plan. Disputes about whether information requests are relevant or unreasonably burdensome, or whether a utility is being properly responsive, may be submitted to the Commission for resolution.	NW Natural provided the public considerable opportunities for participating in the development of the Company's 2022 IRP. The Company held seven Technical Working Group (TWG) meetings, and one meeting for the public. The Company website includes a section on how one can become involved in NW Natural's IRP process and includes the dates and associated presentations for all 2022 IRP meetings, the draft 2022 IRP (which will be replaced with the final 2022 IRP upon filing), and previous IRPs. Additionally, new to the 2022 IRP process, NW Natural utilized virtual platforms to host IRP related meetings, creating a more accessible and inclusive environment for the public and stakeholders. Beginning with TWG No. 3, NW Natural recorded the TWGs and additionally posted these recordings to its website. NW Natural further notified customers of the 2022 IRP process in a June 2022 bill insert, which invited the submission of comments and announced the July 18, 2022, meeting for the public. Chapter Ten discusses the technical working groups and the meeting for the public.	10
Guideline 2(b)	While confidential information must be protected, the utility should make public, in its plan, any non-confidential information that is relevant to its resource evaluation and action plan. Confidential information may be protected through use of a protective order, through aggregation or shielding of data, or through	As evidenced by materials included in the plan, NW Natural has put forth all relevant non-confidential information necessary to produce a comprehensive plan.	

	any other mechanism approved by the Commission.		
Guideline 2(c)	The utility must provide a draft IRP for public review and comment prior to filing a final plan with the Commission.	NW Natural submitted on July 29, after conducting six TWG meetings, an initial draft plan in both Oregon and Washington and posted this plan on the Company website. Further, NW Natural held a Meeting for the Public on July 18, 2022, in which the Company also described the process in which the public can review and comment upon the draft. Finally, the action plan contained within the draft plan was discussed at a TWG meeting held on August 23, 2022.	10
Guideline 3(a)	The utility must file an IRP within two years of its previous IRP acknowledgement order.	NW Natural's 2018 IRP was acknowledged by the Commission on March 4, 2019; see Order No. 19-073 in Docket No. LC 71. NW Natural was granted Temporary Exemption from OAR 860-027-0400(3) with the purpose of changing the filing date of its upcoming Integrated Resource Plan (IRP) from March 4, 2021, to July 2022; see Order 21-013 in Docket No. LC 71. NW Natural was granted an additional Temporary Exemption from OAR 860-027-0400(3) with the purpose of changing the filing date of its upcoming Integrated Resource Plan (IRP) from July 2022 to September 2022; see Order No. 22-288 in Docket No. LC 71.	
Guideline 3(b)	The utility must present the results of its filed plan to the Commission at a public meeting prior to the deadline for written public comment.	NW Natural will comply with this guideline.	
Guideline 3(c)	Commission Staff and parties should complete their comments and	NW Natural looks forward to working with Commission Staff and interested parties in a review of this plan.	

	recommendations within six months of IRP filing.		
Guideline 3(d)	The Commission will consider comments and recommendations on a utility's plan at a public meeting before issuing an order on acknowledgment. The Commission may provide the utility an opportunity to revise the plan before issuing an acknowledgment order.	NW Natural is prepared for this process.	
Guideline 3(e)	The Commission may provide direction to a utility regarding any additional analyses or actions that the utility should undertake in its next IRP.	NW Natural is prepared to receive direction from the Commission regarding analysis required in its next IRP.	
Guideline 3(f)	Each utility must submit an annual update on its most recently acknowledged plan. The update is due on or before the acknowledgment order anniversary date. Once a utility anticipates a significant deviation from its acknowledged IRP, it must file an update with the Commission, unless the utility is within six months of filing its next IRP. The utility must	NW Natural plans to file an annual report as required.	

	summarize the update at a Commission public meeting. The utility may request acknowledgment of changes in proposed actions identified in an update.		
Guideline 3(g)	Unless the utility requests acknowledgement of changes in proposed actions, the annual update is an informational filing that: 1) Describes what actions the utility has taken to implement the plan; 2-Provides an assessment of what has changed since the acknowledgment order that affects the action plan, including changes in such factors as load, expiration of resource contracts, supply-side and demand-side resource acquisitions, resource costs, and transmission availability; and 3-Justifies any deviations from the acknowledged action plan.	NW Natural acknowledges this guideline.	
Guideline 4	At a minimum the plan must include the following elements:		
Guideline 4(a)	An explanation of how the utility met each of the	This appendix is intended to comply with this guideline by providing an itemized response to each of the substantive and procedural requirements.	

	substantive and procedural requirements.		
Guideline 4(b)	Analysis of high and low load growth scenarios in addition to stochastic load risk analysis with an explanation of major assumptions	The IRP looked at high and low customer growth and also analyzes scenarios associated with both high and low demand growth. Due to the degree of uncertainty of loads, policy, costs, and resources, for this IRP rather than developing a base case, NW Natural uses the range of cases, stochastic simulation, and risk analysis to inform its action plan until the next IRP. Chapter Seven provides the stochastic load risk analysis results.	3, 7
Guideline 4(c)	For electric utilities …	Not applicable to NW Natural's gas utility operations.	
Guideline 4(d)	For natural gas utilities, a determination of the peaking, swing and baseload gas supply and associated transportation and storage expected for each year of the plan, given existing resources; and identification of gas supplies (peak, swing and baseload), transportation and storage needed to bridge the gap between expected loads and resources.	New to this IRP, NW Natural utilized the PLEXOS® optimization model as discussed with Staff and stakeholders throughout the 2022 IRP TWG meetings. NW Natural analyzes on an integrated basis gas supply, transportation, and storage, along with demand-side resources to reliably meet peak, swing, and base-load system requirements. For this IRP, NW Natural utilizes a 90% probability coldest winter planning standard augmented with a historic seven-day cold weather event, which includes the probabilistically established planning standard day, against which to evaluate the cost and risk trade-offs of various supply- and demand-side resources available to PLEXOS®. NW Natural's integrated resource planning reflects the Company's evaluation and selection of a planning standard which provides reliability for customers. Resulting resource portfolios provide the best combinations of expected costs and associated risks and uncertainties for the utility and its customers.	7, Appendix B, F, and G

Guideline 4(e)	Identification and estimated costs of all supply-side and demand-side resource options, taking into account anticipated advances in technology.	NW Natural determined the best resource mix by studying supply-side options currently used such as pipeline transportation contracts, and gas supply and renewable natural gas contracts; as well as alternative options such as additional capacity or infrastructure enhancements. The Company also considered future developments such as pipeline enhancements, renewable natural gas projects, power-to-gas (a suite of technologies that use electrolysis in an electrolyzer to separate water molecules into oxygen and hydrogen), and other compliance resources. Chapter Six discusses the various supply-side and compliance resource options and their costs. NW Natural compiled demand-side resource options with assistance from the ETO as well as AEG, and these options are identified in Chapter Five. Further, Chapter Two discusses various efficient end use equipment.	2, 5,6
Guideline 4(f)	Analysis of measures the utility intends to take to provide reliable service, including cost-risk tradeoffs.	NW Natural uses a planning standard that uses statistics and Monte Carlo simulation of the demand drivers to set a standard that the company's resource capacity can serve the highest firm sales demand day going into each future winter with 99% certainty. PLEXOS® is used to determine least-cost, least-risk portfolio and a scenario and stochastic risk analysis is completed to stress test the portfolio. The Synergi Gas™ software package also provides the Company the opportunity to evaluate performance of the distribution system under a variety of conditions, with the analysis typically focused on meeting peak day customer demands while maintaining system stability. Chapter Eight discusses the approach the Company uses to provide reliable service at the distribution system planning level.	3, 6, 7, 8

Guideline 4(g)	Identification of key assumptions about the future (e.g., fuel prices and environmental compliance costs) and alternative scenarios considered.	Chapter Seven describes alternative resource mix scenarios and forward-looking sensitivities involving commodity availability, commodity cost, transportation cost, and/or load forecast inputs evaluated in the IRP. The Company also included expected GHG policy compliance costs in its price forecasts and analyzed sensitivities related to compliance costs. Further, NW Natural factored compliance costs explicitly into the determination of the Company's avoided cost, which in turn factored into the identification of cost-effective demand-side resources and on-system resources such as renewable natural gas.	2, 4, 5, 6 and 7
Guideline 4(h)	Construction of a representative set of resource portfolios to test various operating characteristics, resource types, fuels and sources, technologies, lead times, in-service dates, durations and general locations — system-wide or delivered to a specific portion of the system.	As described above and in more detail in the Plan, NW Natural designed numerous alternate resource mix scenarios, where each scenario allows for changes to the supply-side, demand-side, and compliance resources available for selection. Chapter Seven and associated appendices document the resource portfolio options evaluated in this IRP.	7
Guideline 4(i)	Evaluation of the performance of the candidate portfolios over the range of identified risks and uncertainties.	Chapter Seven discusses the results of the stochastic risk analysis and tests the robustness of the expected resource choice over a wide slate of future environments that represent uncertainty of natural gas prices, weather, policy, and resource costs.	7
Guideline 4(j)	Results of testing and rank ordering of the portfolios by cost and risk metric, and interpretation of those results.	Chapter Seven discusses the results of the stochastic risk analysis and tests the robustness of the expected resource choice over a wide slate of future environments that	7

		represent uncertainty of natural gas prices, weather, and resource costs.	
Guideline 4(k)	Analysis of the uncertainties associated with each portfolio evaluated.	Chapter Seven discusses the results of the stochastic risk analysis and tests the robustness of the expected resource choice over a wide slate of future environments that represent uncertainty of natural gas prices, weather, and resource costs.	7
Guideline 4(l)	Selection of a portfolio that represents the best combination of cost and risk for the utility and its customers.	Chapter Seven discusses the results of the stochastic risk analysis and selection of the resource portfolio.	7
Guideline 4(m)	Identification and explanation of any inconsistencies of the selected portfolio with any state and federal energy policies that may affect a utility's plan and any barriers to implementation.	NW Natural does not believe resource strategy is inconsistent with state or federal energy policies that were established upon filing this IRP. Potential barriers to implementation may relate to the ultimate availability and timing of certain incremental resources selected for the Company's selected portfolio due to facility siting/permitting challenges, market viability, and others. Chapters Two, Six, and Seven discuss such potential barriers.	2, 6, and 7
Guideline 4(n)	An action plan with resource activities the utility intends to undertake over the next two to four years to acquire the identified resources, regardless of whether the activity was acknowledged in a previous IRP, with the key attributes of each resource specified as in portfolio testing.	Chapter One presents NW Natural's multiyear action plan, which identifies the short-term actions the Company intends to pursue within the next two to four years.	1

Guideline 5	Portfolio analysis should include costs to the utility for the fuel transportation and electric transmission required for each resource being considered. In addition, utilities should consider fuel transportation and electric transmission facilities as resource options, taking into account their value for making additional purchases and sales, accessing less costly resources in remote locations, acquiring alternative fuel supplies, and improving reliability.	Chapter 6 discusses pipeline transmission line costs and potential future expansions.	6
Guideline 6(a)	Each utility should ensure that a conservation potential study is conducted periodically for its entire service territory.	As discussed in Chapter Five, NW Natural worked with ETO and AEG to analyze the potential energy savings that could be cost-effectively procured within the Company's service territory over the next 30 years. The studies determined the achievable potential by analyzing customer demographics together with energy efficiency measure data. The results were then evaluated with supply-side resources using PLEXOS®. A deployment scenario was applied to the total potential. NW Natural and ETO review these assumptions annually when ETO plans its program budget for the subsequent calendar year.	5
Guideline 6(b)	To the extent that a utility controls the level of funding for conservation programs in its service territory, the utility	NW Natural's Schedule 301, Public Purposes Funding Surcharge, contains a special condition requiring NW Natural to work with ETO every year to determine if the funding level is appropriate to meet the subsequent year's	1, 9

	should include in its action plan all best cost/risk portfolio conservation resources for meeting projected resource needs, specifying annual savings targets.	therm savings targets. NW Natural has included in its action plan, item 4, identifying specific annual savings targets.	
Guideline 6(c)	To the extent that an outside party administers conservation programs in a utility's service territory at a level of funding that is beyond the utility's control, the utility should: 1) determine the amount of conservation resources in the best cost/ risk portfolio without regard to any limits on funding of conservation programs; and 2) identify the preferred portfolio and action plan consistent with the outside party's projection of conservation acquisition.	See response to Guideline 6(b)	
Guideline 7	Plans should evaluate demand response resources, including voluntary rate programs, on par with other options for meeting energy, capacity, and transmission needs (for electric utilities) or gas supply and transportation needs (for natural gas utilities).	NW Natural offers interruptible rates which account for approximately 22 percent of the Company's throughput. This allows NW Natural to reduce system stress during periods of unusually high demand. NW Natural engaged the Brattle Group to assess additional DR potential and opportunities of technology-enabled voluntary DR programs for peak load shaving. NW Natural is proposing a residential and small commercial DR pilot as part of its Action Plan in this IRP.	

Guideline 8	See Amended Guideline 8 through **ORDER NO. 08-339**		
Guideline 8 (a)	BASE CASE AND OTHER COMPLIANCE SCENARIOS: The utility should construct a base-case scenario to reflect what it considers to be the most likely regulatory compliance future for carbon dioxide (CO_2), nitrogen oxides, sulfur oxides, and mercury emissions. The utility also should develop several compliance scenarios ranging from the present CO_2 regulatory level to the upper reaches of credible proposals by governing entities. Each compliance scenario should include a time profile of CO_2 compliance requirements. The utility should identify whether the basis of those requirements, or "costs," would be CO_2 taxes, a ban on certain types of resources, or CO_2 caps (with or without flexibility mechanisms such as allowance or credit trading or a safety valve). The analysis should recognize significant and important upstream	NW Natural explicitly incorporates expected regulatory compliance costs in its analyses. Due to the degree of uncertainty of loads, policy, costs, and resources, for this IRP rather than developing a base case, NW Natural uses the range of cases, stochastic simulation, and risk analysis to inform its action plan until the next IRP. Within the scenarios analyzed, NW Natural believes Scenario 1- Balanced Decarbonization reflects the most likely near-term regulatory compliance future.	2, 4, 7

	emissions that would likely have a significant impact on its resource decisions. Each compliance scenario should maintain logical consistency, to the extent practicable, between the CO_2 regulatory requirements and other key inputs.		
Guideline 8 (b)	TESTING ALTERNATIVE PORTFOLIOS AGAINST THE COMPLIANCE SCENARIOS: The utility should estimate, under each of the compliance scenarios, the present value of revenue requirement (PVRR) costs and risk measures, over at least 20 years, for a set of reasonable alternative portfolios from which the preferred portfolio is selected. The utility should incorporate end-effect considerations in the analyses to allow for comparisons of portfolios containing resources with economic or physical lives that extend beyond the planning period. The utility should also modify projected lifetimes as necessary to be consistent with	Chapter Seven discusses the results of the stochastic risk analysis and tests the robustness of the expected resource choice over a wide slate of future environments that represent uncertainty of policy and compliance costs.	7

	the compliance scenario under analysis. In addition, the utility should include, if material, sensitivity analyses on a range of reasonably possible regulatory futures for nitrogen oxides, sulfur oxides, and mercury to further inform the preferred portfolio selection.		
Guideline 8 (c)	TRIGGER POINT ANALYSIS. The utility should identify at least one CO_2 compliance "turning point" scenario which, if anticipated now, would lead to, or "trigger" the selection of a portfolio of resources that is substantially different from the preferred portfolio. The utility should develop a substitute portfolio appropriate for this trigger-point scenario and compare the substitute portfolio's expected cost and risk performance to that of the preferred portfolio - under the base case and each of the above CO_2 compliance scenarios. The utility should provide its assessment of whether a CO_2 regulatory future that is equally or more	NW Natural evaluated numerous scenarios including aggressive load reductions. NW Natural's preferred portfolio is based upon a risk-adjusted approach rather than selecting a base case for this reason.	7

	stringent than the identified trigger point will be mandated.		
Guideline 8 (d)	OREGON COMPLIANCE PORTFOLIO: If none of the above portfolios is consistent with Oregon energy policies (including state goals for reducing greenhouse gas emissions) as those policies are applied to the utility, the utility should construct the best cost/risk portfolio that achieves that consistency, present its cost and risk parameters, and compare it to those of the preferred and alternative portfolios.	NW Natural's preferred portfolio is consistent with OR energy policies.	7
Guideline 9	Direct Access Loads.	Not applicable to NW Natural's gas utility operations.	
Guideline 10	Multi-state utilities should plan their generation and transmission systems, or gas supply and delivery, on an integrated-system basis that achieves a best cost/risk portfolio for all their retail customers.	This plan studies the supply-side needs for NW Natural's complete service territory which includes customers in Oregon and Washington.	
Guideline 11	Natural gas utilities should analyze, on an integrated basis, gas supply, transportation, and storage, along with demand-side resources, to reliably meet	NW Natural analyzes on an integrated basis gas supply, transportation, and storage, along with demand-side resources to reliably meet peak, swing, and base-load system requirements. For this IRP, NW Natural utilizes a 90% probability coldest winter planning standard	3, 7

	peak, swing, and base-load system requirements. Electric and natural gas utility plans should demonstrate that the utility's chosen portfolio achieves its stated reliability, cost and risk objectives.	augmented with a historic seven-day cold weather event, which includes the probabilistically established planning standard day, against which to evaluate the cost and risk trade-offs of various supply- and demand-side resources available to PLEXOS®. NW Natural's integrated resource planning reflects the Company's evaluation and selection of a planning standard which provides reliability for customers. Resulting resource portfolios provide the best combinations of expected costs and associated risks and uncertainties for the utility and its customers.	
Guideline 12	Distributed Generation. Electric utilities should…	Not applicable to NW Natural's gas utility operations.	
Guideline 13(a)	Resource Acquisition. An electric utility should…	Not applicable to NW Natural's gas utility operations.	
Guideline 13(b)	Natural gas utilities should either describe in the IRP their bidding practices for gas supply and transportation, or provide a description of those practices following IRP acknowledgment.	Appendix E describes NW Natural's Gas Acquisition Plan (GAP) detailing the Company's strategies and practices for acquiring gas supplies. The Company's Gas Acquisition Plan is centered on the following goals: 1) Reliability, 2) Diversity, 3) Price Stability, and 4) Cost Recovery.	Appendix E
Order No. 19-073, LC 71 - Staff Recommendation No. 1	Staff recommends that the Company provide a narrative in the next IRP to explain the factors that led to the Company's choice for the blending and transitioning years from the SME panel forecast to the econometric forecast, as well as supporting statistical analysis.	NW Natural has provided a narrative in Chapter Three on the factors leading to the Company's choice for the blending and transitioning years from the SME panel forecast to the econometric forecast. Supporting statistical analysis can be found in Appendix B.	3, Appendix B

Order No. 19-073, LC 71- Staff Recommendation No. 2	Staff recommends the establishment of a consistent standard relating to the year in which the Company blends and fully transitions from the SME panel to the econometric forecast. The standard should stay the same from one IRP to the next unless the Company provides statistical and narrative evidence it has found a substantial improvement over the current method.	As a standard, the fourth year of the customer count forecast is "blended". NW Natural has provided a narrative in Chapter Three on the blending and transitioning years from the SME panel forecast to the econometric forecast. Supporting statistical analysis can be found in Appendix B.	3, Appendix B
Order No. 19-073, LC 71- Staff Recommendation No. 3	A common tool used within load forecasting to track the usage of market segments is tracking customers with the NAICS or SICS database. Staff recommends that NW Natural pursue the creation of such a tool for the next IRP.	With this IRP the Company has moved to an improved end use load forecasting model which we believe is more helpful in developing a load forecast.	
Order No. 19-073, LC 71- Staff Recommendation No. 4	Staff recommends the Company work with Staff and stakeholders through technical working groups to address Staff's concerns regarding model evaluation and specification testing for the 2020 IRP.	Prior to filing the 2022 IRP, NW Natural held two supplemental and seven Technical Working Groups in which the Company worked with Staff and stakeholders regarding model evaluation and specification testing.	
Order No. 19-073, LC 71- Staff	Prior to the 2020 IRP, Staff recommends NW Natural	On September 21, 2021, NW Natural held a supplemental Technical Working Group on the topic of Planning Standard	

Recommendation No. 5	coordinate a TWG focused on the Company's method of implementing probabilistic methodology for the capacity planning standard and peak hour standard for distribution system planning. NWN should share the relevant modeling inputs, outputs, and workpapers with stakeholders at least one week in advance of the TWG.	during which the Company discussed its method of implementing probabilistic methodology for the capacity planning standard and peak hour standard for distribution system planning.	
Order No. 19-073, LC 71- Staff Recommendation No. 6	Work with staff to review any proposed end use load profiles that deviate from those used by other independent regional organizations as part of UM 1893 and in their next IRP filing. The review may potentially involve third parties and additional supporting research.	NW Natural participated in stakeholder workshops held in docket UM 1893 and hosted a supplemental avoided cost workshop on October 8, 2021.	
Order No. 19-073, LC 71- Staff Recommendation No. 7	Staff recommends acknowledgement of NWN's Action Item number 9: Working through Energy Trust, NW Natural will acquire therm savings of 5.2 million therms in 2019 and 5.4 million therms in 2020, or the amount identified and approved by the Energy Trust board.	NA. See Update on Action Items in Section A.4.1	

Order No. 19-073, LC 71- Staff Recommendation No. 8	Staff recommends NWN continue to include Staff and stakeholders in the planning and implementation of the targeted DSM pilot with the Commission in 2019.	NW Natural included Staff and stakeholders in the planning and implementation of the targeted DSM pilot (GeoTEE). NW Natural discussed GeoTEE and presented preliminary results during TWG No. 5 on April 25, 2022.	
Order No. 19-073, LC 71- Staff Recommendation No. 9	Staff recommends NWN hire a third party to perform a Demand Response Potential Study in its service territory. This analysis should include an independent review of NWN's analysis of their interruptible rates as a DR option.	NW Natural engaged Brattle Group to perform a Demand Response Potential Study. Please see Chapter 8 for additional information.	8
Order No. 19-073, LC 71- Staff Recommendation No. 10	For significant maintenance projects and studies that could result in significant capital investments to facilitate future use of the resource, Staff recommends the Company consider including these projects in future Action Plans.	The Company has considered including such projects in future Action Plans.	
Order No. 19-073, LC 71- Staff Recommendation No. 11	For any state that continues not to have a carbon policy by the next IRP, include an additional carbon price path in the stochastic analysis that is near or equal to zero.	NA. Washington and Oregon established carbon policies of which NW Natural plans to comply.	1, 2
Order No. 19-073, LC 71- Staff	Based on evidence made available by NWN since Staff's final comments, Staff	NA. See Update on Action Items in Section A.4.1	

Recommendation No. 12	recommends acknowledgement of the following distribution projects: - The Hood River project; - The South Oregon City project; - The Kuebler project; - The Sandy Feeder project; and the - Happy Valley project.		
Order No. 19-073, LC 71- Staff Recommendation No. 13	NW Natural should continue to monitor the area of concern in North Eugene and report back in a future IRP or IRP update if there is a violation of distribution system planning standards.	NW Natural continues to monitor the North Eugene system with an Electronic Portable Pressure Recorder (EPPR) and has not recorded any pressure violations. Additionally, NW Natural created a Eugene Model utilizing CMM customer data forecasts. The Eugene model does not exhibit the low pressures that were found in legacy models and the CMM pressure forecasts resemble the data that has been capture in the field via EPPR. If a violation of DSP standards is found, the Company will report back in a future IRP or IRP update.	
Order No. 19-073, LC 71- Staff Recommendation No. 14	Staff recommends that NW Natural Re-file Appendix H to address the concerns identified by Staff in Final Comments and further elaborated in the Staff Report.	NW Natural refiled Appendix H with the Commission on January 10, 2020, in docket No. LC 71.	
Order No. 19-073, LC 71- Staff Recommendation No. 15	(a) As part of an RNG investigation, Staff recommends NWN provide modeling inputs, outputs, and other relevant workpapers to parties in the investigation docket at least 30 days before signing any RNG contract or initiating any RNG project. (b)	Docket no. UM 2030 was started in 2019 and completed October 2020. The RNG evaluation methodology was amended and approved and is now being used to evaluate RNG resources.	

	Staff recommends acknowledging a revised action item for RNG: "NW Natural will participate in an investigation into the use of the Company's proposed methodology to evaluate renewable natural gas (RNG) cost-effectiveness. Until the investigation is complete, NW Natural will procure RNG deemed cost-effective through the methodology in revised Appendix H, up to a 4.5 million therm annual limit on total delivery, for up to ten years (up to 45 million therms in total). The investigation will review the appropriate process for procuring cost-effective RNG resources that do not align with the timeline of acknowledgement in an IRP as well as review the 4.5 million therm annual limit on cost-effective RNG procurement. If NW Natural seeks to procure additional cost-effective RNG before the conclusion of the investigation, it will seek acknowledgment in an IRP update. If the investigation		

	results in the 4.5 million therm annual limit being adjusted or eliminated, or in other changes, the Commission may direct NW Natural to file an update to reflect its findings."		
Order No. 21-013, LC 71	Grant an exemption for Northwest Natural Gas Company from OAR 860-027-0400(3) allowing a 16 month extension (July 29, 2022) to the Company's March 2021 IRP Filing deadline. And, direct NW Natural to launch its 2022 IRP Technical Working Group meetings upon DEQ's filing of draft CPP rules so as to begin the IRP stakeholder input process on this element and explore any associated work.	NW Natural began its 2022 IRP process, after DEQ's filing of draft CPP rules, with two supplemental Technical Working Groups, Load Considerations held on September 29, 2021, and Emissions Considerations held on December 9, 2021. A central focus of these TWGs was CPP draft rule implications on the IRP and associated work.	10
Order No. 21-274, LC 71 Recommendation No. 1	In response to Staff's question regarding hydrogen, NWN reports that the uprated pipeline will be able to accommodate hydrogen-blended gas without fears of hydrogen leakage. NWN will provide a detailed write up regarding hydrogen blending in its 2022 IRP.	NW Natural discusses hydrogen blending in Chapter 8.	8

Order No. 21-274, LC 71 Recommendation No. 2	Staff finds that a stakeholder process to discuss resiliency in Oregon's natural gas supply could lead to valuable information, including an agreed-upon definition of resiliency and any appropriate credit for the resiliency value of local RNG projects capable of providing supply during a pipeline outage. Staff will consider whether to facilitate the beginning of such a process at an appropriate time. Additionally, Staff expects that NWN will engage Staff and stakeholders on discussions of this issue as part of the development process of the next IRP.	NW Natural discussed the issue of resiliency with Staff and stakeholder during its IRP development process. NW Natural is supportive of the OPUC beginning a process to investigate regional resource adequacy across the natural gas and electric systems, but not as a part of any single utility's IRP.	6, 10
Order No. 21-274, LC 71 Recommendation No. 3	Staff suggests that the Company take steps to address this Staff Recommendation before the next IRP is filed. A stakeholder workshop in Docket No. LC 71 to discuss the Company's monthly factors and end use categories would be adequate.	NW Natural held a workshop on avoided costs on October 8, 2021.	
Order No. 21-274, LC 71	Acknowledge in part and decline to acknowledge in part	NW Natural participated in stakeholder workshops held in docket UM 1893 and hosted a workshop on October 8,	

Recommendation No. 4	NW Natural's third update to its 2018 Integrated Resource Plan. Decline to acknowledge NWN's distribution capacity and risk reduction avoided costs for purposes of its use in NWN's next avoided cost filing, and direct NW Natural to include the updated avoided cost data in its next avoided cost filing, with a supporting explanation for use of the data.	2021, with Staff, members from the Northwest Power and Conservation Council and additional stakeholders to review the methodology and values for the distribution capacity and risk reduction avoided costs filed in the 2018 IRP Update #3.	

A.2 NW Natural's 2022 IRP - Washington Compliance

NW Natural's 2022 IRP - Washington Compliance		
Rule	Requirement	Plan Citation
WAC 480-90-238(4)	Work plan filed no later than 12 months before next IRP due date.	NW Natural filed its original work plan on August 23, 2019. The Company filed three revisions to the work plan on August 23, 2019, March 3, 2020, and February 11, 2021.
WAC 480-90-238(4)	Work plan outlines content of IRP.	The work plan filed on March 3, 2020, outlined the content of the 2022 IRP.
WAC 480-90-238(4)	Work plan outlines method for assessing potential resources (see LRC analysis below).	The work plan file on February 11, 2021, outlines the methodology used in developing the 2022 IRP. NW Natural developed and integrated demand forecasts, weather patterns, natural gas price forecasts, and demand- and supply-side resources into gas supply and planning optimization software. The modeling results guided NW Natural toward the lowest reasonable cost resource portfolio.
WAC 480-90-238(5)	Work plan outlines timing and extent of public participation.	The work plan filed on February 11, 2021, states three supplemental working group meetings and six technical working group meetings, beginning on May 5, 2021, with the final technical working group meeting scheduled for April 14, 2022. Due to delays in various rulemakings in Oregon and Washington, NW Natural worked with Staff and stakeholders to adjust the timing of its technical working groups in order to align with such impactful processes and policies. Supplemental technical working groups began June 1, 2021, with the final technical working group held on August 23, 2022. All IRP related workshops were announced via the NW Natural website with schedule updates provided through the technical working groups, distribution list announcements, and website updates. Lastly, customers were notified of this IRP's process through a May 2022 bill insert, a facsimile of which is included in 0. This bill

		insert welcomed public comments and invited customers to a public meeting, which occurred on July 18, 2022.
WAC 480-90-238(4)	Integrated resource plan submitted within two years of previous plan.	NW Natural filed its 2018 IRP on August 24, 2018. See Docket No. UG-170911. NW Natural was granted an exemption from WAC 80-90-238(4) on February 6, 2020. See Docket No. UG-190711, Order 01. This exemption was extended through Order 03, in Docket No. UG-190711.
WAC 480-90-238(5)	Commission issues notice of public hearing after company files plan for review.	Pending.
WAC 480-90-238(5)	Commission holds public hearing.	Pending.
WAC 480-90-238(2)(a)	Plan describes mix of natural gas supply.	Chapter Six outlines currently held and available supply-side resource options including existing and proposed interstate pipeline capacity from multiple providers, NW Natural's Mist underground storage, offtakes, imported LNG, and satellite LNG facilities. NW Natural has also provided a commentary of renewable supply-side options such as RNG and Hydrogen blending.
WAC 480-90-238(2)(a)	Plan describes conservation supply.	Chapter Five documents how NW Natural determined the achievable potential of demand-side management (DSM) within its service territory through 2050. Chapter Four presents Avoided Costs.

WAC 480-90-238(2)(a)	Plan addresses supply in terms of current and future needs of utility and ratepayers.	NW Natural analyzed current demand and examined uncertainty regarding future demand (peak, swing, and baseload) by using deterministic load forecasts. NW Natural develops a range of customer needs through scenarios and stochastic simulation, through a risk analysis to inform its action plan until the next IRP. The Company analyzed weather uncertainty, gas price uncertainty, cost of compliance uncertainty, load, and resource-costs uncertainty in its stochastic analysis. Finally, NW Natural discusses the impacts of complying with recently passed GHG emissions regulation and the uncertainty associated with the levels of the cost of compliance and potential emissions reduction alternatives.
WAC 480-90-238(2)(a) &(b)	Plan uses lowest reasonable cost (LRC) analysis to select mix of resources.	NW Natural considered the strictly economic data assessed by the PLEXOS® model; the likely availability of certain resources such as imported or satellite LNG; scenario analysis of demand and gas prices; and the results of an extensive risk analysis to various factors to ensure consideration of resource uncertainties and costs of risks when developing the plan. After considering all these factors, the Company selected a near-term preferred portfolio given the various futures and identified resources consistent with that portfolio for that specific future acquisition.
WAC 480-90-238(2)(b)	LRC analysis considers resource costs.	Chapter Seven identifies the costs of supply-side resource portfolios for each of multiple possible futures. A fundamental task associated with this is the estimation of the revenue requirements associated with discrete supply-side resources, including commodity prices. Chapter Seven discusses the results of the stochastic risk analysis and tests the robustness of the expected resource choice over a wide slate of future environments that represent uncertainty of natural gas prices, weather, policy, and resource costs.

WAC 480-90-238(2)(b)	LRC analysis considers market-volatility risks.	NW Natural developed several different risk analyses through a range of scenarios and stochastic simulation to examine risks associated with uncertainty regarding natural gas prices and price volatility, as well as availability of renewable natural gas and other compliance resources. These sensitivities evaluated higher levels of avoided costs, different natural gas price paths over the planning horizon, and the effects of alternative futures involving LNG exports on natural gas prices. NW Natural used the results of these sensitivities to inform its resource acquisition plan.
WAC 480-90-238(2)(b)	LRC analysis considers demand side uncertainties.	Chapters Four, Five, and Seven discuss DSM's effect on the supply-side resource mix. Chapter Eight discusses demand-side resources within the context of Distribution System Planning.
WAC 480-90-238(2)(b)	LRC analysis considers resource effect on system operation.	Chapter Seven discusses the multiple scenarios studied in this plan.
WAC 480-90-238(2)(b)	LRC analysis considers risks imposed on ratepayers.	The primary goal of this IRP is the selection of a portfolio of resources which comply with state and federal environmental regulations and have the best combination of expected costs and risks over the planning horizon. In this IRP, the portfolio selected depends upon the prospective development of a number of renewable natural gas projects. The analysis considers all costs that could reasonably be included in rates over the long-term, which extends beyond the planning horizon and the life of the resource. NW Natural performed a risk analysis including both a stochastic analysis and a wide range of sensitivities to evaluate the impact of risk and uncertainty. The Company analyzed weather uncertainty, gas price uncertainty, cost of compliance uncertainty, load, and resource-costs uncertainty in its stochastic analysis. Finally, NW Natural discusses the impacts of complying with recently passed GHG

		emissions regulation and the uncertainty associated with the levels of the cost of compliance and potential emissions reduction alternatives. Chapter Seven contains the discussion of the Company's risk analysis, assumptions, and results.
WAC 480-90-238(2)(b)	LRC analysis considers public policies regarding resource preference adopted by Washington state or federal government.	NW Natural discusses new and developing state and federal policies in Chapter Two. NW Natural explicitly incorporates expected regulatory compliance costs in its analyses. Due to the degree of uncertainty of loads, policy, costs, and resources, for this IRP rather than developing a base case, NW Natural uses the range of cases, stochastic simulation, and risk analysis to inform its action plan until the next IRP. This IRP includes compliance plans to meet Washington's Climate Commitment Act and other policies that promote GHG emissions reductions. The Company's underlying gas price forecast provided by an outside consultant includes the cost of compliance with most known environmental regulations. The Company includes an emissions forecast associated with the considered resource portfolios, and explicitly models the outcomes of disparate policy futures including deep decarbonization of the natural gas system and an outright moratorium on new natural gas customer growth. Chapter Seven describes alternative resource mix scenarios and forward-looking sensitivities involving commodity availability, commodity cost, transportation cost, and/or load forecast inputs evaluated in the IRP. The Company also included expected GHG policy compliance costs in its price forecasts and analyzed sensitivities related to compliance costs. Further, NW Natural factored compliance

		costs explicitly into the determination of the Company's avoided cost, which in turn factored into the identification of cost-effective demand-side resources and on-system resources such as renewable natural gas.
WAC 480-90-238(2)(b)	LRC analysis considers cost of risks associated with environmental effects including emissions of carbon dioxide.	As stated above, NW Natural explicitly incorporates expected regulatory compliance costs in its analyses. The Company's underlying gas price forecast provided by an outside consultant includes the cost of compliance with most known environmental regulations. The Company includes an emissions forecast associated with the considered resource portfolios, and explicitly models the outcomes of disparate policy futures including deep decarbonization of the natural gas system and an outright moratorium on new natural gas customer growth. Chapter Seven describes alternative resource mix scenarios and forward-looking sensitivities involving commodity availability, commodity cost, transportation cost, and/or load forecast inputs evaluated in the IRP. The Company also included expected GHG policy compliance costs in its price forecasts and analyzed sensitivities related to compliance costs.
WAC 480-90-238(2)(b)	LRC analysis considers need for security of supply.	Chapter Six and Appendix E discuss supply and common gas purchasing practices, respectively. The primary objective of the Gas Acquisition Plan (GAP) is to ensure gas supplies are sufficient to meet firm customer demand. To meet this objective, NW Natural's primary goal is reliability, followed by lowest reasonable cost, rate stability, and cost recovery all while reducing the carbon content of the energy we deliver.
WAC 480-90-238(2)(c)	Plan defines conservation as any reduction in natural gas consumption that results from increases in the efficiency of energy use or distribution.	The Plan defines energy reductions from DSM programs in the Company's service territory as the reduction of gas consumption resulting from the installation of a cost-effective conservation measure.

WAC 480-90-238(3)(a)	Plan includes a range of forecasts of future demand.	This Plan evaluates a range of forecasts including high and low customer growth. The Company explicitly models the outcomes of disparate policy futures including deep decarbonization of the natural gas system and an outright moratorium on new natural gas customer growth.
WAC 480-90-238(3)(a)	Plan develops forecasts using methods that examine the effect of economic forces on the consumption of natural gas.	NW Natural analyzed a range of alternative resource portfolios through risk analysis that accounts for high and low customer growth and a range of load forecasts through scenario and simulation work.
WAC 480-90-238(3)(a)	Plan develops forecasts using methods that address changes in the number, type and efficiency of natural gas end-uses.	NW Natural analyzed a range of alternative resource portfolios through risk analysis that accounts for high and low customer growth and a range of load forecasts through scenario and simulation work. The range of loads may be thought of as resulting from changes in the number, type, and efficiency of natural gas end uses. Additionally, in its risk analysis, the plan evaluates the impact from various avoided costs as well as new gas end-use technologies.
WAC 480-90-238(3)(b)	Plan includes an assessment of commercially available conservation, including load management.	Chapter Five provides a discussion of conservation and demand-side resources. With respect to demand-side load management, NW Natural foresees continuing to shave peak load requirements when and where necessary by curtailing interruptible customers and is exploring other avenues of DSM.
WAC 480-90-238(3)(b)	Plan includes an assessment of currently employed and new policies and programs needed to obtain the conservation improvements.	Chapter Five details how NW Natural delivers energy efficiency programs that offer customers incentives for implementing cost effective demand-side management measures. Additionally, NW Natural, in partnership with Energy Trust of Oregon, has been testing an Accelerated/Enhanced Geographically Targeted DSM pilot since September 2019 (i.e., GeoTEE). New to this IRP, AEG

		evaluated the DSM potential for transportation customers and a summary of the analysis is provided in Chapter Five.
WAC 480-90-238(3)(c)	Plan includes an assessment of conventional and commercially available nonconventional gas supplies.	NW Natural determined the best resource mix by studying supply-side options currently used, such as pipeline transportation contracts and gas supply and renewable natural gas contracts; as well as alternative options such as additional capacity or infrastructure enhancements. The Company also considered future developments such as pipeline enhancements, renewable natural gas projects, power-to-gas (a suite of technologies that use electrolysis in an electrolyzer to separate water molecules into oxygen and hydrogen), and other compliance resources. Chapter Six discusses the various supply-side and compliance resource options and their costs.
WAC 480-90-238(3)(d)	Plan includes an assessment of opportunities for using company-owned or contracted storage.	NW Natural assessed its Mist underground storage, Jackson Prairie underground storage, imported LNG, as well as satellite LNG facilities located at various locations within the Company's service territory as resource options.
WAC 480-90-238(3)(e)	Plan includes an assessment of pipeline transmission capability and reliability and opportunities for additional pipeline transmission resources.	Chapter Six discusses NW Natural's assessment of pipeline capability, reliability, and additional pipeline resources.
WAC 480-90-238(3)(f)	Plan includes a comparative evaluation of the cost of natural gas purchasing strategies, storage options, delivery resources, and improvements in conservation using a consistent method to calculate cost-effectiveness.	NW Natural determined the best resource mix by studying supply-side options currently used such as pipeline transportation contracts, and gas supply and renewable natural gas contracts; as well as alternative options such as additional capacity or infrastructure enhancements. The Company also considered future developments such as pipeline enhancements, renewable natural gas projects, power-to-gas (a suite of technologies that use electrolysis in an electrolyzer to separate water molecules into oxygen and hydrogen), and other compliance resources. Chapter Six discusses the various supply-

		side and compliance resource options and their costs. NW Natural compiled demand-side resource options with assistance from the ETO as well as AEG, and these options are identified in Chapter Five. Further, Chapter Two discusses various efficient end use equipment. Utilizing PLEXOS®, the Company determined the least cost resource mix through linear programing optimization as well as performed various sensitivities in its risk analysis, which is discussed in Chapter Seven.
WAC 480-90-238(3)(g)	Plan includes at least a 10-year long-range planning horizon.	The long-range plans NW Natural discusses in this IRP span more than a 10-year planning horizon, with plans out to 2050.
WAC 480-90-238(3)(g)	Demand forecasts and resource evaluations are integrated into the long-range plan for resource acquisition.	This IRP integrates demand forecasts with the cost, risk, and capabilities of alternative resource portfolios into a long-term plan for resource acquisition.
WAC 480-90-238(3)(h)	Plan includes a two-year action plan that implements the long-range plan.	The Action Plan in this IRP details NW Natural's actions related to supply-side, compliance, and demand-side resource acquisition over the next two to four years of the planning horizon.
WAC 480-90-238(3)(i)	Plan includes a progress report on the implementation of the previously filed plan.	Chapters Five, Six, and Eight discuss progress on both the demand- and supply-side activities since the last previously filed plan. Appendix A, Section A.4 discusses progress on Action Items and other key updates since the last previously filed plan.
WAC 480-90-238(5)	Plan includes description of consultation with commission staff. (Description not required).	WUTC Commission Staff was a party to the Technical Working Groups. NW Natural documents public participation in Chapter Ten and Appendix H.
WAC 480-90-238(5)	Plan includes a description of completion of work plan. (Description not required)	The Multi-Year Action Plan in Chapter One and the Technical Working Groups outlined in Chapter Ten serve to document NW Natural's successful completion of the work plan.
2018 IRP Acknowledgement Letter and	The Company should pursue all conservation measures made cost	NW Natural is pursuing all conservation measures considered to be cost effective.

Attachment, Docket UG-170911, Recommendation No. 1	effective by the projected rise in the Company's avoided cost.	
2018 IRP Acknowledgement Letter and Attachment, Docket UG-170911, Recommendation No. 2	The Company must continuously monitor the usage pattern of the interstate pipeline to determine whether the assumptions in the Plan continue to hold true.	The Company continuously monitors the usage pattern of the interstate pipeline and routinely reevaluates assumptions in the plan. Interstate pipelines are discussed in Chapter 6 and Appendix E.
2018 IRP Acknowledgement Letter and Attachment, Docket UG-170911, Recommendation No. 3	The Company should monitor the conditions that affect the zonal configuration of NW Pipeline's system.	The Company collaborates with NW Pipeline to ensure that assumptions around gas deliveries from Williams are valid and gas deliveries are able to reach citygates as modeled in this IRP.
2018 IRP Acknowledgement Letter and Attachment, Docket UG-170911, Recommendation No. 4	[Capacity Planning Standard] We encourage the Company to pursue refinements and verification of this methodology in future IRP cycles, including further analysis of how many years of historical data is appropriate to use in its modeling.	On September 21, 2021, NW Natural held a supplemental Technical Working Group on the topic of Planning Standard during which the Company discussed its method of implementing probabilistic methodology for the capacity planning standard and peak hour standard for distribution system planning.

2018 IRP Acknowledgement Letter and Attachment, Docket UG-170911, Recommendation No. 5	NW Natural should include a sensitivity that does not include a price on carbon for comparison of both emissions and price.	Washington and Oregon established carbon policies of which NW Natural plans to comply.

A.3 Update on Action Items from the 2018 IRP Update #3

Action Description	Update on Action Item
Complete North Coast Uprate Reinforcement Project	The project began in early 2022 for planning, design and assessing permit requirements. It is anticipated construction will be performed in multiple phases beginning in late 2022 or early 2023. Project planned for completion by October 31, 2024.
Complete Replacement of the Cold Box at NW Natural Newport LNG facility	This project is in the initiation phase and will schedule information will remain preliminary until an EPC contractor is selected and begins work. The preliminary schedule estimates design will continue through late 2023. Procurement would begin for long-lead items in mid-2023 with construction following in the second half of 2024. The project is anticipated to be complete and placed into service in Fall 2025.

A.4 Updates from the 2018 IRP

A.4.1 Updates on the 2018 Action Plan

Joint Multiyear Action Plan	
Supply Resource Investments	Update On Action Item
1) Recall 10,000 Dth/day of Mist storage capacity for the 2020-21 gas year. Recall 35,000 Dth/day of Mist storage capacity for the 2021-22 gas year.	Updated load projections resulted in no Mist Recall being required for the 2020-21 gas year. Lower cost Citygate deliveries of 5,000Dth/Day were deployed for the 2021-22 gas year
2) NW Natural will participate in an investigation into the use of the Company's proposed methodology to evaluate renewable natural gas (RNG) cost-effectiveness. Until the investigation is complete, NW Natural will procure RNG deemed cost-effective through the methodology in revised Appendix H, up to a 4.5 million therm annual limit on total delivery, for up to ten years (up to 45 million therms in total). The investigation will review the appropriate process for procuring cost-effective RNG resources that do not align with the timeline of acknowledgement in an IRP as well as review the 4.5 million therm annual limit on cost-effective RNG procurement. If NW Natural seeks to procure additional cost-effective RNG before the conclusion of the investigation, it will seek acknowledgment in an IRP update. If the investigation results in the 4.5 million therm annual limit being adjusted or eliminated, or in other changes, the Commission may direct NW Natural to file an update to reflect its findings.	Docket no. UM 2030 was started in 2019 and completed October 2020. The RNG evaluation methodology was amended and approved and is now being used to evaluate RNG resources.
Oregon-Only Action Plan	
Distribution System Planning Projects	Update On Action Item
3) Proceed with the Hood River Reinforcement project to be in service for the 2019 heating season and at a preliminary estimated cost ranging from $3.5 million to $7 million.	Construction started and the project was placed into service in September 2020 and included in rates.

4) Proceed with the Happy Valley Reinforcement project to be in service for the 2019 heating season and at a preliminary estimated cost ranging from $3 million to $5 million.	Construction started and the project was placed into service in March, 2020 and included in rates.
5) Proceed with the Sandy Feeder Reinforcement project to be in service for the 2020 heating season and at a preliminary estimated cost ranging from $15 million to $21 million.	Construction started and the project was placed into service in October, 2020 and included in rates.
6) Proceed with the South Oregon City Reinforcement project to be in service for the 2020 heating season and at a preliminary estimated cost ranging from $4 million to $6 million.	Construction started and the project was placed into service in April, 2020 and included in rates.
7) Proceed with the Kuebler Road Reinforcement project to be in service for either the 2020 or 2021 heating season and at a preliminary estimated cost ranging from $14 million to $20 million.	Construction for the project began in June, 2022 and is approximately 75% complete. The project is expected to be placed into service in October 2022.
Demand-side Resources	Update On Action Item
9) Working through Energy Trust, NW Natural will acquire therm savings of 5.2 million therms in 2019 and 5.4 million therms in 2020, or the amount identified and approved by the Energy Trust board.	Energy Trust acquired 97% of the 2019 goal on behalf of NW Natural customers. Energy Trust acquired 114% of the 2020 goal on behalf of NW Natural customers.
Washington-Only Action Item	
10) Working through Energy Trust, NW Natural will acquire therm savings of 368,000 therms in 2019 and 375,000 therms in 2020, or the amount identified and approved by the Energy Trust board.	Energy Trust acquired 101% of the 2019 goal on behalf of NW Natural customers. Energy trust acquired 94% of the 2020 goal on behalf of NW Natural customers.

Appendix B: Resource Needs

B.1 Customer Count Forecast Technical Details

Oregon's Office of Economic Analysis (OEA) was the data source of the exogenous variables used in the four econometric customer forecasting models as specified in Equations from (1) to (4) in the 2022 IRP. As OEA forecasts U.S. housing starts and Oregon's nonfarm employment 10 years ahead, NW Natural used Population Research Center (PRC) at Portland State University (PSU)'s long-term forecast of Oregon's population to project U.S. housing starts[1] and Oregon's nonfarm employment beyond 2030, respectively.

Residential:

$$\Delta OR\ customer\ rate_t = \alpha + b_1 \frac{(\Delta OR\ starts_t + \Delta OR\ starts_{t-1})}{2} \quad (1)$$

$$\Delta WA\ customer\ rate_t = \alpha + b_1 \frac{(\Delta \ln (US\ starts_t) + \Delta \ln (US\ starts_{t-1}))}{2} \quad (2)$$

Commercial:

$$\Delta OR\ customer\ rate_t = \alpha + b_1 \frac{(\Delta \ln (OR\ pop_t) + \Delta \ln (OR\ pop_{t-1}) + \Delta \ln (OR\ pop_{t-2}))}{3} \quad (3)$$

$$\Delta WA\ customer\ rate_t = \alpha + b_1 \frac{(\Delta \ln (OR\ emp_t) + \Delta \ln (OR\ emp_{t-1}) + \Delta \ln (OR\ emp_{t-2}))}{3} \quad (4)$$

The dependent and independent variables used in the equations are defined in Table B.1 while the estimated parameters of the equations are reported in Table B.2.

[1] NW Natural projected U.S. housing starts by first using PRC at PSU's forecast of Oregon's population and the 1991–2021 average historical relationship between the annual average rates of growth of U.S. and Oregon's population to project U.S. population beyond 2027. The Company then used the average annual rate of change in projected U.S. population growth to project U.S. housing starts.

Table B.1: Dependent and Independent Variables used in Equations (1) – (4)

Equation	Dependent Variable	Independent variable
(1) OR Residential	OR Residential Customer Growth	Change in housing stock (OR housing Starts)
(2) WA Residential	WA Residential Customer Growth	Change in housing stock (US housing Starts)
(3) OR Commercial	OR Commercial Customer Growth	Population growth (OR population)
(4) WA Commercial	WA Commercial Customer Growth	Local economic activity (Total employment growth in OR)

Table B.2: Parameter Estimates for Equations (1) – (4)

Equation #	α	β_1
1- OR Residential	-158	405**
2- WA Residential	37	1768**
3- OR Commercial	29	64625*
4- WA Commercial	158**	1.3*
† Note that significance levels are indicated by asterisks: *p<0.1, **p<0.05, and ***p<0.01.		

B.1.1 Allocations

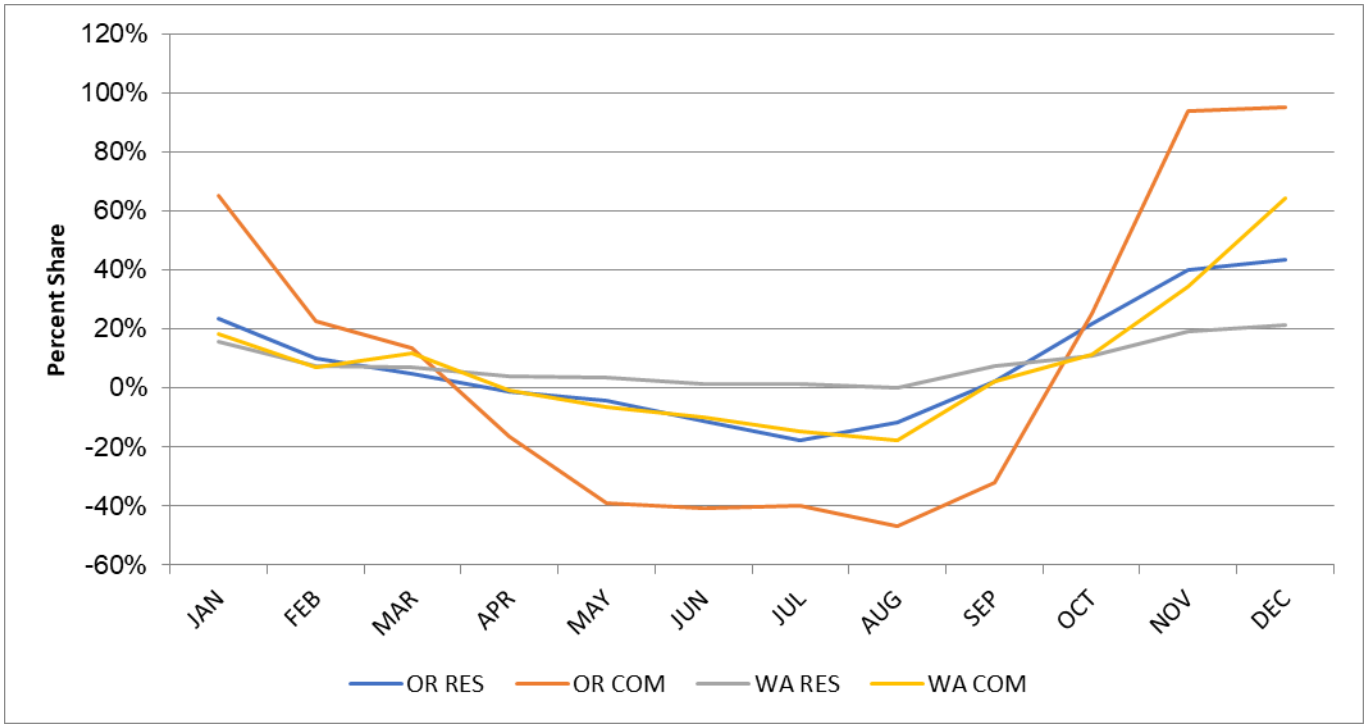
As shown in Table 3.2 Customer Count Series, for purposes of planning associated with the 2022 IRP, NW Natural has 10 load centers: eight in Oregon and two in Washington. The analysis of alternative approaches to forecasting customers described above results in four customer forecasts, each at the state-level: Oregon residential, Oregon commercial, Washington residential, and Washington commercial. As NW Natural has a need to forecast customers not only at the system or state-levels, but also at a more granular distribution level, the Company uses allocation methods to transform the

four state-level forecasts into load center forecasts. Additionally, the customer forecasts at the state-level are for year-end and peak load forecasts require monthly forecasts of customers and NW Natural uses allocation methods to transform year-end customer values into monthly values. Methods used for allocations are described below.

Allocation to Months

Figure B.1 shows the estimated monthly share of calendar year-over-year change in customers represented by each calendar month. Note that monthly share values for Oregon and Washington residential customers and for Washington commercial customers are similar, while those for Oregon Commercial are more extreme.

Figure B.1: Monthly Shares of Calendar Year-over-Year Change in Customers



Allocation to Load Centers

NW Natural allocates month-over-month changes from state-level by month to load center by month on the basis of the contribution of each load center within the state to the increase in state-level customers over the September 2008 through December 2019 timeframe. These allocations are made separately for each of the four customer forecasts; i.e., Oregon residential, Oregon commercial, Washington residential, and Washington commercial.

Table B.3 shows the average annual rates of customer change by load center and state for residential customers and commercial customers over the 2022-2050 planning horizon. Note that NW Natural has provided service to Coos Bay for only two decades and there may be a relatively greater potential for

customer change through conversions from other fuels in this load center than in other parts of the Company's service area.

Table B.3: Average Annual Customer Reference Case Change Rates – 2022-2050

Load Center		Residential	Commercial
	OREGON		
Albany		0.70%	0.60%
Astoria		1.20%	0.40%
Coos Bay		4.70%	4.20%
Columbia River Gorge – OR		1.50%	0.80%
Eugene		1.20%	0.90%
Lincoln City		1.00%	-0.10%
Portland		1.00%	0.80%
Salem		1.00%	1.10%
Total Oregon		**1.00%**	**0.80%**
	WASHINGTON		
Columbia River Gorge – WA		1.70%	0.30%
Vancouver		2.60%	1.90%
Total Washington		**2.60%**	**1.80%**

Allocation to Components of Customer Change

NW Natural models separate usage profiles for existing customers, new construction customer additions, and conversion customer additions. Customer losses are accounted for by a declining existing customer count through time.

NW Natural used the "components" forecasts at state-level and projected customer loss rates based on the SME forecast for 2021-2024 and the new construction rate forecast for 2025 forward to allocate month-end customer levels at the load center level to these components. This was done by state and separately for residential and commercial customers. As the SME panel forecast includes the component detail, these allocations are for 2025 and subsequent years.

B.2 Climate Change Adjusted Weather Forecasts Technical Details

Incorporating data from five different climate models from the Intergovernmental Panel on Climate Change (IPCC), NW Natural has developed a climate change adjusted weather forecast out until 2050. We have selected several representative load centers for the NW Natural service territory, as seen in table.

Table B.4: Climate Change Adjusted Cumulative Annual HDD (base 58°F) Forecasts by Location

Year	Albany	Astoria	Coos Bay	Dallas	Eugene	Lincoln City	Portland	Salem	Vancouver
2022	2488	2574	2039	2797	2551	2407	2077	2443	2528
2023	2403	2444	1892	2752	2452	2237	2030	2337	2483
2024	2494	2611	2014	2815	2542	2411	2091	2455	2579
2025	2302	2440	1884	2502	2337	2245	1897	2228	2343
2026	2421	2515	1973	2719	2477	2324	2044	2374	2501
2027	2681	2801	2296	2988	2726	2630	2303	2632	2729
2028	2397	2501	2027	2639	2439	2355	1974	2323	2437
2029	2372	2500	1978	2686	2421	2336	2046	2338	2464
2030	2405	2513	2002	2671	2448	2332	2033	2360	2472
2031	2624	2789	2259	2952	2663	2595	2254	2581	2698
2032	2542	2678	2167	2832	2587	2502	2135	2500	2618
2033	2252	2396	1856	2501	2309	2218	1872	2203	2297
2034	2465	2563	2129	2703	2551	2455	2049	2401	2473
2035	2207	2242	1780	2442	2316	2088	1814	2150	2243
2036	2181	2324	1762	2412	2236	2135	1831	2127	2234
2037	2266	2326	1828	2559	2333	2175	1903	2207	2321
2038	2047	2146	1585	2304	2097	1980	1691	1987	2106
2039	2075	2130	1577	2292	2097	1952	1703	2020	2129
2040	2280	2356	1849	2572	2339	2154	1912	2220	2350
2041	2361	2483	1944	2566	2395	2326	2004	2275	2415
2042	2246	2388	1791	2512	2273	2211	1879	2180	2302
2043	2223	2226	1666	2446	2233	2061	1795	2131	2254
2044	2210	2264	1733	2483	2249	2110	1841	2123	2273
2045	2119	2263	1660	2453	2156	2075	1809	2047	2210
2046	2187	2341	1737	2453	2193	2159	1861	2126	2297
2047	2174	2273	1753	2522	2232	2112	1866	2137	2298
2048	2281	2328	1807	2528	2300	2151	1899	2188	2316
2049	2277	2365	1883	2490	2317	2262	1903	2217	2331
2050	2239	2319	1748	2482	2284	2115	1852	2210	2312

B.3 Residential and Small Commercial Use per Customer Model Technical Details

In the process of modelling resource needs, we calculate the Use Per Customer (UPC). As detailed in the IRP, use per customer demand is a function of Temperature (T) as follows:

$$\underline{Use\ Per\ Customers\ (UPC)}$$

$$= Y_1 + b_1 * (T) \qquad if\ :\ T \geq K^*$$

$$= Y_2 + b_2 * (T) \qquad if\ :\ T < K^*$$

This formula is used in conjunction with the following table to estimate the UPC for different classes at different temperatures experienced by the system.

Table B.5: UPC Model Coefficients

State	Load Center	Class	Sub-class	k0	k1	y1	b1	b2	y2
OR	ALB	C1	com_exist	55	65	6.669179	-0.06265	-0.55237	34.88348
OR	AST	C1	com_exist	50	61	3.808998	0	-0.43536	28.33427
OR	COOS	C1	com_exist	53	63	4.247724	0	-0.75662	49.61732
OR	DALO	C1	com_exist	55	64	6.312669	-0.04816	-0.51628	33.47306
WA	DALW	C1	com_exist	55	64	6.312669	-0.04816	-0.51628	33.47306
OR	EUG	C1	com_exist	52	64	9.264012	-0.08986	-0.66883	41.67186
OR	LC	C1	com_exist	52	60	5.314521	0	-0.50649	32.63146
OR	POR	C1	com_exist	50	64	8.348593	-0.07674	-0.69673	43.95235
OR	SAL	C1	com_exist	54	64	6.269305	-0.05467	-0.66637	41.07671
WA	VAN	C1	com_exist	50	64	8.754356	-0.08192	-0.64224	40.70289
OR	ALB	R1	res_exist	52	68	1.233887	-0.01193	-0.14742	9.162369
OR	AST	R1	res_exist	50	60	2.208741	-0.02694	-0.15716	9.543513
OR	COOS	R1	res_exist	55	63	0.37091	0	-0.15725	9.658525
OR	DALO	R1	res_exist	50	64	1.322217	-0.0121	-0.10839	7.129867
WA	DALW	R1	res_exist	50	64	1.322217	-0.0121	-0.10839	7.129867
OR	EUG	R1	res_exist	51	67	1.064213	-0.00879	-0.13879	8.674684
OR	LC	R1	res_exist	53	60	2.737316	-0.03725	-0.15457	9.122087
OR	POR	R1	res_exist	50	65	1.798423	-0.01901	-0.1616	10.24808
OR	SAL	R1	res_exist	52	68	1.060155	-0.0087	-0.1594	9.927056
WA	VAN	R1	res_exist	50	66	1.687177	-0.0162	-0.16209	10.23714
OR		C1	com_nc	55	67	4.634968	0	-0.89078	63.75738
OR		C1	com_conv	55	67	3.197445	0	-0.59551	40.3124
WA		C1	com_nc	50	65	3.737502	0	-0.59568	43.12067
WA		C1	com_conv	50	65	3.937895	0	-1.03514	56.96523
OR		R1	res_sfnc	50	67	1.874433	-0.02113	-0.12682	8.2212
OR		R1	res_mfnc	50	67	0.414328	-0.00475	-0.04175	2.370682
OR		R1	res_conv	50	67	0.877146	-0.00973	-0.10727	7.004857
WA		R1	res_conv	53	68	0.265548	0	-0.12328	7.740597
WA		R1	res_sfnc	53	68	0.25363	0	-0.13705	8.493505
WA		R1	res_mfnc	53	68	0.156704	0	-0.04737	2.869121

B.4 Industrial, Large Commercial and Compressed Natural Gas (CNG) Load Forecast Model Technical Details

Using the below equation, Industrial and Large Commercial load is forecasted for our model. D(log) is the first difference logged value. Results from this model are shared in Table B.7.

$$\underline{Industrial\ Load\ Estimation\ Equation}$$

$$\Delta LOG(NW\ Natural\ Industrial\ Demand) = \alpha + \beta * \Delta LOG(Industrial\ Production)$$

Table B.6: Industrial Load Forecast Parameters[2]

Variable	Coefficient	Standard Error
α	-0.016634	0.009474
ΔLOG(Industrial Production)	0.703172	0.216706

[2] Source: OEA.

B.5 Peak Day Forecast Modelling

Table B.7: Model Coefficients – Daily System Load

Driver	Units	Coefficients	Standard Error
Temperature	Hourly Average (°F)	15,852.05	6,749.16
Previous Day Temperature	Hourly Average (°F)	-8,615.11	318.22
+ Temperature Interaction		138.14	6.83
Solar Radiation	Daily Sum (watts/m^2)	-12.72	2.38
+ Temperature Interaction		0.15	0.05
Wind Speed	Hourly Average (mph)	5,341.27	662.89
+ Temperature Interaction		-44.84	15.43
Snow Depth	Daily Measure (inches)	-24,821.04	5,350.68
+ Temperature Interaction		636.52	174.26
Customer Count	N/A	2.67	0.47
+ Temperature Interaction		-0.05	0.01
Friday Indicator	N/A	-35,274.63	7,015.24
+ Temperature Interaction		576.74	154.4
Saturday Indicator	N/A	-52,131.89	7,665.59
+ Temperature Interaction		708.4	172.08
Sunday Indicator	N/A	-44,956.72	6,960.35
+ Temperature Interaction		677.02	156.96
Holiday Indicator	N/A	-26,295.56	3,353.69
Annual Time Trend	Years after 2008	-16,419.67	4,454.15
+ Temperature Interaction		381.99	100.01
Bull Run Creek Temperature	Daily Measure (°F)	-1,539.93	128.64
COVID-19 Indicator		-69,350.23	19140.87
+ Temperature Interaction		1,526.86	429.7813
Constant		-504,550.50	299,508.80

Appendix C: Avoided Costs

C.1 Levelized Avoided Costs by State and End Use

Table C.1: Avoided Cost Summary by State, Year, and Policy

Year	Real (2021$)							
	Infrastructure Costs				Commodity Costs		mental Compliance Costs	
	Supply ($/Dth/Day)	Washington Distribution ($/Dth/Hour)	Oregon Distribution ($/Dth/Hour)	System Distribution ($/Dth/Hour)	Gas and Transport Costs ($/Dth)	Hedge Value ($/Dth)	Oregon Carbon Policy Scenarios: Base Case	Washington Carbon Price:
2022	$0.089	$0.776	$0.469	$0.504	$5.189	$0.149	$5.733	$5.209
2023	$0.089	$0.776	$0.469	$0.504	$4.056	$0.363	$5.786	$5.311
2024	$0.089	$0.776	$0.469	$0.504	$3.149	$0.520	$5.839	$5.412
2025	$0.089	$0.776	$0.469	$0.504	$3.340	$0.605	$5.892	$5.514
2026	$0.089	$0.776	$0.469	$0.504	$3.104	$0.659	$5.946	$5.602
2027	$0.089	$0.776	$0.469	$0.504	$3.105	$0.765	$5.999	$5.691
2028	$0.089	$0.776	$0.469	$0.504	$3.189	$0.727	$6.052	$5.780
2029	$0.089	$0.776	$0.469	$0.504	$3.260	$0.798	$6.105	$5.869
2030	$0.089	$0.776	$0.469	$0.504	$3.234	$0.816	$6.158	$5.957
2031	$0.089	$0.776	$0.469	$0.504	$3.269	$0.810	$6.211	$6.033
2032	$0.089	$0.776	$0.469	$0.504	$3.314	$0.908	$6.264	$6.109
2033	$0.089	$0.776	$0.469	$0.504	$3.375	$0.899	$7.884	$6.185
2034	$0.089	$0.776	$0.469	$0.504	$3.390	$0.967	$7.601	$6.261
2035	$0.089	$0.776	$0.469	$0.504	$3.312	$1.039	$7.308	$6.338
2036	$0.089	$0.776	$0.469	$0.504	$3.330	$1.036	$12.751	$6.439
2037	$0.089	$0.776	$0.469	$0.504	$3.408	$0.953	$12.308	$6.540
2038	$0.089	$0.776	$0.469	$0.504	$3.405	$1.062	$11.874	$6.642
2039	$0.089	$0.776	$0.469	$0.504	$3.411	$1.043	$11.414	$6.743
2040	$0.089	$0.776	$0.469	$0.504	$3.491	$1.106	$10.836	$6.845
2041	$0.089	$0.776	$0.469	$0.504	$3.467	$1.103	$10.350	$6.921
2042	$0.089	$0.776	$0.469	$0.504	$3.604	$1.119	$9.887	$6.997
2043	$0.089	$0.776	$0.469	$0.504	$3.728	$1.120	$9.336	$7.073
2044	$0.089	$0.776	$0.469	$0.504	$3.761	$1.143	$8.871	$7.149
2045	$0.089	$0.776	$0.469	$0.504	$3.836	$1.154	$8.283	$7.225
2046	$0.089	$0.776	$0.469	$0.504	$3.838	$1.264	$7.706	$7.326
2047	$0.089	$0.776	$0.469	$0.504	$3.927	$1.208	$7.262	$7.428
2048	$0.089	$0.776	$0.469	$0.504	$4.019	$1.273	$6.824	$7.529
2049	$0.089	$0.776	$0.469	$0.504	$4.048	$1.248	$6.336	$7.630
2050	$0.089	$0.776	$0.469	$0.504	$4.113	$1.282	$5.832	$7.732
Levelized	**$0.089**	**$0.776**	**$0.469**	**$0.504**	**$3.554**	**$0.862**	**$7.608**	**$6.263**

Figure C.1: Oregon 30-year Levelized Avoided Costs by End Use

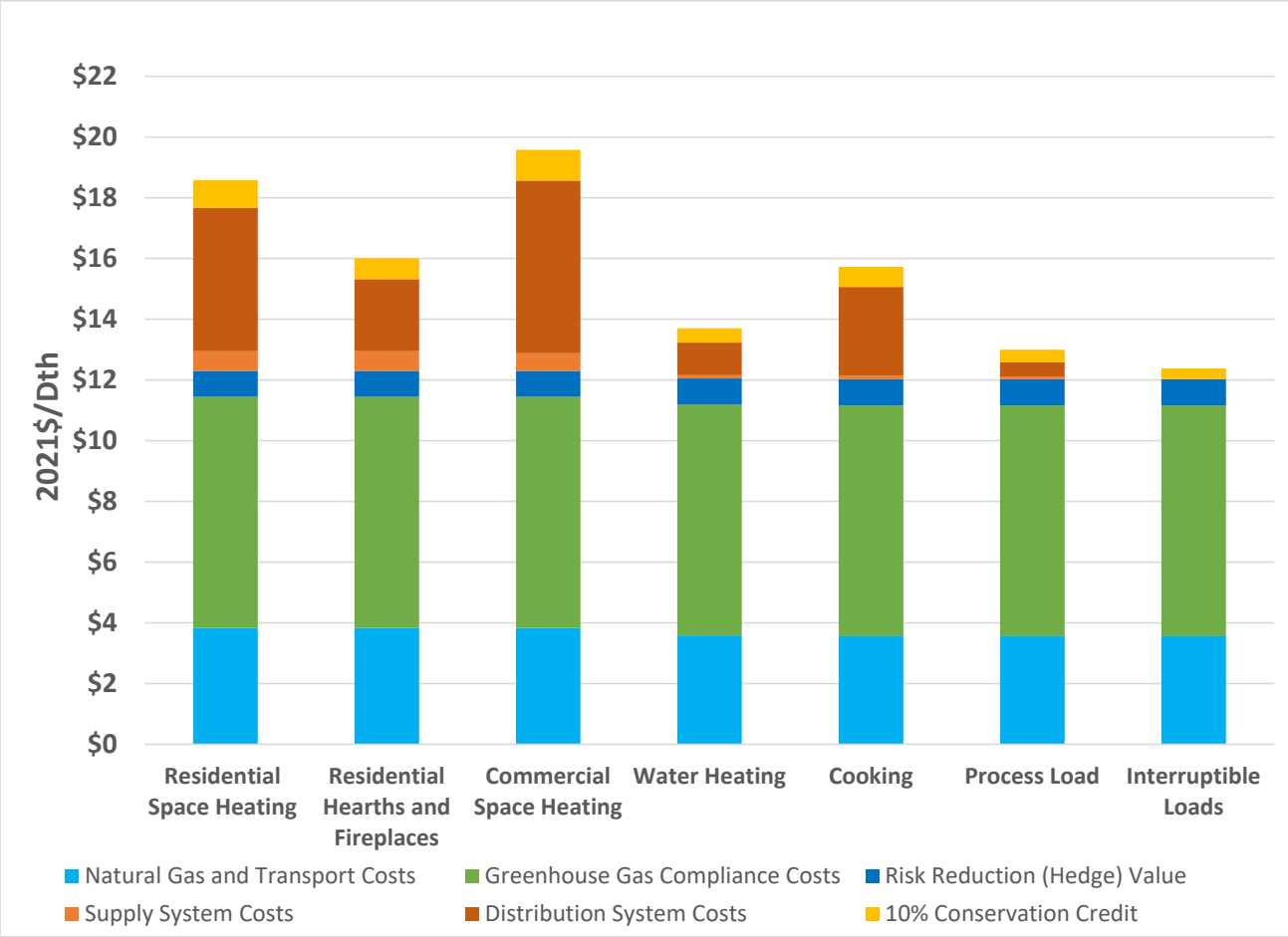


Figure C.2: Washington 30-year Levelized Avoided Costs by End Use

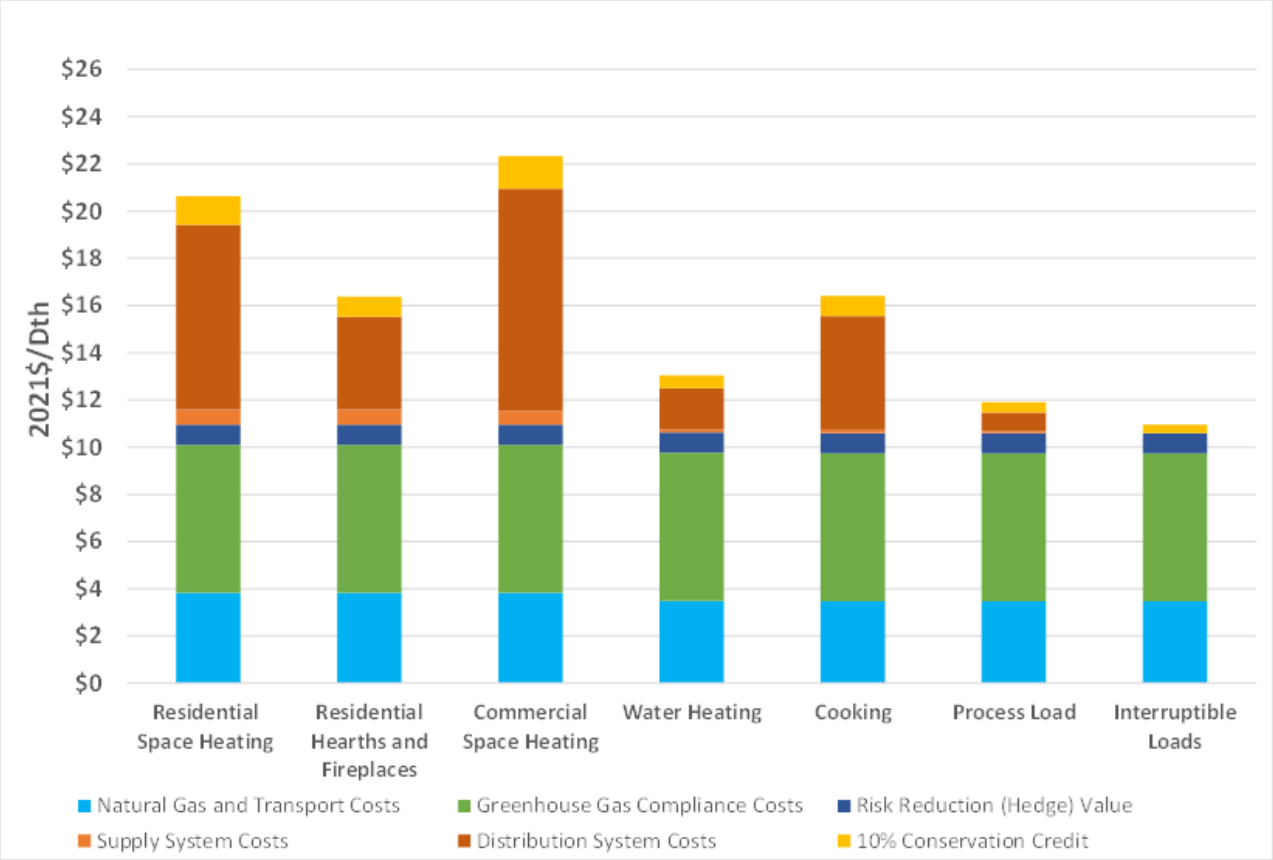


Table C.2: Avoided Cost by Year and End Use

	Oregon Total Avoided Costs by End Use (2021$)							Washington Total Avoided Costs by End Use (2021$)						
	Residential Space Heating	Residential Hearths and Fireplaces	Commercial Space Heating	Water Heating	Cooking	Process Load	Interruptible Load	Residential Space Heating	Residential Hearths and Fireplaces	Commercial Space Heating	Water Heating	Cooking	Process Load	Interruptible Load
2022	$17.41	$14.83	$18.40	$12.88	$14.93	$12.20	$11.59	$20.29	$16.02	$21.98	$13.12	$16.52	$12.02	$11.07
2023	$16.73	$14.15	$17.72	$11.94	$13.95	$11.22	$10.61	$19.66	$15.39	$21.35	$12.23	$15.59	$11.09	$10.13
2024	$16.12	$13.54	$17.11	$11.15	$13.17	$10.44	$9.82	$19.10	$14.83	$20.79	$11.49	$14.85	$10.35	$9.40
2025	$16.37	$13.79	$17.36	$11.49	$13.52	$10.78	$10.17	$19.40	$15.13	$21.09	$11.89	$15.25	$10.74	$9.79
2026	$16.25	$13.67	$17.24	$11.34	$13.36	$10.63	$10.02	$19.31	$15.04	$21.01	$11.77	$15.13	$10.63	$9.68
2027	$16.43	$13.85	$17.42	$11.50	$13.52	$10.79	$10.18	$19.52	$15.26	$21.22	$11.96	$15.32	$10.82	$9.87
2028	$16.57	$14.00	$17.57	$11.61	$13.63	$10.90	$10.29	$19.71	$15.44	$21.40	$12.11	$15.47	$10.97	$10.01
2029	$16.75	$14.17	$17.74	$11.82	$13.83	$11.10	$10.49	$19.92	$15.65	$21.61	$12.35	$15.71	$11.20	$10.25
2030	$16.78	$14.21	$17.78	$11.85	$13.88	$11.15	$10.53	$19.99	$15.72	$21.68	$12.42	$15.78	$11.28	$10.33
2031	$16.87	$14.29	$17.86	$11.94	$13.96	$11.23	$10.62	$20.10	$15.83	$21.79	$12.53	$15.89	$11.39	$10.44
2032	$17.06	$14.48	$18.05	$12.14	$14.16	$11.43	$10.82	$20.31	$16.04	$22.00	$12.75	$16.12	$11.61	$10.66
2033	$18.73	$16.15	$19.72	$13.82	$15.84	$13.11	$12.49	$20.43	$16.16	$22.13	$12.89	$16.25	$11.75	$10.80
2034	$18.51	$15.93	$19.50	$13.62	$15.64	$12.91	$12.30	$20.57	$16.30	$22.26	$13.05	$16.41	$11.91	$10.96
2035	$18.20	$15.62	$19.19	$13.31	$15.33	$12.60	$11.99	$20.63	$16.37	$22.33	$13.11	$16.47	$11.97	$11.02
2036	$23.70	$21.12	$24.69	$18.77	$20.79	$18.06	$17.45	$20.79	$16.52	$22.48	$13.23	$16.59	$12.09	$11.14
2037	$23.21	$20.63	$24.20	$18.33	$20.35	$17.62	$17.01	$20.85	$16.58	$22.54	$13.33	$16.70	$12.19	$11.24
2038	$22.87	$20.30	$23.87	$18.00	$20.02	$17.29	$16.68	$21.05	$16.78	$22.74	$13.53	$16.90	$12.40	$11.45
2039	$22.43	$19.85	$23.42	$17.53	$19.55	$16.82	$16.21	$21.17	$16.90	$22.86	$13.63	$16.99	$12.49	$11.54
2040	$21.97	$19.39	$22.96	$17.10	$19.13	$16.40	$15.78	$21.38	$17.11	$23.07	$13.87	$17.24	$12.74	$11.79
2041	$21.49	$18.92	$22.49	$16.59	$18.61	$15.88	$15.27	$21.47	$17.20	$23.16	$13.93	$17.29	$12.79	$11.84
2042	$21.19	$18.61	$22.18	$16.29	$18.31	$15.58	$14.97	$21.71	$17.44	$23.40	$14.17	$17.53	$13.03	$12.08
2043	$20.74	$18.16	$21.73	$15.87	$17.90	$15.17	$14.56	$21.88	$17.61	$23.57	$14.38	$17.75	$13.25	$12.29
2044	$20.37	$17.79	$21.36	$15.47	$17.49	$14.76	$14.15	$22.05	$17.78	$23.74	$14.52	$17.88	$13.38	$12.43
2045	$19.83	$17.25	$20.82	$14.97	$17.00	$14.27	$13.66	$22.18	$17.91	$23.87	$14.68	$18.05	$13.55	$12.60
2046	$19.41	$16.83	$20.40	$14.51	$16.54	$13.80	$13.19	$22.43	$18.16	$24.12	$14.90	$18.27	$13.76	$12.81
2047	$19.00	$16.42	$19.99	$14.11	$16.13	$13.40	$12.79	$22.57	$18.30	$24.26	$15.04	$18.41	$13.91	$12.96
2048	$18.70	$16.12	$19.69	$13.83	$15.86	$13.13	$12.52	$22.81	$18.54	$24.50	$15.30	$18.68	$14.17	$13.22
2049	$18.23	$15.65	$19.22	$13.35	$15.38	$12.65	$12.04	$22.93	$18.66	$24.62	$15.42	$18.79	$14.28	$13.33
2050	$17.94	$15.36	$18.93	$12.96	$14.98	$12.25	$11.64	$23.25	$18.98	$24.94	$15.63	$18.99	$14.49	$13.54
Levelized	**$18.58**	**$16.00**	**$19.57**	**$13.70**	**$15.72**	**$12.99**	**$12.38**	**$20.64**	**$16.37**	**$22.33**	**$13.12**	**$16.49**	**$11.98**	**$11.03**

C.2 Avoided Costs by IRP and State

Figure C.3: Oregon Levelized Costs by IRP

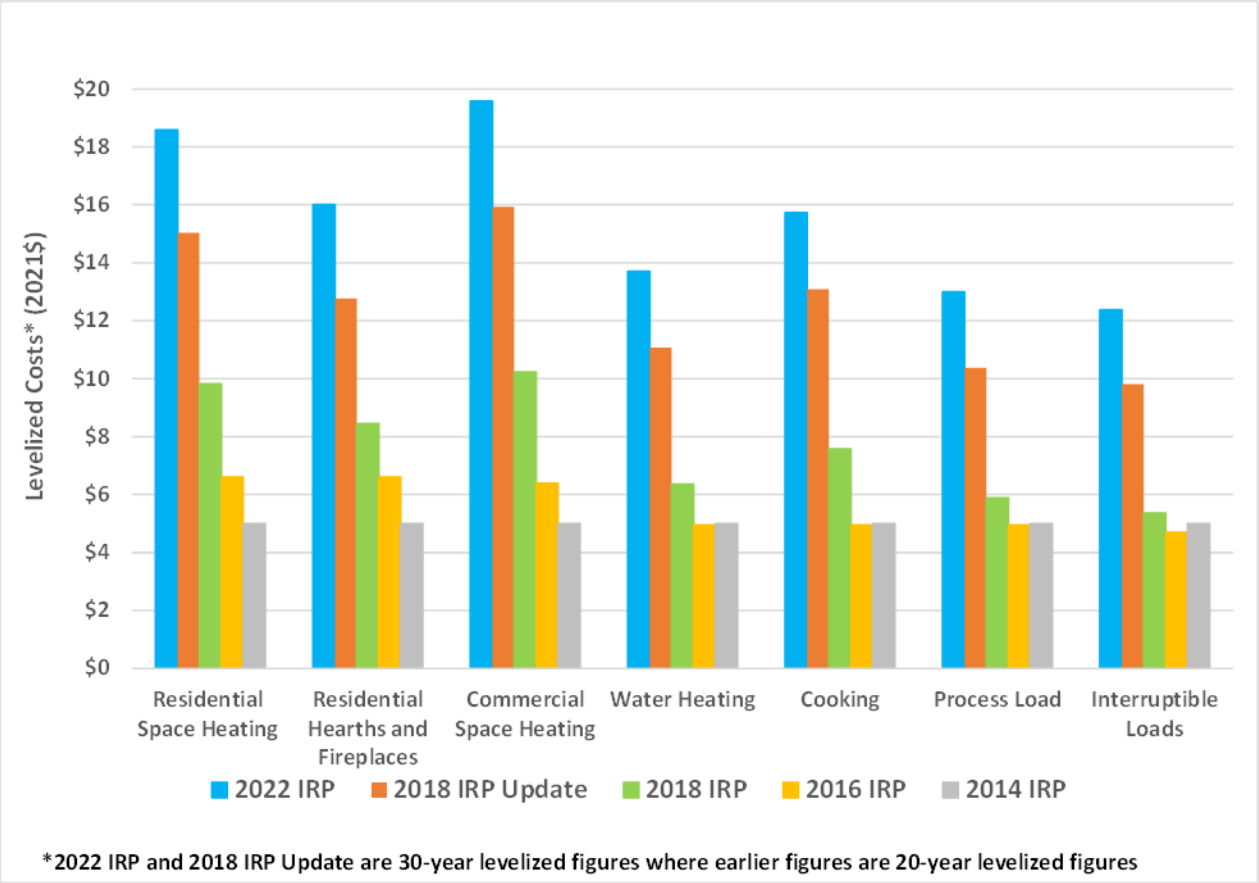
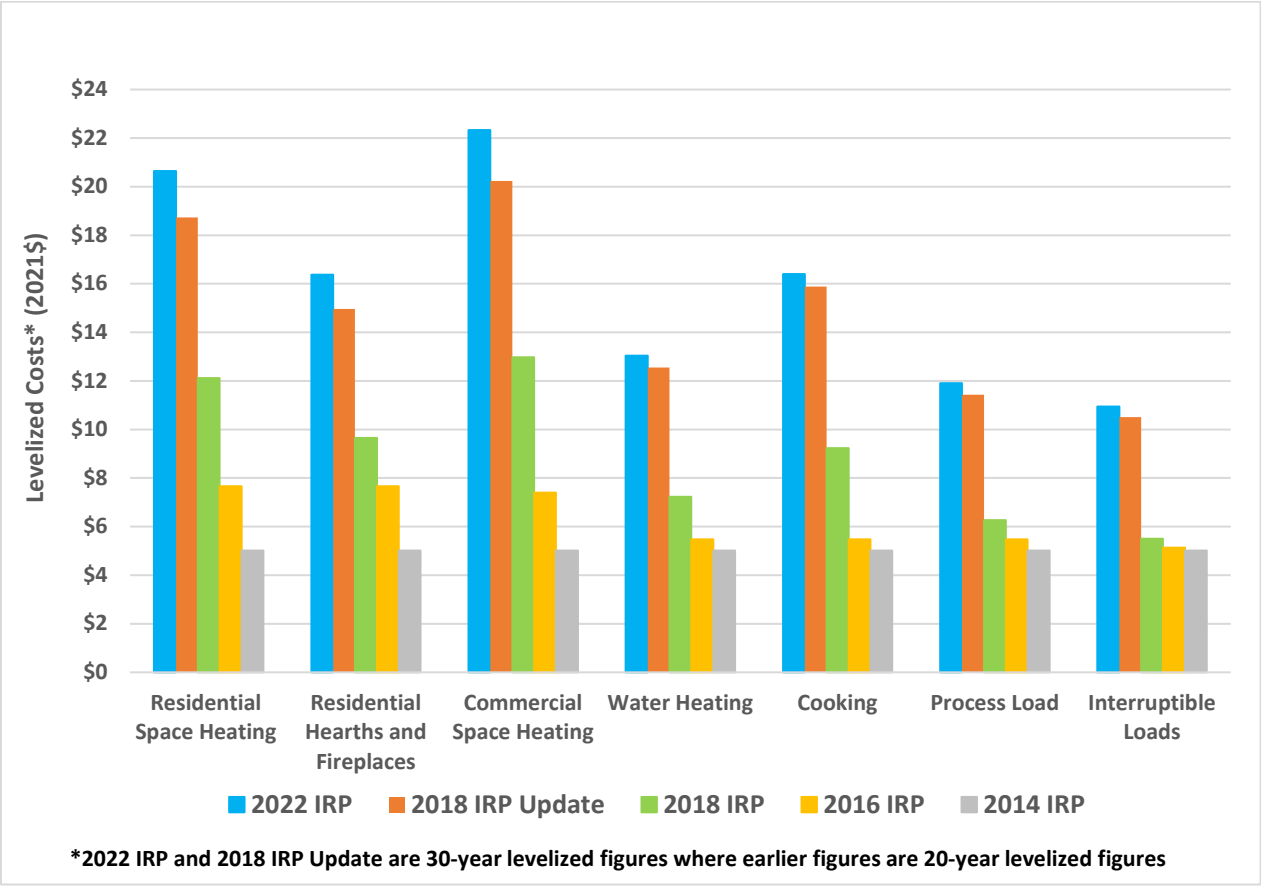


Figure C.4: Washington Levelized Costs by IRP



***2022 IRP and 2018 IRP Update are 30-year levelized figures where earlier figures are 20-year levelized figures**

Figure C.5: Oregon Change in Levelized Costs: 2022 IRP vs 2018 IRP Update

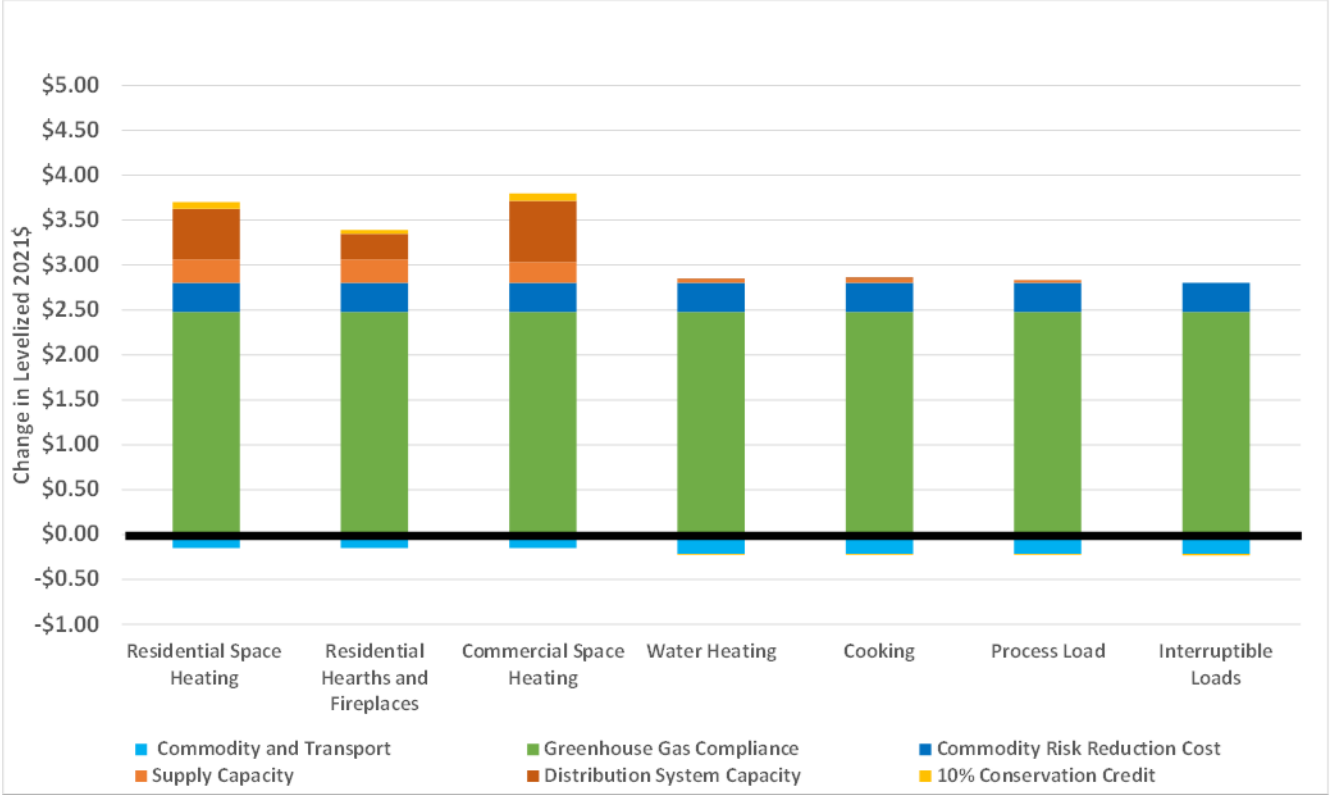
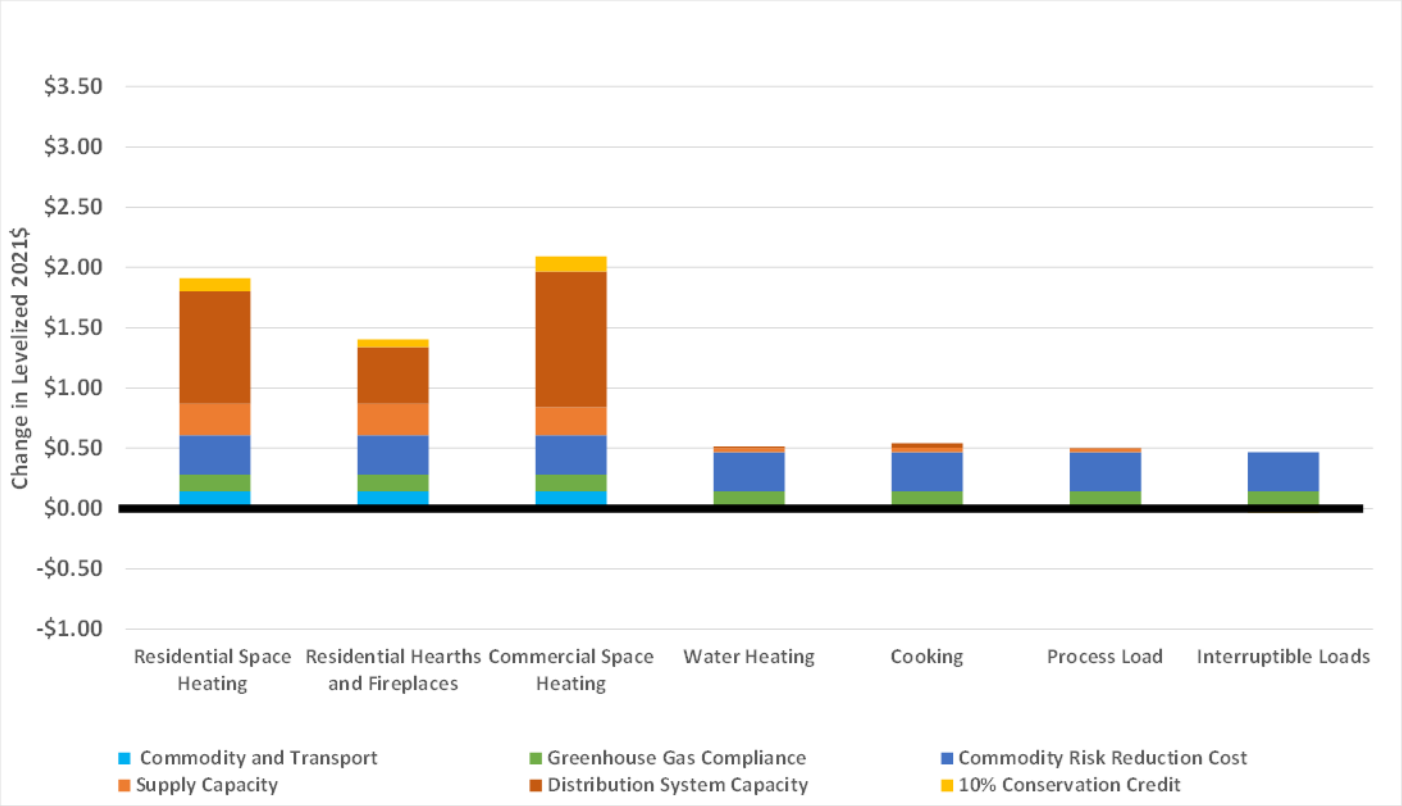


Figure C.6: Washington Change in Levelized Costs: 2022 IRP vs 2018 IRP Update



C.3 Total Avoided Costs by End Use and Year

Figure C.7: Oregon Total Avoided Costs by End Use and Year

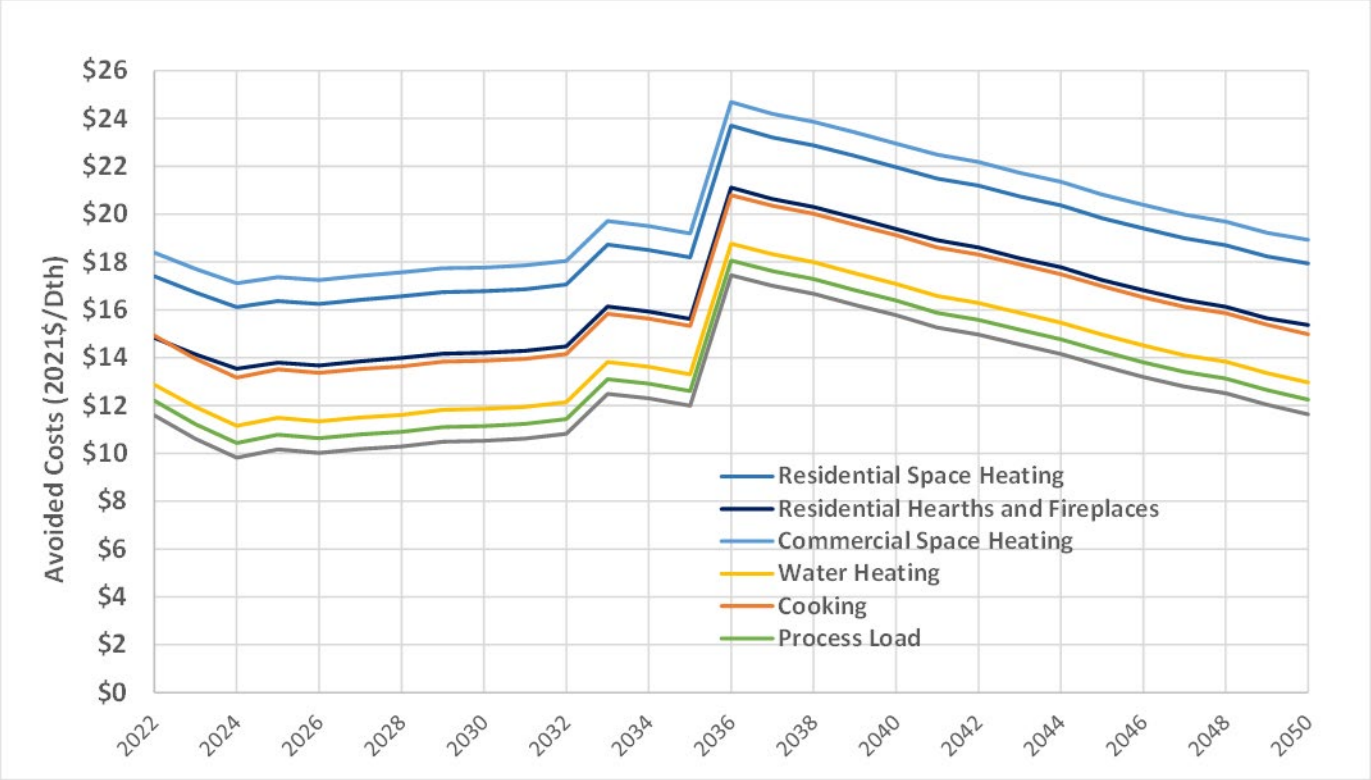


Figure C.8: Washington Total Avoided Costs by End Use and Year

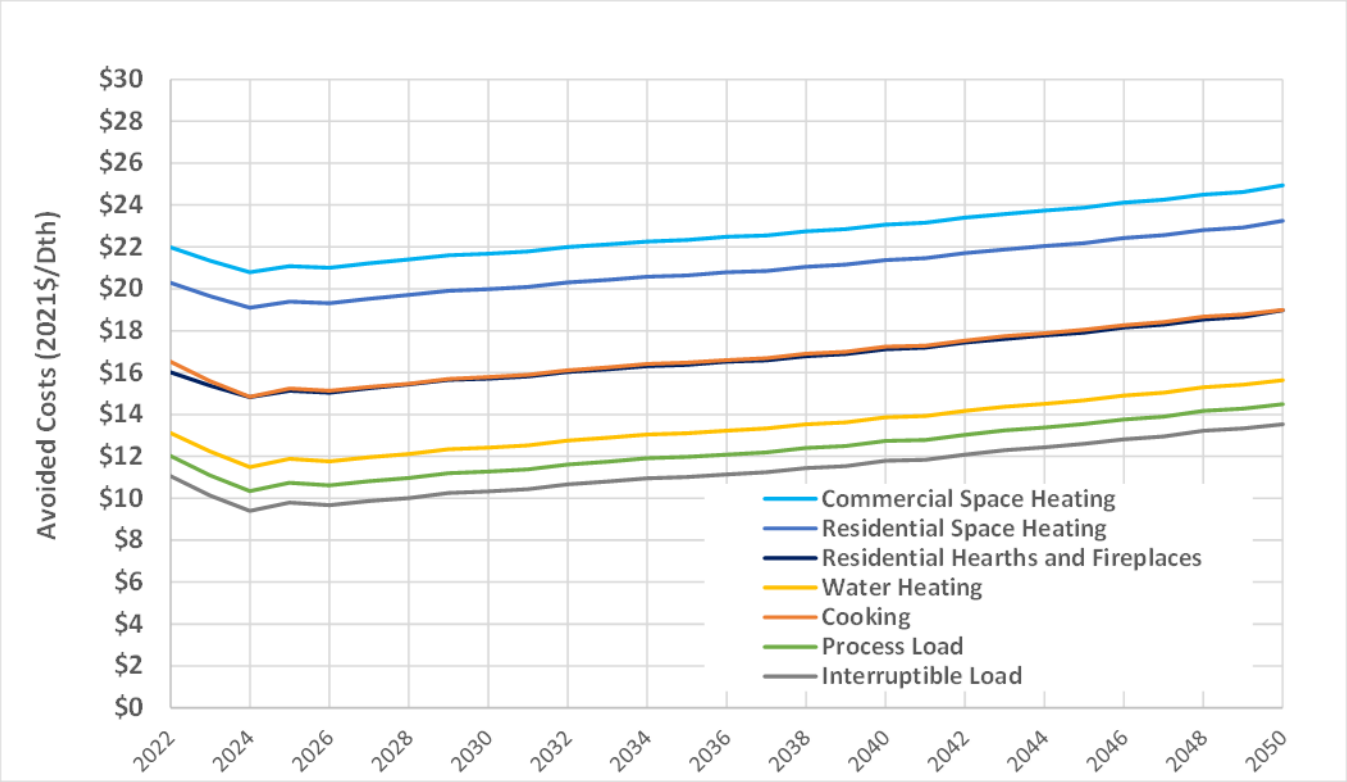


Figure C.9: Residential Space Heating Avoided Cost Breakdown – Oregon

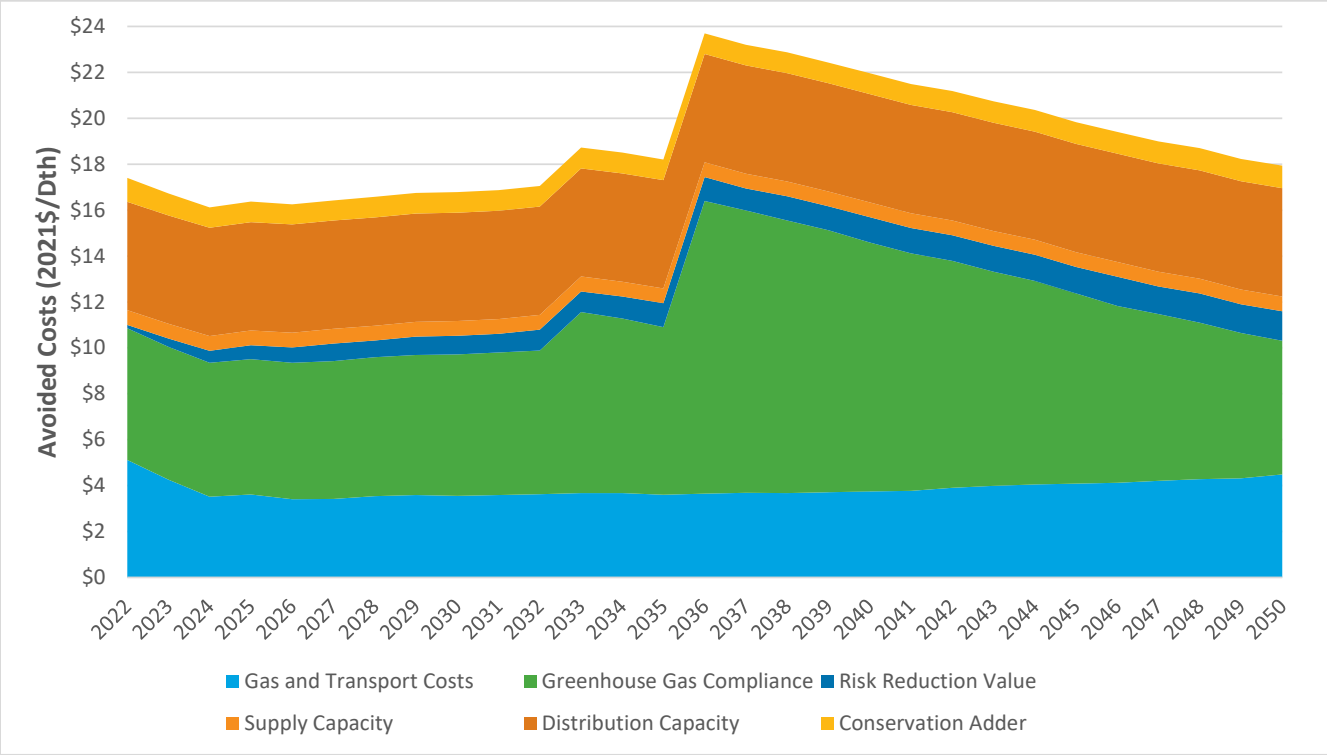
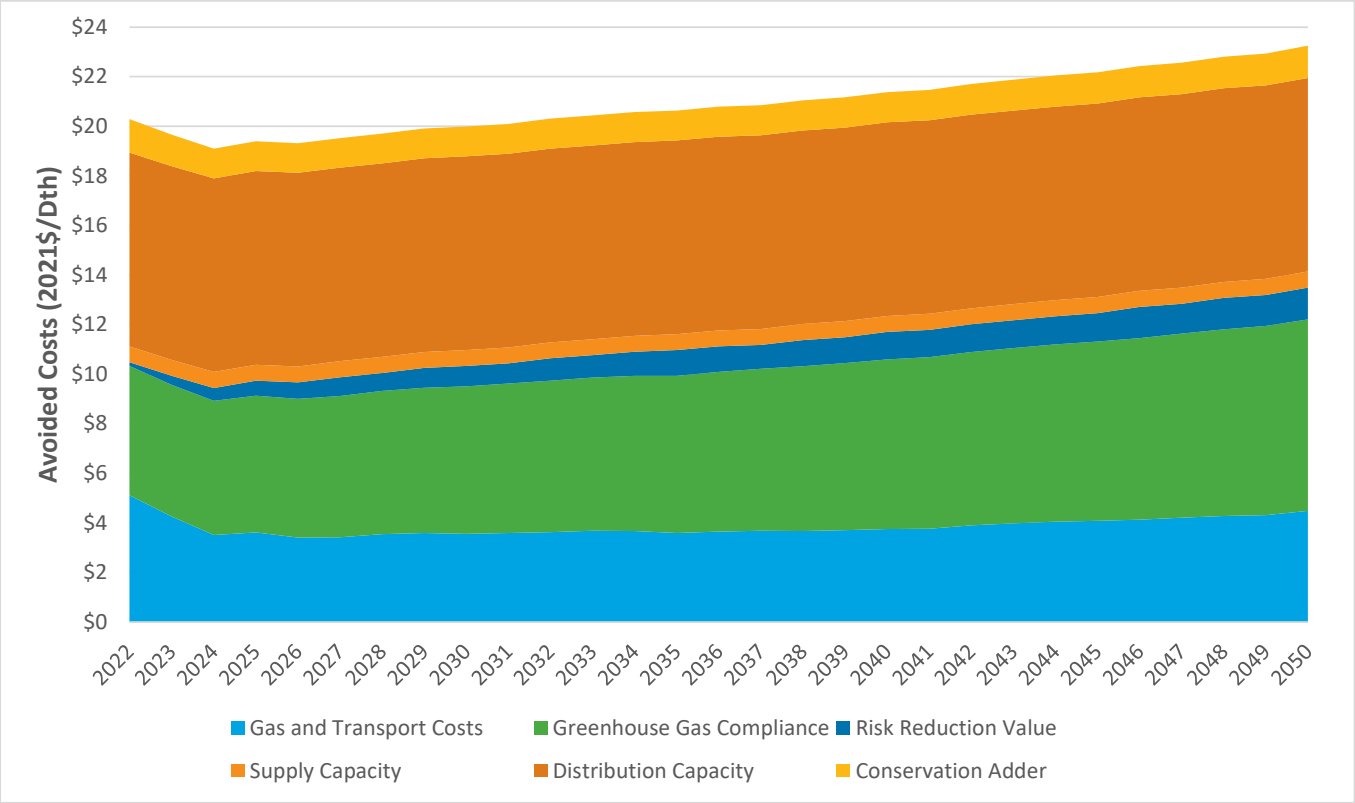


Figure C.10: Residential Space Heating Avoided Cost Breakdown– Washington



Appendix D: Demand-Side Resources

D.1 Deployment Summary[3]

See following pages

Table D.1: Oregon Deployment Summary 2022-2031

Gross Savings (Therms)		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
New Buildings (Includes MF)	Com-New	359,446	311,166	299,823	295,903	298,584	293,030	306,078	320,806	332,610	345,016
	NEEA-MartetTX	122,242	367,872	385,638	385,638	385,638	378,826	372,135	365,561	359,104	352,761
Existing Buildings (No MF)	Com-ROB	221,743	320,669	333,054	347,365	348,776	367,482	383,907	398,060	410,154	420,707
	Com-SEM	285,575	418,683	444,633	479,044	485,792	482,760	511,022	524,242	519,899	497,621
	Com-RET	1,252,113	1,706,450	1,804,364	1,794,076	1,719,743	1,615,804	1,472,899	1,386,060	1,177,535	951,104
Industrial	Ind-RET	1,218,366	1,422,372	1,527,633	1,754,348	1,756,483	1,560,709	1,415,177	1,183,336	916,988	665,824
	Ind-SEM	27,988	30,000	30,000	30,000	30,000	29,622	29,345	29,069	28,792	28,404
	Ind-ROB	54,910	64,936	69,741	80,091	80,189	81,257	81,752	82,212	82,686	83,163
Residential New	Res-ManufNH	1,590	3,394	3,394	3,394	3,394	3,340	3,280	3,215	3,147	3,076
	Res-NewHomes	255,034	247,674	145,991	145,991	145,991	186,669	234,560	288,258	358,029	426,311
	Res-MarketTx	820,903	870,834	1,261,157	1,261,156	1,261,157	1,246,781	1,236,441	1,219,839	1,201,150	1,179,261
Residential Existing	Res-Tstat	574,496	705,768	1,013,410	1,064,081	1,117,285	1,057,379	1,004,745	880,335	711,649	534,480
	Res-TstatOpt	40,390	3,527	4,341	4,341	4,341	24,462	42,551	58,467	72,064	83,194
	Res-WaterHeat	37,539	32,986	41,232	41,232	41,232	78,543	124,096	178,502	241,961	312,936
	Res-Shell	186,605	464,534	444,344	411,719	434,444	475,058	525,361	558,933	569,174	552,569
	Res-Heat-ROB	257,703	317,791	376,317	376,317	376,317	430,711	487,492	546,150	658,470	729,087
Multi-family Existing	MF-RET	48,845	65,329	68,060	68,775	66,396	53,386	44,556	33,898	23,782	15,649
	MF-ROB	87,791	126,957	131,860	137,526	138,084	142,490	145,887	135,532	138,790	140,288
Other	Large-Project Adder	-	-	250,190	250,190	250,190	250,190	250,190	250,190	250,190	250,190
	Com-Cooking	269,935	269,229	274,888	273,136	280,248	288,500	304,584	298,608	329,099	339,447
	Total	**6,123,213**	**7,750,168**	**8,910,070**	**9,204,324**	**9,224,283**	**9,046,998**	**8,976,058**	**8,741,271**	**8,385,273**	**7,911,087**

[3] Provided by the Energy Trust of Oregon

Table D.2: Oregon Deployment Summary 2032-2041

Gross Savings (Therms)		2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	Total
New Buildings (Includes MF)	Com-New	356,429	368,124	378,712	389,431	397,989	411,209	418,551	427,635	436,882	446,892	7,194,314
	NEEA-MartetTX	346,530	340,409	334,396	328,489	322,687	316,987	311,388	305,888	300,485	295,177	6,677,850
Existing Buildings (No MF)	Com-ROB	427,461	423,704	424,381	417,961	314,368	313,100	321,174	324,487	280,479	229,951	7,028,983
	Com-SEM	459,479	409,603	353,234	295,580	240,877	191,911	150,099	115,649	75,851	-	6,941,554
	Com-RET	736,533	553,203	364,862	93,825	61,697	45,676	47,463	47,971	47,020	44,623	16,923,018
Industrial	Ind-RET	459,807	306,262	200,905	131,482	32,547	13,632	14,298	14,551	14,350	13,637	14,622,706
	Ind-SEM	27,961	27,343	26,791	26,220	25,668	25,021	24,453	23,612	23,612	23,124	547,028
	Ind-ROB	83,663	83,979	84,527	85,048	85,665	85,978	86,593	87,235	71,564	52,964	1,568,151
Residential New	Res-ManufNH	3,101	3,028	2,955	2,929	2,855	2,829	2,755	2,729	2,656	2,582	59,640
	Res-NewHomes	466,792	501,887	575,577	651,840	702,185	744,127	810,597	872,941	929,569	988,534	9,678,559
	Res-MarketTx	1,080,834	984,912	969,147	953,242	902,688	851,020	834,420	817,960	801,362	791,860	20,546,124
Residential Existing	Res-Tstat	377,392	254,040	165,202	67,683	-	-	-	-	-	-	9,527,945
	Res-TstatOpt	91,706	105,028	117,817	130,024	141,596	39,690	-	-	-	-	963,537
	Res-WaterHeat	390,302	471,231	552,111	629,201	699,413	760,905	813,239	857,110	893,851	924,975	8,122,597
	Res-Shell	510,309	448,373	375,770	301,802	232,598	174,699	128,272	92,517	65,851	31,639	6,984,574
	Res-Heat-ROB	795,126	860,256	923,720	984,821	1,042,959	1,097,649	1,148,532	1,195,384	1,238,102	1,276,696	15,119,602
Multi-family Existing	MF-RET	9,830	3,454	-	-	-	-	-	-	-	-	501,960
	MF-ROB	141,173	143,040	136,555	136,869	131,023	130,050	128,637	129,697	141,977	86,404	2,630,630
Other	Large-Project Adder	250,190	250,190	250,190	250,190	250,190	250,190	250,190	250,190	250,190	250,190	4,503,423
	Com-Cooking	365,716	351,959	379,521	387,447	413,574	391,257	417,357	423,554	450,636	425,190	6,933,882
	Total	**7,380,334**	**6,890,025**	**6,616,373**	**6,264,086**	**6,000,579**	**5,845,930**	**5,908,019**	**5,989,110**	**6,024,436**	**5,884,439**	**147,076,076**

Table D.3: Oregon Deployment Summary 2041-2050

Gross Savings (Therms)		2042	2043	2044	2045	2046	2047	2048	2049	2050	Total
New Buildings (Includes MF)	Com-New	453,346	456,341	462,099	466,565	470,927	477,998	482,517	486,536	490,536	11,441,179
	NEEA-MartetTX	289,963	284,841	279,810	274,867	270,012	265,243	260,557	255,955	251,434	9,110,532
Existing Buildings (No MF)	Com-ROB	233,847	211,126	246,036	241,161	267,003	223,846	255,330	253,444	278,312	9,239,088
	Com-SEM	-	-	-	-	-	-	-	-	-	6,941,554
	Com-RET	40,999	36,447	31,445	26,398	21,636	17,373	13,714	10,676	8,220	17,129,926
Industrial	Ind-RET	12,573	11,222	9,724	8,166	6,715	5,409	4,286	3,336	2,577	14,686,714
	Ind-SEM	-	-	-	-	-	-	-	-	-	547,028
	Ind-ROB	33,794	11,452	12,233	12,953	13,704	14,437	15,160	15,786	16,429	1,714,100
Residential New	Res-ManufNH	2,514	2,490	2,423	2,356	2,294	2,272	2,210	2,149	2,092	80,441
	Res-NewHomes	996,269	1,003,108	1,008,698	1,022,373	1,038,722	1,053,814	1,067,282	1,089,063	1,112,612	19,070,499
	Res-MarketTx	776,415	761,099	745,654	736,813	722,441	708,190	693,819	685,593	672,220	27,048,368
Residential Existing	Res-Tstat	-	-	-	-	-	-	-	-	-	9,527,945
	Res-TstatOpt	-	-	-	-	-	-	-	-	-	963,537
	Res-WaterHeat	895,528	870,346	851,982	820,999	805,125	734,146	510,433	489,622	511,518	14,612,296
	Res-Shell	-	-	-	-	-	-	-	-	-	6,984,574
	Res-Heat-ROB	1,311,264	1,341,983	1,365,778	1,388,218	1,408,805	1,536,035	1,555,628	1,571,729	1,592,070	28,191,111
Multi-family Existing	MF-RET	-	-	-	-	-	-	-	-	-	501,960
	MF-ROB	77,704	49,887	56,307	55,737	58,611	33,319	37,867	34,034	37,747	3,071,843
Other	Large-Project Adder	250,190	250,190	250,190	250,190	250,190	250,190	250,190	250,190	250,190	6,755,134
	Com-Cooking	263,108	237,452	212,814	99,473	120,885	64,519	86,132	40,722	49,509	8,108,496
	Total	**5,637,513**	**5,527,985**	**5,535,192**	**5,406,270**	**5,457,072**	**5,386,789**	**5,235,125**	**5,188,835**	**5,275,467**	**195,726,325**

D.2 Measure Levels[4]

See following pages

Table D.4: Oregon 20-Year Cumulative Potential (Commercial)

Sector	Measure Name	Measure Type	End Use	20-year Cumulative Technical Potential (therms)	20-year Cumulative Achievable Potential (therms)	20-year Cumulative Cost-Effective Potential (therms)	% of Total Sector C/E Potential	Average Levelized Cost ($/therm)
Commercial	Com - SEM GAS SPHT	Retrofit	Behavioral	8,166,534	6,941,554	6,941,554	13%	$1.05
Commercial	Com - Zero Net Energy	New Construction	Other	5,363,675	4,559,124	-	0%	$7.87
Commercial	Com - Gas Fryer	Replace on Burnout	Cooking	5,334,679	4,534,477	4,534,477	8%	$0.37
Commercial	Com - Gas Absorption HPWH GAS WHT	Replace on Burnout	Water Heating	4,438,716	3,772,909	3,772,909	7%	$0.08
Commercial	Com - Demand Controlled Ventilation GAS SPHT	Retrofit	Ventilation	4,421,679	3,758,427	3,758,427	7%	$0.15
Commercial	Com - NC Package (10% Better than Code)	New Construction	Other	4,393,399	3,734,389	3,277,208	6%	$1.23
Commercial	Com - Condensing Boiler GAS SPHT	Replace on Burnout	Heating	4,372,284	3,716,441	3,716,441	7%	$0.44
Commercial	Com - EMS GAS SPHT	Retrofit	Behavioral	3,218,829	2,736,005	2,736,005	5%	$1.00
Commercial	Com - Condensing Gas RTU GAS SPHT	Replace on Burnout	Heating	2,438,840	2,073,014	2,073,014	4%	$0.74
Commercial	Com - Refrig - Retrofit Doors to Open Display Cases GAS SPHT	Retrofit	Refrigeration	2,326,388	2,210,068	2,210,068	4%	$0.69
Commercial	Com - Gas RTU Advanced Tier 1 Package Upgrade GAS SPHT	Retrofit	Heating	2,137,330	1,816,730	1,816,730	3%	$1.03
Commercial	Com - WiFi Connected Thermostat GAS SPHT	Retrofit	Heating	2,124,080	1,805,468	1,805,468	3%	$0.88
Commercial	Com - Pipe Insulation DHW GAS WHT	Retrofit	Water Heating	1,995,338	1,696,038	1,696,038	3%	$0.36
Commercial	Com - Gas Absorption HPWH GAS WHT - NEW only	New Construction	Water Heating	1,754,052	1,490,944	1,490,944	3%	$0.07
Commercial	Com - Automatic Conveyor Broiler Gas	Replace on Burnout	Cooking	1,716,965	1,459,420	1,459,420	3%	-$0.18
Commercial	Com - Roof Insulation R0 Base GAS SPHT, Z1	Retrofit	Weatherization	1,535,486	921,292	921,292	2%	$0.19
Commercial	Com - Pipe Insulation Space Heating Boiler	Retrofit	Heating	1,468,966	1,248,621	1,248,621	2%	$0.28
Commercial	Com - Condensing Boiler GAS SPHT - NEW only	New Construction	Heating	1,334,287	1,134,144	1,134,144	2%	$0.65
Commercial	Com - Gas Combination Oven	Replace on Burnout	Cooking	1,259,948	1,070,956	1,070,956	2%	$0.00
Commercial	Com - Gas Fryer - NEW Only	New Construction	Cooking	1,198,603	1,018,812	1,018,812	2%	$0.37
Commercial	Com - Efficient Windows GAS SPHT - NEW only	New Construction	Weatherization	1,108,481	665,088	299,328	1%	$2.09
Commercial	Com - Gas Fired Heat Pump GAS SPHT	Replace on Burnout	Heating	1,013,909	963,214	963,214	2%	$0.94
Commercial	Com - WiFi Connected Thermostat GAS SPHT - NEW only	New Construction	Heating	914,956	869,209	854,457	2%	$0.85
Commercial	Com - Gas Griddle	Replace on Burnout	Cooking	883,149	750,676	750,676	1%	$1.04
Commercial	Com - VFD Kitchen Vent Hood GAS SPHT	Retrofit	Heating	878,859	747,030	747,030	1%	$1.24
Commercial	Com - Efficient Windows GAS SPHT	Retrofit	Weatherization	683,398	410,039	-	0%	$16.33
Commercial	Com - Condensing Gas Furnace GAS SPHT	Replace on Burnout	Heating	612,406	520,545	520,545	1%	$0.84
Commercial	Com - Gas Fired Heat Pump GAS SPHT - NEW only	New Construction	Heating	567,365	538,997	538,997	1%	$0.89
Commercial	Com - DHW Circulator Pumps/Controls GAS WHT	Retrofit	Water Heating	554,569	526,841	526,841	1%	$0.30
Commercial	Com - Gas Convection Oven	Replace on Burnout	Cooking	393,598	334,558	334,558	1%	$0.41
Commercial	Com - Automatic Conveyor Broiler Gas - NEW Only	New Construction	Cooking	382,986	325,538	325,538	1%	-$0.18
Commercial	Com - Hot Water Temperature Reset GAS SPHT	Retrofit	Heating	333,108	283,142	283,142	1%	$0.26
Commercial	Com - Thin Triple Pane Windows GAS SPHT - NEW only	New Construction	Weatherization	332,852	199,711	-	0%	$16.62

[4] Provided by the Energy Trust of Oregon

Table D.4- Continued: Oregon 20-Year Cumulative Potential (Commercial)

Sector	Measure Name	Measure Type	End Use	20-year Cumulative Technical Potential (therms)	20-year Cumulative Achievable Potential (therms)	20-year Cumulative Cost-Effective Potential (therms)	% of Total Sector C/E Potential	Average Levelized Cost ($/therm)
Commercial	Com - Gas Combination Oven - NEW Only	New Construction	Cooking	248,411	211,150	211,150	0%	$0.00
Commercial	Com - Thin Triple Pane Windows GAS SPHT	Retrofit	Weatherization	216,469	129,881	-	0%	$16.38
Commercial	Com - Gas Griddle - NEW Only	New Construction	Cooking	191,529	162,800	162,800	0%	$1.03
Commercial	Com - VFD Kitchen Vent Hood GAS SPHT - NEW Only	New Construction	Heating	188,413	160,151	160,151	0%	$1.24
Commercial	Com - PreRinse Spray Valve GAS WHT	Retrofit	Water Heating	184,751	157,039	157,039	0%	-$3.07
Commercial	Com - Wall Insulation GAS SPHT, Z1	Retrofit	Weatherization	180,468	108,281	-	0%	$0.54
Commercial	Com - Roof Insulation R5 Base GAS SPHT, Z1	Retrofit	Weatherization	180,161	108,097	108,097	0%	$1.38
Commercial	Com - Gas Steamer	Replace on Burnout	Cooking	141,034	119,879	119,879	0%	-$2.43
Commercial	Com - Modulating Burner GAS SPHT	Retrofit	Heating	108,283	92,041	92,041	0%	$0.47
Commercial	Com - Gas Convection Oven - NEW Only	New Construction	Cooking	79,743	67,782	67,782	0%	$0.41
Commercial	Com - Pool Heaters Indoor	Replace on Burnout	Water Heating	67,056	56,997	56,997	0%	$0.40
Commercial	Com - Eff. Gas Clothes Washer	Replace on Burnout	Appliance	65,730	62,443	62,443	0%	$0.79
Commercial	Com - Condensing Gas Storage Water Heater GAS WHT - NEW only	New Construction	Water Heating	54,311	46,164	46,164	0%	$0.01
Commercial	Com - Steam Trap Maintenance GAS SPHT	Retrofit	Heating	44,478	37,806	37,806	0%	$0.18
Commercial	Com - Pool Heaters Outdoor	Replace on Burnout	Water Heating	41,159	34,985	34,985	0%	$0.38
Commercial	Com - Gas Steamer - NEW Only	New Construction	Cooking	29,313	24,916	24,916	0%	-$2.43
Commercial	Com - Roof Insulation R0 Base GAS SPHT, Z2	Retrofit	Weatherization	23,430	14,058	14,058	0%	$0.13
Commercial	Com - Condensing Gas Instantaneous Water Heater GAS WHT - NEW only	New Construction	Water Heating	15,549	13,217	13,217	0%	$0.01
Commercial	Com - Eff. Gas Clothes Washer - NEW Only	New Construction	Appliance	10,831	10,289	10,289	0%	$0.79
Commercial	Com - Wall Insulation GAS SPHT, Z2	Retrofit	Weatherization	3,255	1,953	-	0%	$0.30
Commercial	Com - Roof Insulation R5 Base GAS SPHT, Z2	Retrofit	Weatherization	3,033	1,820	1,820	0%	$0.83

Table D.5: Oregon 20-Year Cumulative Potential (Industrial)

Sector	Measure Name	Measure Type	End Use	20-year Cumulative Technical Potential (therms)	20-year Cumulative Achievable Potential (therms)	20-year Cumulative Cost-Effective Potential (therms)	% of Total Sector C/E Potential	Average Levelized Cost ($/therm)
Industrial	Ind - Custom Boiler	Retrofit	Process Heating	3,342,520	2,841,142	2,841,142	16%	$0.22
Industrial	Ind - Custom Primary Process (Gas)	Retrofit	Process Heating	2,760,206	2,346,175	2,346,175	13%	$0.24
Industrial	Ind - Boiler Heat Recovery	Retrofit	HVAC	2,164,508	1,839,832	1,839,832	10%	$0.01
Industrial	Ind - Ceiling/Roof Insulation	Retrofit	Weatherization	1,707,045	1,450,988	1,450,988	8%	$0.05
Industrial	Ind - Wall Insulation (Gas)	Retrofit	Process Heating	1,673,435	1,422,420	1,422,420	8%	$0.05
Industrial	Ind - Gas-fired HP Water Heater	Replace on Burnout	Water Heating	1,130,192	960,663	960,663	5%	$0.22
Industrial	Ind - Radiant Heating (Gas)	Replace on Burnout	Process Heating	1,012,643	860,747	860,747	5%	$0.27
Industrial	Ind - Steam Trap Maintenance	Retrofit	Process Heating	1,008,196	856,967	856,967	5%	$0.02
Industrial	Ind - Custom HVAC (Gas)	Retrofit	HVAC	866,822	736,799	736,799	4%	$0.44
Industrial	Ind - Boiler Load Control	Retrofit	Process Heating	792,879	673,948	673,948	4%	$0.00
Industrial	Ind - Water Heating	Replace on Burnout	Process Heating	750,093	637,579	637,579	4%	$0.49
Industrial	Ind - Advanced Wall Insulation	Retrofit	Weatherization	655,713	557,356	557,356	3%	$1.41
Industrial	Ind - Custom O&M	Retrofit	Process Heating	643,562	547,028	547,028	3%	$0.03
Industrial	Ind - SEM (Gas)	Retrofit	Process Heating	643,562	547,028	547,028	3%	$0.24
Industrial	Ind - Steam Pipe Insulation	Retrofit	Process Heating	605,919	515,031	515,031	3%	$0.05
Industrial	Ind - Process Insulation	Retrofit	Process Heating	353,441	300,425	300,425	2%	$0.16
Industrial	Ind - Greenhouse - Under Bench Heating	Retrofit	Process Heating	326,801	277,781	277,781	2%	$0.17
Industrial	Ind - Custom Secondary Process (Gas)	Retrofit	Process Heating	297,442	252,826	252,826	1%	$0.47
Industrial	Ind - Greenhouse - Thermal Curtain	Retrofit	Process Heating	173,208	147,227	147,227	1%	$0.32
Industrial	Ind - Greenhouse - IR Poly Film	Retrofit	Process Heating	171,604	145,863	145,863	1%	$0.12
Industrial	Ind - Greenhouse - Controller	Retrofit	Process Heating	82,411	70,050	70,050	0%	$0.11
Industrial	Ind - Condensing Greenhouse Boiler	Replace on Burnout	Process Heating	73,750	62,688	62,688	0%	$0.74
Industrial	Ind - Greenhouse - Condensing Unit Heater	Retrofit	Process Heating	54,747	46,535	46,535	0%	$0.22

Table D.6: Oregon 20-Year Cumulative Potential (Residential)

Sector	Measure Name	Measure Type	End Use	20-year Cumulative Technical Potential (therms)	20-year Cumulative Achievable Potential (therms)	20-year Cumulative Cost-Effective Potential (therms)	% of Total Sector C/E Potential	Average Levelized Cost ($/therm)
Residential	Res - Window Replacement Tier 2 (U ≤ 0.27) GAS SPHT	Replace on Burnout	Weatherization	35,250,116	21,150,070	21,150,070	13%	$0.14
Residential	Res - Gas Absorption Heat Pump Water Heater GAS WHT	Replace on Burnout	Water Heating	28,338,580	24,087,793	24,087,793	15%	$0.26
Residential	Res - Window Tier 3 GAS SPHT	Replace on Burnout	Weatherization	24,805,637	14,883,382	14,883,382	9%	$0.17
Residential	Res - Market Transformation NH GAS SPHT DHW - Gas Only - NEW only	New Construction	Weatherization	22,261,413	22,261,413	22,261,413	14%	$0.41
Residential	Res - Smart Tstat - Gas FAF GAS SPHT	Retrofit	Heating	11,428,475	9,714,203	9,714,203	6%	$0.58
Residential	Res - AFUE 90 to 95 Furnace GAS SPHT	Replace on Burnout	Heating	11,145,676	9,473,825	9,473,825	6%	$0.74
Residential	Res - Thin Triple Pane Windows GAS SPHT	Replace on Burnout	Weatherization	10,803,940	6,482,364	6,482,364	4%	$0.74
Residential	Res - Path 4 Advanced Whole Home GAS SPHT DHW - Gas Only - NEW only	New Construction	Heating	9,822,459	8,349,090	8,349,090	5%	$2.76
Residential	Res - Path 2 MECH + DHW GAS WHT Space Heat - Gas Only - NEW only	New Construction	Water Heating	8,274,243	7,033,107	7,033,107	4%	$2.99
Residential	Res - Path 3 MECH + DHW GAS WHT Space Heat - Gas Only - NEW only	New Construction	Water Heating	7,798,140	6,628,419	6,628,419	4%	$2.55
Residential	Res - Gas Fireplace - 70-74 FE GAS SPHT	Replace on Burnout	Heating	4,344,120	3,692,502	3,692,502	2%	$0.00
Residential	Res - AFUE 96+ Furnace GAS SPHT	Replace on Burnout	Heating	3,950,339	3,357,788	3,357,788	2%	$1.85
Residential	Res - Wall insulation GAS SPHT, Z1	Retrofit	Weatherization	3,588,872	2,153,323	2,153,323	1%	$1.93
Residential	Res - Wall insulation R-30 GAS SPHT, Z1	Retrofit	Weatherization	3,306,873	1,984,124	-	0%	$3.58
Residential	Res - Floor insulation GAS SPHT, Z1	Retrofit	Weatherization	3,044,577	1,826,746	1,826,746	1%	$2.28
Residential	Res - AFUE 90 to 95 Furnace GAS SPHT - NEW only	New Construction	Heating	2,852,699	2,424,794	2,424,794	2%	$0.74
Residential	Res - Attic insulation (R13-R18 starting condition) GAS SPHT, Z1- RET	Retrofit	Weatherization	2,755,127	1,653,076	1,653,076	1%	$1.45
Residential	Res - Path 5 Emerging Super Efficient Whole Home GAS SPHT DHW - Gas Only - NEW only	New Construction	Heating	2,189,545	1,861,113	1,861,113	1%	$10.22
Residential	Res - Gas Fired HP (>100% Eff) GAS SPHT	Replace on Burnout	Heating	2,164,390	1,839,732	-	0%	$9.56
Residential	Res - Attic insulation (R0-R11 starting condition) GAS SPHT, Z1- RET	Retrofit	Weatherization	2,065,894	1,239,537	1,239,537	1%	$0.79
Residential	Res - Market Transformation NH GAS SPHT DHW - Elec Only - NEW only	New Construction	Weatherization	2,038,472	2,038,472	2,038,472	1%	$0.46
Residential	Res - Multifamily Commercial Size Condensing Tank Water Heater GAS WHT - NEW only	New Construction	Water Heating	1,279,576	1,087,639	1,087,639	1%	$0.08
Residential	Res - Tankless Gas Hot Water Heater GAS WHT - NEW only	New Construction	Water Heating	1,267,253	1,077,165	-	0%	$2.21
Residential	Res - Multifamily Commercial Size Condensing Tank Water Heater GAS WHT	Replace on Burnout	Water Heating	1,237,874	1,052,193	1,052,193	1%	$0.08
Residential	Res - Tankless Gas Hot Water Heater GAS WHT	Replace on Burnout	Water Heating	1,225,953	1,042,060	-	0%	$2.55
Residential	Res - Tstat Optimization GAS SPHT	Retrofit	Heating	1,133,573	963,537	963,537	1%	$0.26
Residential	Res - Gas Fireplace - 75+ FE GAS SPHT	Replace on Burnout	Heating	1,071,263	910,574	910,574	1%	$0.00
Residential	Res - Attic insulation R-60 GAS SPHT, Z1	Retrofit	Weatherization	1,039,136	623,482	-	0%	$9.49
Residential	Res - Elec Hi-eff Clotheswasher GAS WHT	Replace on Burnout	Water Heating	952,284	809,442	809,442	1%	-$4.91
Residential	Res - AFUE 96+ Furnace GAS SPHT - NEW only	New Construction	Heating	801,747	681,485	453,402	0%	$1.52
Residential	Res - Path 4 Advanced Whole Home GAS SPHT DHW - Elec Only - NEW only	New Construction	Heating	738,329	627,579	627,579	0%	$3.83
Residential	Res - Gas Fired HP (>100% Eff) GAS SPHT - NEW only	New Construction	Heating	711,018	604,365	-	0%	$11.16

Table D.6- Continued: Oregon 20-Year Cumulative Potential (Residential)

Sector	Measure Name	Measure Type	End Use	20-year Cumulative Technical Potential (therms)	20-year Cumulative Achievable Potential (therms)	20-year Cumulative Cost-Effective Potential (therms)	% of Total Sector C/E Potential	Average Levelized Cost ($/therm)
Residential	Res - Path 2 MECH + DHW ER WHT Space Heat - Gas Only - NEW only	New Construction	Water Heating	520,608	442,517	442,517	0%	$6.25
Residential	Res - Path 3 MECH + DHW ER WHT Space Heat - Gas Only - NEW only	New Construction	Water Heating	506,535	430,555	430,555	0%	$4.79
Residential	Res - Condensing Furnaces (MF) GAS SPHT	Replace on Burnout	Heating	416,886	354,353	354,353	0%	$0.38
Residential	Res - Cellular Shades GAS SPHT	Retrofit	Weatherization	380,644	323,547	-	0%	$9.56
Residential	Res - Hot Water Condensing Boiler for Space Heat (MF) GAS SPHT	Replace on Burnout	Heating	350,327	297,778	297,778	0%	$0.30
Residential	Res - Path 2 MECH + DHW GAS WHT Space Heat - Avg. Elec Mixed Market - NEW only	New Construction	Water Heating	326,329	277,379	277,379	0%	$6.35
Residential	Res - Path 3 MECH + DHW GAS WHT Space Heat - Avg. Elec Mixed Market - NEW only	New Construction	Water Heating	292,541	248,660	248,660	0%	$7.48
Residential	Res - Market Transformation NH AVG ELEC SPHT DHW - Gas Only - NEW only	New Construction	Weatherization	275,210	275,210	-	0%	$3.59
Residential	Res - Path 4 Advanced Whole Home AVG ELEC SPHT DHW - Gas Only - NEW only	New Construction	Heating	273,691	232,637	232,637	0%	$9.34
Residential	Res - Multifamily Pipe Insulation GAS WHT	Retrofit	Water Heating	176,614	150,122	150,122	0%	$0.29
Residential	Res - Path 5 Emerging Super Efficient Whole Home GAS SPHT DHW - Elec Only - NEW only	New Construction	Heating	162,711	138,304	138,304	0%	$14.33
Residential	Res - Gas Fireplace - Ignition System GAS SPHT	Replace on Burnout	Heating	151,827	129,053	129,053	0%	$0.99
Residential	Res - Thermostatic Radiator Valves	Retrofit	Water Heating	140,362	119,308	119,308	0%	$0.33
Residential	Res - Hot Water Condensing Boiler for Space Heat (MF) GAS SPHT - NEW only	New Construction	Heating	128,677	109,375	109,375	0%	$0.20
Residential	Res - Elec Hi-eff Clotheswasher MF GAS WHT - NEW only	New Construction	Water Heating	122,842	104,415	104,415	0%	-$3.32
Residential	Res - Elec Hi-eff Clotheswasher MF GAS WHT	Replace on Burnout	Water Heating	118,838	101,013	101,013	0%	-$3.32
Residential	Res - 0.70+ EF Gas Storage Water Heater GAS WHT - NEW only	New Construction	Water Heating	114,854	97,626	97,626	0%	$0.49
Residential	Res - 0.70+ EF Gas Storage Water Heater GAS WHT	Replace on Burnout	Water Heating	111,111	94,445	94,445	0%	$0.49
Residential	Res - Steam trap replacement GAS SPHT- ROB	Replace on Burnout	Heating	103,696	88,142	88,142	0%	$0.18
Residential	Res - Condensing Furnaces (MF) GAS SPHT - NEW only	New Construction	Heating	103,627	88,083	88,083	0%	$0.38
Residential	Res - New MH - Energy Star GAS SPHT, Z1 - NEW only	New Construction	Weatherization	73,085	62,122	62,122	0%	$1.08
Residential	Res - Energy Star Gas Clothes Dryer	Replace on Burnout	Appliance	66,677	63,343	63,343	0%	$1.05
Residential	Res - Path 5 Emerging Super Efficient Whole Home AVG ELEC SPHT DHW - Gas Only - NEW only	New Construction	Heating	62,778	53,361	53,361	0%	$33.60
Residential	Res - Wall insulation R-30 GAS SPHT, Z2	Retrofit	Weatherization	51,284	30,770	-	0%	$2.33
Residential	Res - Duct Sealing MH GAS SPHT	Retrofit	Weatherization	43,926	37,337	37,337	0%	$0.97
Residential	Res - Wall insulation GAS SPHT, Z2	Retrofit	Weatherization	39,737	23,842	23,842	0%	$1.76
Residential	Res - Window Replacement Tier 2 (U ≤ 0.27) GAS SPHT - NEW only	New Construction	Weatherization	39,078	23,447	23,447	0%	$0.14
Residential	Res - Elec Hi-eff Clotheswasher GAS WHT - NEW only	New Construction	Water Heating	36,062	30,653	30,653	0%	-$4.91
Residential	Res - Floor insulation GAS SPHT, Z2	Retrofit	Weatherization	33,682	20,209	20,209	0%	$2.08
Residential	Res - Attic insulation (R13-R18 starting condition) GAS SPHT, Z2- RET	Retrofit	Weatherization	29,970	17,982	17,982	0%	$1.34
Residential	Res - Window Tier 3 GAS SPHT - NEW only	New Construction	Weatherization	27,499	16,500	16,500	0%	$0.17
Residential	Res - Attic insulation (R0-R11 starting condition) GAS SPHT, Z2- RET	Retrofit	Weatherization	20,868	12,521	12,521	0%	$0.79

Table D.6- Continued: Oregon 20-Year Cumulative Potential (Residential)

Sector	Measure Name	Measure Type	End Use	20-year Cumulative Technical Potential (therms)	20-year Cumulative Achievable Potential (therms)	20-year Cumulative Cost-Effective Potential (therms)	% of Total Sector C/E Potential	Average Levelized Cost ($/therm)
Residential	Res - Wall insulation MF GAS SPHT, Z1	Retrofit	Weatherization	17,029	10,217	10,217	0%	$1.93
Residential	Res - Attic insulation R-60 GAS SPHT, Z2	Retrofit	Weatherization	16,115	9,669	-	0%	$6.18
Residential	Res - Ceiling insulation - side by side R49 GAS SPHT, Z1	Retrofit	Weatherization	14,955	8,973	8,973	0%	$0.92
Residential	Res - Ceiling insulation - stacked R49 GAS SPHT	Retrofit	Weatherization	13,175	7,905	7,905	0%	$0.82
Residential	Res - Floor insulation - 2-4 & side by side GAS SPHT, Z1	Retrofit	Weatherization	12,675	7,605	7,605	0%	$2.15
Residential	Res - Dmd Ctrl Recirc. GAS WHT	Retrofit	Water Heating	2,026	1,722	1,722	0%	$1.06
Residential	Res - Showerhead, 1.5 GPM GAS WHT - NEW only	New Construction	Water Heating	1,977	1,681	1,681	0%	-$0.11
Residential	Res - Energy Star Gas Clothes Dryer - NEW only	New Construction	Appliance	1,620	1,539	1,539	0%	$1.05
Residential	Res - Bathroom Faucet Aerators, 0.5 gpm GAS WHT - NEW only	New Construction	Water Heating	1,612	1,371	1,371	0%	-$0.18
Residential	Res - New MH - Energy Star GAS SPHT, Z2 - NEW only	New Construction	Weatherization	738	627	627	0%	$1.08
Residential	Res - Kitchen Faucet Aerators, 1.0 gpm GAS WHT - NEW only	New Construction	Water Heating	662	563	563	0%	-$0.15
Residential	Res - Wall insulation MF GAS SPHT, Z2	Retrofit	Weatherization	189	113	113	0%	$1.74
Residential	Res - Ceiling insulation - side by side R49 GAS SPHT, Z2	Retrofit	Weatherization	151	91	91	0%	$0.92
Residential	Res - Floor insulation - 2-4 & side by side GAS SPHT, Z2	Retrofit	Weatherization	140	84	84	0%	$1.98

D.3 AEG Oregon Transport Memorandum

The following pages are provided by Applied Energy Group (AEG)

Appendix E: Supply-Side Resources

E.1 Gas Purchasing Common Practices

NW Natural also utilizes financial derivative hedges (mainly swaps) to manage cost risks. The physical baseload supply contracts mentioned in Chapter 6, which are priced at a variable index price, can be fixed using financial swaps. This is done for a large portion of our portfolio to lock in prices and decrease the volatility of costs in our gas supply portfolio for customers.

In addition to the long-term supply planning done in this IRP, NW Natural prepares a Gas Acquisition Plan (GAP) each year. The GAP is reviewed and approved by NW Natural's Gas Acquisition Strategy and Policies (GASP) Committee, but such plans are always subject to change based on market conditions. The primary objective of the Gas Acquisition Plan (GAP) is to ensure gas supplies are sufficient to meet firm customer demand. To meet this objective, our primary goal is reliability, followed by lowest reasonable cost, rate stability, and cost recovery all while reducing the carbon content of the energy we deliver. The focus of the GAP is on the upcoming gas contracting year (November through October); however, this focus extends several years into the future for multi-year hedging considerations. Longer-term resource planning is the focus of the IRP and is not covered in the GAP, except of course to assure consistency in the transition from near-term to longer-term planning decisions.

E.2 Pipeline Charges

There are three primary costs components associated with pipeline contracts, one that is a fixed charge and two variable components. Table E.1 outlines these three components.

Table E.1: Three Cost Components for Pipeline Charges

Component	Description
Demand Charge	This is a fix cost associated with holding the capacity rights to ship gas on a pipeline. Often specified in $/Dth/day, this price multiplied by the capacity amount held by the shipper and 365 would provide the annual payment to the interstate pipeline regardless of how much gas is shipped over the course of that year. Also known as a reservation charge.
Variable Charge	This a variable charge associated with how much gas is scheduled on the pipeline each day. Some pipelines have postage-stamp variable charges that are independent of the receipt and delivery points, whereas other pipelines charge based not only the amount of gas scheduled but the distance that it is scheduled.
Fuel Charge	This is a secondary indirect variable charge that takes a percentage of the natural gas that is shipped on the pipeline.

E.3 Gas Supply Contracts

Table E.2: NW Natural Firm Off-System Gas Supply Contracts for the 2021/2022 Tracker Year

Supply Location	Duration	Baseload Qty (Dth/day)	Swing Qty (Dth/day)	Contract Termination Date
British Columbia:				
MacQuarie Energy Canada Ltd.	Nov-Jan	5,000		1/31/2022
TD Energy Trading Inc	Nov-Feb	5,000		2/28/2022
Direct Energy Marketing Limited	Nov-Mar	5,000		3/31/2022
IGI Resources	Nov-Mar	5,000		3/31/2022
J. Aron & Company	Nov-Mar	11,000		3/31/2022
MacQuarie Energy Canada Ltd.	Nov-Mar	10,000		3/31/2022
Powerex Corp	Nov-Mar	6,000		3/31/2022
TD Energy Trading Inc	Nov-Mar	11,000		3/31/2022
Canadian Natural Resources	Nov-Oct	10,000		10/31/2022
ConocoPhillips Canada Marketing	Nov-Oct	3,000		10/31/2022
TD Energy Trading Inc	Nov-Oct	5,000		10/31/2022
Powerex Corp	Apr-May	5,000		5/31/2022
ConocoPhillips Canada Marketing	Apr	10,000		4/30/2022
J. Aron & Company	Apr	2,000		4/30/2022
MacQuarie Energy Canada Ltd.	Apr	5,000		4/30/2022
J. Aron & Company	Oct	5,000		10/31/2022
Alberta:				
ConocoPhillips Canada Marketing	Nov-Jan	5,000		1/31/2022
Direct Energy Marketing Limited	Nov-Jan	5,000		1/31/2022
PetroChina International (Canada) Trading	Nov-Jan	10,000		1/31/2022
J. Aron & Company	Nov-Feb	5,000		2/28/2022
Castleton Commodities	Nov-Mar	5,000		3/31/2022
ConocoPhillips Canada Marketing	Nov-Mar	5,000		3/31/2022
EDF Trading North America, LLC	Nov-Mar	5,000		3/31/2022
Powerex Corp	Nov-Mar	5,000		3/31/2022
Suncor Energy Marketing Inc	Nov-Mar	15,000		3/31/2022
BP Canada Energy Group	Nov-Oct	10,000		10/31/2022
Shell North America (Canada) Inc	Nov-Oct	5,000		10/31/2022
J. Aron & Company	Dec-Feb	5,000		2/28/2022
J. Aron & Company	Dec-Jan	5,000		1/31/2022
Powerex Corp	Dec-Jan	5,000		1/31/2022
Castleton Commodities	Apr-Jun	3,000		6/30/2022
Castleton Commodities	Apr-May	5,000		5/31/2022
Direct Energy Marketing Limited	Apr-May	5,000		5/31/2022
J. Aron & Company	Apr-May	5,000		5/31/2022
Direct Energy Marketing Limited	Feb-Mar	5,000		3/31/2022
Suncor Energy Marketing Inc	Apr	11,000		4/30/2022
ConocoPhillips Canada Marketing	Apr	6,000		4/30/2022
Powerex Corp	Feb	5,000		2/8/2022
J. Aron & Company	Mar	3,000		3/31/2022
BP Canada Energy Group	Oct	5,000		10/31/2022
Castleton Commodities	Oct	13,000		10/31/2022
IGI Resources	Oct	5,000		10/31/2022
Suncor Energy Marketing Inc	Oct	5,000		10/31/2022
Shell North America (Canada) Inc	Oct	5,000		10/31/2022

Table E.2 - Continued: NW Natural Firm Off-System Gas Supply Contracts for the 2021/2022 Tracker Year

Supply Location	Duration	Baseload Qty (Dth/day)	Swing Qty (Dth/day)	Contract Termination Date
Rockies:				
CIMA Energy LTD	Nov-Mar	5,000		3/31/2022
ConocoPhillips Company	Nov-Mar	16,000		3/31/2022
Koch Energy Services, Inc	Nov-Mar	10,000		3/31/2022
MacQuarie Energy, LLC	Nov-Mar	5,000		3/31/2022
XTO Energy Inc	Nov-Mar	5,000		3/31/2022
Citadel Energy Marketing, LLC	Nov-Oct	15,000		10/31/2022
ConocoPhillips Company	Nov-Oct	5,000		10/31/2022
MacQuarie Energy, LLC	Nov-Oct	4,000		10/31/2022
Spotlight Energy, LLC	Nov-Oct	5,000		10/31/2022
CIMA Energy LTD	Dec-Jan	10,000		1/31/2022
Citadel Energy Marketing, LLC	Dec-Jan	5,000		1/31/2022
MacQuarie Energy, LLC	Dec-Jan	5,000		1/31/2022
CIMA Energy LTD	Dec-Feb	5,000		2/28/2022
ConocoPhillips Company	Dec-Feb	5,000		2/28/2022
IGI Resources, Inc	Dec-Feb	15,000		2/28/2022
ConocoPhillips Company	Feb	5,000		2/28/2022
MacQuarie Energy, LLC	Mar	7,000		3/31/2022
MacQuarie Energy, LLC	Apr	6,000		4/30/2022
ConocoPhillips Company	Nov-Mar		10,000	3/31/2022
ConocoPhillips Company	Apr-Oct		10,000	10/31/2022

Month	Baseload Qty (Dth/day)	Baseload+Swing (Dth/day)
Nov-21	221,000	231,000
Dec-21	281,000	291,000
Jan-22	281,000	291,000
Feb-22	241,000	251,000
Mar-22	201,000	211,000
Apr-22	125,000	135,000
May-22	85,000	95,000
Jun-22	65,000	75,000
Jul-22	62,000	72,000
Aug-22	62,000	72,000
Sep-22	62,000	72,000
Oct-22	100,000	110,000

Notes:

† Contract quantities represent deliveries into upstream pipelines. Accordingly, quantities delivered into NW Natural's system are slightly less due to upstream pipeline fuel consumption.

‡ Nov-Mar "Swing" contracts represent physical call options at NWN's discretion, while the Apr-Oct "Swing" contracts represent physical put options at the supplier's discretion.

Table E.3: NW Natural Firm Transportation Capacity for the 2021/2022 Tracker Year

See next page for Table

Pipeline and Contract	Contract Demand (Dth/day)	Termination Date
Northwest Pipeline:		
Sales Conversion (#100005)	214,889	10/31/2031
1993 Expansion (#100058)	35,155	9/30/2044
1995 Expansion (#100138)	102,000	10/31/2030
Occidental cap. acq. (#139153)	1,046	10/31/2030
Occidental cap. acq. (#139154)	4,000	10/31/2030
International Paper cap. acq. (#138065)	4,147	10/31/2030
March Point cap. acq. (#136455)	12,000	12/31/2046
Total NWP Capacity	373,237	
less recallable release to -		
Portland General Electric	(30,000)	10/31/2022
Net NWP Capacity	343,237	
TransCanada - GTN:		
Sales Conversion (#00180)	3,616	10/31/2030
1993 Expansion (#00164)	46,549	10/31/2030
1995 Rationalization (#11030)	56,000	10/31/2030
Total GTN Capacity	106,165	
TransCanada - Foothills:		
1993 Expansion	47,727	10/31/2022
1995 Rationalization	57,417	10/31/2022
Engage Capacity Acquisition	3,708	10/31/2022
2004 Capacity Acquisition	48,669	10/31/2025
Total Foothills Capacity	157,521	
less release to -		
Shell Energy North America (Canada) Inc	(48,669)	10/31/2025
Net Foothills Capacity	108,852	
TransCanada - NOVA:		
1993 Expansion	48,135	10/31/2025
1995 Rationalization	57,909	10/31/2025
Engage Capacity Acquisition	3,739	10/31/2025
2004 Capacity Acquisition	49,138	10/31/2025
Total NOVA Capacity	158,921	
less release to -		
Shell Energy North America (Canada) Inc	(49,138)	10/31/2025
Net NOVA Capacity	109,783	
T-South		
Capacity (through Tenaska)	19,000	3/31/2026
Capacity (through FortisBC)	47,391	10/31/2025
2021 Expansion	25,511	10/31/2061
Total T-South Capacity	91,902	
Notes:		
† All of the above agreements continue year-to-year after termination at NW Natural's sole option except for PGE, which requires mutual agreement to continue, and the T-South contracts with Tenaska and Fortis, which have no renewal rights.		
‡ The T-South contract with FortisBC is for 47,391 Dth from 11/1/2020 through 10/31/2023, and then is reduced to 28,435 Dth from 11/1/2023 through 10/31/2025.		
♠ The numbers shown for the 1993 Expansion contracts on GTN and Foothills are for the winter season (Oct-Mar) only. Both contracts decline during the summer season (Apr-Sep) to approximately 30,000 Dth/day.		
♦ Segmented capacity has not been included in this table.		
♣ T-South capacity includes the new T-South Expansion contract awarded in 2017, which begins November 1, 2021.		
• The 2004 Capacity Acquisition on NOVA and Foothills totaling about 49,000 Dth/day has been released to a third party through 10/31/2025. The revenues related to this arrangement are being credited back to customers as outlined in Schedule P.		

Table E.4: NW Natural Firm Storage Resources for the 2021/2022 Tracker Year

Facility	Max. Daily Rate (Dth/day)	Max. Seasonal Level (Dth)	Termination Date
Jackson Prairie:			
SGS-2F	46,030	1,120,288	10/31/2025
TF-2 (primary firm portion)	23,038	839,046	10/31/2025
TF-2 (primary firm portion)	9,467	281,242	10/31/2025
TF-1	13,525	n/a	10/31/2031
Firm On-System Storage Plants:			
Mist (reserved for core)	305,000	12,258,591	n/a
Portland LNG Plant	130,800	499,656	n/a
Newport LNG Plant	64,500	967,500	n/a
Total On-System Storage	500,300	13,725,747	
Total Firm Storage Resource	546,330	14,846,035	
Notes:			
† The SGS-2F and TF-2 contracts have a unilateral annual evergreen provision (continuation at NW Natural's sole option), while the TF-1 contract requires mutual consent with Northwest Pipeline to continue after the indicated termination date.			
‡ The TF-2 contracts also contain additional "subordinated" firm service of 9,586 Dth/day on the first agreement listed above and 3,939 Dth/day on the second agreement. The subordinated service is NOT included in NW Natural's peak day planning.			
♠ On-system storage peak deliverability is based on design criteria, for example, Mist is at least 50% full.			
♦ Mist numbers pertain to the portion reserved for core utility service per the Company's Integrated Resource Plan. Additional capacity and deliverability at Mist have been contracted under varying terms to Interstate storage customers.			
♣ The Dth numbers for Mist, Newport LNG and Portland LNG are approximate in that they are converted from Mcf volumes, and so depend on the heat content of the stored gas. The current heat content used for Mist is 1060 Btu/cf. The current heat content used for Newport is 1075 Btu/cf and Portland LNG is 1090 Btu/cf.			
• Newport LNG tank de-rated to 90% of the tank capacity pending CO2 removal project.			
♠♠ Due to an Engineering analysis of the Portland LNG tank, liquifaction will be limited to 76% of the tank's capacity.			
♦♦ NW Natural has no supply-basin storage contract for the coming year.			

Table E.5: NW Natural Other Resources: Recall Agreements, City Deliveries and Mist Production for the 2021/2022 Tracker Year

Type	Max. Daily Rate (Dth/day)	Max. Availability (days)	Termination Date
Recall Agreements:			
PGE	30,000	30	10/31/2022
International Paper	8,000	40	Upon 1-year notice
Georgia Pacific-Halsey mill	1,000	15	Upon 1-year notice
Total Recall Resource	39,000		
Citygate Deliveries:			
Citygate Delivery	5,000	5	2/28/2022
On-System Supplies:			
Renewable Natural Gas	≈2,000	n/a	Varying Terms
Mist Production	≈1,000	n/a	Life of the wells
Total On System Supplies	3,000		
Notes:			
† There are a variety of terms and conditions surrounding the recall rights under each of the above agreements, but they all include delivery of the gas to NW Natural's system.			
‡ Citygate deal has been negotiated for 5 days peaking at 5,000 dth/day.			
♠ Mist production is currently flowing at roughly the figure shown above. Flows vary as new wells are added and older wells deplete. NW Natural's obligation is to buy gas from existing wells through the life of those wells.			
♦ Assumes three Renewable Natural Gas (RNG) projects are online this winter.			

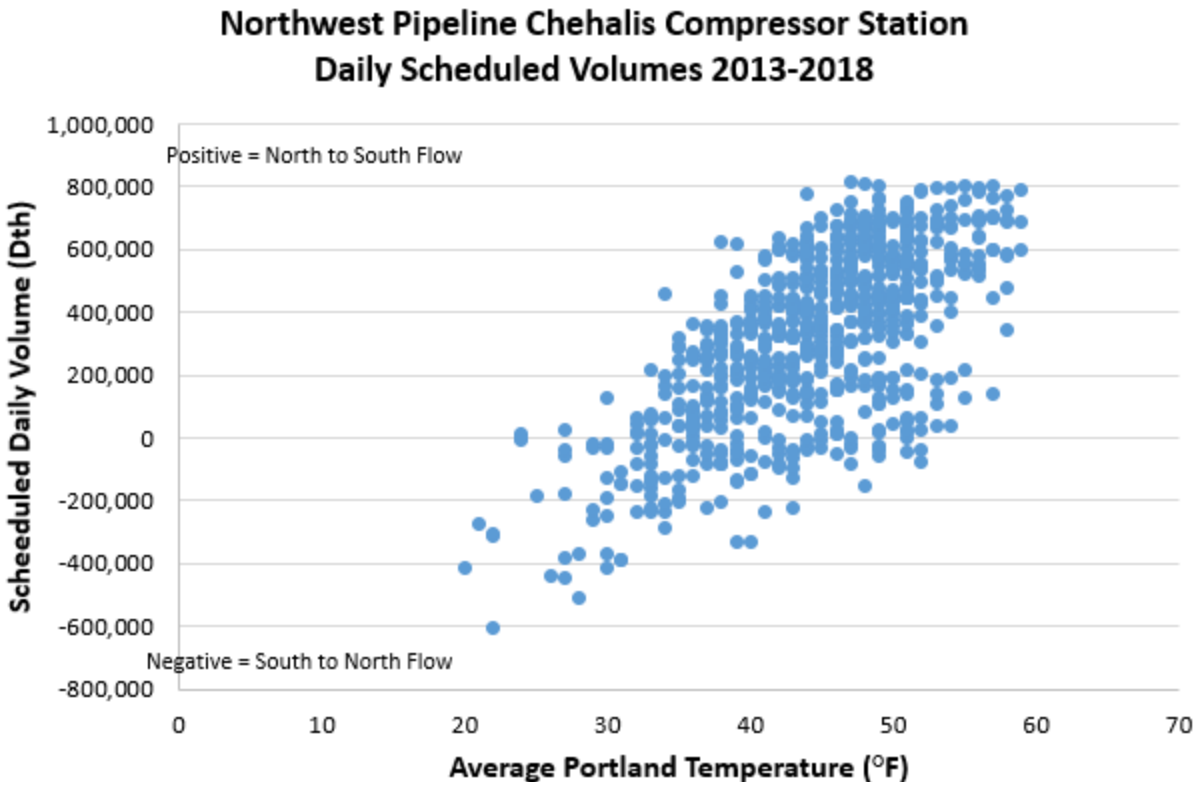
Table E.6: NW Natural Peak Day Resource Summary for the 2021/2022 Tracker Year

Resource Type	Max. Daily Rate (Dth/day)
Net Deliverability over Upstream Pipeline Capacity	343,237
Off-System Storage (Jackson Prairie only)	46,030
On-System Storage (Mist, Portland LNG and Newport LNG)	500,300
Recallable Capacity and Supply Agreements	39,000
Citygate Deliveries	5,000
On-System Supplies	3,000
Segmented Capacity (not primary firm)	60,700
Total Peak Day Resources	997,267
Notes:	
† Per 2018 IRP Update #3, Segmented Capacity currently is included as a firm resource through 2021-2025 gas years. Afterwards reliance reduces to 30,000 dth/day into the future.	

E.4 Chehalis Compressor Analysis

In the 2016 IRP, an analysis of NWP flow data along the I-5 corridor over the prior five winters showed that as the weather gets colder, the predominant flow direction is south to north through the main constraint point at NWP's Chehalis compressor station. Hence, gas flowing south from Sumas on segmented capacity should have greater pipeline reliability as design day conditions are approached. This analysis is shown in Figure E.1 below.

Figure E.1: Implied Reliability of Segmented Capacity



Experience over the past several winters continues to support our use of segmented capacity during cold weather events.

Table E.7 (Jackson Prairie Related Transportation Agreements) shows the configuration of agreements that transport gas from Jackson Prairie on NWP's system.

Table E.7: Jackson Prairie Related Transportation Agreements

Service Type	Primary Firm Rate (Dth/day)	Subordinate Firm Rate (Dth/day)
TF-1	13,525	-
TF-2	23,038	9,586
TF-2	9,467	3,939
Total	46,030	13,525

E.4 Compliance Resource Additional Detail

Table E.8: California LCFS CI Scores

Facility Location	Feedstock	Current Certified CI
California	Wastewater Sludge (030)	76.98
California	Dairy Manure (026)	-758.46
California	Dairy Manure (026)	-750.81
California	Landfill Gas (025)	74.7
California	Dairy Manure (026)	-562.5
Washington	Landfill Gas (025)	44.18
California	Dairy Manure (026)	-431.65
California	Dairy Manure (026)	-420.69
California	Dairy Manure (026)	-418.9
California	Dairy Manure (026)	-417.35
California	Dairy Manure (026)	-417.27
California	Dairy Manure (026)	-417.26
California	Dairy Manure (026)	-417.24
California	Dairy Manure (026)	-414.26
Washington	Landfill Gas (025)	41.09
California	Dairy Manure (026)	-406.28
California	Dairy Manure (026)	-405.57
California	Dairy Manure (026)	-405.41
California	Dairy Manure (026)	-392.44
California	Swine Manure (044)	-390.47
California	Dairy Manure (026)	-389.66
California	Dairy Manure (026)	-388.91
California	Dairy Manure (026)	-388.29
California	Dairy Manure (026)	-385.4
California	Dairy Manure (026)	-382.11
California	Swine Manure (044)	-374.14
California	Dairy Manure (026)	-366.91
California	Dairy Manure (026)	-356.29
California	Swine Manure (044)	-354.78
California	Dairy Manure (026)	-353.38
California	Dairy Manure (026)	-349.17
California	Swine Manure (044)	-338.45
California	Wastewater Sludge (030)	30.31
California	Dairy Manure (026)	-293.72
California	Dairy Manure (026)	-287.07
Washington	Landfill Gas (025)	28.24
California	Dairy Manure (026)	-259.22
California	Dairy Manure (026)	-255.83
California	Dairy Manure (026)	-254.95
California	Dairy Manure (026)	-251.36
California	Dairy Manure (026)	-249.43
California	Dairy Manure (026)	-241
California	Dairy Manure (026)	-239.31
California	Dairy Manure (026)	-220.45
California	Dairy Manure (026)	-216.05
California	Dairy Manure (026)	-210.67
California	Dairy Manure (026)	-204.81
California	Urban Landscaping Waste (028)	2.51
California	Wastewater Sludge (030)	19.28
California	Landfill Gas (025)	18.96
California	Dairy Manure (026)	-179.71
California	Dairy Manure (026)	-169.35
California	Landfill Gas (025)	15.87
California	Landfill Gas (025)	129.09
California	Dairy Manure (026)	-126.52
California	Landfill Gas (025)	125.44
California	Landfill Gas (025)	120.04
California	Landfill Gas (025)	109.81
California	Wastewater Sludge (030)	109.01
California	Other Organic Waste (029)	0.28
California	Landfill Gas (025)	158.25
California	Landfill Gas (025)	138.90
California	Landfill Gas (025)	136.44
California	Landfill Gas (025)	136.31
California	Landfill Gas (025)	131.51
California	Landfill Gas (025)	131.39
California	Landfill Gas (025)	129.09
California	Landfill Gas (025)	109.68
California	Landfill Gas (025)	99.48
California	Landfill Gas (025)	99.48
California	Landfill Gas (025)	99.48
California	Landfill Gas (025)	96.41
California	Landfill Gas (025)	76.71
California	Landfill Gas (025)	73.14
California	Waste Beverage	69.82
California	Landfill Gas (025)	65.77
California	Landfill Gas	62.30
Washington	Landfill Gas (025)	53.11
Washington	Landfill Gas (025)	50.02
California	Landfill Gas	44.07
Washington	Landfill Gas - CNG	42.78
California	Landfill Gas	41.46
California	Landfill Gas	37.39
Washington	Landfill Gas (025)	37.19
California	Landfill Gas	32.28
California	Landfill Gas	31.98
Washington	Landfill Gas - CNG	30.90
California	Landfill Gas - CNG	30.50
California	Waste Wine	22.06
California	Landfill Gas	13.29
California	Landfill Gas	10.71
California	Landfill Gas	10.32
California	Landfill Gas	9.97
California	Landfill Gas	7.74
California	Landfill Gas	7.39
California	Sugarbeets	7.18
California	Landfill Gas	-5.28
California	Landfill Gas	-12.65
California	Dairy Manure (026)	-108.43
Oregon	Dairy Manure (026)	-188.78
California	Dairy Manure (026)	-192.49
California	Other Organic Waste (029)	-233.49
California	Dairy Manure (026)	-323.10
California	Dairy Manure (026)	-352.89
California	Dairy Manure (026)	-355.35
California	Dairy Manure (026)	-368.04
California	Dairy Manure (026)	-374.10
California	Dairy Manure (026)	-377.83
California	Dairy Manure (026)	-525.14
California	Dairy Manure (026)	-558.62
California	Dairy Manure (026)	-592.68
California	Dairy Manure (026)	-630.72

E.5 Storage Plant Asset Management Programs

NW Natural's three on-system storage plants are crucial elements of our resource portfolio, providing approximately half of the gas required on the design peak day. Due to their age and the need to maintain these resources, NW Natural has developed asset management programs for each plant[5] that consists of 10-year plans typically informed by outside consultant studies and inclusive of projects being evaluated in this IRP.

The selection criteria for the projects in each plant's plan includes the following:

- High priority due to failing condition
- Equipment no longer supported by manufacturer
- Cyber-security considerations
- Regulatory compliance
- Safety compliance
- Facility reliability
- End-of-life replacement

End-of-life replacement

The term end-of-life as used here may have several determinants, such as functional degradation, failure risks, or regulatory requirements. End-of-life indicators include:

- Severe corrosion within a component or system, due to atmospheric, galvanic corrosion, or minor issues with insulation over time
- Mechanical wear effects any of the rotating equipment onsite
- Fatigue caused by cycling in materials particularly in systems with significant temperature changes
- Technology that has become unsupported and at risk for failure without the ability to support a repair

All required projects going forward will be constructed to contemporaneous seismic standards. This usually requires replacement of an original foundation with foundation systems designed to accommodate ground liquefaction.

Project execution dates may vary from those identified below due to:

- New information obtained on the facility/component condition, resulting in a change to the urgency of the project
- An opportunity to improve execution efficiency
- The need to prevent and/or reduce interruptions to facility distribution system operations
- Permitting requirements
- Loss of resources redirected to issues which require near term resolutions
- Internal and any required external approval processes

[5] Mist was initially built in the late 1980's, Newport LNG was built in the mid-1970's, and Portland LNG was built in the late 1960's.

The following sections provide details on the key projects for each plant.

E.5.1 Mist Asset Management Program

E.5.2 Newport LNG Asset Management Program

E.5.3 Portland LNG Asset Management Program

Sanborn Head Study - Facility Assessment Report

Please find this study at the end of the document.

Sanborn Head Study- Portland LNG Cold Box

Please find this study at the end of the document.

Appendix F: Simulation Inputs to PLEXOS®

F.1 Gas Price Simulation

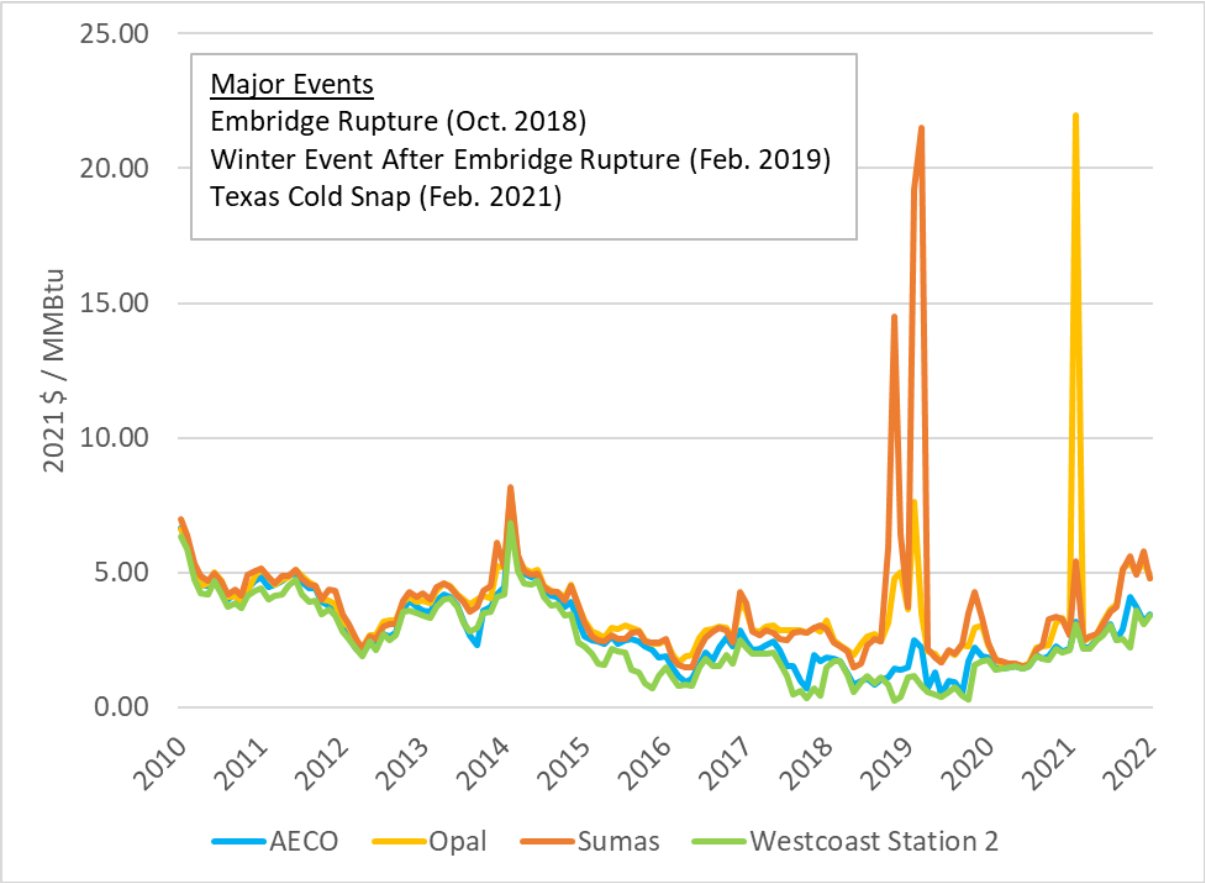
The Monte Carlo gas price simulation produces 500 gas price paths (i.e., stochastic draws) for gas prices hubs across the U.S. and Canada based on historical price shocks. This IRP focuses on the four gas hubs where NW Natural purchases gas for customers (AECO, Sumas, Opal and Westcoast Station 2). These simulations are used in NW Natural's risk assessment.

For gas prices at different locations there are two important correlations which must be considered when simulating stochastic draws:

1) Correlation across time – For example, gas prices today are likely to be correlated with previous gas prices both year-over-year and from month-to-month. These monthly fluctuations in gas prices reflect the continuous shifts in natural gas supply, natural gas storage, and natural gas demand.
2) Correlation across basins or hubs – Interstate pipeline capacity limits the amount of gas able to be transported or "shipped" from one region. In addition to localized supply and demand, these shipping charges create different but highly correlated prices across different basins.

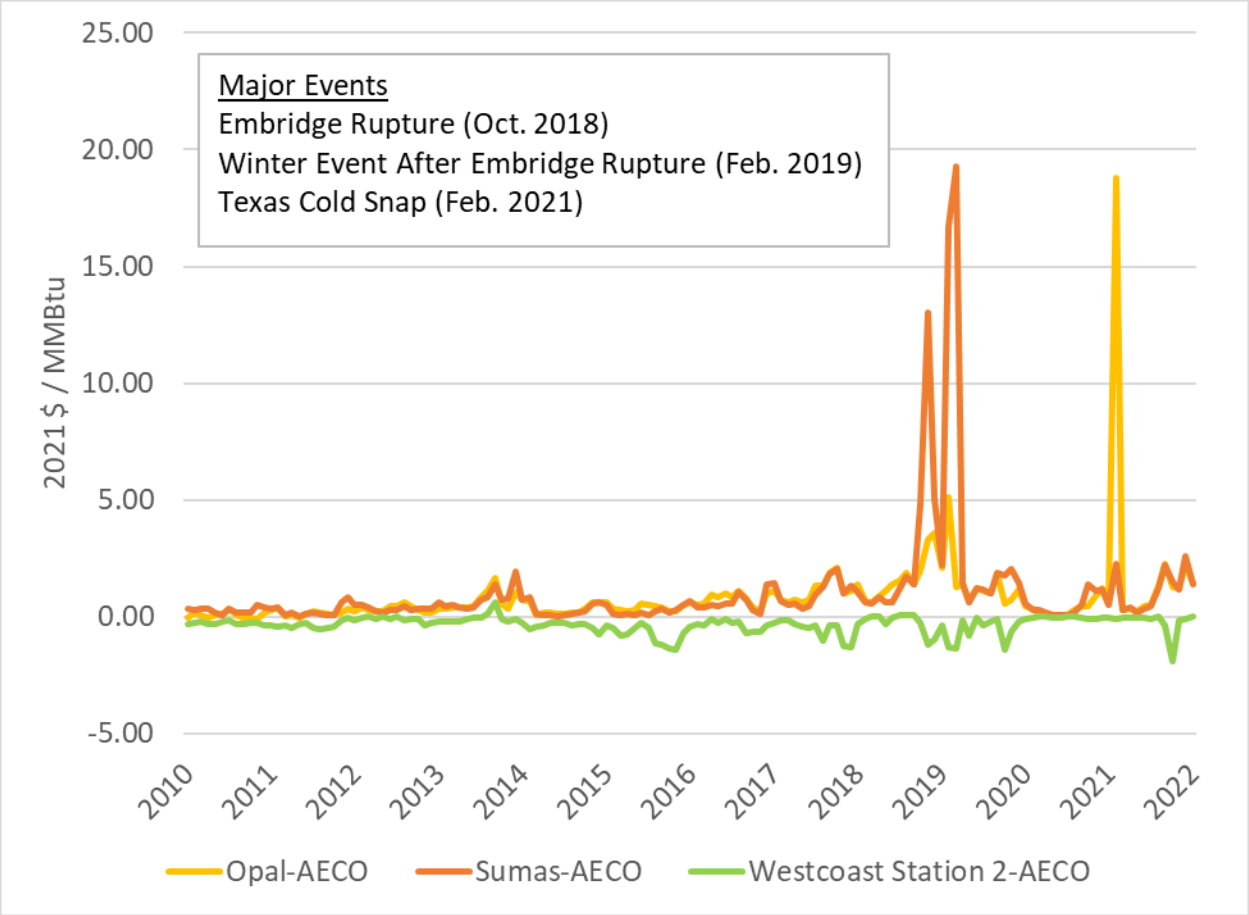
The Monte Carlo process used for this IRP uses historical gas prices to account for these two correlations within the simulation. Figure F.1 shows historical monthly gas prices for the four hubs and illustrates the correlations across time and the four supply basins.

Figure F.1: Historical Gas Prices



The difference between one location and a major gas hub is often referred to as the price basis. Figure F.2 shows the historical monthly basis between the other three gas hubs and AECO (i.e., hub price minus AECO gas prices).

Figure F.2: Historical AECO Basis



The Monte Carlo simulation is coded using RStudio software and uses historical and forecasted monthly gas prices from the *IHS: North American Natural Gas Long-term Outlook – February 2022*.[6] In general, the simulation process first simulates annual gas prices for 500 draws for each basin based on historical annual prices shocks (i.e., changes from one year to the next). After an annual price simulation is complete for each hub, a secondary stochastic process is completed to apply monthly shapes to each hub as well. The simulation is tied to the IHS forecast such that the median annual price of the 500 simulation is equal to the annual IHS price forecast in each year of the forecast for each basin. The more detailed technical steps of the simulation are outlined below in two phases.

[6] The methodology to create simulated gas prices has been improved since the 2018 IRP. In the 2018 IRP the simulation included a reversion factor to tie back to the IHS forecast. The large price spikes at Sumas and Opal in the following years caused issues with this approach as the simulated prices were highly dependent on the strength of the reversion month-over-month. By simulating at the annual level first and at the monthly level second, this new methodology better captures the relationship between annual and monthly prices.

Phase 1: Simulate annual gas prices for each gas hub over the planning horizon

Step 1: Calculate an average historical and forecasted annual price from monthly prices for each hub.

Step 2: Calculate basis to AECO for each hub (i.e., hub price minus AECO gas prices).

Step 3: Use "auto.arima" package to define an ARIMA model for annual AECO prices and calculate residuals from the model based on historical training set.

Step 4: For each year in the planning horizon the AECO price ($AECO_t$) is equal to the previous annual price ($AECO_{t-1}$) plus a randomly selected residual from the ARIMA model (ε_y).

NOTE: A coding loop runs steps 5-7 to generate a value for each year, before looping over these steps again for the following year.

Step 5: For each of the other hubs and each year in the planning horizon apply the annual basis from the same year as the stochastic residual selected.

$$AECO_t = AECO_{t-1} + \varepsilon_y$$

$$Opal_t = AECO_t + (Opal_y - AECO_y)$$

$$Sumas_t = AECO_t + (Sumas_y - AECO_y)$$

$$WestCoastSt2_t = AECO_t + (WestCoastSt_y - AECO_y)$$

$$where:$$

$$t = forecast\ year$$

$$y = stocastic\ historical\ year\ selected$$

Step 6: Adjust gas price levels by adding a factor equal to the IHS forecast price minus median price of the draws. This creates the tie between the simulation and IHS forecast.

Step 7: Adjust any prices that exceed the lower bound parameter.

$$if: Hub_t < lb$$

$$then: Hub_t = Hub_{t-1} - \xi * (Hub_{t-1} - lb)$$

$$where:$$

$$lb = lower\ bound; [set\ to\ \$0.75]$$

$$\{\xi \in \mathbb{R} \mid 0 < \xi < 1\}; [set\ to\ 0.5]$$

Phase 2: Simulate monthly gas prices for each gas hub over the planning horizon

Step 1: Calculate historical monthly shape by dividing the monthly prices by the annual price

Step 2: For each forecast year and draw, randomly select a historical year and apply that monthly shape to the stochastically forecasted annual price.

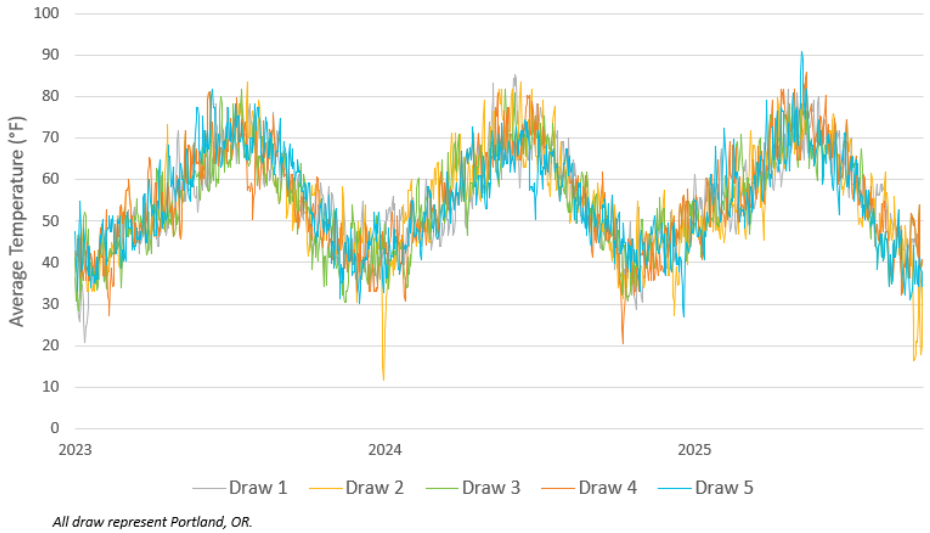
Additional technical notes:

- Historical and forecasted years in the simulation are defined as gas years (November-October).
- The monthly Sumas price is constrained to be greater than or equal to the minimum of AECO and WestCoastStation2.
- Even through daily prices can dip close to zero (even negative on occasion), the lower bound for monthly is set to $0.75. For reference, the minimum monthly price in the historical data is $0.79 at AECO in August 2018.
- All prices are simulated as real 2021 $/MMBtu.
- The training set for the "auto.arima" uses data back to 2005.
- The stochastic shocks are pulled from post data back to 2010 (i.e., post shale gale when horizontal drilling became widespread drastically lowering prices and reduced year over year volatility.

F.2 Daily Temperature Weather Simulation

The process outlined here creates a simulation for daily temperatures inclusive of climate change trends, which is used in combination with heating and non-heating usage coefficients for sub-classes of customers. A separate simulation of yearly peak day conditions, inclusive additional demand drivers, is done for developing the peak day forecast and is separate from the simulation discussed here, which is an input to produce stochastic demand, which in turn is an input to PLEXOS® (see Chapter 3, for details).

Figure F.3: Weather Simulation Draw Example



The daily temperature simulation produces a daily temperature for each location and draw that preserves the two important correlations:

1. Correlation across locations – when it is cold in Eugene it is likely cold in Portland, but the relationship between any two locations is not deterministic and can vary[7]
2. Correlation with climate change trends in overall temperatures – Even though year-over-year cumulative HDDs is random the over trend of HDD is decreasing over the planning horizon

Phase 1: Correlation across locations

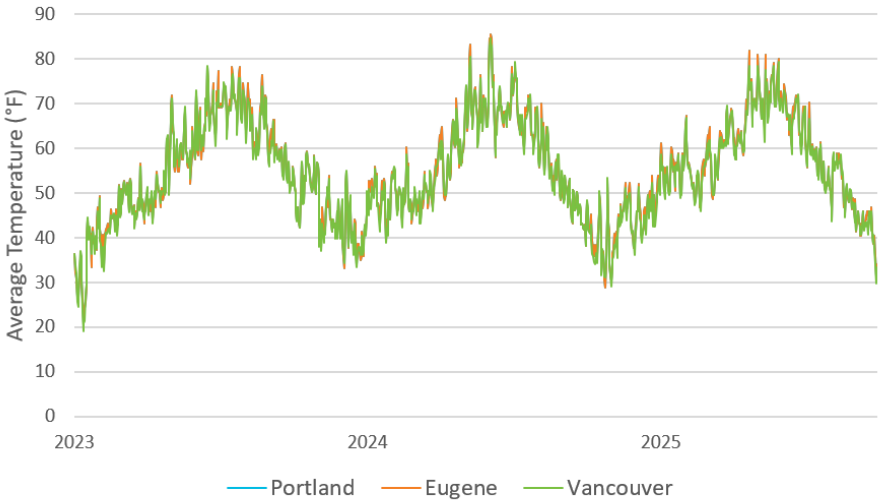
Step 1: Randomly pair a historical year to each forecast month and each draw

Step 2: For each location assign the historical weather for each location based on the randomly selected historical year and matching historical and forecast month

This ensures that data a single historical month is applied across all locations.

[7] In January of 2013 temperatures in Eugene plummeted to historic lows, while temperatures across the rest of the service territory were much milder in comparison.

Figure F.4: Weather Simulation Example by Location



All locations are represented as draw 1.

Phase 2: Correlation with climate change trends

<u>For each location do:</u>

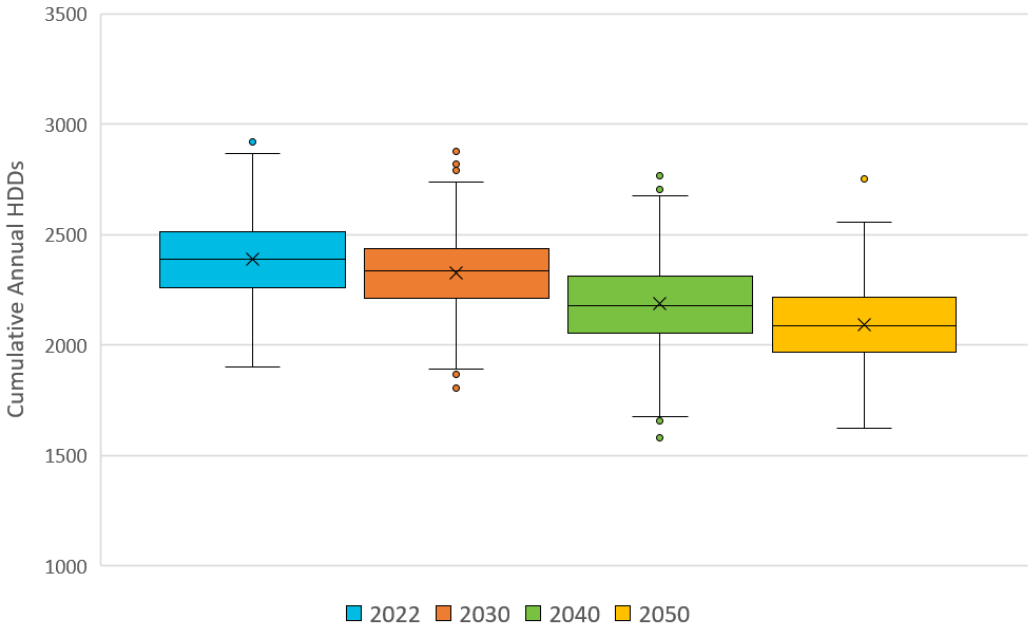
Step 1: For each draw calculate the cumulative HDD for a gas year

Step 2: Calculate the difference between the average cumulative HDD across all draws for a single gas year and the reference case HDD target for that location

Step 3: Adjust all temperatures by this difference divided by 365

Step 4: loop Steps 1 – 3 until the average cumulative gas year HDDs across all draws equal the base case climate change adjusted cumulative HDDs

Figure F.5: Climate Change Trends Across Planning Horizon



All locations are Portland, OR.

F.3 Fixed Resource Cost Simulation

There is uncertainty with the fixed costs associated with capacity resources that the PLEXOS® model can select from. This uncertainty may be caused by unforeseen complications in construction or spikes in sector specific labor or material costs. Cost uncertainty with large capital projects often skews right, therefore the simulation uses a log-normal distribution where the natural log of the high-estimate represents the 95th percentile of the log-normal distribution. The reference case resource cost is the 50th percentile of the log-normal distribution. The sector specific labor and material costs are likely to be correlated across the different capacity resource options. To account for this correlation a 60% correlation factor is applied to shocks in the resource costs.

Figure F.6 shows the range of capacity costs from the simulation for the capacity resources over the planning horizon.

Figure F.7 shows the range of capacity costs for the Portland LNG Cold Box and the two-alternative evaluated through the PLEXOS® model. These figures display capacity costs ($/Dth/Day) for an apples-to-apples comparison based on daily deliverability.

Figure F.6: Capacity Resources Fixed Cost Simulation (500 Draws)

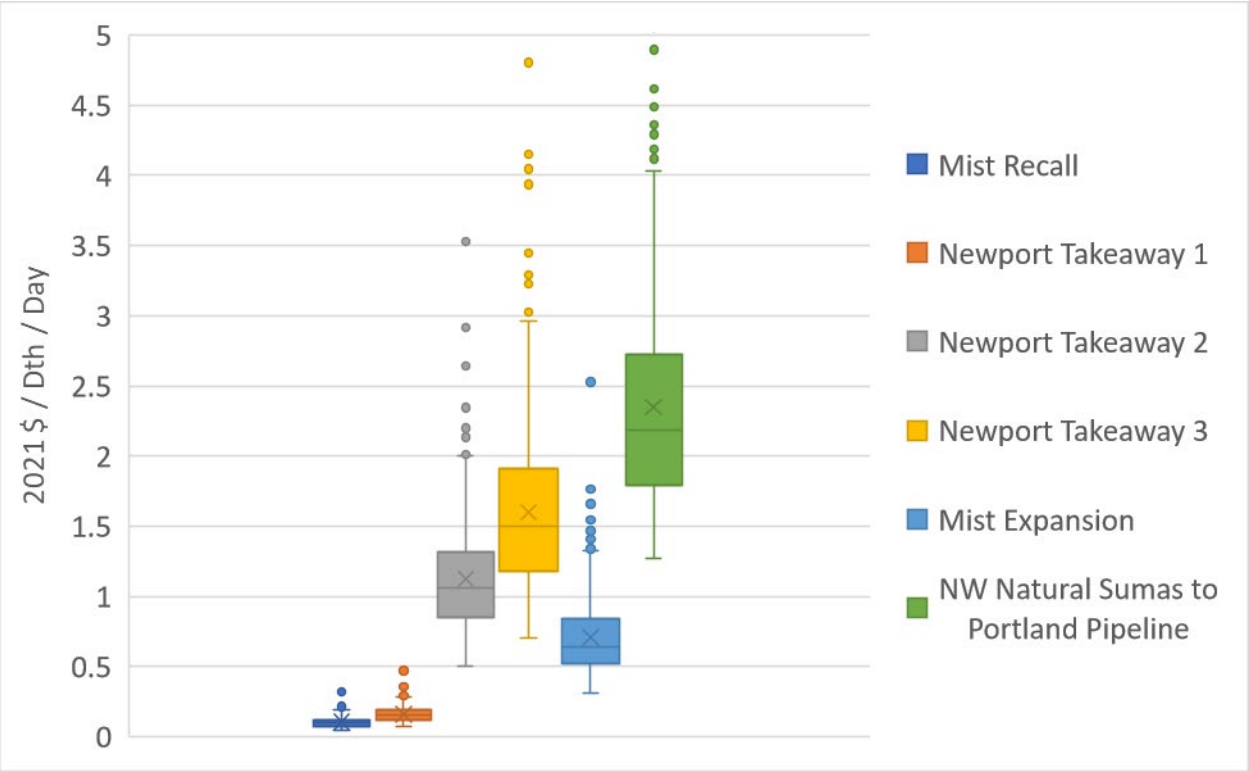
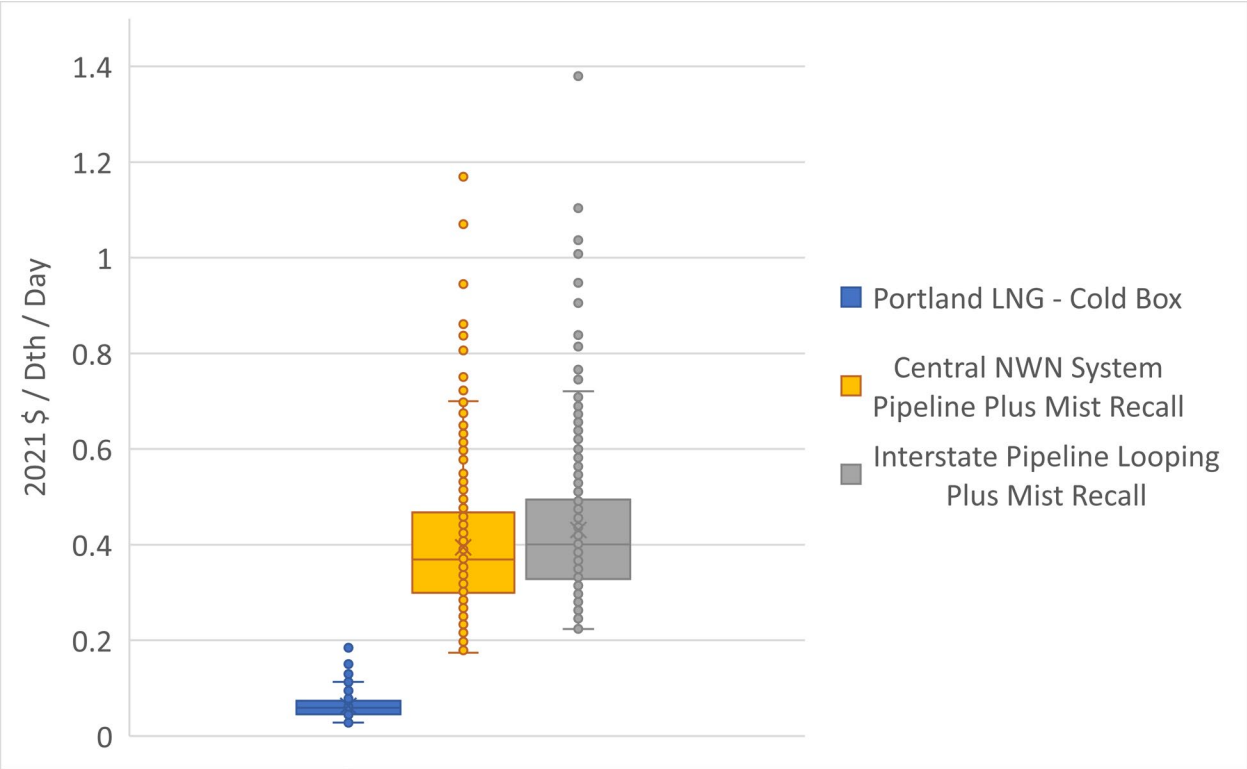


Figure F.7: Portland Cold Box and Cold Box Alternatives



Appendix G: Portfolio Selection

Figure G.1: Peak Day Demand by Scenario

Gas Year	Reference	Scenario 1- Balanced Decarbonization	Scenario 2- Carbon Neutral	Scenario 3- Dual-Fuel Heating	Scenario 4- New Gas Customer Moratorium	Scenario 5- Aggressive Building Electrification	Scenario 6- Full Building Electrification	Scenario 7- RNG and H2 Policy Support	Scenario 8- Limited RNG	Scenario 9- Supply-Focused Decarbonization
	Dth/day	Dth/day	Dth/day	Dth/day	Dth/day	Dth/day	Dth/day	Dth/day	Dth/day	Dth/day
2022-23	1,008,708	1,008,709	1,008,708	1,008,709	1,008,709	1,008,708	1,008,708	1,008,709	1,008,709	1,008,709
2023-24	1,018,191	1,010,720	1,008,013	1,010,720	1,010,720	1,017,804	984,991	1,010,720	1,010,720	1,010,714
2024-25	1,027,864	1,011,574	1,006,556	1,012,252	997,832	997,645	946,244	1,011,574	1,011,516	1,012,239
2025-26	1,038,545	1,012,970	1,006,030	1,015,004	985,146	978,203	908,252	1,012,970	1,012,857	1,014,983
2026-27	1,051,101	1,015,329	1,006,869	1,019,437	974,156	960,909	872,203	1,015,406	1,015,237	1,019,407
2027-28	1,060,815	1,014,358	1,004,614	1,021,126	960,585	941,520	834,291	1,014,510	1,014,287	1,021,098
2028-29	1,072,524	1,014,039	1,003,294	1,024,060	948,233	923,767	797,818	1,014,263	1,013,988	1,024,034
2029-30	1,081,316	1,010,367	998,738	1,024,172	933,842	903,812	759,531	1,010,653	1,010,337	1,024,147
2030-31	1,091,507	1,008,086	995,008	1,025,592	921,272	885,219	722,445	1,008,433	1,008,076	1,025,569
2031-32	1,102,273	1,005,792	990,518	1,026,869	909,993	867,586	686,172	1,006,199	1,005,802	1,026,846
2032-33	1,112,746	1,002,488	984,453	1,026,990	899,077	849,890	649,798	1,002,953	1,002,516	1,026,969
2033-34	1,121,629	999,298	978,003	1,027,140	888,343	831,527	612,948	999,820	999,345	1,027,121
2034-35	1,130,124	996,014	970,749	1,027,118	877,960	812,964	575,985	996,592	996,079	1,027,100
2035-36	1,140,104	993,029	962,939	1,027,307	869,125	795,768	540,003	993,663	993,112	1,027,290
2036-37	1,149,011	988,199	952,918	1,025,480	859,615	777,792	503,429	988,886	988,299	1,025,464
2037-38	1,156,416	982,951	942,161	1,023,110	849,848	759,251	466,541	983,690	983,068	1,023,096
2038-39	1,166,190	980,021	933,473	1,023,077	842,105	742,399	430,653	980,813	980,156	1,023,064
2039-40	1,173,967	975,624	923,133	1,021,413	833,321	724,441	394,125	976,466	975,775	1,021,401
2040-41	1,181,592	971,286	913,072	1,019,739	824,426	706,140	357,375	972,176	971,453	1,019,728
2041-42	1,189,893	970,393	906,729	1,021,633	817,036	688,401	320,934	971,331	970,575	1,021,624
2042-43	1,199,026	969,442	900,301	1,023,430	810,195	671,121	284,660	970,428	969,641	1,023,422
2043-44	1,206,813	967,386	892,785	1,024,001	802,698	653,213	248,122	968,418	967,600	1,023,994
2044-45	1,214,623	964,282	884,447	1,023,445	794,900	635,105	211,456	965,358	964,510	1,023,439
2045-46	1,223,090	961,832	876,719	1,023,534	787,787	617,503	174,960	962,952	962,075	1,023,530
2046-47	1,229,438	957,698	867,516	1,021,775	779,530	598,871	138,202	958,859	957,954	1,021,772
2047-48	1,237,217	955,135	859,813	1,021,647	772,750	581,096	135,986	956,338	955,405	1,021,644
2048-49	1,245,282	951,368	851,080	1,020,236	765,689	563,274	133,710	952,612	951,651	1,020,235
2049-50	1,252,729	947,341	842,042	1,018,346	758,596	545,291	131,398	948,626	947,638	1,018,346

Figure G.2: Mist Recall by Scenario

Fiscal Year	Reference	Scenario 1- Balanced Decarbonization	Scenario 2- Carbon Neutral	Scenario 3- Dual-Fuel Heating	Scenario 4- New Gas Customer Moratorium	Scenario 5- Aggressive Building Electrification	Scenario 6- Full Building Electrification	Scenario 7- RNG and H2 Policy Support	Scenario 8- Limited RNG	Scenario 9- Supply-Focused Decarbonization
	Dth/day	Dth/day	Dth/day	Dth/day	Dth/day	Dth/day	Dth/day	Dth/day	Dth/day	Dth/day
2023	27,409	19,898	17,410	19,898	19,898	27,022	-	19,898	19,898	19,892
2024	37,142	20,757	17,410	21,439	19,898	27,022	-	20,757	20,757	21,426
2025	113,138	53,761	40,168	32,713	30,532	27,022	18,494	73,136	73,136	71,302
2026	113,138	53,761	40,168	32,713	30,532	27,022	18,494	73,136	73,136	71,302
2027	131,321	84,753	75,946	91,415	30,532	27,022	18,494	84,753	84,753	91,378
2028	143,096	84,753	75,946	94,375	30,532	27,022	18,494	84,753	84,753	94,331
2029	151,936	84,753	75,946	94,495	30,532	27,022	18,494	84,753	84,753	94,444
2030	162,184	84,753	75,946	95,931	30,532	27,022	18,494	84,753	84,753	95,875
2031	173,011	84,753	75,946	97,222	30,532	27,022	18,494	84,753	84,753	97,159
2032	183,544	84,753	75,946	97,351	30,532	27,022	18,494	84,753	84,753	97,282
2033	192,478	84,753	75,946	97,509	30,532	27,022	18,494	84,753	84,753	97,435
2034	201,017	84,753	75,946	97,509	30,532	27,022	18,494	84,753	84,753	97,435
2035	201,017	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2036	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2037	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2038	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2039	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2040	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2041	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2042	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2043	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2044	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2045	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2046	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2047	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2048	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2049	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605
2050	203,803	84,753	75,946	97,686	30,532	27,022	18,494	84,753	84,753	97,605

Figure G.3: Oregon Compliance Option: CCIs by Scenario

Fiscal Year	Reference	Scenario 1- Balanced Decarbonization	Scenario 2- Carbon Neutral	Scenario 3- Dual-Fuel Heating	Scenario 4- New Gas Customer Moratorium	Scenario 5- Aggressive Building Electrification	Scenario 6- Full Building Electrification	Scenario 7- RNG and H2 Policy Support	Scenario 8- Limited RNG	Scenario 9- Supply-Focused Decarbonization
	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu
2022	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0
2024	1,003	372	0	0	372	0	0	0	372	372
2025	2,827	1,592	0	902	1,264	0	0	1,728	1,728	1,794
2026	6,481	4,386	9	3,360	3,403	206	0	4,823	4,823	4,941
2027	10,126	7,165	1,618	5,565	5,553	1,266	0	0	7,830	8,029
2028	12,383	9,326	3,225	7,330	7,360	2,123	0	3,892	11,339	10,382
2029	16,109	12,040	4,809	9,234	9,449	3,176	0	6,721	13,538	13,348
2030	20,524	15,399	6,427	11,851	12,222	4,876	0	10,102	16,299	16,950
2031	23,354	15,885	8,022	11,019	11,613	6,210	0	13,417	10,231	19,906
2032	7,611	19,868	10,183	14,347	15,083	8,115	0	17,369	14,175	12,574
2033	10,312	5,524	11,187	15,912	14,581	9,104	0	10,491	16,870	8,797
2034	14,665	8,354	12,764	10,660	10,341	10,636	0	12,310	20,199	12,364
2035	15,190	11,785	14,410	13,521	13,418	12,241	0	15,723	7,835	16,003
2036	3,946	13,662	6,628	9,621	10,043	10,924	0	5,768	5,768	5,435
2037	6,414	15,187	9,522	10,625	11,375	11,101	0	7,297	7,297	7,140
2038	9,400	5,423	7,604	7,942	7,423	8,199	0	9,377	9,377	9,382
2039	12,358	7,562	11,046	9,604	9,373	8,872	0	11,498	11,498	11,649
2040	15,841	10,155	9,169	11,534	11,782	8,386	0	11,242	14,100	14,377
2041	2,012	5,158	4,995	4,717	4,468	6,874	0	4,621	3,193	3,006
2042	4,952	7,493	8,642	6,555	6,556	7,545	0	6,942	5,513	5,422
2043	7,886	9,833	12,347	8,258	8,627	8,285	0	9,278	7,850	7,845
2044	7,916	5,151	4,712	6,034	6,062	4,332	0	8,161	9,590	7,203
2045	1,637	2,455	381	3,147	2,750	4,822	0	0	0	2,391
2046	4,572	4,843	4,151	5,068	4,938	5,629	0	0	2,375	4,823
2047	7,501	7,230	7,922	7,006	7,135	6,445	0	0	4,748	7,251
2048	0	0	0	0	0	0	0	0	4,950	0
2049	0	0	0	0	0	0	0	0	6,964	0
2050	0	0	0	0	0	0	0	0	0	0

Figure G.4: Oregon Compliance Option: RNG Tranche 1 by Scenario

Fiscal Year	Reference	Scenario 1- Balanced Decarbonization	Scenario 2- Carbon Neutral	Scenario 3- Dual-Fuel Heating	Scenario 4- New Gas Customer Moratorium	Scenario 5- Aggressive Building Electrification	Scenario 6- Full Building Electrification	Scenario 7- RNG and H2 Policy Support	Scenario 8- Limited RNG	Scenario 9- Supply-Focused Decarbonization
	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu
2022	1,800	1,797	1,796	1,797	1,797	1,802	1,802	5,388	1,797	1,797
2023	4,188	4,137	4,078	4,107	4,137	4,166	3,911	5,388	2,424	4,137
2024	4,200	4,149	4,089	4,119	4,149	4,178	3,921	5,403	4,149	4,149
2025	5,493	5,373	5,267	5,297	5,337	5,361	4,844	5,388	5,388	5,387
2026	6,257	6,034	5,908	5,907	5,912	5,889	5,181	6,088	6,088	6,084
2027	7,032	6,686	6,544	6,468	6,466	6,389	5,467	14,606	6,776	6,775
2028	9,845	8,570	7,795	7,944	8,009	7,733	5,741	14,943	7,032	8,772
2029	9,818	8,547	7,773	7,922	7,988	7,711	5,725	14,902	7,013	8,749
2030	9,818	8,547	7,773	7,922	7,988	7,711	5,725	14,902	7,013	8,749
2031	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2032	11,427	11,427	7,795	11,427	11,427	7,733	5,741	14,943	7,032	8,961
2033	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2034	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2035	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2036	11,427	11,427	7,795	11,427	11,427	7,733	5,741	14,943	7,032	8,961
2037	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2038	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2039	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2040	11,427	11,427	7,795	11,427	11,427	7,733	5,741	14,943	7,032	8,961
2041	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2042	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2043	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2044	11,427	11,427	7,795	11,427	11,427	7,733	5,741	14,943	7,032	8,961
2045	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2046	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2047	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2048	11,427	11,427	7,795	11,427	11,427	7,733	5,741	14,943	7,032	8,961
2049	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937
2050	11,396	11,396	7,773	11,396	11,396	7,711	5,725	14,902	7,013	8,937

Figure G.5: Oregon Compliance Option: RNG Tranche 2 by Scenario

Fiscal Year	Reference	Scenario 1- Balanced Decarbonization	Scenario 2- Carbon Neutral	Scenario 3- Dual-Fuel Heating	Scenario 4- New Gas Customer Moratorium	Scenario 5- Aggressive Building Electrification	Scenario 6- Full Building Electrification	Scenario 7- RNG and H2 Policy Support	Scenario 8- Limited RNG	Scenario 9- Supply-Focused Decarbonization
	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu
2022	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0	0	0	0
2026	0	0	0	0	0	0	0	0	0	0
2027	0	0	0	0	0	0	0	0	0	0
2028	0	0	0	0	0	0	0	0	463	0
2029	0	0	0	0	0	0	0	0	468	0
2030	0	0	0	0	0	0	0	0	468	0
2031	0	0	0	0	0	0	0	0	468	0
2032	0	0	0	0	0	0	0	0	470	0
2033	0	0	0	0	0	0	0	0	468	0
2034	0	0	0	0	0	0	0	0	468	0
2035	0	0	0	0	0	0	0	0	468	0
2036	0	0	0	0	0	0	0	0	470	0
2037	0	0	0	0	0	0	0	0	468	0
2038	0	0	0	0	0	0	0	0	468	0
2039	0	0	0	0	0	0	0	0	468	0
2040	0	0	0	0	0	0	0	0	470	0
2041	0	0	0	0	0	0	0	0	468	0
2042	0	0	0	0	0	0	0	0	468	0
2043	0	0	0	0	0	0	0	0	468	0
2044	0	0	0	0	0	0	0	0	470	0
2045	0	0	0	0	0	0	0	0	468	0
2046	0	0	0	0	0	0	0	0	468	0
2047	0	0	0	0	0	0	0	0	468	0
2048	0	0	0	0	0	0	0	0	470	0
2049	0	0	0	0	0	0	0	0	468	0
2050	0	0	0	0	0	0	0	0	468	0

Figure G.6: Oregon Compliance Option: Hydrogen by Scenario

Fiscal Year	Reference	Scenario 1- Balanced Decarbonization	Scenario 2- Carbon Neutral	Scenario 3- Dual-Fuel Heating	Scenario 4- New Gas Customer Moratorium	Scenario 5- Aggressive Building Electrification	Scenario 6- Full Building Electrification	Scenario 7- RNG and H2 Policy Support	Scenario 8- Limited RNG	Scenario 9- Supply-Focused Decarbonization
	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu
2022	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0	0	0	0
2026	0	0	0	0	0	0	0	0	0	0
2027	0	0	0	0	0	0	0	0	0	0
2028	0	0	0	0	0	0	0	0	0	0
2029	0	0	0	0	0	0	151	0	604	0
2030	0	0	597	0	0	0	279	0	1,224	0
2031	0	0	1,181	0	0	385	354	0	10,606	448
2032	20,831	0	1,793	0	0	783	409	0	10,635	12,024
2033	21,873	17,040	2,289	511	2,829	1,074	408	9,564	10,606	18,714
2034	21,873	17,560	2,809	8,531	10,057	1,374	408	11,074	10,606	18,714
2035	21,873	17,560	3,322	8,531	10,057	1,649	408	11,074	10,606	18,714
2036	21,933	17,608	13,822	14,632	15,820	4,028	409	23,731	10,635	32,219
2037	21,873	17,560	13,784	14,592	15,777	4,017	408	23,666	10,606	32,131
2038	21,873	17,560	19,122	14,592	15,777	7,573	408	23,666	10,606	32,131
2039	21,873	17,560	19,122	14,592	15,777	7,573	408	23,666	10,606	32,131
2040	21,933	17,608	24,994	14,632	15,820	9,161	409	26,588	10,635	32,219
2041	21,873	17,560	32,160	14,592	15,777	9,136	408	26,515	10,606	32,131
2042	21,873	17,560	32,160	14,592	15,777	9,136	408	26,515	10,606	32,131
2043	21,873	17,560	32,160	14,592	15,777	9,136	408	26,515	10,606	32,131
2044	21,933	17,608	32,248	14,632	15,820	9,161	409	26,588	10,635	32,219
2045	21,873	17,560	32,160	14,592	15,777	9,136	408	26,515	10,606	32,131
2046	21,873	17,560	32,160	14,592	15,777	9,136	408	26,515	10,606	32,131
2047	21,873	17,560	32,160	14,592	15,777	9,136	408	26,515	10,606	32,131
2048	21,933	17,608	32,248	14,632	15,820	9,161	409	26,588	10,635	32,219
2049	21,873	17,560	32,160	14,592	15,777	9,136	408	26,515	10,606	32,131
2050	21,873	17,560	32,160	14,592	15,777	9,136	408	26,515	10,606	32,131

Figure G.7: Oregon Compliance Option: Synthetic Methane by Scenario

Fiscal Year	Reference	Scenario 1- Balanced Decarbonization	Scenario 2- Carbon Neutral	Scenario 3- Dual-Fuel Heating	Scenario 4- New Gas Customer Moratorium	Scenario 5- Aggressive Building Electrification	Scenario 6- Full Building Electrification	Scenario 7- RNG and H2 Policy Support	Scenario 8- Limited RNG	Scenario 9- Supply-Focused Decarbonization
	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu
2022	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0	0	0	0
2026	0	0	0	0	0	0	0	0	0	0
2027	0	0	0	0	0	0	0	0	0	0
2028	0	0	0	0	0	0	0	0	0	0
2029	0	0	0	0	0	0	0	0	0	0
2030	0	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0	0
2035	3,833	0	0	0	0	0	0	0	15,777	0
2036	18,709	804	0	0	0	0	0	0	20,537	0
2037	18,658	802	0	0	0	0	0	0	20,481	0
2038	18,658	12,665	0	4,300	5,862	0	0	0	20,481	0
2039	18,658	12,665	0	4,300	5,862	0	0	0	20,481	0
2040	18,709	12,700	0	4,311	5,878	0	0	0	20,537	0
2041	34,884	19,423	0	12,471	14,761	1,853	0	8,358	33,117	13,199
2042	34,884	19,423	0	12,471	14,761	1,915	0	8,358	33,117	13,199
2043	34,884	19,423	0	12,471	14,761	1,915	0	8,358	33,117	13,199
2044	38,393	26,915	11,764	16,750	19,862	6,956	0	12,255	34,220	16,714
2045	47,014	31,415	19,419	20,787	24,815	6,937	0	22,249	45,579	23,391
2046	47,014	31,415	19,419	20,787	24,815	6,937	0	24,624	45,579	23,391
2047	47,014	31,415	19,419	20,787	24,815	6,937	0	26,997	45,579	23,391
2048	58,048	41,518	31,551	30,103	34,605	14,484	0	29,830	48,274	33,541
2049	60,387	43,492	34,971	31,790	36,464	15,057	0	31,776	48,142	35,510
2050	63,315	46,014	38,798	34,109	38,864	15,910	0	34,139	57,470	37,915

Figure G.8: Washington Compliance Option: Purchase Allowances by Scenario

Fiscal Year	Reference	Scenario 1- Balanced Decarbonization	Scenario 2- Carbon Neutral	Scenario 3- Dual-Fuel Heating	Scenario 4- New Gas Customer Moratorium	Scenario 5- Aggressive Building Electrification	Scenario 6- Full Building Electrification	Scenario 7- RNG and H2 Policy Support	Scenario 8- Limited RNG	Scenario 9- Supply-Focused Decarbonization
	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu
2022	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0
2025	1,435	1,124	0	1,019	1,104	1,102	99	0	1,564	1,132
2026	2,736	2,401	0	2,273	2,268	2,159	1,339	2,166	2,456	2,459
2027	580	300	0	191	176	62	0	0	354	357
2028	3,577	3,020	0	2,758	2,741	2,537	839	1,706	3,194	3,138
2029	4,004	3,298	0	2,929	2,931	2,606	1,360	2,609	3,410	3,445
2030	4,360	3,532	0	3,087	3,096	2,705	1,325	2,920	3,645	3,702
2031	1,738	1,111	0	775	781	469	0	539	1,190	1,240
2032	4,521	3,455	0	2,876	2,892	2,362	162	2,988	3,562	3,671
2033	4,509	3,334	1,053	2,685	2,720	2,129	367	2,932	3,439	3,571
2034	4,552	3,275	1,430	2,567	2,607	1,945	56	2,941	3,376	3,531
2035	1,855	938	0	431	458	0	0	644	1,007	1,124
2036	4,684	3,217	1,093	2,402	2,444	1,582	0	3,026	3,312	3,511
2037	4,658	3,110	2,020	2,245	2,300	1,421	0	2,979	3,202	3,419
2038	4,686	3,050	2,295	2,128	2,202	1,255	0	2,984	3,141	3,374
2039	1,919	774	377	125	193	0	0	745	836	1,003
2040	4,785	2,981	2,898	1,935	2,057	460	0	382	3,069	3,330
2041	4,747	2,886	3,140	1,795	1,932	780	0	352	2,971	3,242
2042	3,875	1,989	925	936	1,065	624	0	379	2,929	1,062
2043	1,196	0	0	0	0	0	0	0	730	0
2044	4,237	2,063	874	148	361	0	0	0	2,964	0
2045	4,331	2,186	2,037	907	1,055	0	0	0	2,912	1,170
2046	4,476	2,239	2,411	866	1,045	0	0	0	2,899	1,233
2047	1,721	163	720	0	0	0	0	0	733	0
2048	4,814	2,390	3,209	35	397	0	0	0	2,911	439
2049	0	0	0	43	4	0	0	0	2,855	0
2050	0	0	0	0	0	0	0	0	0	0

Figure G.9: Washington Compliance Option: Offsets by Scenario

Fiscal Year	Reference	Scenario 1- Balanced Decarbonization	Scenario 2- Carbon Neutral	Scenario 3- Dual-Fuel Heating	Scenario 4- New Gas Customer Moratorium	Scenario 5- Aggressive Building Electrification	Scenario 6- Full Building Electrification	Scenario 7- RNG and H2 Policy Support	Scenario 8- Limited RNG	Scenario 9- Supply-Focused Decarbonization
	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu
2022	0	0	0	0	0	0	0	0	0	0
2023	937	887	0	885	892	898	800	508	1,101	885
2024	1,663	1,549	0	1,509	1,554	1,566	1,146	1,170	1,764	1,547
2025	800	899	0	916	873	847	1,182	1,663	475	909
2026	0	0	154	0	0	0	0	0	0	0
2027	2,614	2,437	322	2,347	2,346	2,274	1,369	1,857	2,465	2,473
2028	0	0	543	0	0	0	582	608	0	0
2029	0	0	649	0	0	0	0	0	0	0
2030	0	0	810	0	0	0	0	0	0	-
2031	2,676	2,355	968	2,177	2,185	2,040	1,000	2,386	2,386	2,419
2032	0	0	1,176	0	0	0	557	0	0	0
2033	0	0	223	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0	0
2035	2,736	2,282	1,587	2,026	2,042	1,766	0	2,311	2,311	2,371
2036	0	0	698	0	0	49	0	0	0	0
2037	0	0	0	0	0	0	0	0	0	0
2038	0	0	0	0	0	0	0	0	0	0
2039	2,791	2,214	2,195	1,872	1,913	1,092	0	2,242	2,242	2,322
2040	0	0	0	0	0	506	0	0	0	0
2041	0	0	0	0	0	0	0	0	0	0
2042	0	0	0	0	0	0	0	0	0	0
2043	2,846	2,057	1,293	927	1,062	517	0	445	2,195	1,143
2044	0	112	831	825	741	420	0	556	0	1,146
2045	0	0	0	0	0	281	0	571	0	0
2046	0	0	0	0	0	172	0	623	0	0
2047	2,898	2,126	2,067	823	1,033	63	0	672	2,151	1,292
2048	0	0	0	806	667	0	0	769	0	963
2049	0	0	0	0	0	0	0	0	0	0
2050	0	0	0	0	0	0	0	0	0	0

Figure G.10: Washington Compliance Option: RNG Tranche 1 by Scenario

Fiscal Year	Reference	Scenario 1- Balanced Decarbonization	Scenario 2- Carbon Neutral	Scenario 3- Dual-Fuel Heating	Scenario 4- New Gas Customer Moratorium	Scenario 5- Aggressive Building Electrification	Scenario 6- Full Building Electrification	Scenario 7- RNG and H2 Policy Support	Scenario 8- Limited RNG	Scenario 9- Supply-Focused Decarbonization
	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu
2022	258	258	258	258	258	258	258	1,249	258	258
2023	893	871	653	861	866	875	807	1,249	656	872
2024	896	873	655	863	868	877	809	1,252	658	875
2025	893	871	866	861	866	875	807	1,249	873	872
2026	992	952	950	937	936	940	848	1,249	959	959
2027	1,091	1,032	1,032	1,005	1,003	1,002	882	2,006	965	1,043
2028	1,298	1,190	1,121	1,130	1,130	1,066	916	2,012	968	1,211
2029	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2030	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2031	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2032	1,298	1,190	1,197	1,130	1,130	1,066	916	2,012	968	1,211
2033	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2034	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2035	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2036	1,298	1,190	1,197	1,130	1,130	1,066	916	2,012	968	1,211
2037	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2038	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2039	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2040	1,298	1,190	1,197	1,130	1,130	1,066	916	2,012	968	1,211
2041	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2042	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2043	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2044	1,298	1,190	1,197	1,130	1,130	1,066	916	2,012	968	1,211
2045	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2046	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2047	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2048	1,298	1,190	1,197	1,130	1,130	1,066	916	2,012	968	1,211
2049	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207
2050	1,295	1,187	1,194	1,127	1,127	1,063	913	2,006	965	1,207

Figure G.11: Washington Compliance Option: RNG Tranche 2 by Scenario

Fiscal Year	Reference	Scenario 1- Balanced Decarbonization	Scenario 2- Carbon Neutral	Scenario 3- Dual-Fuel Heating	Scenario 4- New Gas Customer Moratorium	Scenario 5- Aggressive Building Electrification	Scenario 6- Full Building Electrification	Scenario 7- RNG and H2 Policy Support	Scenario 8- Limited RNG	Scenario 9- Supply-Focused Decarbonization
	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu
2022	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0	0	0	0
2026	0	0	0	0	0	0	0	0	0	0
2027	0	0	0	0	0	0	0	0	0	0
2028	0	0	0	0	0	0	0	0	0	0
2029	0	0	0	0	0	0	0	0	0	0
2030	0	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0	0
2036	0	0	0	0	0	0	0	0	0	0
2037	0	0	0	0	0	0	0	0	0	0
2038	0	0	0	0	0	0	0	0	0	0
2039	0	0	0	0	0	0	0	0	0	0
2040	0	0	0	0	0	0	0	0	0	0
2041	0	0	0	0	0	0	0	0	0	0
2042	0	0	0	0	0	0	0	0	0	0
2043	0	0	0	0	0	0	0	0	0	0
2044	0	0	0	0	0	0	0	0	0	0
2045	0	0	0	0	0	0	0	0	0	0
2046	0	0	0	0	0	0	0	0	0	0
2047	0	0	0	0	0	0	0	0	0	0
2048	0	0	0	0	0	0	0	0	0	0
2049	0	0	0	0	0	0	0	0	0	0
2050	0	0	0	0	0	0	0	0	0	0

Figure G.12: Washington Compliance Option: Hydrogen by Scenario

Fiscal Year	Reference	Scenario 1- Balanced Decarbonization	Scenario 2- Carbon Neutral	Scenario 3- Dual-Fuel Heating	Scenario 4- New Gas Customer Moratorium	Scenario 5- Aggressive Building Electrification	Scenario 6- Full Building Electrification	Scenario 7- RNG and H2 Policy Support	Scenario 8- Limited RNG	Scenario 9- Supply-Focused Decarbonization
	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu
2022	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0	0	0	0
2026	0	0	0	0	0	0	0	0	0	0
2027	0	0	0	0	0	0	0	0	78	0
2028	0	0	0	0	0	0	0	0	165	0
2029	0	0	0	0	0	50	18	0	239	0
2030	104	75	79	56	57	101	32	0	316	80
2031	209	148	156	110	113	147	40	0	390	159
2032	322	226	238	168	170	195	44	0	469	243
2033	424	290	306	208	216	230	44	0	535	314
2034	533	361	378	255	264	265	44	0	606	391
2035	644	432	450	301	312	298	44	0	678	469
2036	765	509	527	354	364	332	44	0	757	554
2037	869	570	586	387	402	352	44	0	817	622
2038	983	636	649	421	443	374	44	0	884	696
2039	1,099	700	711	448	482	392	44	0	950	768
2040	1,227	775	781	487	527	413	44	2,669	1,026	851
2041	1,333	832	832	510	557	419	44	2,662	1,065	914
2042	2,340	1,757	3,407	1,320	1,385	433	44	2,662	1,065	3,137
2043	2,340	1,757	3,407	1,320	1,385	433	44	2,662	1,065	3,137
2044	2,377	1,762	3,416	1,323	1,389	456	44	2,669	1,068	3,272
2045	2,373	1,757	3,407	1,320	1,385	454	44	2,662	1,065	3,263
2046	2,384	1,757	3,407	1,320	1,385	454	44	2,662	1,065	3,263
2047	2,395	1,757	3,407	1,320	1,385	454	44	2,662	1,065	3,263
2048	2,421	1,762	3,416	1,323	1,389	456	44	2,669	1,068	3,272
2049	2,417	1,757	3,407	1,320	1,385	454	44	2,662	1,065	3,263
2050	2,427	1,757	3,407	1,320	1,385	454	44	2,662	1,065	3,263

Figure G.13: Washington Compliance Options: Synthetic Methane by Scenario

Fiscal Year	Reference	Scenario 1- Balanced Decarbonization	Scenario 2- Carbon Neutral	Scenario 3- Dual-Fuel Heating	Scenario 4- New Gas Customer Moratorium	Scenario 5- Aggressive Building Electrification	Scenario 6- Full Building Electrification	Scenario 7- RNG and H2 Policy Support	Scenario 8- Limited RNG	Scenario 9- Supply-Focused Decarbonization
	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu	BBtu
2022	0	0	0	0	0	0	0	0	0	0
2023	0	0	0	0	0	0	0	0	0	0
2024	0	0	0	0	0	0	0	0	0	0
2025	0	0	0	0	0	0	0	0	0	0
2026	0	0	0	0	0	0	0	0	0	0
2027	0	0	0	0	0	0	0	0	0	0
2028	0	0	0	0	0	0	0	0	0	0
2029	0	0	0	0	0	0	0	0	0	0
2030	0	0	0	0	0	0	0	0	0	0
2031	0	0	0	0	0	0	0	0	0	0
2032	0	0	0	0	0	0	0	0	0	0
2033	0	0	0	0	0	0	0	0	0	0
2034	0	0	0	0	0	0	0	0	0	0
2035	0	0	0	0	0	0	0	0	0	0
2036	0	0	0	0	0	0	0	0	0	0
2037	0	0	0	0	0	0	0	0	0	0
2038	0	0	0	0	0	0	0	0	0	0
2039	0	0	0	0	0	0	0	0	0	0
2040	0	0	0	0	0	0	0	0	0	0
2041	0	0	0	0	0	0	0	0	18	0
2042	0	0	0	0	0	0	0	0	88	0
2043	0	0	0	0	0	0	0	0	158	0
2044	0	0	0	0	0	0	0	0	237	0
2045	0	0	0	0	0	0	0	0	296	0
2046	0	0	0	0	0	0	0	0	362	0
2047	0	0	0	0	0	0	0	0	427	0
2048	0	0	0	0	0	0	0	0	503	0
2049	4,894	2,397	3,552	753	1,017	0	0	775	558	1,415
2050	5,028	2,447	3,935	753	1,017	0	0	811	3,449	1,459

Appendix H: Technical Working Group Attendance

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Appendix I: Meeting for the Public Bill Insert Notice

NW NATURAL'S 2022 INTEGRATED RESOURCE PLAN (IRP)

The IRP is NW Natural's long-term plan to serve customers and answer questions, such as: How much gas will our customers use? How much energy can we save through conservation? Where will NW Natural get its gas supply?

Please join us for a discussion of these and other topics to help develop the IRP:

DATE: Monday, July 18, 2022

TIME: 6 p.m. to 8 p.m.

ONLINE OR BY PHONE: See meeting information at nwnatural.com/IRP

You can also mail any questions or comments about the plan to:

NW Natural
Attn: Integrated Resource Plan
250 SW Taylor Street
Portland, OR 97204

A copy of the draft 2022 Integrated Resource Plan will be available on our website in early July, at **nwnatural.com/IRP**.

NW Natural

At NW Natural, we have a responsibility to reliably and affordably meet our customers' current and future energy needs. Every few years, Integrated Resource Planning (IRP) develops a plan that best meets customers' forecasted long-term energy requirements with the goal of minimizing the combination of costs and risks for NW Natural customers. This robust planning process evaluates many factors, including but not limited to:

- Environmental policy
- Customer growth
- Consumption trends
- Demand-side resources, such as energy efficiency and demand response
- Supply-side resources, such as renewable natural gas and storage options

The NW Natural IRP is developed through a process open to the public and informed by feedback and a formal review by a diverse set of interested parties. For more information, please visit **nwnatural.com/IRP**.

NW Natural

Appendix J: Draft Comments

J.1 Draft Comments

NW Natural invited and received comments/questions on its Draft IRP from a number of stakeholders. As several of the comments/questions were similar and often related to the same topic, NW Natural has created the table below which summarizes the comments received by topic and NW Natural's response. NW Natural appreciates the feedback and engagement in its 2022 IRP process.

Topic	Summary of Draft Combined Comments	Response from NW Natural
General	We received comments asking for more explanation of the distinction between Reference Case and Base Case, and the purpose that each case is serving in the analysis.	NW Natural has now included a Reference Case in the Glossary and has also provided a section in Chapter 2 that discusses what is meant by Reference Case as well as a discussion about why NW Natural not including a base case in this IRP. More specifically, a reference case is a projection of demand based on historical trends embedded in customer additions, customer losses, and customer usage profile throughout the year across residential, commercial, and industrial sectors. This is the comparative case that allows one to gain but for understanding. Additionally, due to the degree of uncertainty of loads, policy, costs, and resources, for this IRP rather than developing a base case, NW Natural uses the range of cases, stochastic simulation, and risk analysis to inform its action plan for the next couple of years until the next IRP. For purposes of this IRP, the action plan is the selected portfolio.

Topic	Summary of Draft Combined Comments	Response from NW Natural
General	NW Natural received a few comments, noting typos, missing words, or unclear sentences. Additionally, there were numerous requests for additional discussion and information.	NW Natural appreciates these comments and has made corrections based on this feedback. Additionally, NW Natural has tried to include additional information about key topics such as RNG and Hydrogen within the body of the IRP to provide clarity. Lastly, NW Natural has added more materials and information in the appendices in support of key topics and underlying assumptions.
General	NW Natural received a comment regarding PLEXOS® and suggesting more discussion about it especially with it being new to this IRP and a cause for one of the requested waivers allowing a delay.	NW Natural has updated the Executive Summary to add more about what is new to this IRP or what has changed and PLEXOS® is discussed as the first item. NW Natural also expanded its discussion about the core algorithms of the PLEXOS modelling software and the computational hurdles of completing the complex IRP modeling.
General	NW Natural received comments requesting more information be included regarding the inputs contained in each of the portfolios shown in Chapter 7.	NW Natural has expanded its description and information relating to each of the portfolios in Chapter 7 and included additional information within its Appendices. As the previous chapters build to this portfolio evaluation and selection chapter, additional information has also been added throughout the IRP and the reader may find additional information in other relevant chapters. Further, NW Natural will be providing workpapers that should also contain the requested information in more detail.
General	NW Natural received some comments asking for information like that provided in the UM2178 workshop. More specifically,	NW Natural now includes the estimated bill impacts. Please see Chapter 7 for more information.

Topic	Summary of Draft Combined Comments	Response from NW Natural
	requesting information about potential residential ratepayer impacts.	
General	NW Natural received comments asking about how it compares resources.	NW Natural compares resources using the least cost, least risk framework. It does so by calculating the PVRR for different resources and using risk analysis to evaluate resulting portfolios to inform the action plan.
Gas Price Forecast	NW Natural received some comments about its gas price forecast. More specifically, comments were asking about more details relative to our gas price forecast as well as concerns about the volatility of gas prices and how that is factored into the analysis.	NW Natural has added some additional information about its gas price forecast and in Chapter 2, now includes a chart that shows both the history and forecast range for the weighted average cost of gas. Additionally, as part of its risk analysis, NW Natural includes a detail discussion about the price simulation of conventional natural gas as one of the stochastic variables.
Environmental Policy	NW Natural received several comments asking about the recently passed Inflation Reduction Act and its impact on the IRP.	The IRP process is complex and highly technical. By its nature, to develop portfolios, forecasts must be locked down at some point in time during the process. This is one of the reasons that the IRP is redone on a biannual cadence, recognizing the changing environment. The IRA was passed after NW Natural released its draft IRP and within approximately a month from its filing date. We have referred to it in several places within the IRP but did not specifically include it in the modeling. However, due to the scenario analyses that NW Natural performed, several of areas that will likely be impacted by the IRA have indeed been included. By means of example, one of the scenarios anticipated

Topic	Summary of Draft Combined Comments	Response from NW Natural
		a production tax credit for hydrogen. NW Natural will continue to monitor the environment for impacts from the IRA and other policies and use these to inform its planning processes.
Environmental Policy	NW Natural received comments on SB 98 and, how we are thinking about SB 98 and does the CPP require gas to be on-system?	NW Natural has expanded its compliance discussion of SB 98 and the CPP within the results as well as in Chapter 6 where we discuss resources. SB 98 and the CPP allow for "book and claim" reporting and tracking of RNG. The Greenhouse Gas Reporting program does not require the physical delivery of specific RNG molecules to end-users on NW Natural's distribution system.
Environmental Policy	NW Natural was asked various questions about the CPP and how it would apply. Some of the questions asked about the use of non-local RNG, the use of CCIs, and costs for compliance resources	NW Natural has expanded its compliance discussion and now includes several charts that identify costs for RNG, hydrogen, and CCIs. Please refer to Chapter 6 for additional information.
Emerging Technologies	NW Natural received multiple comments relating to Gas Heat Pumps. A number of the comments were asking about what the adoption rates were and the source of these adoption rates.	The adoption curve for gas heat pumps was based on information from GTI, NEEA and SMEs. Based on feedback from stakeholders, NW Natural has scaled back its adoption curve assumptions. Please refer to end use forecasting in Chapter 3 for more information. Additionally, please refer to the workpapers for additional information.
Load Forecast	NW Natural received several comments related to both its customer forecast and its subsequent load forecast. Many of the comments were related to gas bans, code changes, a presumption of the cost	There is a high degree of uncertainty relative to NW Natural's load forecast in this IRP. For this reason, NW Natural is using a reference case for comparative purposes as well as scenario analysis to understand the implications of various load forecasts

Topic	Summary of Draft Combined Comments	Response from NW Natural
	effectiveness of electrification and environmental policies promoting electrification.	and how that might impact our Action Plan. Additionally, as was mentioned before, the IRP is not a policy making document, but it does take potential futures into consideration including a high electrification scenario. However, no municipality has currently passed a "gas ban" in Oregon. As NW Natural has commented before, NW Natural strongly disagrees that mandating customers to defect from the gas system is a CPP compliance pathway for Oregon gas utilities. The CPP requires gas utilities to meet GHG emissions targets and does not require them to stop serving customers. NW Natural does not know the full cost to serve that customer on the electric system inclusive of the incremental generation, transmission, distribution cost, which are in addition to the incremental equipment and installation costs for customers to switch to an all-electric home. As such NW Natural is not able to validate that electrification would be is a least cost, least risk option for customers that have chosen gas end-use equipment. That said, NW Natural did include several scenarios with varying degrees of electrification. See chapter 7 for scenario details. As is the objective with our scenario and other risk analyses, these are used to inform a low regret and robust action items in our action plan.
Load Forecast	NW Natural received comments asking for more information relating to Washington customers and load forecasts.	NW Natural appreciates the feedback as it relates to Washington and agrees. Additional information has been provided for Clark and Skamania counties and

Topic	Summary of Draft Combined Comments	Response from NW Natural
		has noted that both counties are also included in the Portland MSA.
Load Forecast	NW Natural received several comments about how weather and more specifically climate change was included into its load forecast. Several questions asked for more clarity relative to the role of climate change in determining both the Design Peak Weather and the Design Winter Weather.	NW Natural discussed the role of weather in Chapter 3. As discussed, NW Natural incorporated five selected IPCC climate models for each of its load centers. As the design winter weather is an adjustment to the expected weather forecast for the winter months, by extension it too incorporates climate change trends. The impacts of climate change on cold snaps such as is modeled with the Design Peak Weather is still uncertain and unclear in both frequency and magnitude. NW Natural will continue to test this relationship.
Load Forecast	As was mentioned in previous comments, NW received comments to examine additional scenarios that captured aggressive reductions in gas demand.	NW Natural, in fact, did include scenarios that captured aggressive reductions in gas demand, including full building electrification, which all but eliminates installations of any new natural gas equipment in residential and small commercial buildings. In future IRPs, NW Natural will evaluate any additional scenarios that are relevant and informative, but policies requiring customers to remove their working natural gas equipment before needing replacement is outside the scope of being informative as a scenario to help inform the action plan.
Demand Side Management	NW Natural received several comments relative to Hybrid Heating. More specifically, questions related to adoption	NW Natural does consider hybrid heating to reduce gas use whilst allowing gas customers the ability to use their gas furnace as back up during periods of cold weather. Please see Chapter 3's end use section

Topic	Summary of Draft Combined Comments	Response from NW Natural
	rates and the use of gas public purpose funds to promote hybrid systems.	for a discussion of the anticipated adoption rates. At the time of this writing, NW Natural is not planning to use gas public purpose funds for fuel switching nor is it aware that this is possible. The IRP is not a policy document and the question of using gas public purpose funds for fuel switching is a policy question and not discussed in the IRP.
Demand Side Management	NW Natural received several comments relative to energy efficiency and its value as a compliance resource. It was proposed that NW Natural show energy efficiency graphically in comparison to other compliance resources.	NW Natural strongly agrees with the value of energy efficiency both as a decarbonization tool as well as an affordability measure. NW Natural appreciates the suggestion and adding energy efficiency and other load reductions to the compliance graphs. See Chapter 7 for details.
Demand Side Management	NW Natural received a few comments relative to avoided costs. More specifically, the comments were asking for clarification relative if the CPP caused avoided costs to increase or decrease from the prior IRP.	NW Natural has adjusted its language to clarify that the CPP has caused Avoided Costs related to GHG compliance costs to increase and thus increasing the amount of cost-effective energy efficiency. NW Natural also notes that GHG compliance costs have also increased significantly for Washington as well as HB 1257 requires the use of the Social Cost of Carbon for resource planning, which is used for Washington's avoided GHG compliance costs.
Demand Side Management	NW Natural received comments relative to DSM potential methodology. More specifically, the comments related to the methodology that AEG used and if it was like the ETO's methodology. There were also comments with suggestions for making the table clearer.	Methodology descriptions for the resource assessment process has been included for both ETO and AEG. Please refer to Chapter 5, appendix D, and WUTC Docket 210773 for more information. Additionally, labels for both tables and graphs have been updated.

Topic	Summary of Draft Combined Comments	Response from NW Natural
Demand Side Management	NW Natural received several comments about the forecasted amount of energy efficiency savings by the ETO and how those savings are going to be achieved. More specifically, the comments requested more specificity relative to the program offerings and made mention of increases in the projected energy efficiency forecast. Additionally, the comments asked for more explanation for savings associated with emerging technologies.	As discussed in Chapters 4 and 5, avoided costs for both Oregon and Washington have materially increased since the last IRP and in turn increased the amount of cost-effective energy efficiency. Please see Chapter 4 for the specifics on the avoided costs. Additionally, the Energy Trust of Oregon has provided the deployment summary in Appendix D. Energy Trust also explained that they apply risk adjustment factors to emerging technologies based on market, technical and data risk. Lastly, NW Natural works with the Energy Trust of Oregon to ensure that consistent with methodology in Chapter 5, Energy Trust has sufficient funding to acquire the forecasted therm savings, or the amount identified and approved by the Energy Trust board.
Supply Side Resources	NW Natural received some comments about its one of its demand response programs and more specifically about its Industrial Recall options and how often it is used. There was also a comment about the emissions associated with this option.	NW Natural has utilized the industrial recall options twice over the past five years. These are options are near the top of our resource stack, meaning they are the on of the last resources to be dispatched in order to meet peak capacity requirements and should be expected to rarely be utilized. The counterparties involved with these recall agreements mays switch to alternative fuels, such as diesel, or decide to shut down if their gas supplies are recalled. Therefore, net emissions to society from NW Natural evoking an industrial recall agreement could either increase or decrease, but the magnitude of the impact to net emissions is de minimis due to the rarity of exercising these options.

Topic	Summary of Draft Combined Comments	Response from NW Natural
Supply Side Resources	NW Natural received several comments about the Portland LNG facility and more specifically the replacement of the Cold Box.	NW Natural has updated the section relating to Portland LNG Cold Box replacement and provided additional information. Please see Chapter 6 and the associated appendices for additional information.
Renewables	NW Natural received a few comments and questions relative to RNG. More specifically, the comments requested more information, clarifications, and support for the expected availability and costs of RNG along with comments about the competitiveness of the market and this impact on our assumptions.	Knowing that there is a lot of interest in RNG (and hydrogen) NW Natural has expanded its discussion in Chapter 6 on RNG and specifically addresses concerns about RNG supply. NW Natural's assumptions are informed by third party analysis as well as our own experience through our RFP process. Chapter 6 also includes information on costs. As is recognized, the RNG market is quite dynamic and as the market matures, additional information will become available. NW Natural uses both scenario analysis and stochastic analysis to better understand risks associated with RNG and this in turn is used to information the action plan. Please see Chapter 6 for more information on RNG and please see Chapter 7 for more information on the risk analysis.
Renewables	As mentioned above, NW Natural received several comments asking about carbon intensities of RNG and Hydrogen and how the reporting of carbon intensities between both SB 98 and the CPP compare.	NW Natural has expanded the discussion on carbon intensities in both Chapter 6 as well as in the Appendices. By means of example, Chapter 6 now includes a table for all the carbon intensities for registered projects in the Oregon Clean Fuels Program. NW Natural also discusses carbon intensity reporting. Carbon intensity reporting is required for SB 98 compliance, and it is expected that Washington will also have a reporting requirement. Thus, while the CPP treats RNG acquisitions as zero

Topic	Summary of Draft Combined Comments	Response from NW Natural
		anthropogenic carbon dioxide (i.e., CI score = 0) meeting compliance obligations at this time, the CI information will be available through different reporting vehicles.
Renewables	NW Natural received many comments on Hydrogen and Power to Gas. These comments were regarding the various colors/types of Hydrogen, clarification on what Power to Gas is and similar to questions regarding RNG, questions about availability and costs. NW Natural will respond to these comments by first focusing on the Hydrogen questions and then addressing P2G.	Similar to NW Natural's response to RNG, we have expanded our discussion of Hydrogen and now include a chart that explains the different types of Hydrogen (often described as the different colors of Hydrogen). Chapter 6 also now contains information about costs, availability, and carbon intensity. NW Natural also addresses the pressure related properties that limit Hydrogen as a resource for our Forest Grove Uprate project. Similar to RNG, the Hydrogen market is very dynamic. By means of example, NW Natural notes that in our recent RFP process, hydrogen resources have been identified that are cost competitive with RNG. The Inflation Reduction Act (IRA) enables a hydrogen production tax credit that is predicted to continue to make hydrogen and synthetic methane more cost-effective resources in the next two decades. As with RNG, NW Natural uses both scenario analysis and stochastic analysis to better understand risks associated with Hydrogen and this in turn is used to information the action plan. Please see Chapter 6 for more information on RNG and please see Chapter 7 for more information on the risk analysis.
Renewables	As was mentioned above, as a subset of comments received on Hydrogen, NW	Like the comments above, noting the interest from the comments, NW Natural has expanded its

Topic	Summary of Draft Combined Comments	Response from NW Natural
	Natural received several comments on Power to Gas (P2G). More specifically, what is P2G, what is its role and storage potential and timeline on providing service.	discussion of P2G in Chapter 6. This includes a definition of P2G. Relative to the role of P2G, it will be viewed as a low-carbon resource just like any other resources. The one nuance is that it may make sense to serve large customers with 100% hydrogen from dedicated hydrogen production projects alongside distribution blending to increase decarbonization efficiencies and decrease costs. Relative to the storage potential, Mist appears to have the geology to support more storage development. Hydrogen and synthetic methane can be used to fill these reservoirs and store low-carbon energy for months or years at a time. This energy can be distributed through either the gas or electric grids when it is needed, such as during times of low water/wind/solar resources to thermal generation plants, or to homes and businesses during low temperature winter peak conditions. Lastly, P2G projects are currently in the early planning and development stages.
Compliance Planning	NW Natural has received multiple comments related to compliance with OR and WA legislation. More specifically, the questions were asking how NW Natural plans on complying with these new regulations especially in the medium and long term. NW Natural was also encouraged to include of a discussion relative to how it was thinking of	There is a lot of uncertainty in the future relative to loads, costs, resources, and future policy. For this reason, NW Natural rather than identifying a base case or even a preferred portfolio, NW Natural has identified the compliance actions that it will be taking before the next IRP is filed. NW Natural will comply will all Oregon and Washington laws and will also use a least cost, least risk framework for evaluating its compliance resources.

Topic	Summary of Draft Combined Comments	Response from NW Natural
	compliance and specifically a comment was offered to include more information regarding GHG compliance costs.	NW Natural appreciates the comment about adding more information to the discussion relative to GHG costs. To this end, in addition to GHG compliance costs included in avoided costs in Chapter 4, it has also added substantially to the section about both RNG and Hydrogen in Chapter 6. Additionally, NW Natural has added some additional discussion to Chapter 7 which discusses both the portfolio results of the different scenarios as well as the risk analysis used to inform the action.
Compliance Planning	NW Natural received some comments relative to using unbundled RTCs to meet CPP compliance obligations. There were concerns that this may not be correct or that our interpretation and the rules around using RTCs may become more stringent in future years.	NW Natural is confident in its interpretation of the CPP Compliance obligations, and we continue to keep in close communication with the DEQ to plan properly for our ratepayers.
Portfolio Results	NW Natural received comments regarding the portfolio results and the impacts on customers.	NW Natural has updated the IRP to include a section on Customer Bill Impacts. Please see Chapter 7 for more information.
Portfolio Results	NW Natural received a number of comments and questions relative to the sawtooth shape of the results and with offset and purchase allowance amounts were alternating every few years.	NW Natural has updated these charts for the final submission, please see Chapter 7 for details about the flexibility of compliance instruments within a compliance period.
Portfolio Results	NW Natural was asked about results and the need for capacity resources. More specifically, NW Natural was asked to	NW Natural has revised the portfolio results in Chapter 7. For NW Natural cost estimates and resources quantities needed to serve its Peak Day

Topic	Summary of Draft Combined Comments	Response from NW Natural
	quantify the amount of investment needed to serve peak.	please refer to Chapters 3 and 6. Lastly, NW Natural includes detailed information on its portfolio analysis in the appendix.
Risk Analysis/Scenario Analysis	As noted above, NW Natural received many comments regarding electrification. More specifically, electrification was seen to potentially reduce load and thus, needed to be considered to inform the action plan.	As was noted above, NW Natural did evaluate several scenarios with varying levels of electrification. The results of these portfolios were used to inform our action plan. As the policy and market landscape continues to evolve, NW Natural will continue to monitor policy, codes and standards, and trends in customer additions and losses. The IRP is updated and refiled approximately every two years to update the data, assumptions, and models to reflect changes through time.
Risk Analysis/Scenario Analysis	NW Natural received a question about the scenarios that were evaluated. More specifically, NW Natural was asked about why other scenarios were not included.	The company works together with stakeholders during the Technical Working Groups to identify what scenarios to include in the IRP and must limit the scope to a manageable number of scenarios to be able to complete the IRP.
Distribution System Planning	NW Natural received comments relative to non-pipeline alternatives as distribution system planning solutions. More specifically, there were comments to include more discussion about the non-pipeline solutions explored, costs of these alternatives and the implications of electrification.	NW Natural does evaluate nonpipelined solutions for distribution system planning and has included this discussion in Chapter 8. NW Natural uses the same framework for distribution system planning as it does for system planning – least cost least risk. As such, alternative non-pipeline solutions may provide an opportunity to reduce costs and risks. In order to be able to evaluation non-pipeline solutions the Company needs to be able estimate the cost, quantity and reliability of any distribution system a option included non-pipeline options. The primary

Topic	Summary of Draft Combined Comments	Response from NW Natural
		objective of our current GeoTEE pilot program is to develop as supply curve so that it may be included as a solution on an equal basis as our pipeline solutions. It is also one of the reasons that we are proposing a GeoDR pilot as well.
Distribution System Planning	NW Natural received comments about using electrification to "prune" the gas system or as a non-pipeline solution for distribution system planning.	As stated above, as a fuel of choice, customers can leave the gas system today. When they chose to stay, NW Natural has an obligation to serve and to serve with the fuel and end use equipment selected by the customer. Additionally, NW Natural is not privy to the cost and emissions shift that would take place on the electric side, it is not able to do a complete analysis of least cost – least risk.
Distribution System Planning	NW Natural received several comments requesting clarification about the Forest Grove project and more specifically about the need for the project.	NW Natural has rewritten our Distribution System Planning section to clarify. Please see Chapter 8. More specifically though, the uprates to the Forest Grove Feeder are necessary to serve existing communities. It is needed to serve an existing pressure issue.
Distribution System Planning	NW Natural received several comments about future distribution system planning needs and more specifically if there are additional sections that may need reinforcements.	As discussed in more detail in Chapter 8, NW Natural is completing an improvement to its distribution system planning process and tools. This improvement should provide more granularity and insights into our distribution system planning. As discussed in the Chapter 8, normally NW Natural provides a 10-year system reinforcement plan with the IRP. However; since the Company is in transition with a significant improvement to distribution system planning NW Natural will provide this 10-

Topic	Summary of Draft Combined Comments	Response from NW Natural
		year plan via an IRP update once these improvements are complete.
Public Engagement	NW Natural received several comments and suggestions about how the company is engaging the public in the IRP process.	With this IRP, NW Natural posted its presentations and to the extent available also posted video of its technical working groups. NW Natural will continue this practice moving forward. We have recently launched a Community and Equity Advisory Group and we hope to integrate these valuable comments into our IRP process. There is still more that can be done, and we value the input of our communities in improving the IRP process and serving our stakeholders better.
Data/Assumption/Workpaper	NW Natural received many comments with regard to data, assumptions and workpapers. More specifically, comments requested that excel files be provided with intact formulas, workpapers be provided with assumptions identified, the data behind some of the charts and graphs be provided and so on.	An IRP is quite complex and includes many models some run in excel but many models must use more complex statistical and optimization software. It is NW Natural's objective to provide comprehensive and user-friendly workpapers to be as transparent as possible. Due to the extent and complexity of the workpapers as discussed at the last TWG, it may take some time to pull all the workpapers together in a format and organization that is most helpful and transparent for stakeholders.

Appendix K: Low Emissions Gas Resource Evaluation Methodology

K.1 Terminology

Renewable Natural Gas (RNG): Per ORS 757.392, means any of the following products processed to meet pipeline quality standards or transportation fuel grade requirements:

(a)Biogas that is upgraded to meet natural gas pipeline quality standards such that it may blend with, or substitute for, geologic natural gas;

(b)Hydrogen gas derived from renewable energy sources; or

(c)Methane gas derived from any combination of: (A)Biogas; (B)Hydrogen gas or carbon oxides derived from renewable energy sources; or (C)Waste carbon dioxide.

While a more comprehensive description of RNG resources would be "low carbon gas" the term RNG will be used interchangeable with low carbon gas in this methodology.

RNG Portfolio: The collection of RNG resources delivering, or contractually committed to deliver in the future, RTCs to NW Natural customers.

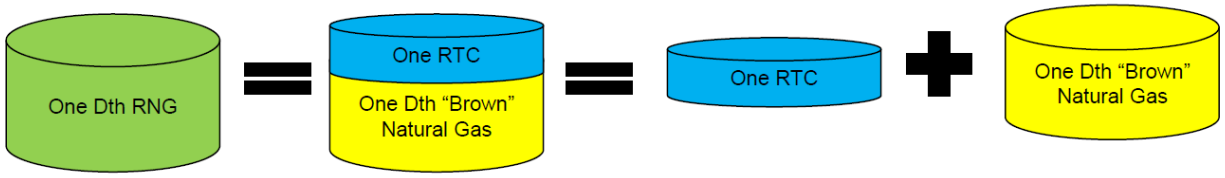
RNG Resource Pipeline: A list of all RNG resources known to the Renewable Resources team that could become part of NW Natural's RNG portfolio. This pipeline includes information gathered during origination activities including issuance of RFPs for RNG resources.

Acquisition: In this policy, any RNG or RTC procurement contract, investment in RNG project development, or acquisition of an RNG project is referred to collectively as an "acquisition" of an RNG resource.

Offtake: an RNG resource that is purely a contract for the purchase of RTCs or bundled RNG (environmental attributes plus "brown gas.") An offtake requires no capital investment and is a pure pass-through cost that, per the final OPUC rules related to SB 98, is to be recovered via the Purchased Gas Adjustment.

Development Project: An RNG resource that requires some amount of capital investment and legal agreements associated with ownership of assets.

Brown gas: When RNG is purchased as a bundled commodity it can be separated into RTCs and "brown" gas. Once the RTC is separated from the underlying gas, the brown gas does not carry any environmental benefits. It can be separately accounted for distinct from the transactions associated with the RTCs. In most cases the brown gas will be sold locally to a buyer able to take delivery of physical gas near the point of RNG production. The costs or revenues associated with transacting any brown gas related to an RNG transaction are taken into account when determining a resource's total incremental cost.



Renewable Thermal Certificate (RTC): The unique environmental attributes from the production, transportation, and use of one dekatherm of RNG.

Senate Bill 98 (SB 98)/ OAR 860-150: A bill passed by the Oregon Legislature and signed into law in 2019.[8] The law establishes targets for Oregon's natural gas utilities to procure renewable natural gas for its sales customers and recover costs prudently incurred to meet those targets. The rules to implement SB 98 are Division 150 of Chapter 860 of Oregon's Administrative Rules (OAR 860-150), which were ordered into rule by the Oregon Public Utility Commission (OPUC).[9]

Cost of Service model: An Excel-based financial model that calculates the overall cost to customers of an RNG or RTC resource, considering the utility costs of debt and equity if any capital investments are required, utility tax burden, anticipated cost recovery activity and timing, and other relevant and salient aspects of a procurement, project development, or investment (collectively "Transaction").

Incremental Cost Workbook: An Excel-based model that evaluates the value of RNG resources for NW Natural customers. It calculates the incremental cost of RNG based upon "all-in costs," where the difference in the cost of service of an RNG resource and the costs avoided from not needing to procure an equivalent amount of conventional natural gas is the incremental cost. Using the most recent methodology approved by the OPUC to calculate incremental costs[10] and the direction of OAR 860-150, this model produces a levelized incremental cost, both in expectation and on a risk-adjusted basis. The model yields the cost of delivering the RTC and brown gas, bundled together, to NW Natural customers. Thus, when evaluating RNG resources, this policy stipulates the incremental cost of an RNG resource is the incremental cost of delivering that RNG as a bundled resource, inclusive of the underlying gas. When a transaction is for RTCs only, the model attributes a brown gas purchase to the deal in order to compare deals on an apples-to-apples basis.

Incremental Cost: The levelized incremental cost of projects contributing to NW Natural's RNG portfolio over the remaining expected life of the project. This metric is the expected incremental cost of an RNG resource to NW Natural customers and is not risk-adjusted. The incremental cost of each resource in the RNG portfolio is included in the annual RNG compliance report detailed in OAR 860-150-0600, where the summation of the total incremental cost of each resource in the portfolio is the total incremental revenue requirement of the RNG portfolio.

FYRALIC (First Year Risk-Adjusted Levelized Incremental Cost): The levelized risk-adjusted incremental cost as calculated as an output of the Incremental Cost model for the first year a prospective project is

[8] https://olis.leg.state.or.us/liz/2019R1/Measures/Overview/SB98
[9] See OPUC Order No. 20-227 and https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=271677
[10] See OPUC Order No. 20-403 at https://apps.puc.state.or.us/orders/2020ords/20-403.pdf

expected to deliver RTCs to NW Natural customers. This cost, in levelized $/Dth over the expected life of the project, is deemed to be the incremental cost of RNG for evaluation of prospective RNG resources based upon OAR 860-150-0200 and the calculation methodology approved by the OPUC in Order No. 20-403.

RNG Acquisition Target: A year by year state specific target of RNG for delivery to NW Natural customers in each state based upon complying with OR SB 98 and the Oregon Department of Environmental Quality's (ODEQ's) Climate Protection Program (CPP) in Oregon; and WA HB 1257 and Washington's Cap-and-Invest program under the Climate Commitment Act (CCA) in Washington.

K.2 Purpose and Overview

As part of its 2018 Integrated Resource Plan (IRP), NW Natural proposed a methodology to evaluate prospective low emissions gas resources based upon risk-adjusted "all-in" costs. While there are low emissions gas resources that are not renewable natural gas (RNG), this appendix will colloquially refer to low emissions gas as RNG. This methodology went through a regulatory investigative process and resulted in an order by the OPUC (Order 20-403) where the methodology was approved by the Commissions.

This appendix updates the methodology approved in OPUC Order No. 20-043 to account for developments from SB 98 rulemaking in Oregon and the establishment of the Oregon Department of Environmental Quality's (ODEQ's) Climate Protection Program (CPP). The purpose of this methodology is to calculate the levelized incremental cost of each resource in NW Natural's RNG portfolio for the compliance reports detailed in OAR 860-150-0200 and 0600 and to calculate the risk-adjusted levelized incremental cost to compare *prospective* RNG resources using the stochastic Monte Carlo simulation analysis in the 2022 IRP. This methodology is an application of numerous resource planning and rate-making concepts and accounting, including:

- Comparing resources on a fair and consistent basis
- Least cost/least risk planning standard
- Incremental costs
- Avoided costs
- Cost of service
- Levelized costs
- Accounting for risk/risk-adjustment

The methodology is also developed to be able to be flexible enough to appropriately assess all potential RNG resource types, of which there are many. While there are many sub-types, Table K.2 shows the types of resources that allow NW Natural to obtain the renewable thermal credits that prove RNG ownership for its customers:

Table K.1: Low Emissions (RNG) Resource Types

	RTC Acquired	Attach physical gas to obtain bundled RNG for Incrmental Cost	Sale of "Brown" gas	Avoided Commodity Costs	Avoided Capacity Costs
Unbundled Environmental Attribute (RTC) Purchase	✓	✓			
Bundled RNG Delivered to NW Natural's System	✓			✓	
Bundled RNG with Brown Gas Sales	✓	✓	✓	✓*	
On-System Bundled RNG	✓		✓	✓	✓

In addition to being able to account for different resource types, the evaluation methodology needs to take into account the RNG acquisition process which the evaluation methodology folds into accounts for market conditions for RNG projects. As a practical matter, we will need to make decisions at the pace that the RNG market dictates, which is usually faster than IRP acknowledgement allows. The Incremental Cost Workbook that implements this methodology was developed taking into account RNG market conditions, which requires the ability to make frequent updates to the terms of prospective RNG resources while maintaining the ability to compare all prospective resources on equal footing.

K.3 Evaluation Methodology

The RNG Incremental Cost Workbook that is included in the workpapers to NW Natural's 2022 IRP implements the following calculations of the risk-adjusted levelized incremental "all-in" cost:

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:

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

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

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

The levelized incremental cost (IC) for each prospective resource is used for evaluation where IC is:

$$IC = \sum_{T=k}^{T=k+z} \frac{R_T - C_T}{[1+d]^T}$$

This is risk-adjusted to account for uncertainty where the metric used for evaluating prospective projects is the first-year risk-adjusted levelized incremental cost (FYRALIC):

$$FYRALIC_{T=k} = 0.75 * \text{deterministic } LIC_{T=k} + 0.25 * 95\text{th Percentile Stochastic } LIC_{T=k}$$

Table K.2: Project Evaluation Component Descriptions

Term	Units	Description	Source	Project Specific?	Input or Output of IC Workbook?	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	Yes	Input	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 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 no contractual obligation
z	Years	Duration of RNG purchase in years	Project evaluation or RNG supplier counterparty	Yes	Input	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	Marginal price of conventional gas dispatched in PLEXOS in run without RNG project	Yes	Input	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 marginal gas dispatched in PLEXOS	Yes	Input	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	Based upon marginal supply capacity resource cost by year as determined from PLEXOS modeling in most recent IRP	No	Input	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 derived from most recently concluded general rate case outcome	No	Input	No

Table K.3: Input Update Frequency

Inputs and Forecasts	Frequency of Update	Additional Explanation
Resource Under Evaluation	Most Current Estimate	For example, if an RNG project requires any capital costs, the most current estimate of those costs will be run through the cost-of-service model and used for the evaluation.
Gas Prices (Deterministic and Stochastic)	Once a year	Stochastic gas prices are updated once a year using the Monte Carlo process detailed in the most recent IRP and the most recent gas price forecast from a third-party consultant
Peak Day & Annual Load Forecast	Once a year	These forecasts are updated spring/summer to include data from the most recent heating season.
GHG Compliance Cost Expectations (Deterministic and Stochastic)	Once a year	The GHG compliance cost assumptions will be updated each year after the legislation sessions in each state or when legislation is signed into law.
Design, Normal, and Stochastic Weather	Each IRP	Resources are planned based on design weather, but are evaluated on cost using normal and stochastic weather.
Gas Supply Capacity Costs (Deterministic and Stochastic)	Each IRP	The cost of the marginal system capacity resource by year, based upon the results in the most recent IRP. Consistent with value used for energy efficiency and demand response.
Distribution System Capacity Costs	Each IRP	NW Natural will calculate and present the avoided distribution avoided costs through the IRP process. Consistent with value used for energy efficiency and demand response.

K.4 Incremental Cost Workbook

The version of this methodology that was last reviewed by stakeholders and the Commission was completed prior to acquisition of NW Natural's first RNG resource to deliver RNG to its customers. NW Natural has now began acquiring RNG for its customers. Consequently, the description of how NW Natural *planned* to evaluate RNG resources for its customers has been replaced with the tools NW

Natural is actually using to evaluate and acquire RNG. The RNG evaluation methodology described in this document is now implemented in the Company's RNG Incremental Cost Workbook, which is provided as a workpaper to the 2022 IRP. Each prospective project has its own incremental cost workbook that calculates FYRALIC and can be updated at any time so that resources can be compared on equal footing and the LIC of existing projects can be calculated for portfolio management and compliance reporting.

K.5 Evaluation Methodology as Part of Acquisition Process

NW Natural's Renewable Resources team continually collects information about the RNG market and specific opportunities for the procurement of RNG. This information is collected through research and communication with RNG project developers, marketers, investment funds, feedstock owners, and others involved in the RNG market. Additionally, the Renewable Resources team will issue RFPs for new RNG resources at least once per year. Prospective resources are analyzed for their eligibility to be used for compliance with the policies under which NW Natural is a covered party (OR-SB 98, OR-CPP, WA-HB 1257, and WA-CCA). Resources deemed eligible are incorporated into the full list of RNG resources assessed for feasibility (the RNG Resource Pipeline).

The RNG Resource Pipeline is updated continually as new information is collected on potential RNG resources. Once the Renewable Resources team has sufficient information about a resource, it conducts an initial feasibility assessment. Inputs to this activity typically include the financial information shared by the counterparty as well as the team's own analysis of the gas production, equipment costs, and other relevant information. The Renewable Resources team uses the Cost-of-Service model and the Incremental Cost model to determine whether the RNG Resource could potentially yield a First Year Risk-Adjusted Levelized Incremental Cost (FYRALIC) that would be competitive with other RNG resources in the RNG Pipeline. If relevant, the Renewable Resources team works with Gas Supply to estimate the impact of any sale of brown gas or any requirements to transport the commodity associated with the RNG resource. The feasibility assessment produces an estimated FYRALIC in the form of $/Dth of delivered RNG.

The FYRALIC reflects the Renewable Resources team's current assessment of risks of the RNG resource. These risks are quantified as risk inputs in the Incremental Cost Workbook. As new information is gathered about the resource throughout its evaluation, these risk inputs may be updated.

If this initial feasibility assessment yields an estimated FYRALIC at or below the current known average incremental cost of delivered RNG in the RNG Resource Pipeline, the prospective resource will move forward to a diligence phase and a potential recommendation for acquisition.