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May 4, 2022

Via Electronic Filing

Public Utility Commission of Oregon
Attention: Filing Center
201 High Street Southeast, Suite 100
Post Office Box 1088
Salem, Oregon 97308-1088

Re: UM 2166 – In the Matter of Portland General Electric Company 2021 All-Source Request for Proposals – Independent Evaluator's Sensitivity Analysis

Dear Filing Center:

Enclosed for filing today in the above-referenced docket is the redacted version of Portland General Electric Company's ("PGE") Sensitivity Analysis prepared by Bates White, the Independent Evaluator for this docket. The content included in this filing will also be included in the Independent Evaluator's Closing Report to be filed on May 5, 2022.

Please direct any questions regarding this filing to Jimmy Lindsay at (503) 464-8311. Please direct all formal correspondence and requests to the following email address pge.opuc.filings@pgn.com.

Thank you in advance for your assistance.

Sincerely,

Erin Apperson
Assistant General Counsel II

EA:dm
Enclosure

REDACTED

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MEMORANDUM

May 4, 2022

TO: Chair Decker
Commissioner Tawney
Commissioner Thompson
Oregon Public Utility Commission

FROM: Frank Mossburg
Bates White, LLC

SUBJECT: IE Analysis of Sensitivities

The purpose of this memo is to provide the Independent Evaluator (IE)'s analysis of Portland General Electric (PGE)'s sensitivity analysis for it's 2021 All Source RFP (RFP). This memo fulfills requirements under OAR 860-089-450.(8).

Because this is being filed one day in advance of the IE's Final Shortlist Report the text here is essentially the same as will be featured in that report. Please see that filing for a more complete description of the RFP process and results. We focus on the portfolio construction and analysis that PGE conducted with the 29 offers on the shortlist since this was the major sensitivity analysis provided.

METHODOLOGY

Because of the sheer number of possible combinations with 29 bid offers, PGE created a methodology to narrow down the possible portfolios under consideration. They first looked at all combinations that a) contained no mutually exclusive offers (i.e. two variants from the same project), and b) did not exceed the renewable MWa target. PGE looked at three different levels of MWa target; a)180 MWa – representing the RFP target of 150 MWa plus supply for the GEAR program, b) 250 MWa, representing a Staff request made during the RFP process that looks for 215 MWa of supply plus GEAR program projects and c) a maximum amount of 400 MWa representing a more aggressive push toward meeting future renewable energy targets.

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PGE used the price score of each offer to determine portfolio cost and added in generic wind (if the portfolio was short of meeting renewable targets in 2025) or capacity (if the portfolio was short of meeting capacity targets in 2025). PGE selected the top 50 performing portfolios under this method from each level of renewable supply target, for 150 portfolios overall. A final adjustment made was to ensure that each resource option on the shortlist was included in at least one portfolio.

INITIAL RESULTS

Having selected the candidate portfolios PGE began the portfolio modelling process as described in the RFP. In this process PGE used the ROSE-E model to calculate the cost of the portfolios under a wide variety of future conditions - a process also used in the 2019 IRP. The ROSE-E model calculated the cost of a given portfolio through 2050 as a net present value of revenue requirements (NPVRR). Per the RFP ROSE-E was set to meet the carbon reduction goals of HB 2021 via generic wind additions as needed. The model also used generic capacity additions to meet reliability requirements.

ROSE-E looked at the costs of each of the 150 candidate portfolios under a variety of circumstances. This included reference, low and high cases for

a. Load
b. Gas Prices
c. Hydro levels
d. Carbon Costs
e. Future Wind construction costs

In addition, PGE looked at reference and high cases for WECC-wide renewables buildout, which would affect wholesale market prices.

Per the RFP, PGE ranked each portfolio based on three traditional metrics, cost, variability and severity as described in the IRP.[1] As was done in the IRP, PGE created an "efficient frontier" (set with a slope of -1 to reflect an even tradeoff between risk and cost) below which would fall the best performing portfolios in terms of cost and variability. The following charts show this analysis - one graph plots the cost of each portfolio versus the severity of the portfolio (i.e.

[1] IRP p 186-187.

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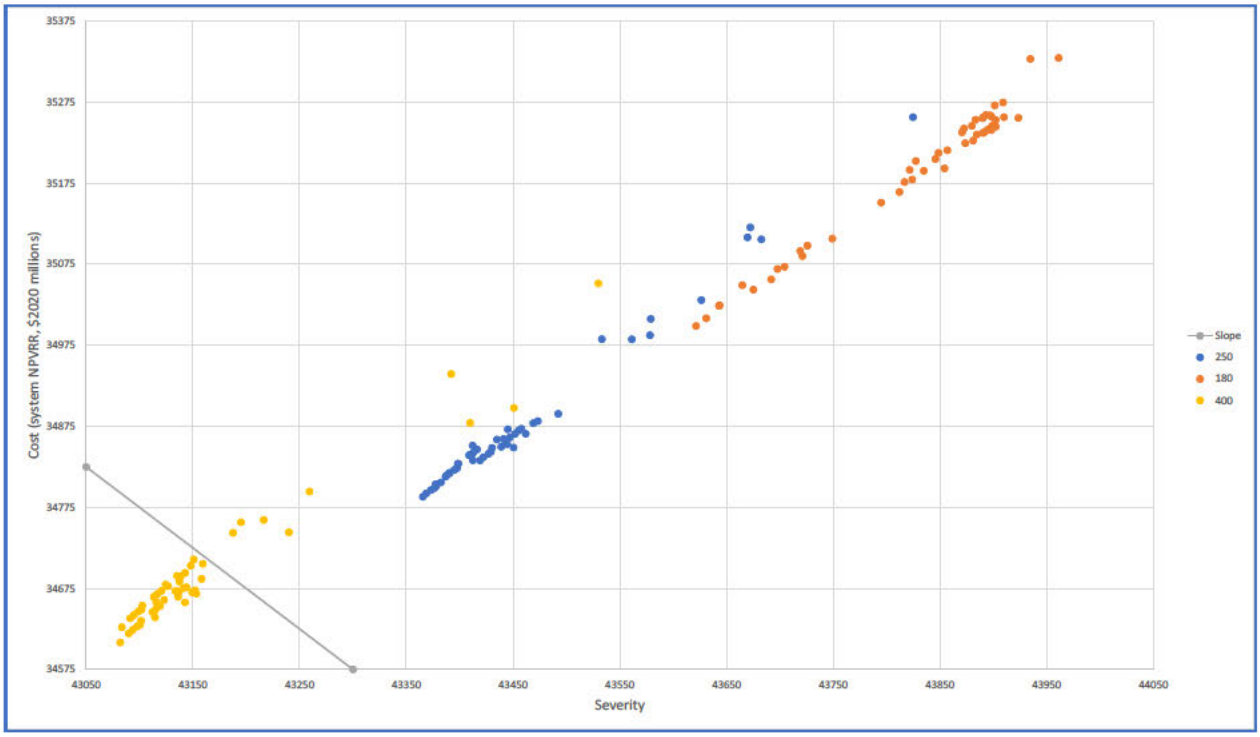
the cost at the 90th percentile). The graph uses different colors for the 180 MWa, 250 MWa and 400 MWa portfolios.

Figure 1: Costs vs Severity for Portfolios



The next graph shows the cost versus the variability of the portfolio (i.e. the semi-deviation of the NPVRR relative to the reference case).

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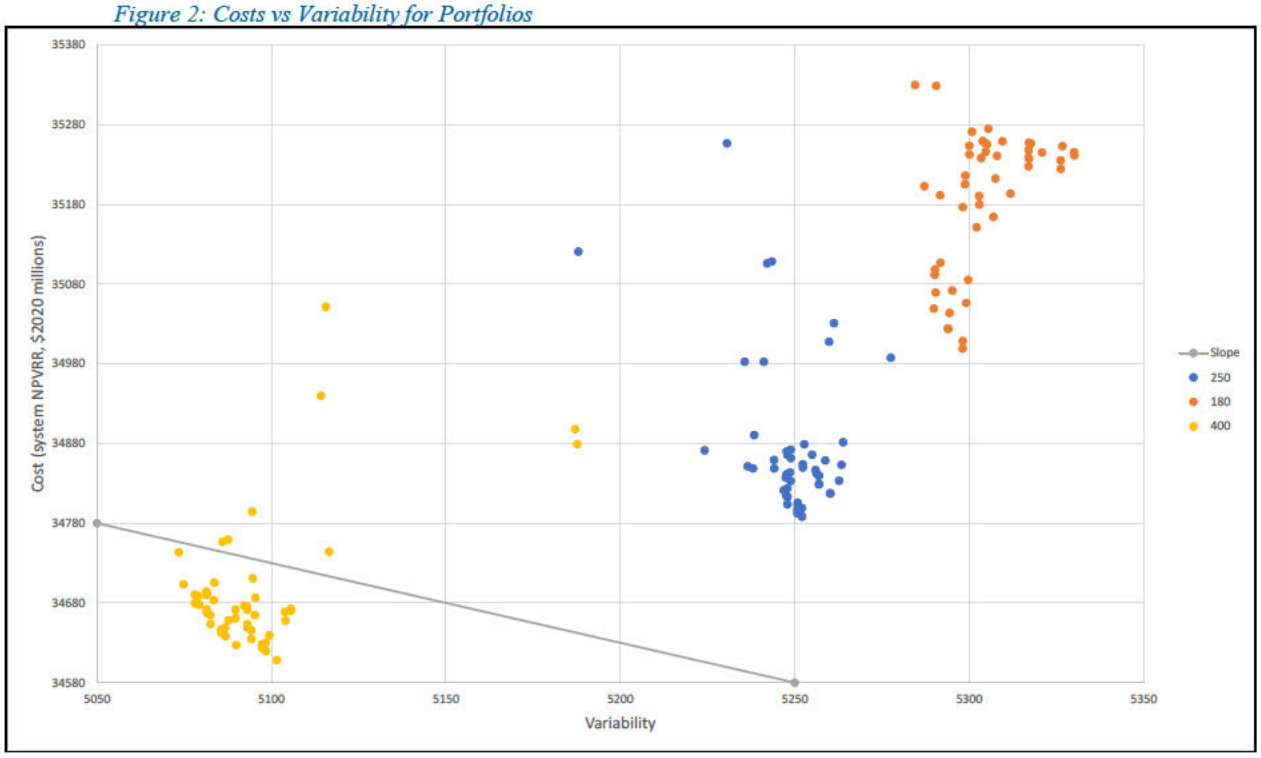
Figure 2: Costs vs Variability for Portfolios



Note that in both cases, the portfolios with highest levels of renewable supply had lower costs and risks than the portfolios with lower levels of supply, in fact there is a fairly visible and clear difference in the grouping of portfolios.

PGE then looked at portfolios that "passed" both tests (i.e. were under the "efficient frontier" dividing line) and ranked them on a weighed scale based 50% on reference case costs and 50% on standard deviation of costs over the sensitivity cases, assigning the best portfolio 812 points and deducting points for other portfolios based on the degree of divergence from the lowest-priced portfolio. PGE then added in the non-price scores of the bids in that portfolio (weighted by MW) to get a total portfolio score. This was all as described in Appendix N of the RFP.[2]

We note at the outset that because the portfolios made up just a small portion of PGE's supply and because many portfolios had similar resources, the

[2] See p 18 of Appendix N. Note that this states that 700 points will be awarded for the top value portfolio, this was adjusted to 812 points to appropriately reflect the price-non-price split in the initial shortlist scoring process.

differences in NPVRR were relatively small. Therefore the total scores of the portfolios were almost identical. All 41 portfolios that passed both efficient frontier tests scored within 7 points (on a scale of 0 to 1000). Below we show the top five scoring portfolios

Table 1: Top Portfolios

[Begin Highly Confidential]

[redacted]

[End Highly Confidential]

This is generally aligned with our results from the shortlist process. The top portfolios feature **[Begin Highly Confidential]** [redacted] **[End Highly Confidential]** Because the renewable projects are mostly hybrid and therefore providing a good deal of capacity **[Begin Highly Confidential]** [redacted]. **[End Highly Confidential]**

This structure is generally followed throughout the portfolios which sit under PGE's "efficient frontier". The next table below shows how many times each resource appears in an efficient frontier portfolio.

[3] **[Begin Highly Confidential]** [redacted]. **[End Highly Confidential]**

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Table 2: Bids in Top Portfolios

Category	Bid	Name	[Begin Highly Confidential]	Number of times in efficent frontier portfolios	Cost/Benefit Ratio
[redacted]				41	96%
				40	82%
				40	78%
				34	98%
				17	102%
				13	92%
				8	103%
				8	92%
				7	100%
				6	99%
				3	99%
				1	103%
				1	77%
				1	82%
				0	104%
				0	101%
				0	100%
				0	97%
				18	104%
				12	103%
				11	111%
				8	135%
				0	131%
				0	135%
				0	130%
				0	101%
				0	135%
				0	139%
				0	168%

[End Highly Confidential]

We see the same offers showing up repeatedly in the top portfolios, matching with the cost benefit analysis from the shortlist process. The one noteworthy difference is the **[Begin Highly Confidential]** [redacted]. **[End Highly Confidential]**

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This analysis only considers larger renewable portfolios (i.e. those with 400 MWa of additions) because those have lower cost and risk per PGE's analysis. To see how bid selection might change with lower levels of renewable selection we adjusted PGE's efficient frontier lines so that more portfolios would be up for consideration. We then looked at the top scoring 250 MWa and 180 MWa portfolios. Below with show the top 5 scoring portfolios in the 250 MWa case

Table 3 Bids in Top 250 MWa Portfolios

[Begin Highly Confidential]

[redacted]

[End Highly Confidential]

Here we see the **[Begin Highly Confidential]** [redacted] **[End Highly Confidential]**

We then looked at the 180 MWa offers. Here are the top five portfolios – again we note that scores were extremely close for many offers.

Table 4: Bids in Top 180 MWa Portfolios

[Begin Highly Confidential]

[redacted]

[End Highly Confidential]

We see here the **[Begin Highly Confidential]** [redacted] **[End Highly Confidential]**. Interestingly, because renewable supply is more limited, the selection includes **[Begin Highly Confidential]** [redacted]

[redacted]. **[End Highly Confidential]**

Looking at all of this we see some general points to be made. First, the projects with the top cost/benefit ratios are generally selected first. Second, more capacity from the renewable side means less need for standalone storage. Third, at lower levels the cap on renewable supply can lead to some less straightforward decisions (e.g. using the **[Begin Highly Confidential]** [redacted]) **[End Highly Confidential]** as the models try and optimize the selected portfolio.

ADDITIONAL SENSITIVTIES

The analysis furnished by PGE roughly matched the value provided by the bids in the initial scoring, showing that the bids with the lowest cost to benefit ratios were consistently the top performing portfolios. It also displayed a clear preference for a larger renewable purchase than contemplated in the RFP. To look into this a bit more closely we reviewed the detailed analysis produced by PGE.

As stated above, PGE looked at portfolio performance under a wide range of conditions, including changes in gas price, market buildout, load, technology cost and more. To see how these changes affected portfolio value we focused at a high level on the differences between the three renewable portfolio sizes (180 MWa, 250 MWa and 400 MWa).

We looked at the average net present value of revenue requirements (NPVRR) of each group of 50 portfolios under each portfolio size. The average is shown in the chart below for the reference case.

Table 5: Reference Case NPVRR - Average of 50 portfolios

Case	180	250	400
Reference	$ 35,189	$ 34,879	$ 34,694

Consistent with the findings above, we see that the 400 MWa portfolio is less expensive on a NPVRR basis than the 180 MWa case, specifically by $494 million.

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We then looked at varying one element from the analysis to see what factor might most impact the optimal size of renewable purchase. The chart below shows the average NPVRR across all portfolios with the noted change from the reference case.

Table 6: Sensitivities from Reference Case - Average of 50 portfolios

Case	180	250	400	Difference (400-180)
Reference	$ 35,189	$ 34,879	$ 34,694	$ 494
Low cost wind	$ 32,434	$ 32,225	$ 32,227	$ 207
High cost wind	$ 37,771	$ 37,354	$ 36,989	$ 783
low need	$ 31,507	$ 31,192	$ 31,011	$ 496
high need	$ 39,513	$ 39,200	$ 39,013	$ 500
High WECC Buildout	$ 32,088	$ 31,870	$ 31,736	$ 352
High carbon adder	$ 34,465	$ 34,152	$ 33,958	$ 507
Low carbon adder	$ 37,583	$ 37,284	$ 37,120	$ 462
High Gas	$ 34,697	$ 34,357	$ 34,124	$ 573
Low Gas	$ 34,755	$ 34,444	$ 34,256	$ 499
Low Hydro	$ 39,215	$ 38,899	$ 38,700	$ 515
High Hydro	$ 32,134	$ 31,832	$ 31,663	$ 471

In every case the 400 MWa portfolio is, on average, the lowest cost portfolio. This does reinforce the findings of PGE, which determined that such portfolios were not only lower in cost but lower in variability and severity. Some items, while affecting overall portfolio cost, do not seem to materially change the relative difference between the portfolios. However, we see that higher WECC-wide buildouts and future lower cost wind projects do shrink the advantage of the larger portfolio by a good deal. This does make some logical sense as lower cost wind in the future (and lower market prices via a WECC wide buildout) would tend to lead toward a decision to buy less wind power now. In fact, if both effects are combined, the 250 MWa portfolio becomes the low-cost choice.

Table 7: High WECC/Low Wind Buildout NPVRR- Average of 50 portfolios

Case	180	250	400	Difference (400-180)
High buildout low cost wind	$ 29,537	$ 29,434	$ 29,488	$ 49

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To further stress test this decision we looked at a "worst case" scenario with the above high buildout and low cost wind plus low gas prices, carbon costs and need.

Table 8: Stress Case Scenario- Average of 50 portfolios

Case	180	250	400	Difference (400-180)
Low need/low cost wind/high buildout/low gas/low carbon/high hydro	$ 26,276	$ 26,166	$ 26,261	$ 16

Here again, the 250 MWa purchase is lowest cost while the difference between the small and large portfolios is minimal. This reinforces the point that certain conditions argue for a reduced renewable purchase.

PGE did conduct two additional sensitivities using the same general analysis as above. The first was to examine the effect of extending the PTC as proposed in recent legislation. This doesn't seem to affect the choice of bids, but it does have some impact on the difference in value between the three renewable purchase sizes. The table below shows the results of the reference case and each sensitivity.

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Table 9: PTC Extension Results- Average of 50 portfolios

Case	180	250	400	Difference (400-180)
Reference	$ 32,118	$ 31,839	$ 31,755	$ 363
Low cost wind	$ 29,058	$ 28,849	$ 28,857	$ 201
High cost wind	$ 35,000	$ 34,651	$ 34,469	$ 532
low need	$ 29,573	$ 29,354	$ 29,423	$ 150
high need	$ 36,296	$ 36,008	$ 35,861	$ 435
High WECC Buildout	$ 29,437	$ 29,296	$ 29,336	$ 101
High carbon adder	$ 31,176	$ 30,870	$ 30,737	$ 439
Low carbon adder	$ 34,974	$ 34,755	$ 34,778	$ 196
High Gas	$ 31,321	$ 30,981	$ 30,754	$ 566
Low Gas	$ 33,018	$ 32,870	$ 32,957	$ 62
Low Hydro	$ 35,982	$ 35,679	$ 35,524	$ 458
High Hydro	$ 29,254	$ 29,002	$ 28,946	$ 309
High buildout low cost wind	$ 26,399	$ 26,314	$ 26,431	$ (33)
Low need/low cost wind/high buildout/low gas/low carbon/high hydro	$ 24,685	$ 24,675	$ 25,004	$ (319)

The reference case difference between large and small portfolios shrinks by over $130 million on a NPVRR basis. This makes sense as future wind projects would be even less expensive – removing a significant advantage that is gained in purchasing wind at the moment. The other drivers have similar effects as before. Now in the low cost wind and high buildout scenario the smaller portfolio becomes preferable to the large portfolio - though the 250 MWa purchase is better than both.

PGE also looked at a sensitivity where the cost of "fill" capacity was changed from that of a simple-cycle combustion turbine to the average cost of a BESS unit. This used data from this RFP to establish a new, and higher, cost for future capacity.

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Table 10: High-capacity fill cost Results- Average of 50 portfolios

Case	180	250	400	Difference (400-180)
Reference	$ 35,540	$ 35,267	$ 35,086	$ 454
Low cost wind	$ 32,693	$ 32,514	$ 32,517	$ 176
High cost wind	$ 38,123	$ 37,742	$ 37,380	$ 743
low need	$ 31,578	$ 31,296	$ 31,118	$ 461
high need	$ 40,181	$ 39,905	$ 39,723	$ 458
High WECC Buildout	$ 32,437	$ 32,255	$ 32,124	$ 313
High carbon adder	$ 34,795	$ 34,516	$ 34,324	$ 471
Low carbon adder	$ 37,934	$ 37,672	$ 37,512	$ 423
High Gas	$ 34,955	$ 34,645	$ 34,413	$ 542
Low Gas	$ 35,106	$ 34,831	$ 34,648	$ 459
Low Hydro	$ 39,567	$ 39,287	$ 39,091	$ 475
High Hydro	$ 32,486	$ 32,220	$ 32,054	$ 431
High buildout low cost wind	$ 29,886	$ 29,819	$ 29,876	$ 10
Low need/low cost wind/high buildout/low gas/low carbon/high hydro	$ 26,347	$ 26,268	$ 26,365	$ (18)

The dynamic is similar here, though the deltas between low and high purchase cases do shrink some the general effects are similar to the other two cases.

Overall, these scenarios reinforce the risk factors inherent in the decision to purchase a greater supply of renewables at the present moment. Under general assumptions the decision would appear to be fairly simple as the larger portfolio is lower cost and generally robust. However, the risks to such a strategy hinge on the future cost and federal support of wind power and the level of market prices going forward (which would be affected by increased renewable development in the WECC). The more that we believe that wind subsidies are going away, wind prices are going up and that market buildout will not depress wholesale prices the more we would argue for a larger renewable buy.

Optimization Runs

In addition, as promised in the RFP, PGE conducted a set of what it termed "optimization runs" these are where the ROSE-E model was allowed to

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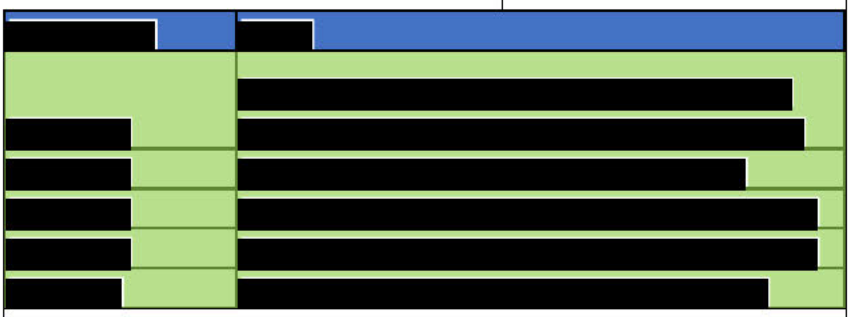
select a portfolio of offers from the entire candidate list with the goal of producing the lowest cost portfolio. Under reference case assumptions the model selected the following portfolio.

Table 11: Reference Case Optimization Portfolio

[Begin Highly Confidential]



[End Highly Confidential]

This is generally as expected, the top offers in terms of value **[Begin Highly Confidential]** [redacted] **[End Highly Confidential]** are selected with the noteworthy change that the **[Begin Highly Confidential]** [redacted] **[End Highly Confidential]** is now taken. As PGE's modelling was showing that more renewable supply would lower costs it is not too surprising to see this change.

As with the rest of the portfolio modelling, PGE looked at optimized portfolios under changes in load, future technology cost, carbon cost, hydro levels, WECC buildout and gas prices. PGE also examined a number of other sensitivity cases. These included the PTC extension and higher cost fill capacity (what they termed "CapFill" here) just as they did in the portfolio modelling above. In addition, they looked at combinations of PTC extension and higher cost filler capacity and scenarios where all 2025 need had to be met by resources from this RFP (here termed "No_Cap").

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Table 12: Bid Count in Optimal Portfolios

[Begin Highly Confidential]

[redacted]

Reference	CapFill	PTC Ext	PTC and CapFill	No_Cap	PTC No_Cap	Total	Cost/Benefit
21	30	17	27	27	28	150	111%
38	51	47	51	51	68	306	104%
0	0	2	1	1	2	6	103%
3	24	3	23	23	23	99	131%
0	0	0	0	0	3	3	135%
0	0	0	0	0	14	14	135%
0	0	0	0	0	32	32	135%
0	0	0	0	0	27	27	139%
0	0	0	0	0	0	0	98%
0	0	0	0	0	0	0	104%
1	0	15	8	8	0	32	100%
120	138	95	114	114	146	727	96%
0	0	0	0	0	0	0	168%
23	33	2	7	7	34	106	99%
17	31	5	12	12	54	131	103%
8	40	2	7	7	64	128	102%
37	23	54	20	20	14	168	82%
105	135	61	103	103	142	649	82%
37	10	29	19	19	12	126	77%
119	140	94	108	108	147	716	78%
4	9	4	14	14	2	47	101%
17	0	4	0	0	10	31	99%
35	0	19	0	0	10	64	92%
6	18	1	5	5	30	65	103%
71	128	53	105	105	98	560	92%
0	15	0	24	24	14	77	101%
27	15	27	10	10	15	104	100%
82	81	20	22	22	96	323	97%
0	1	0	1	1	8	11	130%

[End Highly Confidential]

Again, the general bid selection is something that we might have predicted looking at the cost/benefit ratios of the offers. The most selected bids are the **[Begin Highly Confidential]** [redacted]. **[End Highly Confidential]** Beyond this we see a few other findings.

- **[Begin Highly Confidential]** [redacted] **[End Highly Confidential]** This suggests that its selection in the 400 MWa case was more about it fitting in under the imposed renewable cap and that, at least under the model's view, even more renewable supply is preferred in many cases.
- In the PTC extension case, not only does demand for the **[Begin Highly Confidential]** [redacted] **[End Highly Confidential]** but fewer bids in total are selected. In several individual

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cases the optimization model selects no options at all from this set of RFP bids. Those tend to be cases in which factors drive down the value of selecting renewable facilities (low future tech costs, low gas prices and need, high WECC buildout, and so forth) so this result makes intuitive sense.

- Higher costs of fill capacity also bring in more selections, all else equal. For example, the **[Begin Highly Confidential]** [redacted] **[End Highly Confidential]** project is also selected often in these cases.
- When trying to fill the entire 2025 need from the bids selected the model tends to drop the **[Begin Highly Confidential]** [redacted] **[End Highly Confidential]**, among other options.

Generally, these runs reinforce the results in the basic portfolio modelling as well as the initial shortlist modelling and ranking of the offers.

Non-Traditional Metrics

PGE also provided a small number of what are termed "non-traditional" metrics. These metrics come from the 2019 IRP.[4] Specifically, PGE provided a) the year 2025 rate impact in the reference case for all 150 candidate portfolios and b) the CO2 emission reductions for all reference case portfolios.

PGE shows that, on average, the larger renewable portfolios will have a higher near-term rate impact. The table below shows the average and median rate increase in 2025 across each group of 50 candidate portfolios for a given renewable purchase level.

Table 13: 2025 Rate Impact (average across portfolios)

Portfolio	Average	Median
180 MWa	7.0%	6.2%
250 MWa	9.4%	9.6%
400 MWa	11.0%	11.1%

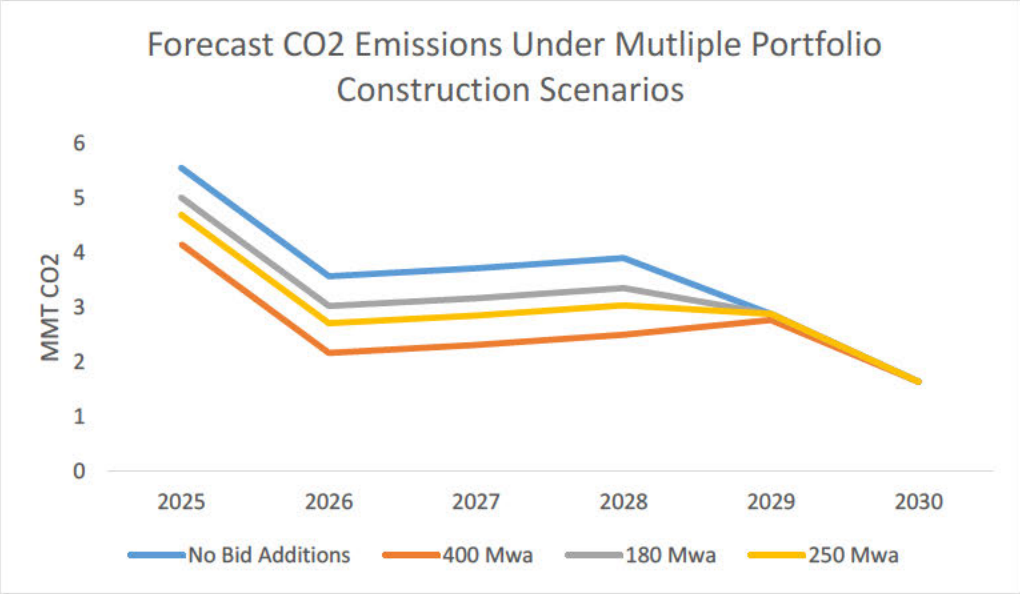
This shows that, on average, the larger renewable buy also results in the larger cost increases in the short-term. This may argue for a smaller renewable

[4] 2019 IRP, p 187.

buy despite the generally larger forecast savings above. We note that this only looks at reference case conditions and it would be useful to see performance under other states of the world. We would encourage PGE to provide this data so that others can gain insight from it.

PGE also provided reductions in carbon dioxide emission across the portfolios. As expected, greater reductions come from higher renewable portfolios.

Table 14: Forecast Reference Case Reductions



Because each model run will add renewable supply to hit 2030 targets the results do converge, but reductions in the near term are greater with a larger renewable buy. Under reference case conditions, the 400 MWa portfolio reduces about 860,000 metric tons more of carbon dioxide per year than the 180 MWa portfolio.

We note that PGE's IRP also examined reductions in other GHG and new resource criteria pollutants. We would encourage PGE to provide that information in this docket as well. While the information would likely have no bearing on the rank order of bids it might shed additional light on the tradeoffs between larger and smaller renewable portfolios.

CERTIFICATE OF SERVICE

I certify that I filed a true and correct copy of **Portland General Electric Company's Sensitivity Analysis prepared by Bates White, the Independent Evaluator** was served on the parties listed below via electronic mail and/or overnight delivery in compliance with OAR 860-001-0180.

Service List
UM 2166

STAFF	
Zachariah Baker Public Utility Commission of Oregon Post Office Box 1088 Salem, Oregon 97308 Zachariah.baker@puc.oregon.gov	Johanna Riemenschneider PUC Staff – Department of Justice Business Activities Section 1162 Court Street Northeast Salem, Oregon 97301 Johanna.riemenschneider@doj.state.or.us

Dated this 4th of May 2022.

Danielle McCain

Danielle McCain
Legal Assistant