**BEFORE THE PUBLIC UTILITY COMMISSION OF OREGON**

**LC 48**

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| In the Matter of<br>PORTLAND GENERAL ELECTRIC CO.<br>2009 Integrated Resource Plan | )<br>)<br>) | Comments<br>of the<br>**NW Energy Coalition** |

# Comments on PGE's Integrated Resource Plan
# NW Energy Coalition

*Steven Weiss – May 14, 2010*

## I. Introduction

The NW Energy Coalition (NWEC or "Coalition") appreciates this opportunity to comment on Portland General's Integrated Resource Plan, as amended (IRP or "Plan"). Although PGE's Plan encompasses a great number of issues, we will focus in these comments on two central questions: (1) a request to acknowledge a preferred Action Plan that includes the 2020 shutdown of Boardman; and, (2) a related request to approve an "alternative Action Plan" if the Company is unable to resolve several difficult regulatory contingencies by March 31, 2011, making the preferred plan, in PGE's determination, impossible to complete.

The Coalition believes it is in the interests of ratepayers, Oregon state policy and the environment to shut down the Boardman coal plant as soon as possible. Investing over \$500 million in pollution controls[1] for the state's largest CO2 emitter would be a very risky bet to make as the country and the world seek to reduce emissions consistent with what the overwhelming scientific consensus tells us is needed to avert drastic climate impacts. The idea that there is 0% possibility that Boardman will have to close before 2040 after making that investment—PGE's modeling assumption—is on its face ludicrous. The time to close the plant is before that money is put at risk.

While NWEC has numerous problems with the IRP analysis that will be examined in detail below, we believe that there is certainly enough evidence to say that closure of Boardman sometime before 2020 is definitely less costly and less risky than (attempting to) keeping it open through 2040. In many ways we are fortunate, because of the timing of the pollution control requirement, to be able to close Boardman at a cost that is insignificantly different than the costs of keeping it open—the closure will have little impact on rates. The task is how to best make that occur. Unfortunately, PGE's plan for closure is likely to fail, causing its customers and the state to lose this opportunity.

PGE has sought to frame this discussion in a particular order. First, approve a 2020 shutdown plan, but then in addition, if that plan is impossible to implement, approve an

[1] In this discussion, when we mention pollution controls we mean the avoidable larger scrubber/bag house and Selective Catalytic Reduction (SCR) investments, not the smaller 2011-12 investments to control mercury and the low-Nox Burner/OFA that we do not oppose.

"alternative" plan to make the pollution controls investment and run Boardman through 2040. The problem with this is that PGE's 2020 plan depends upon an extremely ambitious schedule to achieve federal clean-air rule changes.

We see the order differently. First commit to shutdown Boardman. Then design a strategy to do this at the least cost and risk to ratepayers. The reason this order is critically different is that PGE's preferred plan depends upon receiving federal regulatory approval by March 31, 2011. As Attachment A shows,[2] a large proportion of the nation's coal fleet faces the same EPA Clean Air Act issues as Boardman. Without further developments, EPA's new requirements (forced by a Circuit Court consent decree) will cause some of those coal plants' economics to lead to shutdown, requiring the acquisition of replacement power or conservation; while others will require the installation of costly pollution controls—all of this to be done by late 2015 or early 2016.

So currently the nation faces a "train wreck" at the end of 2015 when roughly *half of the entire generating capacity of the country* will either have to be replaced with cleaner resources or install expensive pollution control equipment such as that needed by Boardman. It is logistically challenging, to say the least, to expect this to be able to occur by 2016, and of equal importance, it is politically daunting. Thus, while we expect that the nation will work out some sort of deal to avoid the train wreck—a deal that may well look much like what PGE is trying to obtain—the magnitude of the problem and the number of players makes it almost certain to take a few years to come to fruition. Way later than PGE's timeline.

The bottom line is that PGE must be able to take advantage of any such deal, but approving the "alternative plan" almost guarantees that PGE will be left out. We urge the Commission to weigh the cost of missing out on a negotiated closure schedule from the federal government vs. the extremely questionable "benefits" of keeping Boardman open.

We do not believe that PGE's evidence for its choice of 2020 as "the best" date for closure of Boardman is compelling. It was chosen, as far as we can tell, as simply the date that the utility believes is the latest possible closure date that it can request given DEQ and federal EPA requirements. However, the particular date is not of great concern to us, because if the Commission refuses to acknowledge the alternative Plan, the actual closure date determination will most likely be made by EPA, after possible intervention by Congress. We do not think it is important, or perhaps even in its authority for the Commission to "set" a particular closure date. Instead, it is necessary for the Commission to make sure that closure can occur. For this reason, we believe it is prudent for this Commission to acknowledge a closure date of "no later than the end of 2020," and to not acknowledge the alternative Plan.

In sum, we oppose acknowledgment of the alternative Plan for three reasons. First, a premature decision to spend a large sum on control equipment might very well mean that PGE could not take advantage of a likely national resolution. Second, it would be unprecedented to allow the Company to make this momentous decision based on vague and undefined criteria ("reasonable assurance") without further stakeholder or Commission input. What if there is a disagreement over how close parties are to a

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[2] This attachment is the same as that provided to the Commission at the public meeting on April 26, 2010.

national resolution, or the acceptability of that resolution? PGE should not at this time be given the authority to switch to its alternative Plan without any oversight. Finally, PGE has not made the case that its alternative choice is the least cost/least risk for customers and the environment.

Thus we come to the question at the heart of our comments. PGE argues that if it cannot receive adequate resolution of the DEQ and EPA issues by March 31, 2011, its second best plan is to make the pollution investment and run Boardman through 2040. We will show that the evidence for this plan being second best is not compelling. Instead the second best plan is also the first one: foreswear the large pollution control expense and shut the plant down when required by federal or state rule, or by 2020 at the latest. The earliest that we would realistically expect that to be would be at the end of 2015 when federal compliance with the MACT standards could be required. We will demonstrate that PGE's justification for its 2040 plan vs. a 2015 date is not convincing. Certainly not enough to justify making the huge pollution control investment bet proposed by PGE.

One would expect that it is in regard to this question that the IRP's analysis would be most useful. Unfortunately there are so many flaws and omissions in PGE's analysis that it is difficult to come to any defensible conclusion.

## II. PGE's Choice – Diversified Thermal with Green (with or without Lease) – is not the "second best" Plan

PGE argues that if it cannot implement its best plan—2020 shutdown—its second best choice is the Diversified Thermal with Green (with or without Lease) portfolio ("Alternative Plan") which keeps Boardman open through 2040. This is really the key issue for the parties in this docket. For if the second best plan was a portfolio that shut down Boardman by 2015 or earlier, there would be no need to make the expensive pollution control investment decision that PGE is requesting it be allowed to make if March, 2011 passes without a national solution. PGE argues that on the basis of its IRP analysis, the Diversified Thermal with Green (with or without return of the California lease of a slice of the output of Boardman) is the best portfolio. We ask the Commission to deny acknowledgment of this choice for a great number of reasons that we will discuss in detail below.

The results of the IRP illustrate both the benefits and shortcomings of this type of modeling exercise. On the plus side, the IRP provides useful information about the choices—and the consequences of those choices—faced by PGE. But on the negative side the plan reveals the limitations of the Company's modeling and interpretation of the results: in particular, an over-reliance on false precision, arbitrary scoring, a lack of statistical insight or understanding, and a failure to value flexibility. It also reveals how seemingly close the different choices are, given the metrics chosen by PGE, thus calling into question the ability to rely upon them for specific guidance.

The errors, omissions and inherent limitations in PGE's methodology call for the exercise of more judgment and less reliance on tables and scores. We wish that PGE had listened to its own advice: "Ultimately such [modeling] acts as a guide to inform decision making rather than as a substitute for business judgment."(p. 238) Besides seeking Commission disapproval of the alternative Action Plan, we ask that it require the Company to modify its methodology in future IRPs to reflect our concerns.

**Summary of errors in the IRP analysis**

It is not our intention to try to overwhelm the Commission with a long list of insignificant errors in PGE's analysis. But a thorough investigation into the Company's methodology reveals so many substantial errors and omissions as to call the entire IRP into question.

1. Assumptions regarding load growth, "tightness" of the market, and long-term potential for cost-effective energy efficiency are questionable and disagree with NW Power and Conservation Council ("Council") estimates. These errors skew the results toward needing more resources and less reliance on the market.

2. PGE's cost metric—NPVRR—is incorrectly based on a single deterministic "reference case" run. Instead, PGE should have used the average value of the 100 stochastic runs. Doing so changes the ranking of the portfolios somewhat—an important result in its own right—but most importantly, it allows some statistical analysis to be done. The bottom line coming from that statistical analysis is that most of the cost differences between PGE's tested portfolios are actually statistically insignificant and should not be used for comparison purposes.

3. PGE performs no statistical analysis of its results. Failure to do so leads to the overvaluation of statistically insignificant differences. Another result of this omission is that costs are never put into perspective—we see cost differences on tables and graphs, but never know whether the differences are statistically significant, much less have a meaningful impact on rates.

4. Although PGE seemingly tests 16 different portfolios, in reality the utility considers a large number of them to be risky or even impossible to implement. This limits the "choices" to a very few similar portfolios. Also, when a portfolio appears to score better than PGE's choice, the utility introduces other factors or new criteria to discredit it. Finally, PGE should take the results of its analysis and attempt some optimization. Instead of accepting its initial portfolios as its only choices, the Company should learn from the results to see which elements of the portfolios seem to lead to higher scores, and then mix and match them for a more optimal package.

5. The IRP fails to include the benefits of optionality, especially when dealing with huge capital-cost resources, mainly the half-billion dollar investment in Boardman pollution controls.

6. Several of the Company's risk metrics are not meaningful or reflect customer concerns and should not be used. Other real risks are not included.

7. The scoring weights used by PGE are arbitrary, and therefore their results should be taken with a large measure of skepticism. The results for most of the portfolios are so close as to be meaningless, but PGE treats these minute differences as dispositive. This is especially suspect when one understands how large the

margins of error are for each individual score. One piece of evidence for this is that very minor changes in the weighting of scores result in quite different ranking—evidence that the weighting system is not reliable. In addition, PGE inappropriately combines risk and cost metrics into a single score without even discussing the justification for making this particular tradeoff between cost and risk.

8. In its risk assessment, PGE gives equal weight to futures with high and low emissions, so that CO2 becomes no longer a risk factor. (We compliment the Company for using a fairly robust CO2 adder in its cost analysis—this discussion is regard to its risk analysis.) Portfolios with lower emissions are not valued any more than those with high emissions. Given the very real threat of global warming, as well as this state's legislative goals for emission reductions, we believe that futures with higher CO2 adders should be given more weight than low penalties.

9. PGE has not made a good faith effort to model a portfolio that results in meeting the state's CO2 reduction goals. Relying on nuclear power, while unabashedly telling a public participation meeting that this is a completely unrealistic portfolio, is unacceptable and does not meet the standard of the PUC guidelines. PGE should develop a more actionable portfolio that meets the state's goals.

10. PGE's estimate of wind integration costs is too high.

We will address each of these issues in more detail below.

**1. Assumptions**

PGE makes three assumptions that are questionable; all of which tend in the direction of creating a larger resource need.

a. <u>PGE's assumed load growth is much higher than historic rates and the NW Power and Conservation Council's ("Council") forecasts</u>. In a letter to OPUC staff on Feb. 16, 2010 (Attachment B, excerpted, but see also the comments in this proceeding of Mr. Kaser, on behalf of the Willard Rural Association), Mr. Bruce Kaser examined PGE's historic loads, both energy and capacity, over the past decade, using OPUC statistics. He shows that the utility's need has been essentially flat over that period. Most telling is this statement appearing on Mr. Kaser's letter, p. 4 regarding PGE's predictive ability:

> Moreover, PGE was wrong ten years ago (in 1999) when it made exactly the same prediction:
>
> > The demand for energy within PGE's service territory has experienced an average annual growth rate of approximately 2.5% over the last 10 years and retail demand is expected to continue this upward trend. [*See* PGE SEC 10-K filing (FY 1999), p. 7 of 46 (.txt format).]

PGE provides no evidence for why the next ten years should look so different than the past ten. Mr. Kaser also compares PGE's present forecast to PacifiCorp's 2008 IRP (May, 2009) of 0.3% annual load growth in Oregon over the next ten years. (Kaser, p. 3)

Finally, he notes that, "PGE's peak loads have not increased for 10 years: PGE's all-time high net system load peak was 4,073 MW and occurred in *December 1998*."

PGE also argues that its "energy growth forecasts are consistent with the Northwest Power and Conservation Council's Draft Sixth Plan forecasts…" In Table 1 below we include PGE's forecasts from Table 3-2 (IRP, p. 37), and then for comparison include the Council's Oregon forecasts [see: http://www.nwcouncil.org/energy/powerplan/6/ Detail Assumptions and Load Forecasts tables 6th Power Plan –Feb 2010 update.xls.] The differences are very large.

**Table 1 – Comparison of PGE and Council's Annual Energy Growth Forecasts**

| Forecast Period | PGE forecast without EE | Council's OR forecast without EE | PGE forecast after removing EE | Council's OR forecast after removing EE |
|---|---|---|---|---|
| 2010-30 | 2.22% | 1.24% | 1.91% | 0.34% |
| 2010-15 | 2.37 | 1.96 | 1.72 | 0.47 |
| 2015-30 | 2.24 | 1.00 | 1.97 | 0.30 |

PGE's winter and summer capacity forecasts summarized in Table 3-1 (IRP, p.36) are also inconsistent with the Council's (6th Plan Table 3-6). While the Council did not break down its peak load forecasts (capacity) by state, it did forecast the region's winter and summer peak requirements both before and net of conservation. The comparisons of the annual growth rates are shown in the Table 2 below.

**Table 2 – Comparison of PGE and Council's Annual Capacity Growth Forecasts**

| 2010-30 forecast before subtracting EE | PGE Winter capacity growth | Council Winter capacity growth | PGE Summer capacity growth | Council Summer capacity growth |
|---|---|---|---|---|
| Low | 1.38% | 0.5% | 1.88% | 1.1% |
| Medium | 2.0 | 1.1 | 2.44 | 1.6 |
| High | 2.77 | 1.5 | 3.22 | 1.9 |
| 2010-30 forecast after subtracting EE | | | | |
| Low | 1.03 | | 1.65 | |
| Medium | 1.7 | -0.25 | 2.24 | 0.94 |
| High | 2.53 | | 3.05 | |

As can be seen from Table 2, PGE's forecasts of growth in peak demand are close to double the Council's before energy efficiency (EE) is removed, and after EE subtracted, the difference is even more stunning.

To put these different growth rates into perspective, over 20-years' time a one per cent difference in annual growth rate translates to about 500 aMW of annual energy and 900 MW of peak demand for PGE's system. Most important, if the Council's forecasts are even close to correct, there is no doubt that there is no need to continue running the Boardman coal plant past 2015 or so.

b. PGE's forecast of new energy efficiency achievements is way too low. PGE has assumed that the ETO's programs will essentially phase down over time (IRP p. 57 and Table 4-3), because emerging technologies are not included. Neither are savings from so-called "free riders."[3] This is contrary to the Council's forecasts and the historical record where the EE record has experienced sustained growth through the continual development and adoption of new technologies, plus the investments many customers make in energy efficiency outside of traditional utility programs. PGE argues,

> These back end differences will not have a material impact on PGE's IRP Action Plan, which focuses more on the near-to-mid-term for resource additions. Note that the ETO and NWPCC values include free-riders, while the values used in our IRP do not. (IRP, p. 57)

We disagree with this minimizing of the difference. In reality, PGE's resource portfolios, including any resource additions, are analyzed over their whole lifetimes. Thus an inflation of the need for new resources can make a substantial impact on their costs. In addition, several of the higher scoring portfolios tested by PGE are eliminated due to "high execution risk." (IRP addendum, p. 86) If load growth were slower due to higher amounts of energy efficiency, this risk would lessen.

c. PGE argues that it will face "tight markets" (p. 49) for power in the future. PGE bases its conclusion partly on reliance on the Council's 2008 Adequacy assessment, done before the current recession. PGE also misinterprets the Council's analysis of independent power producer (IPP) plant availability. The Council analyzed the availability of IPP generation, including *only that amount that had no access to transmission outside the region*. Instead, PGE states incorrectly that, "The Northwest is vulnerable to supply deficits resulting from market inefficiencies and the commitment or sale of merchant generation to demand outside the region." (p.49) If anything, the Council forecasts a continuing and even growing energy surplus in the region over the next 20 years, due to the large potential for energy efficiency and the amount of RPS renewables. Together these two factors will cover about 125-130% of the region's load growth. Finally, while the details are still being debated, it appears that California will allow some amount of unbundled tradable renewable energy credits (TRECS) to be used to qualify for its RPS. This will create a further surplus of power in the region—so much so that BPA and other traditionally surplus utilities fear dropping market prices will hurt their sales revenues significantly.

It is interesting to note that this concern over availability of market purchases is somewhat new to this IRP. Slide 19 from PGE's April 26, 2010 presentation to the Commission shows two pie charts: before and after acquisitions in the proposed action Plan by 2015. The "before" chart shows a portfolio with 3% long-term and 32% spot market purchases. The "after" chart shows the same amount of long-term purchases, but now only 2% spot market. It is difficult to understand why PGE is now becoming so

[3] We suspect that "free riders" as defined by PGE includes savings from improved codes and standards. This is likely one reason why PGE and Council load forecasts differ so much. The recent PNUCC NW Regional Forecast, to which PGE contributes, differs substantially from the Council's forecast, because it excludes price-induced demand reductions and savings from appliance efficiency standards and energy codes. Thus PNUCC utilities are planning on needing thousands of MWs more new supply-side resources than does the Council. (*Clearing Up, May 3, 2010, p. 8*)

worried about being in the market or attempting to transition out of the market so quickly.

As a result of these incorrect assumptions PGE is overestimating both its overall need for new resources and underestimating the availability in the market of low-cost resources to meet its needs. In fact, in the face of the recession and the Council's analysis, PGE restricts its portfolios to less market purchases than even its last IRP. Correcting these assumptions, and modeling portfolios that have more market purchases, would likely result in less need for new resources and less costs, as is evident from the superior performance of its pure "market" portfolio on many cost and risk measures.

**2. PGE's cost metric and other statistical fallacies**

PGE uses the net present value of revenue requirements (NPVRR) to assess the expected cost of portfolios. It is often called the "Expected Cost" throughout the Plan, and is given 50% of the ultimate scoring weight in choosing the preferred portfolio. Unfortunately, it is an extremely poor measure of actual expected costs. For one thing, it is not really an "expected" value,[4] it is instead just the mean of a single reference case run of each portfolio. Another serious drawback of this metric is that because there is just one single number for each portfolio, it is impossible to know whether two different portfolios have *statistically significant costs*. If one says, as PGE does, that portfolio A has an NPVRR that is $100 million higher than portfolio B, there is no way to know whether this is a meaningful difference—unless we are absolutely sure that each assumption in the reference case (load growth rate, gas costs, hydro year, etc., each staying constant over 20 years) is true, which of course is extremely unlikely.

A much better cost metric available is the expected NPVRR obtained from the 100 stochastic futures tested by PGE. While each future is certainly suspect, using the average of 100 plausible futures is a much better way to represent the actual, but unknown, future. And doing so also allows us to judge the statistical significance of cost differences expected from the performance of the different portfolios.

Attachment C comes from PGE's response (supplemental) to our data response No.39 asking for the 100 stochastic runs, means and standard deviations of the tested portfolios. The shaded portions were added by NWEC.

First note the very large standard deviations of $3-5 billion, depending upon the portfolio. What this means is that the portfolios' costs have large variations depending upon which future it was tested against. Plus or minus one standard deviation includes about two-thirds of the 100 futures, meaning one-third varied from the mean by way more than that amount. The actual costs customers will face is much more dependent upon future conditions than upon the actual choice in portfolio. Then note the change in rankings from column C to E. Many of the portfolios changed by 6 or 7 places depending upon whether PGE's single deterministic cost metric is used, or the stochastic mean derived

[4] The use of the term "expected cost" is misleading as used by PGE. Mathematically the term refers to the probability-weighted sum of several numbers. Wikipedia has a good definition: "It is often helpful to interpret the expected value of a random variable as the long-run average value of the variable over **many independent repetitions** of an experiment." (emphasis added) But PGE incorrectly uses the term to be the average value of a single deterministic run.

from 100 runs. This is interesting, but is it significant?

The real value of this exercise is to be able to test whether the differences in the costs are statistically significant, and that is done with a paired t-test, shown in columns D, E and F (rows 23-27). The paired t-test is a way to see if two means are significantly different when an experiment is repeated many times. Basically it is a measure of the average difference between the 100 pairs of costs relative to the standard deviation of those 100 differences (divided by the square root of the number of pairs). If the average of the differences is large compared to the standard deviation, then one can be confident that the average of the differences is significant, and not due to chance variations. (A table of critical t-test values, found in any statistics textbook, gives how large the result must be to be significant.)

We compared three pairs of portfolios to determine if they were significantly different or not. These included: row 24 — Alternative Plan vs. 2014 shutdown; row 25 — 2014 vs. 2020 shutdown; row 26 — Alternative Plan vs. 2020. The important result is that *none of the three portfolios have significantly different costs*! Depending upon the particular standard deviation of the differences between two portfolios, one can generalize that it takes a difference in NPVRR of at least $500 million to be significant given the huge variability of results across the many futures tested. Or put another way, after the top-scoring portfolio ("market"), rejected for other reasons, portfolios ranking 2 through 11 are essentially tied when it comes to comparing their costs.

While statistics can be technical, sometimes it is better to look at the underlying data to illustrate the point that the results are so variable that it is disingenuous to give too much weight to small average differences. If one looks at the individual stochastic runs in row 24—the comparison between PGE's preferred 2040 alternative and a 2014 shutdown—one can find extremely large costs in both directions, depending upon the particular future tested. Cell AU24 shows that in one possible future, customers *save* $11.970 billion by keeping Boardman open through 2040, but the future in cell AW24 shows that keeping the plant open *costs* them over $13 billion! On *average*, the difference between these two futures is around a half billion dollars, but clearly that information is not important for making the decision, if those were the only two choices.

PGE's reliance on single deterministic "costs" without any statistical foundation for understanding them is irresponsible. That is why the Commission should take with a very large grain of salt the Company's recent presentations showing rate impacts of various portfolio choices, since they are based on a single forecast future.[5] For example, the Company has been presenting its cost numbers to different audiences that assert that its 2020 plan would save customers more than $600 million over the next decade compared to a 2014 closure date. This is irresponsible. In reality, there are many other futures where the numbers are radically different. As Cell B25 of Attachment C shows, over the 100 stochastic futures tested, PGE found that *on average* closing Boardman later saved customers about $410 million in NPVRR, but that in 50 of those futures, exactly half, a 2014 shutdown was cheaper (cell G29). The Commission needs to reject the use of statistically insignificant results. And in the future, the Commission should require

[5] Just labeling a future the "reference" case does not make it particularly special or accurate, given the uncertainty the utility industry faces.

statistical analysis as a critical part of the IRP.

**3. Costs need to be put into perspective**

Not only is it important to test conclusions for statistical significance, it is also important to look at financial significance to customers. Throughout the IRP, PGE presents its results in the form of X-Y plots of cost and risk, for example Figure 11A-1. The utility then discusses the various portfolios with statements about how some portfolios outperform others or have higher or lower costs or risks. What is left out, unfortunately, is an attempt to put the scale of the axes into perspective for customers. The scale is generally marked in units of about $500 million for NPVRR and risk. At first glance it seems like the distance between points on the graphs are meaningful. After all, that is a lot of money. But is it really?

To put a $500 million difference in NPVRR into perspective, it must be compared to the total NPVRR of around $28 billion. But PGE's NPVRR does not include its ongoing distribution costs that are about equal to half those costs[6] so the total base upon which the $500 million should be compared is more like $42 billion. Thus the rate impact of that $500 million difference is about 1.2%. That means that after the (rejected) "market" portfolio, all the portfolios that rank between number 2 and 11 have costs within that range of each other. Even if these differences were statistically significant—which they are not—they are so financially similar as to make a choice based on rate impact to customers essentially meaningless.

**4. PGE's portfolio choices are too limited**

PGE tested 16 different portfolios, but for all intents and purposes, only a much fewer number were given much consideration. This is due to a number of reasons.

PGE stated at the start of the IRP process that it was going to analyze a few unrealistic "pure plays" to learn about how certain resources affected the scoring. In this category were three of the sixteen, "wind," "natural gas," and "market." Two portfolios included new nuclear plants for which no one could reasonably estimate costs. While interesting, even the Company admitted in a public meeting that no one believed that they could be constructed in the Northwest in this timeframe given the many risks they face. For similar reasons, the IGCC portfolio was considered very doubtful by all parties.[7] That left 10 portfolios still standing.

Two portfolios, "Diversified Thermal with Green" and Diversified Thermal with Green without the Boardman Lease" are practically identical, in that the lease in question is for only 72 aMW.

At this point there are nine choices, but now PGE introduces another criterion to

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[6] In response to NWEC data request #41—renumbered 42 by PGE—the utility states: "the revenue requirement for distribution and other costs not contained in NPVRR totals approximately 34% of PGE's overall revenue requirement."

[7] In PacifiCorp's most recent IRP, the feasibility and economics of IGCC plants was investigated in depth. The conclusion was that they were not ready for prime time for over 20 years. Many parties have great hopes for their commercialization, but they are too soon in their development stage to be counted on.

eliminate portfolios that score too well against its preferred (alternative) plan. In its discussion of the modeling results, PGE argues against the top-performing portfolio, “Green with On-Peak Energy Target,” by stating it has too much wind in it. PGE thus eliminates it from consideration:

> It is not yet clear if such a high amount of additional wind in the Pacific Northwest would be available or whether assumed costs for smaller volumes would hold for larger amounts over a relatively short time-frame. In short, this portfolio carries higher execution risk. (Ch. 11-A, p.86)

Since the amount of wind in this portfolio is identical to that in “Diversified Green,” we can assume that it was also never really in contention. Now we’re at 7. Boardman through 2020 is one of the remaining choices and is PGE’s preferred Plan. But as we discussed earlier, the real question is choosing an alternative, so 2020 is not among those, nor is 2017 Boardman closure that has the same regulatory hurdles. Finally, while arguably a real choice, the “Diverse Green with wind in WY” portfolio has such a high cost that it too is eliminated. That brings us down to 4 actual choices: Boardman through 2011 and 2014, Diversified Thermal with Wind, and Diversified Thermal with Green (with or without the Lease). Even these two last portfolios are quite similar. The first has a bit more wind compared to a little less biomass and geothermal, but both have the same large natural gas additions. The two Boardman options are also almost exactly the same, the only difference being a three-year bridge PPA to allow Boardman to close three years earlier. (Given PGE’s concern with the “tightness of the market,” we have a feeling a 2011 shutdown would probably also be ruled out anyway.) So in reality, we are down to two actual options for the alternative plan: Diversified Thermal with Green (with or without the lease) and Boardman closure in 2014.

This situation is unacceptable. PGE should not be allowed to narrow the choices so much that only two options are being discussed. Especially troubling is that PGE has broken its initial commitment to use the initial analysis results in order to design a more optimal portfolio. There is valuable information to be gained from PGE’s analysis, and we believe a better alternative can be designed based upon that information. But either for lack of time, or complacency with the portfolio it has chosen, the Company did not attempt to tweak its preferred choice using information from this modeling effort.

While we have criticized the Company’s analysis and scoring system, we do believe it can provide valuable feedback. Some portfolios perform much better on certain metrics than do others. PGE should use this information to improve on the limited number of portfolios tested. Features of a portfolio that cause it to score well on a metric should be combined or added to other portfolios to attempt to create a better performing plan.

For example, only one portfolio—the “Green with on-peak energy target”—explicitly overbuilds (mainly with wind). Perhaps the extra renewables or the extra energy in that portfolio make it score high. One indication is that it has a superior reliability score. This portfolio also emits less CO2 than even the Boardman shutdown portfolios. What factors lead to this counterintuitive result? Another lesson should be taken from the least-cost portfolio: “market.” PGE seems bound and determined to get away from market purchases, but the data clearly show that a market strategy is valuable.

The valuable attributes gleaned from the results discussed above are not inextricably bound to the portfolios of which they are a part. That is, *every* portfolio might profit from adding additional wind and market purchases—the hypothesis is surely worth testing. The other portfolios should likewise be examined for similar clues to assembling an optimum mix. In this way PGE could have, and should, design more optimal portfolios. NWEC's preferred portfolio discussed toward the end of these comments takes just that approach.

Finally, as previously noted, 2015, rather than 2014 may well be the actual "drop-dead" date for Boardman closure without adding expensive control equipment. PGE has known this for some time, and it should have run that date through its methodology. We believe that date is truly the real alternative to PGE's preferred alternative Plan (Diversified Thermal with Green).

**5. Optionality**

The Coalition has addressed this issue in past IRPs, both PGE's and PacifiCorp's. Because their models test resource portfolios against static, deterministic futures, they fail to capture the value of optionality. The Council's model does this, however, and the result is that small-shaft investments and energy efficiency are worth more than just their avoided costs.

This issue is especially important for the consideration of Boardman. Keeping Boardman open is making a large wager for two reasons. First, it costs something like $500 million up front, before we know emerging climate policy. Much of the reason that Boardman shutdown scenarios do not score higher is that they do badly with very low carbon prices. Before betting $500 million on a plan that is economic only if the plant can run for decades, it would be prudent to be flexible.

Second, portfolios that keep Boardman open only score well if the plant stays open until 2040. PGE has not given any probability to scenarios where it makes the pollution control investment and later has to shut the plant down before 2040 anyway. Surely this possibility is not zero. Making a $500 million investment in a resource portfolio that is only marginally better on a few metrics when compared to portfolios that shut down Boardman is a case where keeping options open is critical. This is especially important given how the nation will deal with upcoming MACT control requirements. If PGE's alternative plan makes the pollution control investment too soon, as requested by the Company, it will not be able to take advantage of a federal deal that allows for a later shutdown than 2015 which could well be negotiated in the next few years, but not by March 31, 2011. Portfolios that do not make this big bet should be valued higher in the scoring system.

**6. Modeling risk**

PGE's scoring system appears to reflect risks, but in actuality masks or hides risky portfolios, especially for carbon costs. Take, for example, two portfolios: one with high emissions and one with low emissions. The high emission portfolio would score well in scenarios where CO2 prices were low, and score badly in scenarios where prices were high. The low-emission portfolio would do the opposite. Both would therefore rank about the same when it came to average costs. They would also both have a number of poor outcomes and good outcomes, so their risk scores would also be similar. We could only conclude that the two portfolios were both reasonable choices, *even though they were actually quite different*.

This masking of differences through the scoring system is not only a problem for CO2 costs. PGE's methodology actually hides different portfolios' differential performance against other variables such as gas prices, load growth, etc. Only portfolios that do exceptionally poorly under almost all conditions (e.g., with such high costs that it doesn't matter what else happens—i.e., nuclear or IGCC) will actually be screened out. Not surprisingly, all the other portfolios score so closely that one can hardly tell them apart.

This should not be a surprise. Looking along what is called the "efficient frontier," one sees that there is a tradeoff between cost and risk. Where costs are high, risks are low, and vice versa. So now <u>if you construct a scoring system that gives equal weight to costs and risks, the sum will always be pretty constant anywhere along that frontier.</u> Only portfolios off the frontier will score worse. And only resources that *shift* the frontier, not just move along the frontier will stand out in all portfolios. Thus high cost resources that are high cost in all futures will always score badly (nukes, for example); and, low-cost energy efficiency which scores well in all futures will always improve scores.

This is why the Council's model does not choose the "best" portfolio. It only chooses the *set* of best portfolios—the efficient frontier. It is up to the policy makers to decide where on the frontier they wish to be.

To solve this problem one must make a *judgment* regarding the tradeoff between risk and cost: which scenarios are more likely, which outcomes are more desirable, and which risks are more dangerous. Only by doing so can one start to make a decision. PGE needs to make and justify a decision that, for example, $X million in cost is worth $Y million in risk, if it wishes to mechanically add cost and risk metrics together.

Sadly, PGE is unwilling to make those judgments, or implicitly makes judgments in choosing weighting factors. Instead, it relies upon the minuscule—and manipulable through tiny changes to the weighting scheme (if one wished to posit ulterior motives)—differences its scoring system produces to pick its preferred portfolio.

As noted above, we have serious concerns with PGE's scoring system. In particular, several of the risk metrics either do not measure what they purport to measure, measure factors that duplicate or are contained in other metrics, or are unimportant. (Problems with the weightings are addressed in the next section.)

Two measures—"Risk Magnitude: worst 4 vs. reference case"; and "Tail Var less mean"—are measures of spread or variability, not measures of risk of bad outcomes. Any metric such as these that subtracts out the mean, in cases where the mean can be very different across tested portfolios, is faulty, since high variability in itself is not a bad outcome. Only high absolute costs are bad

A third risk measure is “Year to year variation.” Consider a ten-year period as we asked for in DR 18 (Attachment D). Assume that in one portfolio, costs increase 2% each year, and a second portfolio that alternates 0 and 4% rate increases. The Year to Year variation metric scores the second scenario many times worse than the first. But clearly the two scenarios are not all that different from a customer’s point of view. (In fact, due to compounding, at the end of the day the alternating 0% and 4% increase results in lower rates than the yearly 2% increase.) While overall costs are important to consumers, using the year-to-year variation as a risk measure, especially as calculated by PGE, is worse than nothing.

These three metrics—“Risk Magnitude: worst 4 vs. reference case,” “Tail Var less mean” and “Year to year variation” should not be used.

Another risk metric of questionable value in the context of this IRP is PGE’s measure of reliability that is given a 15% weighting factor, larger than any other risk factor. But as Table 11A-23 shows, annual unserved energy, is a matter of independent choice wholly unrelated to each portfolio. The reason for this is that it is simply a function of how “long” the utility chooses to be. The table shows that the amount of unserved energy can be cut in half by adding an increment of about 100 MW of additional flexible gas-fired capacity. But this is true of *any* portfolio. Therefore, if PGE believes that a certain level of reliability is prudent, it can add or subtract additional capacity to any portfolio to achieve that standard. But if this measure of reliability can be determined independently in any portfolio, it should not be used as an attribute of each portfolio in the scoring matrix.

Finally, PGE has introduced two new measures that measure resource type and fuel type diversity using the Herfindahl-Hirschman index (HHI). First of all, PGE has not provided evidence to show that the relatively small differences that the HHI shows across portfolios are very significant. Secondly, if they were, then the results should correlate with other risk measures and so are duplicative. Without having more experience with the HHI, it is good that PGE has weighted them only 5%.

**7. Scoring matrix**

There are several problems with the scoring matrix that call its results into question.

The first problem, as discussed above, practically guarantees that the results of many portfolios on or near the efficient frontier (i.e., that are not otherwise fatally flawed) are going to have extremely similar scores. This means that the scoring differences are essentially meaningless and should not be relied upon to choose a preferred portfolio.

Second, the normalization process is completely arbitrary and ultimately affects the weightings (themselves quite arbitrary). PGE normalizes its raw scores by assuming the full range is simply the difference between the highest and lowest portfolio’s scores on a given measure. Thus the difference between two candidate portfolios is actually determined mostly by the range of the two greatest outliers. The outliers are usually pure plays or portfolios clearly off the efficient frontier. Their influence is irrelevant and should not affect the rankings of leading portfolios. Instead, a judgment should be made of how important each metric is so that differences can be somewhat comparable.

To illustrate these two problems, it is only necessary to look at how the portfolio rankings are affected when extremely small changes in the weightings are made. For example, changing just one factor infinitesimally, PGE's weighting of "Risk Durability" from 10% to 11%, switches the three top contenders' rankings! (The remaining factors were normalized so as to keep the total weight to 100%. See attachment E.[8]) That might be acceptable if those portfolios were fairly similar. But instead they represent quite different strategies. Some have more or less wind, one closes Boardman, and one builds to a different capacity target (on-peak energy). More important, the three portfolios differ in their CO2 output by as much as 20%. Basing multi-million dollar decisions on a scoring system that is so fragile is not prudent business practice.

**8. CO2**

We are pleased to see that PGE uses a $30/ton CO2 cost in its deterministic cost analysis. However, PGE's risk metrics all represent scores averaged over futures that have prices of $0, $12, $20, $45 and $65 (2009 real levelized dollars). The metrics treat high and low-emitting portfolios equally: the high emitters score well in the low price cases, and vice versa. Thus the Company's risk analysis ultimately places no weight on CO2 emissions.

We do not believe all CO2 penalties are created equal. If we are wrong, and human-caused global warming turns out to be a hoax, all that will have been "risked" is that we have developed cleaner resources and more energy efficiency than otherwise. But if we are right, the environmental damage created by the CO2 will be much larger than the penalties we are talking about here. Given the serious asymmetry of global warming costs and the huge uncertainty over how emissions will be treated in the future, we request that PGE weight the higher adders more heavily in its risk scoring.

To sum up, PGE's scoring is based first upon cost differentials that are not significantly different, and then to a large part on risk measures that are irrelevant. But the Company ignores the very real risks of future CO2 regulation (not to mention CO2 *damage*), the possibility that Boardman will not operate through 2040 in those scenarios for which the plant is kept open, and the possibility that premature installation of costly pollution control equipment will mean that PGE will not be able to participate in a national settlement of federal MACT requirements.

This IRP needs a major "do-over." The Commission should condition any acknowledgment on marked improvements in the next IRP cycle. PGE must include statistical analysis, so that its results can be understood. The utility also needs to rely on risk measures that are meaningful. Finally, PGE should provide more justification for its weighting decisions by explicitly choosing quantitative tradeoffs between risk and cost.

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[8] We thank Ken Dragoon from RNP for providing this spreadsheet. It is a "live" spreadsheet, so the reader can change weightings in row 5 and see how the rankings change. As we noted, very small changes can reorder many of the portfolios.

NWEC also urges the Commission also to recognize that when the various portfolio choices have little difference on the various scoring factors tested by PGE, it should weigh the CO2 and other risks we have discussed. In a sense, "a tie should go to the environment."

**9. Oregon CO2 compliance option**

PGE's response to IRP rules requiring the analysis of at least one portfolio that meets the state's CO2 reduction goals is a portfolio that relies on a new nuclear plant. At the same time the Company has admitted publicly that it is a completely unrealistic scenario. PGE needs to work with the parties to develop a doable alternative. The Commission should not accept this portfolio as meeting the intent of the rule.

In general, CO2 reductions should be elevated in importance in the IRP, with more emphasis given to ways to meet the state's goals.

**10. Wind Integration Costs**

We disagree with the analysis that PGE has done regarding its estimate of over $11/MWhr for wind integration costs. We defer to RNP for more detailed comments. However, given that Bonneville has developed a rate of about $5.40, PGE could either purchase integration from that agency if that would be less costly or apply some of the lessons learned that have allowed BPA to lower its cost. These include things like intra-hour scheduling and requirements on wind developers and their customers to deal with extreme wind ramps. These measures have allowed BPA to carry fewer balancing reserves at almost no cost. PGE should run a sensitivity to integration costs in order to see if its portfolios would change under a cost of the range offered by Bonneville.

**II. Using lessons from the IRP to design a better portfolio**

While we have criticized the Company's analysis and scoring system, we do believe it can provide valuable feedback. Some portfolios perform much better on certain metrics than do others. PGE should use this information to improve on the limited number of portfolios tested. Features of a portfolio that cause it to score well on a metric should be combined or added to other portfolios to attempt to create a better performing plan.

PGE originally stated that this was one reason it tested a number of "pure plays." But either for lack of time, or complacency with the portfolio it has chosen, the Company did not attempt to tweak its preferred choice using information from this modeling effort.

For example, only one portfolio—the "Green with on-peak energy target"—explicitly overbuilds (mainly with wind). Perhaps the extra renewables or the extra energy in that portfolio are what make it score well, if only because we know that extra resources reduce unserved energy. PGE should test these hypotheses by adding the extra renewables to other portfolios to see if they are also improved. The other portfolios should likewise be examined for similar clues to assembling an optimum mix.

Rather than just criticizing PGE's Plan, NWEC believes it is important to put forth a better alternative portfolio.

We start with the closure date for Boardman. As discussed earlier, the particular closure date will almost certainly be determined by the federal government (unless the opportunity is lost through a premature decision to install the pollution controls). That will either be about the end of 2015 when new MACT rules will require it under the consent agreement, or somewhat later if a "deal" is made by Congress to change those rules. We believe this latter result is a good possibility, due to the number of coal plants in the country that find themselves in the same boat with Boardman. It is important that PGE be positioned to take advantage of such a deal, thus the Commission should not acknowledge the Company's 2014 alternative. <u>Therefore, the Coalition's proposal is for a closure date "no later than 2020,"</u> with the particular date determined by federal regulators and/or Congress.

Next we take the lessons learned from PGE's analysis, especially of the "Market" and "Diversified Green with On-peak Energy Target" portfolios. As discussed above, these two portfolios performed remarkably well on several measures. There seem to be two attributes of the Market portfolio that deserve to be captured. First, there is an inherent flexibility in a somewhat larger market exposure—we see this for the most part as 1-3 year power purchase agreements (PPAs), not the spot market. Given our skepticism regarding PGE's high load growth forecast, it makes sense to have more market flexibility in the portfolio. Second, the market provides very low cost electricity for a number of reasons. PGE explains that the market is priced at short-term marginal cost that does not include fixed costs of the resource; plus, reserve margins imposed to assure reliability may cause the market to be surplus most hours of the year. (Addendum, p. 13). The Council's 6$^{th}$ Plan mirrors this finding, coming from a different direction. The Council forecasts that the large amount of cost-effective energy efficiency combined with required RPS resources also causes a surplus. NWEC would not go so far as to recommend an excusive reliance on the market, but a somewhat larger exposure—similar to PGE's past history—seems likely to be both prudent (adding flexibility) and low cost.

The "Diversified Green with On-peak Energy Target" portfolio also offers lessons. This portfolio reduced reliability risk by being somewhat long, and it reduced CO2 emissions by adding more wind. It is long due to adding both an additional CCCT and 405 aMW of wind. We would substitute 1-3 year rolling PPAs for the CCCT. We understand that this portfolio added a lot more wind than PGE's preferred alternative Plan that the Company believes may be difficult to acquire, an extra 405 aMW. But why not try? "Diversified Thermal with Wind," a portfolio PGE did not eliminate, adds 145 aMW, so evidently the utility believes that much extra wind can be acquired. 145 aMW of additional wind seems doable.

Our proposal thus attempts to capitalize on some of the positive attributes gleaned from PGE's analysis: a little longer, a little more reliance on the market, a little more wind.

We therefore propose the following portfolio. See Table 10A-4,5 for comparison to the others.

- Close Boardman sometime before the end of 2020, to be determined by federal requirements.

- Start with the high-performing "Diversified Green with On-peak Energy Target" portfolio, and then modify it in two ways. (a) Add only 145 additional aMW of local wind (rather than 405) beyond RPS requirements; and, (b) substitute 300 aMW of 1-3 year PPAs for the 2015 CCCT.

- Wait for two-three years to determine how to replace the power from Boardman closure. This is prudent at this time given the uncertainty of the exact date of closure[9], the uncertainty regarding future load growth, difficulties in acquiring the additional renewables, and the ETO's ability to achieve its aggressive EE goals.

## III. Conclusion

The NW Energy Coalition was very supportive when PGE first made its announcement that it would close Boardman. However we have come to believe that the Company's good intentions will be caught in a whirlpool of federal politics that will not reach a satisfactory conclusion by the end of March next year. Therefore the question of a back-stop or alternative plan becomes of critical importance for the Commission to focus on.

We urge the Commission not to acknowledge PGE's Alternative Plan for a number of reasons.

1. PGE should not be given the authority to switch from its preferred Plan to its Alternative Plan without Commission oversight, especially given the total lack of rigorous criteria upon which the utility seeks to make that decision.

2. There is a high probability that if PGE makes the pollution control investment too early, it will not be able to participate in a federally negotiated settlement involving hundreds of similarly-situated coal plants.

3. PGE has not presented convincing evidence that its Alternative Plan to run Boardman through 2040 is the least cost, least risk choice if its 2020 closure Plan is not possible to implement.

   Instead, the IRP is rife with errors. First and foremost, PGE has done no statistical analysis to justify its choice as much better than any other choice. Second, PGE's load forecast is way too high, calling into question the fundamental need for much of the new resources in its Plan. (We also suspect that this is true regarding PGE's gas price forecast, especially given the latest evidence of the quantity of low-cost shale gas that is becoming available. However we have not had the time to look into this issue.) Third, PGE is relying upon one single deterministic future to use as its cost metric, without regard to its incredibly high margin of error demonstrated in the 100 stochastic runs. Fourth, PGE's risk metrics are fundamentally flawed for a number of reasons described above. Fifth, its scoring system is arbitrary and fragile. Sixth, PGE

[9] The earliest date is most likely to be the end of 2015, allowing time to procure replacement power if needed.

has not attempted to create an optimized portfolio based upon the information in its analysis, even though it pledged to do so at the beginning of the process. Seventh, PGE has not included the asymmetric risk of CO2 emissions in its analysis. Finally, PGE has narrowed down its choices so radically that there are in reality only 2-3 being considered.

Instead, NWEC offers our preferred Plan described in the previous section. We also urge the Commission to direct the Company to improve future IRPs to correct the many flaws pointed out in these comments.

Dated this fourteenth day of May, 2010

Respectfully submitted,

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Steven Weiss,
Senior Policy Associate,
NW Energy Coalition
steve@nwenergy.org
503-851-4054

BERNSTEINRESEARCH

**Hugh Wynne** (Senior Analyst) • hugh.wynne@bernstein.com • +1-212-823-2692
**Francois D. Broquin** • francois.broquin@bernstein.com • +1-212-756-4051
**Saurabh Singh** • saurabh.singh@bernstein.com • +1-212-756-4113

# U.S. Utilities: A Visit to Washington Finds Utility Lobbyists & Environmentalists Agreeing on the Grim Outlook for Coal

| Ticker | Rating | CUR | 3/1/2010 Closing Price | Target Price | TTM Rel. Perf. | EPS 2009A | EPS 2010E | EPS 2011E | P/E 2009A | P/E 2010E | P/E 2011E | Yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AEP | M | USD | 33.94 | 39.00 | -30.8% | 2.97 | 3.06 | 3.26 | 11.4 | 11.1 | 10.4 | 4.8% |
| D | M | USD | 38.30 | 38.00 | -24.9% | 3.27 | 3.28 | 3.21 | 11.7 | NM | 11.9 | 4.1% |
| DUK | M | USD | 16.49 | 15.00 | -29.4% | 1.22 | 1.26 | 1.32 | 13.5 | 13.1 | 12.5 | 5.6% |
| EIX | M | USD | 33.32 | 37.00 | -29.4% | 3.25 | 3.37 | 3.48 | 10.3 | 9.9 | 9.6 | 3.7% |
| EXC | M | USD | 44.46 | 45.00 | -57.6% | 4.12 | 3.79 | 4.25 | 10.8 | 11.7 | 10.5 | 4.7% |
| FE | O | USD | 39.07 | 49.00 | -60.0% | 3.77 | 3.45 | 4.43 | 10.4 | 11.3 | 8.8 | 5.6% |
| FPL | M | USD | 47.38 | 51.00 | 0.0% | 4.05 | 4.27 | 4.28 | 11.7 | 11.1 | 11.1 | 4.0% |
| PCG | O | USD | 42.04 | 49.00 | -41.8% | 3.21 | 3.42 | 3.68 | 13.1 | 12.3 | 11.4 | 4.0% |
| SPX | | | 1115.71 | | | 61.49 | 79.19 | 95.66 | 18.1 | 14.1 | 11.7 | 2.0% |

O – Outperform, M – Market-Perform, U – Underperform, N – Not Rated

## Highlights

- On a trip to Washington yesterday to meet with regulators, politicians, utility lobbyists and environmental groups, we found consensus on one point: EPA regulation of mercury and other air toxics will drive rapid and far-reaching changes within the utility sector, far outstripping the impact of regulatory standards for other air pollutants, including $CO_2$, $SO_2$ and NOx.
- The Edison Electric Institute (EEI), the power industry trade group, and the Natural Resources Defense Council (NRDC), a prominent environmental group, agree that EPA regulation of mercury and acid gases could require the installation of costly flue gas desulfurization equipment ($SO_2$ scrubbers) across the coal fired fleet, potentially forcing the early retirement of a significant portion of U.S. coal fired capacity.
- In October 2009 the EPA submitted to a consent decree that requires, first, that by March 2011 it publish proposed emissions standards for hazardous air pollutants from coal and oil fired power plants and, second, that by November 2011 it issue final emissions standards.
- Within three years of issuance of the final rule (i.e., by November 2014), the Clean Air Act stipulates that sources of hazardous air pollutants must comply with MACT standards. While one-year extensions may be granted on a case-by-case basis, 2015 may be thought as the year by which all U.S. coal fired fleet power plants must have installed maximum achievable control technology for hazardous air pollutants.
  - Referred to as "air toxics," these hazardous air pollutants include mercury and other toxic metals, such as arsenic, lead and selenium; acid gases such as hydrogen chloride, hydrogen fluoride, and hydrogen cyanide; and organic air pollutants including organic hydrocarbons and volatile organic compounds.
- The Clean Air Act limits the EPA's flexibility in setting MACT standards for hazardous air pollutants. Specifically, Section 112(d) of the Act stipulates that MACT standards shall not be less stringent than "the average emission limitation achieved by the best performing 12 percent of existing sources" of the hazardous pollutant.
  - Some of the highest levels of mercury emissions reductions have been achieved at coal fired power plants that have installed expensive flue gas desulfurization equipment ($SO_2$ scrubbers), a selective

**Hugh Wynne** (Senior Analyst) • hugh.wynne@bernstein.com • +1-212-823-2692

catalytic reduction system for NOx control, and a fabric filter for particulate matter. The EPA may find that this combination of expensive emissions controls constitutes MACT for mercury.

 - EEI and NRDC agree that a similar configuration of pollution controls is very likely to be deemed MACT for acid gases.

- The Electric Power Research Institute, a research institute sponsored by the power industry, estimates the cost of installing only an SO2 scrubber at a typical 500 MW Midwestern plant to be some \$420/kW – approximately the cost per kW of building a new gas turbine peaker.

**Investment Conclusion**

We have argued elsewhere (see our March 5, 2010 *Bernstein Commodities and Power Blast*, "Dark Days Ahead for Coal Clear the Skies for Gas") that the cost of installing scrubbers will be prohibitive at certain coal fired power plants, particularly those older, less efficient units whose high operating costs, consequently limited hours of operation, and short remaining useful lives make it impossible to recover the capital cost of a scrubber out of the future cash flows of the plant. Based on a comparison of the present value of future gross margin at these units with the capital cost of installing scrubbers, we estimate that such a requirement would likely result in the retirement of coal fired power plants that today generate 452 million MWh (24% of U.S. coal fired generation), while forcing plants that generate an additional 537 million MWh (29% of total) to install SO2 scrubbers.

**Details**

On a trip to Washington yesterday to meet with regulators, politicians, utility lobbyists and environmental groups, we found consensus on one point: EPA regulation of mercury and other air toxics will drive rapid and far-reaching changes within the utility sector, far outstripping the impact of regulatory standards for other air pollutants, including CO2, SO2 and NOx.

Our trip to Washington included visits with the Edison Electric Institute (EEI), the power industry trade group; Mr. Robert Meyers, former head of the EPA's Office of Air and Radiation and currently senior counsel at the law firm Crowell & Moring; the legislative assistants for energy policy to Senators Lindsay Graham (R-SC) and Lamar Alexander (R-TN); and John Walke, Senior Attorney and Clean Air Director at the Natural Resources Defense Council (NRDC). This note will summarize our findings.

*Air Toxics*

EEI and NRDC were in surprising agreement on one critical issue: that EPA regulation of air toxics could require the installation of costly flue gas desulfurization equipment (SO2 scrubbers) across the coal fired fleet, potentially forcing the early retirement of a significant portion of U.S. coal fired capacity.

Air toxics include three categories of hazardous air pollutants: mercury and other toxic metals, such as arsenic, lead and selenium; acid gases such as hydrogen chloride, hydrogen fluoride, and hydrogen cyanide; and organic air pollutants including organic hydrocarbons and volatile organic compounds.

In 2000, the EPA determined that emissions of mercury and other hazardous air pollutants from coal and oil fired power plants should be regulated. The Clean Air Act requires all sources of hazardous air pollutants to install "maximum achievable control technology," or MACT, and directs the EPA to promulgate the applicable MACT standards.

To date, however, the EPA has failed to stipulate MACT standards for the air toxics. This failure led the Natural Resources Defense Council and other environmental organizations to sue the EPA in December 2008. This suit was settled in October 2009 when the EPA submitted to a consent decree that requires, first, that by March 2011 it publish proposed emissions standards for hazardous air pollutants from coal and oil fired power plants and, second, that by November 2011 it issue final emissions standards.

**Hugh Wynne** (Senior Analyst) • hugh.wynne@bernstein.com • +1-212-823-2692

Within three years of issuance of the final rule (i.e., by November 2014), the Clean Air Act stipulates that sources of hazardous air pollutants must comply with MACT standards. Although a one-year extension may be granted on a case-by-case basis, 2015 may be thought as the year by which all U.S. coal fired fleet power plants must have installed maximum achievable control technology for air toxics.

The Clean Air Act limits the EPA's flexibility in setting MACT standards for hazardous air pollutants. Specifically, Section 112(d) of the Act stipulates that MACT standards shall not be less stringent than "the average emission limitation achieved by the best performing 12 percent of existing sources" of the hazardous pollutant. According to the United States General Accountability Office (GAO), "EPA 1999 data, the most recent available, indicate that about one-fourth of the industry achieved mercury reductions of 90 percent or more as a co-benefit of other pollution control devices," specifically a combination of a scrubber for sulfur dioxide control, a selective catalytic reduction system for nitrogen oxides control, and a fabric filter for particulate matter control. Under the Clean Air Act, therefore, this array of expensive emissions control devices may be deemed to be maximum achievable control technology for mercury. EEI and NRDC agree that a similar configuration of pollution controls is likely to be deemed MACT for acid gases. Because the Clean Air Act requires that all sources of hazardous air pollutants deploy maximum achievable control technology, a finding by the EPA that MACT for air toxics involves such a combination of pollution control devices would require all coal and oil fired power plants in the country to deploy such controls by 2015.

To secure relief from what are likely to be onerous EPA regulations, EEI supports a legislative amendment of the Clean Air Act. Senators Carper (D-DE) and Alexander (R-TN) have introduced such a bill, entitled the Clean Air Act Amendments of 2010, which would codify the regulation of SO2, NOx and mercury emissions from utility boilers. As it now stands, however, the Carper-Alexander bill offers little relief to the industry, as it calls for mercury emissions to be reduced by 90% by 2015. By engaging with Senators Carper and Alexander to craft the legislation, however, EEI hopes to mitigate the impact on the industry of the EPA's regulation of air toxics. The bill could be used, for example, to amend the Clean Air Act to remove acid gases from the list of hazardous air pollutants.

Surprisingly, given its potential impact, EEI is aware of no comprehensive analysis of the impact on the coal fired fleet of EPA regulation of air toxics, and particularly the requirement that the full range of pollution control devices (i.e., scrubbers, SCRs and baghouses) be deployed to control them. Within this group of required pollution controls, scrubbers are the critical component. The Electric Power Research Institute, a research institute sponsored by the power industry, estimates the cost of installing an SO2 scrubber at a typical 500 MW Midwestern plant to be some $420/kW – approximately the cost per kW of building a new gas turbine peaker. We have argued elsewhere (see our March 5, 2010 *Bernstein Commodities and Power Blast*, "Dark Days Ahead for Coal Clear the Skies for Gas") that the cost of installing scrubbers will be prohibitive at certain coal fired power plants, particularly those older, less efficient units whose high operating costs, consequently limited hours of operation, and short remaining useful lives make it impossible to recover the capital cost of a scrubber out of the future cash flows of the plant. Based on a comparison of the present value of future gross margin at these units with the capital cost of installing scrubbers, we estimate that such a requirement would likely result in the retirement of coal fired power plants that today generate 452 million MWh (24% of U.S. coal fired generation), while forcing plants that generate an additional 537 million MWh (29% of total) to install SO2 scrubbers.

### *SO2 and NOx*

From our discussions with EEI and NRDC, it was clear that the EPA regulation likely to have the most radical effect on the power industry would be a universal requirement to install SO2 scrubbers as the maximum achievable control technology for mercury or acid gases. Even in the absence of this threat, however, the industry will likely face significant challenges from new EPA regulations governing SO2. Both the EEI and the NRDC expect that by April or May the EPA will propose new regulatory standards for SO2 and NOx. These standards will replace the Clean Air Interstate Rule (CAIR), a set of regulations issued by the EPA in March 2005 to limit SO2 and NOx emissions in 25 states in the eastern U.S.

NOx contributes to the formation of ground-level ozone, a precursor of smog, and SO2 and NOx contribute to the formation of fine airborne particles. Inhaling these fine particles can cause or worsen respiratory diseases, such as emphysema, bronchitis, and asthma, and can aggravate existing heart disease, leading to increased hospitalization and premature death among at-risk populations, particularly the elderly. The EPA therefore adopted stringent National Ambient Air Quality Standards for fine particulate matter in 1997. Many areas remained in violation of the standard, however, so in March 2005 the EPA issued the Clean Air Interstate Rule. Compared with 2003 levels, CAIR mandated cuts in regional SO2 emissions of 45% by 2010 and 57% by 2015. NOx emissions were subject to cuts of 53% by 2009 and 61% by 2015, again measured against 2003 levels.

To achieve its targeted reduction in regional emissions, CAIR implemented a cap and trade scheme under which the EPA issued allowances to emit SO2 and NOx up to the targeted levels, and allocated these allowances to the coal fired power plants in the region. The recipients were free to trade the allowances; consequently, while the aggregate amount of allowances declined over time, individual generators could emit at or above historical levels provided they purchased the allowances necessary to cover their emissions. In July 2008, however the D.C. Circuit Court of Appeals vacated the Clean Air Interstate Rule (*North Carolina v. EPA*). The Court of Appeals found that CAIR's regional cap-and-trade system violated the "Good Neighbor Provision" of the Clean Air Act, which prohibits "any...type of emissions activity [that] contribute[s] significantly to nonattainment in, or interfere[s] with maintenance by, any other state with respect to any [National Ambient Air Quality Standard]" [42 U.S.C. Sec. 7410(a)(2)(D)]. Contrary to the Good Neighbor Provision, the Court found, CAIR permitted power plants in upwind states to continue to emit SO2 and NOx, provided they purchased the allowances to do so, and thus to contribute to air quality deterioration in downwind states. The Court therefore remanded the rule to the EPA, requiring it to measure each upwind state's contribution to downwind states' nonattainment of the air quality standards stipulated under the CAA, and to promulgate a revised regulation that would eliminate these contributions.

To comply with the Court's ruling, the EPA's new regulations must curtail the use of SO2 and NOx emissions allowances so as to ensure that the emissions of upwind states do not contribute to air quality deterioration in downwind states. As a result, generators will likely face significant constraints on their ability to comply with emissions limits through the purchase of allowances. To meet the new standards, therefore, it will likely be necessary for a larger number of coal fired generating units to install SO2 scrubbers.

In other respects, however, the EPA's new SO2 and NOx regulations are likely to resemble the rule they replace. EEI expects that EPA will maintain a 2015 target date in its revised regulations. In part this reflects the implementation schedule for the EPA's regulation of air toxics, under which 2015 is likely to be the first full year that utility boilers will be required to comply with the new emissions standards. Robert Meyers, former head of the EPA's Office of Air and Radiation and currently senior counsel at the law firm Crowell & Moring, also expects CAIR's 2015 target date to be preserved, likewise expecting that the EPA will seek to conform its schedule for SO2 emissions cuts to that for the air toxics. Finally, EPA is expected to continue to focus its regulations on the eastern United States, although Meyers believes that two additional states could be added to the western edge of the 25 state CAIR region.

Under CAIR, permitted emissions of SO2 were to be cut to 3.7 million tons in 2010 and 2.6 million tons in 2015 – the 2015 target representing a 50% reduction from 2008 levels of some 5.3 million tons. As discussed in our March 5, 2010 *Bernstein Commodities and Power Blast*, "Dark Days Ahead for Coal Clear the Skies for Gas," we estimate that to achieve the CAIR target of limiting SO2 emissions in the eastern United States to 2.6 million tons by 2015 it will be necessary (i) to retire unscrubbed coal fired power plants that today generate some 431 million MWh, or 23% of U.S. of coal-fired net generation, and (ii) to install

**Hugh Wynne** (Senior Analyst) • hugh.wynne@bernstein.com • +1-212-823-2692

SO2 scrubbers at power plants that today generate 254 million MWh, or a further 14% of U.S. coal fired generation. Given the age profile of the U.S. coal fired fleet, most of the retirements required to meet CAIR's SO2 target for 2015 are likely to occur through the natural attrition of older coal fired power plants over the next five years.

It is possible, however, that the EPA's regulations will be more stringent. Meyers believes it likely that the EPA will cut allowed emissions of SO2 in the CAIR states by a further 1.0 million tons, to 1.6 million tons in 2015, or 70% below 2008 levels. Such a regional target would imply a cut of approximately 50% in national emissions of SO2.

Even more stringent cuts in permitted emissions of SO2 are under consideration in Congress. As noted above, Senators Carper and Alexander have introduced a bill (the Clean Air Act Amendments of 2010) that would set national rather than regional emissions limits for SO2 and NOx and create a national cap and trade program for the two pollutants. Specifically, the bill would seek to cut national emissions of SO2 by 80 percent (from 7.6 million tons in 2008 to 1.5 million tons in 2018) and cut $NO_X$ emissions by 53 percent (from 3 million tons in 2008 to 1.6 million tons in 2015). The Carper-Alexander bill would also require mercury emissions to be cut by 90% no later than 2015. Cap and trade would not be allowed in respect of this pollutant, however; rather, utilities would be required to implement the maximum achievable control technology. The Carper-Alexander bill would thus do little to modify the EPA's current approach to the regulation of mercury. The bill's 80% target reduction in emissions of SO2, moreover, would imply almost as stringent a requirement for the installation of SO2 scrubbers as is likely to result from the implementation of the EPA's air toxics rule.

In summary, whether through the EPA's regulation of SO2 or through its regulation of air toxics, we estimate that power plants generating between 14% and 29% of the nation's coal fired generation will likely be required to install SO2 scrubbers. More importantly, we estimate that power plants accounting for a further 23% of U.S. coal fired generation are likely to be retired. Legislative action such as that contemplated by the Carper-Alexander bill seems unlikely to change this result.

# Coal Fleet Transition – Preliminary Data

## Coal Units by Age, Capacity and Emissions

U.S. Generating Units, 10 Year Increments

| Age of Units* | Generating Units | | Total Nameplate Capacity | | Total Net Generation Year 2008 | | Total $CO_2$ Emissions Year 2008 | | Total $SO_2$ Emissions Year 2008 | | Total $NO_x$ Emissions Year 2008 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | # | Percent of Total | GW | Percent of Total | GWH | Percent of Total | MTons | Percent of Total | Tons | Percent of Total | Tons | Percent of Total |
| 0-10 Years | 16 | 1.4% | 5.3 | 1.6% | 19,788 | 1.1% | 28.7 | 1.4% | 18,083 | 0.2% | 13,779 | 0.5% |
| 11-20 Years | 64 | 5.8% | 14.9 | 4.5% | 78,261 | 4.2% | 78.1 | 3.8% | 137,803 | 1.9% | 108,115 | 3.8% |
| 21-30 Years | 186 | 16.7% | 86.1 | 26.1% | 541,408 | 29.0% | 615.0 | 29.6% | 1,336,033 | 18.0% | 763,207 | 26.9% |
| 31-40 Years | 238 | 21.4% | 122.5 | 37.1% | 724,206 | 38.8% | 780.7 | 37.6% | 2,750,025 | 37.1% | 1,053,259 | 37.1% |
| 41-50 Years | 270 | 24.3% | 60.8 | 18.4% | 316,029 | 16.9% | 352.2 | 16.9% | 1,879,152 | 25.4% | 533,038 | 18.8% |
| 51-60 Years | 304 | 27.3% | 39.3 | 11.9% | 187,473 | 10.0% | 220.7 | 10.6% | 1,265,388 | 17.1% | 356,902 | 12.6% |
| 61-70 Years | 30 | 2.7% | 0.9 | 0.3% | 1,166 | 0.1% | 2.5 | 0.1% | 19,223 | 0.3% | 6,554 | 0.2% |
| > 70 Years | 4 | 0.4% | 0.0 | 0.01% | 5 | 0.0003% | 0.1 | 0.004% | 87 | 0.001% | 484 | 0.02% |
| Coal Unit Totals | 1,112 | 100.0% | 329.95 | 100.0% | 1,868,336 | 100.0% | 2077.9 | 100.0% | 7,405,794 | 100.0% | 2,835,339 | 100.0% |

Source: Ventyx, Inc.—EV Suite
MTon = million tons
* Does not include units that came online in 2009

February 16, 2010

Ms. Lisa Gorsuch lisa.gorsuch@state.or.us
Mr. Maury Galbraith maury.galbraith@state.or.us
Oregon Public Utilities Comm.
P.O. Box 2148
Salem, OR 97308-2148

Subject: LC 48 - PGE Integrated Resource Plan (2009)

Dear Ms. Gorsuch & Mr. Galbraith,

I am writing this as a family property owner in East Marion County. I am concerned about the impact of Portland General Electric's ("PGE") plan to add to the power grid by building a privately owned 500 kV transmission line from Boardman to Salem ("Cascade Crossing").

Last November, PGE submitted to the Oregon Public Utility Commission ("OPUC") a 2009 Integrated Resource Plan ("IRP") that includes a plan to incur $823 million in new capital costs for the Cascade Crossing project.[1]

There are a variety of reasons why OPUC should not acknowledge the Cascade Crossing portion of the IRP at this point in time.

**1. The IRP fails to provide data justifying public "need" for the project**

As an initial matter, PGE's IRP filing raises questions that relate back to PGE's recent 2008-09 rate case before OPUC. At that time, a PGE witness noted:

> Oregon has a longstanding commitment, as a matter of both law and policy, to pursue all cost-effective electricity savings and avoid unnecessary expenditure on generation and grid additions.

*See* UE 197/PGE/2100/Cavanagh/p. 5.

Part of the recent rate case involved PGE's increasing employment costs. However, "decoupling" was a primary issue – which involves using utility companies to influence energy conservation – while still allowing utilities to recapture lost profits when *less* energy is sold due to successful conservation efforts. PGE's CFO testified about PGE's lost profits when energy consumption drops. *See, e.g.,* UE 197/PGE/100/Piro/p. 19.

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[1] PGE 2009 Integrated Resource Plan, Table 8-4, page 197 (*See* p. 5, *infra.)*. PGE's projected total cost is reduced to $613 million if PGE builds a single-circuit versus double-circuit line. *Id.* at page 192. However, the IRP advocates the double-circuit line. *Id*. at page 199.

On January 22, 2009, OPUC agreed with PGE and issued an order approving PGE's request for a rate increase. At that time, OPUC stated:

> This translates to an approximate 7.6 percent rate increase overall for PGE's customers.

*See* UE 197, Order No. 09-020.

Less than one year after increasing the rates per KWh charged to PGE customers due, in part, to less energy consumption, PGE now submits an IRP that forecasts rapidly increasing energy demand.[2]

### a. PGE is overestimating growth

Although PGE's rates have increased on a regular basis, OPUC's statistics show that PGE experienced "zero" or even slightly negative energy growth from 1999 to 2008:

Portland General Electric Company
**TEN-YEAR SUMMARY**
**SELECTED STATISTICS**

| | Oregon Total[A] | | | | | Residential Averages in Oregon | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Average[D] | | | | Per Customer | |
| | Revenue From Retail Energy Customers | Energy Sold to Retail Customers (MWh)[B] | Delivery to ESS Customers (MWh)[B] | Number of Customers | Revenue Per kWh (Cents) | Number of Customers | Revenue Per kWh (Cents) | Revenue | kWh |
| 1999 | $973,326,617 | 19,258,992 | NA | 714,130 | 5.05 | 627,396 | 5.90 | $697 | 11,802 |
| 2000 | $1,038,204,376 | 19,872,544 | NA | 726,039 | 5.22 | 637,331 | 6.02 | $702 | 11,663 |
| 2001 | $1,096,155,658 | 19,040,188 | NA | 733,058 | 5.76 | 643,596 | 6.59 | $725 | 11,001 |
| 2002 | $1,384,322,786 | 18,771,884 | 0 | 741,949 | 7.37 | 649,674 | 8.05 | $874 | 10,864 |
| 2003 | $1,283,136,445 | 18,425,854 | 0 | 750,496 | 6.96 | 658,232 | 7.82 | $844 | 10,785 |
| 2004 | $1,262,880,182 [C] | 17,764,138 | 775,878 | 762,336 | 7.11 [E] | 668,830 | 8.05 | $875 | 10,870 |
| 2005 | $1,264,877,648 [C] | 17,540,047 | 1,213,906 | 775,533 | 7.21 [E] | 680,093 | 8.10 | $872 | 10,768 |
| 2006 | $1,361,008,240 [C] | 18,432,527 | 998,574 | 788,831 | 7.38 [E] | 691,931 | 8.29 | $907 | 10,944 |
| 2007 | $1,439,248,223 [C] | 17,461,742 | 2,164,687 | 800,587 | 8.24 [E] | 701,952 | 9.31 | $1,020 | 10,953 |
| 2008 | $1,483,317,814 | 17,575,806 | 2,417,316 | 811,315 | 8.44 | 710,991 | 9.62 | $1,066 | 11,080 |

[A] Oregon Total excludes Sales for Resale and Other Electric Revenue.
[B] 1 Megawatt hour (MWh) = 1,000 Kilowatt hours (kWh).
[C] Beginning January 1, 2004, certain commercial and industrial customers have chosen to be served by Electricity Service Suppliers (ESSs) for their energy needs.
These figures have been revised from prior reports to exclude revenues received by Portland General Electric from providing distribution services to ESS customers.
[D] These figures exclude ESS customers.
[E] These figures have been revised from prior reports to exclude Oregon revenue from ESS customers and MWh of ESS deliveries.

*See* 2008 Oregon Utility Statistics (Oregon PUC), p. 8.

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[2] The IRP predicts "…long term energy demand growth rates of 2.2% annually…."*See* PGE IRP, p. 32 ("Chapter Highlights").

The above OPUC statistics appear to reflect a successful state policy initiative that has reduced per capita energy consumption by the Oregon public over the last ten years. It is interesting that PGE's total number of Oregon customers increased while the total energy units sold (consumed by those customers) declined from 19,258,992 MWh in 1999 to 17,575,806 MWh in 2008. These statistics are evidence of no new "need" for another large-scale power transmission line from Boardman into the Willamette Valley.

Despite OPUC statistics that indicate otherwise, PGE is now suggesting to the public that energy demand is growing at rates not seen for decades:

> The Pacific Northwest continues to be one of the fastest growing regions in the country. Over the next 20 years, the demand for more electricity to serve Oregon customers will increase more than 45 percent, compared to 30 percent nationally.

*See* Portland General Electric, *Issues in Perspective*, November 2009.

Leaving aside how the above PGE representation conflicts with OPUC statistics, even one of PGE's competitors (PacifiCorp) is publishing information that contradicts PGE and indicates very little growth in energy demand for the next ten years:

**Table E.1 – Forecasted Sales Growth in Oregon**

| Sales – Gigawatt Hour (GWh) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Residential | Commercial | Industrial | Irrigation | Lighting | Other | Total |
| **2009** | 5,401 | 4,819 | 2,781 | 266 | 38 | 0 | **13,304** |
| **2010** | 5,439 | 4,836 | 2,816 | 265 | 37 | 0 | **13,393** |
| **2011** | 5,445 | 4,849 | 2,816 | 265 | 37 | 0 | **13,413** |
| **2012** | 5,476 | 4,872 | 2,853 | 265 | 37 | 0 | **13,504** |
| **2013** | 5,435 | 4,892 | 2,891 | 265 | 37 | 0 | **13,520** |
| **2014** | 5,413 | 4,924 | 2,915 | 265 | 37 | 0 | **13,554** |
| **2015** | 5,390 | 4,955 | 2,936 | 265 | 37 | 0 | **13,583** |
| **2016** | 5,388 | 4,999 | 2,961 | 265 | 37 | 0 | **13,651** |
| **2017** | 5,351 | 5,016 | 2,980 | 265 | 37 | 0 | **13,651** |
| **2018** | 5,376 | 5,040 | 3,000 | 265 | 37 | 0 | **13,718** |
| **Average Annual Growth Rate** | | | | | | | |
| **2009-2018** | (0.1)% | 0.5% | 0.8% | (0.0)% | (0.1)% | N/A | **0.3%** |

*See* LC 47, PacifiCorp 2008 Integrated Resource Plan, Vol. II, Appendix E. (May 28, 2009).

The difference between 2.2% (PGE) and 0.3% (PacifiCorp) in annual growth is material to the "need" for more transmission lines over the next 10 and 20 year time periods. In terms of simple math, it is the difference between 45% and 6% cumulative growth over a 20 year span.

Moreover, PGE was wrong ten years ago (in 1999) when it made exactly the same prediction:

> The demand for energy within PGE's service territory has experienced an average annual growth rate of approximately 2.5% over the last 10 years and retail demand is expected to continue this upward trend.

*See* PGE SEC 10-K filing (FY 1999), p. 7 of 46 (.txt format).

With respect to the short-term peak capacity loads that PGE puts on the system, the most current PGE 10-K filing (for FY 2008) indicates that PGE's peak loads have not increased for 10 years:

> PGE's all-time high net system load peak was 4,073 MW and occurred in *December 1998*.

*See* PGE SEC 10-K filing (FY 2008), p. 12 (emphasis added).

### b. PGE speculates about increasing BPA transmission charges

The IRP's financial cost-benefit analysis for the Cascade Crossing project is premised on the assumption that BPA will increase its future charges to PGE for use of BPA power lines – and those assumed future charges are likely to cover the $823 million capital cost of the project – thus justifying the project's cost.

However, one does not need to dig very deeply to discover that PGE's assumptions about higher BPA costs are based on another underlying assumption – PGE is assuming BPA will also build new power lines in the region; and BPA will then recoup the costs of BPA's not-yet-built lines by charging higher transmission rates to PGE and other private utilities. This last assumption might be better if PGE could point to issued construction permits that BPA presently has in place that makes BPA line construction more certain. However, BPA does not appear to have any permits in place.

As an example of the difficulty in obtaining these permits, BPA met resistance in Marion County about 7 or 8 years ago when it attempted to double the size of its transmission line easement beyond an easement grandfathered in before passage of Oregon's current land use zoning laws (designed to protect farm lands in the area). Instead of running afoul of Oregon's land use statutes that protect farm lands, BPA eventually decided to stay within a right of way granted in the 1950's by upgrading transmission capacity of its 230 kV single-circuit line to double-circuit (Mehama to Chemawa).

There is published information that indicates the cost of the BPA upgrade was about $12 million for upgrading the transmission capacity from Mehama to Chemawa. It is interesting that PGE has made no effort to upgrade its single-circuit 230 kV line to double-circuit within existing right of way easements in the same area. There are other single-circuit lines in the same area that could be upgraded as well.

The point is this: everyone involved with these issues probably agrees that the electrical transmission system may achieve a higher reliability factor if there is greater transmission capacity. However, no one is presently saying the system is unable to meet current needs. No one is building windmills in eastern Oregon unless they already know they can connect them to the power grid. There is no evidence that Oregon's energy consumption will increase by 45% in 20 years – but there is evidence it will not happen.

Growth in energy consumption is linked to population growth. It is wrong to build more power lines based on antiquated assumptions when historical data is now showing that growth rates are slowing everywhere.

According to the U.S. Census Bureau, Oregon's population grew about 8.8% from July 2000 to July 2008. *See* www.census.gov/popest/states/tables/NST-EST2008-01.xls. That is about 1% per year in average population growth during a period of time of relative economic prosperity, when only the front and back ends were subject to recessions. Reliable authorities are now starting to predict zero population growth in the United States in 20 or 30 years.

## 2. PGE underestimates right of way acquisition costs

In addition to failing to establish need, there are other reasons for not acknowledging the Cascade Crossing portion of the IRP, because of the likelihood of significant underestimates in other kinds of costs. The IRP breaks down total project cost as follows:

**Table 8-4: Cascade Crossing Capital Cost (Double-Circuit)**

| Capital Expenditures | Total |
|---|---|
| Substations | $201,500,000 |
| Transmission - Structures | $377,000,000 |
| Transmission - Conductors | $125,300,000 |
| Transmission - Capacitor Banks | $19,200,000 |
| Power Transformer at Bethel Sub | $25,800,000 |
| Land and Right of Way | $43,300,000 |
| Environmental Assessment & Studies | $4,600,000 |
| Permitting, Licenses & Fees | $2,600,000 |
| Project Management | $4,100,000 |
| Outside Legal Services | $1,000,000 |
| Preliminary Engineering | $500,000 |
| Public Relations & Education | $1,400,000 |
| Habitat Mitigation Costs | $10,200,000 |
| Contingency & Other Costs | $6,200,000 |
| Total Project Cost | $822,700,000 |

PGE 2009 Integrated Resource Plan, Table 8-4, page 197.

| | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | | **DR 39 Supp 1 Attach B** | | | | |
| 2 | **Attachment C (Shaded cells added by NWEC)** | **NPVRR for 100 Stochastic Iterations of Reference Case ($Millions)** | | | | |
| 3 | | | | | | |
| 4 | **Portfolio\Iteration No.** | **Deterministic Mean** | **Rank** | **Stochastic Mean** | **Rank** | **Standard Deviation** |
| 5 | Boardman through 2011 | 28,777 | 6 | 28,591 | 13 | 5,211 |
| 6 | Boardman through 2014 | 28,593 | 3 | 28,423 | 9 | 5,257 |
| 7 | Boardman through 2017 | 28,780 | 7 | 28,520 | 12 | 5,131 |
| 8 | Boardman through 2020 | 28,396 | 2 | 28,012 | 4 | 4,959 |
| 9 | Bridge to IGCC in WY | 30,828 | 16 | 30,553 | 16 | 3,386 |
| 10 | Bridge to Nuclear | 29,853 | 13 | 28,457 | 10 | 3,312 |
| 11 | Diverse Green with wind in WY | 30,825 | 15 | 29,208 | 14 | 3,235 |
| 12 | Diversified Green | 28,987 | 10 | 28,094 | 6 | 3,468 |
| 13 | Diversified Green with On-peak Energy Target | 28,971 | 9 | 27,964 | 3 | 3,427 |
| 14 | Diversified Thermal with Green | 28,674 | 5 | 27,945 | 2 | 4,435 |
| 15 | Diversified Thermal with Green w/o Boardman lease | 28,668 | 4 | 28,029 | 5 | 4,557 |
| 16 | Diversified Thermal with Wind | 28,891 | 8 | 28,150 | 7 | 4,329 |
| 17 | Market | 27,211 | 1 | 26,783 | 1 | 4,693 |
| 18 | Natural Gas | 29,027 | 11 | 28,217 | 8 | 4,635 |
| 19 | Oregon CO2 Goal | 30,375 | 14 | 29,447 | 15 | 3,409 |
| 20 | Wind | 29,288 | 12 | 28,490 | 11 | 3,417 |
| 21 | | | | | | |
| 22 | | | | | | |
| 23 | | Average differences | St. Dev. Of differences | Paired T-test | Difference is significant at 90% confidence? | Difference is significant at 95% confidence? |
| 24 | Diversified Thermal w Green w/o Boardman lease vs 2014 | $ (380) | $ 2,429 | (1.57) | Almost | no |
| 25 | 2014 vs 2020 | $ 410 | $ 7,700 | 0.53 | No | no |
| 26 | Diversified Thermal w Green w/o Boardman lease vs. 2020 | $ (16) | $ 7,278 | (0.02) | No | no |
| 27 | | | | | | |
| 28 | | | Is 2014 shutdown LESS costly than 2020? Yes = 1 | | | |
| 29 | | | Number of "Yes" answers out of 100 | | | |
| 30 | | | | | | |

| | G | H | I | J | K | L | M | N | O | P | Q | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | **NWEC Attachment C** | | | | | | | | | | |
| 2 | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | |
| 4 | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** |
| 5 | 28,561 | 27,104 | 23,978 | 32,935 | 33,180 | 30,246 | 28,038 | 34,147 | 31,472 | 22,874 | 30,643 | 33,236 |
| 6 | 32,955 | 26,905 | 23,772 | 32,750 | 28,359 | 30,007 | 27,802 | 34,064 | 31,321 | 22,673 | 30,460 | 33,039 |
| 7 | 32,803 | 27,126 | 23,969 | 33,096 | 28,536 | 30,266 | 28,068 | 33,951 | 31,373 | 22,836 | 30,624 | 33,170 |
| 8 | 33,404 | 28,871 | 21,938 | 37,591 | 30,995 | 22,586 | 26,813 | 26,424 | 23,410 | 37,182 | 34,480 | 22,944 |
| 9 | 33,276 | 29,471 | 27,567 | 33,057 | 30,342 | 31,483 | 30,199 | 34,315 | 32,468 | 26,779 | 31,742 | 33,347 |
| 10 | 31,080 | 27,367 | 25,529 | 30,930 | 28,198 | 29,346 | 28,045 | 32,179 | 30,286 | 24,789 | 29,547 | 31,057 |
| 11 | 31,742 | 28,115 | 26,347 | 31,552 | 28,917 | 30,018 | 28,787 | 32,836 | 30,979 | 25,649 | 30,273 | 31,725 |
| 12 | 27,788 | 26,849 | 25,040 | 30,586 | 30,784 | 29,033 | 27,734 | 31,887 | 30,060 | 24,323 | 29,185 | 30,827 |
| 13 | 30,692 | 26,766 | 24,959 | 30,480 | 27,671 | 28,946 | 27,630 | 31,695 | 29,934 | 24,203 | 29,144 | 30,690 |
| 14 | 31,758 | 26,668 | 24,005 | 31,508 | 27,872 | 29,376 | 27,556 | 32,793 | 30,398 | 23,021 | 29,652 | 31,797 |
| 15 | 31,885 | 26,695 | 24,001 | 31,670 | 27,968 | 29,403 | 27,552 | 32,903 | 30,591 | 22,989 | 29,741 | 31,953 |
| 16 | 28,039 | 26,835 | 24,323 | 31,574 | 31,808 | 29,499 | 27,753 | 32,884 | 30,572 | 23,365 | 29,757 | 31,848 |
| 17 | 30,768 | 25,407 | 22,607 | 30,488 | 26,727 | 28,319 | 26,375 | 31,887 | 29,352 | 21,614 | 28,503 | 30,909 |
| 18 | 32,330 | 26,969 | 24,097 | 32,033 | 28,204 | 29,819 | 27,895 | 33,264 | 30,792 | 23,036 | 30,107 | 32,321 |
| 19 | 29,048 | 28,073 | 26,456 | 31,849 | 31,965 | 30,153 | 28,863 | 33,015 | 31,361 | 25,852 | 37,270 | 31,972 |
| 20 | 31,104 | 27,206 | 25,500 | 30,882 | 28,145 | 29,433 | 28,168 | 32,181 | 30,452 | 24,805 | 29,534 | 31,160 |
| 21 | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | |
| 24 | $ (1,069) | $ (210) | $ 229 | $ (1,080) | $ (392) | $ (604) | $ (250) | $ (1,161) | $ (730) | $ 316 | $ (719) | $ (1,086) |
| 25 | (449) | (1,965) | 1,833 | (4,841) | (2,635) | 7,420 | 989 | 7,640 | 7,912 | (14,509) | (4,021) | 10,094 |
| 26 | 1,518 | 2,176 | (2,063) | 5,921 | 3,027 | (6,817) | (739) | (6,478) | (7,182) | 14,193 | 4,739 | (9,009) |
| 27 | | | | | | | | | | | | |
| 28 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| 29 | **50** | | | | | | | | | | | |
| 30 | | | | | | | | | | | | |

| | S | T | U | V | W | X | Y | Z | AA | AB | AC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** |
| 5 | 40,436 | 23,993 | 24,340 | 23,654 | 24,236 | 24,611 | 21,977 | 24,434 | 26,257 | 31,988 | 32,713 |
| 6 | 40,396 | 23,779 | 24,101 | 23,488 | 24,011 | 24,474 | 21,734 | 24,303 | 26,038 | 31,837 | 32,479 |
| 7 | 40,116 | 24,019 | 24,327 | 23,700 | 24,231 | 24,567 | 21,984 | 24,405 | 26,222 | 31,899 | 32,661 |
| 8 | 22,521 | 26,382 | 34,440 | 23,588 | 35,388 | 23,442 | 30,033 | 22,226 | 29,883 | 37,963 | 25,649 |
| 9 | 38,288 | 27,786 | 27,806 | 27,762 | 27,827 | 28,375 | 26,127 | 28,077 | 28,949 | 34,360 | 32,947 |
| 10 | 36,004 | 25,723 | 25,777 | 25,727 | 25,748 | 26,389 | 24,172 | 26,060 | 26,847 | 32,256 | 30,721 |
| 11 | 36,606 | 26,527 | 26,561 | 26,539 | 26,579 | 27,199 | 25,017 | 26,902 | 27,679 | 31,156 | 31,343 |
| 12 | 35,971 | 25,203 | 25,265 | 25,203 | 25,229 | 25,933 | 23,626 | 25,585 | 26,496 | 31,868 | 30,572 |
| 13 | 35,693 | 25,114 | 25,180 | 25,101 | 25,131 | 25,811 | 23,542 | 25,518 | 26,434 | 31,766 | 30,397 |
| 14 | 37,956 | 24,150 | 24,352 | 23,920 | 24,289 | 24,711 | 22,204 | 24,432 | 25,902 | 32,587 | 31,398 |
| 15 | 38,365 | 24,098 | 24,320 | 23,873 | 24,270 | 24,696 | 22,156 | 24,437 | 25,942 | 30,962 | 31,501 |
| 16 | 37,928 | 24,451 | 24,646 | 24,256 | 24,579 | 25,052 | 22,550 | 24,767 | 26,178 | 32,691 | 31,468 |
| 17 | 37,416 | 22,724 | 22,947 | 22,505 | 22,878 | 23,368 | 20,736 | 22,955 | 24,533 | 31,565 | 30,615 |
| 18 | 38,623 | 24,253 | 24,480 | 23,927 | 24,402 | 24,738 | 22,212 | 24,513 | 26,127 | 33,055 | 31,893 |
| 19 | 30,390 | 26,484 | 26,620 | 26,658 | 26,571 | 27,465 | 25,183 | 27,177 | 27,839 | 31,426 | 31,694 |
| 20 | 36,228 | 25,650 | 25,709 | 25,671 | 25,648 | 26,403 | 24,101 | 26,049 | 26,961 | 32,203 | 30,981 |
| 21 | | | | | | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | $ (2,031) | $ 318 | $ 219 | $ 386 | $ 260 | $ 222 | $ 422 | $ 134 | $ (96) | $ (875) | $ (978) |
| 25 | 17,875 | (2,603) | (10,339) | (101) | (11,378) | 1,032 | (8,299) | 2,078 | (3,845) | (6,126) | 6,831 |
| 26 | (15,844) | 2,285 | 10,120 | (285) | 11,118 | (1,255) | 7,877 | (2,212) | 3,941 | 7,001 | (5,853) |
| 27 | | | | | | | | | | | |
| 28 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| 29 | | | | | | | | | | | |
| 30 | | | | | | | | | | | |

| | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM | AN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | **24** | **25** | **26** | **27** | **28** | **29** | **30** | **31** | **32** | **33** | **34** |
| 5 | 28,098 | 33,823 | 23,350 | 29,125 | 35,822 | 30,477 | 23,423 | 27,437 | 35,392 | 37,972 | 38,282 |
| 6 | 27,896 | 33,801 | 23,147 | 28,981 | 35,803 | 30,288 | 23,217 | 27,310 | 35,269 | 37,979 | 38,295 |
| 7 | 28,061 | 33,766 | 23,324 | 28,960 | 35,555 | 30,306 | 23,458 | 27,358 | 35,332 | 37,698 | 38,079 |
| 8 | 26,035 | 24,921 | 21,972 | 31,787 | 22,233 | 22,806 | 28,347 | 37,915 | 27,286 | 29,284 | 21,540 |
| 9 | 30,095 | 32,628 | 27,128 | 30,930 | 35,351 | 31,449 | 27,250 | 30,013 | 34,970 | 36,918 | 37,193 |
| 10 | 27,989 | 30,482 | 25,148 | 28,849 | 33,168 | 29,251 | 25,231 | 27,880 | 32,725 | 34,720 | 35,071 |
| 11 | 28,765 | 32,810 | 25,954 | 29,660 | 33,937 | 30,038 | 26,085 | 28,711 | 33,251 | 35,313 | 35,731 |
| 12 | 27,725 | 30,106 | 24,618 | 28,566 | 33,085 | 29,017 | 24,645 | 27,474 | 32,642 | 34,667 | 34,999 |
| 13 | 27,598 | 30,026 | 24,484 | 28,438 | 32,807 | 28,890 | 24,527 | 27,409 | 32,439 | 34,356 | 34,808 |
| 14 | 27,478 | 30,802 | 23,461 | 28,466 | 34,108 | 29,350 | 23,575 | 27,076 | 33,739 | 36,046 | 36,345 |
| 15 | 27,595 | 32,759 | 23,442 | 28,550 | 34,388 | 29,532 | 23,552 | 27,122 | 33,962 | 36,445 | 36,646 |
| 16 | 27,713 | 30,883 | 23,781 | 28,669 | 34,223 | 29,530 | 23,867 | 27,311 | 33,787 | 36,102 | 36,405 |
| 17 | 26,299 | 29,726 | 22,151 | 27,273 | 33,347 | 28,226 | 22,207 | 25,717 | 33,014 | 35,470 | 35,559 |
| 18 | 27,772 | 31,280 | 23,482 | 28,755 | 34,575 | 29,724 | 23,624 | 27,335 | 34,269 | 36,541 | 36,888 |
| 19 | 29,073 | 33,100 | 26,079 | 29,830 | 34,511 | 30,374 | 26,075 | 28,708 | 33,849 | 36,040 | 36,348 |
| 20 | 28,170 | 30,423 | 25,059 | 28,955 | 33,405 | 29,388 | 25,057 | 27,867 | 33,020 | 34,980 | 35,326 |
| 21 | | | | | | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | $ (302) | $ (1,042) | $ 295 | $ (431) | $ (1,415) | $ (756) | $ 335 | $ (189) | $ (1,306) | $ (1,534) | $ (1,649) |
| 25 | 1,861 | 8,880 | 1,175 | (2,806) | 13,569 | 7,482 | (5,130) | (10,605) | 7,982 | 8,696 | 16,755 |
| 26 | (1,560) | (7,838) | (1,470) | 3,237 | (12,154) | (6,726) | 4,795 | 10,793 | (6,676) | (7,162) | (15,106) |
| 27 | | | | | | | | | | | |
| 28 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 |
| 29 | | | | | | | | | | | |
| 30 | | | | | | | | | | | |

| | AO | AP | AQ | AR | AS | AT | AU | AV | AW | AX | AY |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | **35** | **36** | **37** | **38** | **39** | **40** | **41** | **42** | **43** | **44** | **45** |
| 5 | 34,919 | 33,357 | 22,535 | 24,958 | 25,055 | 28,403 | 22,111 | 30,253 | 35,526 | 34,468 | 22,740 |
| 6 | 34,889 | 33,150 | 22,287 | 24,736 | 24,951 | 28,184 | 21,856 | 30,180 | 35,335 | 34,272 | 22,538 |
| 7 | 34,702 | 33,313 | 22,535 | 24,913 | 24,978 | 28,401 | 35,317 | 30,190 | 22,106 | 34,404 | 22,735 |
| 8 | 28,874 | 26,617 | 22,219 | 28,565 | 26,908 | 30,529 | 28,440 | 22,009 | 23,430 | 27,133 | 33,179 |
| 9 | 35,003 | 33,203 | 26,472 | 28,069 | 28,602 | 30,363 | 34,503 | 32,032 | 26,159 | 33,918 | 26,717 |
| 10 | 32,804 | 30,952 | 24,538 | 26,024 | 26,634 | 28,229 | 32,180 | 29,917 | 24,182 | 31,737 | 24,744 |
| 11 | 33,582 | 31,620 | 25,343 | 26,846 | 27,533 | 28,948 | 32,849 | 30,700 | 25,053 | 32,284 | 25,627 |
| 12 | 32,698 | 30,752 | 23,991 | 25,518 | 26,248 | 27,828 | 31,983 | 29,591 | 23,658 | 31,515 | 24,218 |
| 13 | 32,514 | 30,597 | 23,924 | 25,454 | 26,148 | 27,724 | 23,584 | 29,499 | 31,745 | 31,298 | 24,119 |
| 14 | 33,487 | 31,799 | 22,671 | 24,810 | 25,062 | 27,740 | 22,289 | 29,559 | 33,550 | 32,781 | 22,903 |
| 15 | 33,711 | 31,995 | 22,636 | 24,809 | 25,062 | 27,846 | 33,826 | 29,662 | 22,236 | 32,971 | 22,860 |
| 16 | 33,635 | 31,838 | 23,021 | 25,067 | 25,417 | 27,919 | 33,535 | 29,767 | 22,641 | 32,796 | 23,252 |
| 17 | 32,574 | 30,956 | 21,193 | 23,377 | 23,618 | 26,544 | 32,898 | 28,323 | 20,763 | 32,091 | 21,426 |
| 18 | 33,964 | 32,354 | 22,712 | 24,995 | 25,106 | 28,050 | 34,147 | 29,895 | 22,325 | 33,320 | 22,936 |
| 19 | 33,993 | 31,995 | 25,569 | 26,853 | 27,838 | 29,158 | 25,162 | 30,879 | 33,248 | 32,709 | 25,816 |
| 20 | 33,057 | 31,076 | 24,469 | 25,930 | 26,728 | 28,217 | 31,829 | 29,986 | 24,139 | 32,244 | 24,677 |
| 21 | | | | | | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | $ (1,178) | $ (1,155) | $ 349 | $ 73 | $ 111 | $ (338) | $ 11,970 | $ (518) | $ (13,099) | $ (1,301) | $ 323 |
| 25 | 6,015 | 6,532 | 69 | (3,829) | (1,957) | (2,344) | (6,584) | 8,171 | 11,905 | 7,140 | (10,641) |
| 26 | (4,837) | (5,378) | (418) | 3,756 | 1,845 | 2,683 | (5,385) | (7,653) | 1,194 | (5,839) | 10,319 |
| 27 | | | | | | | | | | | |
| 28 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| 29 | | | | | | | | | | | |
| 30 | | | | | | | | | | | |

| | AZ | BA | BB | BC | BD | BE | BF | BG | BH | BI | BJ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | **46** | **47** | **48** | **49** | **50** | **51** | **52** | **53** | **54** | **55** | **56** |
| 5 | 37,195 | 22,566 | 21,902 | 33,896 | 23,200 | 34,352 | 29,212 | 22,233 | 38,795 | 31,876 | 22,915 |
| 6 | 37,118 | 22,333 | 21,677 | 33,668 | 23,005 | 34,215 | 29,022 | 22,014 | 38,756 | 31,691 | 22,727 |
| 7 | 36,903 | 22,579 | 21,927 | 33,792 | 23,191 | 34,170 | 29,199 | 22,237 | 31,670 | 38,458 | 22,929 |
| 8 | 22,788 | 21,734 | 27,544 | 23,857 | 32,987 | 27,973 | 26,755 | 23,551 | 32,155 | 32,509 | 29,934 |
| 9 | 35,839 | 26,523 | 26,137 | 33,680 | 27,139 | 34,258 | 31,069 | 26,327 | 32,475 | 37,479 | 26,958 |
| 10 | 33,609 | 24,519 | 24,160 | 31,483 | 25,136 | 32,078 | 28,914 | 24,355 | 30,361 | 35,289 | 24,956 |
| 11 | 34,237 | 25,365 | 24,989 | 32,064 | 25,955 | 32,719 | 29,619 | 25,189 | 35,864 | 31,086 | 25,776 |
| 12 | 33,377 | 23,995 | 23,578 | 31,377 | 24,611 | 31,789 | 28,482 | 23,849 | 30,165 | 35,392 | 24,394 |
| 13 | 33,142 | 23,909 | 23,433 | 31,207 | 24,495 | 31,589 | 28,406 | 23,721 | 30,044 | 35,237 | 24,275 |
| 14 | 35,041 | 22,743 | 22,218 | 32,325 | 23,378 | 32,818 | 28,596 | 22,469 | 36,678 | 30,656 | 23,127 |
| 15 | 35,407 | 22,698 | 22,153 | 32,480 | 23,349 | 33,053 | 28,603 | 22,420 | 37,025 | 30,803 | 23,090 |
| 16 | 35,010 | 23,061 | 22,550 | 32,426 | 23,713 | 32,883 | 28,740 | 22,809 | 30,844 | 36,790 | 23,454 |
| 17 | 34,384 | 21,253 | 20,846 | 31,507 | 21,988 | 31,991 | 27,438 | 21,754 | 29,568 | 35,843 | 21,080 |
| 18 | 35,589 | 22,800 | 22,192 | 32,861 | 23,404 | 33,292 | 28,951 | 22,474 | 31,118 | 37,292 | 23,121 |
| 19 | 34,849 | 25,421 | 25,041 | 32,514 | 26,042 | 33,101 | 29,694 | 25,377 | 36,721 | 31,392 | 25,880 |
| 20 | 33,595 | 24,455 | 24,021 | 31,775 | 25,066 | 32,070 | 28,845 | 24,321 | 30,564 | 35,801 | 24,838 |
| 21 | | | | | | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | $ (1,711) | $ 364 | $ 476 | $ (1,189) | $ 344 | $ (1,162) | $ (419) | $ 406 | $ (1,731) | $ (888) | $ 363 |
| 25 | 14,330 | 600 | (5,867) | 9,812 | (9,982) | 6,242 | 2,267 | (1,537) | 6,601 | (818) | (7,207) |
| 26 | (12,620) | (964) | 5,391 | (8,623) | 9,638 | (5,080) | (1,848) | 1,131 | (4,870) | 1,706 | 6,844 |
| 27 | | | | | | | | | | | |
| 28 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| 29 | | | | | | | | | | | |
| 30 | | | | | | | | | | | |

| | BK | BL | BM | BN | BO | BP | BQ | BR | BS | BT | BU |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | **57** | **58** | **59** | **60** | **61** | **62** | **63** | **64** | **65** | **66** | **67** |
| 5 | 27,446 | 27,341 | 23,695 | 38,379 | 35,418 | 23,224 | 22,845 | 27,101 | 35,556 | 23,893 | 36,375 |
| 6 | 27,249 | 27,210 | 23,500 | 38,290 | 35,224 | 23,057 | 22,659 | 26,971 | 35,483 | 23,672 | 36,388 |
| 7 | 27,364 | 27,160 | 23,708 | 38,057 | 35,162 | 23,242 | 22,835 | 27,010 | 35,228 | 23,923 | 36,225 |
| 8 | 27,773 | 33,347 | 30,717 | 22,527 | 30,150 | 32,621 | 39,162 | 23,709 | 23,947 | 23,397 | 23,850 |
| 9 | 29,574 | 29,603 | 27,513 | 37,033 | 34,696 | 27,215 | 26,844 | 29,334 | 34,614 | 27,577 | 36,198 |
| 10 | 27,527 | 27,579 | 25,496 | 34,819 | 32,654 | 25,155 | 24,834 | 27,276 | 32,377 | 25,504 | 34,056 |
| 11 | 28,299 | 28,392 | 26,329 | 35,460 | 33,033 | 26,018 | 25,668 | 28,153 | 33,304 | 26,305 | 34,729 |
| 12 | 27,096 | 27,238 | 25,009 | 34,861 | 32,223 | 24,641 | 24,323 | 26,939 | 32,569 | 24,937 | 33,827 |
| 13 | 26,950 | 27,070 | 24,910 | 34,624 | 32,018 | 24,538 | 24,188 | 26,816 | 32,365 | 24,867 | 33,646 |
| 14 | 26,909 | 26,756 | 23,854 | 36,238 | 33,607 | 23,420 | 23,052 | 26,504 | 33,660 | 24,016 | 34,837 |
| 15 | 26,984 | 26,887 | 23,811 | 36,593 | 33,819 | 23,392 | 23,021 | 26,616 | 33,994 | 23,953 | 35,121 |
| 16 | 27,103 | 27,046 | 24,169 | 36,312 | 33,598 | 23,740 | 23,379 | 26,763 | 33,773 | 24,300 | 34,928 |
| 17 | 25,704 | 25,554 | 22,436 | 35,538 | 32,874 | 21,975 | 21,710 | 25,237 | 22,584 | 32,805 | 33,962 |
| 18 | 27,165 | 26,887 | 23,920 | 36,822 | 34,147 | 23,458 | 23,045 | 26,692 | 24,146 | 34,180 | 35,319 |
| 19 | 28,397 | 28,850 | 26,437 | 36,275 | 33,423 | 26,101 | 25,823 | 28,517 | 34,114 | 26,176 | 35,188 |
| 20 | 27,450 | 27,657 | 25,468 | 35,221 | 32,498 | 25,093 | 24,772 | 27,358 | 25,354 | 32,937 | 34,106 |
| 21 | | | | | | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | $ (265) | $ (323) | $ 312 | $ (1,697) | $ (1,406) | $ 335 | $ 362 | $ (355) | $ (1,490) | $ 282 | $ (1,267) |
| 25 | (524) | (6,137) | (7,217) | 15,762 | 5,074 | (9,564) | (16,503) | 3,262 | 11,536 | 275 | 12,538 |
| 26 | 789 | 6,460 | 6,906 | (14,066) | (3,668) | 9,230 | 16,141 | (2,907) | (10,046) | (556) | (11,271) |
| 27 | | | | | | | | | | | |
| 28 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| 29 | | | | | | | | | | | |
| 30 | | | | | | | | | | | |

| | BV | BW | BX | BY | BZ | CA | CB | CC | CD | CE | CF |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | **68** | **69** | **70** | **71** | **72** | **73** | **74** | **75** | **76** | **77** | **78** |
| 5 | 23,856 | 30,811 | 22,533 | 30,449 | 39,193 | 23,205 | 28,666 | 26,118 | 26,533 | 25,516 | 22,229 |
| 6 | 23,656 | 30,663 | 22,307 | 30,287 | 39,125 | 22,958 | 28,592 | 25,924 | 26,421 | 25,406 | 22,009 |
| 7 | 23,825 | 30,726 | 22,573 | 30,406 | 38,921 | 23,178 | 28,696 | 26,090 | 26,488 | 25,429 | 22,249 |
| 8 | 24,235 | 21,693 | 24,011 | 25,711 | 31,395 | 32,244 | 27,601 | 33,164 | 22,942 | 28,434 | 34,691 |
| 9 | 27,602 | 31,918 | 26,588 | 31,754 | 26,971 | 37,613 | 31,183 | 28,893 | 29,643 | 28,829 | 26,444 |
| 10 | 25,581 | 29,751 | 24,609 | 29,615 | 24,945 | 35,449 | 29,080 | 26,788 | 27,556 | 26,846 | 24,486 |
| 11 | 26,438 | 30,503 | 25,442 | 30,322 | 36,003 | 25,739 | 29,825 | 27,558 | 28,375 | 27,728 | 25,295 |
| 12 | 25,149 | 29,437 | 24,091 | 29,361 | 35,482 | 24,370 | 28,662 | 26,305 | 27,114 | 26,403 | 23,926 |
| 13 | 25,044 | 29,234 | 23,971 | 29,255 | 24,254 | 35,225 | 28,590 | 26,248 | 26,987 | 26,276 | 23,804 |
| 14 | 23,931 | 29,834 | 22,760 | 29,595 | 23,298 | 36,997 | 28,344 | 25,853 | 26,410 | 25,394 | 22,522 |
| 15 | 23,919 | 29,993 | 22,710 | 29,689 | 37,346 | 23,264 | 28,420 | 25,878 | 26,435 | 25,444 | 22,460 |
| 16 | 24,278 | 29,962 | 23,105 | 29,756 | 37,071 | 23,588 | 28,569 | 26,086 | 26,675 | 25,712 | 22,862 |
| 17 | 22,506 | 28,881 | 21,364 | 28,504 | 36,363 | 21,902 | 27,108 | 24,506 | 25,087 | 24,046 | 21,125 |
| 18 | 23,960 | 30,193 | 22,775 | 30,000 | 37,601 | 23,354 | 28,627 | 26,108 | 26,542 | 25,444 | 22,500 |
| 19 | 26,668 | 30,685 | 25,605 | 30,559 | 36,949 | 25,801 | 29,867 | 27,516 | 28,420 | 27,968 | 25,493 |
| 20 | 25,623 | 29,769 | 24,558 | 29,768 | 35,825 | 24,797 | 29,067 | 26,697 | 27,531 | 26,836 | 24,391 |
| 21 | | | | | | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | $ 263 | $ (671) | $ 403 | $ (598) | $ (1,779) | $ 306 | $ (172) | $ (45) | $ 14 | $ 38 | $ 450 |
| 25 | (580) | 8,970 | (1,704) | 4,576 | 7,729 | (9,286) | 991 | (7,240) | 3,479 | (3,028) | (12,682) |
| 26 | 317 | (8,299) | 1,301 | (3,978) | (5,951) | 8,980 | (819) | 7,286 | (3,493) | 2,989 | 12,232 |
| 27 | | | | | | | | | | | |
| 28 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 |
| 29 | | | | | | | | | | | |
| 30 | | | | | | | | | | | |

| | CG | CH | CI | CJ | CK | CL | CM | CN | CO | CP | CQ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | **79** | **80** | **81** | **82** | **83** | **84** | **85** | **86** | **87** | **88** | **89** |
| 5 | 32,251 | 22,545 | 38,970 | 27,932 | 30,297 | 21,905 | 27,333 | 29,314 | 26,913 | 22,580 | 29,136 |
| 6 | 32,069 | 22,328 | 38,966 | 27,843 | 30,086 | 21,655 | 27,105 | 29,124 | 26,665 | 22,372 | 28,914 |
| 7 | 32,249 | 22,538 | 38,760 | 27,767 | 30,101 | 21,901 | 27,341 | 29,313 | 26,912 | 22,607 | 29,059 |
| 8 | 29,534 | 23,098 | 26,926 | 34,660 | 36,958 | 37,116 | 33,990 | 32,527 | 22,157 | 24,586 | 24,595 |
| 9 | 33,328 | 26,538 | 37,586 | 30,643 | 31,331 | 26,075 | 29,822 | 30,957 | 29,502 | 26,583 | 30,709 |
| 10 | 31,090 | 24,566 | 35,493 | 28,638 | 29,190 | 24,112 | 27,690 | 28,838 | 27,369 | 24,596 | 28,588 |
| 11 | 31,727 | 25,360 | 36,116 | 29,507 | 29,918 | 24,942 | 28,447 | 29,498 | 28,141 | 25,397 | 29,355 |
| 12 | 30,862 | 24,011 | 35,521 | 28,253 | 28,834 | 23,579 | 27,219 | 28,404 | 26,960 | 24,074 | 28,214 |
| 13 | 30,720 | 23,930 | 35,272 | 28,137 | 28,571 | 23,472 | 27,141 | 28,297 | 26,870 | 23,982 | 28,128 |
| 14 | 31,310 | 22,748 | 36,912 | 27,578 | 29,219 | 22,158 | 26,979 | 28,639 | 26,616 | 22,772 | 28,382 |
| 15 | 31,392 | 22,707 | 37,277 | 27,676 | 29,413 | 22,105 | 26,984 | 28,663 | 26,598 | 22,738 | 28,442 |
| 16 | 31,436 | 23,072 | 36,979 | 27,872 | 29,379 | 22,502 | 27,126 | 28,771 | 26,821 | 23,113 | 28,536 |
| 17 | 30,371 | 21,347 | 36,261 | 26,206 | 28,270 | 20,726 | 25,709 | 27,570 | 25,361 | 21,361 | 27,232 |
| 18 | 31,723 | 22,787 | 37,498 | 27,739 | 29,537 | 22,147 | 27,264 | 29,018 | 26,902 | 22,791 | 28,754 |
| 19 | 32,002 | 25,501 | 36,966 | 29,784 | 30,245 | 25,073 | 28,350 | 29,513 | 28,033 | 25,592 | 29,432 |
| 20 | 31,250 | 24,465 | 35,882 | 28,672 | 29,142 | 24,057 | 27,587 | 28,759 | 27,373 | 24,547 | 28,565 |
| 21 | | | | | | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | $ (678) | $ 378 | $ (1,689) | $ (168) | $ (673) | $ 450 | $ (121) | $ (461) | $ (67) | $ 366 | $ (472) |
| 25 | 2,536 | (769) | 12,040 | (6,816) | (6,872) | (15,461) | (6,885) | (3,402) | 4,509 | (2,213) | 4,320 |
| 26 | (1,858) | 391 | (10,351) | 6,984 | 7,545 | 15,011 | 7,006 | 3,863 | (4,441) | 1,848 | (3,848) |
| 27 | | | | | | | | | | | |
| 28 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 29 | | | | | | | | | | | |
| 30 | | | | | | | | | | | |

| | CR | CS | CT | CU | CV | CW | CX | CY | CZ | DA | DB |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | **90** | **91** | **92** | **93** | **94** | **95** | **96** | **97** | **98** | **99** | **100** |
| 5 | 31,083 | 28,868 | 22,297 | 23,885 | 27,325 | 34,332 | 23,215 | 22,021 | 27,884 | 24,159 | 33,790 |
| 6 | 30,913 | 28,640 | 22,056 | 23,656 | 27,093 | 23,017 | 34,280 | 21,772 | 27,738 | 23,998 | 33,581 |
| 7 | 31,019 | 28,859 | 22,315 | 23,848 | 27,351 | 34,069 | 23,174 | 22,035 | 27,863 | 24,185 | 33,709 |
| 8 | 27,796 | 21,803 | 29,666 | 34,578 | 33,679 | 22,424 | 36,024 | 22,261 | 21,630 | 33,096 | 22,840 |
| 9 | 31,970 | 30,570 | 26,403 | 27,422 | 29,644 | 26,973 | 34,450 | 26,169 | 30,200 | 28,086 | 33,481 |
| 10 | 29,802 | 28,420 | 24,370 | 25,380 | 27,524 | 24,993 | 32,310 | 24,199 | 28,078 | 26,091 | 31,250 |
| 11 | 30,534 | 29,152 | 25,224 | 26,188 | 28,243 | 33,100 | 25,843 | 25,024 | 28,837 | 26,933 | 31,862 |
| 12 | 29,467 | 28,054 | 23,838 | 24,884 | 27,099 | 24,493 | 32,073 | 23,638 | 27,739 | 25,614 | 31,040 |
| 13 | 29,310 | 28,000 | 23,738 | 24,769 | 26,967 | 24,402 | 31,846 | 23,570 | 27,679 | 25,497 | 30,835 |
| 14 | 30,064 | 28,173 | 22,539 | 23,895 | 26,910 | 23,275 | 32,845 | 22,236 | 27,462 | 24,349 | 32,180 |
| 15 | 30,174 | 28,204 | 22,481 | 23,883 | 26,907 | 33,161 | 23,276 | 22,185 | 27,496 | 24,324 | 32,386 |
| 16 | 30,145 | 28,337 | 22,874 | 24,208 | 27,085 | 23,607 | 32,939 | 22,592 | 27,677 | 24,684 | 32,222 |
| 17 | 29,124 | 26,973 | 21,115 | 22,496 | 25,774 | 31,913 | 21,801 | 20,746 | 26,180 | 22,937 | 31,438 |
| 18 | 30,471 | 28,559 | 22,570 | 23,996 | 27,195 | 33,236 | 23,320 | 22,251 | 27,772 | 24,374 | 32,704 |
| 19 | 30,711 | 29,174 | 25,259 | 26,279 | 28,300 | 26,068 | 33,509 | 25,207 | 28,891 | 27,073 | 32,268 |
| 20 | 29,791 | 28,435 | 24,293 | 25,324 | 27,495 | 32,357 | 24,952 | 24,117 | 28,169 | 26,083 | 31,353 |
| 21 | | | | | | | | | | | |
| 22 | | | | | | | | | | | |
| 23 | | | | | | | | | | | |
| 24 | $ (739) | $ (436) | $ 425 | $ 227 | $ (186) | $ 10,144 | $ (11,003) | $ 413 | $ (242) | $ 325 | $ 164 |
| 25 | 3,117 | 6,838 | (7,610) | (10,922) | (6,586) | 593 | (1,744) | (489) | 6,108 | (9,098) | 10,741 |
| 26 | (2,378) | (6,402) | 7,185 | 10,695 | 6,772 | (10,737) | 12,747 | 76 | (5,866) | 8,772 | (9,547) |
| 27 | | | | | | | | | | | |
| 28 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |
| 29 | | | | | | | | | | | |
| 30 | | | | | | | | | | | |

**Scenario 1**

| Year | Portfolio Cost | Pct Change | Delta1 | Delta (detrended) |
|---|---|---|---|---|
| 1 | 100.00 | NA | NA | NA |
| 2 | 102.00 | 2.00% | 2.00 | (0.17) |
| 3 | 104.04 | 2.00% | 2.04 | (0.13) |
| 4 | 106.12 | 2.00% | 2.08 | (0.09) |
| 5 | 108.24 | 2.00% | 2.12 | (0.05) |
| 6 | 110.41 | 2.00% | 2.16 | (0.00) |
| 7 | 112.62 | 2.00% | 2.21 | 0.04 |
| 8 | 114.87 | 2.00% | 2.25 | 0.08 |
| 9 | 117.17 | 2.00% | 2.30 | 0.13 |
| 10 | 119.51 | 2.00% | 2.34 | 0.18 |
| | | average | 2.17 | |

Portfolio Variance **0.013811998**

**Scenario 2**

| Year | Portfolio Cost | Pct Change | Delta1 | Delta (detrended) |
|---|---|---|---|---|
| 1 | 100.00 | NA | NA | NA |
| 2 | 104.00 | 4.00% | 4.00 | 1.83 |
| 3 | 104.00 | 0.00% | - | (2.17) |
| 4 | 108.16 | 4.00% | 4.16 | 1.99 |
| 5 | 108.16 | 0.00% | - | (2.17) |
| 6 | 112.49 | 4.00% | 4.33 | 2.16 |
| 7 | 112.49 | 0.00% | - | (2.17) |
| 8 | 116.99 | 4.00% | 4.50 | 2.33 |
| 9 | 116.99 | 0.00% | - | (2.17) |
| | | average | 2.12 | |

Portfolio Variance **5.171932607**

**Scenario 3**

| Year | Portfolio Cost | Pct Change | Delta1 | Delta2 |
|---|---|---|---|---|
| 1 | 100.00 | NA | NA | NA |
| 2 | 100.00 | 0.00% | - | (2.17) |
| 3 | 104.00 | 4.00% | 4.00 | 1.83 |
| 4 | 104.00 | 0.00% | - | (2.17) |
| 5 | 108.16 | 4.00% | 4.16 | 1.99 |
| 6 | 108.16 | 0.00% | - | (2.17) |
| 7 | 112.49 | 4.00% | 4.33 | 2.16 |
| 8 | 112.49 | 0.00% | - | (2.17) |
| 9 | 116.99 | 4.00% | 4.50 | 2.33 |
| | | average | 2.12 | |

Portfolio Variance **5.171932607**

Inputs

| | Exp Cost | Risk Durabilty | Worst 4 Avg | Worst 4 vs Ref Case |
|---|---|---|---|---|
| *Original Weights* | 50.00% | 10.00% | 5.00% | 5.00% |
| New Weights | 50.00% | 10.00% | 5.00% | 5.00% |
| *Normalized* | 50.01% | 10.00% | 5.00% | 5.00% |

Addendum stochastic IRP Weighted Scores

| Portfolios | Stoch. Cost score | Risk Durabilty | Worst 4 Avg | Worst 4 vs Ref Case |
|---|---|---|---|---|
| 1 Market | 50 | 10 | 2.7 | 0 |
| 2 Natural Gas | 31.0 | 5.1 | 3.4 | 2.9 |
| 3 Wind | 27.4 | 5.9 | 4.7 | 4.6 |
| 4 Diversified Green | 32.6 | 6.2 | 4.9 | 4.5 |
| 5 Diversified Thermal with wind | 31.9 | 5.1 | 4.0 | 3.3 |
| 6 Bridge to IGCC in WY | 0.0 | 0.0 | 0.0 | 3.5 |
| 7 Bridge to nuclear | 27.8 | 1.0 | 4.1 | 4.6 |
| 8 Green w/On-peak Energy Target | 34.3 | 6.4 | 5.0 | 4.5 |
| 9 Diversified Thermal with Green | 34.6 | 6.4 | 4.0 | 3.1 |
| 10 Boardman through 2014 | 28.2 | 8.7 | 3.8 | 2.8 |
| 11 Oregon CO2 Goal | 14.7 | 1.8 | 3.9 | 5.0 |
| 12 Boardman through 2011 | 26.0 | 5.4 | 3.6 | 2.9 |
| 13 Boardman through 2020 | 33.7 | 9.7 | 4.2 | 3.0 |
| 14 Diverse Green with wind in WY | 17.8 | 0.8 | 2.9 | 4.4 |
| 15 Diversified Thermal w/Green w/o Lease | 33.5 | 8.7 | 4.0 | 3.2 |
| 16 Boardman through 2017 | 27.0 | 4.9 | 3.6 | 2.9 |

New Weighted Scores

| Portfolios | Stoch. Cost score | Risk Durabilty | Worst 4 Avg | 'orst 4 vs Ref Cas |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| ***1 Market*** | 50.0 | 10.0 | 2.7 | 0.0 |
| ***2 Natural Gas*** | 31.0 | 5.1 | 3.4 | 2.9 |
| ***3 Wind*** | 27.4 | 5.9 | 4.7 | 4.6 |
| ***4 Diversified Green*** | 32.6 | 6.2 | 4.9 | 4.5 |
| ***5 Diversified Thermal with wind*** | 31.9 | 5.1 | 4.0 | 3.3 |
| ***6 Bridge to IGCC in WY*** | 0.0 | 0.0 | 0.0 | 3.5 |
| ***7 Bridge to nuclear*** | 27.8 | 1.0 | 4.1 | 4.6 |
| ***8 Green w/On-peak Energy Target*** | 34.3 | 6.4 | 5.0 | 4.5 |
| ***9 Diversified Thermal with Green*** | 34.6 | 6.4 | 4.0 | 3.1 |
| ***10 Boardman through 2014*** | 28.2 | 8.7 | 3.8 | 2.8 |
| ***11 Oregon CO2 Goal*** | 14.7 | 1.8 | 3.9 | 5.0 |
| ***12 Boardman through 2011*** | 26.0 | 5.4 | 3.6 | 2.9 |
| ***13 Boardman through 2020*** | 33.7 | 9.7 | 4.2 | 3.0 |
| ***14 Diverse Green with wind in WY*** | 17.8 | 0.8 | 2.9 | 4.4 |
| ***15 Diversified Thermal w/Green w/o Lease*** | 33.5 | 8.7 | 4.0 | 3.2 |
| ***16 Boardman through 2017*** | 27.0 | 4.9 | 3.6 | 2.9 |

| Tail Var | Tail Var less Mean | Year to Year Variation | Reliability | Technology H-H | Fuel H-H | Total |
|---|---|---|---|---|---|---|
| 3.33% | 3.33% | 3.33% | 15.00% | 2.50% | 2.50% | 99.99% |
| 3.33% | 3.33% | 3.33% | 15.00% | 2.50% | 2.50% | 99.99% |
| 3.33% | 3.33% | 3.33% | 15.00% | 2.50% | 2.50% | 100.00% |

| Tail Var | Tail Var less Mean | Year to Year Variation | Reliability | Technology H-H | Fuel H-H | Total |
|---|---|---|---|---|---|---|
| 2.5 | 1 | 0.6 | 0 | 2.2 | 0 | 69.000 |
| 1.3 | 1.2 | 2.0 | 13.2 | 0.5 | 1.0 | 61.600 |
| 2.8 | 3.0 | 0.0 | 12.0 | 0.0 | 1.3 | 61.700 |
| 3.1 | 2.9 | 1.4 | 12.2 | 1.1 | 1.8 | 70.700 |
| 1.8 | 1.6 | 1.7 | 12.9 | 1.1 | 1.2 | 64.600 |
| 1.1 | 3.1 | 2.5 | 10.1 | 1.7 | 0.5 | 22.500 |
| 3.1 | 3.2 | 3.1 | 11.8 | 2.5 | 1.7 | 62.900 |
| 3.3 | 3.0 | 1.6 | 13.1 | 1.1 | 2.1 | 74.400 |
| 1.8 | 1.4 | 2.0 | 13.1 | 1.4 | 1.2 | 69.000 |
| 0.0 | 0.0 | 1.3 | 14.0 | 0.1 | 0.7 | 59.600 |
| 1.8 | 2.9 | 1.2 | 12.9 | 1.0 | 2.5 | 47.700 |
| 0.0 | 0.1 | 1.3 | 15.0 | 0.1 | 0.4 | 54.800 |
| 1.0 | 0.7 | 1.4 | 13.4 | 0.1 | 1.2 | 68.400 |
| 2.5 | 3.3 | 3.3 | 12.5 | 1.3 | 1.8 | 50.600 |
| 1.5 | 1.2 | 1.9 | 13.6 | 1.2 | 1.2 | 70.000 |
| 0.2 | 0.3 | 1.4 | 14.0 | 0.1 | 1.0 | 55.400 |

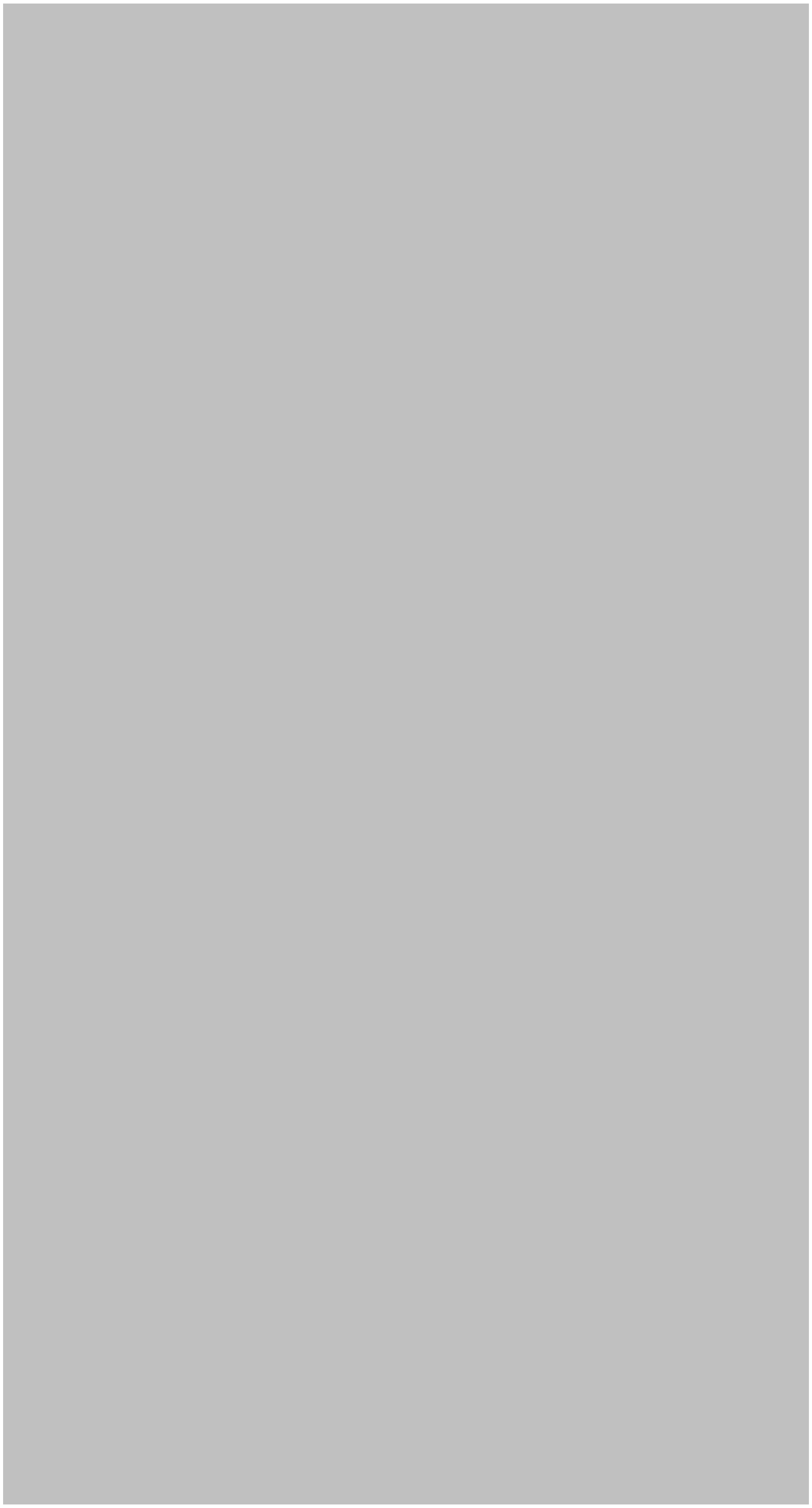
| Tail Var | Tail Var less Mean | to Year Varia | Reliability | Technology H-H | Fuel H-H | Total |
|---|---|---|---|---|---|---|

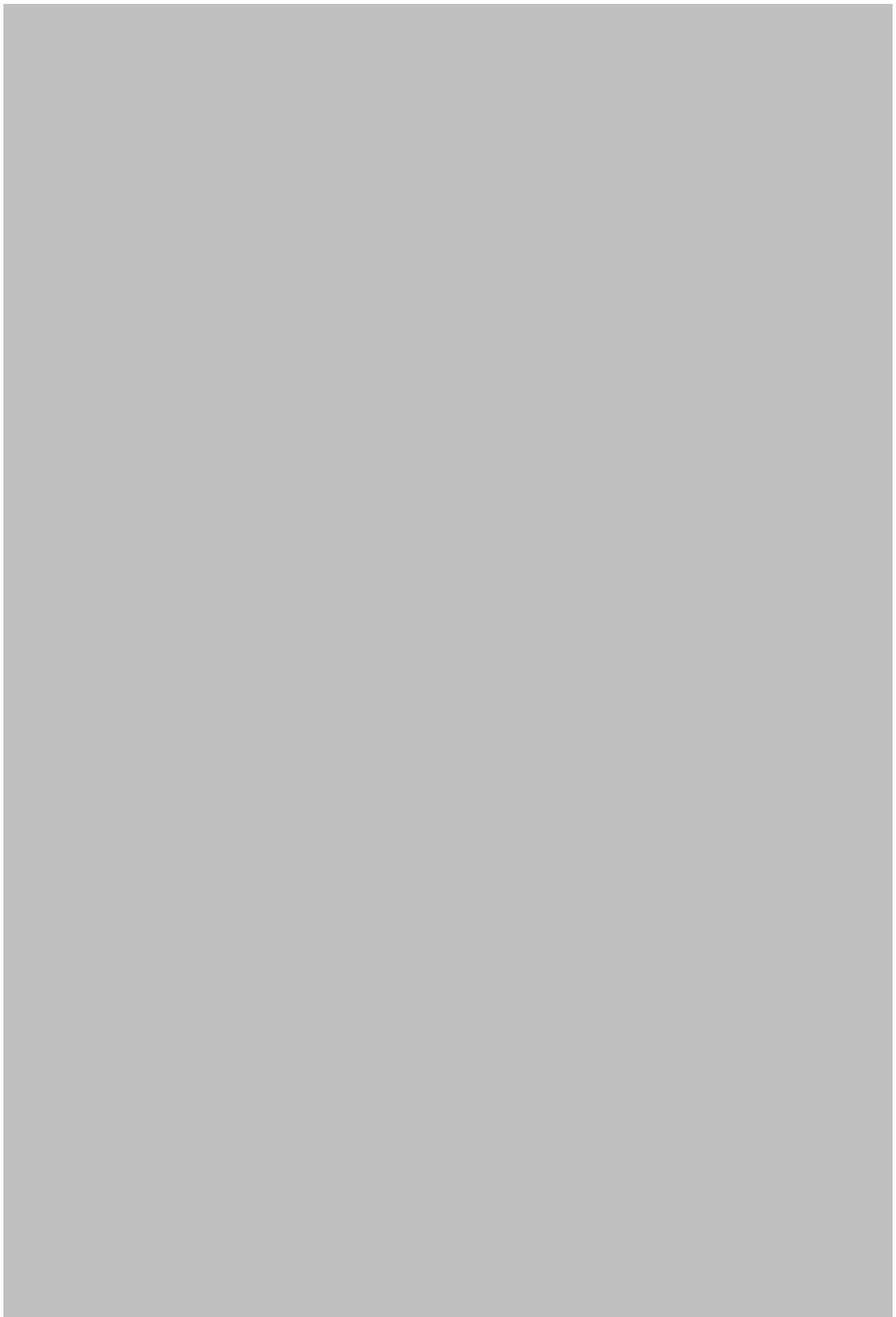
| | | | | | | |
|---|---|---|---|---|---|---|
| 2.5 | 1.0 | 0.6 | 0.0 | 2.2 | 0.0 | 69.01 |
| 1.3 | 1.2 | 2.0 | 13.2 | 0.5 | 1.0 | 61.61 |
| 2.8 | 3.0 | 0.0 | 12.0 | 0.0 | 1.3 | 61.71 |
| 3.1 | 2.9 | 1.4 | 12.2 | 1.1 | 1.8 | 70.71 |
| 1.8 | 1.6 | 1.7 | 12.9 | 1.1 | 1.2 | 64.61 |
| 1.1 | 3.1 | 2.5 | 10.1 | 1.7 | 0.5 | 22.50 |
| 3.1 | 3.2 | 3.1 | 11.8 | 2.5 | 1.7 | 62.91 |
| 3.3 | 3.0 | 1.6 | 13.1 | 1.1 | 2.1 | 74.41 |
| 1.8 | 1.4 | 2.0 | 13.1 | 1.4 | 1.2 | 69.01 |
| 0.0 | 0.0 | 1.3 | 14.0 | 0.1 | 0.7 | 59.61 |
| 1.8 | 2.9 | 1.2 | 12.9 | 1.0 | 2.5 | 47.70 |
| 0.0 | 0.1 | 1.3 | 15.0 | 0.1 | 0.4 | 54.81 |
| 1.0 | 0.7 | 1.4 | 13.4 | 0.1 | 1.2 | 68.41 |
| 2.5 | 3.3 | 3.3 | 12.5 | 1.3 | 1.8 | 50.61 |
| 1.5 | 1.2 | 1.9 | 13.6 | 1.2 | 1.2 | 70.01 |
| 0.2 | 0.3 | 1.4 | 14.0 | 0.1 | 1.0 | 55.41 |

| Original Stochastic ranking |
|---|
| 4 |
| 10 |
| 9 |
| 2 |
| 7 |
| 16 |
| 8 |
| 1 |
| 4 |
| 11 |
| 15 |
| 13 |
| 6 |
| 14 |
| 3 |
| 12 |

| New Stochastic ranking | Deterministic Ranking | Stochastic NPVRR | Stoch. Cost score | Rank |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| 4 | 6 | 26783 | 50.0 | 1 |
| 10 | 11 | 28217 | 31.0 | 8 |
| 9 | 9 | 28490 | 27.4 | 11 |
| 2 | 4 | 28094 | 32.6 | 6 |
| 7 | 8 | 28150 | 31.9 | 7 |
| 16 | 16 | 30553 | 0.0 | 16 |
| 8 | 13 | 28457 | 27.8 | 10 |
| 1 | 1 | 27964 | 34.3 | 3 |
| 5 | 5 | 27945 | 34.6 | 2 |
| 11 | 7 | 28423 | 28.2 | 9 |
| 15 | 14 | 29447 | 14.7 | 15 |
| 13 | 10 | 28591 | 26.0 | 13 |
| 6 | 2 | 28012 | 33.7 | 4 |
| 14 | 15 | 29208 | 17.8 | 14 |
| 3 | 3 | 28029 | 33.5 | 5 |
| 12 | 12 | 28520 | 27.0 | 12 |





## LC 48 NWEC Attachment E

### Inputs

| Row | B | Exp Cost | Risk Durability | Worst 4 Avg | Worst 4 vs Ref Case | Tail Var | Tail Var less Mean | Year to Year Variation | Reliability | Technology H-H | Fuel H-H | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Original Weights | 50.00% | 10.00% | 5.00% | 5.00% | 3.33% | 3.33% | 3.33% | 15.00% | 2.50% | 2.50% | 99.99% |
| 5 | New Weights | 50.00% | 11.00% | 5.00% | 5.00% | 3.33% | 3.33% | 3.33% | 15.00% | 2.50% | 2.50% | 100.99% |
| 6 | Normalized | 49.51% | 10.89% | 4.95% | 4.95% | 3.30% | 3.30% | 3.30% | 14.85% | 2.48% | 2.48% | 100.00% |

### Addendum IRP Weighted Scores

| Row | Portfolios | Exp Cost | Risk Durability | Worst 4 Avg | Worst 4 vs Ref Case | Tail Var | Tail Var less Mean | Year to Year Variation | Reliability | Technology H-H | Fuel H-H | Total | Original Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 1 Market | 50 | 10 | 2.7 | 0 | 2.5 | 1 | 0.6 | 0 | 2.2 | 0 | 69.000 | 6 |
| 11 | 2 Natural Gas | 33.6 | 5.1 | 3.4 | 2.9 | 1.3 | 1.2 | 2.0 | 13.2 | 0.5 | 1.0 | 64.200 | 11 |
| 12 | 3 Wind | 31.2 | 5.9 | 4.7 | 4.6 | 2.8 | 3.0 | 0.0 | 12.0 | 0.0 | 1.3 | 65.500 | 9 |
| 13 | 4 Diversified Green | 33.9 | 6.2 | 4.9 | 4.5 | 3.1 | 2.9 | 1.4 | 12.2 | 1.1 | 1.8 | 72.000 | 4 |
| 14 | 5 Diversified Thermal with wind | 34.8 | 5.1 | 4.0 | 3.3 | 1.8 | 1.6 | 1.7 | 12.9 | 1.1 | 1.2 | 67.500 | 8 |
| 15 | 6 Bridge to IGCC in | 0.0 | 0.0 | 0.0 | 3.5 | 1.1 | 3.1 | 2.5 | 10.1 | 1.7 | 0.5 | 22.500 | 16 |
| 16 | 7 Bridge to nuclear | 26.1 | 1.0 | 4.1 | 4.6 | 3.1 | 3.2 | 3.1 | 11.8 | 2.5 | 1.7 | 61.200 | 13 |
| 17 | 8 Green w/On-peak Energy Target | 34.1 | 6.4 | 5.0 | 4.5 | 3.3 | 3.0 | 1.6 | 13.1 | 1.1 | 2.1 | 74.200 | 1 |
| 18 | 9 Diversified Thermal with Green | 36.8 | 6.4 | 4.0 | 3.1 | 1.8 | 1.4 | 2.0 | 13.1 | 1.4 | 1.2 | 71.200 | 5 |
| 19 | 10 Boardman through 2014 | 37.5 | 8.7 | 3.8 | 2.8 | 0.0 | 0.0 | 1.3 | 14.0 | 0.1 | 0.7 | 68.900 | 7 |
| 20 | 11 Oregon CO2 Goal | 21.4 | 1.8 | 3.9 | 5.0 | 1.8 | 2.9 | 1.2 | 12.9 | 1.0 | 2.5 | 54.400 | 14 |
| 21 | 12 Boardman through 2011 | 35.8 | 5.4 | 3.6 | 2.9 | 0.0 | 0.1 | 1.3 | 15.0 | 0.1 | 0.4 | 64.600 | 10 |
| 22 | 13 Boardman through 2020 | 39.3 | 9.7 | 4.2 | 3.0 | 1.0 | 0.7 | 1.4 | 13.4 | 0.1 | 1.2 | 74.000 | 2 |
| 23 | 14 Diverse Green with wind in WY | 17.3 | 0.8 | 2.9 | 4.4 | 2.5 | 3.3 | 3.3 | 12.5 | 1.3 | 1.8 | 50.100 | 15 |
| 24 | 15 Diversified Thermal w/Green w/o Lease | 36.8 | 8.7 | 4.0 | 3.2 | 1.5 | 1.2 | 1.9 | 13.6 | 1.2 | 1.2 | 73.300 | 3 |
| 25 | 16 Boardman through 2017 | 35.8 | 4.9 | 3.6 | 2.9 | 0.2 | 0.3 | 1.4 | 14.0 | 0.1 | 1.0 | 64.200 | 12 |

### New Weighted Scores

| Row | Portfolios | Exp Cost | k Durabi | Worst 4 Avg | rst 4 vs Ref Ca | Tail Var | l Var less Me | to Year Var | eliability | chnology H | Fuel H-H | Total | New Ranking |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 29 | 1 Market | 49.5 | 10.9 | 2.7 | 0.0 | 2.5 | 1.0 | 0.6 | 0.0 | 2.2 | 0.0 | 69.31 | 6 |
| 30 | 2 Natural Gas | 33.3 | 5.6 | 3.4 | 2.9 | 1.3 | 1.2 | 2.0 | 13.1 | 0.5 | 1.0 | 64.08 | 11 |
| 31 | 3 Wind | 30.9 | 6.4 | 4.7 | 4.6 | 2.8 | 3.0 | 0.0 | 11.9 | 0.0 | 1.3 | 65.44 | 9 |
| 32 | 4 Diversified Green | 33.6 | 6.8 | 4.9 | 4.5 | 3.1 | 2.9 | 1.4 | 12.1 | 1.1 | 1.8 | 71.91 | 4 |
| 33 | 5 Diversified Thermal with wind | 34.5 | 5.6 | 4.0 | 3.3 | 1.8 | 1.6 | 1.7 | 12.8 | 1.1 | 1.2 | 67.34 | 8 |
| 34 | 6 Bridge to IGCC in | 0.0 | 0.0 | 0.0 | 3.5 | 1.1 | 3.1 | 2.5 | 10.0 | 1.7 | 0.5 | 22.28 | 16 |
| 35 | 7 Bridge to nuclear | 25.8 | 1.1 | 4.1 | 4.6 | 3.1 | 3.2 | 3.1 | 11.7 | 2.5 | 1.7 | 60.70 | 13 |
| 36 | 8 Green w/On-peak Energy Target | 33.8 | 7.0 | 5.0 | 4.5 | 3.3 | 3.0 | 1.6 | 13.0 | 1.1 | 2.1 | 74.11 | 2 |
| 37 | 9 Diversified Thermal with Green | 36.4 | 7.0 | 4.0 | 3.1 | 1.8 | 1.4 | 2.0 | 13.0 | 1.4 | 1.2 | 71.14 | 5 |
| 38 | 10 Boardman through 2014 | 37.1 | 9.5 | 3.8 | 2.8 | 0.0 | 0.0 | 1.3 | 13.9 | 0.1 | 0.7 | 69.09 | 7 |
| 39 | 11 Oregon CO2 Goal | 21.2 | 2.0 | 3.9 | 5.0 | 1.8 | 2.9 | 1.2 | 12.8 | 1.0 | 2.5 | 54.04 | 14 |
| 40 | 12 Boardman through 2011 | 35.4 | 5.9 | 3.6 | 2.9 | 0.0 | 0.1 | 1.3 | 14.9 | 0.1 | 0.4 | 64.50 | 10 |
| 41 | 13 Boardman through 2020 | 38.9 | 10.6 | 4.2 | 3.0 | 1.0 | 0.7 | 1.4 | 13.3 | 0.1 | 1.2 | 74.24 | 1 |
| 42 | 14 Diverse Green with wind in WY | 17.1 | 0.9 | 2.9 | 4.4 | 2.5 | 3.3 | 3.3 | 12.4 | 1.3 | 1.8 | 49.69 | 15 |
| 43 | 15 Diversified Thermal w/Green w/o Lease | 36.4 | 9.5 | 4.0 | 3.2 | 1.5 | 1.2 | 1.9 | 13.5 | 1.2 | 1.2 | 73.44 | 3 |
| 44 | 16 Boardman through 2017 | 35.4 | 5.3 | 3.6 | 2.9 | 0.2 | 0.3 | 1.4 | 13.9 | 0.1 | 1.0 | 64.06 | 12 |

## LC 48 CERTIFICATE OF SERVICE

I hereby certify that I served the foregoing **Initial Comments of NWEC in Portland General Electric's 2009 Integrated Resource Plan (LC48)** on the following persons on May, 14, 2010 by hand-delivering, e-mailing, or mailing (as indicated below) to each a copy thereof, and if mailed, contained in a sealed envelope, with postage paid, addressed to said attorneys at the last known address of each shown below and deposited in the post office on said day at Salem, Oregon.

DATED this 14th day of May, 2010.

By: /s/ Steven Weiss
steve@nwenergy.org
NW Energy Coalition
steve@nwenergy.org
503-851-4054

BRUCE A KASER PO BOX 958
SILVERTON OR 97381-0958
brucekaser@comcast.net

*DEPARTMENT OF JUSTICE
JANET L PREWITT (C)
ASSISTANT AG
NATURAL RESOURCES SECTION
1162 COURT ST NE
SALEM OR 97301-4096
janet.prewitt@doj.state.or.us

OREGON DEPARTMENT OF ENERGY
KIP PHEIL (C)
SENIOR POLICY ANALYST
625 MARION ST NE - STE 1
SALEM OR 97301-3737
kip.pheil@state.or.us

VIJAY A SATYAL (C)
SENIOR POLICY ANALYST
625 MARION ST NE
SALEM OR 97301
vijay.a.satyal@state.or.us

ASSOCIATED OREGON INDUSTRIES
JOHN LEDGER
1149 COURT ST NE
SALEM OR 97301
johnledger@aoi.org

BOMA PORTLAND
SUSAN STEWARD
EXECUTIVE DIRECTOR 200
SW MARKET, SUITE 1710
PORTLAND OR 97201
susan@bomaportland.org

CABLE HUSTON BENEDICT ET AL
J LAURENCE CABLE (C)
1001 SW 5TH AVE STE 2000
PORTLAND OR 97204-1136
lcable@cablehuston.com

CABLE HUSTON BENEDICT HAAGENSEN & LLOYD LLP
RICHARD LORENZ (C)
1001 SW FIFTH AVE - STE 2000
PORTLAND OR 97204-1136
rlorenz@cablehuston.com

CITIZENS' UTILITY BOARD OF OREGON
GORDON FEIGHNER (C)
ENERGY ANALYST
610 SW BROADWAY, SUITE 308
PORTLAND OR 97205
gordon@oregoncub.org

ROBERT JENKS (C)
EXECUTIVE DIRECTOR
610 SW BROADWAY STE 308
PORTLAND OR 97205
bob@oregoncub.org

G. CATRIONA MCCRACKEN (C)
LEGAL COUNSEL/STAFF ATTY

610 SW BROADWAY - STE 308
PORTLAND OR 97205
catriona@oregoncub.org

CITY OF PORTLAND - CITY ATTORNEY'S OFFICE
BENJAMIN WALTERS (C)
CHIEF DEPUTY CITY ATTORNEY 1
221 SW 4TH AVE - RM 430
PORTLAND OR 97204
ben.walters@portlandoregon.gov

CITY OF PORTLAND - PLANNING & SUSTAINABILITY
MICHAEL ARMSTRONG
SUSTAINABILITY MANAGER
1900 SW 4TH AVE, STE 7100
PORTLAND OR 97201
michael.armstrong@portlandoregon.gov

DAVID TOOZE (C)
SENIOR ENERGY SPECIALIST

1900 SW 4TH STE 7100
PORTLAND OR 97201
david.tooze@portlandoregon.gov

CLACKAMAS COUNTY BUSINESS ALLIANCE
BURTON WEAST
EXECUTIVE DIRECTOR
300 OSWEGO POINTE DR, STE 220
LAKE OSWEGO OR 97034
burton@ccba.biz

COLUMBIA CORRIDOR ASSOCIATION
CORKY COLLIER
PO BOX 55651
PORTLAND OR 97238
corky@columbiacorridor.org

COLUMBIA RIVERKEEPER
LAUREN GOLDBERG (C)
724 OAK STREET
HOOD RIVER OR 97031
lauren@columbiariverkeeper.org

DAVIS WRIGHT TREMAINE LLP
JOHN DILORENZO
1300 SW FIFTH AVE, STE 2300
PORTLAND OR 97201
johndilorenzo@dwt.com

MARK P TRINCHERO
1300 SW FIFTH AVE STE 2300
PORTLAND OR 97201-5682
marktrinchero@dwt.com

DAVISON VAN CLEVE
IRION A SANGER (C)
ASSOCIATE ATTORNEY 333 SW TAYLOR - STE 400
PORTLAND OR 97204
ias@dvclaw.com

DEPARTMENT OF JUSTICE
STEPHANIE S ANDRUS (C)
ASSISTANT ATTORNEY GENERAL
REGULATED UTILITY & BUSINESS SECTION
1162 COURT ST NE SALEM OR 97301-4096
stephanie.andrus@state.or.us

ECUMENICAL MINISTRIES OF OREGON
JAMES EDELSON
415 NE MIRIMAR PL
PORTLAND OR 97232
edelson8@comcast.net

ECUMENICAL MINISTRIES OF OREGON
JENNY HOLMES
ENVIRONMENTAL MINISTRIES DIRECTOR
0245 SW BANCROFT, SUITE B
PORTLAND OR 97239
jholmes@emoregon.org

ESLER STEPHENS & BUCKLEY
JOHN W STEPHENS (C)
888 SW FIFTH AVE STE 700
PORTLAND OR 97204-2021
stephens@eslerstephens.com; mec@eslerstephens.com

FRIENDS OF COLUMBIA GORGE
MICHAEL LANG (C)
522 SW FIFTH AVENUE, SUITE 720
PORTLAND OR 97204
michael@gorgefriends.org

IBERDROLA RENEWABLES, INC
KEVIN LYNCH
1125 NW COUCH ST STE 700
PORTLAND OR 97209
kevin.lynch@iberdrolausa.com

TOAN-HAO NGUYEN
1125 NW COUCH ST
PORTLAND OR 97209
toan.nguyen@iberdrolausa.com

IBEW LOCAL 125
MARCY PUTMAN
POLITICAL AFFAIRS & COMMUNICATION REPRESENTATIVES
17200 NE SACRAMENTO STREET
PORTLAND OR 97230
marcy@ibew125.com

INDUSTRIAL CUSTOMERS OF NORTHWEST UTILITIES
MICHAEL EARLY
EXECUTIVE DIRECTOR
1300 SW 5TH AVE, STE 1750
PORTLAND OR 97204-2446
mearly@icnu.org

NORTHWEST ENERGY COALITION
STEVEN WEISS
SR POLICY ASSOCIATE
4422 OREGON TRAIL CT NE
SALEM OR 97305
steve@nwenergy.org

NORTHWEST ENVIRONMENTAL DEFENSE CENTER
MARK RISKEDAHL
10015 SW TERWILLIGER BLVD
PORTLAND OR 97219
msr@nedc.org

NORTHWEST FOOD PROCESSORS ASSOCIATION
DAVID ZEPPONI
PRESIDENT
8338 NE ALTERWOOD RD, STE 160
PORTLAND OR 97220
pbarrow@nwfpa.org

NORTHWEST PIPELINE GP
JANE HARRISON (C)
MGR-MARKETING SERVICES
295 CHIPETA WAY
SALT LAKE CITY UT 84158
jane.f.harrison@williams.com

BRUCE REEMSNYDER (C)
SENIOR COUNSEL
295 CHIPETA WAY
SALT LAKE CITY UT 84108
bruce.reemsnyder@williams.com

NW INDEPENDENT POWER PRODUCERS
ROBERT D KAHN
EXECUTIVE DIRECTOR
1117 MINOR AVENUE, SUITE 300
SEATTLE WA 98101
rkahn@nippc.org

OREGON AFL-CIO
JOHN BISHOP
1635 NW JOHNSON ST
PORTLAND OR 97209
jbishop@mbjlaw.com

OREGON CATTLEMEN'S ASSOCIATION
KAY TEISL
3415 COMMERCIAL ST SE, #217
SALEM OR 97302
kayteisl@orcattle.com

OREGON DEPARTMENT OF ENERGY
ANDREA F SIMMONS (C)
625 MARION ST NE
SALEM OR 97301-3737
andrea.f.simmons@state.or.us

OEC -- JANA GASTELLUM
PROGRAM DIRECTOR, GLOBAL WARMING
222 NW DAVIS ST, STE 309
PORTLAND OR 97309-3900

OREGON FOREST INDUSTRIES COUNCIL
RAY WILKESON
PO BOX 12826
SALEM OR 97309
ray@ofic.com

OREGON SIERRA CLUB
IVAN MALUSKI
1821 SE ANKEY ST
PORTLAND OR 97214
ivan.maluski@sierraclub.org

PACIFIC ENVIRONMENTAL ADVOCACY CENTER
AUBREY BALDWIN (C)
STAFF ATTORNEY/CLINICAL PROFESSOR
10015 SW TERWILLIGER BLVD
PORTLAND OR 97219
abaldwin@lclark.edu

PACIFIC ENVIRONMENTAL ADVOCACY CENTER
ALLISON LAPLANTE
10015 SW TERWILLIGER BLVD
PORTLAND OR 97219
laplante@lclark.edu

PACIFIC POWER & LIGHT
JORDAN A WHITE
SENIOR COUNSEL
1407 W. NORTH TEMPLE, STE 320
SALT LAKE CITY UT 84116
jordan.white@pacificorp.com

PACIFICORP ENERGY
PETE WARNKEN MANAGER, IRP
825 NE MULTNOMAH - STE 600
PORTLAND OR 97232
pete.warnken@pacificorp.com

PHYSICIANS FOR SOCIAL RESPONSIBILITY
OREGON CHAPTER
CATHERINE THOMASSON
CLIMATE CHANGE CHAIR
OREGON PSR
1227 NE 27TH #5
PORTLAND OR 97232
thomassonc@comcast.net

PNGC POWER
JOHN PRESCOTT
PRESIDENT AND CEO
711 NE HALSEY
PORTLAND OR 97232
jprescott@pngcpower.com

PORTLAND GENERAL ELECTRIC
PATRICK G HAGER (C)
MANAGER - REGULATORY AFFAIRS
121 SW SALMON ST 1WTC0702
PORTLAND OR 97204
pge.opuc.filings@pgn.com

DENISE SAUNDERS (C)
ASST GENERAL COUNSEL
121 SW SALMON ST - 1WTC1711
PORTLAND OR 97204
denise.saunders@pgn.com

PUBLIC UTILITY COMMISSION
MAURY GALBRAITH
PO BOX 2148
SALEM OR 97308
maury.galbraith@state.or.us

RENEWABLE NORTHWEST PROJECT
KEN DRAGOON
917 SW OAK, SUITE 303
PORTLAND OR 97205
ken@rnp.org

RICHARDSON & O'LEARY
GREGORY MARSHALL ADAMS (C)
ATTORNEY
PO BOX 7218
BOISE ID 83702
greg@richardsonandoleary.com

RICHARDSON & O'LEARY PLLC
PETER J RICHARDSON
(C) PO BOX 7218
BOISE ID 83707
peter@richardsonandoleary.com

SALEM CHAMBER OF COMMERCE
MIKE MCLARAN
CHIEF EXECUTIVE OFFICER
1110 COMMERCIAL ST SE
SALEM OR 97301
mike@salemchamber.org; jason@salemchamber.org

SEDCOR
RAYMOND BURSTEDT
PRESIDENT
625 HIGH ST NE, STE 200
SALEM OR 97301
rburstedt@sedcor.com

SIERRA CLUB LAW PROGRAM
GLORIA D SMITH (C)
85 SECOND STREET
SAN FRANCISCO CA 94105
gloria.smith@sierraclub.org

TURLOCK IRRIGATION DISTRICT
RANDY BAYSINGER
ASSISTANT GENERAL
MANAGER
PO BOX 949
TURLOCK CA 95381-0949
rcbaysinger@tid.org