

Confidential Per WAC 480-07-160
Exhibit No. RTL-1CT
Docket UE-15____
Witness: Rick T. Link

**BEFORE THE
WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION**

In the Matter of

PACIFIC POWER & LIGHT
COMPANY,

Petition For a Rate Increase Based on a Modified
Commission Basis Report, Two-Year Rate Plan,
and Decoupling Mechanism.

Docket UE-15____

PACIFIC POWER & LIGHT COMPANY

REDACTED – CONFIDENTIAL DIRECT TESTIMONY OF RICK T. LINK

November 2015

TABLE OF CONTENTS

QUALIFICATIONS	1
PURPOSE OF TESTIMONY.....	1
METHODOLOGY	2
NATURAL GAS AND CO ₂ PRICE SCENARIOS	8
BASE CASE RESULTS.....	13
NATURAL GAS AND CO ₂ PRICE SCENARIO RESULTS	18
EARLY RETIREMENT SENSITIVITY ANALYSIS.....	25
CONCLUSION.....	26

ATTACHED EXHIBITS

Confidential Exhibit No. RTL-2C—Summary of Planned Capital Investments

Confidential Exhibit No. RTL-3C—Jim Bridger Plant Coal Costs

Confidential Exhibit No. RTL-4C—Contributions to Mine Reclamation Trust

Confidential Exhibit No. RTL-5C—Jim Bridger Coal Company Mine Capital Costs

Confidential Exhibit No. RTL-6C—Natural Gas Price Assumptions used in the Evaluation of
Jim Bridger Units 3 and 4

Confidential Exhibit No. RTL-7C—SO Model Results for Gas Price Scenarios

Confidential Exhibit No. RTL-8C—West Control Area

Confidential Exhibit No. RTL-9C—Relationship between Gas Prices and the PVRR

Confidential Exhibit No. RTL-10C—Relationship between CO₂ Prices and the PVRR

1 **Q. Please state your name, business address, and present position with PacifiCorp.**

2 A. My name is Rick T. Link. My business address is 825 NE Multnomah Street, Suite
3 600, Portland, Oregon 97232. My present position is Director, Origination. I am
4 testifying for Pacific Power & Light Company (Pacific Power or Company), a
5 division of PacifiCorp.

6 **QUALIFICATIONS**

7 **Q. Please describe your education and professional experience.**

8 A. I received a Bachelor of Science degree in Environmental Science from Ohio State
9 University in 1996 and a Masters of Environmental Management from Duke
10 University in 1999. I have been employed in the energy supply management
11 department of PacifiCorp since 2003 where I have held positions in market
12 fundamentals, valuation, planning, and origination. Currently, I oversee the
13 Company's integrated resource plan, development of long-term commodity price
14 forecasts, origination and evaluation of new structured commercial contracts, long-
15 term resource procurement, and administration of existing contracts managed within
16 the energy supply management department. Before joining the Company, I was an
17 energy and environmental economics consultant for ICF Consulting (now ICF
18 International) from 1999 to 2003.

19 **PURPOSE OF TESTIMONY**

20 **Q. What is the purpose of your testimony?**

21 A. My testimony explains the economic analysis performed in 2012 that supported the
22 Company's decision to install selective catalytic reduction (SCR) emission control
23 systems on Units 3 and 4 of the Jim Bridger generating plant.

1 **Q. Please summarize your testimony.**

2 A. My testimony describes the Company's economic analysis of SCR systems at Jim
3 Bridger Units 3 and 4 as compared to alternatives that include conversion to natural
4 gas and early retirement. Specifically, my testimony presents the following:

- 5 • A description of the methodology using the System Optimizer Model (SO
6 Model) to analyze the SCR systems required to continue operating Jim
7 Bridger Units 3 and 4 as coal-fueled facilities.
- 8 • Base case results from the SO Model show a total-company [REDACTED]
9 present value revenue requirement differential (PVRR(d)) favorable to the
10 SCR systems required to continue operating Jim Bridger Units 3 and 4 as
11 coal-fueled assets.¹
- 12 • Base case results on a west control area basis show a [REDACTED] PVRR(d)
13 favorable to the SCR systems on Jim Bridger Units 3 and 4.
- 14 • Natural gas price and carbon dioxide (CO₂) price scenario assumptions and
15 results showing a range of PVRR(d) outcomes that support the SCR systems
16 in six of the nine scenarios studied.
- 17 • A description of an additional sensitivity showing that the Jim Bridger Units 3
18 and 4 SCR systems are favorable to both gas conversion and early retirement
19 alternatives.

20 **METHODOLOGY**

21 **Q. What model was used to evaluate the SCR systems for Jim Bridger Units 3
22 and 4?**

23 A. The Company used the SO Model to perform a PVRR(d) financial analysis of the
24 SCR systems at Jim Bridger Units 3 and 4 to support the Company's investment
25 decision. This same analysis was presented in the Company's 2013 Integrated
26 Resource Plan and Update filed with the Washington Utilities and Transportation
27 Commission (Commission). The same SO Model analysis was also used to support

¹ Except for the analysis conducted on a west control area basis, all PVRR(d) results are stated on a total-company basis.

1 the Certificate of Public Necessity and Convenience process for the SCR systems at
2 Jim Bridger Units 3 and 4 described in the testimony of Mr. Chad A. Teply.

3 **Q. Please describe the SO Model and how it is used by the Company.**

4 A. The SO Model is a capacity expansion optimization tool that is used in the
5 Company's integrated resource plan to produce resource portfolios in support of long-
6 term system planning. The SO Model is also used in the Company's analysis of
7 resource acquisition opportunities and resource procurement activities. The Company
8 used this model to evaluate system benefits in support the successful acquisition of
9 the Chehalis combined cycle plant, which the Commission reviewed and approved in
10 Docket UE-090205, the Company's 2009 Rate Case. The SO Model endogenously
11 considers tradeoffs between operating and capital revenue requirement costs of both
12 existing and prospective new resources while simultaneously evaluating tradeoffs in
13 energy value between existing and prospective new resource alternatives.

14 **Q. Why is the SO Model an appropriate tool for analyzing incremental emission
15 control equipment installations required on coal resources?**

16 A. The SO Model is the appropriate modeling tool when evaluating capital investment
17 decisions and alternatives to those investments that might include early retirement
18 and replacement or conversion of assets to natural gas. The SO Model is capable of
19 simultaneously and endogenously evaluating capacity and energy tradeoffs between
20 emission control equipment required to meet emerging environmental regulations and
21 a broad range of alternatives including fuel conversion, early retirement and
22 replacement with greenfield resources, market purchases, demand-side management
23 resources, and/or renewable resources. In this way, the SO Model captures the cost

1 implications of prospective emission control installation decisions by evaluating net
2 power cost impacts along with the impacts those decisions might have on future
3 resource acquisition needs. This is particularly important when resource retirement
4 and replacement is considered to be an environmental compliance alternative.

5 **Q. How was the SO Model used to analyze the PVRR(d) of the SCR systems**
6 **required for Jim Bridger Units 3 and 4?**

7 A. For a range of market price scenarios, which I describe later in my testimony, two SO
8 Model simulations were completed – an optimized simulation and a change case
9 simulation. In the optimized simulation, the SO Model determines whether continued
10 operation of Jim Bridger Units 3 and 4 inclusive of incremental SCR systems and
11 other planned costs required to achieve compliance with emerging environmental
12 regulations is a lower cost solution than avoiding those expenses through early
13 retirement and resource replacement or through conversion to natural gas. In the
14 change case simulation, the SO Model is forced to produce a suboptimal decision by
15 not allowing it to make the preferred decision that was made in the optimized
16 simulation.

17 In the analysis for Jim Bridger Units 3 and 4, when the optimized simulation
18 selected continued operations with incremental SCR systems and other planned costs,
19 then the change case was created by removing the SCR systems as an alternative,
20 allowing the SO Model to select either an early retirement or gas conversion
21 alternative. In each of these simulations, the SO Model selected natural gas
22 conversion as a lower cost alternative to early retirement. In scenarios where the
23 optimized simulation selected conversion to natural gas, then the change case forced

1 continued operations with incremental SCR systems and other planned costs. The
2 difference in total-company costs, inclusive of differences in net power costs,
3 operating costs and capital costs, between the two simulations for any given market
4 price scenario represents the PVRR(d), which establishes how favorable or
5 unfavorable the incremental environmental capital investments planned for Jim
6 Bridger Units 3 and 4 are in relation to the next best alternative.

7 **Q. What incremental environmental investment costs were assumed for Jim**
8 **Bridger Units 3 and 4?**

9 A. Incremental environmental investment costs applied in the SO Model include the cost
10 of the SCR systems required for Jim Bridger Units 3 and 4, along with costs required
11 to achieve compliance with an array of known and prospective emerging
12 environmental regulations. This includes costs to achieve compliance with the U.S.
13 Environmental Protection Agency's mercury and air toxics standard, and costs to
14 achieve compliance with prospective rules on coal combustion residuals and cooling
15 water intake structures. The incremental investment costs assumed in the SO Model
16 for Jim Bridger Units 3 and 4 along with other coal resources in the Company's fleet
17 are summarized in Confidential Exhibit No. RTL-2C.

18 **Q. What resource replacement alternatives were made available to the SO Model in**
19 **the event SCR systems are not made for Jim Bridger Units 3 and 4?**

20 A. In addition to brownfield natural gas conversion of Jim Bridger Units 3 and 4, the SO
21 Model was configured with a range of resource replacement alternatives, which
22 include:

- 23 • greenfield natural gas resources;

- 1 • firm market purchases;
- 2 • demand side management; and
- 3 • incremental wind resources.

4 With the installation of SCR systems required by December 31, 2015, for Jim Bridger
5 Unit 3 and by December 31, 2016, for Jim Bridger Unit 4, resource retirement and
6 replacement alternatives were assumed to be available beginning January 2016 and
7 January 2017, respectively. Natural gas conversion alternatives were made available
8 beginning March 2016 for Jim Bridger Unit 3 and March 2017 for Jim Bridger Unit
9 4, assuming coal-fueled operation would continue as long as possible and the work to
10 complete the gas conversion could be accomplished over a two-month period.

11 **Q. Did the Company's SO Model analysis consider the power requirements from**
12 **the SCR systems required at Jim Bridger Units 3 and 4?**

13 A. Yes. The SCR systems, once installed and operational, are assumed to reduce the
14 Company's share of capacity of both Jim Bridger Unit 3 and Unit 4 by approximately
15 3.5 megawatts.

16 **Q. Did your analysis account for changes in the fueling plan at the Jim Bridger**
17 **plant between the SCR and natural gas conversion or early retirement**
18 **scenarios?**

19 A. Yes. If Jim Bridger Units 3 and 4 were to convert to natural gas or retire early, the
20 coal fueling needs at the four-unit Jim Bridger plant would be reduced, which in turn,
21 would influence mine plans and reclamation plans. Cash coal cost assumptions used
22 in the SO Model were based upon non-capital-related costs to fuel the Jim Bridger
23 plant, which included then-current third party coal prices and transportation costs

1 from Black Butte coal as well as then-current cash operating cost forecasts for
2 Bridger Coal Company inclusive of final reclamation trust contributions. Under a
3 two-unit coal operating plan, cash costs assumed closure of the Bridger Coal surface
4 mine. Under a four-unit coal operating plan, cash costs assumed a two dragline
5 operation at the surface mine. Cash coal cost assumptions for both the two-unit and
6 four-unit coal operating plans used in the SO Model analysis are provided in
7 Confidential Exhibit No. RTL-3C.

8 **Q. Please describe mine reclamation costs considered in the Company's PVRR(d)**
9 **analysis.**

10 A. In 1989, the Bridger Coal Company owners established a final reclamation trust to
11 fund actual final reclamation work. A sinking fund calculation is used to determine
12 the appropriate final reclamation trust contribution rate and ensure sufficient funds
13 exist in the trust to support final reclamation work once coal production ceases.
14 Contributions to the final reclamation trust were included as part of the Jim Bridger
15 plant cash coal costs through 2030, the study horizon used for the SO Model analysis.
16 Considering that reclamation costs continue beyond the 2030 study horizon,
17 reclamation costs from 2031 through 2037 were included in the PVRR(d) calculations
18 to capture differences in reclamation costs beyond the SO Model study horizon.
19 Confidential Exhibit No. RTL-4C summarizes reclamation costs for both the two-unit
20 and four-unit coal operating plans used in the SO Model analysis.

21 **Q. Did the Company consider differences in incremental mine capital costs between**
22 **the two-unit and four-unit coal operating plans?**

23 A. Yes. Over the period 2013 through 2030, average annual mine capital cost

1 assumptions for a four-unit coal operating plan are higher than those in a two-unit
2 coal operating plan by approximately [REDACTED] Confidential Exhibit No. RTL-5C
3 shows annual mine capital cost assumptions used in the SO Model analysis for both
4 the two-unit and four-unit coal operating plans.

5 **NATURAL GAS AND CO₂ PRICE SCENARIOS**

6 **Q. Please explain why natural gas and CO₂ price assumptions are important when**
7 **analyzing the SCR systems at Jim Bridger Units 3 and 4.**

8 A. Alternatives to the SCR systems include early retirement and resource replacement or
9 conversion of Jim Bridger Unit 3 and Unit 4 to natural gas. Consequently, the
10 assumed price for natural gas directly affects the cost for gas-fueled replacement
11 resources in the case of an early retirement alternative or the fuel cost and
12 replacement energy in the case of a gas conversion alternative. The price for natural
13 gas is also a key factor in setting wholesale power prices. In this way, natural gas
14 prices disproportionately affect the value of energy net of operating costs from Jim
15 Bridger Units 3 and 4 when operating as a coal-fueled resource versus the value of
16 energy net of operating costs from a natural gas-fueled resource replacement
17 alternative. Similarly, because of the relatively high level of carbon content in coal as
18 compared to natural gas, higher CO₂ prices disproportionately affect the prospective
19 cost of emissions between coal resources and natural gas as an alternative to the
20 incremental investments required to continue operating Jim Bridger Units 3 and 4 as
21 coal-fueled assets.

1 **Q. Did the Company evaluate different assumptions for natural gas prices and CO₂**
 2 **prices in its analysis of the Jim Bridger Units 3 and 4 SCR systems?**

3 A. Yes. In the Company’s analysis of the SCR systems at Jim Bridger Units 3 and 4,
 4 eight different combinations of natural gas and CO₂ price assumptions were analyzed
 5 as variations to the base case, which is tied to the September 2012 official forward
 6 price curve (OFPC). Table 1 summarizes the directional changes to base case
 7 assumptions among the eight scenarios. Two scenarios assume low and high natural
 8 gas prices with base case CO₂ assumptions held constant; two scenarios assume low
 9 and high CO₂ price assumptions with the underlying base case natural gas prices held
 10 constant; and four scenarios pair different combinations of natural gas price and CO₂
 11 price assumptions. In any scenario where the CO₂ assumption varies from that used
 12 in the base case, the underlying natural gas price assumption was adjusted to account
 13 for any natural gas price response from changes in electric sector natural gas demand.

Table 1		
Natural Gas and CO₂ Price Scenarios		
Description	Natural Gas Prices	CO₂ Prices
Base Case	September 2012 OFPC	\$16/ton in 2022 rising to \$23/ton by 2030
Low Gas, Base CO ₂	Low	\$16/ton in 2022 rising to \$23/ton by 2030
High Gas, Base CO ₂	High	\$16/ton in 2022 rising to \$23/ton by 2030
Base Gas, \$0 CO ₂	Base case adjusted for price response	No CO ₂ costs
Base Gas, High CO ₂	Base case adjusted for price response	\$14/ton in 2020 rising to \$65/ton by 2030
Low Gas, High CO ₂	Low case adjusted for price response	\$14/ton in 2020 rising to \$65/ton by 2030
High Gas, \$0 CO ₂	High case adjusted for price response	No CO ₂ costs
Low Gas, \$0 CO ₂	Low case adjusted for price response	No CO ₂ costs
High Gas, High CO ₂	High case adjusted for price response	\$14/ton in 2020 rising to \$65/ton by 2030

1 **Q. Why are natural gas price assumptions adjusted in those scenarios where CO₂**
2 **price assumptions vary from the base case?**

3 A. CO₂ prices disproportionately affect the prospective cost of emissions between coal
4 resources and natural gas alternatives. This is primarily driven by the relatively high
5 level of carbon content in coal as compared to natural gas. With rising CO₂ prices,
6 generating resources with lower CO₂ emissions, such as natural gas-fueled resources,
7 begin to displace coal-fueled generation, thereby increasing the demand for natural
8 gas within the electric sector of the U.S. economy. Displacement of coal generation
9 is also influenced by low- or zero-emitting renewable generation sources; however,
10 not enough to entirely offset increased natural gas demand. Conversely, with falling
11 CO₂ prices (or a market that is absent CO₂ prices), there is no incremental emissions-
12 based cost advantage for natural gas or renewable generation as compared to coal,
13 and demand for natural gas in the electric sector of the U.S. economy is slightly
14 lower. It is assumed that any change in natural gas demand must be balanced with a
15 change in supply such that higher natural gas demand yields an upward movement in
16 price and lower natural gas demand yields a downward movement in price.

17 **Q. Does the Company only apply upward adjustments to natural gas prices in**
18 **response to changes in CO₂ price level?**

19 A. No. The assumed interaction between natural gas prices and CO₂ prices is bi-
20 directional. That is, the Company not only assumes natural gas prices rise in the
21 presence of a CO₂ price (or with increased CO₂ price levels), but also incorporates
22 downward natural gas price pressures when CO₂ prices are removed or lowered.

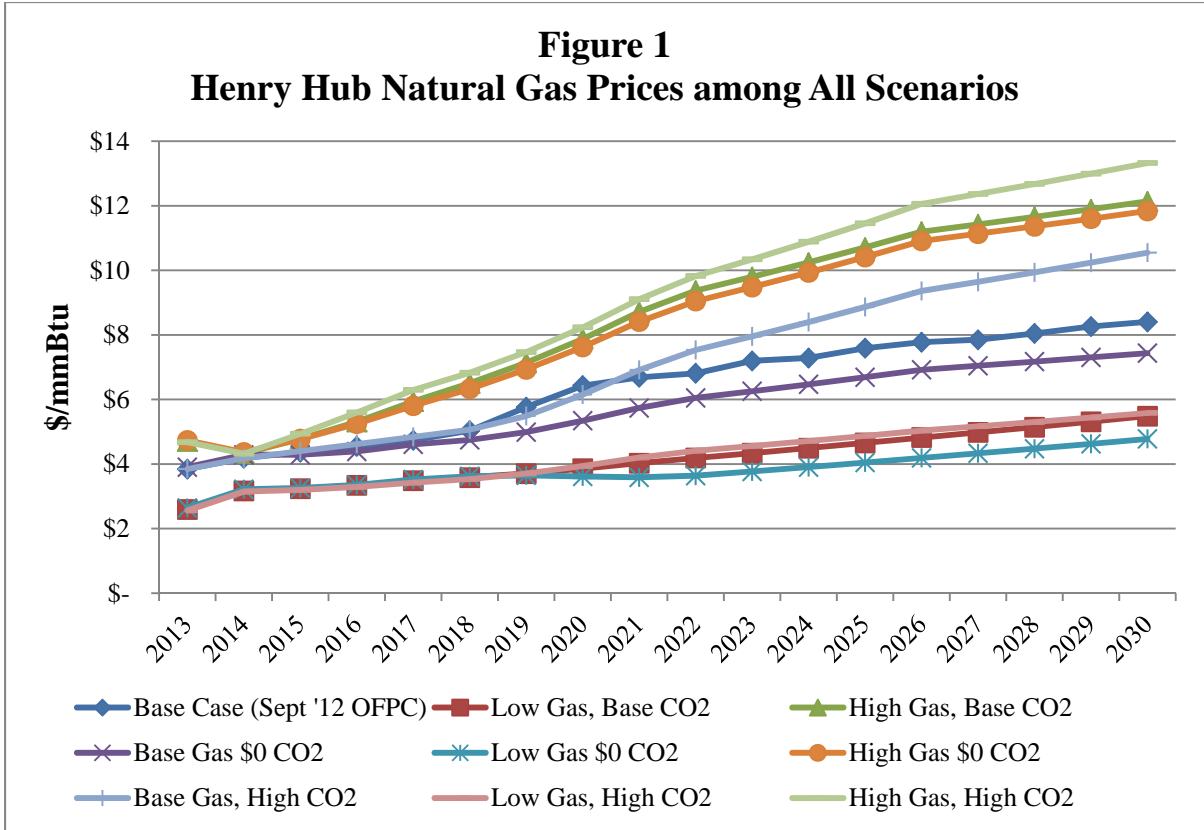
1 **Q. How did the Company choose its natural gas and CO₂ price assumptions as used**
2 **in the eight market price scenarios?**

3 A. The range of low- and high-price assumptions were based upon the range of then
4 current third-party expert forecasts and government agency price projections.
5 Confidential Exhibit No. RTL-6C shows how the low and high price assumptions
6 used in the Company's analysis compare to these third-party forecasts.

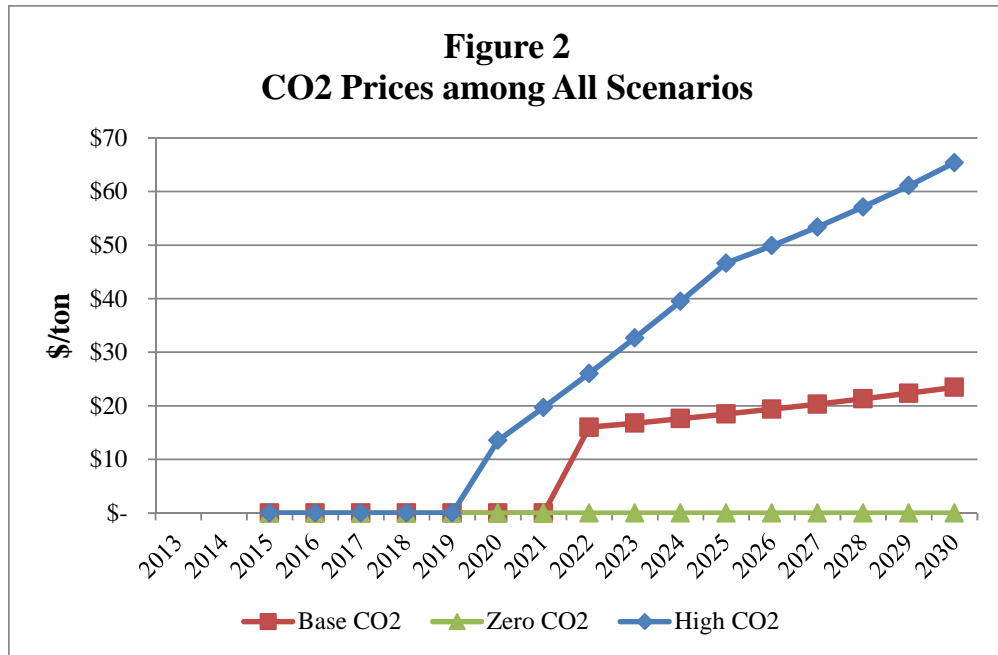
7 Low natural gas price assumptions were derived from a third-party, low price
8 scenario, which is characterized by strong and price resilient shale gas supply growth
9 and stagnant exports of liquefied natural gas out of the U.S. natural gas market. The
10 high natural gas price assumptions were based on a blend of two, third-party price
11 scenarios. This blending approach recognizes that the most extreme high natural gas
12 price forecast reviewed is a strong outlier relative to price projections from other
13 forecasters, and yields a high price scenario that exceeds the highest of 47 natural gas
14 price forecasts in the U.S. Energy Information Administration's 2011 Annual Energy
15 Outlook.²

16 Fundamental drivers to a high price scenario would include constraints or
17 disappointments in shale gas production, linkage to rising oil prices through
18 substantial new demand in the transportation sector, and/or significant increases in
19 liquefied natural gas exports out of the U.S. natural gas market. Figure 1 shows the
20 Henry Hub natural gas price forecast among all market price scenarios included in the
21 analysis of SCR systems at Jim Bridger Units 3 and 4.

² The U.S. Energy Information Administration is the statistical and analytical agency within the U.S. Department of Energy. The highest natural gas price forecast in the 2011 Annual Energy Outlook assumes that total unproved technically recoverable shale gas resources are reduced by 49 percent and that the estimated ultimate recovery per shale gas well is 50 percent lower than in their reference case.



1 The Company assumed a zero CO₂ price for the low scenario recognizing that
 2 there had been limited activity in the CO₂ policy arena. For the high CO₂ price
 3 scenario, prices are assumed to begin in 2020, escalate rapidly through 2025 and
 4 reach \$65/ton by 2030. The high CO₂ price scenario aligns with the then-current high
 5 CO₂ price forecast from [REDACTED], a reputable third-party source. Figure 2
 6 shows the three CO₂ price assumptions used in the market price scenarios in the
 7 analysis of SCR systems at Jim Bridger Units 3 and 4.



BASE CASE RESULTS

1

2 **Q. Please describe the results from the base case SO Model analysis.**

3 A. The optimized base case simulation from the SO Model selected the SCR investment
 4 at Jim Bridger Unit 3 and Jim Bridger Unit 4. The change case simulation in which
 5 Jim Bridger Units 3 and 4 were not allowed to select SCR systems shows that gas
 6 conversion is the next best, albeit higher cost, alternative to the installation of SCR
 7 emission controls. The PVRR(d), as summarized in Confidential Exhibit No. RTL-
 8 7C, shows that installation of SCR systems is [REDACTED] lower cost than gas
 9 conversion.

10 **Q. How are system costs impacted between the base case simulation, where SCRs**
 11 **are installed on Jim Bridger Units 3 and 4, and the change case simulation,**
 12 **where both units are converted to natural gas?**

13 A. When SCR systems are installed on Jim Bridger Units 3 and 4, total-company fuel
 14 costs are lower and net system balancing revenues are higher relative to a natural gas

1 conversion alternative that would significantly reduce generation levels from the two
2 units. These total-company benefits more than offset the increased fixed costs
3 associated with the capital for the SCR systems, which is approximately [REDACTED]/kW
4 higher than gas conversion capital costs, and levelized annual operating and run-rate
5 capital costs, which are approximately [REDACTED]/kW higher than projected gas conversion
6 costs. On a total-company basis, the PVRR(d) of system variable costs is [REDACTED]
7 million favorable to the SCR systems compliance alternative, which more than offsets
8 the [REDACTED] million increase to total-company fixed costs.³

9 **Q. Have you evaluated the base case PVRR(d) results on a west control area basis?**

10 A. Yes. While the Company conducts its resource planning and uses the SO Model on a
11 total-company basis, for illustrative purposes in this filing, the Company evaluated
12 the base case PVRR(d) results from the 2012 studies on a west control area basis.
13 These results are even more definitive than the total-company base case results the
14 Company relied on in deciding to move forward with the SCR systems at Jim Bridger
15 Units 3 and 4.

16 **Q. How is the west control area defined for purposes of this analysis?**

17 A. Consistent with the definition used in the Company's Washington rate proceedings,
18 the west control area is composed of load and resources in PacifiCorp's west
19 balancing authority area (control area). As such, the west control area includes
20 resources and load obligations that are physically located or electrically connected to

³ System variable costs include fuel, net system balancing revenue, variable O&M expenses, and CO₂ emissions expenses. System fixed costs include incremental environmental controls costs, fixed O&M and run-rate capital expenses for existing and new resources, and changes to system demand-side management costs.

1 the Company's service territory in the three western states: Washington, Oregon, and
2 California.

3 **Q. Please describe the process used to convert base case results on a total-company**
4 **basis to a west control area basis.**

5 A. The process starts with a list of resources and load obligations that are in the west
6 control area. Next, annual SO Model outputs used to derive PVRR(d) results on a
7 total-company basis were summarized for the west control area, including an
8 accounting of west control area energy balances on a monthly basis. The process of
9 differentiating the SO Model results on a west control area basis is done for both the
10 coal-fueled and gas-fueled scenarios. The present value revenue requirement cost of
11 each scenario used to calculate the PVRR(d) on a west control area basis reflect
12 variable and fixed costs from the SO Model assigned to the west control area and the
13 net cost to balance any long or short energy position created by excluding resources
14 and obligations that are not in the west control area.

15 **Q. What resources did you assign to the west control area?**

16 A. The existing west control area resources include owned resources and power purchase
17 agreements that are physically located or electrically connected and delivered to the
18 three western states, and purchases from qualifying facilities in the state of
19 Washington. These are the same resources included in the west control area in the
20 Company's Washington rate proceedings. New resources added to the portfolio over
21 the twenty-year study period include those located in the same three western states.
22 These resources include offsets to load from energy efficiency programs, distributed
23 generation, and firm forward market purchases (front office transactions, or FOTs)

1 along with system balancing sales and purchases at the Mid-Columbia, California
2 Oregon Border, and the Nevada Oregon Border markets. Consistent with how the
3 west control area is defined in Washington rate proceedings, the Jim Bridger units,
4 including Jim Bridger Unit 3 and Unit 4, whether operating as coal-fueled or gas-
5 fueled assets, are assigned to the west control area.

6 **Q. How did you treat generation from the Jim Bridger plant that may not be**
7 **entirely deliverable to the west control area due to transmission limitations?**

8 A. Consistent with the approach used in the Company's Washington rate proceedings, an
9 annual ratio is applied to the output and costs from the Jim Bridger plant. The ratio is
10 calculated as the capacity of the Company's firm transmission rights from the Jim
11 Bridger plant to the west control area divided by the Jim Bridger plant. The annual
12 ratios are slightly higher for the coal-fueled scenario because of the slight reduction in
13 capacity when SCR systems are installed on Jim Bridger Unit 3 and Unit 4.

14 **Q. How are the long or short energy positions determined for the west control area?**

15 A. The SO Model simulations use economic dispatch to balance system loads and
16 resources on a total-company basis, considering transfer limits from owned and
17 purchased transmission rights throughout the system, including transfers between the
18 east and west sides of the Company's system. When the west control area is isolated
19 from the rest of the system, energy imbalances occur. For example, without east side
20 load obligations, the west control area may have less need for market purchases.
21 Conversely, without east side resources, the west control area may have less surplus
22 generation to support wholesale sales.

1 **Q. How are additional revenues and expenses calculated to fill the long and short**
2 **positions?**

3 A. The Company has filled long and short west control area positions from the SO
4 Model results consistent with method used to determine the west control area actual
5 net power costs for purposes of the annual Washington power cost adjustment
6 mechanism true-up. When the west control area is in a long position for a given
7 month, costs are reduced by removing the highest cost short term market purchases
8 until the west control area loads and resources are balanced. When the west control
9 area is in a short position for a given month, revenues are reduced by removing the
10 lowest cost short term market sales until the west control area loads and resources are
11 balanced. If forecasted short term volumes from the SO Model are insufficient to
12 cover the entire west control area position, any remainder is priced at the Mid-
13 Columbia market price for that month.

14 **Q. What is the base case result when evaluated on a west control area basis?**

15 A. On a west control area basis, installation of SCR systems on Jim Bridger Unit 3 and
16 Unit 4 is [REDACTED] lower cost than the next best, albeit higher cost alternative to
17 convert these two units to natural gas. As compared to the base case results on a
18 total-company basis, results on a west control area basis are directionally more
19 favorable to installation of the SCR systems. This outcome is driven by reduced
20 generation under a gas conversion scenario. On a total Company basis, the reduction
21 in generation is at least partially offset by generation from resources on the east side
22 of the Company's system. However, on a west control area basis, there is a reduction
23 in revenues from market sales and/or increases in expenses for incremental market

1 purchases. Confidential Exhibit No. RTL-8C provides detailed base case PVRR(d)
2 results on a west control area basis.

3 **NATURAL GAS AND CO₂ PRICE SCENARIO RESULTS**

4 **Q. Please describe the results from the natural gas and CO₂ price scenarios.**

5 A. The natural gas and CO₂ price scenario results show that the investment in SCR
6 systems at Jim Bridger Unit 3 and Jim Bridger Unit 4 remains favorable to the next
7 best, albeit higher cost natural gas conversion alternative under all base and high
8 natural gas price scenarios at all assumed CO₂ price levels. In these scenarios, the
9 PVRR(d) ranges between [REDACTED] favorable for the SCR systems (base gas, high
10 CO₂) and [REDACTED] favorable for the SCR systems (high gas, zero CO₂). The
11 PVRR(d) results are unfavorable for the SCR systems only in those scenarios where
12 low natural gas prices are assumed.

13 When low natural gas price assumptions are paired with base CO₂ price
14 assumptions, the nominal levelized price of natural gas at Opal over the period 2016
15 to 2030 is \$3.70 per mmBtu and the PVRR(d) is [REDACTED] unfavorable for the
16 SCR systems required at Jim Bridger Units 3 and 4. In the low natural gas, zero CO₂
17 scenario, the nominal levelized price of natural gas at Opal is \$3.41 per mmBtu over
18 the 2016 to 2030 timeframe, and the PVRR(d) is [REDACTED] unfavorable for the
19 SCR systems. When low natural gas prices are paired with high CO₂ price
20 assumptions, the nominal levelized price at Opal over the period 2016 to 2030 is
21 \$3.78 per mmBtu, and the PVRR(d) is [REDACTED] unfavorable for the SCR systems.
22 The PVRR(d) results from the natural gas and CO₂ price scenarios are summarized
23 alongside the base case results in Confidential Exhibit No. RTL-7C.

1 **Q. How do the PVRR(d) results trend among the different updated natural gas**
2 **price assumptions?**

3 A. The scenario results show that there is a strong trend between natural gas price
4 assumptions and the PVRR(d) benefit/cost associated with the SCRs required for
5 continued operation of Jim Bridger Units 3 and 4 as coal-fueled assets. With higher
6 natural gas price assumptions, the SCRs become more favorable as compared to the
7 Jim Bridger Unit 3 and Unit 4 gas conversion alternative. Conversely, lower natural
8 gas prices improve the PVRR(d) results in favor of the gas conversion alternative.
9 Lower natural gas prices reduce the fuel cost of the gas conversion alternative, reduce
10 the fuel cost of the other natural gas-fueled system resources that partially offset the
11 generation lost from the coal-fueled Jim Bridger units, and reduce the opportunity
12 cost of reduced off-system sales when Jim Bridger Units 3 and 4 operate as a gas-
13 fueled generation assets.

14 **Q. Can you infer from this trend how far natural gas prices would need to fall for**
15 **gas conversion to have been favorable to installation of SCR systems at Jim**
16 **Bridger Units 3 and 4?**

17 A. Yes. Confidential Exhibit No. RTL-9C graphically displays the relationship between
18 the nominal levelized natural gas price at the Opal market hub over the period 2016
19 through 2030 and the PVRR(d) benefit/cost of continued coal operation of Jim
20 Bridger Units 3 and 4 with installation of SCR systems. To isolate the effects of CO₂
21 prices, which as I described earlier are assumed to elicit a natural gas price response
22 due to changes in demand for natural gas in the electric sector, the natural gas price
23 relationship with PVRR(d) results is shown for the natural gas price scenarios in

1 which the base case CO₂ price assumption is used. Based on this trend, levelized
2 natural gas prices over the period 2016 through 2030 would need to decrease by 15
3 percent, from \$5.72 per mmBtu to \$4.86 per mmBtu, to achieve a breakeven
4 PVRR(d).

5 **Q. Based on this analysis described above, was it in customers' best interest to**
6 **pursue the installation of SCR systems at Jim Bridger Units 3 and 4?**

7 A. Yes. The economic analysis conducted by the Company clearly showed that
8 installation of the SCR systems was the least-cost, least-risk alternative.

9 **Q. When did the Company financially commit to installing the SCR systems at Jim**
10 **Bridger Units 3 and 4?**

11 A. The Company issued a partial notice to proceed to the engineer, procure, and
12 construct contractor on May 31, 2013, and a full notice to proceed on December 1,
13 2013.

14 **Q. What were forward natural gas prices at the time the Company committed to**
15 **installing SCR systems at Jim Bridger Units 3 and 4?**

16 A. Levelized natural gas prices at Opal over the period 2016 through 2030 from the
17 September 2013 OFPC, the most current OFPC at the time the full notice to proceed
18 was issued, were \$5.35 per mmBtu. Based upon the relationship described above, the
19 predicted PVRR(d) with natural gas prices applicable at the time the Company
20 committed to install SCR systems at Jim Bridger Units 3 and 4 would have been
21 approximately [REDACTED] lower cost than the gas conversion alternative.

22 **Q. How do the PVRR(d) results trend among the different CO₂ price assumptions?**

23 A. Higher CO₂ price assumptions improve the PVRR(d) in favor of the gas conversion

1 alternative, and lower CO₂ prices improve the economics of the investments required
2 to continue operating Jim Bridger Units 3 and 4 as coal-fueled assets. As with the
3 trend described in the relationship between natural gas prices and the PVRR(d)
4 results, the relationship between CO₂ prices and the PVRR(d) benefit/cost of the SCR
5 systems required at Jim Bridger Units 3 and 4 is intuitive. Because the CO₂ content
6 of coal is nearly double the CO₂ content of natural gas, higher CO₂ prices lead to
7 relatively lower cost of emissions for the gas conversion alternative and offset the
8 costs related to any generation lost from the coal-fueled Jim Bridger Units 3 and 4
9 assets.

10 **Q. What CO₂ price would be required to change the PVRR(d) results in favor of**
11 **converting Jim Bridger Units 3 and 4 to natural gas?**

12 A. Confidential Exhibit No. RTL-10C includes a graphical representation of the
13 relationship between the nominal levelized CO₂ price over the period 2016 to 2030
14 and the PVRR(d) benefit/cost of the incremental investments required for continued
15 coal operation of Jim Bridger Units 3 and 4. To isolate the effects of fundamental
16 shifts in the natural gas price assumptions, the CO₂ price relationship with the
17 PVRR(d) results is shown for the two CO₂ price scenarios that are paired with the
18 same underlying base case natural gas price assumption. Based upon the trend
19 between PVRR(d) and nominal levelized CO₂ price assumptions, the levelized CO₂
20 prices over the period 2016 through 2030 would need to exceed \$30 per ton, more
21 than three times the base case nominal levelized CO₂ price assumption, to achieve a
22 breakeven PVRR(d) for the Jim Bridger Unit 3 and Unit 4 SCR systems.

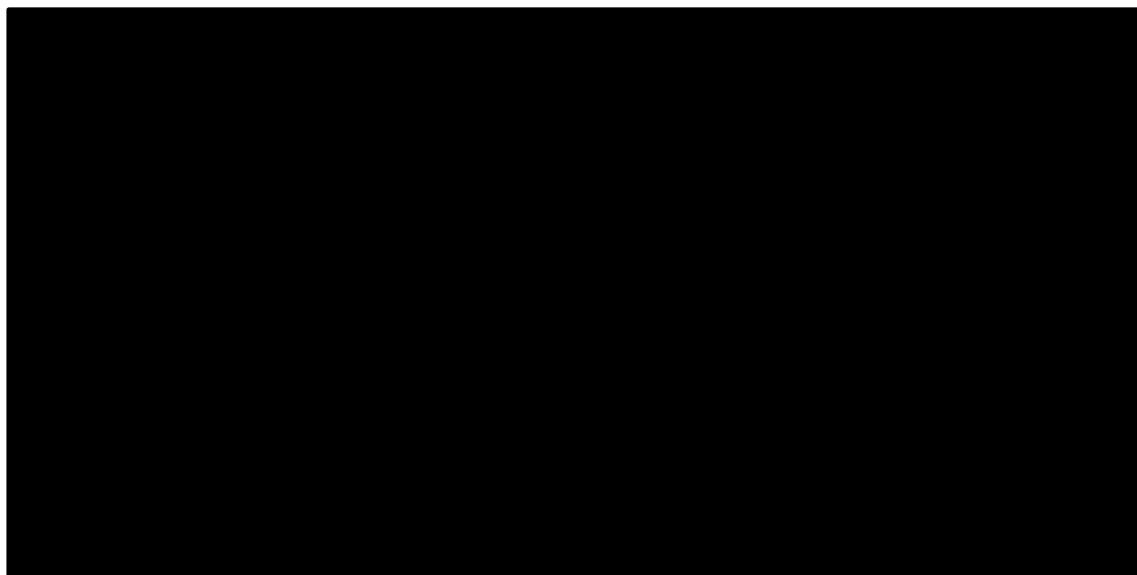
1 **Q. How did the Company use the natural gas and CO₂ price scenario results to**
2 **inform its decision to install the Jim Bridger Unit 3 and Unit 4 SCR systems?**

3 A. The Company first reviewed the magnitude of the PVRR(d) results from the base
4 case, which is defined by assumptions representing the Company's best estimate of
5 forward-looking assumptions at the time the analysis was completed. The base case
6 results provide an initial look at how favorable or unfavorable the SCR systems are in
7 relation to the next best alternative and provide context when reviewing scenario
8 results. The base case results summarized earlier in my testimony yield a PVRR(d)
9 showing that the Jim Bridger Unit 3 and Unit 4 SCR systems are [REDACTED] lower
10 cost than the natural gas conversion alternative. This outcome also indicates that
11 when the Company's best estimate of forward-looking assumptions was used, there
12 was a reasonably sized "cushion" in the PVRR(d) results allowing for some erosion
13 of the favorable economics should long-term natural gas prices or CO₂ prices change
14 from what was assumed in the base case analysis. The natural gas and CO₂ price
15 scenarios were then used to quantify how sensitive the PVRR(d) results are to these
16 key assumptions and provide the foundation for judging risk.

17 **Q. Can you describe how the Company has evaluated risk in the context of the**
18 **updated results from the natural gas and CO₂ price scenarios?**

19 A. Yes. Confidential Figure 3 shows the distribution of PVRR(d) results for the base
20 case and the eight natural gas and CO₂ price scenarios. The figure shows that of the
21 nine cases analyzed, six scenarios produce a PVRR(d) favorable to the SCR systems
22 and the three scenarios with low gas price assumptions produce a PVRR(d) that is
23 unfavorable to the SCR systems. The figure further illustrates the range of potential

1 PVRR(d) outcomes among the scenarios analyzed. At one end of the spectrum, the
2 PVRR(d) for the high gas zero CO₂ scenario is [REDACTED] favorable to the SCR
3 systems. On the other end of the spectrum, the PVRR(d) for the low gas high CO₂
4 scenario is [REDACTED] unfavorable to the Jim Bridger Unit 3 and Unit 4 SCR
5 systems. Among the scenarios analyzed, the distribution of PVRR(d) outcomes
6 indicate a disproportionate risk profile. While there is a possibility that the evolution
7 of future natural gas prices could render the decision to invest in SCR systems to be
8 higher cost than a gas conversion alternative, the cost impacts to customers of such an
9 outcome are higher under a gas conversion alternative should future natural gas prices
10 rise relative to the base case.



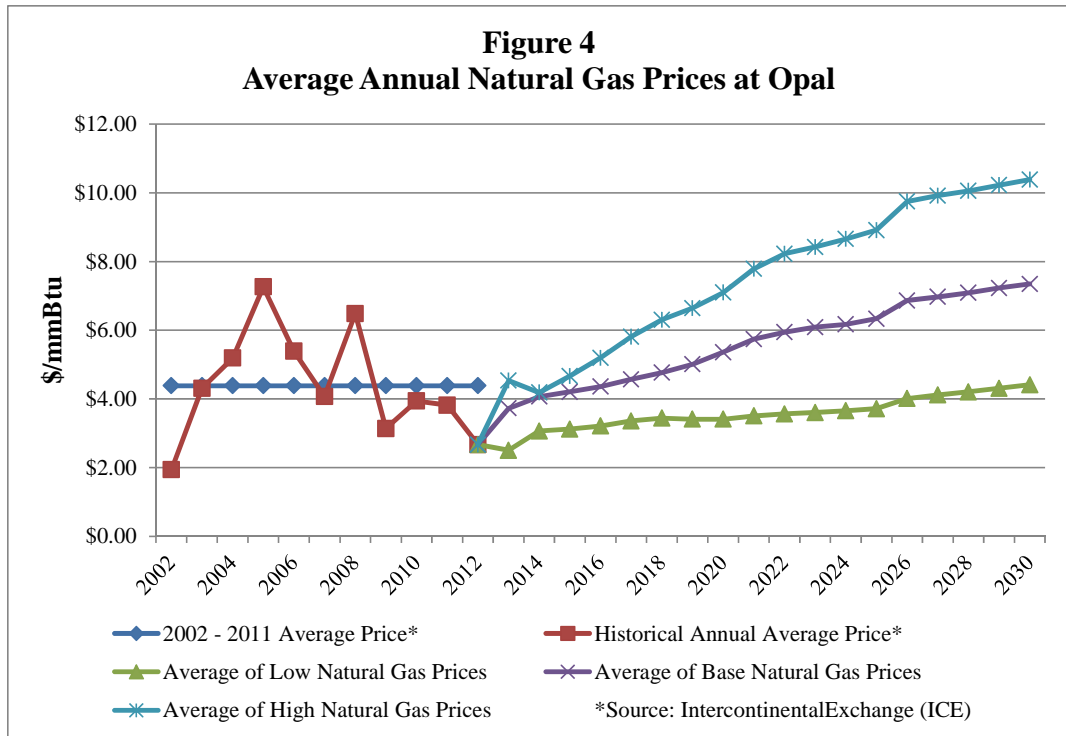
11 **Q. Given the impact of low gas prices on the PVRR(d) results, how did you analyze**
12 **the uncertainty around future natural gas prices?**

13 A. A useful metric is to compare the potential range of future natural gas price scenarios
14 in the context of historical natural gas price levels. Figure 4 plots historical natural
15 gas prices alongside the average annual natural gas price at the Opal hub among the

1 three low natural gas price scenarios, the three base natural gas price scenarios, and
2 the three high natural gas price scenarios.

3 Opal natural gas prices among the low natural gas price scenarios never reach
4 2002 to 2012 historical average price levels over the course of the next 18 years.

5 Among the low natural gas price scenarios, the average annual price for natural gas at
6 Opal over the period 2013 through 2030 is \$3.59 per mmBtu, which is 18 percent
7 below 2002 to 2012 historical price levels. Among the base natural gas price
8 scenarios, which are representative of the best estimate of forward-looking
9 assumptions available at the time, the average annual price for Opal natural gas was
10 \$5.66 per mmBtu, or 29 percent above 2002 – 2012 historical price levels. Among
11 the high natural gas price scenarios, Opal natural gas prices average \$7.60 per
12 mmBtu, representing a 73 percent increase relative to 2002 to 2012 historical prices.



EARLY RETIREMENT SENSITIVITY ANALYSIS

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Q. Did the Company's base case and scenario analyses allow for early retirement as an alternative to the SCR systems?

A. Yes. The PVRR(d) was calculated by taking the difference in system costs between two SO Model simulations. One simulation assumes the SCR systems are made and Jim Bridger Unit 3 and Unit 4 continue operating as coal-fueled assets. The second simulation forces Jim Bridger Unit 3 and Unit 4 to stop operating as coal-fueled assets, allowing the model to choose among the most economical alternative to the SCR systems, which includes gas conversion and early retirement. In all of the simulations forcing Jim Bridger Unit 3 and Unit 4 to stop operating as coal-fueled assets, the SO Model chose gas conversion over early retirement when it is assumed the SCR systems are not made.

Q. Did the Company perform an additional sensitivity that shows gas conversion as a lower cost SCR alternative than early retirement with a replacement resource located closer to load centers?

A. Yes. For this sensitivity, in the case where Jim Bridger Unit 3 and Unit 4 stop operating as coal-fueled assets, each unit is forced to retire (not allowing it to choose gas conversion) for purposes of calculating the PVRR(d).

Q. What are the results of this sensitivity analysis?

A. When Jim Bridger Unit 3 and Unit 4 are forced to retire early, the SO Model adds a 597 MW combined cycle unit located in southern Utah in 2017.⁴ As compared to an early retirement alternative, the PVRR(d) is [REDACTED] in favor of the Jim Bridger

⁴Incremental front office transactions are also included in the portfolio when Jim Bridger Unit 3 and 4 are forced to retire early.

1 Unit 3 and Unit 4 SCR systems. The sensitivity also shows that gas conversion,
2 while unfavorable to the SCR systems, has a PVRR(d) that is [REDACTED] favorable
3 to early retirement.

4 **CONCLUSION**

5 **Q. Please summarize the conclusions of your testimony.**

6 A. The conclusions of my testimony are as follows:

- 7 • The base case analysis results in a PVRR(d) that is [REDACTED] favorable to
8 the Jim Bridger Unit 3 and Unit 4 SCR systems as compared to a natural gas
9 conversion alternative.
- 10 • Base case results on a west control area basis show a [REDACTED] PVRR(d)
11 favorable to the SCR systems on Jim Bridger Units 3 and 4.
- 12 • Additional sensitivity analysis shows a PVRR(d) that is [REDACTED]
13 favorable to the Jim Bridger Unit 3 and Unit 4 SCR systems as compared to
14 an early retirement and resource replacement alternative.
- 15 • Natural gas and CO₂ price scenario results support the SCR systems in all
16 scenarios but those with low natural gas price assumptions, which do not
17 reach historical price levels for the next 18 years.

18 **Q. Does this conclude your direct testimony?**

19 A. Yes.