

Application No. 18-04-____
Exhibit PAC/600
Witness: Timothy J. Hemstreet

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

PACIFICORP

REDACTED

Direct Testimony of Timothy J. Hemstreet

Wind Repowering

April 2018

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ATTACHED EXHIBITS

Exhibit PAC/601 – Major Components of a Wind Generator

Exhibit PAC/602 – Wind Facilities Map

Exhibit PAC/603 – List of Projects to be Repowered

Exhibit PAC/604 – Repowering Project Details, Capital Costs, and In-Service Dates

Exhibit PAC/605 – Existing and Repowered Turbine Power Curve Comparison

Exhibit PAC/606 – Wind Repowering Project Schedule

1 **Q. Please state your name, business address, and present position with PacifiCorp**
2 **d/b/a Pacific Power (PacifiCorp).**

3 A. My name is Timothy J. Hemstreet. My business address is 825 NE Multnomah
4 Street, Suite 1500, Portland, Oregon 97232. My present position is Director of
5 Renewable Energy Development.

6 **I. QUALIFICATIONS**

7 **Q. Briefly describe your education and business experience.**

8 A. I hold a Bachelor of Science degree in Civil Engineering from the University of Notre
9 Dame in Indiana and a Master of Science degree in Civil Engineering from the
10 University of Texas at Austin. I am also a Registered Professional Engineer in the
11 state of Oregon. Before joining the company in 2004, I held positions in engineering
12 consulting and environmental compliance. Since joining PacifiCorp, I have held
13 positions in environmental policy, engineering, project management, and
14 hydroelectric project licensing and program management. In 2016, I assumed the role
15 of Director of Renewable Energy Development, in which I oversee the development
16 of renewable energy resources.

17 **II. PURPOSE OF TESTIMONY**

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

19 A. In support of PacifiCorp's application for approval of wind repowering and
20 associated ratemaking treatment, my testimony provides technical information
21 regarding the company's proposal to upgrade, or "repower," most of its wind fleet.
22 Specifically, my testimony addresses:

- 23
- The scope of the project;

- 1 • The financial benefits of repowering resulting from the qualification for
- 2 federal production tax credits (PTCs);
- 3 • The increased energy benefits following repowering;
- 4 • The reduced ongoing operating costs following repowering;
- 5 • The extension of wind facility asset lives after repowering;
- 6 • Project contract status and construction schedule; and
- 7 • The disposition of removed equipment.

8 **III. OVERVIEW OF WIND REPOWERING AND PROJECT SCOPE**

9 **Q. Please briefly describe what repowering a wind facility entails.**

10 A. Repowering broadly describes the upgrade of an existing, operating wind facility with
11 new wind-turbine-generator (WTG) equipment that can increase a facility's
12 generating capacity and the amount of electrical generation produced from the
13 facility. Specifically, PacifiCorp's repowering plan involves replacing the nacelle,
14 hub and rotor of the WTG. See Exhibit PAC/601 for a depiction of a wind turbine
15 and its various components.

16 **Q. Which facilities does PacifiCorp propose to repower?**

17 A. By the end of 2019, PacifiCorp is planning to upgrade (i) all of its wind facilities in
18 Wyoming (except the company's Foote Creek I and Dunlap facilities), including the
19 facilities known as Glenrock I, Glenrock III, Rolling Hills, Seven Mile Hill I, Seven
20 Mile Hill II, High Plains, and McFadden Ridge; (ii) its Leaning Juniper facility in
21 Oregon; and (iii) its Marengo I, Marengo II, and Goodnoe Hills facilities in
22 Washington. PacifiCorp plans to repower its Dunlap facilities in Wyoming in 2020
23 and, as discussed below, is still evaluating whether it is economic to repower its Foote

1 Creek I facility in Wyoming. See Exhibit PAC/602 for a map depicting the locations
2 of each of PacifiCorp's wind facilities.

3 **Q. Please explain why repowering is feasible for these wind facilities.**

4 A. The wind facilities PacifiCorp proposes to repower began commercial operations
5 between 2006 and 2010. Because of their age, they can be economically repowered,
6 or upgraded, with new technology that will improve their efficiency and increase their
7 generation output, without incurring the cost to replace the existing towers,
8 foundations, and energy collection systems. The existing foundations and towers,
9 although more than 10 years old in some instances, are adequately designed to
10 accommodate larger, more modern WTG equipment and have a sufficient remaining
11 useful life to economically justify the associated investment.

12 In contrast, at facility sites developed more than about 15 years ago, the WTG
13 equipment typically has a low generating capacity (*i.e.*, sub-1,000 kilowatt) and the
14 towers and foundations supporting the nacelle and rotor do not have the height or
15 design strength to accommodate the installation of modern, larger nacelles and rotors
16 capable of generating a much greater amount of electricity per WTG. With these
17 older facilities, repowering usually involves the removal of all of the old wind turbine
18 equipment, including towers, foundations, and energy collection system, and the
19 redevelopment of the entire site.

20 Because PacifiCorp plans to repower its facilities in a way that allows the
21 company to reuse the existing infrastructure of the towers, foundations, and energy
22 collection systems, the energy and PTC benefits can be realized with a lower capital
23 investment.

1 **Q. Did PacifiCorp's 2017 Integrated Resource Plan (2017 IRP) evaluate repowering**
2 **all of the facilities described above?**

3 A. Yes, except for Goodnoe Hills. When the 2017 IRP was developed, PacifiCorp had
4 not assessed repowering Goodnoe Hills. Since that time, however, PacifiCorp has
5 evaluated the facility and determined that Goodnoe Hills can be economically
6 repowered similar to the facilities evaluated in the 2017 IRP.

7 **Q. Are the costs to repower the Dunlap facilities in Wyoming included in this**
8 **general rate case?**

9 A. No. The Dunlap facilities will be repowered in 2020 which is outside the 2019 test
10 period for the rate case. Only the wind facilities repowered in 2019 are included in
11 this rate case.

12 **Q. Why did PacifiCorp exclude Foote Creek I in Wyoming from the proposed wind**
13 **repowering project at this time?**

14 A. As noted in the 2017 IRP action plan item 1a, PacifiCorp is still evaluating the
15 potential of repowering Foote Creek I. Repowering this older facility would involve
16 more comprehensive site redevelopment, as described above, which is different in
17 scope than the repowering projects proposed here. If PacifiCorp determines that
18 repowering Foote Creek is economic for customers, it will pursue the appropriate
19 regulatory process for doing so.

20 **Q. How many megawatts (MW) of installed wind capacity is PacifiCorp proposing**
21 **to repower?**

22 A. PacifiCorp is planning to repower 12 of its 13 wind facilities in 2019 and 2020,
23 representing 999.1 MW of installed wind capacity. Broken down by state, this

1 consists of eight facilities in Wyoming comprising 594 MW, one facility in Oregon of
2 100.5 MW, and three facilities in Washington comprising 304.6 MW. Detailed
3 information about the wind facilities PacifiCorp plans to repower is included in
4 Exhibit PAC/603.

5 **IV. FINANCIAL BENEFITS OF REPOWERING INCLUDING**
6 **REQUALIFICATION FOR PTCs**

7 **Q. What benefits will customers realize from wind repowering?**

8 A. Repowering the proposed wind facilities will requalify them for PTCs, and these
9 benefits will be fully passed on to PacifiCorp's customers through the Energy Cost
10 Adjustment Clause (ECAC) as described in Mr. Michael G. Wilding's testimony
11 (Exhibit PAC/900). Additionally, repowering will increase the amount of emissions-
12 free energy produced from the repowered turbines by 17 to 39 percent, depending on
13 the facility, as shown in Confidential Exhibit PAC/604.¹ Further, by replacing older
14 WTG equipment, which is subject to more failure and maintenance issues than newer
15 equipment, repowering will reduce PacifiCorp's ongoing operating costs. Finally,
16 repowering the wind facilities with new WTG equipment will extend the useful lives
17 of the facilities by at least 10 years, creating substantial energy benefits for customers
18 in the future when these wind facilities would otherwise have been retired from
19 service.

20 **Q. How are the repowered wind facilities able to requalify for PTCs?**

21 A. On December 18, 2015, Congress enacted changes to the federal Internal Revenue
22 Code that extended the full value of the PTC for wind energy facilities that began

¹ This range reflects increases under existing transmission interconnection agreements. The range is 22 percent to 39 percent if transmission interconnection agreements are modified to reflect the additional capacity available from the repowered turbines.

1 construction in 2015 and 2016. The legislation also provided for a phase-out of the
2 PTC over three years, reducing the PTC value by 20 percent for wind facilities
3 beginning construction in 2017, 40 percent for wind facilities beginning construction
4 in 2018, and 60 percent for wind facilities beginning construction in 2019. The
5 Internal Revenue Service (IRS) has issued guidance that establishes a “safe harbor”
6 for taxpayers to demonstrate the year a facility will be deemed to “begin
7 construction,” thereby setting the value of the PTC. If at least five percent of the total
8 project costs are incurred in 2016, then the facility qualifies under the IRS safe harbor
9 for the full value of the PTC, provided the taxpayer can demonstrate “continuous
10 efforts” to complete construction. The IRS has issued additional guidance that
11 establishes a safe harbor for satisfying this continuous-efforts standard. Under the
12 continuous-efforts safe harbor, the wind facilities must be in service by the end of the
13 fourth calendar year following the calendar year in which construction began. Thus,
14 wind facilities that began construction in 2016 must be in service no later than
15 December 31, 2020, to satisfy the continuous-efforts safe-harbor provisions. If not
16 installed by December 31, 2020, the projects must satisfy IRS requirements that
17 continuous-efforts were expended to repower the facilities, which is a difficult
18 standard to meet.

19 **Q. Does PacifiCorp’s repowering project qualify for the full value of the PTC under**
20 **these rules?**

21 A. Yes. Consistent with IRS guidance, a facility owner can demonstrate that
22 construction of a facility has begun in the year in which at least five percent of the
23 applicable project costs are incurred. If wind turbine equipment is purchased and

1 delivered in 2016, and the equipment comprises at least five percent of the applicable
2 project costs, a PTC safe harbor is created for the wind facilities subsequently
3 constructed. To meet this requirement, PacifiCorp executed safe-harbor equipment
4 purchases with General Electric International, Inc. (GE) and Vestas American Wind
5 Technology, Inc. (Vestas) in December 2016, and took delivery of equipment with a
6 value sufficient to give the company the ability to repower its entire wind fleet and
7 qualify the repowered wind facilities for 100 percent of the PTC value.

8 **Q. What is the full value of the PTC for wind facilities?**

9 A. For 2018, wind facilities that are qualified for the PTC will receive an estimated
10 2.4 cents per kilowatt-hour, or \$24 per megawatt-hour. This PTC value is adjusted
11 annually based upon an inflation index, and the PTC is available for energy produced
12 during the 10-year period after the wind facility begins commercial operation.

13 **Q. What other requirements must repowered projects satisfy to qualify for the**
14 **PTC?**

15 A. On May 5, 2016, the IRS issued Notice 2016-31² (Notice) which provides guidance
16 on various aspects of qualifying for the PTC and whether new tax credits can be
17 claimed when wind turbines are repowered or retrofitted. The Notice generally
18 provides that the repowering costs must equal at least four times the fair market value
19 of the equipment that the owner retains from the original facility for the repowered
20 turbines to qualify for new PTCs. Thus, 80 percent of the fair market value of the
21 repowered WTG must result from repowering project costs while the value of the
22 retained components cannot exceed 20 percent of the fair market value of the new

² The IRS Notice 2016-31 is available at: https://www.irs.gov/irb/2016-23_IRB/ar07.html.

1 facility. This “80/20” test is applied on a turbine-by-turbine basis. Each wind
2 turbine—composed of a foundation, tower, and machine head (including nacelle, hub
3 and rotor)—is considered a separate facility.

4 **Q. Do all of the wind turbines PacifiCorp is proposing to repower meet this 80/20**
5 **test?**

6 A. Yes. The repowering project has been scoped to ensure that the 80/20 test, which is
7 applied at the time the turbine is repowered, will be met for each turbine repowered.
8 Not all turbines at all wind facilities, however, will be repowered because the retained
9 value of the towers and foundations at certain wind turbines does not allow them to
10 meet the 80/20 test before the end of 2020, when the repowered wind facilities must
11 be completed to obtain the full PTC value.

12 **Q. Which wind facilities will not have all wind turbines repowered?**

13 A. Repowering at Glenrock I, Rolling Hills and Glenrock III, all of which are located
14 near Glenrock, Wyoming, will not include all wind turbines. At these locations, 32 of
15 the 158 wind turbines will not be repowered because they were constructed atop mine
16 tailings at the company’s reclaimed Glenrock coal mine and required special pile
17 foundations. These special foundations were more expensive to construct than the
18 standard foundations found elsewhere on those facility sites and at other PacifiCorp
19 wind facility locations. Because the original construction cost of these foundations
20 was higher than for standard foundations, the retained value of these foundations is
21 also higher than the other foundations. For these 32 wind turbine locations, the
22 higher retained value of the foundations means that repowering, while technically
23 feasible, would not qualify those turbines for PTCs, which is necessary for the

1 repowering to be economic. PacifiCorp plans to repower all of the turbines at the
2 other wind facilities discussed above.

3 **Q. How else has PacifiCorp scoped the repowering project to maximize the benefits**
4 **of available PTCs?**

5 A. As shown in Exhibit PAC/603, the majority of the wind facilities PacifiCorp proposes
6 to repower are still within 10 years of their original commercial online date. Thus,
7 the PTCs from original construction are still accruing to the benefit of PacifiCorp's
8 customers. The existing PTCs for these wind facilities will expire 10 years after the
9 facilities' commercial online date. Between May 2018 and October 2020, the PTCs
10 associated with approximately 2.275 terawatt-hours (TWh) of electricity generated at
11 PacifiCorp's wind facilities will expire. On an annual basis, in 2018 dollars, the
12 expiration of these PTCs represents the loss of approximately \$72 million per year in
13 customer PTC benefits, as shown in Exhibit PAC/603.

14 To maximize the benefits of the existing PTCs available from the wind
15 facilities, PacifiCorp will generally delay repowering until the original PTCs have
16 expired. While not included in this rate case, the exception to this is Dunlap, where
17 the PTCs expire in October 2020. To repower Dunlap by the end of 2020, as required
18 to re-qualify for PTCs, repowering must begin before October 2020 so construction
19 can be completed before the winter season. This results in a slight truncation of the
20 existing, original 10-year PTC period for that facility. As with all of the wind
21 facilities, however, once Dunlap is repowered, it will then re-start a 10-year period
22 where its generation is eligible for the full value of PTCs.

1 **Q. Have recent changes to federal tax laws impacted the ability of the repowering**
2 **projects to qualify for PTCs?**

3 A. No. The recent tax law changes enacted into law in December 2017 have not
4 impacted the ability of the repowering projects to qualify for the full value of PTCs.

5 **V. INCREASED ENERGY BENEFITS FOLLOWING REPOWERING**

6 **Q. Once repowered, how do the energy benefits of the wind facilities increase?**

7 A. Repowering will involve the replacement of the existing machine heads including the
8 nacelle, hub and rotor. The new nacelles have generators that have a greater
9 nameplate generating capacity than the equipment that is removed. For example, the
10 nameplate of each turbine at the Wyoming facilities will increase from 1.5 MW to
11 1.85 MW, while at the Marengo facility, the generator nameplate rating will increase
12 from 1.8 MW to 2.0 MW. Details regarding the proposed wind turbine upgrades,
13 capital project costs, in-service dates, and resulting energy benefits are shown in
14 Confidential Exhibit PAC/604.

15 In addition to the larger generators in the repowered turbines, PacifiCorp will
16 also install larger blades. With the larger blades, the rotor-swept area of the wind
17 turbines will increase between 37 to 56 percent, depending on the type of turbine. A
18 larger rotor-swept area allows more of the wind energy flowing past the wind turbine
19 to be captured and converted by the wind turbine into electricity. Because the size of
20 the rotors will increase, the repowered turbines will also include more robust hubs,
21 main shafts, bearings and couplings, and gearboxes suitable to handle the greater
22 torque exerted by the larger rotors.

1 **Q. Will the larger blades installed with repowering increase the potential for avian**
2 **impacts at the wind facilities?**

3 A. Although the larger blades will increase the overall risk zone (rotor-swept area) of the
4 repowered wind turbines, this does not necessarily correlate with an increased risk of
5 avian impacts at existing turbine sites. PacifiCorp will continue to implement its
6 current informed-curtailment protocols after repowering to minimize avian impacts.
7 Informed curtailment involves the shutdown of wind turbines when species of interest
8 are in the vicinity. PacifiCorp's informed-curtailment protocols avoid avian impacts
9 regardless of the swept area of the rotor. PacifiCorp performs monthly monitoring at
10 all of its wind facilities and reports all findings to state wildlife agencies and the U.S.
11 Fish and Wildlife Service. PacifiCorp will continue this monthly monitoring to
12 determine if the new turbine blades cause additional impacts to avian species and will
13 engage with the appropriate agency to discuss and, if prudent and practicable,
14 implement additional avoidance, minimization, or mitigation measures.

15 **Q. How did PacifiCorp determine the amount of additional generation that will be**
16 **produced from the repowered wind turbines?**

17 A. PacifiCorp worked with its consultant, Black & Veatch (B&V), to use the extensive
18 data history from PacifiCorp's facilities to derive precise estimates of the energy
19 production expected from repowering. This analysis used more than 160 million data
20 points from the operational record of the wind facilities and incorporated additional
21 modeled wake losses anticipated from the new equipment. Wake losses are the
22 reduction in generation at turbines downwind of other turbines due to reduced wind
23 speed and increased turbulence in the airflow—or wake—behind a turbine.

1 Based on its analysis, PacifiCorp and B&V estimate that energy production
2 following repowering will increase as shown in Confidential Exhibit PAC/604, as
3 further discussed below. These results reflect as accurately as possible the energy
4 production that would have occurred from the repowered turbines under the same
5 operational conditions and availability as the existing equipment. However, these
6 repowering energy estimates likely are conservative. They are based solely on the
7 different equipment performance specifications of the newer equipment and do not
8 account for expected improvements in operational availability of the wind facilities
9 following repowering. Availability of the wind turbines likely will improve after
10 repowering given the additional sensors and condition monitoring systems in the
11 repowered turbines that should allow for improved diagnostics and implementation of
12 preventative maintenance measures that can reduce turbine down-time. Additionally,
13 PacifiCorp will enter into service agreements with the turbine suppliers GE and
14 Vestas with performance guarantees and incentives that are likely to result in more
15 availability and generation than PacifiCorp has achieved in the past under similar
16 wind conditions. These contracts are discussed in more detail later in this testimony.

17 **Q. What are the major power production advantages of the new equipment?**

18 A. The larger rotor size and improvements in blade design of the new equipment
19 generate more power at all ranges of wind speeds. Additionally, some of the new
20 turbines begin producing power at a lower wind speed than the existing equipment;
21 thus, the turbines can produce energy during lower wind conditions in which the
22 current equipment may sit idle. Because the new turbines, at most facilities, will have
23 an increased generator capacity, the turbines will also produce more energy when

1 wind speeds are high and the turbines are at their maximum output. Exhibit PAC/605
2 illustrates these power production advantages and compares the power curves of an
3 existing wind turbine to those of a repowered wind turbine.

4 **Q. Why did PacifiCorp not install this larger equipment when the wind facilities**
5 **were initially constructed?**

6 A. Wind turbine technology has continued to advance since the facilities were first
7 constructed between 2006 and 2010. The use of new composite materials has
8 allowed blade lengths to increase without adding weight, allowing for the extraction
9 of more energy from the available wind resources at the facility sites. In addition,
10 more sophisticated sensor and control systems in the wind turbines, combined with
11 improved blade pitch control systems, increase the ability of the wind turbine control
12 systems to implement load mitigation strategies on the wind turbines to reduce the
13 loading on the power train, towers and foundations. For new wind facilities, these
14 technology improvements mean that longer blades and additional generating capacity
15 is possible without a commensurate increase in cost to strengthen the turbine
16 structural components (including the tower and foundation). For new wind facilities,
17 this is one of the drivers towards reduced energy costs. For existing wind facilities,
18 these new load mitigation technologies mean that the existing towers and foundations
19 are suitable for the installation of larger equipment through repowering.

20 **Q. How much additional energy will the repowered wind facilities produce?**

21 A. As shown in Confidential Exhibit PAC/604, across the wind fleet, the proposed
22 repowered wind facilities are estimated to increase generation by 738 gigawatt-hours
23 (GWh) per year if the facilities are operated within the limits of their existing large

1 generator interconnection agreements—an increase of 25.7 percent. If the facilities in
2 Wyoming are able to operate at their full generating capability following a
3 modification to the applicable transmission interconnection agreements, the
4 additional generation increases to 855 GWh per year, or an increase of 29.8 percent.

5 **Q. Is PacifiCorp planning to use the additional generating capacity provided by the**
6 **repowered wind turbines?**

7 A. Yes. In order to use the additional generating capacity provided by the repowered
8 wind turbines, PacifiCorp will need to modify its existing transmission agreements
9 for these facilities. Accordingly, PacifiCorp has filed generation interconnection
10 applications for the additional generation at the existing points of interconnection for
11 the planned repowering projects, except for Leaning Juniper and Goodnoe Hills. Due
12 to transmission constraints at Leaning Juniper and Goodnoe Hills, PacifiCorp does
13 not expect additional transmission capacity to be available for those facilities.

14 PacifiCorp's transmission function is currently reviewing the submitted
15 applications and preparing the required studies under the company's Open Access
16 Transmission Tariff. Two separate studies are required, including (i) a system impact
17 study and (ii) a facilities study. The completed studies will provide information on
18 the transmission upgrades, if any, needed to accommodate the interconnection
19 request. Once all studies are complete, PacifiCorp's transmission function will
20 determine if it can offer revised Large Generator Interconnection Agreements to the
21 company's merchant function.

22 Transmission studies for the Marengo I and Marengo II facilities have been
23 completed and the company has executed a new interconnection agreement with

1 PacifiCorp's transmission function that allows the additional capacity to be
2 interconnected so that these facilities can deliver the increased capacity and the
3 associated energy to customers. The remaining transmission studies are still pending.

4 **Q. If the generation interconnection agreements are modified, does PacifiCorp**
5 **expect there will be additional costs to realize that additional generation?**

6 A. Yes. Due to the higher nameplate capacity of the repowered turbines in Wyoming,
7 PacifiCorp will need to replace the turbine pad-mount transformers, upgrade some
8 segments of the collector systems, and retrofit or replace certain generator step-up
9 transformers to allow the turbines to operate at full capacity. PacifiCorp expects the
10 total cost of these upgrades to increase project costs by \$36 million, for a total cost of
11 approximately \$1.137 billion if the transmission interconnection agreements can be
12 modified. In addition, ongoing transmission studies will determine the costs of
13 interconnecting the additional project capacity to the transmission system. Studies
14 completed to date have estimated these costs at less than \$200,000 per facility.

15 **Q. Is the repowering project economic even without the ability of the wind facilities**
16 **to generate at their full repowered nameplate capacity?**

17 A. Yes, Mr. Rick T. Link demonstrates in his testimony (Exhibit PAC/500) the
18 repowering project is economic even if the facilities are operated within their existing
19 transmission capacity limits. An adjustment to the large-generator interconnection
20 agreements to allow the facilities to be operated at full nameplate capability following
21 repowering simply improves the already favorable economics of the repowering
22 project. Because of the uncertainty regarding the ability of the Wyoming wind
23 facilities to interconnect the additional capacity, PacifiCorp's economic analysis is

1 based upon a scenario in which the Wyoming projects are operated within the
2 existing capacity of their transmission interconnection agreements.

3 **VI. REDUCED ONGOING OPERATIONAL COSTS FOLLOWING**
4 **REPOWERING**

5 **Q. Aside from increased generation and the associated PTC benefits, what other**
6 **benefits will be realized with the repowering project?**

7 A. The repowering project will lower the ongoing capital costs of operating the existing
8 wind facilities. PacifiCorp's turbine-supply contracts for repowering, consistent with
9 wind industry standards for new equipment, will include a two-year warranty on the
10 new equipment. This will reduce capital costs associated with replacing or
11 refurbishing the equipment currently in service. Additionally, the new turbine
12 equipment associated with repowering, will obviate, to a large extent, capital costs
13 associated with major turbine component replacements and refurbishments
14 (generators, gearboxes, blades, and small components). After the two-year warranty
15 period for the new equipment expires, these costs are expected to be lower than the
16 costs for the current equipment that has now been in service for up to 11 years.
17 Further, capital costs will be reduced before repowering as the investment horizon for
18 the existing wind turbines closes and various capital replacements no longer make
19 economic sense given the short remaining installed life of the turbines to be
20 repowered.

21 The repowering project will also result in more certainty related to ongoing
22 operations and maintenance costs of the existing wind facilities. PacifiCorp will
23 execute full service agreements on the new GE turbines under which GE will be
24 responsible for operating and maintaining the new turbines for a fixed cost while

1 attaining a guaranteed production-based availability on the turbines, with failure to
2 meet the guaranteed availability resulting in the payment of liquidated damages to the
3 company. Customers will benefit by having operations and maintenance costs fixed
4 for the term of the agreement. Thus, there is cost certainty related to the run-rate
5 capital expenditures and operations and maintenance costs of the repowering projects
6 in addition to the cost certainty related to construction. PacifiCorp's negotiated full
7 service agreement with GE is for a 10-year period, which the company may elect to
8 extend to 13 years. For facilities employing Vestas turbines, PacifiCorp will execute
9 service agreements for an additional three years beyond the two-year warranty period.

10 **Q. Will PacifiCorp's reduced capital investments during the transition to**
11 **repowering cause a reduction in the generation from the facilities?**

12 A. Yes. Before repowering is complete, some of the existing turbines may experience
13 component failures that render them unable to be economically returned to service. It
14 will be more economic for customers to idle these turbines than repair them given the
15 short period before repowering. As a result, PacifiCorp estimates that generation
16 from the wind facilities targeted for repowering will be reduced before repowering.
17 These estimates of pre-repowering generation impacts are factored into the economic
18 analysis.

19 **Q. Will the new equipment address any other operational cost issues?**

20 A. Yes. In addition to the reduced capital run rate of the new equipment in its early
21 years after installation, repowering will avoid costs from replacing certain major
22 turbine components that are experiencing high failure rates. One category of avoided
23 costs relates to failures of certain models of gearboxes found in the Wyoming wind

1 fleet and Leaning Juniper and Marengo projects. These gearboxes, which are original
2 equipment from the manufacturers, are experiencing high failure rates compared to
3 other models of gearboxes installed in WTGs at these facilities and elsewhere within
4 the wind fleet. Consequently, PacifiCorp has experienced increased capital costs in
5 recent years to address the gearbox failures, and these models are no longer being re-
6 installed as long-term replacement equipment after failure, given their poor historical
7 performance.

8 **Q. Why are these gearbox failures significant?**

9 A. These gearbox failures generally cannot be repaired “up-tower”. The repair cannot be
10 completed within the nacelle without removing the damaged equipment by crane.
11 These failures cost approximately \$400,000 per occurrence, including equipment and
12 labor costs to purchase and install a replacement gearbox and the costs of mobilizing
13 a large crane to the site to remove and replace the equipment. These costs also do not
14 account for the lost generation from the time the turbine is down until the repair is
15 completed.

16 **Q. How many gearbox failures of this type are expected if there is no repowering?**

17 A. There are 230 of these gearbox models remaining in the wind fleet, and PacifiCorp
18 anticipates that all of these remaining gearboxes will fail within the next 15 years.

19 **Q. Will repowering completely address these gearboxes with shorter-than-
20 anticipated service lives?**

21 A. No. Twelve of the 32 wind turbines that will not be repowered at Glenrock I,
22 Glenrock III, and Rolling Hills have these gearbox models that will need to be
23 replaced, which is factored into the economic analysis. Following repowering, these

1 gearboxes—as well as potential failures of other gearbox models at the non-
2 repowered units—can be replaced with those removed from the existing turbines as
3 part of the repowering effort, reducing the repair costs of the remaining gearboxes.
4 The cost savings of doing so, however, have not been factored into PacifiCorp’s
5 economic analysis because the company is still evaluating how best to realize value
6 for customers from the removed equipment.

7 **Q. Are other significant capital costs avoided with repowering?**

8 A. Aside from the gearbox issues, repowering will also avoid ongoing capital
9 expenditures related to blade costs at Goodnoe Hills. Blade expenditures at this
10 facility represent approximately 60 percent of the budgeted capital costs associated
11 with blade failures and refurbishments across PacifiCorp’s wind fleet, even though
12 Goodnoe Hills accounts for only seven percent of the turbines. Repowering is
13 expected to bring blade costs for that facility in line with PacifiCorp’s expenditures at
14 its other facilities, resulting in reduced capital costs to keep the wind fleet meeting its
15 operational performance targets.

16 Given these ongoing gearbox and blade failure costs, repowering is
17 particularly attractive because repowering avoids significant forecast capital
18 expenditures to maintain turbine production while extending asset life, increasing
19 generation, and requalifying the wind turbine for PTCs for another 10-year period.

20 **Q. Will the new repowering equipment have similar failure issues as the old**
21 **gearboxes?**

22 A. No. The gearbox models in the fleet that are experiencing high failure rates will not
23 be included in the equipment installed for repowering. Further, the equipment that

1 will be installed has evolved from the product lines of the existing turbines, rather
2 than arising from entirely new product offerings. Thus, the turbine suppliers have
3 had time to learn from their past experience with these turbine models and have made
4 adjustments in their designs, specifications, and choice of subcomponent suppliers to
5 enhance turbine reliability. Because of the warranty service requirements in the
6 turbine-supply contracts and because the turbine suppliers are often under long-term
7 service agreements for the turbines they supply—such as will be the case with the GE
8 turbines—the turbine suppliers have an incentive to improve the reliability of their
9 turbines. Thus, PacifiCorp does not expect to have the problems and expense it has
10 had in the past with specific gearbox models and the associated reliability concerns.

11 **VII. EXTENSION OF WIND FACILITY ASSET LIFE AFTER REPOWERING**

12 **Q. What is the current asset life of the wind facilities that will be repowered?**

13 A. All of the existing wind facilities are currently being depreciated assuming a 30-year
14 asset life. The facilities PacifiCorp plans to repower are currently scheduled to be
15 retired between 2036 and 2040 (see Confidential Exhibit PAC/604).

16 **Q. Will repowering the wind facilities extend their useful operating lives beyond the
17 currently planned retirement dates?**

18 A. Yes, repowering the wind facilities will extend their life 30 years from the repowering
19 date, adding approximately 10 years to their planned retirement dates.

20 **Q. How will repowering extend the useful life by 30 years from the repowering
21 date?**

22 A. The repowering projects are being designed by the turbine equipment suppliers to
23 meet the same design requirements that apply to WTGs used in new wind facility

1 construction. The wind turbine equipment suppliers are contractually required, as
2 would be the case with a new wind facility, to have their wind turbine designs for the
3 repowering projects certified by an independent third party to ensure that they meet or
4 exceed applicable International Electrotechnical Commission design standards used
5 in the wind turbine industry. These design standards are intended to ensure that the
6 equipment is appropriate for the site conditions and will perform satisfactorily over
7 the standard design life.

8 **Q. What factors will be independently reviewed to assess and certify the design?**

9 A. The third-party design assessment evaluates the site-specific load assumptions based
10 upon the climactic conditions at each facility and will assess the control and
11 protection systems for the wind turbine and their ability to meet the site design
12 conditions. It will also assess the electric components, the rotor blades, hub, machine
13 components (*i.e.*, drivetrain, main bearing and gearbox), and the suitability of the
14 existing tower upon which the new wind turbine equipment will be installed.

15 **Q. Does the design certification also evaluate the ability of the existing foundations
16 to handle the loads associated with the repowered turbines?**

17 A. No. The design certification will assess the design loads and the design assumptions
18 regarding the ability of the new turbines and the existing towers to handle those loads.
19 But as with new wind facility development, the facility owner must provide a
20 foundation suitable to handle the loads imparted by the tower on the foundation.

21 **Q. Has PacifiCorp reviewed the foundations to ensure they are capable of handling
22 the new turbines?**

23 A. Yes. PacifiCorp retained B&V to evaluate the ability of the existing foundations to

1 handle the loads of the repowered turbines. B&V's evaluation indicates that the
2 existing foundations are suitable for the repowered turbines. At the Leaning Juniper
3 and Goodnoe Hills facilities, the foundations will require a standard retrofit to
4 increase their strength.

5 **Q. Has PacifiCorp evaluated the foundations to determine if they are suitable for a**
6 **30-year service life following repowering?**

7 A. Yes, for the foundations in which fatigue loading is a controlling design variable,
8 B&V has assessed the ability of the foundations to handle the estimated fatigue
9 loading anticipated for a 30-year period following repowering and has determined
10 that all the foundations will be able to accommodate the additional loading.

11 **VIII. PROJECT CONTRACT STATUS AND CONSTRUCTION SCHEDULE**

12 **Q. What is the status of contracting related to the proposed repowering projects?**

13 A. PacifiCorp has negotiated a master retrofit contract with GE for the eight Wyoming
14 projects, and has negotiated a turbine supply contract with Vestas for the other four
15 projects. The scope, language, and risk profile of the agreements with each of the
16 companies is different.

17 The master retrofit contract commits GE to perform turn-key supply, delivery,
18 installation, and commissioning of the repowering turbines at a fixed price. While
19 PacifiCorp has also completed negotiations on a fixed-price turbine supply agreement
20 with Vestas, it is still in the process of obtaining a contract for installation of the
21 Vestas equipment.

1 **Q. Does the GE retrofit contract provide off-ramps to address potential changes in**
2 **circumstances that may affect the economics of the wind repowering project or**
3 **the ability of PacifiCorp to execute the project as currently anticipated?**

4 A. Yes. Before issuance of a retrofit work order directing GE to repower a facility, the
5 contract allows PacifiCorp to decide not to proceed with the retrofit work for a
6 number of reasons, including:

- 7 • Situations in which PacifiCorp is unable to timely obtain any required permit
8 or the terms and conditions imposed by a permit are unacceptable to the
9 company;
- 10 • For technical reasons related to the suitability of the new turbines for the site
11 or existing foundations; or
- 12 • PacifiCorp's determination that changes in local, state, or federal law or
13 corporate tax law create a material risk to the project; or if the federal PTC
14 law or IRS guidance regarding PTCs (including the safe-harbor requirements
15 or the 80/20 Rule) is adversely modified, amended, or changed.

16 **Q. When does PacifiCorp anticipate issuing its first retrofit work order to repower**
17 **a GE facility?**

18 A. The first retrofit work order is expected to be issued in [REDACTED] to allow turbine
19 delivery to begin in time to support repowering of facilities in 2019.

1 **Q. If a retrofit work order is issued to GE for a facility and there are subsequent**
2 **changes in tax laws, PTC rules, or permitting requirements, what recourse does**
3 **PacifiCorp have once those off-ramps are no longer automatically available to**
4 **the company?**

5 A. Following the issuance of a retrofit work order, the GE retrofit contract has provisions
6 that allow PacifiCorp to terminate the retrofit work order for convenience at known
7 costs that escalate from the date the retrofit work order is executed up to the date of
8 the first anticipated turbine delivery. Thus, PacifiCorp will still have the ability to
9 respond to potential legal or regulatory changes that impact the value of the GE
10 repowering facilities.

11 **Q. When will PacifiCorp execute the turbine supply contract with Vestas?**

12 A. PacifiCorp has completed negotiations with Vestas and has fixed pricing for turbines
13 ordered [REDACTED]

14 [REDACTED]

15 **Q. Do the two contracts with the turbine suppliers provide for the costs of the**
16 **turbines (and installation in the case of GE) to be adjusted up or down for**
17 **factors such as inflation, currency indexes, or steel price indexes?**

18 A. No. The contracts provide that the prices are fixed and have no such adjustment
19 mechanisms for those common price indexes. Generally, the turbine suppliers can
20 only seek a change order for price relief as a result of changes in state and/or local
21 law that impacts their costs. As such, the vast majority of repowering costs are now
22 fixed under these negotiated contracts which substantially reduces risk of cost over-
23 run.

1 **Q. When must PacifiCorp issue retrofit work orders to GE and execute its supply**
2 **contract with Vestas to proceed on schedule with the repowering projects?**

3 A. Under the terms of the master retrofit contract negotiated with GE, for repowering
4 projects to be completed before March 31, 2020, PacifiCorp must notify GE of its
5 intent to execute a retrofit work order eight months before the date requested by the
6 company for commissioning of the first retrofitted unit for any facility. For
7 repowering projects to be completed on or after March 31, 2020, PacifiCorp must
8 notify GE of its intent to execute a retrofit work order 12 months before the date
9 requested by the company for completion of commissioning of the first retrofitted
10 unit for that project. Similarly, PacifiCorp will need to execute a contract with Vestas
11 in [REDACTED] to provide sufficient lead time for turbine deliveries to begin in 2019.
12 PacifiCorp's construction schedule has been developed to optimize the PTC benefits
13 of the facilities and ensure that the facilities can be constructed during the low-wind
14 season—between March and November. A detailed project schedule for the
15 repowering projects is attached as Exhibit PAC/606.

16 **Q. Why is there such a long lead time between the execution of retrofit contracts**
17 **and the time that turbines can actually be repowered or delivered to the site to**
18 **support the repowering projects?**

19 A. Like all equipment suppliers in the wind industry, both GE and Vestas are currently
20 responding to demand to supply equipment for wind facilities that are slated to be
21 installed before December 31, 2020, to qualify the facilities for the full value of the
22 PTC. Because this equipment is manufactured to order, long lead times are required
23 to ensure manufacturing capacity is available and to meet specific project delivery

1 requirements. In some cases, additional manufacturing capacity may need to be
2 sourced to meet the equipment supply demands.

3 **Q. Aside from manufacturing lead times, are there other drivers for the lead times**
4 **associated with constructing these facilities?**

5 A. Yes, in addition to the manufacturing constraints, lead times are necessary to ensure
6 that construction contractors and work crews and cranes are available to install the
7 repowering equipment. Because of the large-scale efforts involved in repowering the
8 facilities, these resources must be secured well in advance of project construction to
9 ensure project schedules are met. Also, both skilled labor resources and construction
10 cranes are likely to be in greater demand given the amount of activity involved in new
11 wind facility construction and wind repowering projects across the country that must
12 achieve commercial operation by December 31, 2020, to meet the safe-harbor rules
13 summarized above in my testimony to qualify for the full value of the PTCs. Thus,
14 securing these necessary resources well before beginning these time-sensitive projects
15 mitigates both cost and schedule risk.

16 **Q. How has PacifiCorp designed the repowering projects to work within these**
17 **constraints?**

18 A. As discussed above, the 2019 construction schedule for most of the facilities, other
19 than Dunlap, optimizes the existing PTC benefits of the facilities and also allows for
20 their construction, generally, more than a year in advance of the December 31, 2020
21 deadline to achieve commercial operation.

1 **Q. Given the potential for there to be a high demand for wind energy construction**
2 **resources, has PacifiCorp made progress in securing the construction resources**
3 **necessary to implement the repowering project?**

4 A. Yes. PacifiCorp issued a request for proposals in early December 2017 and received
5 qualified bids for installation of Vestas turbines from several wind energy
6 construction contractors in mid-January 2018. PacifiCorp is still evaluating these
7 proposals to determine which proposal provides the best value to customers. As
8 discussed above, GE will be responsible for turn-key installation services under the
9 negotiated master retrofit contract.

10 **Q. Has PacifiCorp factored the information gained from the responsive bids into its**
11 **cost estimates for constructing the facilities employing Vestas turbines?**

12 A. Yes, PacifiCorp's cost estimates have been updated to reflect cost information gained
13 through the competitive bid process for installation, foundation retrofits (where
14 necessary), and other site construction services that will be provided by the successful
15 wind energy contractor.

16 **Q. When factoring in cost information from the competitive bids for installation**
17 **and foundation retrofit work (where necessary) for the Vestas projects, did**
18 **PacifiCorp simply take the costs from the lowest bid and incorporate that into**
19 **the company's cost estimates?**

20 A. No. Because PacifiCorp has not yet fully evaluated the bids or completed
21 negotiations with the bidders, the company did not simply rely on the lowest bid
22 submitted to develop its revised cost estimates. Instead, PacifiCorp excluded the low
23 bid in the event it was non-responsive and used pricing reflective of the average of

1 the next three lowest cost proposals. For this reason, PacifiCorp has a high degree of
2 confidence that these construction services can be contracted at pricing equal to or
3 better than the pricing included in the company's current cost estimates.

4 **Q. When does PacifiCorp anticipate having the construction contract for the Vestas**
5 **turbines completed?**

6 A. PacifiCorp expects to have a fully negotiated construction contract with the
7 successful bidder completed in April 2018.

8 **Q. What permitting requirements apply to repowering projects and is there any**
9 **risk that the construction schedule would be delayed due to permitting issues?**

10 A. Because repowering does not increase the footprints of the existing wind facilities,
11 and since the facilities are operating under current local, state and federal permits and
12 authorizations, the permitting requirements for repowering are minimal. Because the
13 facility footprints are not altered and since repowering is unlikely to disturb additional
14 acreage not already covered by existing permits, additional standard construction
15 permits are limited. Throughout the repowering process PacifiCorp will ensure that
16 the requirements of the existing permits and authorizations are met, and will provide
17 needed information to permitting authorities to amend or modify the existing permits
18 for the facilities to reflect the change in turbine equipment, if needed.

19 **Q. Has PacifiCorp made progress in obtaining necessary permits for repowering its**
20 **facilities?**

21 A. Yes. The Wyoming Industrial Siting Division has determined that no amendments to
22 PacifiCorp's existing permits for its Wyoming wind facilities are necessary in order
23 to repower those projects. Klickitat County, Washington has determined that no

1 additional permitting through its Planning Department is necessary for PacifiCorp's
2 proposed repowering of the Goodnoe Hills facility. Similarly, PacifiCorp has
3 received notice from Columbia County, Washington, that its conditional use permit
4 for the Marengo facility need not be modified and that no additional permits are
5 needed to repower the facility. With these approvals, 11 of the 12 facilities have been
6 approved by the relevant county or Industrial Siting Division. PacifiCorp does not
7 expect any issues in obtaining permits for the remaining facility.

8 **IX. DISPOSITION OF REMOVED EQUIPMENT**

9 **Q. What is PacifiCorp planning to do with the existing equipment that will be**
10 **removed?**

11 A. PacifiCorp has not yet determined how it will dispose of this equipment but will
12 explore various options to realize the greatest customer benefit from the equipment.
13 Because PacifiCorp will be replacing the entire machine head (nacelle, hub, and
14 rotor) of the repowered turbines, the removed equipment has the potential to be
15 reused and redeployed to another site location. This may make the equipment
16 valuable for redeployment elsewhere in the country, or perhaps elsewhere in North
17 America.

18 PacifiCorp understands that a significant number of turbines of all makes and
19 models will be repowered before 2020. This creates potential value for the removed
20 equipment as spare parts for similar type turbines that will remain in service. This
21 also makes it difficult, however, to use current market pricing for used turbines as a
22 proxy for the potential salvage value of the equipment given the large number of
23 repowered turbines and associated spare parts that will become available in the next

1 several years. Because not all PacifiCorp's GE turbines will be repowered, some of
2 the equipment can potentially be used as spare parts to service the non-repowered
3 turbines.

4 **Q. Given the uncertainty of the market for the removed equipment either for**
5 **redeployment or as spare parts, what was assumed in the economic analysis for**
6 **the salvage value of the equipment?**

7 A. PacifiCorp did not assume any salvage value for the removed equipment in its
8 economic analysis, which is a conservative assumption given the potential for the
9 equipment to be reused, repurposed as spare parts, or merely salvaged for scrap metal
10 value. To the extent PacifiCorp determines any salvage value by reusing the
11 equipment, or by selling or auctioning it to third parties, the company will pass
12 through any and all additional financial benefits to its customers.

13 **X. SUMMARY AND CONCLUSION**

14 **Q. Please summarize your testimony.**

15 A. The wind repowering project presents the opportunity to leverage prior investments in
16 the wind fleet and enhance its future value for customers. By executing wind turbine
17 equipment purchases in late 2016, PacifiCorp was able to secure the opportunity to
18 repower and renew the wind fleet and deliver the maximum value of these facilities to
19 customers by qualifying for the full value of the PTCs. Repowering now provides a
20 unique opportunity to return PacifiCorp's wind turbines to like-new condition while
21 enhancing their performance and avoiding expenditures that maintain but do not
22 enhance the value of the wind fleet.

23 By incorporating recent technical advances that allow for longer blades to be

1 installed on the existing towers and foundations, repowering will result in
2 significantly more low-cost energy for customers—738 GWh annually, or an increase
3 of 25.7 percent. With increases to the allowable transmission capacity of the facilities
4 in Wyoming, these generation benefits will be 855 GWh, or an increase of
5 29.8 percent. Further, repowering with new equipment will extend the asset lives of
6 the wind facilities by at least 10 years—allowing the wind facilities to continue
7 serving customers well into the future.

8 Finally, these benefits from repowering can be delivered to customers while
9 reducing, rather than increasing, costs to customers, as further described by Mr. Link.

10 **Q. What is your recommendation to the Commission?**

11 A. I recommend the Commission enter a finding that the decision to repower certain
12 wind facilities as described in my testimony is prudent and in the public interest.

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

14 A. Yes.