BEFORE THE PUBLIC UTILITY COMMISSION

OF OREGON

LC 62

In the Matter of PacifiCorp's 2015 Integrated Resource Plan	SIERRA CLUB'S FINAL COMMENTS ON PACIFICORP'S ENERGY STORAGE MODELING AND SYSTEM OPTIMIZER

October 15, 2015

Gloria D. Smith
Managing Attorney
Sierra Club Environmental Law Program
85 Second Street, 2nd Floor
San Francisco, CA 94105
415-977-5532
gloria.smith@sierraclub.org

TABLE OF CONTENTS

I. Introduction

Virtually every aspect of PacifiCorp's forward going resource portfolio is developed from complex modeling software. A utility's use of various modeling programs is not surprising given the intricacy of the modern electrical grid. However, PacifiCorp's heavy reliance on modeling comes at a price. For example, the company's selection of its core cases and portfolios, risk analyses, screening tools and sensitivities are all products of an opaque, clunky and often inflexible process that leaves regulators and the public in the dark on how the company makes critical decisions in a rapidly changing planning environment.

In an era when most large utilities are moving away from carbon intensive resources like coal-fired generation, PacifiCorp stubbornly clings to its aging coal fleet. In particular, over the next 10 years, the company intends to retrofit approximately 13 coal units with expensive SCR pollution controls while it simultaneously works to quash rooftop solar in Utah.

For the 2015 IRP, Sierra Club's technical experts licensed and ran the company's System Optimizer model in order to independently assess the company's least-cost planning decisions. The following final comments address the company's September 24, 2015 responses to Sierra Club's opening findings and conclusions. Specifically, these comments cover company errors in its modeling of energy storage technology and its coal plants.

Sierra Club's final comments were prepared with the technical expertise of Chris Edgette of Strategen LLC, and Dr. Jeremy Fisher of Synapse Energy Economics.

II. Flaws in PacifiCorp's Energy Storage Modeling

Throughout the 2015 IRP, Sierra Club has described multiple ways in which PacifiCorp's energy storage analysis was insufficient and/or inaccurate. However, PacifiCorp's reply comments continue to assert:

"Currently, PacifiCorp does not believe it is economically competitive to implement a battery storage solution."[1] Tellingly, the company has not provided modeling results to support this sweeping assertion. Instead the company claims that it is developing a process to evaluate storage, but again falls short of committing to such an evaluation:

"To this end, PacifiCorp is working to develop battery storage evaluation tools. Once the process is refined, it **may** be used to evaluate battery storage as an option for applicable capital investment projects."[2]

---

[1] Page 37 – Reply Comments of PacifiCorp, September 24, 2015
[2] Page 50 – Reply Comments of PacifiCorp, September 24, 2015 (emphasis added).

The company additionally claims that battery energy storage costs "will remain far above the costs for other utility scale storage, such as pumped hydro." [3] Again, PacifiCorp does not support its sweeping claims. Nor does the company address the fact that battery energy storage systems offer several advantages over pumped storage and conventional generating units:

- Unlike traditional resources, battery energy storage can be sited close to loads;
- Battery energy storage can be installed much more quickly than conventional resources, with far fewer permitting issues, due to lack of emissions or serious siting constraints; and,
- Battery energy storage can also be sized very precisely to the load duration and peaks required at a given location.

The above attributes result in real benefits to ratepayers, and cannot be overlooked in a legitimate analysis. Additionally, PacifiCorp's reply comments make clear that the company will only commit to the minimum 5MWh project required by law for 2020, which is incredibly shortsighted given the rapid advances in this technology:

"The Company will continue to improve upon its modeling approach for energy storage systems and will be evaluating procurement alternatives to acquire an energy storage system of at least five MWh by January 1, 2020, as required by Oregon House Bill 9 2193."[4]

Given PacifiCorp's obstinacy over the last 3 IRPs to appropriately evaluate or test energy storage, it is clear that PacifiCorp will not select an energy storage resource as an alternative to conventional generation without more accurate and appropriate modeling. At this time, the company provides only a vague suggestion that it will conduct such modeling in the future.

As discussed below, Sierra Club asks PacifiCorp to contract with a reliable third party to conduct such a meaningful evaluation of energy storage systems. Only through an independent analysis will the company clearly demonstrate that energy storage is, or is not, a viable alternative to the conventional resources proposed in the company's IRP. Otherwise, it appears the company is rejecting storage based on woefully outdated information.

III. Deficiencies in PacifiCorp's Energy Storage Modeling for the 2015 IRP

Both Sierra Club and Oregon Department of Energy raised concerns regarding PacifiCorp's modeling of energy storage technologies in its 2015 IRP. These concerns arise mainly from PacifiCorp's assertion that energy storage in the form of utility-scale battery installations is not economical at the present time, and that storage is unlikely to become economical in the near-term future. PacifiCorp reached this conclusion through a set of assumptions regarding battery prices in combination with modeling using System Optimizer (SO). However, that modeling

---

[3] Page 50 – Reply Comments of PacifiCorp, September 24, 2015

technique is unlikely to accurately represent the benefits of using battery energy storage systems, thereby undervaluing their contribution.

PacifiCorp's System Optimizer has limited flexibility for storage due to the non-chronological nature of the model's optimization. Because SO cannot capture specific charging or discharging times, ramping ability or flexibility, or rapid response characteristics, SO cannot capture many of the benefits intrinsic to battery storage systems and other storage technologies. In fact, within System Optimizer, all storage technologies look virtually the same – batteries, compressed air, and pumped storage – differentiated only by their capital and fixed costs, variable costs of production, and efficiency. Factors such as energy to capacity ratio, response time, and charging times are not captured.

The company's modeling approach has two significant drawbacks that fatally skew its modeling of energy storage. First, it is non-chronological: the available supply in any given hour is assumed to be independent of the hour before and after. While this approach may be sufficient for resources that operate on a synchronous basis, energy storage is inherently asynchronous. Indeed, the purpose of energy storage is to enable energy generated at one point in time to be consumed at a different point in time. As a result, a system with no "memory" cannot adequately represent the behavior of energy storage systems such as battery storage, which may be operated in charge or discharge modes at many different points throughout a day and therefore have different amounts of energy in reserve at different times. Instead of accurately modeling the charge level of a battery storage system over time, System Optimizer assumes only that energy storage acts as a consumer of electricity during demand trough hours and as a capacity resource during demand peak hours, with no granularity beyond the hourly level. Such a methodology is better-suited to the power arbitrage behavior of pumped hydropower storage, which is the dominant form of energy storage on the grid today. It is not appropriate for battery-based systems that may operate in both charge and discharge mode within the space of a single hour depending on system needs.

Second, System Optimizer treats energy storage as a capacity resource only, on a one-to-one basis with other forms of generation (including gas turbines). PacifiCorp's model will not select energy storage as the best option unless it can avoid the installation of new capacity or allow the retirement of existing capacity. This is problematic for several reasons, and inaccurate for the value of storage. First, PacifiCorp has acknowledged that its system has little room for additional capacity. Because System Optimizer maintains coal units and selects no new renewable energy (high energy, low capacity) resources, the model limits or omits storage and other capacity provisions. Secondly, SO values only the nameplate capacity value of storage, which is an inaccurate approach for several reasons. Battery storage systems are capable of providing full power within several seconds or less, significantly more rapidly than even open-cycle gas turbines. As a result, battery storage can more easily be "right-sized" to meet realistic demand peaks. For example, a recent battery installation in Modesto, CA was sized at 25 MW but intended to provide equivalent flexible capacity to a 50 MW gas turbine. As such, comparing the per-capacity price of battery storage systems and other flexible capacity options on a one-to-one basis is not justified based on actual system needs.

Moreover, the rapid response times of battery storage enable greater flexibility in terms of selecting and operating other system resources. The amount of energy storage allowed in the model is relatively small (18 MW total) and is unlikely to eliminate the need to install other new capacity resources. However, the presence of rapidly-responding battery storage can allow the other needed capacity to be in the form of intermittently-available renewable generation resources (including photovoltaic panels and wind turbines) or in the form of combined-cycle gas turbines, which are significantly more efficient than the open-cycle gas turbines generally used to meet extreme demand peaks. Similarly, if desired, battery storage can be operated so asto reduce the need to ramp conventional fossil generation, enabling these conventional resources to run with greater efficiencies. This has the effect of reducing both fuel costs and wear-and-tear of generation equipment.

Finally, PacifiCorp failed to capture a wide variety of ancillary services and benefits to the grid that battery storage is capable of, such as frequency regulation and reliability services. Appropriately-located battery storage systems can also allow deferral of transmission or distribution system upgrades and reduce system congestion. PacifiCorp does not appear to consider the financial implication of these benefits in its IRP, none of which can be provided by competing generation resources. Indeed, a wide variety of battery systems exist with varying energy, power, cost, and lifetime characteristics. By combining multiple types, a wide variety of system needs can be met while still providing capacity services. However, PacifiCorp's model appears to consider only sodium sulfur batteries at a single size and price point, disregarding the amount of flexibility offered by varying types of battery systems.

Ultimately, all of the above miscalculations suggest that PacifiCorp's modeling of energy storage misrepresented the costs of energy storage as higher than necessary, the benefits as less than are likely to be accrued, and the uses as significantly more limited than is realistic. It is possible that a more accurate modeling effort would still lead to the conclusion that energy storage is not economical, as battery prices have only recently declined to the point that they are commercially viable in some utility-scale applications. However, without fairly representing the capabilities and behavior of storage, it is impossible to properly evaluate the potential financial and resource impact of energy storage for PacifiCorp's system. In order to address the concerns raised by the Sierra Club and Oregon Department of Energy, a revised modeling effort should be undertaken to more accurately represent both the costs and the benefits of energy storage.

IV. A Recommended Approach to Energy Storage Modeling

A. Appropriate Model Characteristics

As shown above, PacifiCorp's use of System Optimizer to model storage is unworkable. System Optimizer considers resources only on a very limited timeslice-based load duration curve approach, with no ability to recall the state-of-charge of an energy storage system at any given time, or to model charge-discharge events that occur in less than an hour. As a result, SO cannot adequately model the wide variety of services that may be provided by energy storage.

A more appropriate modeling tool would use more granular time steps (hourly or even sub-hourly) and employ chronological tracking of the state-of-charge of energy storage installations. This would enable accurate modeling of services beyond demand shifting, including rapid peak smoothing and frequency regulation. While the high performing ramp rates of electrochemical and flywheel storage can be incorporated in an hourly production cost model, sub-hour modeling would also allow the rapid ramp rates achievable by electrochemical (battery) and flywheel storage systems to be taken into account for additional ancillary service use cases, which require these shorter timeframes. The quick response times of some energy storage technologies mean that they can serve the same load as a natural gas peaking plant at a smaller nominal capacity. This capability is obscured by using aggregated time blocks, leading to an inability for the model to appropriately size storage systems for a given need, and therefore making storage seem costlier than necessary.

A modeling tool capable of accurately representing energy storage would also consider a greater range of storage technologies and take into account the granularity of storage size options. Storage installations, especially battery-based systems, can be sized in very small increments, allowing precise determination of the minimum investment needed to satisfy a certain goal. A model capable of adequately addressing storage must be able to select an appropriate size for a storage installation, quantify the level of energy being stored at a given moment, and optimize the times and durations of charge and discharge events based on this storage capacity. Battery storage systems can also provide a range of both power and energy capabilities depending on the chemistry and particular cell type. An ideal modeling tool would allow selection of multiple types of energy storage to provide the best value for a given set of use cases.

Many of the characteristics identified above can be analyzed using conventional industry-standard production cost models; however, purpose-built tools dedicate more computational resources to the key areas of power system operation. Both sizing storage optimally and using it effectively depend on a thorough understanding of a power system's behavior and needs. It is important that a tool examining storage be able to model several applicable use cases and prioritize among them, taking into account that no storage system is an endless reservoir.

The Energy Storage Valuation Tool developed by the Electric Power Research Institute (EPRI) was designed to address these concerns in particular, and is capable of modeling storage sited at various points (including on the transmission system and at distribution substations). The Energy Storage Valuation Tool also allows for modeling of multiple use cases rather than just demand shifting and can prioritize the use of storage to produce the greatest value.

B. Use Cases

Energy storage is likely to provide benefits in PacifiCorp territory in several ways, each of which is discrete in terms of system design and dispatch. As PacifiCorp models energy storage, Sierra Club recommends modeling at least the following four use cases:

1. Use Case 1 – Pure Frequency Regulation

EPRI has demonstrated that energy storage providing pure frequency regulation can have a positive cost/benefit ratio.[5] In addition, over 100 MW of energy storage resources are currently providing cost effective frequency regulation in PJM territory. Given that energy storage costs have fallen since the EPRI evaluation, Sierra Club feels that it would be appropriate to evaluate a pure frequency regulation resource in PacifiCorp territory.

2. Use Case 2 – Capacity + Frequency Regulation

Southern California Edison, in its 2014 energy storage procurement, found that energy storage was cost effective in its system as a capacity resource that could also provide frequency regulation and other ancillary services. Given PacifiCorp's future capacity and flexibility needs, Sierra Club recommends that PacifiCorp consider this type of resource in its evaluation.

3. Use Case 3 – Transmission Services + Capacity + Frequency Regulation

PacifiCorp should consider an energy storage asset providing transmission services as well as capacity and frequency regulation. When dispatched in order to support transmission, energy storage can be highly valuable and can eliminate or defer a need for new installations of large transmission lines and/or facilities. However, transmission support dispatch may only be required a few times per year, at times of peak local transmission congestion. Depending upon the exact dispatch and location, it is typically possible to use the energy storage resource to provide other valuable services to the grid during low-congestion periods. These services may include capacity support (peaking), ancillary services, and energy shifting.

4. Use Case 4 – Distribution Services + Capacity + Frequency Regulation

Energy storage can be located at a substation to provide distribution services as well as larger grid services. PacifiCorp should consider an energy storage asset providing distribution services as well as capacity and frequency regulation. As with transmission services, distribution support dispatch may only be required a few times per year, at times of peak local distribution

---

[5] Cost-Effectiveness of Energy Storage in California, EPRI, 2013
http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002001162

congestion. Depending upon the exact dispatch and location, it is typically possible to use the energy storage resource to provide other valuable services to the grid during low-congestion periods. These services may include capacity support (peaking), ancillary services, and energy shifting.

The model inputs for energy storage should be based upon the currently projected best in class public data. Due to the rapidly falling costs and increasing capabilities of energy storage, it may also be appropriate to solicit inputs directly from the energy storage industry. Specifically, PacifiCorp should solicit input from industry leaders such as AES, Panasonic, Tesla, Advanced Microgrid Systems, and others with existing utility contracts.

5. Technology

Where possible, the company's evaluation should be as technology neutral as possible. The most successful energy storage procurements are based around a contractual agreement to provide a certain range of capabilities, rather than a procurement of a specific technology. These agreements can be generalized and are more comparable to one another than a complex procurement based upon technology-specific characteristics. This is similar to a power purchase agreement, where the resource is contracted for capability and dispatch rather than purchased outright.

Where possible, we recommend modeling the all-in cost of an agreement for a resource over a 10 or 20 year period. The cost would be based upon a fixed annual cost for dispatch within the energy and capacity ranges described in number 8 below.

6. Costs

The prices of energy storage technologies are changing rapidly. By relying on historical cost data, the likely cost of a project with a reasonable forward timeframe for procurement (2018 or 2020) may be significantly overestimated. Instead, modeled costs should be based upon best in class publicly available numbers such as the 2020 utility scale procurement numbers published by the Brattle Group, or forward forecasting by an entity familiar with storage, such as Navigant Consulting or GTM Research. In order to ensure that pricing includes any performance risk, PacifiCorp should consider evaluating and soliciting costs for energy storage as a service. A solicitation approach will provide a robust verification of an all-inclusive cost for a given time period in the evaluation.

7. Response Times

Given that most battery storage capacity can ramp from full negative capacity (charge) to full positive capacity (discharge) in under four seconds, PacifiCorp should assume that response times for batteries and flywheels are within that range.

8. Energy Storage Resource Capacity (MW)

Energy storage systems are rated by their maximum discharge capacity in MW. In order for the modeled resources to have significant impact in the grid, capacity ratings should suit the need and the location, but should generally be in the 50-100 MW range for Use Cases 1-3. Use Case 4 should be sized more appropriately to the specific need at a specific location on the distribution grid.

9. Duration (MWh per MW)

Unlike many grid resources, the amount of time that an energy storage resource can charge or discharge onto the grid during a given usage event is limited by the number of MWh of energy per MW of capacity. This can be understood as the discharge duration available at the resource's maximum capacity. For instance, a 100 MW, 400 MWh resource can discharge onto the grid for four hours at the maximum capacity of 100 MW, while a 100 MW, 200 MWh resource can discharge onto the grid for only two hours at its maximum capacity of 100 MW.

Most energy storage resources can be readily configured to provide different amounts of energy relative to their capacity. Increasing the storage time available from an energy storage resource increases the value of that resource on the grid, but may also increase the cost of the resource. Generally, the ideal cost/benefit ratio comes when the energy storage resource is sized at the most appropriate duration for a given use case.

To arrive at the appropriate duration for an energy storage resource for various configurations and use cases, PacifiCorp should model multiple durations and corresponding costs for each resource type. A duration of 15 minutes to 1 hour should be entirely capable of providing pure frequency regulation (Use Case 1). For other use cases, PacifiCorp should model durations of 2, 3, 4, 5, and 6 hours at a given capacity to understand the optimal balance of duration, cost, and benefit.

10. Approach to Multiple Services

An energy storage resource should be modeled with one priority service, with other services provided at other times as needed. This means that the service approach should consider the hourly and sub-hourly dispatch of the energy storage resource.

For instance, a resource providing transmission services as a primary value stream may only need to dispatch to support the transmission system a limited number of hours per year. In other hours, that system may provide ancillary services such as frequency regulation.

PacifiCorp should account for the fact that each MW of fast response frequency regulation resource is able to provide frequency regulation across its full charge/discharge range, which equates to a 2 MW frequency regulation range for each MW of energy storage. Additionally, fast regulating energy storage resources have been shown in PJM and other markets to displace an even greater capacity of slower conventional resources in frequency regulation due to their speed. PacifiCorp's evaluation should take into account the full value of fast regulation.

11. Services

As noted above, energy storage can provide a variety of services, either at the same time or at different times. Energy storage modeling should include all services applicable to the grid location and interconnection, including:

- Frequency Regulation
- Spinning reserves
- Capacity
- Energy
- Transmission services
- Distribution services

12. Summary Table

The following table summarizes the different recommended configurations to model:

Use Cases	**Pure Frequency Regulation**	**Capacity + Frequency Regulation**	**Transmission Services + Capacity + Frequency Regulation**	**Distribution Services + Capacity + Frequency Regulation**
10 year agreement	$500/kW, or as verified by solicitation	$350/kWh, or as verified by solicitation	$350/kWh, or as verified by solicitation	$350/kWh, or as verified by solicitation
Response Times	<4s	<4s	<4s	<4s
Capacity	Sized to need	50 MW	50 MW	50 MW
Duration	15m, 1h	2, 3, 4 hours	3, 4, 5, 6 hours (location dependent)	3, 4, 5, 6 hours (location dependent)
Primary Service Secondary Services	· Frequency Regulation	· Capacity · Frequency Regulation · Spinning reserves · Energy	· Transmission services · Frequency Regulation · Spinning reserves · Capacity · Energy	· Distribution services · Frequency Regulation · Spinning reserves · Capacity · Energy

V. <u>Modeling Recommendations</u>

EPRI has conducted several evaluations for utilities and utility commissions in the United States. EPRI has developed advanced modeling capabilities relating to utility scale energy storage, and is known to be capable of the production cost and market benefit modeling that would be appropriate to the modeling outlined above. As an entity partly funded by utilities, EPRI could also be looked at as a reasonably balanced party in a solid energy storage evaluation.

VI. Energy Storage Conclusion

Given the advances in energy storage technology, and the potential ratepayer and societal benefits that energy storage can provide, it is critical that PacifiCorp conduct a thorough and transparent evaluation of energy storage at this time. Sierra Club looks forward to collaborating with PacifiCorp and other stakeholders on this analysis.

VII. Final Comments on System Optimizer Modeling

PacifiCorp's reply comments critiqued Synapse Energy Economics' System Optimizer analysis attached to Sierra Club's opening comments.[6] PacifiCorp challenged the Synapse analysis on four fronts, but then went on to (wrongly) assert that Synapse's work simply confirmed that PacifiCorp's preferred portfolio is ultimately the least cost solution for the company's customers. PacifiCorp's four points of contention were:

- Synapse's use of endogenous coal retirements;
- Synapse's assumption of a carbon price to represent a mass-based carbon cap;
- Utah Clean Energy's wind and solar costs; and,
- Synapse's findings that the PacifiCorp preferred scenario likely does not represent a least cost plan for PacifiCorp ratepayers.

A. PacifiCorp Challenged Synapse's Treatment of Endogenous Coal Retirements

As we emphasized in preliminary comments, the company's modeling framework failed to allow coal-fired units to retire economically, a significant step back from the 2013 IRP modeling framework. PacifiCorp defends its retreat on grounds that endogenous coal retirements cannot consider "coal contracts and fixed costs shared by multiple units of a plant, or even multiple plants."[7] Importantly, however, the value of PacifiCorp's exclusion of endogenous coal retirements far outweighs either of these concerns, and both are imminently addressable through fairly straightforward modeling approaches.

---

[6] *Review of the Use of the System Optimizer Model in PacifiCorp's 2015 IRP: Including treatment of the Clean Power Plan and economic coal plant retirement.* August 21, 2015. Prepared by Synapse Energy Economics on behalf of Sierra Club, Western Clean Energy Campaign, Powder River Basin Resource Council, Utah Clean Energy, and Idaho Conservation League.
[7] PacifiCorp Reply Comments at p. 52.

Of PacifiCorp's 26 coal-fired units, only [redacted] ([redacted]) contain some form of liquidated damages[8] for failure to take coal in long-term contracts: [redacted]. In PacifiCorp's 111(d)[9] Scenario Maker workpapers, the company assesses if individual units may fall below contract minima. Those workpapers list "Plant Contract Supply Minimums" for a number of units. PacifiCorp recently signed a new coal supply agreement (CSA) at Huntington, impacting both the supply of that plant and Hunter. While the new contract contains liquidated damages for failure to take a minimum amount, PacifiCorp has represented to this Commission that its broad termination rights mitigate those damages substantially, if not completely.[10] In the face of this new contract, the coal supply of both Huntington and Hunter should be modeled as avoidable (i.e. no damages). Similarly, PacifiCorp supplies the bulk of coal at Jim Bridger (Bridger Coal Company), and while PacifiCorp has argued that the closure of specific units at Bridger would entail a change in coal costs at the plant, it is not clear that the coal costs differentials alone could, or should, drive a decision to maintain this plant if it were otherwise non-economic to do so. Coal contracts at the other listed plants provide other options to avoid liquidated damages,[11] such as the re-direction of coal deliveries from one plant to another, or re-marketing of delivered coal to other entities. Contracts at [redacted], and [redacted] all expire prior to [redacted], so that economic retirements in the one or two years prior to that date would be unlikely to incur significant damages at all. Overall, the number of units for which this is an applicable concern is fairly small, and should not preclude endogenous coal retirements.

Finally, coal liquidated damages can be modeled, if necessary directly, as an unavoidable fixed cost. If a coal unit cannot avoid liquidated damages through retirement or cessation of operations, those costs are effectively sunk. The incremental coal that the unit could take (or avoid) above and beyond the contract minima is variable in nature. Alternatively, declining coal damages (i.e. as a contract nears its end) can be modeled as a cost hurdle to retirement, as the equivalent of a decommissioning cost. In any given year, in order to retire, the coal unit must absorb remaining contract costs that would otherwise not be incurred should it continue to operate. Both of these options for handling coal contract damages are well within reach of PacifiCorp's modeling team.

Next, PacifiCorp's claim that the complicated nature of shared expenses at existing units prevents the utility from examining endogenous coal retirement is also not reasonable. In general, a first cut assumption should be that units split shared-costs ratably is both a common assumption, and a reasonable starting point. In fact, PacifiCorp's screening analysis utilized to

---

[8] For purposes of these comments, Sierra Club uses the term "liquidated damages" to refer to any type of penalty or payment for early termination of a coal contract, including take-or-pay requirements

[9] For reasons unclear, the Company refers to the Clean Power Plan as "111(d)".

[10] See Docket Um 1712. See specifically Order 15-161.

[11] See notes in PacifiCorp 111(d) Scenario Maker workpapers, tab "Min Coal Burns."

derive the annualized cost of environmental retrofits,[12] and other workpapers[13] show that PacifiCorp generally assumes that common costs (such as coal ash and effluent control costs) are simply divided ratably at units. If an endogenous coal unit retirement assessment shows that a single unit retires at a unit with complicated shared fixed costs, PacifiCorp could test that specific retirement assessment in a one-off analysis, wherein fixed costs are parsed more finely for that specific decision. It is unlikely that the difference between a ratable division of fixed costs and a more complicated breakdown would result in substantially different decisions for retirement.

Overall, Sierra Club believes that the endogenous coal retirement results are important and indicative, and that PacifiCorp should not be permitted to substitute opaque business-driven decisions about coal unit retirements for (near) optimal least-cost planning.

B. PacifiCorp Challenged Synapse's Use of a Carbon Price Instead of a Carbon Cap

Synapse's analysis included a carbon cap through a price adder. According to PacifiCorp, "it is unclear why Synapse models a CO_2 price as opposed to using the mass-cap approach…"[14] The answer should be readily apparent to PacifiCorp, as it forms the basis of their response against Oregon Department of Energy's (ODOE) concern about the impact of wholesale market prices. Synapse used a CO_2 price adder rather than a simple hard cap because modeling a hard cap without the benefit of knowing what happens to the price of wholesale trading markets is fraught and problematic. When PacifiCorp models a hard cap, or CO_2 price, or any other form of regulation that impacts states beyond the PacifiCorp service territory, it employs up to two additional proprietary models to derive impacts on wholesale market prices and natural gas production prices, and then includes these prices in the System Optimizer model. PacifiCorp used the Aurora model to produce wholesale market prices at the PacifiCorp trading hubs, and in some cases ICF's Integrated Planning Model (IPM) to produce natural gas forwards in the presence of additional regulatory pressures.[15] Failing to account for changes in wholesale market prices associated with carbon regulation would result in an erroneous accounting of wholesale market trades (both spot and front office transactions), and thus could not reflect a reasonable reality.

PacifiCorp was quite clear in responding to ODOE that the impact of different carbon regulation structures on wholesale market prices is a critical factor in evaluating the cost and efficacy of various portfolios. There is no reason why it would be different here. If Synapse employed a hard cap on the PacifiCorp system while leaving market prices unchanged, the model would likely

---

[12] See workpapers provided by PacifiCorp: Workpapers\CONF\Disk 4_CONF\Screening Models, CONF\Coal Screening Model_RH3
[13] See workpapers provided by PacifiCorp: Workpapers\CONF\Disk 3_CONF\Assumptions-Inputs\Master Assumptions\Revenue Requirement of Investments\Core Cases\C05a-3_CONF\
[14] PacifiCorp Reply Comments at p. 53.
[15] IRP at pp. 148-149.

start importing from the cheaper external market while reducing production in PacifiCorp's system. PacifiCorp would not meet the Clean Power Plan standard by virtue of actually controlling emissions, but simply by importing from neighboring states that were not modeled with a carbon constraint. This inconsistency would drive incorrect results and be poor planning.

Why did Synapse not employ the two additional models used by PacifiCorp? Simply stated, each proprietary model accessed by an intervenor represents an astronomical budget requirement. Short, discrete model licensures for stakeholders frequently run into the tens of thousands of dollars. While these licensure fees are negligible to the utility on a relative scale, such costs are a significant barrier for regulators, intervenors and stakeholders. It is unfair to imagine that stakeholders in PacifiCorp's IRP process could simply pick up another high cost model to implement a mass cap. Instead, Synapse utilized a CO_2 price adder, and included the impacts of that adder in wholesale market prices and front office transactions, a reasonable and common use proxy approach. This method maintained market purchases and sales at a level comparable to PacifiCorp's preferred scenario.

C. Synapse Demonstrated that PacifiCorp's Preferred Portfolio is Not Least-Cost

After reviewing the Synapse analysis, PacifiCorp concluded that "PacifiCorp's Preferred Portfolio is the least-cost in comparison to all of the Synapse cases…Synapse has demonstrated that the PacifiCorp 2015 IRP Preferred Portfolio is the least cost approach to meeting Synapse's interpretation of the revised EPA 111(d) rules."[16] PacifiCorp based this finding on Table 3 of Synapse's report, showing that the endogenous coal retirement case with a low CO_2 price (Case A) was $42 million more expensive than PacifiCorp's preferred portfolio. PacifiCorp neglected a key component of Synapse's analysis: Synapse assumed, for the purposes of this study, that PacifiCorp would be compelled to comply with the Regional Haze federal implementation plan in Wyoming. Overall, incurring these costs represents an additional $730 million (NPV, 2015$) in federally required environmental controls that are not represented in PacifiCorp's plan. While a comparison of a Regional Haze compliant plan against PacifiCorp's possibly non-compliant plan is not straightforward, there are clearly costs neglected from PacifiCorp's analysis that would raise the cost of the company's plan substantially. Conversely, had Synapse reviewed a non-compliant portfolio, the re-analysis would have come out several hundred million dollars less expensive than PacifiCorp's plan.

There is no evidence that PacifiCorp's preferred portfolio and "committed" retirements would actually meet EPA's requirements for regional haze. The reference case emissions plan (i.e. compliance) results in 62,000 tons of NOx emissions less than PacifiCorp's preferred portfolio, a reduction of over 10%. Many of those emissions reductions are realized through earlier years. Synapse's Low CO_2 case (Case A) has nearly 15% lower NOx than the PacifiCorp preferred plan

---

[16] PacifiCorp's Reply Comments at p. 57.

from 2017 through 2025 (305,000 tons vs. 357,000 tons). These emission reductions are important to EPA's requirement to reduce regional haze on an incremental basis, and are not without cost.

It is an imprudent planning strategy for PacifiCorp to *hope* that it might prevail in federal court over EPA's regional haze rule. Further, PacifiCorp's use of an opaque business strategy to plan unit retirements, and manual model manipulations through the 111(d) (Clean Power Plan) Scenario Maker are clearly non-optimal.[17] By definition, PacifiCorp could not have produced a least-cost plan because the plan is not optimized, and PacifiCorp's assertion that the Synapse mechanism is higher cost is unfounded and incorrect.

VIII. <u>Conclusion</u>

Unsurprisingly, when Sierra Club ran System Optimizer, it found that the model can be detrimentally inflexible and opaque for assessing least-cost coal plant retirements and the cost and benefits of energy storage technology. Based on our ongoing work, we reiterate our initial recommendations.

First, the company should conduct a current and fully formulated analysis of battery storage systems, as detailed above. We believe that an evaluation from an independent third party such as EPRI would confirm that energy storage would allow PacifiCorp to cost effectively and reliably reduce overall system and operational costs by adding this rapidly evolving resource.

Second, Synapse's introduction of an endogenous retirement sensitivity for System Optimizer demonstrated clearly that the units chosen by PacifiCorp for retirement under the preferred portfolio were not necessarily the most cost-effective units to retire under a more flexible approach. By forcing units to retire based on fixed assumptions, PacifiCorp violated basic principles of least-cost resource planning, and took a major step backward from the significant progress it made in its 2013 IRP. In future, rather than blame the static nature of its model, the company must consider easily quantifiable factors such as coal contracts and fixed costs shared by multiple plants in it coal plant retirement scenarios.

[17] PacifiCorp staff noted multiple times in stakeholder meetings that the mechanism used by PacifiCorp to determine a Clean Power Plan compliance pathway requires significant manual work and is not optimized, nor optimal.

Sierra Club appreciates the opportunity to comment on PacifiCorp's 2015 IRP. We look forward to working with the company to improve the plan as described above and in the Synapse report.

October 15, 2015

Respectfully submitted,

/s/ Gloria D. Smith

Gloria D. Smith
Managing Attorney
Sierra Club Environmental Law Program
85 Second Street, 2nd Floor
San Francisco, CA 94105
415-977-5532
gloria.smith@sierraclub.org

CERTIFICATE OF SERVICE

I hereby certify that on this 15th day of October, 2015, I caused to be served the foregoing SIERRA CLUB'S FINAL COMMENTS ON PACIFICORP'S ENERGY STORAGE MODELING AND SYSTEM OPTIMIZER upon all party representatives on the official service list for this proceeding via electronic mail. The public version of this document was served upon parties via email, and the confidential portion of this document was served pursuant to Protective Order No. 14-416 upon all eligible party representatives via FedEx.

Dustin T. Till (C)
Oregon Dockets
Pacific Power
825 NE MULTNOMAH ST, STE 1800
PORTLAND OR 97232
dustin.till@pacificorp.com
oregondockets@pacificorp.com

Michael O'Brien (C)
RNP Dockets
Renewable Northwest Project
421 SW 6TH AVE #1125
PORTLAND OR 97204
michael@renewablenw.org
dockets@renewablenw.org

Jess Kincaid (C)
Phil Carver (C)
Oregon Department of Energy
625 MARION ST NE
SALEM OR 97301
jess.kincaid@state.or.us
phil.carver@state.or.us

Renee M. France (C)
Oregon Department of Justice
Natural Resources Section
1162 COURT ST NE
SALEM OR 97301-4096
renee.m.france@doj.state.or.us

Robert Jenks (C)
Sommer Templet (C)
OPUC Dockets
Citizens' Utility Board of Oregon
610 SW BROADWAY, STE 400
PORTLAND OR 97205
bob@oregoncub.org
sommer@oregoncub.org
dockets@oregoncub.org

Melinda J Davison (C)
Jesse E Cowell (C)
Davison Van Cleve
333 SW TAYLOR - STE 400
PORTLAND OR 97204
mjd@dvclaw.com
jec@dvclaw.com

Colin McConnaha (C)
Department Of Environmental Quality
811 SW SIXTH AVE
PORTLAND OR 97204
colin.mcconnaha@state.or.us

Bradley Mullins (C)
Mountain West Analytics
333 SW TAYLOR STE 400
PORTLAND OR 97204
brmullins@mwanalytics.com

Wendy Gerlitz (C)
NW Energy Coalition
1205 SE FLAVEL
PORTLAND OR 97202
wendy@nwenergy.org

Fred Heutte (C)
NW Energy Coalition
PO BOX 40308
PORTLAND OR 97240-0308
fred@nwenergy.org

Paul Garrahan (C)
Oregon Department of Justice
1162 COURT ST NE
SALEM OR 97301-4096
paul.garrahan@doj.state.or.us

Franco Albi (C)
V. Denise Saunders (C)
Patrick G. Hager
Portland General Electric
121 SW SALMON ST 1WTC0702
PORTLAND OR 97204
franco.albi@pgn.com
denise.saunders@pgn.com
patrick.hager@pgn.com
pge.opuc.filings@pgn.com

Angus Duncan (C)
Natural Resources Defense Council
2373 NW JOHNSON ST
PORTLAND OR 97210
angusduncan@b-e-f.org

Ralph Cavanagh
Natural Resources Defense Council
111 SUTTER ST FL 20
SAN FRANCISCO CA 94104
rcavanagh@nrdc.org

John Crider (C)
Oregon PUC
PO BOX 1088
SALEM OR 97308-1088
john.crider@state.or.us

Michael T. Weirich (C)
Oregon Department of Justice
Business Activities Section
1162 COURT ST NE
SALEM OR 97301-4096
michael.weirich@state.or.us

Justin Wilson (C)
Western Clean Energy Campaign
1536 Wynkoop St., Suite 420
Denver, CO 80202
justin@westerncec.org

IRP Mailbox
825 NE Multnomah Street, Suite 800
Portland, OR 97232
irp@pacificorp.com

Teresa Hagins
Northwest Pipeline GP
8907 NE 219TH STREET
BATTLE GROUND WA 98604
teresa.l.hagins@williams.com

Stewart Merrick
Northwest Pipeline GP
295 CHIPETA WAY
SALT LAKE CITY UT 84108
stewart.merrick@williams.com

John Lowe
Renewable Energy Coalition
12050 SW TREMONT ST
PORTLAND OR 97225-5430
jravenesanmarcos@yahoo.com

Irion A. Sanger (C)
Sanger Law PC
1117 SE 53RD AVE
PORTLAND OR 97215
irion@sanger-law.com

Nancy Esteb
Renewable Energy Coalition
PO BOX 490
CARLSBORG WA 98324
esteb44@centurylink.net

Dated this 15th day of October, 2015 at San Francisco, CA.

/s/ Alexa Zimbalist

Alexa Zimbalist
Legal Assistant
Sierra Club Environmental Law Program
85 Second St., 2nd Floor
San Francisco, CA 94105
(415) 977-5649
alexa.zimbalist@sierraclub.org