Comments on NorthWestern Energy's Final 2019 Electricity Supply Resource Procurement Plan

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1. INTRODUCTION

NorthWestern Energy ("NorthWestern," "NWE," or "the Company") implemented a capacity-based long-term approach to resource planning beginning with its 2015 Electricity Supply Resource Procurement Plan ("2015 Plan"). The aim was to address the imbalance between projected peak loads and the Company's owned and contracted physical resources. In its 2015 Plan, submitted in March 2016, the Company proposed a strategy to achieve minimal resource adequacy over a 10-year period, acquiring flexible generating capacity according to the results of an analysis of portfolio costs and risks. The analysis used the PowerSimm planning model developed by Ascend Analytics. In February 2017, the Montana Public Service Commission ("PSC" or "Commission") issued comments finding the 2015 Plan to be deficient in areas relating to resource adequacy, evaluation of different types of capacity, and areas of uncertainty, among others. In supplemental comments issued by the PSC in December 2017, the Commission emphasized the relationship between the regional electric system and NorthWestern's capacity needs as well as the importance of testing the market for available resources. NWE was directed to file its next resource plan in December 2018.

After a request for extension, NorthWestern Energy issued its *Draft 2019 Electricity Supply Resource Procurement Plan* ("Draft Plan") on March 5, 2019. Stakeholders and the public were given 60 days to submit comments to NWE on its resource plan. The utility reviewed these comments and submitted its *2019 Electricity Supply Resource Procurement Plan* ("Final Plan") in August 2019.

NorthWestern's Final Plan describes its current capacity deficit of 645 megawatts (MW), which is expected to increase to 725 MW by 2025 without new peaking capacity. The Company currently meets peak demand needs through market purchases and proposes to add up to 200 MW per year of flexible capacity from 2022 to 2025 in order to close its capacity gap. NorthWestern describes its need as one for "flexible capacity," which is defined by the Company as a resource that can be dispatched on demand to ramp up or shut down relatively quickly. The resulting "least-cost resource" portfolio that results from its PowerSimm capacity expansion modeling consists exclusively of new gas-fired Reciprocating Internal Combustion Engines (RICE) of various sizes.[1] NorthWestern is quick to assert that the modeling results do not represent a commitment to RICE generation, however, and that all new resources will be procured through a competitive resource solicitation conducted by the Company. NorthWestern has stated that the resources procured through these competitive solicitations may or may not be those identified in the modeling conducted for its Final Plan.

The Montana PSC hired Synapse Energy Economics, Inc. (Synapse) as a consultant to evaluate NWE's efforts in both its Draft Plan and Final Plan to address the Commission's concerns with the 2015 Plan. This included participation in NorthWestern's stakeholder process and review of the PowerSimm model

[1] 2019 Electricity Supply Resource Procurement Plan. Table 10-2.

used by NorthWestern for resource portfolio modeling. For the purpose of these comments, Synapse obtained "Dashboard" access to the PowerSimm model used by NorthWestern for its 2019 Electricity Supply Resource Procurement Plan. This means that Synapse was able to see the inputs used in the modeling and the associated outputs but could not make any edits or run the model. We submitted comments on the Draft Plan to NorthWestern on May 5, 2019 that addressed several areas of concern identified by the Montana Commission. These concerns included resource adequacy, evaluation of alternative resources, uncertainty, stakeholder involvement, the forecast horizon, specific elements of NorthWestern's transmission system, and the competitive procurement process.

These comments on NorthWestern's Final Plan address our findings on the adequacy of the resource planning process as well as the modeled resource portfolios. These comments represent a deeper analysis into the PowerSimm modeling performed by Ascend Analytics at the direction of the Company and the input values that lead to certain results. We do not repeat certain comments that we made on the Draft Plan, particularly in instances where we believed that NorthWestern had sufficiently addressed areas of concern identified by the Commission. However, some issues that we identified in the Draft Plan remain issues in the Final Plan. For those areas, we provide additional analysis. Of particular concern are the capacity values given by NorthWestern to renewable resources in the PowerSimm modeling, which we believe lead to an overreliance on new thermal capacity in the resulting resource portfolios. We identify and describe a number of other issues in subsequent sections of this report.

2. PowerSimm Modeling

In its 2017 comments on NWE's previous resource plan, the Commission requested that the Company provide increased transparency around the modeling process and give legitimate stakeholders access to the PowerSimm model in future planning processes. The Company has provided Synapse, as consultants to the PSC, "dashboard" access to the PowerSimm model's user interface via remote access and allowed us to view input and output variables through this interface. We could not make any changes to any input assumptions nor could we execute any of our own PowerSimm model runs. Synapse is the only party to have such access to PowerSimm, and NWE did not grant access to the capacity expansion resource portfolio modeling runs until after it had published the Draft Plan. There was no opportunity for Synapse or any other ETAC member or stakeholder to suggest alternative model runs that should be done by NWE and Ascend prior to the publication of the Draft plan. Stakeholders were also unable to evaluate the adequacy of the use of the PowerSimm model or the subsequent conclusions about resource adequacy and resource procurements presented in the Draft Plan. This creates the sort of "information asymmetry that undercuts the legitimacy of NorthWestern's resource-planning exercise" that the Commission warned about in 2017.[2] After review of the Draft Plan, several stakeholders

[2] Montana Public Service Commission Comments in Response to NorthWestern Energy's 2015 Electricity Supply Procurement Plan. Docket No. N2015.11.91. February 2, 2017. Page 17.

(including Synapse) proposed alternate input assumptions and scenarios to be modeled in PowerSimm. Nonetheless, NorthWestern did no new modeling runs between the Draft Plan and this Final Plan. The modeling results presented in NWE's Final Plan are thus dated March 2019. Ascend Analytics, consultants to NorthWestern, also confirmed that it had not executed any new modeling on behalf of the utility between the publication of the Draft Plan and the Final Plan.

Based on its single set of PowerSimm scenarios from March 2019, NorthWestern concluded in the Final Plan that the best way to meet its capacity deficit and ensure resource adequacy is to procure hundreds of MW of "flexible" gas-fired generation in the form of RICE units. This is essentially a foregone conclusion given certain of the input assumptions and constraints present in the PowerSimm model that favor thermal resources over renewables and storage. First, NorthWestern did not allow for market capacity purchases in its modeling runs, which leads PowerSimm to build 985 MW of gas-fired generation over the analysis period in the Base portfolio. Inclusion of an option to purchase capacity from the market likely would have led to a smaller capacity build and lower revenue requirement in the resulting resource portfolio. Second, the low capacity credit for renewable resources, i.e. the resource's contribution to peak, and the higher capital cost of renewables practically guarantees that the PowerSimm model will not select these resources as part of a least-cost resource portfolio under reference assumptions. Another factor affecting renewable resource selection is NorthWestern's use of an atypical method to calculate effective load carrying capability (ELCC) values for wind and solar. This method, described in Section 2.1, resulted in little to no capacity credit being allocated to these resources.

In addition, several observed modeling errors beg the question as to whether additional errors could have been discovered with more time with the PowerSimm model. Specific concerns with the PowerSimm modeling that we were able to identify following the issuance of the Draft plan include the following:

1. NorthWestern failed to correctly set up and model the High Natural Gas Price scenario.
2. PowerSimm cannot endogenously retire uneconomic resources.
3. The fixed operations and maintenance (O&M) costs assigned to solar are much higher than industry benchmarks such as NREL's 2019 ATB.
4. There are discrepancies between the model and the plan with regard to the costs and nameplate capacity for new resources.

The following sections describe each of these issues in more detail.

2.1. Market energy and capacity purchases

One of the critical deficiencies of the analysis, which we called out in our comments on the Draft Plan as well, is that the analytical construct does not allow for direct purchase or procurement of market-based capacity resources. The ARS module of PowerSimm does not include, for example, slice-of-system contracts for short-term capacity from those Pacific Northwest providers or utilities that may be long on capacity. The modeling is "limited to resources with known and measurable operating characteristics,"[3] and thus omits possible resource supply paths that include bilateral purchases of regional capacity despite the fact that NorthWestern stated in its plan that it "will continue to rely on wholesale power markets to meet some portion of our capacity need."[4]

The approach to determining an optimal capacity expansion should allow for inclusion of market-based capacity resources. The Current portfolio includes only NorthWestern's existing resources and does not meet the presumed 16 percent planning reserve requirements because it lacks the market purchases on which NWE currently relies. NWE should therefore define and develop a "Current Plus Market Capacity" scenario which includes market-price-based capacity resources to allow for an apples-to-apples comparison to other scenarios.

NorthWestern notes that the regional shortfall in capacity expected in 2021–2022 is on the order of 300–400 MW.[5] Southwest supply availability, and hydro levels, could eliminate or increase this estimated need. NWE also notes that different entities in the region have different capacity positions. For instance, Avista (notably, now an expected CAISO Energy Imbalance Market, or EIM, participant in 2022) is long on capacity (page 2-13) while NorthWestern is short. These facts support the general notion that bilateral procurements of capacity should be an economically efficient way to ensure there is not an overbuilding of requirement in the Pacific Northwest. This is particularly applicable for a region about to become better integrated, economically, through the EIM—which also allows for more efficient "sharing" of any needed "flexible" capacity. The impending entry of more Pacific Northwest entities into the EIM, and enhancements to that EIM (towards an RTO-like construct in 2025), make it even more certain that a significant part of the economically optimum outcome for ratepayers in the region is to "share" (i.e., buy and sell) capacity resources and not overbuild.

Given that context, NorthWestern's statement on page 2-15 that it "should not continue to rely on the short-term regional energy market to meet its future capacity needs" is unsupported. There is generally sufficient capacity and the region is integrating at a faster rate than envisioned in 2015 (the time of NWE's last supply plan). The Company's near-term resource plans should explicitly incorporate this integration and defer any investments that might be better valued after seeing the economic picture when a more integrated region emerges over the next two to five years.

Lastly, as we noted earlier in this section, the best way to assess the value of potentially deferring any ratepayer-funded capacity investments (instead, capturing the value of the marketplace for NWE ratepayers) is to explicitly include a scenario in the Final Plan that contains capacity provision through short-term purchases (of capacity and/or firm energy) to allow for comparison to scenarios that would otherwise consider commencing build-out of NWE resources in the near term.

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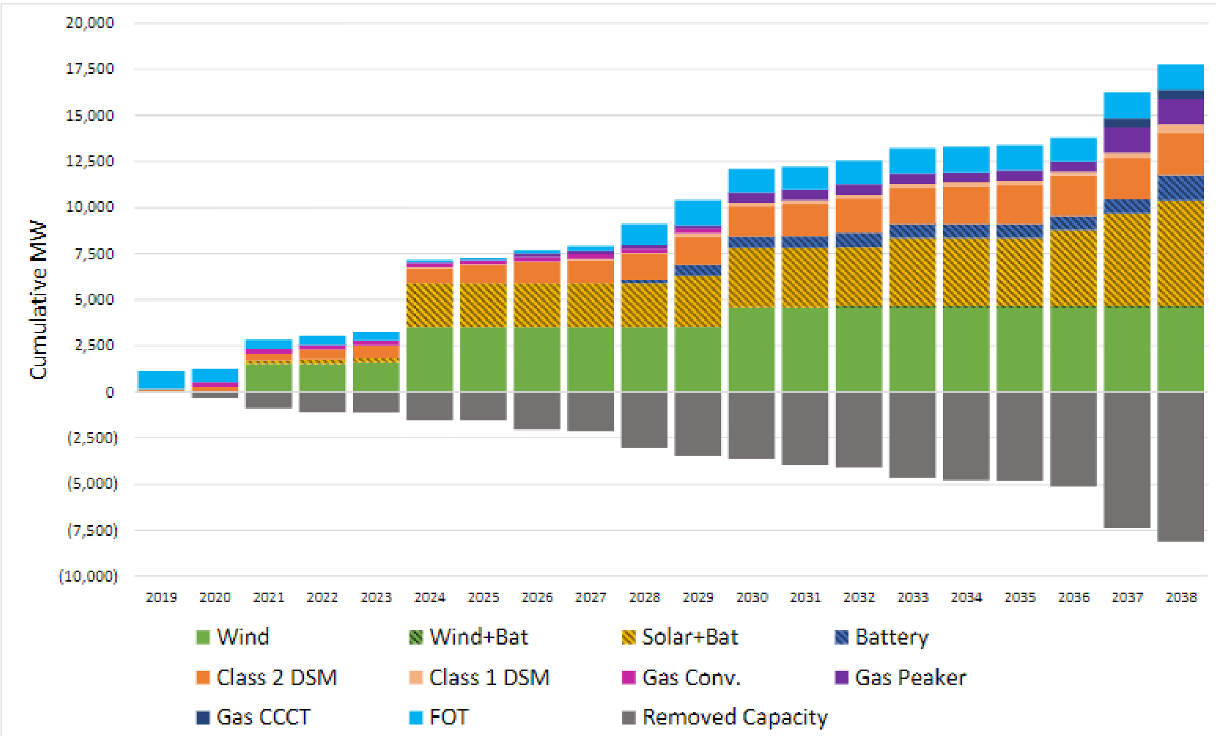
[3] 2019 Electricity Supply Resource Procurement Plan. Page 10-2.

[4] 2019 Electricity Supply Resource Procurement Plan. Page 11-11.

[5] 2019 Electricity Supply Resource Procurement Plan. Page 2-10.

Other utilities in the Pacific Northwest region have incorporated market capacity purchases in resource portfolio modeling. For example, in PacifiCorp's 2019 IRP, the preferred portfolio selected a sizeable amount of market purchases, which PacifiCorp calls "Front Office Transactions," in both the near term and long term.[6] Figure 1 shows the optimal resource portfolio from PacifiCorp's most recent IRP. The Front Office Transactions are abbreviated "FOT."

Figure 1. PacifiCorp 2019 IRP Front Office Transactions



Source: 2019 IRP Preferred Portfolio (All Resources). PacifiCorp 2019 IRP, Volume I.

NorthWestern addresses its impending participation in the EIM, but at best it is unclear if, or to what extent, its resource planning and portfolio analyses actually explicitly account for the transformed energy, ancillary service, and capacity market constructs that will exist in the region in 2021–2022 and beyond. In our comments on the Draft Plan, we asked that NWE ensure that its Final Plan describe in detail how the transformed constructs are explicitly represented in the modeling work that produces various estimates of net present value (NPV) for resource portfolios. This has not yet been done to our satisfaction.

[6] *2019 Integrated Resource Plan*, PacifiCorp. *Available at* https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/integrated-resource-plan/2019_IRP_Volume_I.pdf

Bonneville Power Administration (BPA) is in the process of making a set of final decisions to join the EIM.[7] Avista announced in April 2019 that it will join the EIM. The CAISO marketplace will institute its day-ahead enhancements in the fall of 2021[8] (those enhancements have been underway for some time). It is likely that similar day-ahead market improvements will be part of the EIM perhaps as early as 2022. NWE is joining the EIM in 2021 and expects that a market construct akin to an RTO will be in place by 2025 (page 5-10). These facts will directly, if not forcefully, bear on the nature, timing, cost, and need for the capacity resources NWE discusses in its plan.

An RTO market construct implies the ability for participating utilities to effectively buy and sell capacity in a more efficient manner than currently exists in the somewhat balkanized environment of the Pacific Northwest (e.g., multiple balancing areas). The timing of these EIM developments is such that it is critical that NWE's action plan, and any possible procurement alternatives, explicitly recognize the changing landscape and not commit ratepayers to inefficient or costly investments in resources prior to knowing how the new market construct could allow NWE to reduce costs for its customers.

NorthWestern in its supply plan emphasizes a need for flexible supply and describes requirements for additional incremental (INC) and decremental (DEC) capacity. However, NWE does not address how the different market construct will affect any need for INC and DEC requirements within the Company's service territory, compared to overall requirements across the EIM footprint. NWE acknowledges that the EIM allows for "reductions in flexibility reserves" and "sub-hourly dispatch benefits and savings" (page 5-5), but NWE should ensure its supply planning analyses explicitly incorporate a construct that aligns with the realities of the EIM in 2021 and 2022, and 2025 and beyond. For example, NorthWestern acknowledges that "the market itself addresses intra-hour balancing" (page 5-10) and thus concerns about NWE having sufficient INC/DEC capacity may be somewhat moot, since regional capability (reflecting regional supply and load diversity effects) will be the more salient factor.

2.2. Capacity credit given to renewables

The capacity credit the Company gives to potential new solar and wind resources is prohibitively low in the PowerSimm modeling. New solar resources are credited for none of their nameplate capacity (0 percent) even though there is now, and will be in the future, a summer peak (during daylight hours when solar PV produces) that is only slightly lower than NorthWestern's winter peak. Also, new wind resources are credited for just 1.9 percent of nameplate even though Montana's winter wind profile is strong, is generally sustained during peak evening hours, and will contribute towards supporting winter peak loads. As a result, NorthWestern's Base portfolio builds only new gas resources and fails to build any solar or wind projects. Based on nameplate capacity information provided in Tables 7-6 and 7-7 of NWE's 2019 Final Plan, as well as the Reserve Margin Capacity inputs taken from PowerSimm, Synapse

[7] See., e.g., April 26, 2019 BPA news piece, at https://www.bpa.gov/news/newsroom/Pages/Energy-Imbalance-Markets-The-Grid-Mod-and-Strategic-Plan-connection.aspx.

[8] CAISO. 2019. *Day Ahead Market Enhancement Status and Next Steps.* Stakeholder Call. Available at: http://www.caiso.com/Documents/Presentation-Day-AheadMarketEnhancementsInitiativeUpdate-May2-2019.pdf.

was able to calculate the capacity credit tied to each resource. Right away, one will see that all gas resources can contribute 87–95 percent of their nameplate capacity towards NWE's reserve margin. While it is true that renewable resources do not provide as much firm capacity as a gas resource, assigning a near-zero or zero credit causes these resources to be undervalued, and thus they are never selected by ARS in the Base portfolio.

Table 1. Western Montana reserve margin capacity by resource

Resource	Nameplate Capacity (MW)	Reserve Margin Capacity (MW)	Calculated Capacity Credit (%)
Source	*2019 RPP, Table 7-6*	*PowerSimm*	
Gas Resources			
Simple Cycle 1x0 CT- 50 MW Frame	48.1	44	91.5%
Simple Cycle 1x0 CT- 25 MW Aeroderivative	28.1	25.9	92.2%
Simple Cycle 1x0 CT- 50 MW Aeroderivative	47.4	42.63	89.9%
Combined Cycle 2x1 CT-Frame/Industrial CT	133.3	123	92.3%
DGGS Buildout 3x0 RICE - 18 MW	58.2	50.67	87.1%
Simple Cycle 1x0 RICE- 18 MW	19.4	16.89	87.1%
Simple Cycle 1x0 RICE- 9 MW	9.6	9.17	95.5%
Storage			
Battery Storage	26.3	25	95.1%
Renewables			
Wind Energy	105	1.9	1.8%
Solar PV	105	0	0.0%

Table 2. Eastern Montana reserve margin capacity by resource

Resource	Nameplate Capacity (MW)	Reserve Margin Capacity (MW)	Calculated Capacity Credit (%)
Source	*2019 RPP, Table 7-7*	*PowerSimm*	
Gas Resources			
Simple Cycle 1x0 CT- 50 MW Frame	51.4	44	85.6%
Simple Cycle 1x0 CT- 50 MW Aeroderivative	49.6	47.8	96.4%
Combined Cycle 2x1 CT-Frame/Industrial CT	140.2	129.6	92.4%
Simple Cycle 1x0 RICE- 18 MW	19.4	16.89	87.1%
Simple Cycle 1x0 RICE- 9 MW	9.6	9.17	95.5%
Storage			
Battery Storage	26.3	25	95.1%
Renewables			
Wind Energy	105	1.9	1.8%
Solar PV	105	0	0.0%

The differences in capacity credit between new gas and renewable resources leads PowerSimm to select new gas resources when allowed to optimize in every resource portfolio. The only exception to this is the No Carbon Additions portfolio, in which the model is constrained to add only resources that emit no carbon dioxide. The resource additions under each modeled portfolio are shown in Table 3. Resources highlighted in orange were hard coded into PowerSimm by Ascend Analytics.

Table 3. Resource additions in each of NorthWestern's modeled portfolios

Resource	Current	Unconstrained Expansion	Base	Pumped Hydro	Wind	Solar	Li-ion Battery	Carbon Cost	High Carbon Cost	High Natural Gas	No Carbon Additions
105 MW Solar	0	0	0	0	0	210	0	0	0	0	0
105 MW Wind	0	0	0	210	210	105	0	0	420	0	1680
100 MW Pumped Hydro	0	0	0	100	0	0	0	0	0	0	300
26.3 MW Li-ion Battery	0	0	0	0	0	0	105.2	0	0	0	631.2
25 MW Aero	0	525	0	0	0	0	0	0	0	0	0
18 MW Rice	0	162	738	828	936	720	828	702	756	738	0
9 MW Rice	0	180	189	0	0	198	0	216	162	189	0
19.4 MW Rice - DGGS	0	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	0
Total Additions	**0**	**925.2**	**985.2**	**1,196.2**	**1,204.2**	**1,291.2**	**991.4**	**976.2**	**1,396.2**	**985.2**	**2,611.2**

In every resource portfolio shown in Table 3 that allows for the addition of carbon-emitting resources, the PowerSimm model adds at least 828 MW of new gas capacity. PowerSimm must build resources to meet NWE's 16 percent reserve margin, and those that do not receive a higher firm capacity credit are therefore severely disadvantaged in the modeling. If these resources are not credited for providing any capacity to the grid, the model will not choose to build them regardless of their competitive low cost in the market. Additionally, a low capacity credit can inflate the cost of portfolio renewables by overbuilding resources with low firm capacity representations at a high cost. Synapse has seen no evidence that NorthWestern evaluated any alternative scenarios for uncertainty around the capacity credits for renewable resources.

The capacity credits given to wind and solar in this resource plan do not align with the historical contributions of these resources in the NorthWestern service territory, nor do they align with industry standard assumptions around capacity crediting. Treatment of ELCC for renewable resources must account for different values based on a summer peak need and a winter peak need, both of which occur on NWE's system. Solar PV generally does not contribute to winter peak needs, but it does contribute to summer peak needs. In contrast, wind has a much higher contribution for winter peak needs than for summer peak needs. While a zero-capacity credit for solar in winter months may be reasonable, NorthWestern should allow intermittent resources to provide different capacity requirements on a monthly basis, so that their benefit in summer peak months is recognized.

In Chapter 4 of the Final Plan, Northwestern states that it determines resource peak-load contribution based on production during historical peak-load periods, as demonstrated in its Table 4-1. NWE's Table 4-1 lists historical peak-load contributions for some existing wind resources but lists the peak-load contribution as "TBD" for newer renewables. The modeling output workbooks provided to Synapse indicate that the default capacity credit for all existing solar and wind resources without sufficient historical data is 10 percent and 5 percent respectively. Thus, a credit of 0 percent and 1.9 percent for new generic resources does not align with historical output.

This capacity credit also conflicts with general industry understanding of solar and wind operation. In CAISO, the 2018 solar and wind ELCCs ranged from 0-47.5 percent by month and resource, with an average annual ELCC for both around 22.6 percent. While the CAISO system differs substantially from the NWE service territory, CAISO's treatment of ELCC is a relevant model for utilities. The Navigant NEM study described in Chapter 4 of the Final Plan assigns a 6.1 percent capacity contribution factor to behind-the-meter solar resources in the NorthWestern service territory and points to the need for a more comprehensive analysis across the region.

Using simulated hourly load, wind, and solar data provided by Ascend Analytics, Synapse was able to estimate the forecasted solar and wind contributions to daily energy load (on peak days) over the time period of 2020 through 2048. This data was provided by project for the existing wind and solar resources represented in Table 4-1 of NorthWestern's plan. For the purpose of our high-level analysis, we took the average of the hourly load, wind output, and solar output values across the 100 simulations executed by Ascend.

Upon looking at the annual winter peak day over the time period through 2025, we observe that wind on NWE's system on average can contribute close to 30 percent of daily energy load, while solar contributes about 1 percent of daily energy load on average. For the summer peak day, wind can contribute around 12 percent of daily energy load, and solar increases to contribute 4 percent of daily energy load. Data from 2020 through the middle of the decade is the most indicative of wind contribution to NWE's load, as the data we were provided included projects that retire beginning 2027. Table 4 below provides our calculated wind and solar contributions to daily energy load on winter and summer peak days through 2025.

Table 4. Wind and solar contributions to daily energy load in winter and summer peak days, through 2025

	Winter Peak Day		Summer Peak Day	
Year	**Solar**	**Wind**	**Solar**	**Wind**
2020	1.0%	26.8%	4.6%	12.0%
2021	1.1%	28.4%	4.5%	12.5%
2022	0.9%	29.4%	4.4%	12.1%
2023	1.1%	28.7%	4.4%	12.4%
2024	1.0%	27.8%	4.4%	11.9%
2025	1.3%	29.8%	4.4%	11.8%

Source: Underlying data from Ascend Analytics. Reflects 538 MW of wind (nameplate), and 97 MW of solar PV.

Contributions to daily energy requirements do not reflect the expected contribution of the wind or solar resource to capacity needs during the peak hours, but they do highlight the critical importance of the resource to meeting energy requirements over the course of a peak winter or summer day. The average peak hour (winter, 6 PM) contribution from wind from our computations was greater than 40% in all years, although we did not control for correlations between load level and wind level within the 100 simulations provided by Ascend in the PowerSimm model.

One of the projects included in the wind data we received was for the proposed 320 MW Beaver Creek wind-plus-storage project (four wind turbines at 80-MW each, plus 160 MWh of battery storage). These data included contributions from this project for the years 2020–2037. The contributions of this project were excluded from the analysis in Table 4 above, but we note that when the project is added back to the mix, the average contribution of wind projects increases noticeably. Figure 2 and Figure 3, below, represent the average simulated winter peak day in 2020 with and without the Beaver Creek resource, respectively.

Figure 2. Average hourly energy contribution on peak day with Beaver Creek

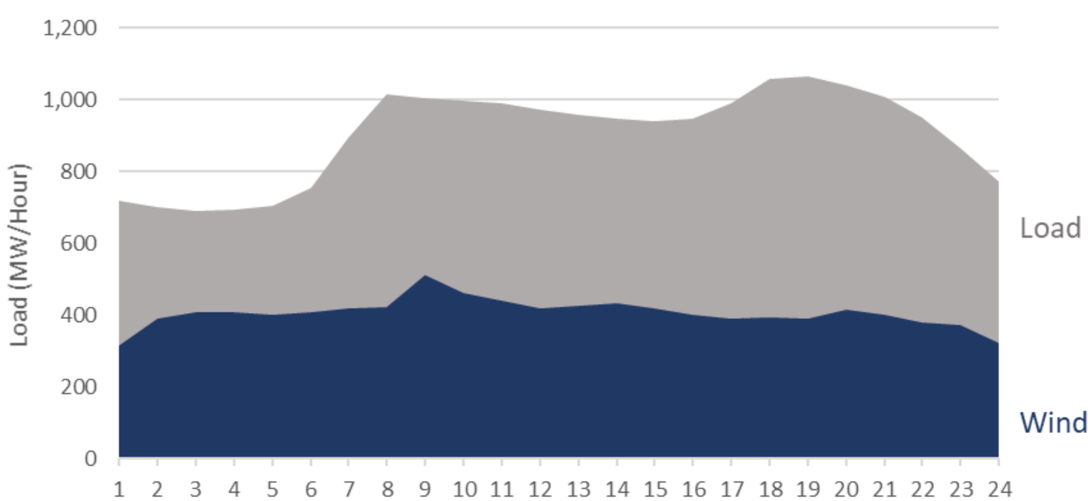
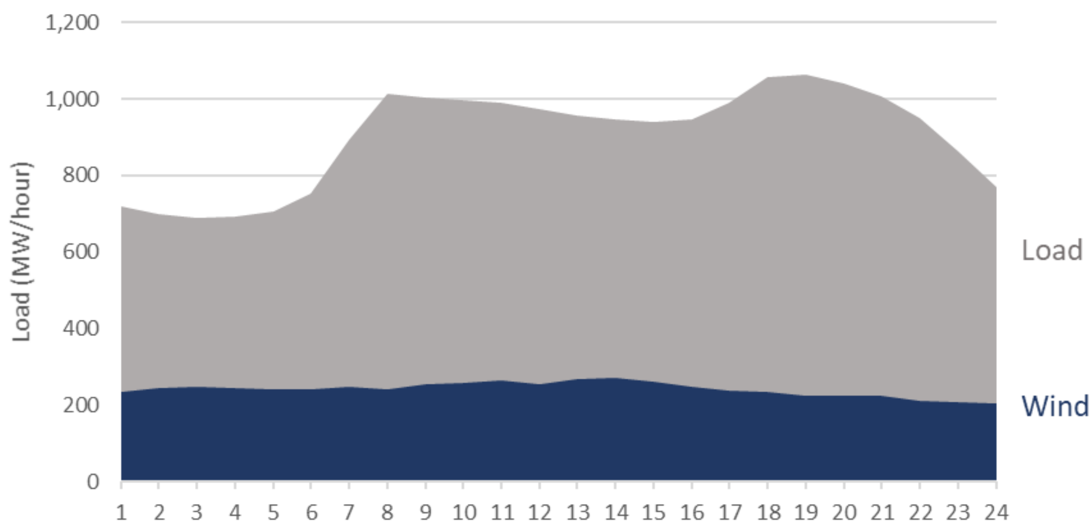


Figure 3. Average hourly energy contribution on a peak day without Beaver Creek



Source for Figures 2 and 3: Underlying data from Ascend Analytics. Reflects 320 MW of additional wind (nameplate) capacity and 160 MWh of battery storage capacity.

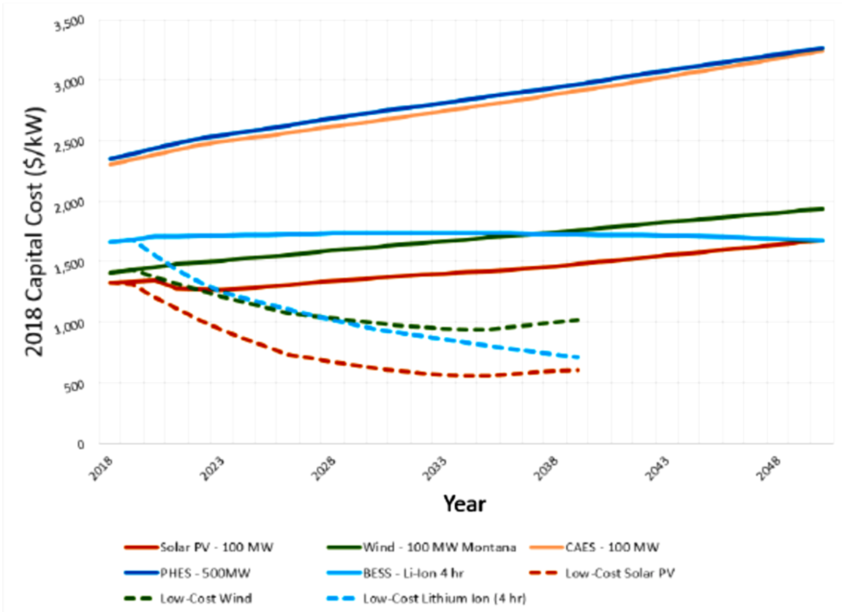
2.3. Capital costs of renewable resources

In Chapter 11 of its Final Plan, NorthWestern notes that it received comments from several parties stating that the unsubsidized costs of renewable resources are too high.[9] Comments also noted that Ascend Analytics developed lower cost trajectories for wind, solar, and Li-ion batteries but did not use those costs in portfolio modeling.[10] Those trajectories are shown in Figure 4, below.

[9] 2019 Electricity Supply Resource Procurement Plan. Page 11-4.

[10] 2019 Electricity Supply Resource Procurement Plan. Page 11-5.

Figure 4. NorthWestern's new resource costs for renewables and batteries



Source: 2019 Electricity Supply Resource Procurement Plan. Figure 7-2.

NorthWestern's response to these comments is that the original Base Case was re-run with the lower cost trajectories for these resources, and these lower cost futures had no effect on the resource selection. Therefore, NorthWestern chose not to include these resources, at these lower costs, as an option in future scenario modeling.[11] This is flawed, as described below.

NorthWestern has repeatedly stated its need for firm capacity resources and used this stated need to impose constraints in its PowerSimm modeling that do not realistically allow the model to choose anything other than thermal generators. First, PowerSimm is required to build toward NWE's required reserve margin, which causes the model to select only those resources that can contribute firm capacity toward the Company's reserves. As described above, NorthWestern gave solar a capacity credit of zero and wind a credit of 1.9 percent. The PowerSimm model will thus never choose either of these resources to meet a capacity need, no matter the price. The exception to this is if those resources are selected in combination with a resource that provides capacity but not energy, such as batteries or pumped storage. Ascend modeled only standalone resources, and we see in Table 3, above, that when pumped storage resources are hard-coded in the Pumped Storage resource portfolio, the model also chooses wind resources as part of the optimal resource mix. Paired renewables-plus-storage resources were not selectable resources in PowerSimm as part of either the Draft or Final plans, but we would expect to see these resources evaluated as part of the upcoming competitive solicitation process.

[11] 2019 Electricity Supply Resource Procurement Plan. Page 11-6.

If renewable resources receive a low capacity value, a capacity optimization model might choose to build renewables anyway for energy purposes. This would occur if the all-in cost of energy (capital plus any fixed and variable costs) is less than the marginal price of energy on a utility's system, and the least-cost option for energy generation is to build and run renewables that would displace higher cost existing resources, resulting in a net savings. NorthWestern has repeatedly stated that it is energy-long, and thus has little need for resources that provide only energy and not capacity. To that end, NWE constrained market sales of energy within PowerSimm to no more than 10 percent over annual customer load with the intent of preventing the model from overbuilding resources for the express purpose of selling energy into the market.[12] This constraint may be limiting any renewable builds that would provide low-variable cost energy to NorthWestern's system. Also, in a world with a more integrated Pacific Northwest marketplace, that would value winter energy (for example), a market sales limit of 10% of customer load is arbitrary and analytically unsupported.

NorthWestern modeled several portfolios in which specific levels of renewable and storage resources were manually forced into the model. Those include, specifically, the "Pumped Hydro," "Wind," "Solar," and "Li-ion Battery" portfolios. The resource portfolios and their revenue requirements are shown in Table 5.

Table 5. Modeled resource portfolios and associated revenue requirements

Portfolio	NPV Revenue Requirement ($M)	Difference from Base
Base	$5,717	-
Pumped Hydro	$5,923	$206
Wind	$5,893	$176
Solar	$5,914	$197
Li-ion Battery	$5,732	$15
Carbon Cost	$5,883	$166
High Carbon Cost	$6,034	$317
High Natural Gas	$5,714	($3)
No Carbon Additions	$6,240	$523

Sources: 2019 Electricity Supply Resource Procurement Plan. Figures 10-1, 10-2, and 10-3.

At a minimum, it would have been useful for NorthWestern to model the portfolios that fix the additions of renewable and storage resources using the lower cost trajectories. The Li-ion Battery portfolio has a revenue requirement that is only $15 million more than NorthWestern's Base portfolio under reference capital costs. A lower capital cost for battery storage technologies would lower the revenue requirement associated with that particular portfolio, perhaps bringing the cost below that of the Base portfolio.

[12] 2019 Electricity Supply Resource Procurement Plan. Page 10-4.

Adjustments to both the capacity values given to renewables and the capital cost trajectories associated with renewable and storage technologies in the PowerSimm modeling would result in the most meaningful set of resource portfolios. While NorthWestern can defer actual capacity additions to the competitive solicitation process, the importance of including current and reasonable assumptions in the resource planning process should not be overlooked or undervalued.

2.4. Limited alternative resource options

In order to test the market, NorthWestern issued an RFI in July 2018, designed to assess "potentially available resources for potential inclusion in capacity planning." While the RFI responses align somewhat with the slate of resources available in the modeling analysis, NWE has overlooked some key resource options. We described this limiting of potential resource options in our comments on the Draft Plan that were submitted to NorthWestern in May. However, the Company did not perform any additional model runs with an updated list of resource options, and so we believe that this comment should be reiterated here.

Table 6 below shows the number of responses to the Company's RFI by resource type in order of frequency, as compared to the number of resources NWE provided to its model. Solar plus storage, hydroelectric, internal combustion plus storage, coal, demand response, and wind plus storage resources are all absent from the available modeled resource slate. In contrast, NWE models three combined cycle resources when no relevant developers responded to the RFI. While the modeling exercise must not be perfectly aligned with an RFI, the dearth of renewable resource options and excess of natural gas-fired options available to the model seems incongruous.

Table 6. Number of July 2018 RFI responses versus available modeled resources by resource type

Resource Type	RFI	Modeled
CT/ICE	6	5
BESS	5	2
Solar + Storage	5	0
Wind	4	1
Hydro	3	0
Coal	2	0
CT/ICE + Storage	2	0
DR/DSM	2	0
PV	1	1
Wind + Storage	1	0
CAES	0	1
CC	0	3
Geothermal	0	1
Pumped Hydro	0	1

Based on the RFI, Northwestern should include at least two paired storage resource options, and it should consider whether the abundance of gas-fired resource options influences the modeling exercise unreasonably.

2.5. Modeling errors and omissions

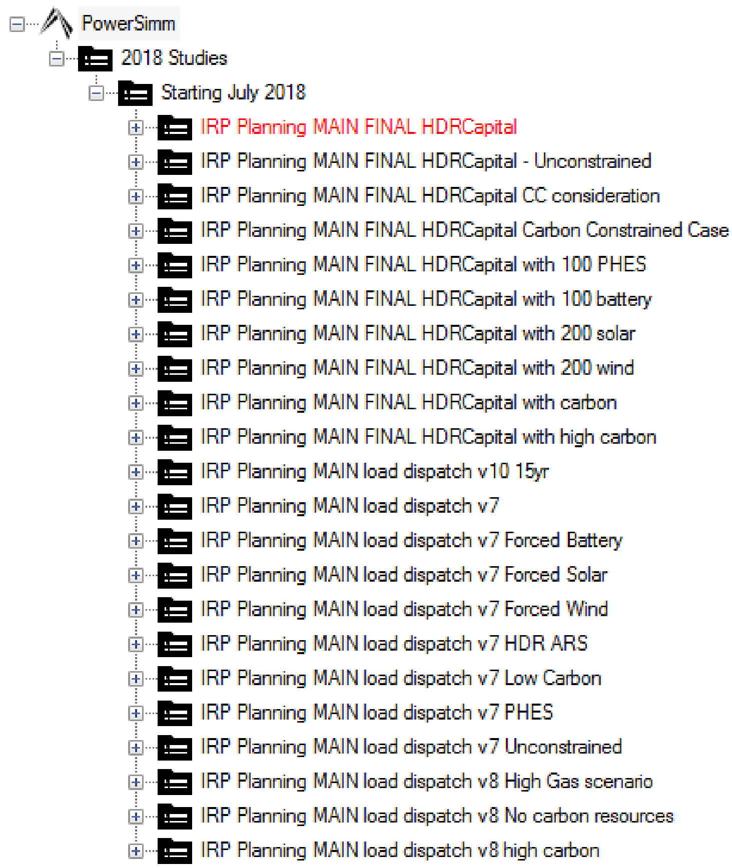
The PowerSimm modeling contains certain data entry-type errors that we observed in our review. We describe those errors here.

NorthWestern did not properly model a High Natural Gas Price scenario

NorthWestern claims in the Final Plan that it modeled a High Natural Gas Prices Scenario, which contains all of the assumptions included in the Base portfolio but escalates gas prices at 150 percent of the Base case escalation. The Company also claims that, as in the Base portfolio, resources were added to the portfolio using constrained ARS analysis.[13] However, upon looking at the setup of the PowerSimm model, Synapse noticed that there was no High Gas Price capacity expansion portfolio, meaning PowerSimm would be unable to run a constrained ARS analysis with this new sensitivity (see Figure 5, in which there is a “load dispatch” study for a High Gas scenario, but no “HDRCapital” study). Additionally, the load dispatch portfolio labeled as the “High Gas scenario” uses the same forward price curve (AECO 2018) for natural gas as the Base scenario, as opposed to using prices 150% higher than the Base scenario as stated in the Plan (see Figure 6). For these reasons, we believe that NorthWestern did not actually model a High Natural Gas Price scenario despite describing one in its plan.

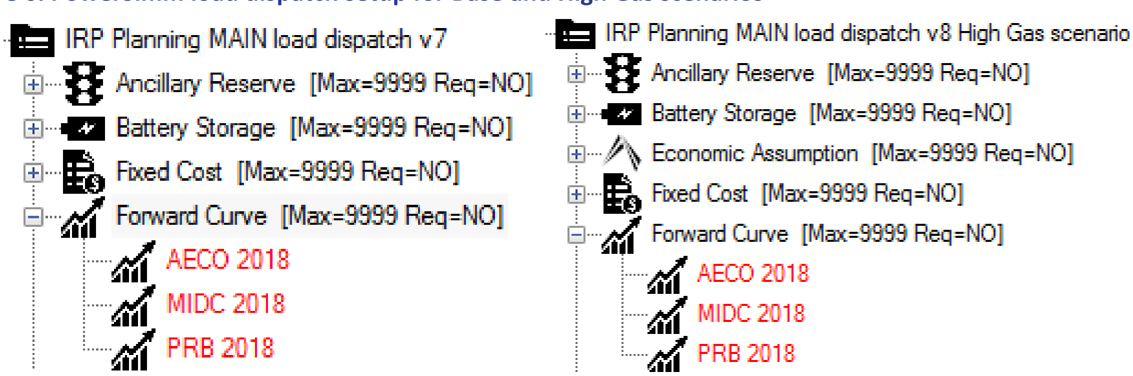
[13] 2019 Electricity Supply Resource Procurement Plan. Page 10-15.

Figure 5. PowerSimm portfolio setup



Source: Screen capture taken from NorthWestern's PowerSimm model dashboard.

Figure 6. PowerSimm load dispatch setup for Base and High Gas scenarios



Source: Screen capture taken from NorthWestern's PowerSimm model dashboard.

NorthWestern states that "The High Natural Gas Prices scenario had no effect on resource selection."[14] However, we cannot know this with any certainty given that this scenario was not actually included as an optimized run in PowerSimm. Additionally, the net present value of revenue requirement (NPVRR) for the High Natural Gas scenario is shown as being approximately $3 million less than the Base portfolio, for which NorthWestern has not provided an explanation.

It would have been wise for NorthWestern to model a scenario, or sensitivity to its Base scenario, in which winter gas supply was curtailed. The Company notes that "[c]urrently, gas-fired generation on the system operates utilizing interruptible gas transportation arrangements. As a result, during the coldest days of the year, gas supply to electric generation is subject to curtailment."[15] The Company's emphasis has consistently been on its winter peak throughout the stakeholder process and in both the Draft and Final Plan. While two of the simple cycle options considered in the Plan, the 50 MW aeroderivative CT and the 18 MW RICE, include the option to switch to a backup fuel in the event that the natural gas supply to the power generation facility is curtailed,[16] NorthWestern did not model or otherwise attempt to quantify the risk associated with gas curtailment.

PowerSimm cannot endogenously retire uneconomic resources

In PowerSimm, projects can be defined as new assets, existing assets, or retirement options. However, in NorthWestern's model, all resources were set up as either new or existing assets, thus preventing the model from being able to select a unit for retirement if its economics are poor relative to other units over the course of the planning period. Crucially, this means the model does not have the capability to optimize the early retirement of potentially uneconomic units arising from exposure to existing operational costs or future operational plus fixed (including capital investment) costs. This is important with respect to the operation of the Colstrip units. They are the most expensive resource in NorthWestern's resource portfolio, as shown in Figure 7, inclusive of all costs collected in rates.

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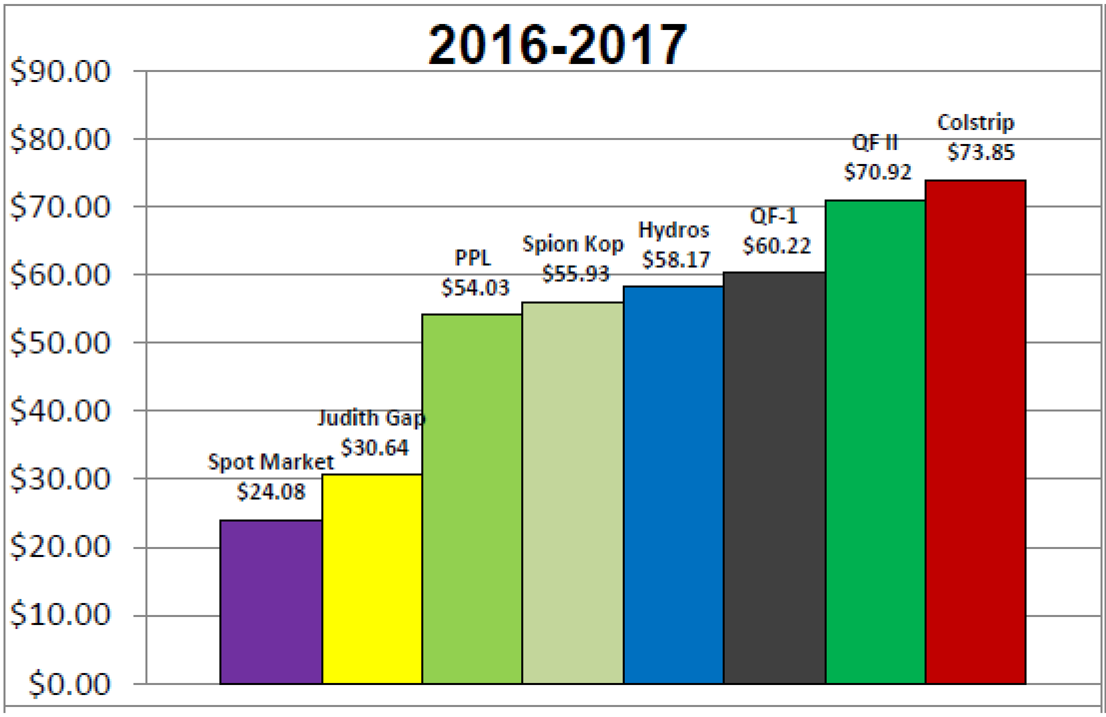
[14] 2019 Electricity Supply Resource Procurement Plan. Page 10-21.

[15] 2019 Electricity Supply Resource Procurement Plan. Page 6-27.

[16] 2019 Electricity Supply Resource Procurement Plan. Page 7-18.

Figure 7. Selected NorthWestern electricity average unit prices



Source: Montana Consumer Counsel. 2017. Residential Electricity Prices of NorthWestern Energy Through June 2017. Available at: https://leg.mt.gov/content/Committees/Administration/Consumer%20Counsel/Reports/NWERateGraphs.pdf.

NorthWestern does not model any scenarios with early retirements for Colstrip 3 or 4, despite comments from the public requesting such a scenario.[17] One method to remedy this would be to allow PowerSimm to optimize retirement dates endogenously.

Fixed O&M costs for solar resources

The solar resource fixed O&M assumptions in PowerSimm used in NorthWestern's IRP modeling were unreasonably high, at $21.60/kW-year for a new 100 MW solar installation.[18] Lazard's Levelized Cost of Energy study from 2019, which was referenced by several stakeholders in their comments on the Draft Plan, estimates that utility-scale solar PV Fixed O&M costs are between $9–$12 per kW-year.[19] NREL's 2019 ATB estimates 2019 Fixed O&M costs to be about $13 per kW-year[20] with costs continuing to decline in real terms over time. This means that industry standards are about two-times lower than

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[17] 2019 Electricity Supply Resource Procurement Plan. Page 11-4.

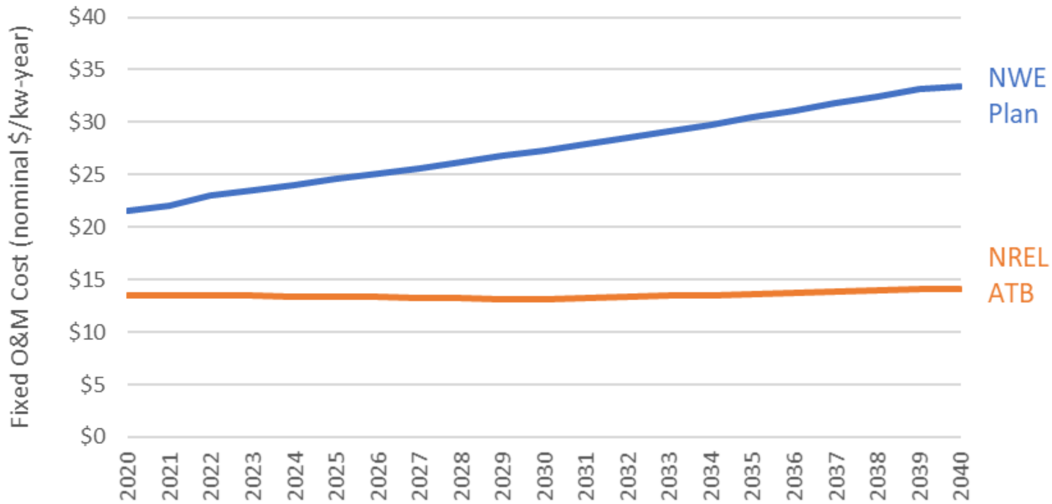
[18] 2019 Electricity Supply Resource Procurement Plan. Page 7-8.

[19] Lazard, *Lazard's Levelized Cost of Energy Analysis- Version 13.0* p. 16 (Nov. 2019). *Available at* https://www.lazard.com/perspective/lcoe2019

[20] NREL, ATB: Utility-Scale PV (2019), Mid-Case. *Available at* https://atb.nrel.gov/electricity/2019/index.html?t=su

what NorthWestern assumes in its plan. A comparison between NorthWestern's assumption and the NREL 2019 ATB is shown in Figure 8.

Figure 8: Solar fixed O&M cost comparison



This assumption is an important one because the PowerSimm model considers capital, fixed, and variable costs of new resources in its optimization. A high fixed cost is one more disadvantage unreasonably given to solar resources by NorthWestern, in addition to higher capital costs and a capacity credit of zero.

Discrepancies between the Final Plan and the PowerSimm interface

There are multiple places in the PowerSimm model where the inputs, whether they be costs or resource attributes, do not match the values published in the Plan. Synapse raised these concerns to NorthWestern and received the response that some of the discrepancies in cost values may be attributed to rounding and/or annual escalation, but that they could not say definitively. While we cannot confirm whether or not the changes listed in Table 7 impact the final results, it does raise some flags. For example, the nameplate capacity listed for the wind resource in Tables 7-6 and 7-7 of the resource plan is 105 MW, while the capacity value in PowerSimm is 100 MW. This affects the ELCC of wind, because the 1.9 MW Reserve Margin Capacity results in a 1.9 percent ELCC if the 100 MW value from PowerSimm is used, and a 1.8 percent ELCC if the 105 MW value from the Final Plan is used. While this difference is slight, it is nonetheless NorthWestern's responsibility to ensure that the values published in the Plan are reflected accurately in modeling inputs to ensure transparency throughout this process.

Table 7: Observed discrepancies between the Final Plan and PowerSimm

Resource	Category	Final Plan	PowerSimm
9 MW RICE	Capital Costs	$2,324/kW	$1,987/kW
9 MW RICE	Fixed O&M Costs	$54.62/kW-year	$56.88/kW-year
Wind	Capital Costs	$1,410/kW	$1,330/kW
Wind	Fixed O&M Costs	$37/kW-year	$24/kW-year
Wind	Nameplate Capacity	105 MW	100 MW
Solar	Nameplate Capacity	105 MW	100 MW
Li-Ion Battery Storage	Nameplate Capacity	26.3 MW	25 MW

3. Competitive Procurement Process

The Company intends to procure any new resources through the RFP process, soliciting competitive proposals from a variety of resources. NorthWestern has stated that the resources procured through these competitive solicitations may be those identified in the Final Plan, but that it is more likely that resources not identified or modeled will be those that are actually acquired by the Company.[21]

NWE's issuance of an RFP for capacity procurement contains several, severe flaws which essentially restrict the ability for resources to compete to serve Northwestern's needs and do not adhere to the spirit of House Bill 597 because of the effective restriction to competition. Those flaws are:

1. Limiting resources to those considered "dispatchable," even though NWE's need is for incremental capacity resources, not necessarily for 100 percent incrementally dispatchable capacity resources.
2. Not allowing for wind resources absent storage characteristics to participate in the bidding process. Additionally, while NWE indicates it will model the entire portfolio of resource bids received, the RFP still indicates a very low capacity contribution ascribed to wind resources.
3. Restricting resource participation by defining overly stringent resource output duration tiers that are not supported by any PowerSimm modeling result requiring such lengthy duration.

[21] 2019 Electricity Supply Resource Procurement Plan. Page 11-3.

Each of these is addressed in turn below.

Northwestern's need is for capacity resources to meet its peak load, plus reserve requirements. With its entry into the EIM in 2021, the overall need for any one utility to hold a certain level of dispatchable resources is lessened.[22] NWE did not compute a minimum value of required dispatchable resources for its system, and the value of any capacity resource bidding into the RFP can be assessed (through the portfolio modeling) without first limiting the potential entry of new resources. This may particularly effect solar and wind resources, which while technically dispatchable in a downward direction, and potentially dispatchable in an upwards direction (if postured, and "held back" for energy production), are not generally considered dispatchable. NWE should remove this requirement from the RFP and allow its portfolio modeling process to address the extent to which a given respondent to the RFP, with a dispatchable resource, adds value for NWE.

Wind resources in central Montana are being modeled by NWE at a 44 percent annual capacity factor, reflecting the strength of this resource for NWE. Montana wind is stronger in the winter, and weaker in the summer; thus, contributions to winter peak needs can be expected. NWE's winter credit of 1.9 percent is too low: NWE used a cumulative frequency computation, and not an explicit ELCC computation, to arrive at this value. NWE offers no credible reason for the stringent, 95 percent confidence parameter it uses to arrive at the 1.9 percent value.

We note that winter peaking regions usually recognize the strength of the resource, such as Saskatchewan assigning a 20 percent credit for wind, based on use of the median value for wind capacity during peak hours, and not reflective of a 95 percent confidence of exceedance. If a cumulative frequency computation is to be used, NWE should consider using a median level of expected wind output during winter peak periods. Preferably, a true ELCC computation should be used to determine capacity contributions from wind resources (for winter) and solar resources (for summer).

In Avista's draft 2020 IRP, the location of wind resources determines the capacity credit they receive. Northwest wind receives a 5 percent capacity credit for its operational contribution to winter peak, while Montana wind receives a 40 percent capacity credit.[23] This fairly dramatic difference in wind capacity contribution crediting reflects the distinction between, for example, Columbia Gorge winter peak period wind patterns, and those of central Montana (with vastly different topography and

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[22] Notably, EIM improvements may allow for even less flexible capacity to meet Resource Sufficiency requirements, according to the CAISO. October 2019: http://www.caiso.com/InitiativeDocuments/IssuePaper-ExtendedDayAheadMarket.pdf. "Resource sufficiency evaluation: Since resource participation in EDAM will be voluntary, i.e. there will not be an obligation to offer specific resources into the day-ahead market, this initiative must develop resource sufficiency evaluation criteria and related rules. Similar to the existing criteria and rules in the EIM, EDAM resource sufficiency rules must ensure that balancing authority areas do not inappropriately lean on the capacity, flexibility, or transmission of other balancing authority areas. As part of this, **this initiative will explore potential mechanisms to trade resource flexibility and/or balancing authority area obligations needed to pass the resource sufficiency evaluation** between EDAM balancing authority areas." (emboldened emphasis added).

[23] Avista. 2020. *Electric Integrated Resource Plan.* Available at: https://www.myavista.com/-/media/myavista/content-documents/about-us/our-company/irp-documents/2020-avista-electric-irp-tac-draft.pdf?la=en.

meteorological characteristics) during the same time periods.[24] Similarly, in PacifiCorp's most recent IRP, wind and solar resources receive different capacity credits based on location. The values for standalone wind, solar, and storage are shown in Table 8. Capacity contributions rise when paired with storage, as shown in Table 9.

Table 8. PacifiCorp's final capacity contribution values for wind, solar and storage.

	Capacity Factor (%)	Capacity Contribution (%)	
Summer/Winter:	**Annual**	**S**	**W**
Solar			
Idaho Falls, ID	28%	12%	13%
Lakeview, OR	29%	15%	14%
Milford, UT	32%	10%	23%
Yakima, WA	25%	12%	10%
Rock Springs, WY	30%	11%	19%
Wind			
Pocatello, ID	37%	19%	27%
Arlington, OR	37%	57%	21%
Monticello, UT	29%	18%	22%
Goldendale, WA	37%	57%	21%
Medicine Bow, WY	44%	13%	35%
Stand-alone Storage			
2 hour duration		78%	89%
4 hour duration		94%	100%
9 hour duration		98%	100%

Source: PacifiCorp. 2019 Integrated Resource Plan. Volume II, Appendices M-R. Page 404.

[24] See, for example, a memo and presentation by John Fazio (Senior Systems Analyst) of the Northwest Power and Conservation Council, August 2, 2016, on "System Capacity Contribution of Montana Wind Resources", available at https://www.nwcouncil.org/sites/default/files/3_131.pdf.

Table 9. PacifiCorp's final capacity contribution values for wind and solar combined with storage.

	Capacity Factor (%)	Capacity Contribution (%)	
Summer/Winter:	Annual	S	W
Solar & Storage			
Idaho Falls, ID	28%	33%	37%
Lakeview, OR	29%	35%	39%
Milford, UT	32%	30%	48%
Yakima, WA	25%	33%	34%
Rock Springs, WY	30%	31%	43%
Wind & Storage			
Pocatello, ID	37%	38%	50%
Arlington, OR	37%	77%	44%
Monticello, UT	29%	37%	44%
Goldendale, WA	37%	76%	44%
Medicine Bow, WY	44%	32%	58%

Source: PacifiCorp. 2019 Integrated Resource Plan. Volume II, Appendices M-R. Page 405.

Storage resources can compete with gas-fired capacity for capacity provision. NWE's tier specification is overly stringent. Peak periods do not require peaking output from a single resource to be sustained for 20 hours, or even 10 hours, as NWE's tier structure demands. Storage resources of durations ranging from 2 hours to 6 hours are commonly seen to provide sufficient capacity to cover peak periods or contingency event operation. NWE provides no technical or computational (PowerSimm modeling) justification for the stringent (i.e., too high) tier threshold duration values.

4. Opportunity Resources

NorthWestern notes that opportunity resources, which are existing or new-build resources that remain unknown as to their availability until the purchase opportunity arises, may be obtained outside of the competitive solicitation process. There are currently two opportunity resources of note. The first is the availability of Puget Sound Energy's 25 percent share of Colstrip Unit 4, which is available to NorthWestern for $1. If NWE were to purchase this asset, it would acquire 185 MW of generation but sell 90 MW back to Puget Sound Energy for the next five years. Though the capital cost is practically zero, as shown in Figure 7, Colstrip has the highest operating cost of any of NorthWestern's units. It is also counter to the behavior of other utilities in the Pacific Northwest region that are actively retiring or divesting themselves of existing coal units.

To our knowledge, Northwestern has not put Colstrip options to a competitive test against alternative opportunity resources, especially, for example, what may be available from Bonneville Power Administration (BPA) or merchant providers. Such an analysis would include updated capacity values for renewables, as described in Section 2.2, lower capital cost trajectories for renewable resources, and a price on emissions of carbon dioxide associated with federal regulations.

In the Final Plan, NorthWestern describes the potential Regional Haze risk facing Colstrip Units 3 and 4, stating that:

> *It is likely that Colstrip Units 3 and 4 will undergo analysis to determine whether additional controls will be required. NorthWestern cannot predict how the results of this analysis may, or may not, affect Colstrip Units 3 and 4. For purposes of the Plan, we assume Colstrip Units 3 and 4 will not require additional material upgrades to comply with the RHR during the 20-year planning period of the Plan. Obviously, should Montana conclude Units 3 and 4 require material upgrades a detailed analysis would be required at that time.*[25]

Future analysis of the Colstrip 4 acquisition should consider the risk of additional upgrades to comply with Regional Haze rules.

Second, BPA is currently in the process of more aggressively seeking longer-term contracts for its resources. In its 2018 Strategic Plan, BPA states that it seeks to:

> *Increase power revenues through new market opportunities for clean capacity. BPA will seek to increase revenues from its secondary sales by pursuing new capacity market opportunities and using new and improved approaches for ancillary and control area service offerings. Taking a more systematic approach, BPA will also develop, package and sell a portfolio of products and services to take advantage of real-time, short-term, cyclical, long-term and emerging opportunities. BPA's long-term objective is to re-subscribe the federal system to its preference customers through new long-term contracts in 2028. However, BPA will also target potential sales of surplus or excess federal power to entities that seek low-carbon power or other FCRPS attributes (such as flexibility and responsiveness). These entities may include investor owned utilities, high-tech facilities and qualified community choice aggregators. Targeting these sales will serve as a hedge against declining secondary revenues and create longer-term sales opportunities if we experience a reduction in the amount of power that preference customers buy from BPA after 2028.*[26]

The availability of such resources from BPA should be explored and evaluated by NorthWestern outside of its competitive solicitation process.

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[25] 2019 Electricity Supply Resource Procurement Plan. Page 9-16.

[26] Bonneville Power Administration. 2018 Strategic Plan. Page 36. Available at: https://www.bpa.gov/StrategicPlan/StrategicPlan/2018-Strategic-Plan.pdf.