Northwest **Power** and **Conservation** Council

July 6, 2016

MEMORANDUM

TO: **Council Members**

FROM: **John Fazio, Senior Systems Analyst**

SUBJECT: **Power Supply Adequacy Assessment for 2021**

BACKGROUND:

Presenter: John Fazio

Summary: In 2011, the Council adopted a methodology to assess the adequacy of the Northwest's power supply. The purpose of this assessment is to provide an early warning should resource development fail to keep pace with demand growth. The Council's standard defines an adequate power supply to have no more than a 5 percent chance of a resource shortfall in the year being assessed. This metric is commonly referred to as the loss-of-load probability (LOLP) and any future power supply with an LOLP greater than 5 percent is deemed to be inadequate.

The Pacific Northwest's power supply is expected to be adequate through 2020, however, by 2021 – with the loss of the Boardman and Centralia-1 coal plants (1,330 MW nameplate) – the LOLP rises to about 10 percent[1] and would lead to an inadequate supply without intermediate actions. These results assume that the region will continue to acquire energy

[1] Boardman and Centralia 1 coal plants are scheduled to retire in December of 2020. However, because the Council's operating year runs from October 2020 through September 2021, these two plants would be available for use during the first three months of the 2021 operating year. For this scenario, the LOLP is 7.6 percent. The Council must take into account the long term effects of these retirements and, therefore, uses the more generic study that has both plants out for the entire operating year.

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efficiency savings as targeted in the Council's Seventh Power Plan, which amount to 1,400 average megawatts of savings through 2021.

Actions to bring the 2021 power supply into compliance with the Council's standard will vary depending on the types of new generating resources or demand reduction programs that are considered. Designing a resource strategy to ensure an adequate power supply for 2021 is more appropriately done using the strategy outlined in the Council's Seventh Power Plan. In all likelihood, some combination of new generation and load reduction programs will be used to bridge the gap.

Northwest utilities, as reported in the Pacific Northwest Utilities Conference Committee's 2016 Northwest Regional Forecast have identified about 550 megawatts of planned generating capacity for 2021. However, these planned resources are not sited and licensed and are therefore, not included in the 2021 adequacy assessment. It is important to note that demand response programs could play a vital role in maintaining power supply adequacy, as reported in the Council's Seventh Power Plan.

Relevance: Besides being an early warning to ensure that the regional power supply remains adequate, the Council's adequacy standard is converted into Adequacy Reserve Margins (for both energy and capacity) that are fed into the Regional Portfolio Model to ensure that resource strategies developed by that model will produce an adequate supply.

Workplan: A.5.2. Complete Annual Adequacy Assessments

Background: Since the late 1990s, the Council has worked to develop a more robust method of assessing the adequacy of the region's power supply. In 2011 it formally adopted the loss-of-load probability (LOLP) metric as the measure to assess adequacy and set its maximum threshold at 5 percent. The Council reassesses this every year, looking at the adequacy of the power supply five years out, as an early warning to ensure that adequacy is maintained.

More Info: For more information please go to the Resource Adequacy Advisory Committee webpage:

http://www.nwcouncil.org/energy/resource/home/

Power Supply Adequacy for the 2021 Operating Year

Council Meeting
Olympia, Washington
July 12-13, 2016

Contents

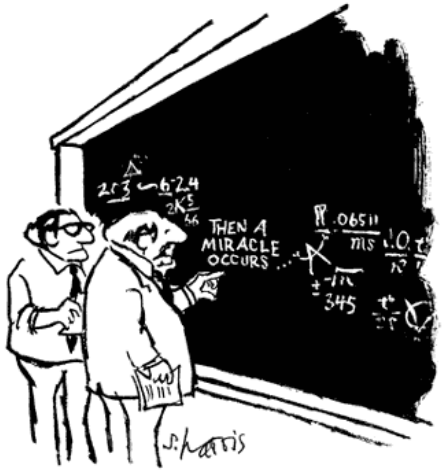
How is adequacy assessed?

- Simulate 2021 power system operation thousands of times
- Each simulation has different combinations of:
  - River flows
  - Temperature
  - Wind generation
  - Forced outages
- Count how many simulations had at least one shortfall
- Shortfall Likelihood = Number of simulations with shortages divided by the total number of simulations (a.k.a. loss of load probability or LOLP)
- **Supply is adequate if LOLP is 5% or less**

2021 Power Supply Adequacy

- 2021 power supply expected to be inadequate (LOLP = 10%)
  - For medium load forecast
  - Existing resources + 121 MW planned DR
  - Seventh plan EE target (1,400 aMW)
- Primarily capacity short – 1,040 to 2,230 MW of new capacity needed (med to high load)
- Results are consistent with the Seventh Power Plan
- Demand response could play a role in maintaining adequacy but uncertainties remain about its availability and viability
- About 550 MW of planned (but not sited and licensed) new resources (from PNUCC)

Adequacy Primer

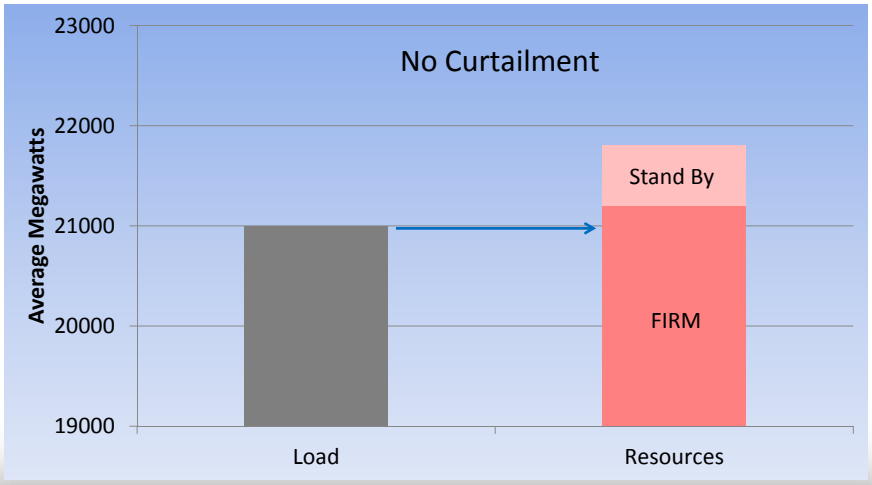


"I think you should be more explicit here in step two."

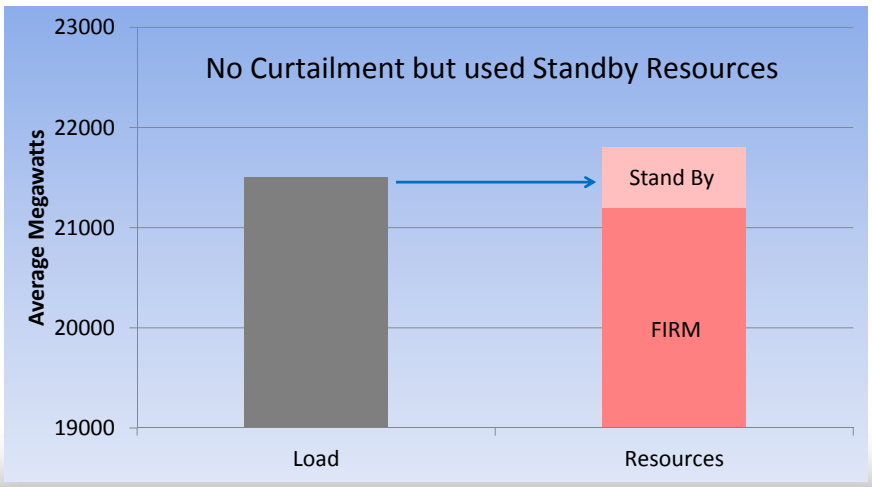
Resource Dispatch Order

Resource	Description	
Firm Hydro and Thermal	From lowest to highest operating cost	Modeled in GENESYS
Non-firm and Markets	In-region and out-of-region markets, surplus hydro, borrowed hydro	
Standby Resources Type 1	Non-declared utility resources (diesel generators, etc.)	Modeled in Post Processor
Standby Resources Type 2	Demand response and buy-back load provisions	
Emergency Action 1	More expensive non-declared resources or contract provisions	
Emergency Action 2	Governor's call for voluntary curtailment of energy	Not Modeled, Not part of Assessment
Emergency Action 3	Rolling black outs or brown outs	

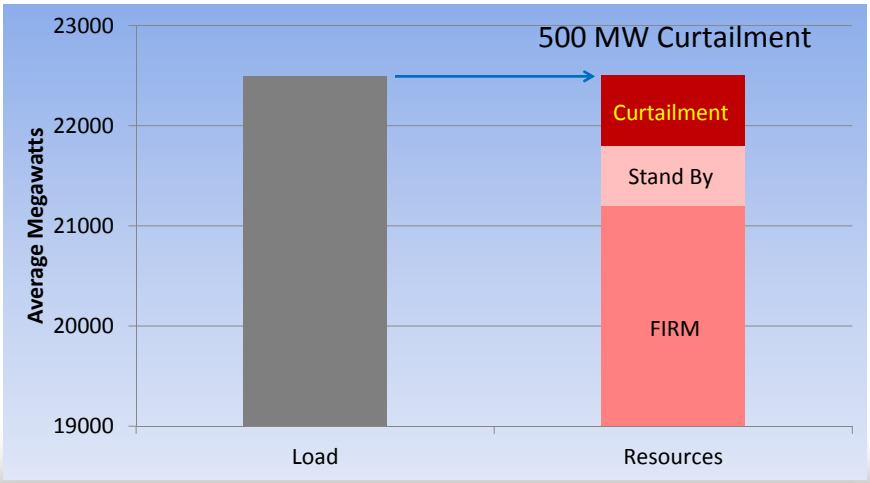
Sample Future Simulation 1



Sample Future Simulation 2



Sample Future Simulation 3

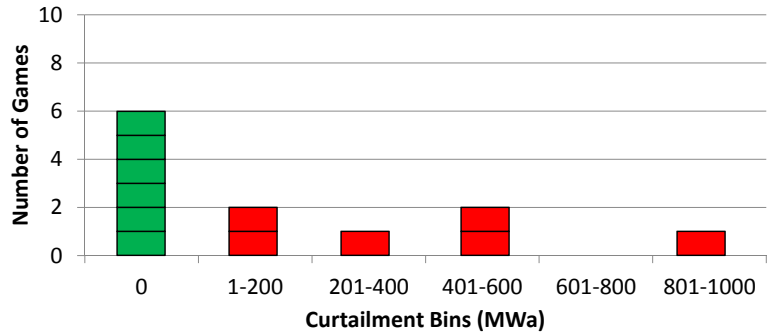


Tally Curtailments by Game

Game	Curtailment (MW)
1	0
2	0
3	500
4	0
5	900
6	100
7	0
8	450
9	0
10	150
…	…
100	0

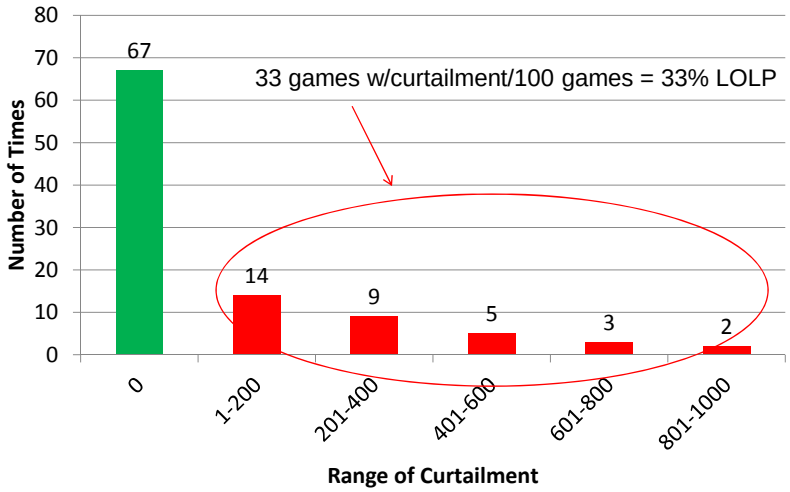
Tally Curtailments - Graphically

(Step through games and fill curtailment bins)



Curtailment Histogram

100 Games



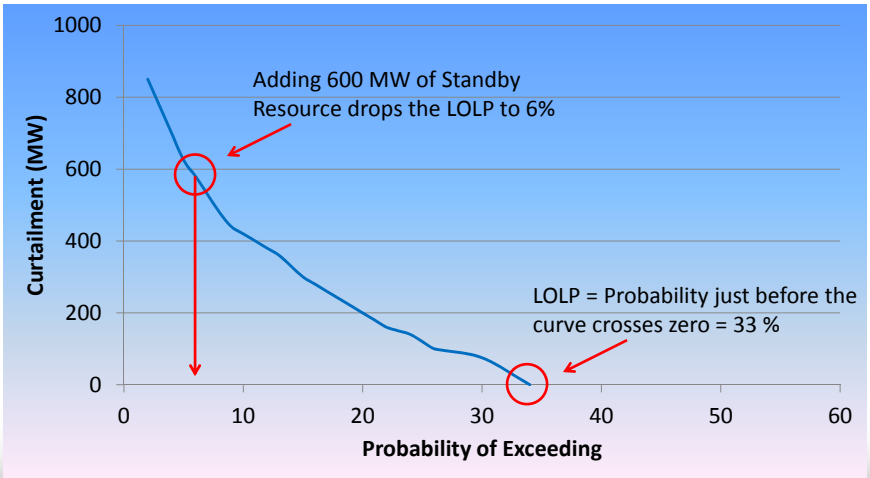
Sort by Curtailment Size

Game	Probability of Exceeding	Curtailment (MW)
54	1%	950
30	2%	900
18	3%	850
73	4%	800
6	5%	700
22	6%	600
33	7%	450
…	…	…
20	32%	10
10	33%	1
…		…
100	100%	0

Then graph these results

33% of the games have a curtailment, LOLP = 33%

Peak-Hour Curtailment Probability Curve (for 100-game sample case)

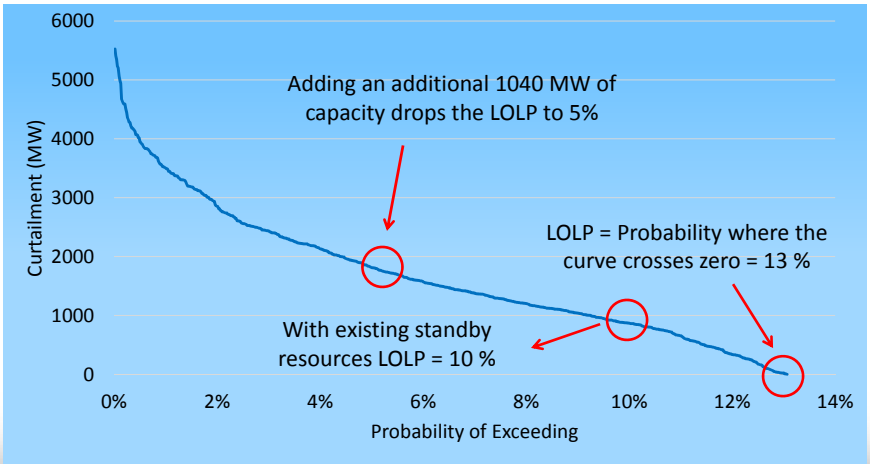


Sort by Curtailment Size

Game	Probability of Exceeding	Curtailment + 600 MW
54	1%	~~950~~ 350
30	2%	~~900~~ 300
18	3%	~~850~~ 250
73	4%	~~800~~ 200
6	5%	~~700~~ 100
22	6%	~~601~~ 1
33	7%	~~450~~ 0
…	…	…
20	32%	~~10~~ 0
10	33%	~~1~~ 0
…		…
100	100%	0

6% of the games have a curtailment, LOLP = 6%

2021 Peak-Hour Curtailment Probability (Medium load, no standby – 6,160 games)



Alternative Scenarios

LOLP (%) Heat Map

(Standby Generation + Exist DR + 121 MW DR)

Let's examine the effects of adding DR to the reference case.

Loads	Imports 3400	Imports 2500	Imports 1700
High	22	24	26
Med	8	10	12
Low	2	4	6

Effects of DR on LOLP
(2500 MW import)

Reference Case

Standby ➡ / Loads ⬇	Standby Gen. + exist DR + 121 MW DR	Standby Gen. + exist DR + 500 MW DR	Standby Gen. + exist DR + 1,257 MW DR
High Load	24	19	10
Med Load	10	8	5
Low Load	4	3	2

Sensitivity Case
Loss of gas supply for IPP/
Market friction effect

Ref Case	Standby ➡ / Loads ⬇	Loss of 650 MW IPP 2500 MW import: Standby Gen. + exist DR + 121 MW DR	Standby Gen. + exist DR + 500 MW DR	Standby Gen. + exist DR + 1,257 MW DR
24	High Load	30	23	13
10	Med Load	13	10	6
4	Low Load	6	5	3

What's Next

- Today
  - Council decision to release 2021 assessment
- Before 2022 Assessment
  - Reassess import availability & intertie capability
  - Explore gas supply/market friction issues
  - Review hourly load shapes
- Before next power plan
  - GENESYS redevelopment
  - Review of adequacy standard

Additional Slides (if needed)

2021 Reference Case

(see next 3 slides for more detail)

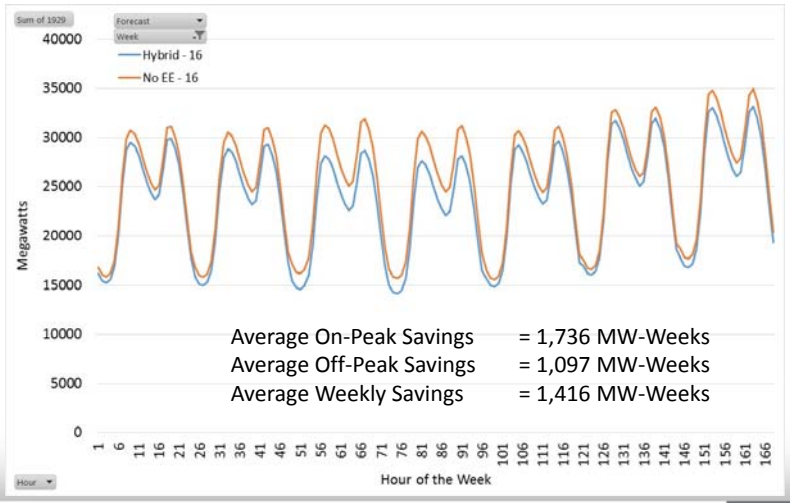
- Loads (from long-term model hybrid method)
  - Long-term model weather-normalized frozen-efficiency monthly loads
  - Add weather-normalized daily and hourly shapes
  - Add 7th plan EE targets by applying monthly effects
  - Add temperature variations from short-term model
- Demand Response: Existing + 121 MW planned DR
- Import availability
  - Spot (available all hours, winter only)
  - Purchase Ahead (available light-load hours, all year)
- IPP generation
  - Full availability (2,943 MW) winter
  - Limited availability (1,000 MW) summer
- Wind 4,896 MW nameplate (modeled as Columbia Gorge wind)
- Solar 396 MW nameplate, fixed generation pattern

Reference Case Assumptions

Item	Quarter 4	Quarter 1	Quarter 2	Quarter 3
Mean Load (aMW)	21,234	20,975	18,813	19,987
Peak Load (MW)	33,768	33,848	26,504	28,302
DSI Load[2] (aMW)	338	338	338	338
Mean EE (aMW)	1,545	1,574	1,274	1,208
Peak EE (MW)	2,660	2,660	1,680	1,680
Spot Imports (MW)	2,500	2,500	0	0
Purchase Ahead (MW)	3,000	3,000	3,000	3,000

[2]DSI load is 338 aMW in low, med and high load cases in 2021.

Example of Energy Efficiency Savings 2021 Hybrid Loads January (1929 Temp)



Scenarios

- Reference Studies (for heat map)
  - Reference Case (see previous slides)
  - Load Ranges (low, medium and high)
  - Import Ranges (1700, 2500, 3400 MW)
- Sensitivity Studies
  - Reference Case using STM loads
  - Fuel Limitation Case: Reduce winter gas IPP capability by 35% (650 MW), reduces all-fuel winter IPP cap by 22%
    - Reduces winter IPP total cap from 2943 to 2293 MW
    - Reduces summer IPP total cap from 1000 to 779 MW
  - Standby Resource Sensitivity
    - Existing + Planned DR and Emergency Generation
    - Existing + Planned + RPM Minimum DR (500 MW)
    - Existing + Planned + RPM Expected DR (1,257 MW)

Comparison to last year's 2021 Assessment

(from 8.3 to 9.9% LOLP)

- 2021 Annual Load:
  - Last year's forecast 21,780 aMW
  - Current forecast[1] 20,250 aMW (range 19,580 to 20,900)
  - Net decrease - 1,530 aMW
- 2021 Average Winter Peak Load:[2]
  - Last year's forecast 30,865 MW
  - Current forecast 33,848 MW
  - Net increase 2,983 MW
- Resources
  - Small amount of new solar capacity
  - Up to 2,000 MW less hydro peaking (from BPA-only to regional INC/DEC)
- Newer version of GENESYS (tends to show slightly higher LOLP)

Main reasons why LOLP is higher in this year's assessment

[1]Load forecasting method was modified for a more accurate reflection of energy efficiency savings and the impacts of future codes and standards.

[2]Even though the current annual average load forecast for 2021 is lower than last year's, this year's winter peak load forecast is much higher. Council will continue to investigate this and also why off-peak loads in this year's forecast appear to be lower than expected.

Comparison to Past Assessments

Year Analyzed	Operation Year	LOLP	Observations
2010	2015	5%	Was part of the Council's 6th Power Plan
2012	2017	7%	Imports deceased from 3,200 to 1,700 MW, load growth 150 aMW per year, only 114 MW of new thermal capacity
2014	2019	6%	Load growth 0.6%, over 600 MW new generating capacity, increased imports by 800 MW
2015	2020	5%	Lower load forecast, 350 MW of additional EE savings
2015	2021	8.3%	Early estimate (BPA INC/DEC only) Loss of Boardman and Centralia 1 (~1,330 MW)
2016	2021	10%	2021 loads lower than last year's forecast (~1,500 aMW) but winter peaks are higher (~3,000 MW), using regional INC/DEC reduces hydro peaking by as much as 2,000 MW

Northwest **Power** and **Conservation** Council

July 6, 2016

DECISION MEMORANDUM

TO: Council Members

FROM: John Fazio, Senior Systems Analyst

SUBJECT: Council Decision to Approve the 2021 Resource Adequacy Assessment

PROPOSED ACTION: Approval of the 2021 power supply adequacy assessment

SIGNIFICANCE:

- Approving the resource adequacy assessment for 2021 meets the requirements for action item Res-8 in the Council's Seventh Power Plan, "In order to track Seventh Plan implementation and adapt as needed the Council, in cooperation with regional stakeholders, will provide: an annual resource adequacy assessment."
- Results from this analysis are used in the Council's resource strategy methodology to ensure that future strategies will provide adequate supplies.
- Results have also proven to be valuable to regional utilities (to aid in the assessments of their own resource plans) and to utility commissions who review those plans.
- Results are also shared with other electricity industry planning entities, such as the Western Electricity Coordinating Council (WECC) and the North American Electric Reliability Corporation (NERC).

BUDGETARY/ECONOMIC IMPACTS:

There are no effects on the Council's budget. Analysis supporting the adequacy assessment for the Northwest's power supply was performed by Council staff, aided by members of the Council's Resource Adequacy Advisory Committee. Preparing the final report, which includes a technical appendix, will also be done in house. There is no anticipated contract work to complete this task.

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BACKGROUND:

Events such as the Western energy crisis of 2001, which led to West-wide electricity price spikes, have forced utilities and regulators to rethink their approach to planning and operating the power system. The crisis demonstrated that the public has little tolerance for high and volatile market prices over a prolonged period. It also became clear that the financial community will not lend money for power-plant construction unless developers have power contracts in hand and/or utilities have included the costs of those contracts in their rates.

In an environment where an increasing number of parties have taken on the responsibility for acquiring resources to serve regional load, a resource adequacy standard is key to ensuring overall regional sufficiency of resources to meet load at reasonable costs. The Pacific Northwest is unique, not only in the predominately hydroelectric nature of its resources, but also in the ratio of publicly-owned utilities (POUs) to investor-owned utilities (IOUs).

Monitoring and assessing regional resource adequacy is especially important in the Pacific Northwest for the following reasons:

- The ability to rely on wholesale electricity markets and surplus hydroelectric generation (in most years) can mask a condition of resource deficiency.
- The capital risk of constructing new resources in a market with substantially varying supply levels from year to year may be too great for many developers.
- There is a continuing lack of clarity about the responsibility for resource acquisition among public utilities, BPA and independent power producers.

In its Fifth Power Plan, the Council recognized the importance of developing a resource adequacy standard and implementation framework. Action items ADQ-1 and ADQ-2 in that plan called for the establishment of resource information-gathering protocol and for the development of a resource adequacy standard for the Pacific Northwest. To achieve these goals, the Council chartered the Resource Adequacy Advisory Committee (RAAC), with the intention that this group would aid the Council in developing a resource adequacy standard for the Northwest.

In December of 2011, the Council formally adopted its resource adequacy standard. This assessment of the 2021 power supply adequacy should help utilities and their regulators gauge whether they have enough resources to meet their loads under a regionally accepted measure of generation sufficiency.

ANALYSIS:

The RAAC has been aiding Council staff on this task since fall of 2013. Analysis and documents, including meeting notes, are posted on the Council's web site at http://www.nwcouncil.org/energy/resource/Default.asp. The RAAC is comprised of a technical work group and a policy steering committee.

During this past year, the RAAC has reviewed load forecast and resource data, including potential market supplies from within the region and imports from the Pacific Southwest. These data are input to the GENESYS model, which simulates the hourly operation of the power supply over many different future conditions. The model calculates how many of those simulated yearly operations experience at least one occurrence of a failure to meet load. The number of simulations in which at least one curtailment occurred divided by the total number of simulations yields the loss of load probability or LOLP, which must be 5 percent or less for the power supply to be deemed adequate.

ALTERNATIVES:

- One alternative would be to delay the release of this assessment for the purpose of obtaining a more comprehensive review of the data. However, RAAC members already represent a wide range of interested parties, ranging from private and public utilities, to federal agencies, utility commissioners, environmental groups, trade associations and transmission planners. All RAAC meetings were open to the public. The RAAC members support the results from this analysis but understand that some data can be improved upon. However, if the release of this report is delayed substantially, the schedule for implementing some of the action items in the Seventh Power Plan may be jeopardized.
- A second alternative would be to delay the release until certain improvements to the model can be made. Those improvements include the addition of more sub-regional “bubbles” to better address transmission limitations and to more thoroughly explore the issue of market “friction.” Other enhancements include a more detailed hourly hydro dispatch algorithm to better address capacity issues. This alternative is detailed in the Seventh Power Plan Action item ANLYS-22 and would make the model and results better but it would also effectively delay the release of adequacy assessment for several years.

ATTACHMENTS:

Attached is the Council’s report entitled, “Pacific Northwest Power Supply Adequacy Assessment for 2021.”

July 12, 2016

2021 POWER SUPPLY ADEQUACY ASSESSMENT

The Pacific Northwest's power supply is expected to be adequate through 2020. The Northwest Power and Conservation Council estimates that the likelihood of a power supply shortage in that year is just under the 5 percent standard set by the Council in 2011. By 2021, however, after the planned retirements of the Boardman and Centralia-1 coal plants (1,330 MW nameplate), the likelihood of a shortfall (also referred to as the loss-of-load probability or LOLP) rises to about 10 percent[1] and would lead to an inadequate supply without additional resource acquisition actions.

These results are based on a stochastic analysis that examines the operation of the power supply over thousands of different combinations of river flow, wind generation, forced outage, and temperature for the 2021 operating year. Since last year's assessment for 2021, which resulted in an 8 percent LOLP, the annual average load forecast for that year has dropped by about 1,500 average megawatts. However, the winter peak load forecast has increased by close to 3,000 megawatts. Also, last year's assessment only included the Bonneville Power Administration's share of balancing reserves. Applying regional balancing reserves to the analysis in combination with the higher winter peak load forecast raises the LOLP to the 10 percent level, in spite of the lower annual average load forecast.

For each simulation, the underlying demand was set to the Council's medium forecast and the availability of imports from the Southwest was also set to a fixed value. If demand growth were to vary from the medium forecast and if the availability of imports were to change, the LOLP could drop as low as 2 percent or rise as high as 26 percent. But those extreme cases are not likely to occur.

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[1] Boardman and Centralia 1 coal plants are scheduled to retire in December 2020. However, because the Council's operating year runs from October 2020 through September 2021, these two plants would be available for use during the first three months of the 2021 operating year. For this scenario, the LOLP is 7.6 percent. The Council must take into account the long-term effects of these retirements, and therefore uses the more generic study that has both plants out for the entire operating year.

These results also assume that the region will continue to acquire energy efficiency savings as targeted in the Council's Seventh Power Plan, which amounts to 1,400 average megawatts of savings through 2021. The region will also need to add between 1,000 to 2,300 megawatts of capacity, depending on load growth, to ensure an adequate supply.

Resource acquisition plans to bring the 2021 power supply into compliance with the Council's standard will vary depending on the types of new generating resources or demand reduction programs that are considered. In all likelihood, some combination of new generation and load reduction programs will be used to bridge the gap. It should be noted that developing a strategy to maintain an adequate, efficient, economical, and reliable power supply is beyond the scope of this analysis. Designing a resource strategy to ensure an adequate power supply for 2021 is more appropriately done using the strategy outlined in the Council's Seventh Power Plan.

Northwest utilities, as reported in the Pacific Northwest Utilities Conference Committee's 2016 Northwest Regional Forecast, show about 550 megawatts of planned generating capacity for 2021. However, these planned resources are not sited and licensed and are therefore not included in the 2021 adequacy assessment. As conditions change over the next few years, it is expected that utilities will revise their resource acquisition strategies to ensure that sufficient investments in new resources, which include energy efficiency and demand response, will be made to maintain an adequate supply.