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

June 5, 2018

MEMORANDUM

TO: **Council Members**

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

SUBJECT: **Briefing on 2022-23 Adequacy Analysis and Report**

BACKGROUND:

Presenter: John Fazio

Summary: For the regional power supply to be deemed adequate under the Council's standard, its Loss of Load Probability (LOLP) must be 5 percent or less. The Northwest power supply is expected to remain adequate through 2020. In 2021, however, with the retirement 1,330 megawatts of capacity, the LOLP is projected to increase up to about 6 percent, meaning that the supply would no longer be deemed adequate. In 2022, with an additional retirement of 479 megawatts, the LOLP increases to about 7 percent. The projected LOLP for 2023 remains at about 7 percent because no major retirements are planned and the net load growth (after accounting for energy efficiency savings) is very low.

These results assume the Council's energy efficiency targets through 2023 will be achieved. However, the region will have to acquire approximately 300 megawatts of capacity by 2021 and an additional 300 to 400 megawatts by 2022 in order to maintain an adequate supply through 2023. Utility integrated resource plans identify about 800 megawatts of (unspecified) capacity that should be available by 2021. In addition, the Council has identified about 400 megawatts of demand response that could be implemented by 2021.

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It should be noted that the LOLP can change significantly if either demand or market conditions change. For example, the 2023 LOLP can range from a low of 3.5 percent (low load and high market) to a high of 14 percent (high load and low market), although those cases would be extremely rare. The need for additional capacity to maintain adequacy for these extreme cases ranges from zero (low load and high market) to 1,650 megawatts (high load and low market).

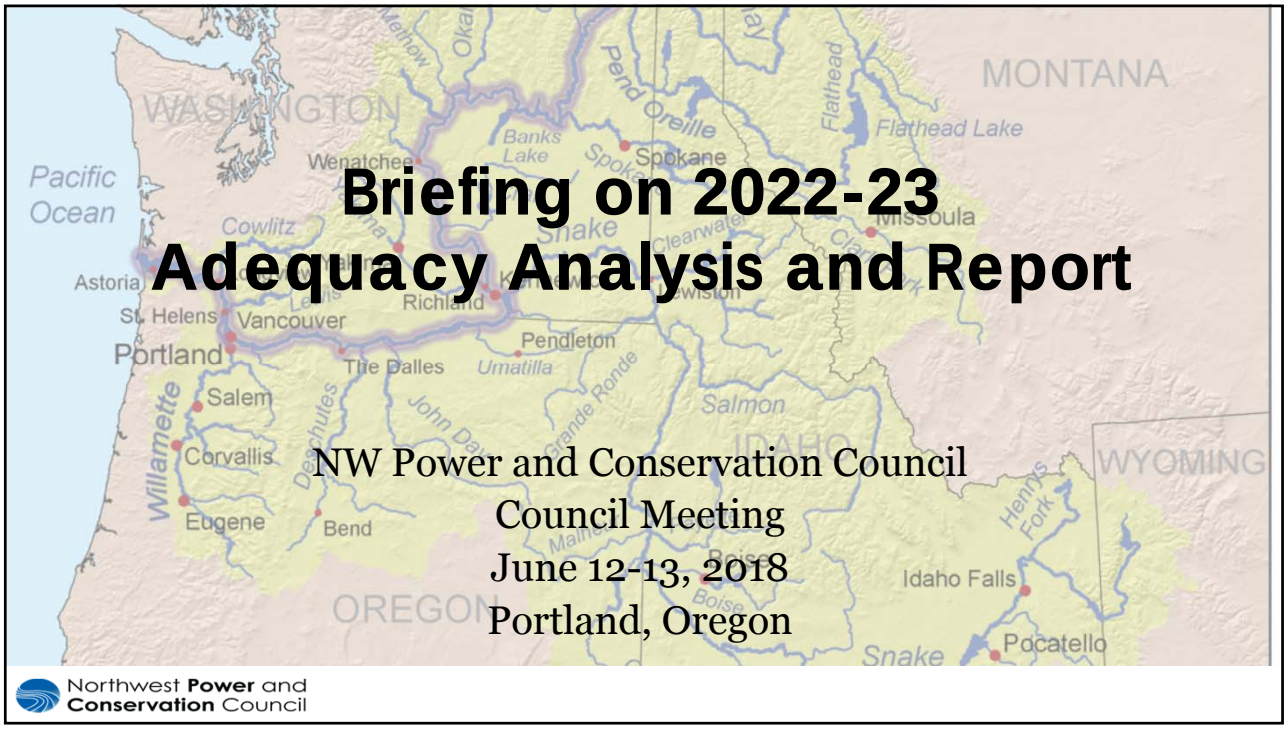
Relevance: Besides being an early warning to ensure that the regional power supply remains adequate, the Council's adequacy standard is converted into Adequacy Reserve Margins (for both energy and capacity) that are fed into the Regional Portfolio Model to ensure that resource strategies developed will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

Workplan: A.5.2 Complete Annual Adequacy Assessments

Background: 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 Council makes this assessment every year, investigating the adequacy of the power supply five years into the future.

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

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



Briefing on 2022-23 Adequacy Analysis and Report

NW Power and Conservation Council
Council Meeting
June 12-13, 2018
Portland, Oregon

Northwest Power and Conservation Council

Outline

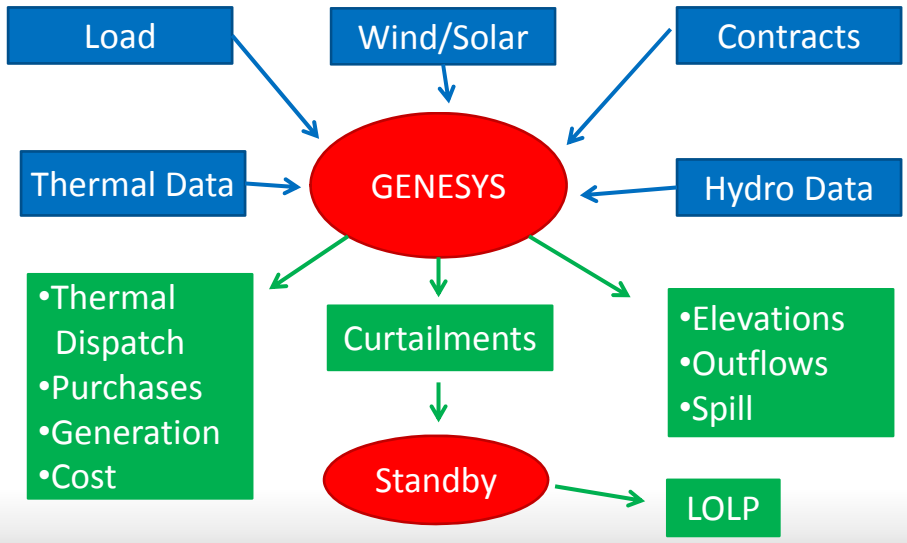
- How does the Council assess resource adequacy?
  - GENESYS computer model
  - Loss of load probability
- 2023 Resource Adequacy Assessment
  - Coal retirements put region into inadequate range (LOLP > 5%)
  - Utilities are prepared – planned resources
  - Which months are most likely to see curtailments?
  - Curtailment statistics – what would they look like?
- Background Slides

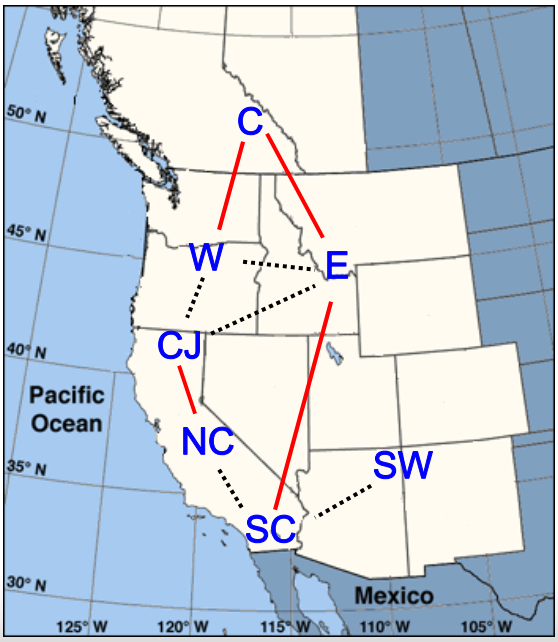
What is GENESYS

- A computer model that simulates the operation of the regional power system on an hourly basis
- For a single year (8760 hours)
- Thousands of times with different combinations of future unknowns[1]
  - River flows
  - Temperatures
  - Wind generation
  - Forced outages

[1]This is commonly referred to as a Monte-Carlo program.

GENESYS Flow Diagram





Transmission in GENESYS

- NW region includes:
  - East (E)
  - West (W)
- Solid lines indicate transmission into and out of the region
- Not a power-flow analysis
- East/west transmission capability varies based on BPA data
- Southern interties have fixed transfer capability
- SW modeled as import market only

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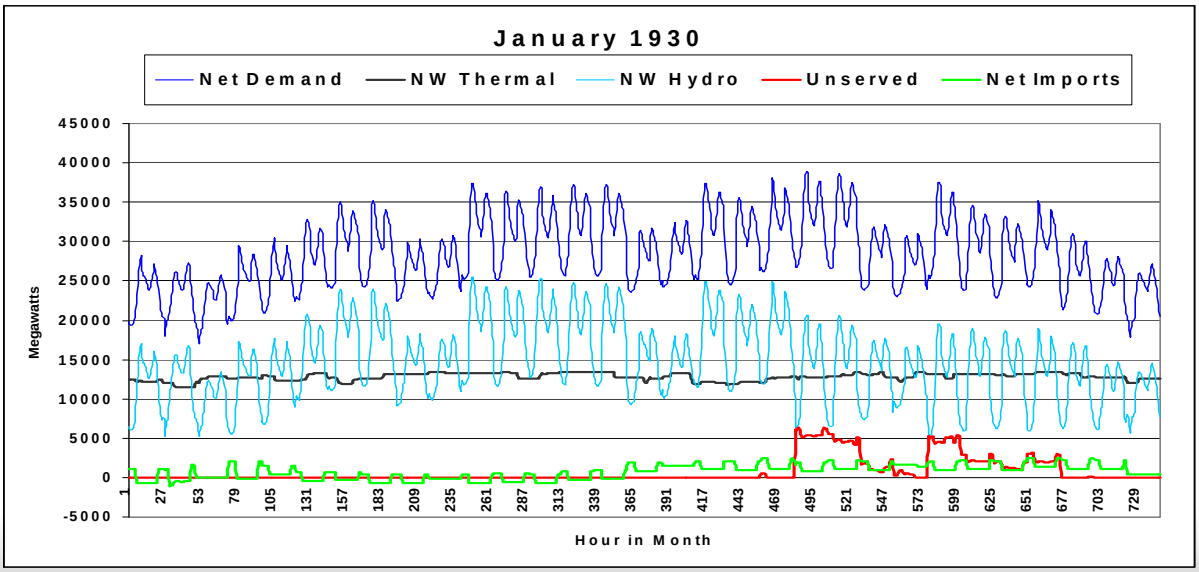
Simulated Dispatch January



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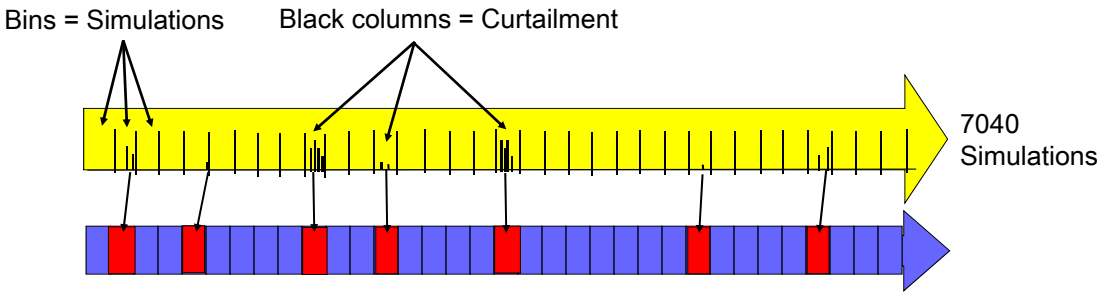
Assessing Resource Adequacy

- Simulate power system operation over every combination of temperature years and streamflow years (88 times 80 = 7,040)
- Count only existing resources or those that are sited and licensed, EE is built into the load forecast
- Count the number of simulations that have at least one curtailment
- LOLP = Number of simulations with at least one curtailment / Total number of total simulations

Loss of Load Probability



Out of 7040 simulations, 352 had at least one curtailment (red bins)

Loss of Load Probability (LOLP) = 352/7040 = 5 percent

2023 Resource Adequacy Assessment

- LOLP — Max for adequacy 5%
  - 2018-20 < 5%
  - 2021 6+% — 1330 MW retired: Boardman, Centralia 1
  - 2022 7% — 479 MW retired: Colstrip 1 & 2, Pasco and N Valmy 1
  - 2023 7% — No major resource change
- Need[1] — ≈ 300 MW by 2021 (range 0 to 750 MW); 300 to 400 MW by 2022 (range 0 to 750 MW)
- Available[2] — ≈800 MW of unspecified capacity + ≈400 MW of DR

[1]Capacity need is based on generic CT additions.
Low-end need assumes low load and high SW imports and high-end need assumes high load and low SW imports.
[2]Available capacity for 2021 is taken from the 2018 PNUCC NRF.
The 400 MW of demand response is the projected amount from the Council's 7th power plan minus DR already implemented.

2023 LOLP Heat Map (%)

SW Import (MW)	1500	2000	2500	3000[1]
High Load (+2%)	14.3	12.1	10.1	7.8
Med Load	11.0	8.6	6.9	5.1
Low Load (-2%)	8.0	6.4	4.9	3.5

[1]The "3000 MW import" case represents the maximum amount of market import capability from California. This is based on the Bonneville Power Administration's recommendation to use 3400 MW as the maximum S-to-N transfer capability for the transmission interties and accounts for approximately 400 MW of space required for firm capacity imports.

2023 Estimated[1] Capacity Need (MW)

SW Import (MW)	1500	2000	2500	3000
High Load (+2%)	1650	1500	1100	600
Med Load	1400	1050	650	50
Low Load (-2%)	950	550	0	0

[1]The amount of additional capacity needed in 2023 to maintain adequacy (i.e. an LOLP of 5%) is estimated by using a surrogate dispatchable resource, in this case a combined cycle combustion turbine. GENESYS studies were run for the "2500 MW import medium load" case and for the "1500 MW import high load" case to estimate nameplate capacity needed to get to 5% LOLP. Other values were estimated using linear interpolation and are rounded to the nearest 50 MW.

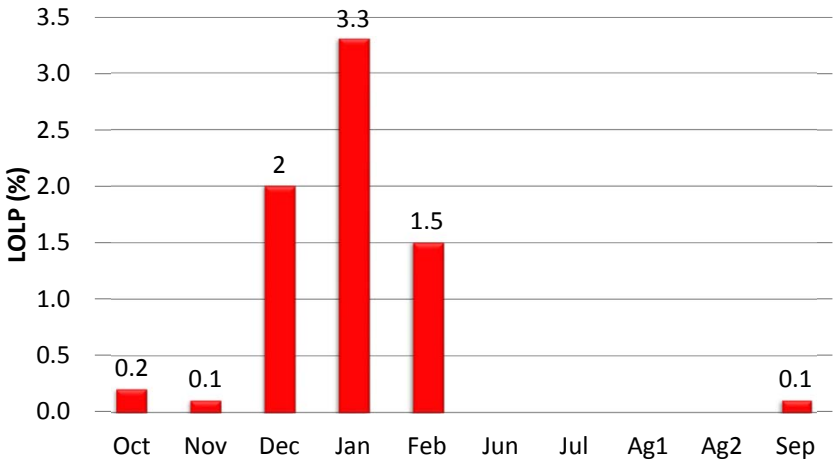
Potentially Available Resources

Source: PNUCC 2018 NRF, Table ES-1 Planned Resources

Nameplate (MW)	2021	2022	2023
Solar	0	266	266
Hydro	29	29	29
Wind	540	540	540
Capacity[1]	809	809	809
Battery	39	39	89
Demand Response[2]	400		

[1]Fuel source is unspecified.
[2]Available demand response for 2021 is the potential estimated in the Council's 7th power plan minus DR already implemented.

2023 Monthly LOLP[1]



[1]Sum of monthly LOLP values is equal to or greater than the annual LOLP value because curtailments across multiple months can occur in the same year.

Simulated Curtailment Statistics

Statistic	Value	Comments
Events per year	0.14	1.4 events per 10 years
Frequency of events	1 per every 7 years	Common standard 1 in 10 years
Average event duration	21 hours	16 hours most frequent duration[1]
Average event magnitude	42,500 MW-hours	≈ 2000 MW/hour over 21 hours
Average annual shortfall	≈ 6000 MW-hours	42,500 MW-hours once every 7 years
Average shortfall hours/year	3.0 hours	21 hours once every 7 years

[1]Anticipated shortfalls are spread over the WECC-defined peak hours of the day (16 hours) using hydro storage in order to minimize impacts and facilitate solutions.

Background Slides

2023 NERC Adequacy Metrics

Metric	Definition
LOLEV (events/year)	**Loss of load events** = Total events divided by total number of games (event = contiguous set of curtailment hours)
EUE (MW-hours)	**Expected Unserved Energy** = Total curtailment energy divided by the total number of games
NEUE (ppm)	**Normalized Expected Unserved Energy** = EUE divided by average annual load in MW-hours times 1,000,000
LOLH (hours/year)	**Loss of load hours** = Total curtailment hours divided by total number of games

SW Import (MW)	1500	2000	2500	3000	3500
LOLEV (events/year)	0.28	0.20	0.14	0.10	0.07
EUE (MW-hours)	11,450	8,440	6,190	3,908	2,516
NEUE (ppm)	61	45	33	21	13
LOLH (hours/year)	5.1	3.9	3.0	1.9	1.3

While NERC is NOT likely to establish metric thresholds (i.e. a standard), a commonly accepted threshold for LOLEV is 1-event-in-10 years or LOLEV = 0.1

Key Sensitivity Studies

1. **Temperature record length (88 vs. 77 years)**

   Previously limited to 77 temperature-year profiles because temperature-correlated wind capacity factors were only available through 2005. Added historic wind CFs for 2006 through 2016 to give us 88 years.

2. **Non-zero summer imports**

   Previously assumed no summer peak-hour imports. Added 2500 MW of available summer imports from 7am to 2pm to reflect increasing California solar surplus.

3. **Thermal resource balancing reserves**

   Previously only accounted for hydro balancing reserves (INC and DEC). Added thermal resource INC reserves by derating specific thermal resources.

Key Sensitivity Studies

(Medium Load, 2500 SW Import)

Metric	Ref Case 88 years	Case 1 77 years	Case 2 Summer Import	Case 3 Thermal INC[1]
LOLP (%)	6.9	7.3	6.5	9.9
CVAR_E (MW-Hour)	121883	122915	121759	181828
CVAR_P (MW)	3216	3192	3214	3974
EUE (MW-Hour)	6190	6253	6170	9625
LOLH (Hour)	3.0	3.1	3.0	4.5
LOLEV (Event/year)	0.14	0.15	0.14	0.20

[1]It should be noted that even though the LOLP increases when applying thermal resource INC reserves, an argument can be made that these reserves would be used during an emergency.

Pacific Northwest Resource Adequacy Assessment for 2022-23

Executive Summary

Accounting for existing resources, planned resources that are sited and licensed, and the implementation of the Council's energy efficiency targets, the Northwest power supply is likely to become inadequate by 2021, primarily due to the retirement of the Centralia 1 and Boardman coal plants (1,330 megawatts combined). The loss-of-load probability (LOLP) for that year is estimated to be over 6 percent, which exceeds the Council's standard of 5 percent.

By 2022 the LOLP is projected to rise to about 7 percent, due to the additional retirements of the North Valmy 1 coal plant, the Colstrip 1 and 2 coal plants and the Pasco gas-fired plant (479 megawatts combined). In 2023 the LOLP is expected to remain at about 7 percent. The increase in LOLP would be higher except for the Council's targeted energy efficiency savings and savings from codes and federal standards. Additional capacity needed to maintain adequacy is estimated to be on the order of 300 megawatts in 2021 with an additional need for 300 to 400 megawatts in 2022.

It should be noted that this analysis examines the adequacy of the aggregate regional power supply. Individual utilities within the Northwest have varying resource mixes and loads and, therefore, have varying needs for new resources. In aggregate, Northwest utilities have identified 540 megawatts of wind, about 800 megawatts of (unspecified fuel source) ~~dispatchable~~ capacity and other small resources that could be developed by 2021, if needed.[1] These planned resources are not included in this assessment because they are not sited and licensed. Also excluded from this analysis are approximately 400 megawatts of demand response, which is the remaining part of the 600 megawatts identified in the Council's Seventh Power Plan as likely being available by 2021. While the Council believes this level of demand response will be available, it is not included in this analysis because of ongoing concerns regarding barriers to its acquisition.

While it appears that regional utilities are well positioned to face the anticipated shortfall beginning in 2021, different manifestations of future uncertainties could significantly alter the outcome. For example, the results provided above are based on medium load growth. Reducing the 2023 load forecast by 2 percent[2] results in an LOLP of just under 5 percent and has roughly the same effect as adding 650 megawatts of capacity. Increasing the load forecast by 2 percent[3] raises the 2023 LOLP to about 10 percent and almost doubles the amount of capacity needed (from 650 to 1,000 megawatts) to satisfy the Council's 5 percent standard.

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[1] Source: Pacific Northwest Utilities Conference Committee's 2018 Northwest Regional Forecast.

[2] This means multiplying the load in each hour of the year by 0.98.

[3] This means multiplying the load in each hour of the year by 1.02.

The reference case results assume a conservative level of available Southwest market supply. Increasing that supply by 500 megawatts lowers the 2023 LOLP to a little over 5 percent and only about 50 megawatts of additional capacity are needed to meet the Council's 5 percent standard. However, decreasing the Southwest market supply by 500 megawatts raises the LOLP to 8.6 percent and would require 1,050 megawatts of additional capacity.

Reducing the load forecast by 2 percent and increasing the Southwest market availability by 500 megawatts lowers the LOLP to 3.5 percent and no additional capacity is required for adequacy. However, increasing the load forecast by 2 percent and decreasing the Southwest market by 500 megawatts raises the LOLP to 12 percent and requires about 1,500 megawatts of additional capacity to satisfy the Council's adequacy standard.

Potential shortfall events for the 2023 operating year occur almost exclusively during December, January and February. Event durations range from a single hour to over 24 hours and average about 20 hours. The most common event duration is 16 hours, which occur over the commonly defined peak hours of the day. Events also tend to have a uniform hourly magnitude because, whenever possible, the hydro system is operated in a way to spread out projected shortfalls evenly across the peak hours of the day. For example, it is much easier to resolve a flat 100 megawatt shortfall over the 16 peak hours of the day than a 2-hour 800 megawatt shortfall.