MEMORANDUM

TO: Council Members

FROM: Daniel Hua

SUBJECT: Short Term Load Forecast for Resource Adequacy Assessment

BACKGROUND:

Presenter: Daniel Hua

Summary: Staff will provide the short term load forecast that supports Resource Adequacy Assessment studies of the Northwest Power System for operating year 2029. The short term load forecast model is developed from historical loads and input data which include regional population, economic indices, and temperatures, among other inputs. The model is then used to predict a portion of the hourly loads for 2029 using forecasted input data for 2029. Due to the more recent growth in electric vehicle (EV) and data center (DC) loads, and to the selected input data, the model by itself is not sufficient to capture the dependences of these loads. Therefore, staff developed estimates for these loads separately (as presented at the March Power Committee meeting), and they are incorporated into the final load forecast for 2029. Furthermore, to test the strategy from the 2021 Power Plan as part of the adequacy assessment, the Power Plan energy efficiency savings are also incorporated in the final load forecast. Overall, this annual averaged load forecast for 2029 is higher than that estimated in the 2021 Power Plan for 2029 due to three main drivers: the load growth per unit population and associated economic activities, and the rates of load growth of electric vehicles and data centers. These load growths are also higher than those used in the
Resource Adequacy Assessment for 2027 which would also have increased the load forecast for that assessment.

Relevance: The Council usually performs an annual Resource Adequacy (RA) Assessment of the Northwest power system 5 years into the future, which will be 2029. One of the inputs of the RA Assessment is the short term load forecast.

Workplan: A.2.2 Create an updated in-region hourly load forecast to support Periodic Studies on Regional Adequacy.
1. Two types of Load Forecasts
   A. Long-Term Forecast
      i. Power Plan Forecast
      ii. Monthly forecast of load across 20+ years
         iii. End-Use Methodology
   B. Short-Term Forecast
      i. Adequacy Assessment Forecast
      ii. Annual system load from 1 to 5 years out – shaped into an hourly pattern
         iii. Econometric (regression model) Methodology
2. Both rely on historic demand, weather and economic conditions

1. Long-Term (End-Use) Forecast
   A. Captures future changes in
      i. Stock characteristics
      ii. Efficiencies
      iii. Codes and Standards
      iv. End-Uses – new and existing
   B. Compiling a forecast is data, labor and time intensive – resulting in slow turn around times

2. Short-Term (Econometric) Forecast
   A. Captures recent overall trends in load and simply projects forward
   B. Requires relatively simple data sets and has a quick turn-around times
   C. Can struggle with accurately projecting future new uses of energy and changing behavior of exiting uses – this limits the forecast horizon
FORECAST COMPARISON

The Resource Adequacy Assessment Forecast for 2029 is projecting higher loads than the 2021 Power Plan Long Term Forecast for 2029:

1. Forecast Timing – the Resource Adequacy Assessment Forecast for 2029 has three additional years of recent load, weather and economic history to work with

2. Much of the growth in load projections is explained by the updated information and forecasts for Data Centers and Electric Vehicles

3. There is still some additional growth projected after these two drivers – which can mean there is another growth signal in the recent load history or some facet of efficiency that is being missed, as an example the load reduction due to future codes and standards

What is The Short-Term Load Forecast Model?
Two Types of Models

- The Load Forecast Model consists of two parts:
  - A model to forecast the *annual averaged load*°
  - Another model to forecast the *hourly load ratios*:
    \[
    \text{(hourly load ratios)} = \left(\frac{\text{hourly loads}}{\text{annual averaged load}}\right)
    \]

- Finally, the hourly load forecast is calculated from outputs of the two models:
  \[
  \text{(hourly load)} = \text{(hourly load ratios)} \times \text{(annual averaged load)}°
  \]

**The Hourly Load Ratio**

*Hourly Load for January 1 to January 7 for Year 2021*

*Hourly Load Ratio for January 1 to January 7 for Year 2021*
**Types of Data for the Two Models**

- **Annual Data** (demographic, economic, and temperatures) → Annual Model → (annual average load) *

- **Hourly Data** (date-times and temperatures) → Hourly Model → (hourly load ratios) → (hourly loads) *

*Adjustments for energy efficiency savings, electric vehicle loads and data center loads

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**Outline**

- The annual model forecast for annual averaged load

- The hourly model forecast for hourly load ratio

- Combining the two models - the hourly load forecast
  - How well do they replicate the historical loads?
  - Load forecasts for 2029 with adjustments for energy efficiency savings, electric vehicle loads and data center loads
**Predictor Data for the Annual Model**

- Population
- Number of households
- Gross State Products \((GSP)\)
- Non-Farm Employment
- Personal Income
- Cooling-Degree-Days \((CDDs)\)
- Heating-Degree-Days \((HDDs)\)
GSP vs Population

CDDs and HDDs

Historical Annual CDDs vs Year

Climate Model Annual CDDs

Historical Annual HDDs vs Year

Climate Model Annual HDDs
The Annual Averaged Load

- With the chosen predictor variables, the annual model is not expected to be able to produce good estimates for:
  - Annual Averaged Energy-Efficiency Savings (EE)
  - Annual Averaged Electric Vehicle Load (EV)
  - Annual Averaged Data Center Load (DC)

- Therefore, the annual model is developed without the EE savings, EV, or DC loads

- The annual model forecast will then be adjusted by
  - subtracting the 2021 Power Plan target EE savings, and
  - adding the forecasted EV and DC loads (produced by other specialized models)

Target EE Savings, Forecasted EV and DC Loads and Other Predictor Data

- Predictors in Annual Load Model

<table>
<thead>
<tr>
<th></th>
<th>Population (10⁶)</th>
<th>Annual CDDs</th>
<th>Annual HDDs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2022</td>
<td>15.1</td>
<td>582</td>
<td>4,862</td>
</tr>
<tr>
<td>2029</td>
<td>15.9</td>
<td>climate models</td>
<td>climate models</td>
</tr>
</tbody>
</table>

- Power Plan Target EE Savings and
- Forecasted EV and Data Center Loads from other Models

<table>
<thead>
<tr>
<th></th>
<th>EE Savings</th>
<th>EV Loads</th>
<th>Data Center Loads</th>
</tr>
</thead>
<tbody>
<tr>
<td>2023 to 2029</td>
<td>926</td>
<td>1,048</td>
<td>2,384*</td>
</tr>
</tbody>
</table>

*Reference: 2,386 aMW
High: 3,976 aMW
Historical and Forecasted Loads for 2029

Historical and Model Annual Averaged Loads

Forecasted Loads 2029

3 climate scenarios
climate-years: 2019 to 2039

Hourly Model
Predictor Data for Hourly Models

- **Date-Time data:**
  - hours of a day: 0, 1, ..., 23
  - weekdays, weekends: Mon, Tues, ..., Fri, Sat, Sun
  - major holidays: New Year’s, Memorial, July-4th, Labor Day, Thanksgiving, Christmas week
  - months: Jan, Feb, ..., Nov, Dec
  - days of the month: 1, ..., 30, 31

- **Temperature data:**
  - hourly temperatures at the airports in Boise, Portland, Spokane, and Seattle

Hourly Model: Historical Load Ratio vs Prediction

![Hourly Model: Historical Load Ratio vs Prediction](image-url)
Combining the Annual and Hourly Models*:
Comparisons to Historical Loads

*And adjust for historical EE savings, EV and data center loads

Load Forecast Model Prediction vs Historical Loads

Historical Load and Model Load for Year 2021 and Month 1
Load Forecast Model Prediction vs Historical Loads: Jan 2021
Historical Load and Model Load for Year 2021 and Month 1

Load Forecast Model Prediction vs Historical Loads: Jan 2021
Historical Load and Model Load for Year 2021 and Month 1

News - Spokane

Woman killed, 100K without power in aftermath of brutal windstorm


Woman killed, 100K without power in aftermath of brutal windstorm

Rescuers in Oregon were searching through mud as deep as 10 feet Wednesday after a landslide east of Portland, looking for a person who was believed to have been swept away by the debris flow.

The landslide was triggered by an overnight wind and rain storm made worse by recent heavy rainfall. The storm left more than 80,000 homes and businesses without power.
Load Forecast Model Prediction vs Historical Loads: Jun 2021 – Heat Dome

Historical Load and Model Load for Year 2021 and Month 6

Max $PDX \geq 110 F$
Max $SEA \geq 100 F$
Max $GEG \geq 100 F$
Max $BOI \approx 100 F$

Load Forecast Model Prediction vs Historical Loads: Dec 2022 – Cold Snap

Historical Load and Model Load for Year 2022 and Month 12

20F $\leq PDX \leq 40 F$
18F $\leq SEA \leq 30 F$
10F $\leq GEG \leq 8 F$
8F $\leq BOI \leq 30 F$
Combining the Annual and Hourly Models*:
Forecast for 2029 (examples)

*And adjust for historical EE savings, EV and data center loads

Load Forecast for 2029, Feb – Cold Snap

Final Load Forecast for 2029 and Month 2

CNRM-CM5 Climate Model
Temperature-year 2021

6F ≤ PDX ≤ 31F
10F ≤ SEA ≤ 38F
−16F ≤ GEG ≤ 21F
−14F ≤ BOI ≤ 34F
Load Forecast for 2029, Jul – Heat Wave

Final Load Forecast for 2029 and Month 7

CanESM2 Climate Model
Temperature year 2022

97°F ≤ Max PDX ≤ 107°F
96°F ≤ Max SEA ≤ 101°F
100°F ≤ Max GEG ≤ 104°F
102°F ≤ Max BOI ≤ 106°F

Questions?