MEMORANDUM

TO: Power Committee

FROM: Massoud Jourabchi, Manager, Economic Analysis

SUBJECT: Draft Frozen-efficiency Load Forecast for 2021 Plan

BACKGROUND:

Presenters: Massoud Jourabchi, Steven Simmons and Adam Rovang

Summary: Draft Frozen-efficiency load forecast for period 2021-2041 shows slow growth in demand for electricity and end-use natural gas.

Relevance: Producing a 20-year load forecast for the Northwest is a key requirement of the Northwest Power Act and a starting building block of the Resource Plan. Frozen-efficiency load forecast is part of a whole family of forecasts that will be used in development of conservation potential, resource adequacy, and resource plan.

Background: Load forecast is the starting point for development of the resource plan. The load forecast produces a detailed account of forecast of number of homes, square footage of commercial buildings, output from industrial activities in the region. In the 2021 Plan, a more detailed forecast of transportation, behind-the-meter solar and battery storage analytics was added. For each sector, enduse, fuels, and state, detailed forecasts are produced under varying climate and economic conditions. For the 2021 Plan, a full accounting of greenhouse gases is provided and will be used in testing climate impact of various policies.

More Info: Council’s load forecast benefits from review by Demand Forecast Advisory Committee.
Draft Frozen-efficiency Load Forecast

September 17th, 2019

Massoud Jourabchi, Steve Simmons, and Adam Rovang

In Today’s Presentation

- Where we are in the Plans process flow
- Review of recent sales, loads and impact of temperature on loads
- Review of Economic Drivers
- Update on Secondary Impacts of Climate Change
- Draft load forecast for two GCMs
- Draft hourly load forecast for one GCM
- Discussion of Behind-the-meter solar installation
- Discussion of Transportation
- Discussion of Demand for Natural Gas
- Discussion of Solar and Batteries impact of loads

Next steps:
- Selecting GCMs based on hydro generation and load forecasts
- Complete review of transportation, Natural gas, behind the meter Solar and battery.
- Refining pollutants tracking in long-term model
Recent Sales show flat growth
Regional Loads also show slow recovery. Temperature fluctuations have greater impact than economic drivers.

Temperatures Variations continue to play a larger role in Loads (aMW).
Current Forecasts are for Slower Growth in Key Economic Drivers

<table>
<thead>
<tr>
<th>Sector</th>
<th>6th Plan (2010-2030)</th>
<th>7th Plan (2015-2035)</th>
<th>8th Plan (Draft 2020-2040)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>1.37%</td>
<td>1.19%</td>
<td>1.09%</td>
</tr>
<tr>
<td>Commercial</td>
<td>1.25%</td>
<td>1.20%</td>
<td>1.08%</td>
</tr>
<tr>
<td>Industrial</td>
<td>1.74%</td>
<td>1.06%</td>
<td>0.74%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>2.78%</td>
<td>0.81%</td>
<td>1.41%</td>
</tr>
</tbody>
</table>

Refresher on Climate Change Models

- All GCMs produce results that show warming trends
- Degree of warming varies across GCMs.
- Degree of warming expands over the next few decades.
- In near-term difference in warming does not vary as much as next few decades.
- All GCMs produce Daily Min and Daily Max temperatures on a decadal basis not annual.
- East of Cascade is expected to see higher warming trends
- Most of NW loads are coastal areas which will see smaller increase in temperatures.
Average Winter Temperature Warming by the 2040s*  
RCP8.5  
(MACA)

- Interior more warming than coast
- Winter loads tend to decrease

courtesy of David Rupp at OSU

Average Summer Temperature Warming by the 2040s*  
RCP8.5  
(MACA)

- Interior more warming than coast
- Some GCMs show more summer warming than winter
- Summer loads tend to increase

courtesy of David Rupp at OSU
To incorporate impact of GCMs on Load
Multiple Analytical Layers are Needed

- Starting with economic conditions
- Incorporating climate change temperature conditions
- The produce load forecasts we need to have:
  1. An starting load forecast
  2. Temperature conditions under different scenarios
  3. In-direct impact of temperature changes on the economy
  4. Freeze efficiency of devices at 2021 levels.

Layer 1: Direct Impacts
Although temperatures are expected to increase, annual variations remain
Indirect Impacts of Climate Change on Load Forecast in the Northwest

Presented by Adam Rovang

Economic Impacts

• $1.2 trillion in damages between 2010 and 2050.
• Annual economic growth could be slowed by 0.5% by 2100.
• Additional risks may increase precautionary spending.
• More frequent extreme weather may cause shocks to price levels and supply chains.
• Damages will likely be concentrated among the poorest counties.
Agricultural Impacts

- Temperature breakpoint in crop growth
- 12% increase in crop yield per 1°C of warming.
Migration Impacts

- Migration pattern similar to 1930’s Dust Bowl
- 3.7% of the adult population in rural counties to move out of the Corn Belt
- 3.6 million people migrating to the US from Mexico
- Each 1°C of increase results in a 5% increase in outmigration from agricultural countries

Regional Impacts from Climate-Induced Migration in 2065 (%)

<table>
<thead>
<tr>
<th>Regions</th>
<th>Population</th>
<th>GRP</th>
<th>Consumption</th>
<th>Per Capita Income</th>
<th>Net Exports</th>
<th>Welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>9.11</td>
<td>6.57</td>
<td>6.37</td>
<td>-2.86</td>
<td>6.80</td>
<td>6.05</td>
</tr>
<tr>
<td>Midwest</td>
<td>-4.58</td>
<td>-3.14</td>
<td>-3.14</td>
<td>1.50</td>
<td>-4.63</td>
<td>-3.16</td>
</tr>
<tr>
<td>South</td>
<td>-8.07</td>
<td>-5.55</td>
<td>-5.49</td>
<td>2.97</td>
<td>-7.58</td>
<td>-5.38</td>
</tr>
<tr>
<td>West</td>
<td>14.67</td>
<td>10.41</td>
<td>9.95</td>
<td>-4.64</td>
<td>11.95</td>
<td>9.43</td>
</tr>
<tr>
<td>California</td>
<td>12.52</td>
<td>8.69</td>
<td>8.23</td>
<td>-4.28</td>
<td>8.42</td>
<td>7.78</td>
</tr>
<tr>
<td>United States</td>
<td>.00</td>
<td>.37</td>
<td>.20</td>
<td>.07</td>
<td>.38</td>
<td>.09</td>
</tr>
</tbody>
</table>

- Between 2010 and 2065:
  - Midwest and Southern shrink
  - California, West, and Northeast grow
Migration Estimates

• Splitting growth into Northwest state estimates
  • Scale population changes in MW and S to change from 2017 to 2050
  • Incorporate 2017 migration patterns from ACS

<table>
<thead>
<tr>
<th>Impact in 2050</th>
<th>Washington</th>
<th>Oregon</th>
<th>Idaho</th>
<th>Montana</th>
<th>Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population in 2017</td>
<td>7,437,915</td>
<td>4,151,415</td>
<td>1,723,275</td>
<td>1,054,054</td>
<td>14,366,659</td>
</tr>
<tr>
<td>Forecast Population in 2050 (from Global Insight)</td>
<td>9,394,824</td>
<td>4,994,743</td>
<td>2,405,147</td>
<td>1,164,422</td>
<td>17,959,136</td>
</tr>
<tr>
<td>Additional Migration</td>
<td>864,981</td>
<td>338,895</td>
<td>157,957</td>
<td>-35,478</td>
<td>1,326,355</td>
</tr>
<tr>
<td>Total 2050 Population</td>
<td>10,259,805</td>
<td>5,333,638</td>
<td>2,563,104</td>
<td>1,128,945</td>
<td>19,285,491</td>
</tr>
<tr>
<td>Additional Growth</td>
<td>9.21%</td>
<td>6.79%</td>
<td>6.57%</td>
<td>-3.05%</td>
<td>7.39%</td>
</tr>
<tr>
<td>Total Growth from 2017 to 2050</td>
<td>37.9%</td>
<td>28.5%</td>
<td>48.7%</td>
<td>7.1%</td>
<td>34.2%</td>
</tr>
</tbody>
</table>

Secondary Impacts of climate change show a modest increase in loads
(Draft-work-in-progress)

Medium Economic Conditions
Preliminary Load forecasts

Total Demand for energy is growing at a modest level. Demand for space-heating is projected to decline,

Total Demand for Energy is expected to grow at historic rates (with Temp and Secondary impacts)
Energy Load Forecast
medium economic growth and CanESM2 GCM

Example of Hourly Loads in 2040
Under Different Hourly Temperature Profiles
As of 2018, the estimate of BTM solar capacity in the region is 326 MW. Roughly half of the capacity has been installed in Oregon.

Compiled from a monthly report from the EIA - note that 2018 numbers are not final.

By Sector - the breakout is:
- Res 68%
- Com 28%
- Ind 4%

Estimate of Historic Installations
Forecast of Solar Installations

In near term, OR accounts for roughly 50% of the installed solar capacity. WA shares grow over time and by 2045 - OR & WA are about the same.

By sector, the forecast is around 70% residential.

In terms of energy, overall in 2020 - forecast is 1,117 GWh, 127 aMW by 2035 it’s 5,214 GWh, 595 aMW.

Forecast of Solar Installation Cost ($/kW)

Costs for solar have dropped significantly since 2010 - and are expected to continue to decline.

One of the reasons the current forecast for installations is much more aggressive than past forecasts.
Background

The economics of Solar + Battery systems are improving

- Solar (PV) material and installation costs have been declining for many years
- Now battery costs are also on the decline (such as Li-ion)
- In some areas net metering rates have declined or could be dropped – making storage for self-generation more attractive
- Solar + Battery installation packages are now available
Background

How could the Solar + Battery systems be used?

- Provide backup power – for the home or business
- Lower retail electricity bills by modifying time of use (if TOU rates apply)
- Behind-the-meter solar and storage could also potentially be used to enhance grid operations – such as peak load reduction

this is the focus of the project

Simulation Tool

1. A behind the meter Solar + Battery System could be configured to provide backup power, optimize self-generation for the site, and/or to enhance overall grid performance

2. This project is focusing on a “holistic” perspective – how to produce an overall “flattening” of the system load – in which individual installations of Solar + Battery could be aggregated for optimal system results
### Implementation into Energy2020

1. The base forecast model selects the level of solar capacity alone to install over time.
2. A scenario run was set up to use the level of solar capacity to pair with battery – at a one to one ratio of solar to battery.
3. The load reduction equations from the outside simulation were used to forecast the level of load reduction from behind the meter solar+battery.
4. In the forecast period all the solar is assumed to be paired with battery.
5. This enables us to separate the load reduction effects from solar alone, as well as solar+battery.
Breakout of Peak Load Reduction - for a single year

- Solar along contributes to peak load reduction in the spring and summer months
- Pairing solar with battery provides peak reduction in the fall and winter
Transportation Forecast Methodology

1. Currently using a Transportation Module in Energy2020
2. The forecast is an integrated look across all forms of transportation technologies and fuels—focus to date is on personal vehicles—cars & light duty trucks—but will also be looking at mass transit later
3. The overall vehicle stock in the forecast model changes in size, technologies/fuel, and efficiency over time as population growth drives new vehicle growth, and older stock retires and is replaced
4. Since we cover all fuels—we’ll have a forecast of emissions from the transport sector— including GHG from gasoline/diesel vehicles, and related power sector emissions to supply electric vehicles
Sales of Electric Vehicles
Cars and light duty trucks
Battery Electric (BEV) and Plug In
Hybrid Electric (PHEV)

Draft Forecast
-subject to
change

Stock of Electric Vehicles
Cars and light duty trucks
Battery Electric (BEV) and Plug In
Hybrid Electric (PHEV)

Draft Forecast
-subject to
change
Electricity Demand – annual aMW
Cars and light duty trucks
Battery Electric (BEV) and Plug In
Hybrid Electric (PHEV)

Annual electricity consumption per electric vehicle in stock declines over time - the average is around 2,800 kWh per vehicle per year.

Electricity Demand – load profile for electric vehicles

Current load profiles indicate a large late afternoon peak - this assumes mostly home charging.

As charging stations are added to workplace and retail locations - profile is expected to level out, along with utility programs to incent smart charging.
End Use Natural Gas Forecast
Steven Simmons

Why is it important?

1. Gain a more holistic look at the overall natural gas demand in the region– the electric generation and end-use sectors share much of the same natural gas infrastructure.

2. A forecast of the overall gas consumption allows us to view a more complete picture of greenhouse gas emissions in the region.

3. By having a gas forecast integrated with the electric load forecast, we can better develop regional carbon reduction scenarios. Important- in the region right now, gas meets winter heating peaking demands for a large section of the population.
End Use Natural Gas Load Forecast
Idaho-Montana-Oregon-Washington
Residential-Commercial-Industrial-Transportation

End Use Natural Gas Load
Historic & Forecast
All Sectors - 4 NW States

Average Annual Growth Rate % (2019-2045)
End Use Consumption of Natural Gas

End Use Natural Gas Load Forecast
By State and Sector
Comparison of the Forecast to other sources:

NW Natural (in red) provided estimates of historic load for the 3 states ID, OR, and WA.

The Northwest Gas Association (in blue) produces an annual outlook for the region - this is the 2018 Outlook. Similar overall rates, but the NWGA has a higher level of Industrial use, and Residential use.

Summary

• Compared to past Plans, key economic drivers are on a slow growth trajectory.
• Behind-the-meter installations, EV and Solar/Battery will influence residential sector loads.
• Codes and Standards are expected to keep downward pressure on loads.
• Industrial sector continues its decline in demand.
• Impact of temperature on loads is not stationary.
• Overall demand for energy in the economy is growing slowly.
Next Steps

• Selecting GCMs to use
  • Hydro generation consideration
• Completing review of transportation, natural gas and behind-meter solar and battery
• Enhancing Pollution tracking in long-term model
• Producing range of energy forecasts under different economic scenarios
• Producing hourly load forecasts for RA and RPM.
• Producing impact of code and standards on loads.
• Producing load forecast for various scenarios