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

September 10, 2019

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.

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Draft Frozen-efficiency Load Forecast

September 17th , 2019

Massoud Jourabchi, Steve Simmons,
and Adam Rovang

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FOR A SECURE & AFFORDABLE ENERGY FUTURE

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

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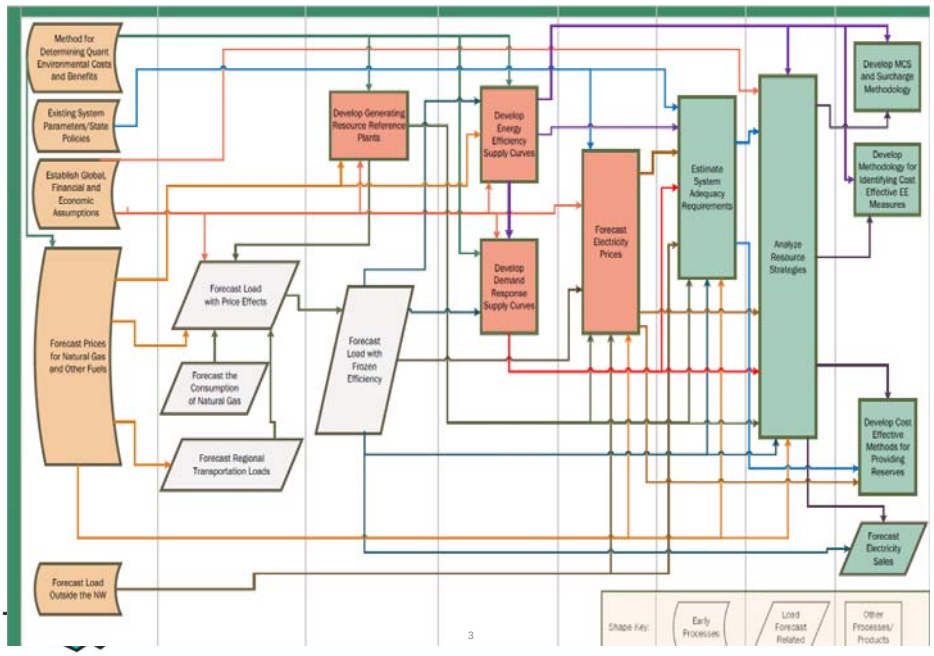
Method for Determining Quant. Environmental Costs and Benefits
Existing System Parameters/State Policies
Establish Global, Financial and Economic Assumptions
Forecast Prices for Natural Gas and Other Fuels
Forecast Load Outside the NW
Forecast Load with Price Effects
Forecast the Consumption of Natural Gas
Forecast Regional Transportation Loads
Develop Generating Resource Reference Plants
Forecast Load with Frozen Efficiency
Develop Energy Efficiency Supply Curves
Develop Demand Response Supply Curves
Forecast Electricity Prices
Estimate System Adequacy Requirements
Analyze Resource Strategies
Develop MCS and Surcharge Methodology
Develop Methodology for Identifying Cost Effective EE Measures
Develop Cost Effective Methods for Providing Reserves
Forecast Electricity Sales
Shape Key:
Early Processes
Load Forecast Related
Other Processes/ Products
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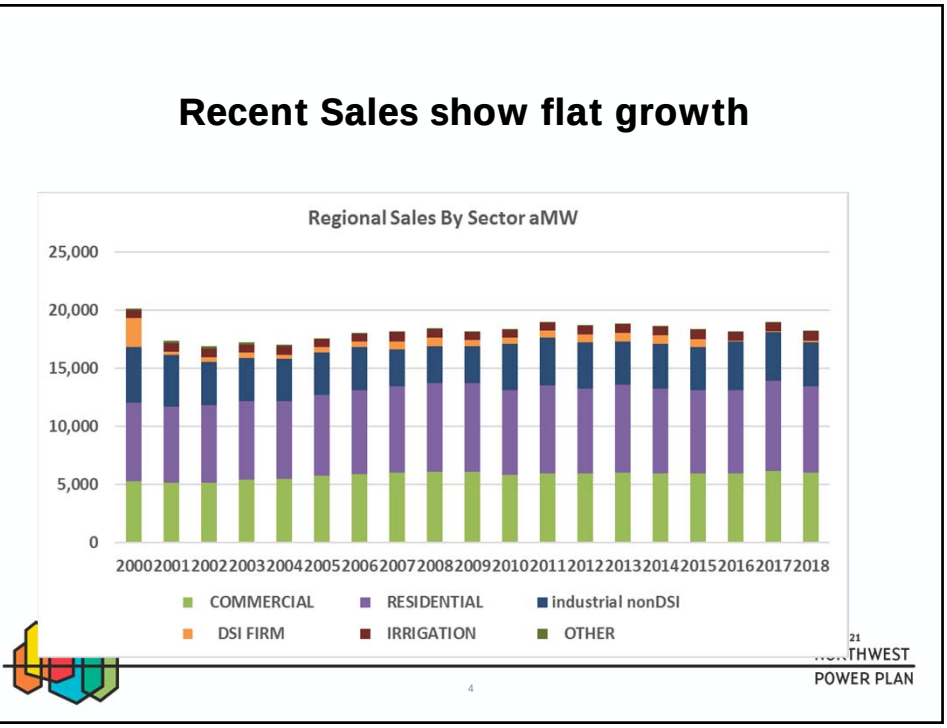
Recent Sales show flat growth
Regional Sales By Sector aMW
25,000
20,000
15,000
10,000
5,000
0
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018
COMMERCIAL
RESIDENTIAL
industrial nonDSI
DSI FIRM
IRRIGATION
OTHER
POWER PLAN
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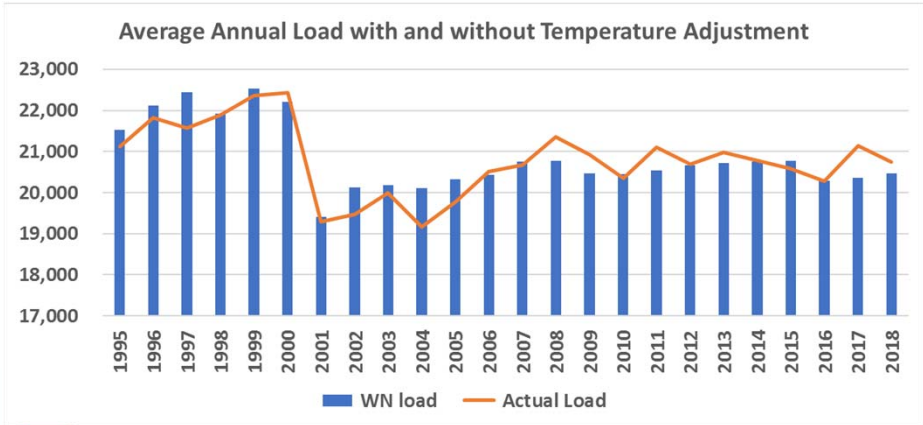
Regional Loads also show slow recovery. Temperature fluctuations have greater impact than economic drivers



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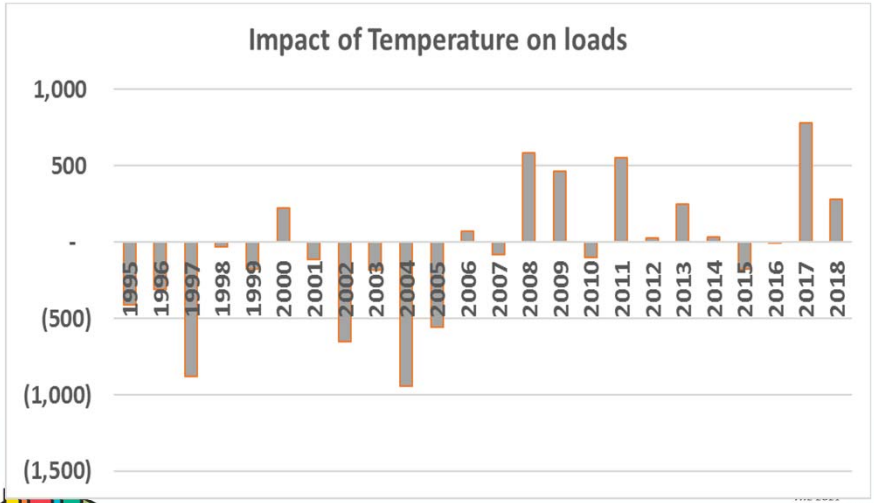
Temperatures Variations continue to play a larger role in Loads (aMW)



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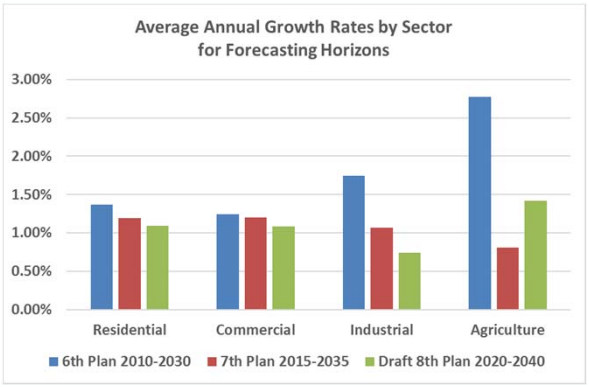
Current Forecasts are for Slower Growth in Key Economic Drivers



	6th Plan	7th Plan	8th Plan (draft)
Average Annual Growth Rate	2010-2030	2015-2035	2020-2040
Residential	1.37%	1.19%	1.09%
Commercial	1.25%	1.20%	1.08%
Industrial	1.74%	1.06%	0.74%
Agriculture	2.78%	0.81%	1.41%

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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.

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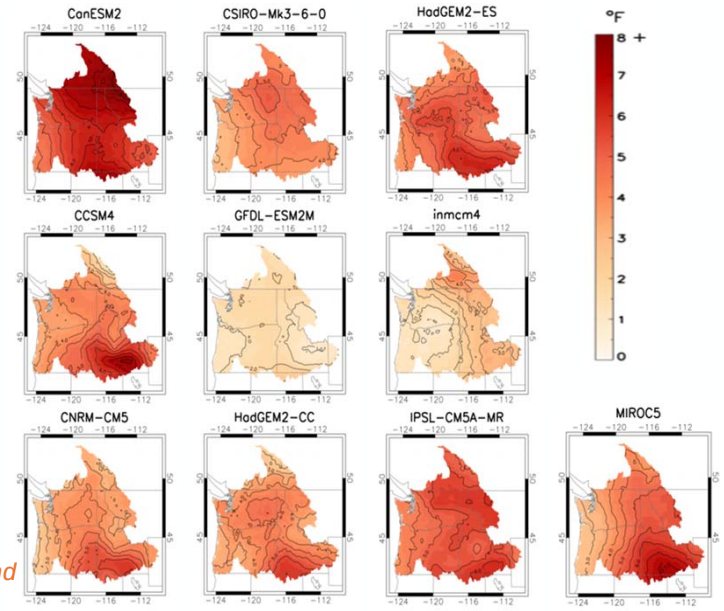
Average Winter Temperature Warming by the 2040s*

RCP8.5

(MACA)

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



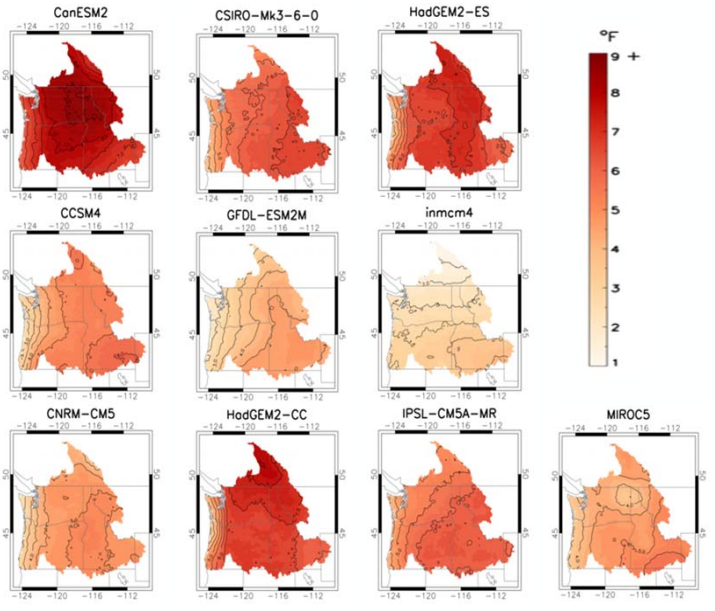
courtesy of David Rupp at OSU

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.

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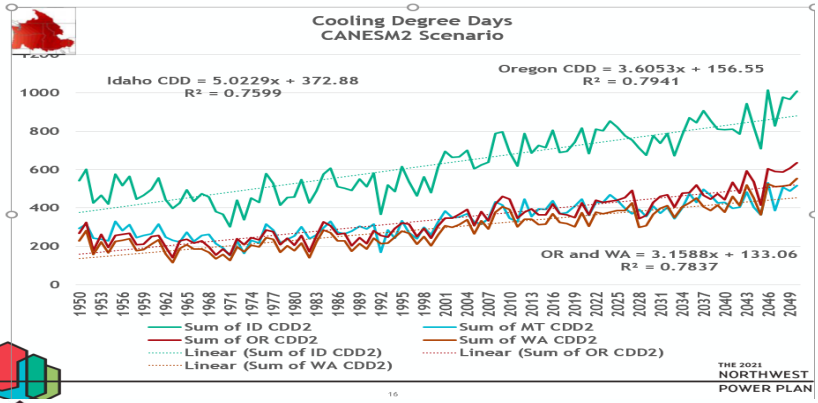
Layer 1:Direct Impacts Although temperatures are expected to increase, annual variations remain



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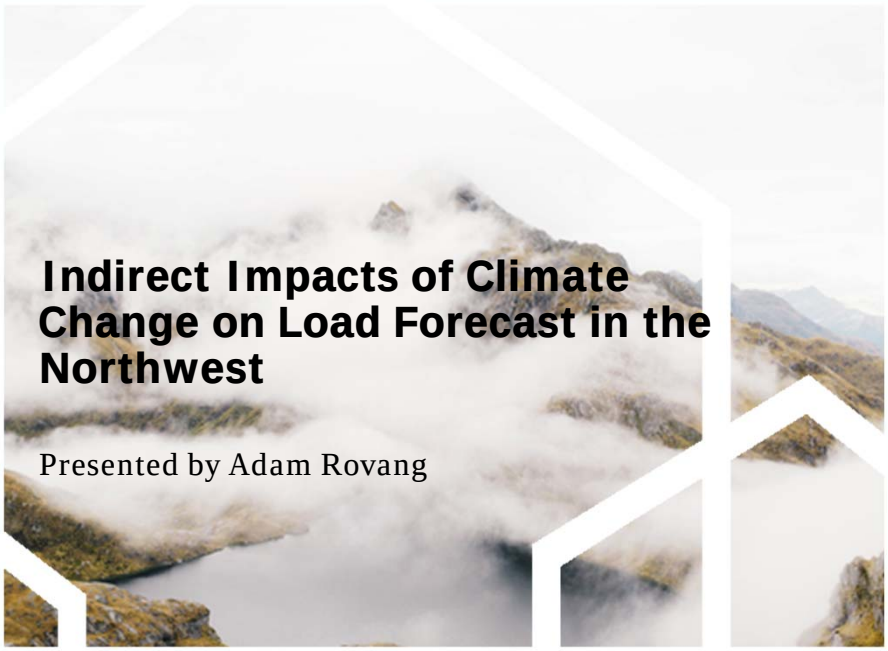


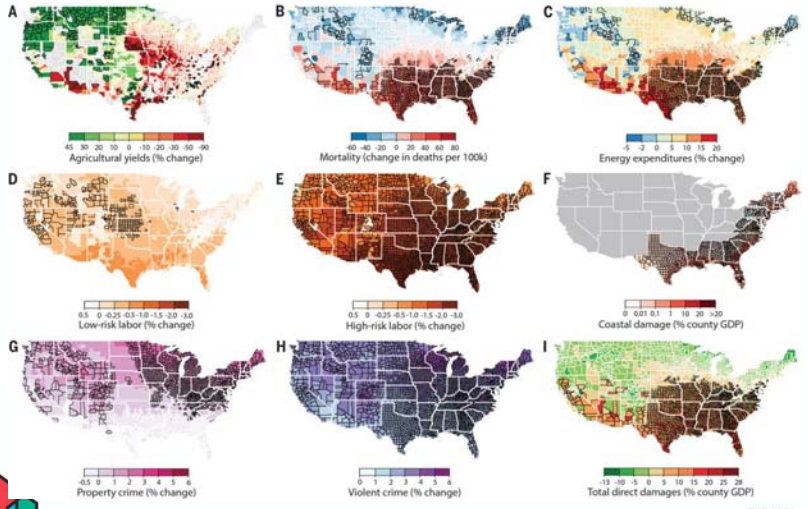
Indirect Impacts of Climate Change on Load Forecast in the Northwest

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.

Median Impact by 2080 to 2099



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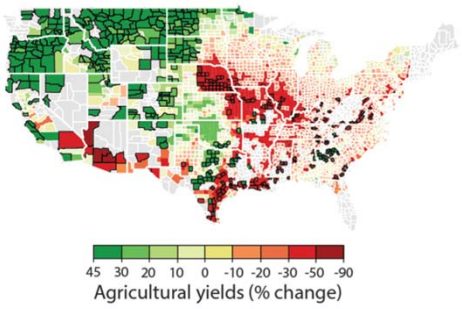
Agricultural Impacts

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

Percent change in yields for maize, wheat, soybeans, and cotton



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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

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

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

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

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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

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

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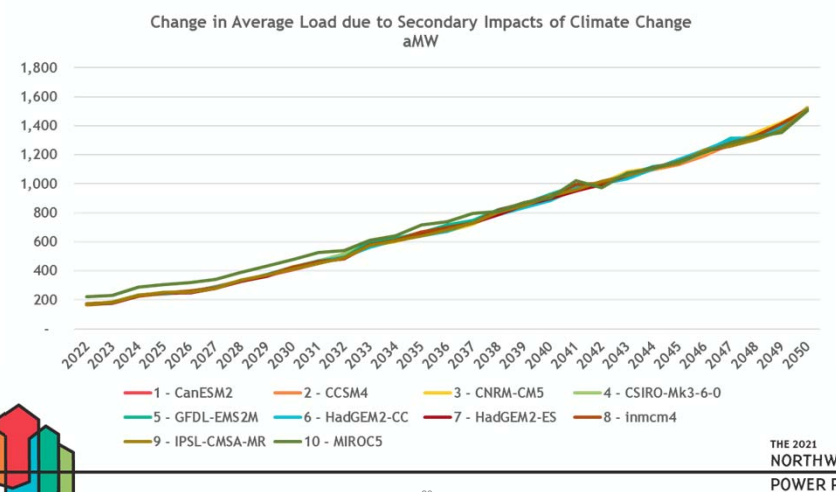
Secondary Impacts of climate change show a modest increase in loads

(Draft-work-in-progress)



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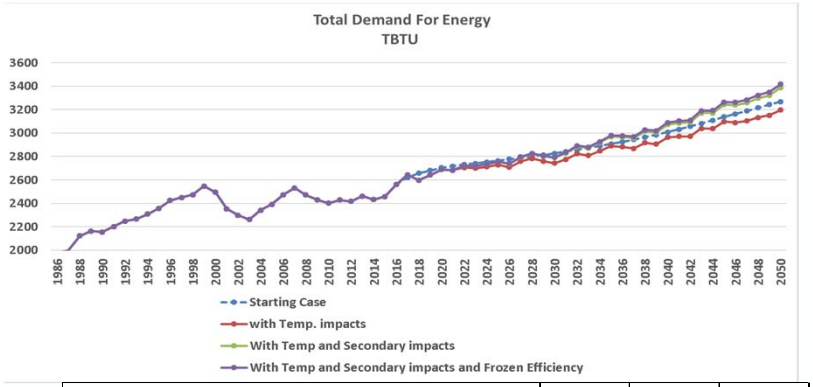
Medium Economic Conditions

Preliminary Load forecasts

Total Demand for energy is growing at a modest level.

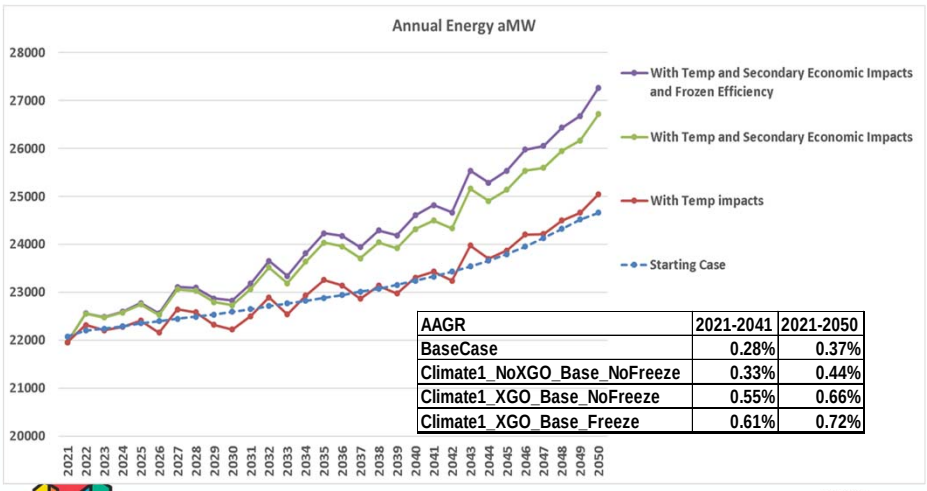
Demand for space-heating is projected to decline,

Total Demand for Energy is expected to grow at historic rates (with Temp and Secondary impacts)



Medium Economic Growth and CanESM2 GCM	2000-2021	2021-2041	2041-2050
Starting Case	0.7%	0.55%	0.8%
with Temp. impacts	0.7%	0.51%	0.7%
With Temp and Secondary impacts	0.7%	0.71%	0.9%
With Temp and Secondary impacts and Frozen Efficiency	0.7%	0.73%	1.0%

Energy Load Forecast
medium economic growth and CanESM2 GCM



AAGR	2021-2041	2021-2050
BaseCase	0.28%	0.37%
Climate1_NoXGO_Base_NoFreeze	0.33%	0.44%
Climate1_XGO_Base_NoFreeze	0.55%	0.66%
Climate1_XGO_Base_Freeze	0.61%	0.72%

Medium Economic Conditions

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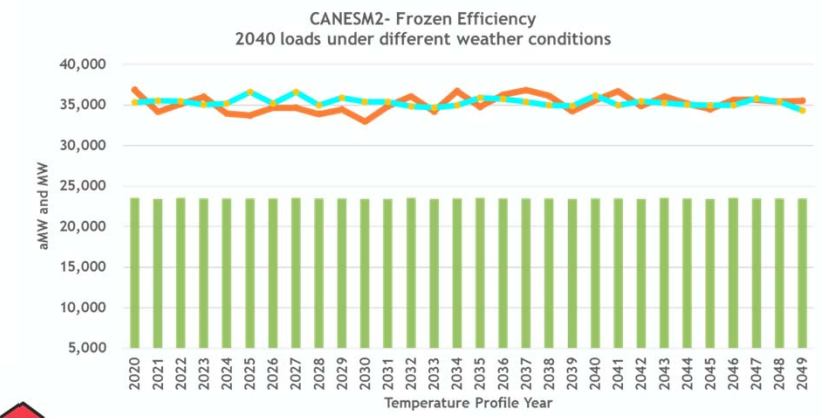
Example of Hourly Loads in 2040
Under Different Hourly Temperature Profiles



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Behind the Meter Solar

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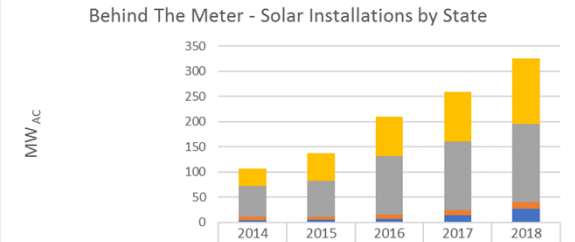
Estimate of Historic Installations



	2014	2015	2016	2017	2018
Historic Solar Capacity - WA (MW)	34	55	78	99	131
Historic Solar Capacity - OR (MW)	61	71	117	136	155
Historic Solar Capacity - MT (MW)	8	6	8	11	14
Historic Solar Capacity - ID(MW)	3	5	7	13	26

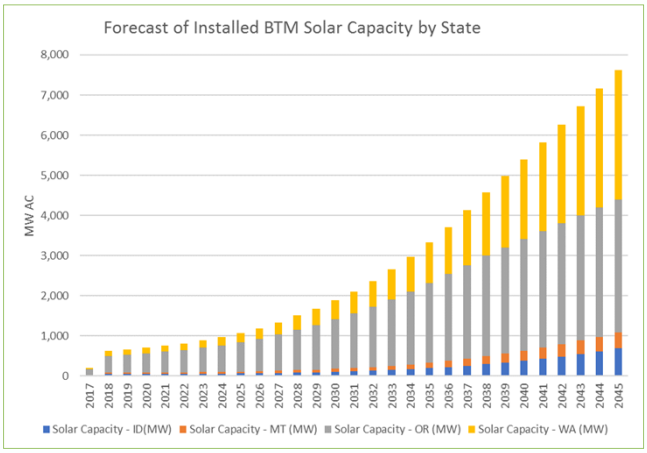
As of 2018, the estimate of BTM solar capacity in the region is 326 MW. Roughly half of the capacity has been installed in Oregon.

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 %

Forecast of Solar Installations

**** Note: Draft - subject to change ****

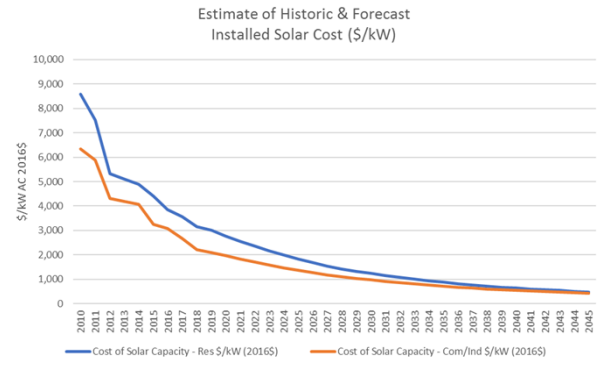


In near term, OR accounts for roughly 50% of the installed solar capacity. WA shares grow over time and by 2045 - OR & WA are about the same

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

Behind the Meter - Solar + Battery

Steven Simmons

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

Grid	Solar (PV system)	Battery
		
Can serve load directly	Can serve load directly	Can be charged from the PV system
Can charge the battery for later use	Can be sent to the battery for later use	Can be charge from the grid Can discharge to serve load The state of charge is kept within operation limits and round trip battery losses are accounted for

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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

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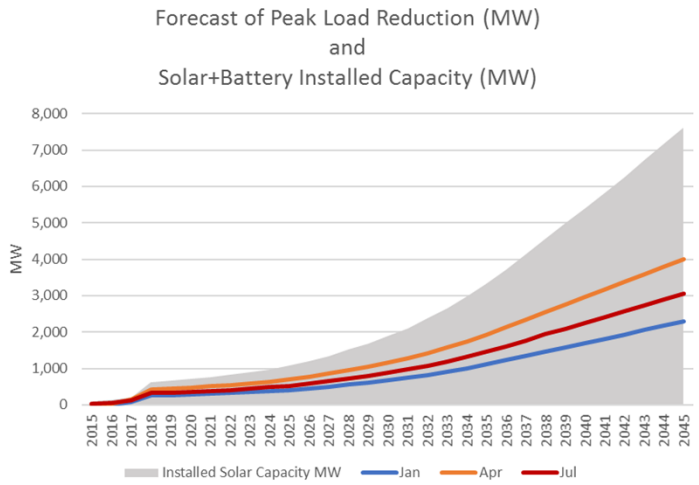
Load Forecast – Implementation Results



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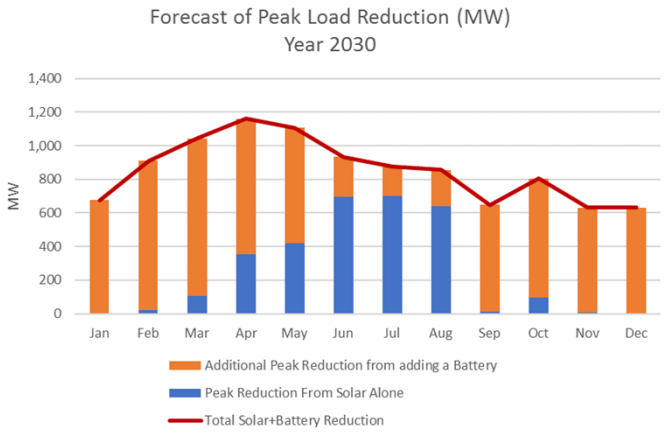
Breakout of Peak Load Reduction – for a single year



- 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

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Transportation

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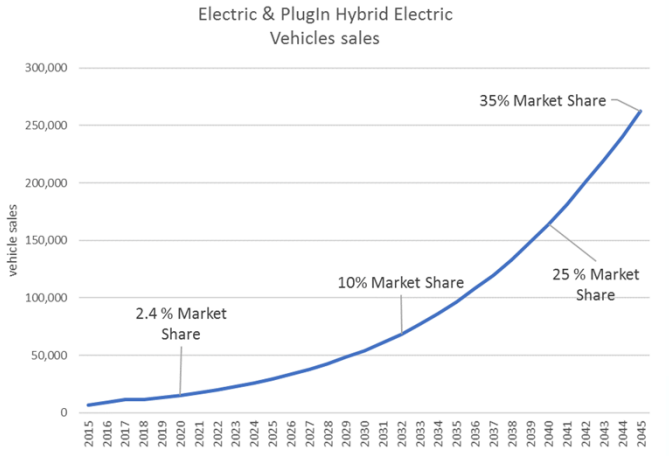
Transportation Forecast Methodology

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

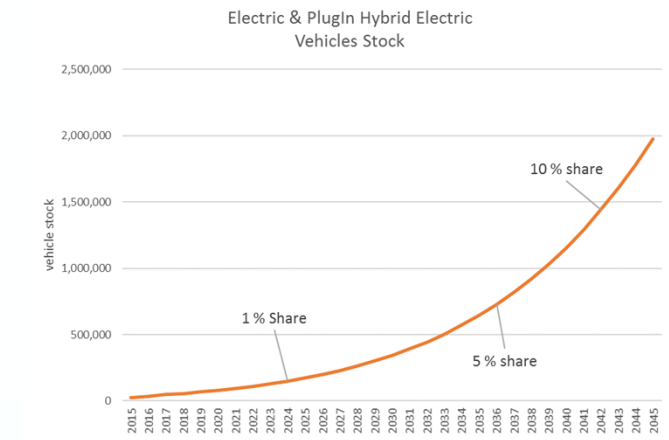
Sales of Electric Vehicles
Cars and light duty trucks
Battery Electric (BEV) and Plug In Hybrid Electric (PHEV)

Draft Forecast -subject to change



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

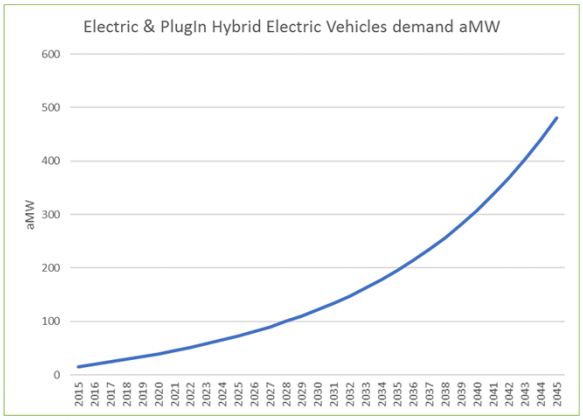
Draft Forecast -subject to change



Electricity Demand – annual aMW

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

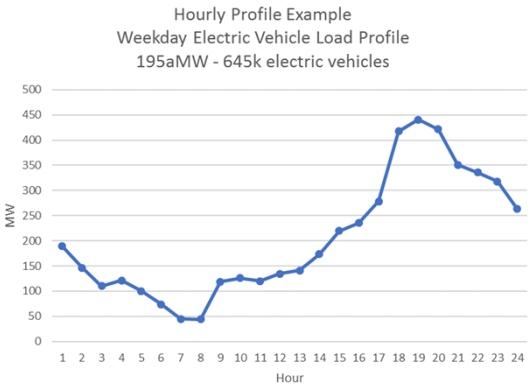
Draft Forecast -subject to change



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

Draft Forecast -subject to change



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 utiity programs to incent smart charging

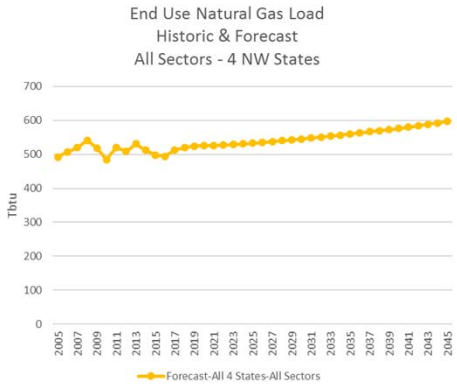
End Use Natural Gas Forecast

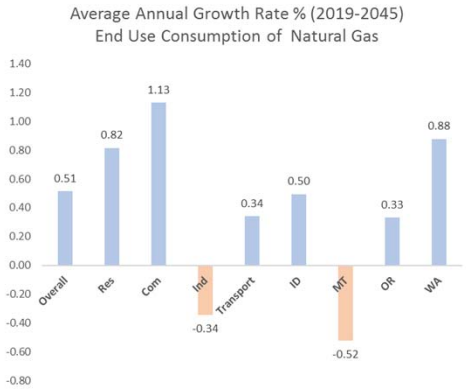
Steven Simmons

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





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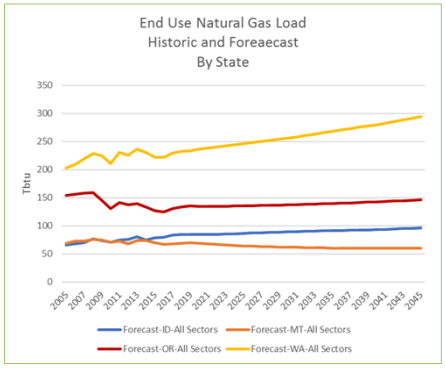
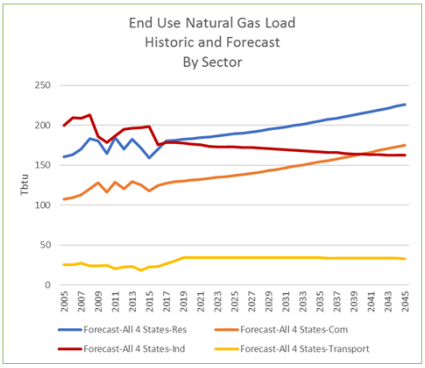
End Use Natural Gas Load Forecast
By State and Sector





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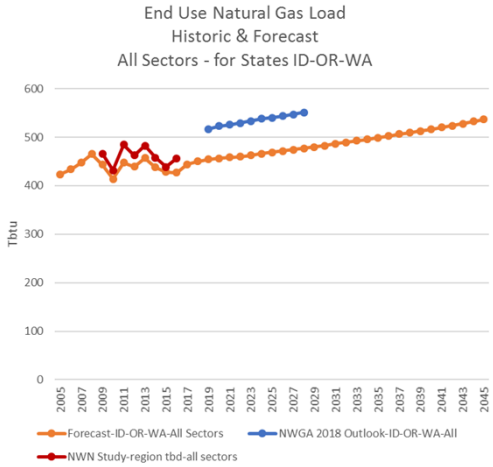

Comparison of the Forecast to other sources:

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 it 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