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October 6, 2015

MEMORANDUM

TO: Power Committee Members

FROM: John Fazio, Senior Systems Analyst

SUBJECT: Discussion of Methods Used to Assess Climate Change Impacts

BACKGROUND:

Presenter: John Fazio, Senior Systems Analyst

Summary: The most recent Intergovernmental Panel on Climate Change (IPCC) Report (released in 2014) indicates that future global temperatures are very likely to increase. Unfortunately, data collected from global circulation models will not be downscaled and processed for the Northwest region until early 2017. However, using conclusions from the current IPCC report in conjunction with past climate change data; Council staff was able to construct a set of projected temperature increases and a set of climate-adjusted unregulated streamflows, which were used to analyze potential effects on the adequacy of the region's future power supply.

From previous climate modeling downscaling efforts, the prediction for the Northwest is for less snow and more rain during winter months, resulting in a smaller spring snowpack and lower summer flows. Winter electricity demands would decrease with warmer temperatures, easing generating requirements. In the summer, demands driven by air conditioning and irrigation loads would rise.

Power supplies for 2026 and 2035, as projected by the Regional Portfolio Model under a future high-load-growth path, were examined under two

scenarios, one with and one without climate change. Results show that the 2026 power supply meets the Council's adequacy standard in both cases. For 2035, the resource mix created by the RPM (under normal climate conditions) leads to an inadequate supply when subjected to climate-adjusted loads and stream flows. In this case, additional resources would be needed to maintain power supply adequacy.

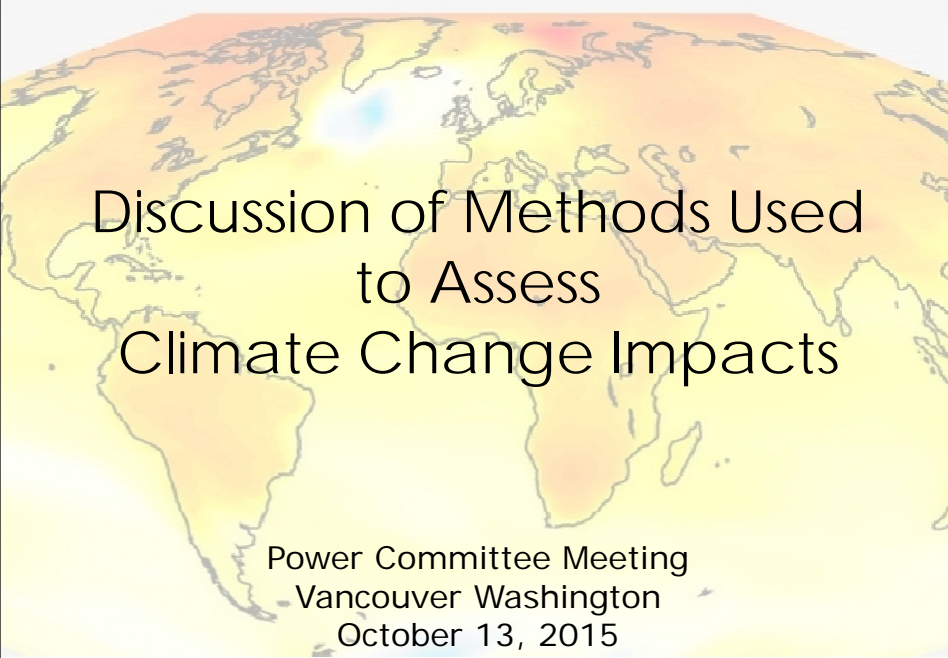
Overall conclusions from this analysis indicate that even under a high-temperature climate change future, no additional resource actions would be required at least until 2026. Beyond 2026, additional resources would only be needed when the region's load is greater than the medium forecast. Based on this analysis, regional resource acquisition actions between 2016 and 2021, as outlined in this power plan, would not change.

Relevance: While policies pertaining to greenhouse gas emissions unquestionably have an impact on future resource choices, the Council must also investigate any potential physical impacts of climate change on future resource acquisitions. Depending on if and how climate change materializes affects not only the amount but also the types of resources required to maintain an adequate, reliable, efficient and economical power supply. Current analysis described in Appendix M indicates that no modifications to the Council's action plan are required to offset potential physical impacts of climate change, at least through 2021.

Work Plan: B. Develop Seventh Power Plan and maintain analytical capability

Background: The issue of climate change and its potential effects to the environment and the region's power supply has been discussed for several decades. Through time, more robust data related to climate change has been collected and analyzed. The latest Intergovernmental Panel on Climate Change Report (issued in 2014) continues to show a general trend toward increasing global temperatures. Data from this report must be downscaled for the Northwest region in order to be of use in the Council's planning models. That data will not be available until 2017, however, using past data in conjunction with the IPCC latest report, Council staff has been able to develop useable data to assess the physical impacts of climate change on the region's loads and river flows. Based on that analysis, staff has concluded that climate change would not have an effect on the Seventh Power Plan's action items over the next five years.

More Info: **See the full Council Packet to review** the Draft Seventh Power Plan, Appendix M: Climate Change Impacts to Loads and Resources



Discussion of Methods Used
to Assess
Climate Change Impacts

Power Committee Meeting
Vancouver Washington
October 13, 2015

Northwest Power and Conservation Council

SEVENTH NORTHWEST POWER PLAN

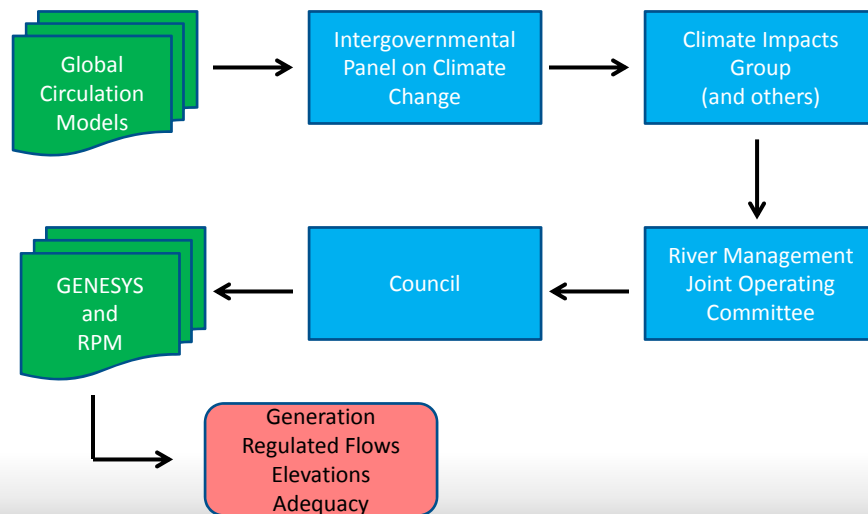
Outline

1. Source of Climate Change Data
2. 2026 and 2035 Analysis
3. Climate induced changes in loads
4. Climate induced changes in natural flows
5. Analysis Results and Key Findings

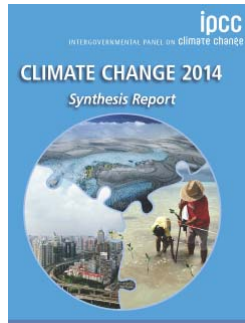
1. Source of Climate Change Data

- Data and Analysis Flowchart
- Intergovernmental Panel on Climate Change
- Summary of Precipitation and Temperature Changes for Various Scenarios

Climate Change Analysis Flowchart



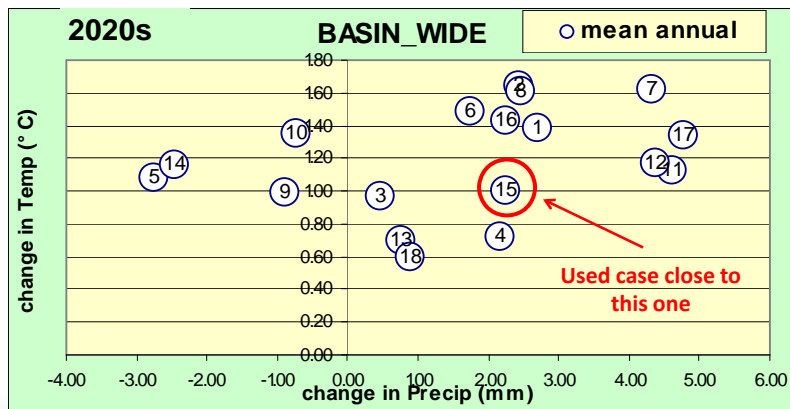
Intergovernmental Panel on Climate Change 2014 Assessment Report



- Completed in November 2014
- Compilation of dozens of Global Circulation Model studies
- Temperature increase projections somewhat lower than the AR4 report
- **Need downscaled temperature changes and climate adjusted natural flows**
- Downscaled data not available until 2017

Downscaled NW Temperature and Precipitation Change Forecasts

(IPCC 4 Data)

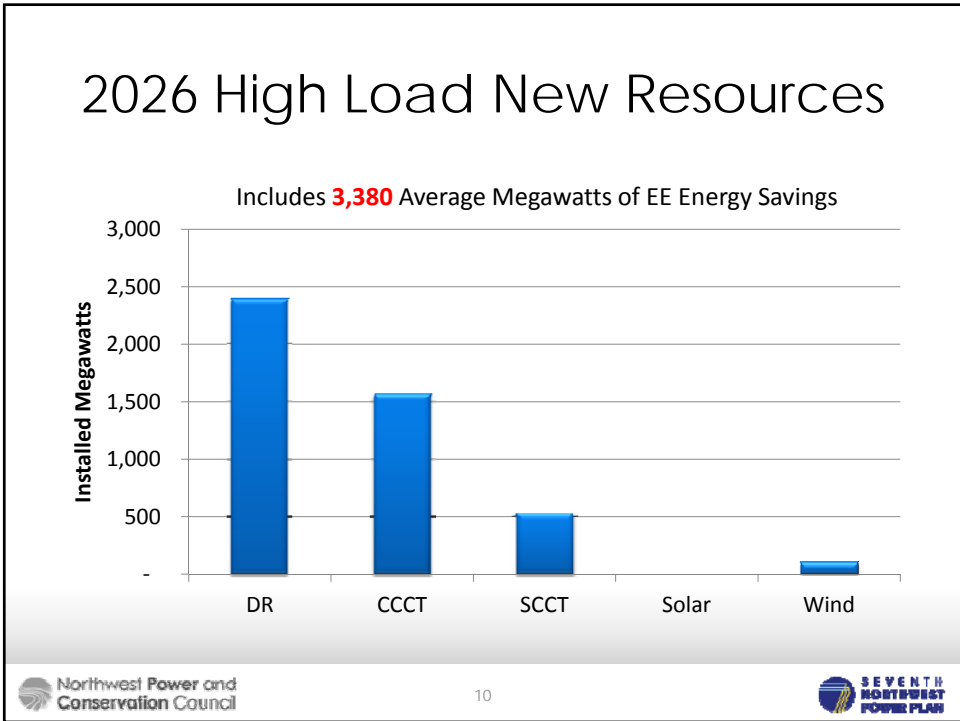
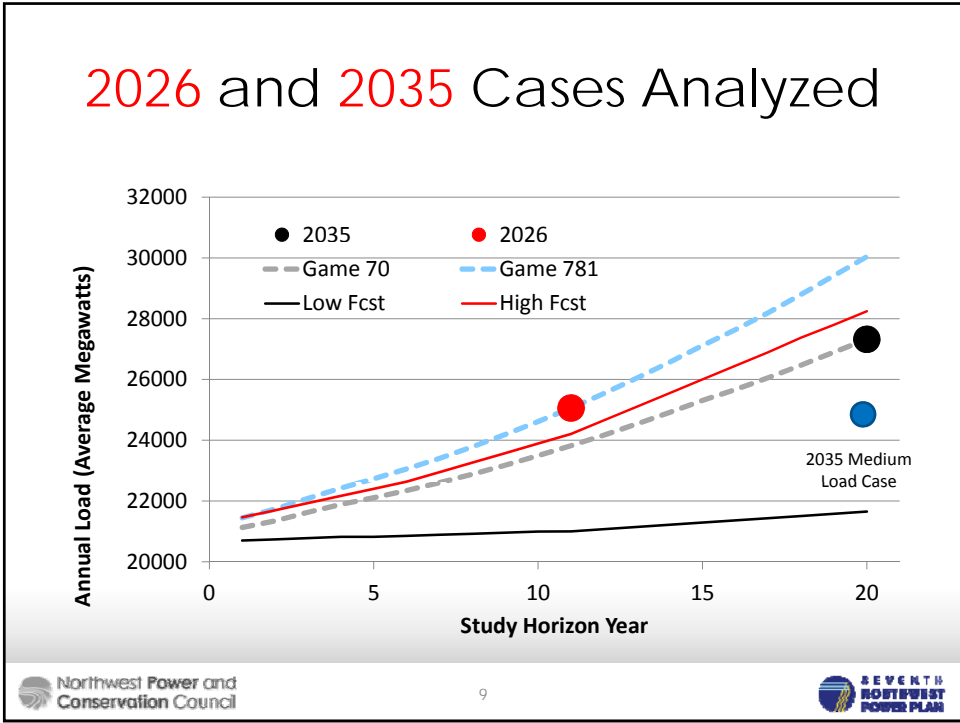


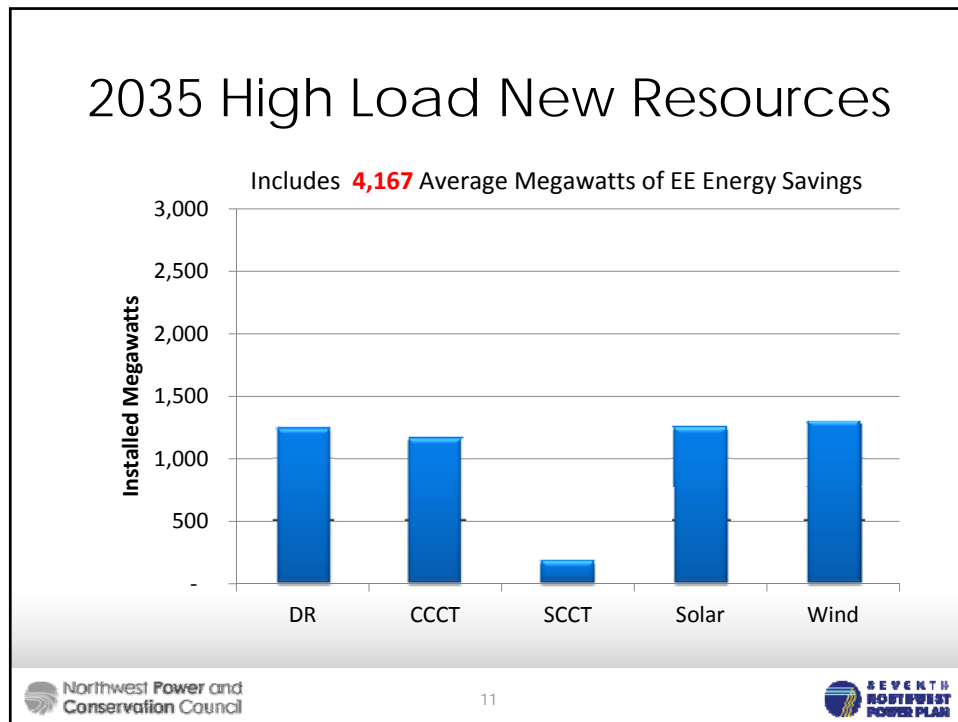
2. Analysis for 2026 and 2035

- **General Methodology**
- **2026 and 2035 Load Scenarios**
- **RPM Resources for 2026**
- **RPM Resources for 2035**

Methodology

- **Take resource builds for 2026 and 2035 from various RPM futures**
- **Use RPM loads and resources in GENESYS to assess adequacy**
- **Apply climate induced changes to loads and unregulated flows**
- **Reassess adequacy for 2026 and 2035 under various load conditions**



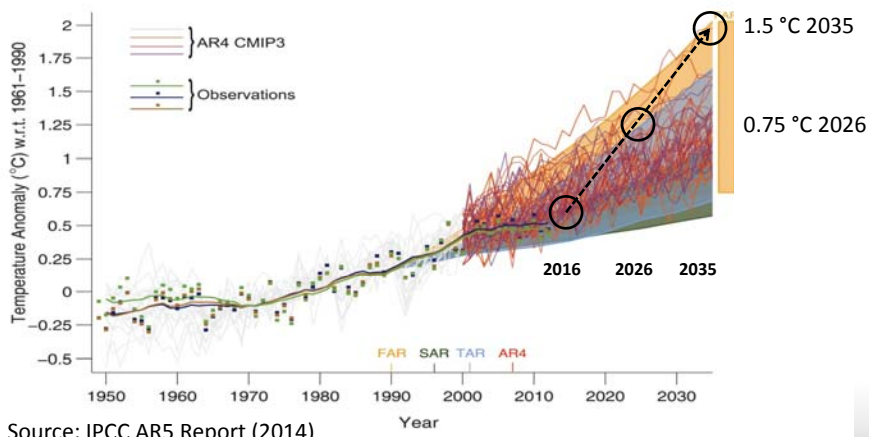


3. Climate Induced Loads

- IPCC 5 Temperature Forecast
- Projected NW Temperature Increases for 2026 and 2035
- Projected Load Changes for 2026
- Projected Load Changes for 2035

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Projected Temperature Change for 2026 and 2035

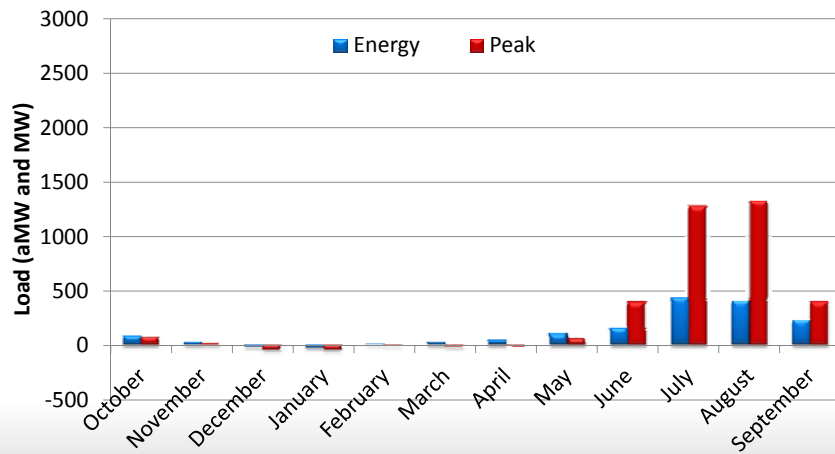


Projected NW Temperature Increase Used in the Analysis

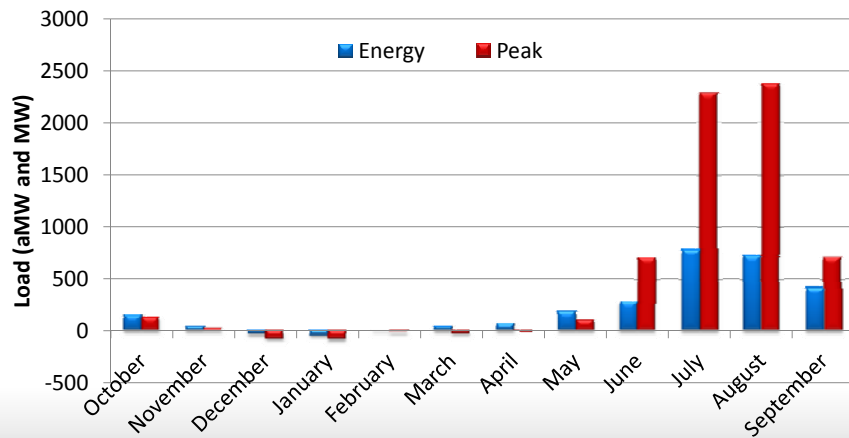
(High case only, **using linear interpolation**)

Year	2026	2035
High	0.75 °C	1.50 °C
Medium	0.38 °C	0.75 °C

2026 Projected Load Change



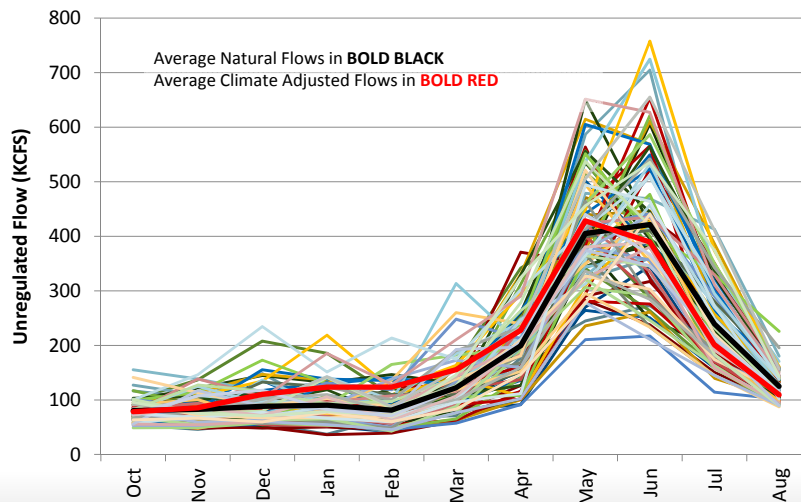
2035 Projected Load Change



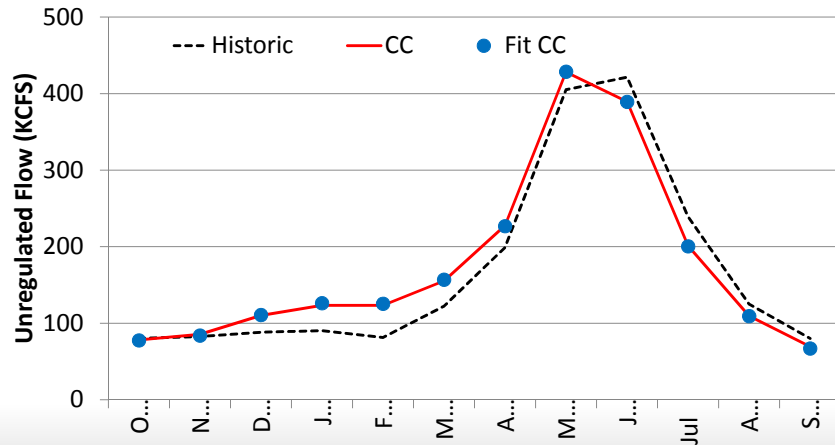
4. Climate Induced Flows

- Average vs. Year-to-Year Flow Patterns
- Weighting historical flows to generate a set of climate change natural flows
- Flow changes for 2026
- Flow changes for 2035

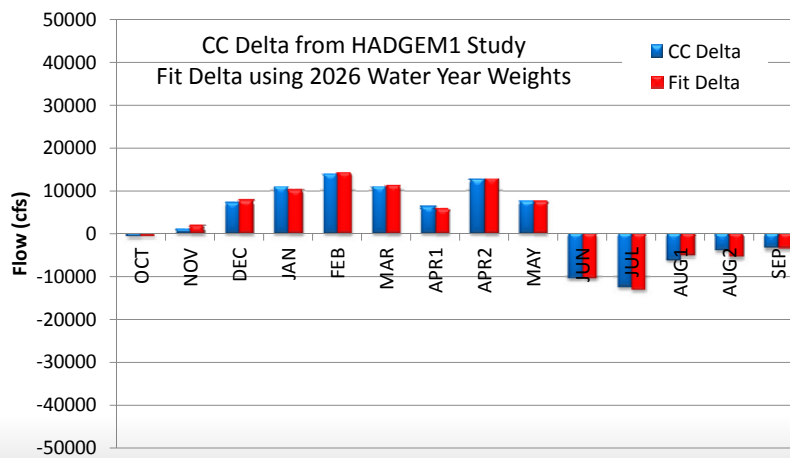
Average Flows vs. Year-to-Year Variation



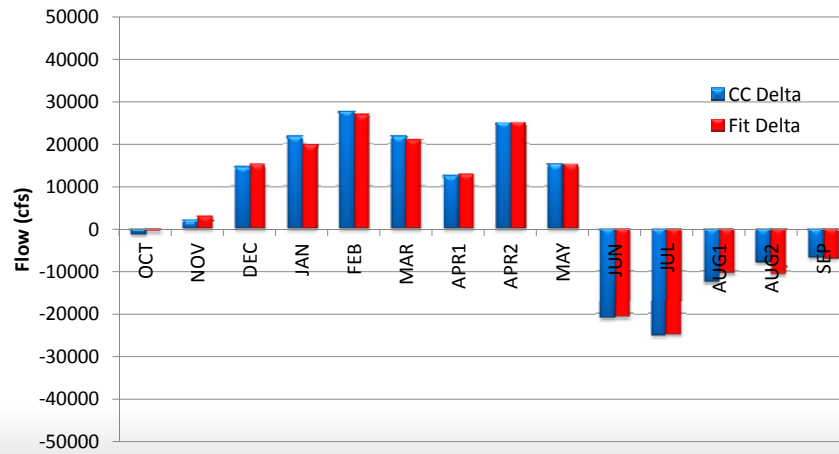
2045 Average Unregulated Flows



2026 Change in Unregulated Flows

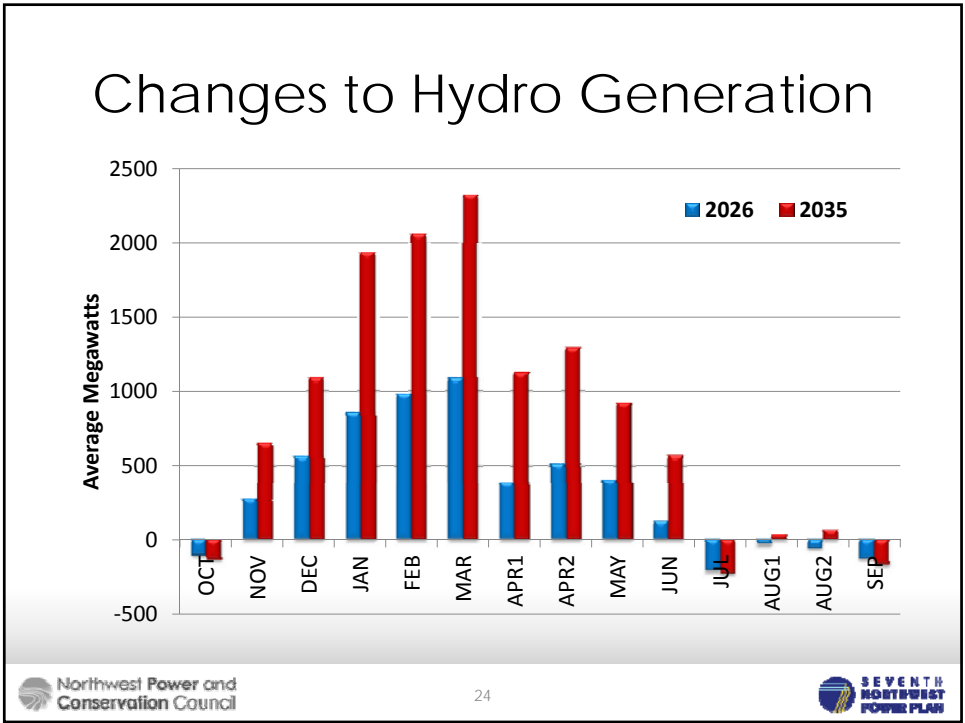
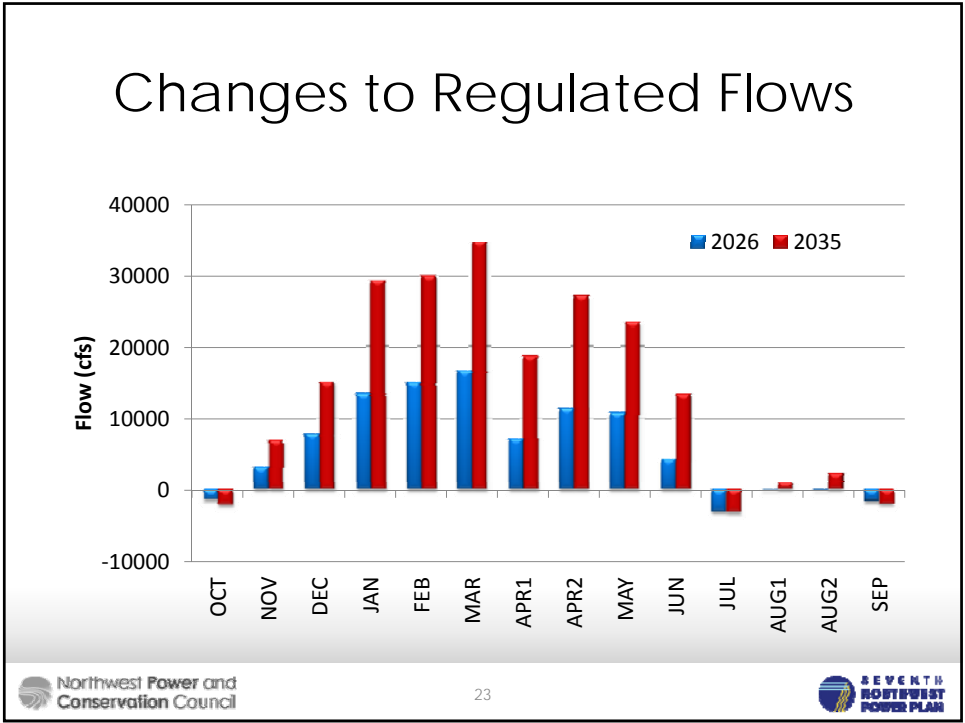


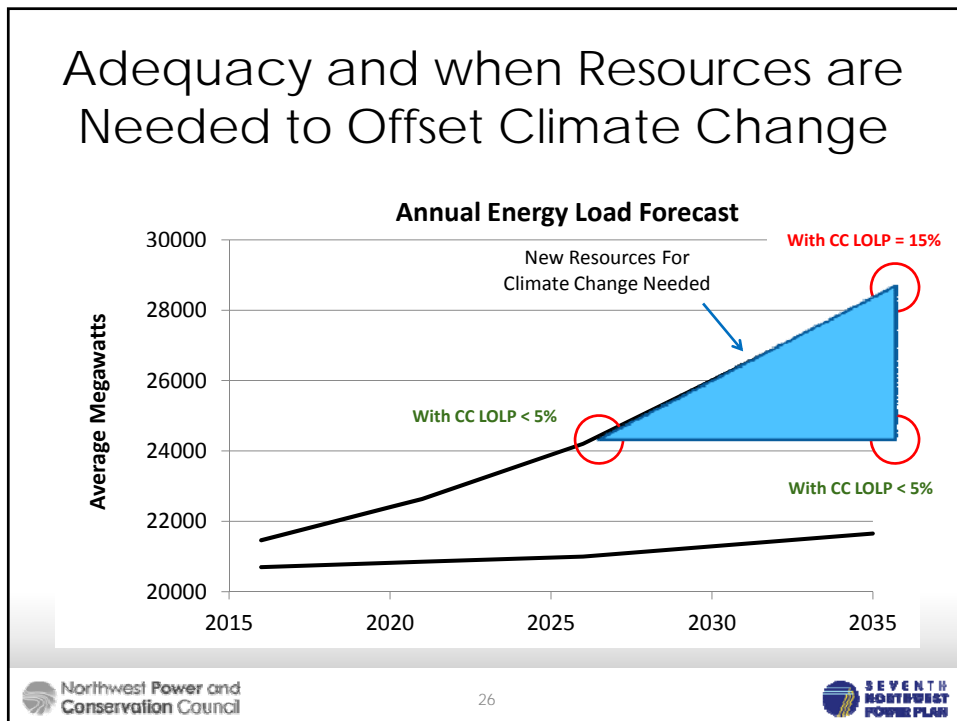
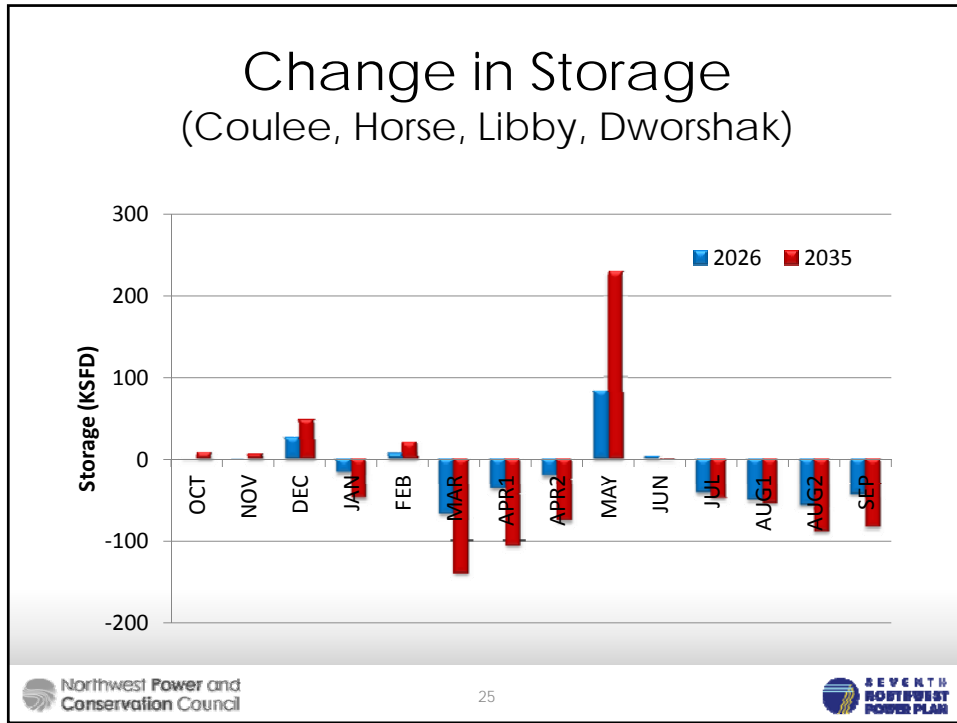
2035 Change to Unregulated Flows

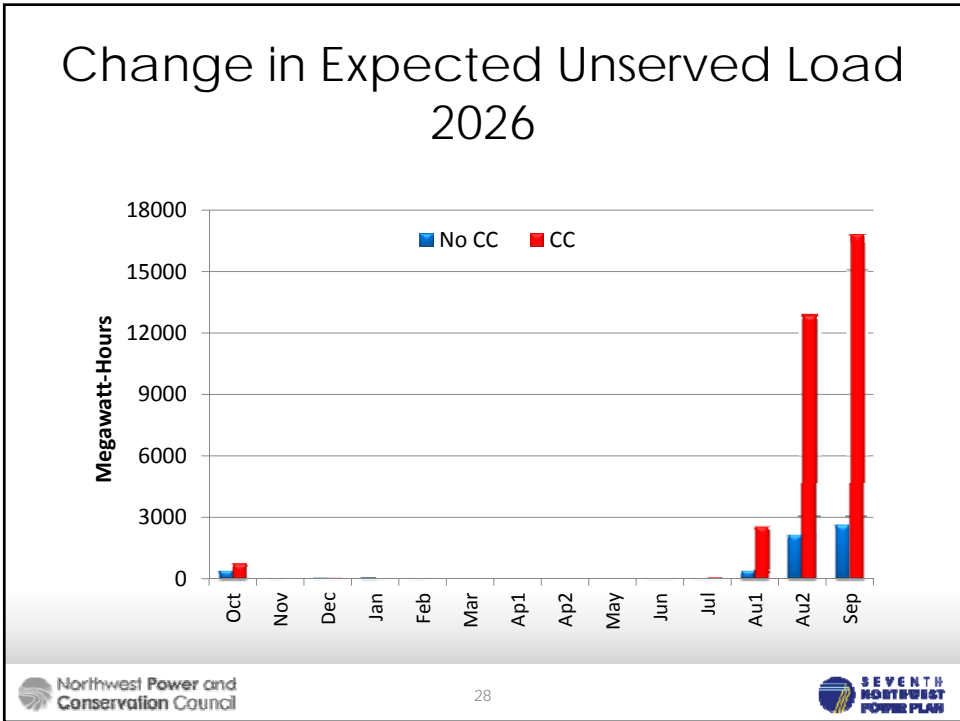
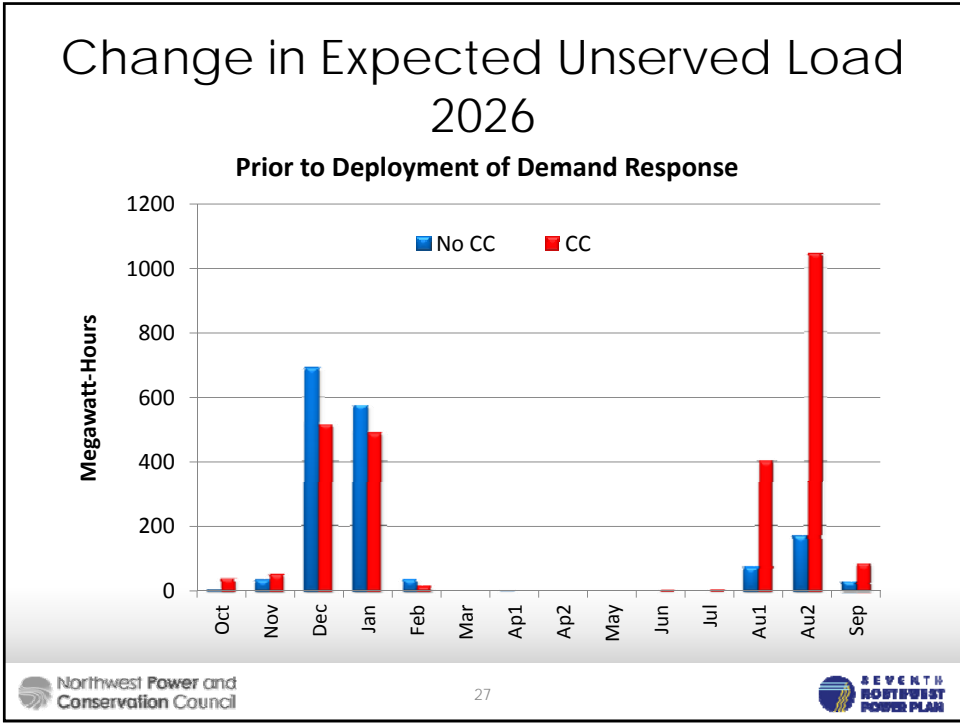


5. Analysis Results

- Regulated Flows
- Hydroelectric Generation
- Reservoir Storage
- Adequacy and when Resources are needed to Offset Climate Change
- Load/Resource Balance
- Key Findings







Climate Induced **ENERGY** L/R Balance Changes (aMW)

	2026 High Load Case		2035 High Load Case	
	Winter	Summer	Winter	Summer
Hydro Generation	700	-125	1,500	-140
Load	-20	400	-40	750
Resource - Load	720	-525	1,540	-890



Climate Induced **CAPACITY** L/R Balance Changes (MW)

	2026 High Load Case		2035 High Load Case	
	Winter	Summer	Winter	Summer
Hydro Generation	700	-100	1,500	-100
Load	-50	1,300	-80	2,300
Resource - Load	750	-1,400	1,580	-2,400



Key Findings (Climate Change Impacts)

1. **Load**
 - Lower in winter
 - Higher in summer
2. **River Flows**
 - Higher in winter
 - Lower in summer
3. **Resource Acquisitions to offset climate change**
 - 2016 to 2026: None
 - 2026 to 2035: Only when load > medium forecast
4. **2016-2021 Resource Strategy: No Change**
5. **Add Action Item: Continue to participate in climate change research**