Resource, asset, and contingency planning with climate variability

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Outline

- Context – The Pacific Northwest power supply
- Resource Planning - Planning for an adequate power supply
- Transitioning to climate change data
- Effects of climate change on power system planning

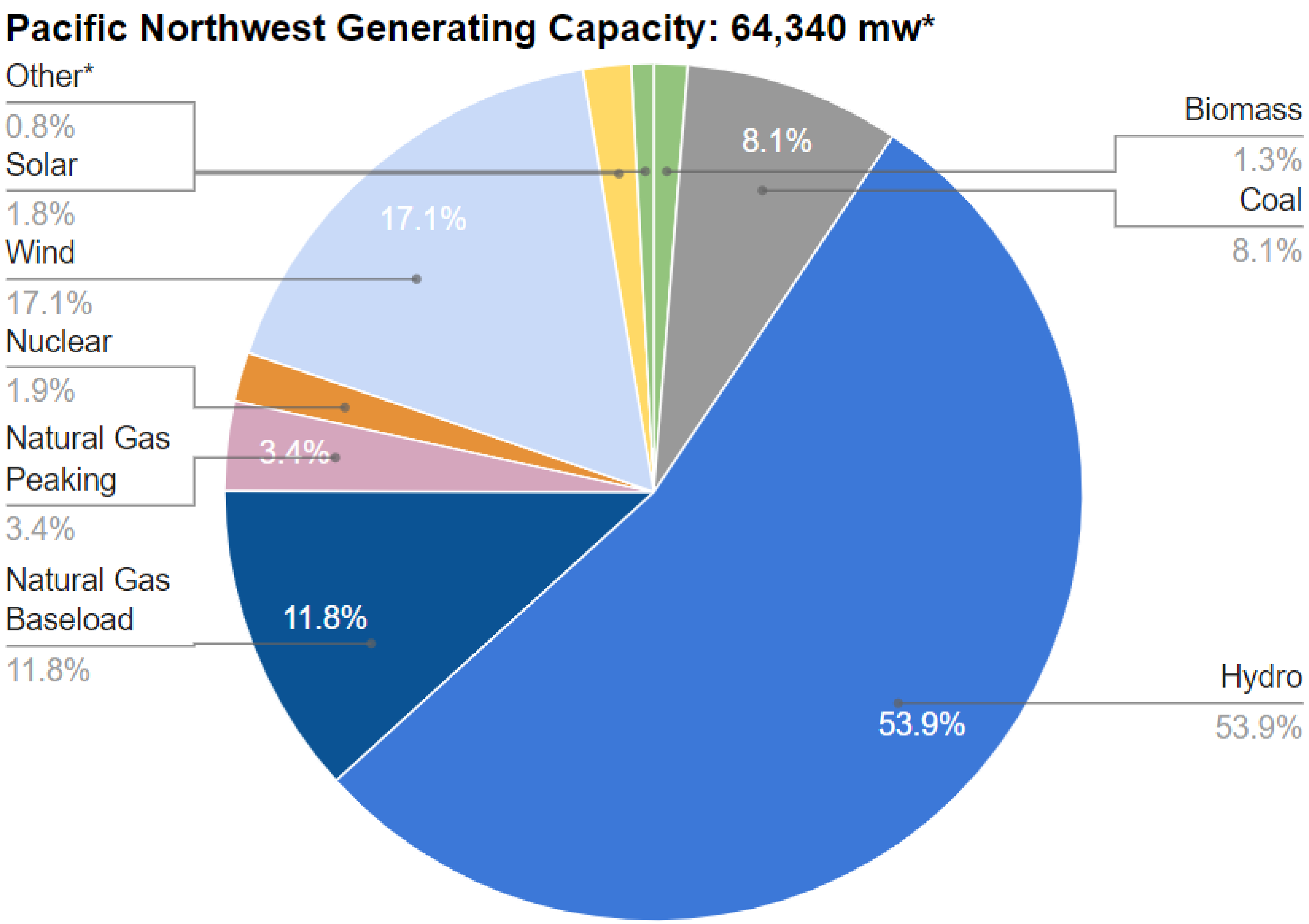
NW Power and Conservation Council

- The 1980 Northwest Power Act authorized Idaho, Montana, Oregon, and Washington to develop a regional power plan and fish and wildlife program to balance the Northwest's environment and energy needs.

- Goal is to ensure an adequate, efficient, economic and reliable power system

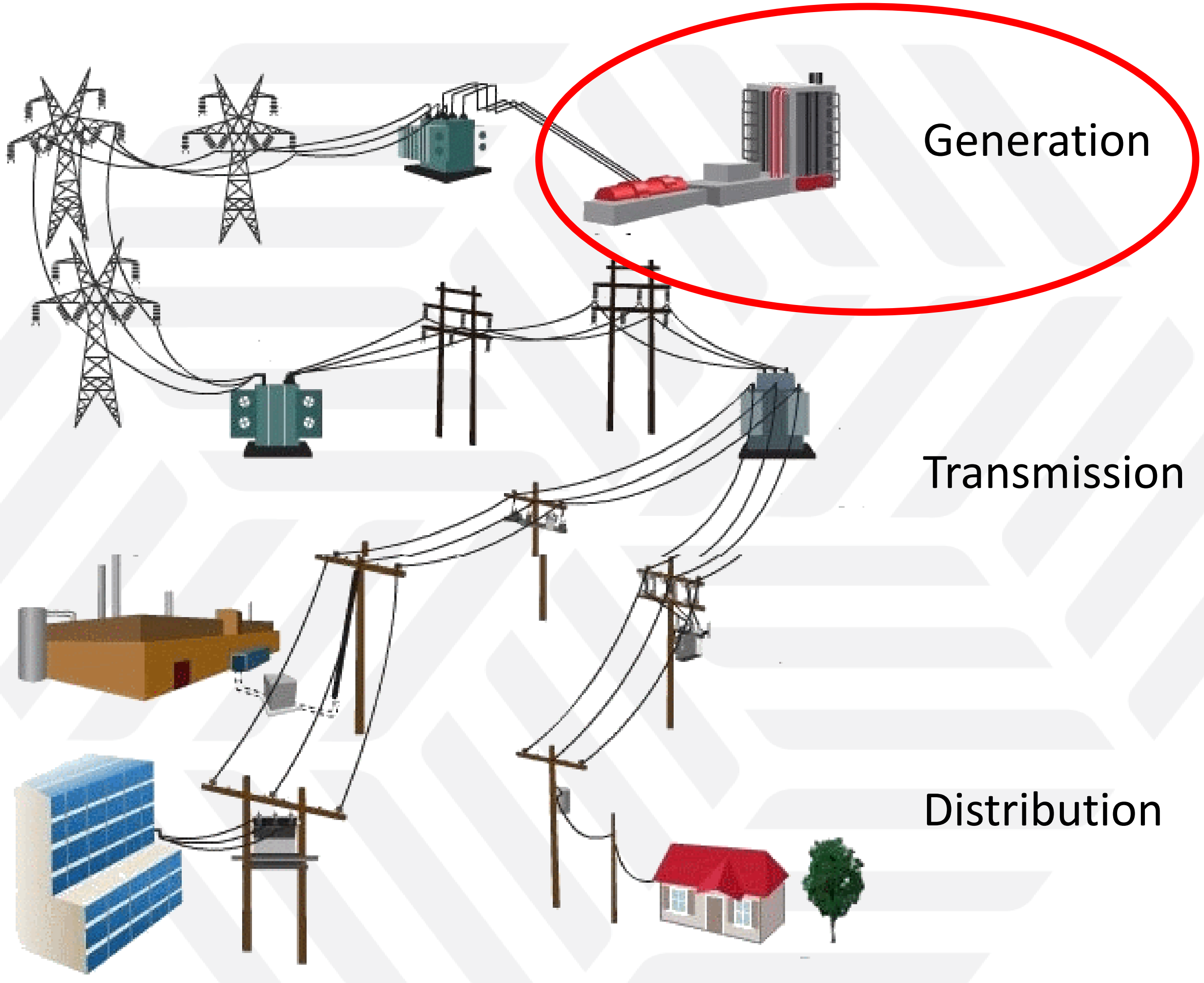
- Jurisdiction
  - By statute, plan guides Bonneville Power Administration’s resource decisions
  - By tradition, plan serves as an independent reference for the region’s utilities, regulatory commissions and policy-makers

Pacific NW Power Supply



Since 1980, the region has implemented energy efficiency measures, codes and standards that save about 7,000 average megawatts of energy annually.

Three Major Areas for Assessment



Most adequacy standards for long-term resource planning focus only on generation

How the Council defines Resource Adequacy

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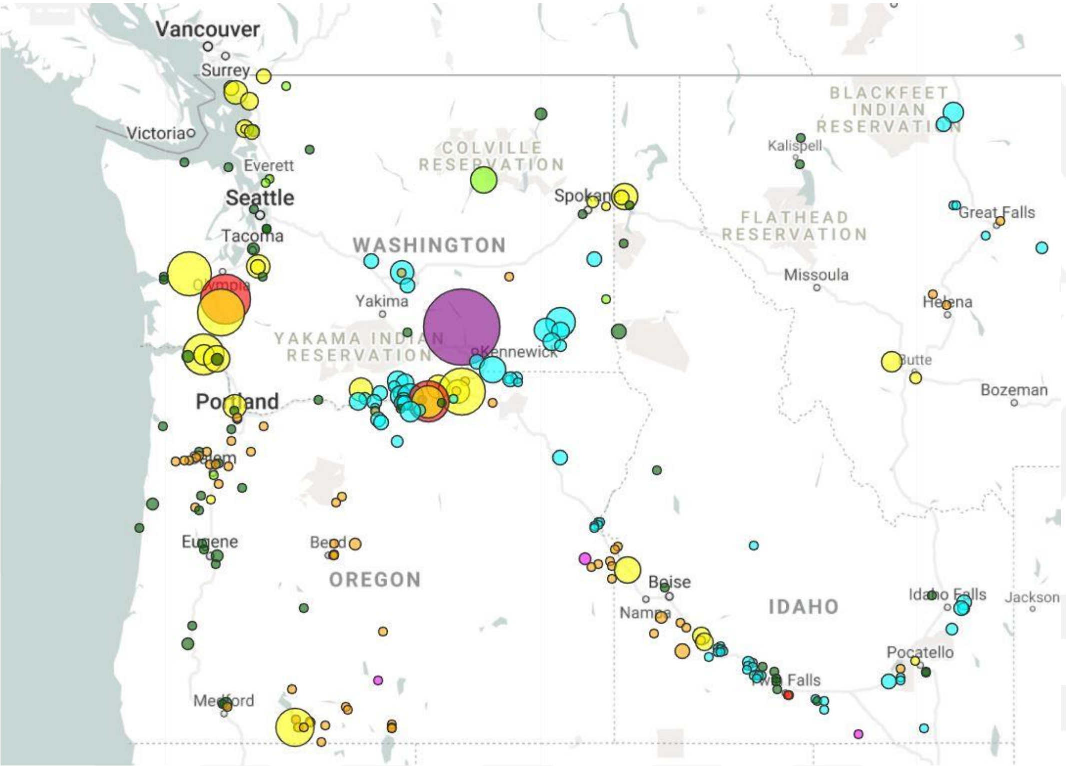
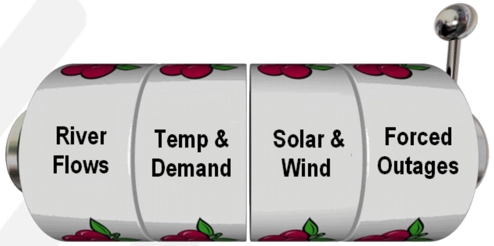
- An adequacy standard is composed of two parts:
  - Metric (measure of frequency, magnitude or duration of shortfalls)
  - Threshold (limit for each metric)
- No industry-wide standard – the most used standard is the 1-day-in-10-year loss of load expectation (LOLE).
- The Council uses a loss of load probability (LOLP) metric.

Assessing Resource Adequacy for the PNW



The Council deems the power supply to be adequate if the likelihood of having one or more shortfalls in a future year is less than or equal to 5 percent (i.e., LOLP ≤ 5%)

- **GENESYS**: Chronological hourly simulation of all PNW resources for one year
- Thousands of simulations with different combinations of future unknowns



- Record all hours when load cannot be served
- Annual Loss of Load Probability:

$$\text{LOLP} = \frac{\text{Number of simulations with shortfalls}}{\text{Total number of simulations}}$$

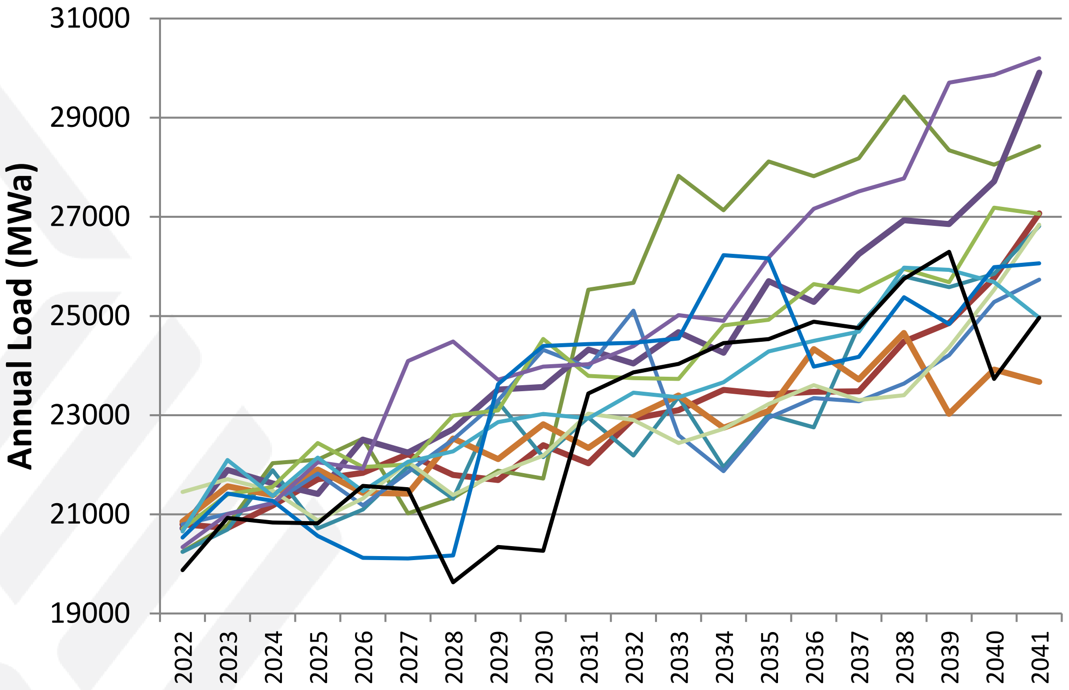
Adequacy and Resource Planning

- The Council's resource expansion model (Regional Portfolio Model) uses a Monte-Carlo approach to develop the most economic resource buildout given uncertain future conditions

- The RPM uses an adequacy reserve margin (ARM), based on a 5% LOLP, to ensure that future power supplies are adequate

- Resources are acquired if they are:
  - Required under clean-air laws
  - Deemed to be profitable or
  - Needed to meet the ARM threshold

- The effective capacity of every potential resource portfolio addition is estimated using an Effective Load Carrying Capacity array

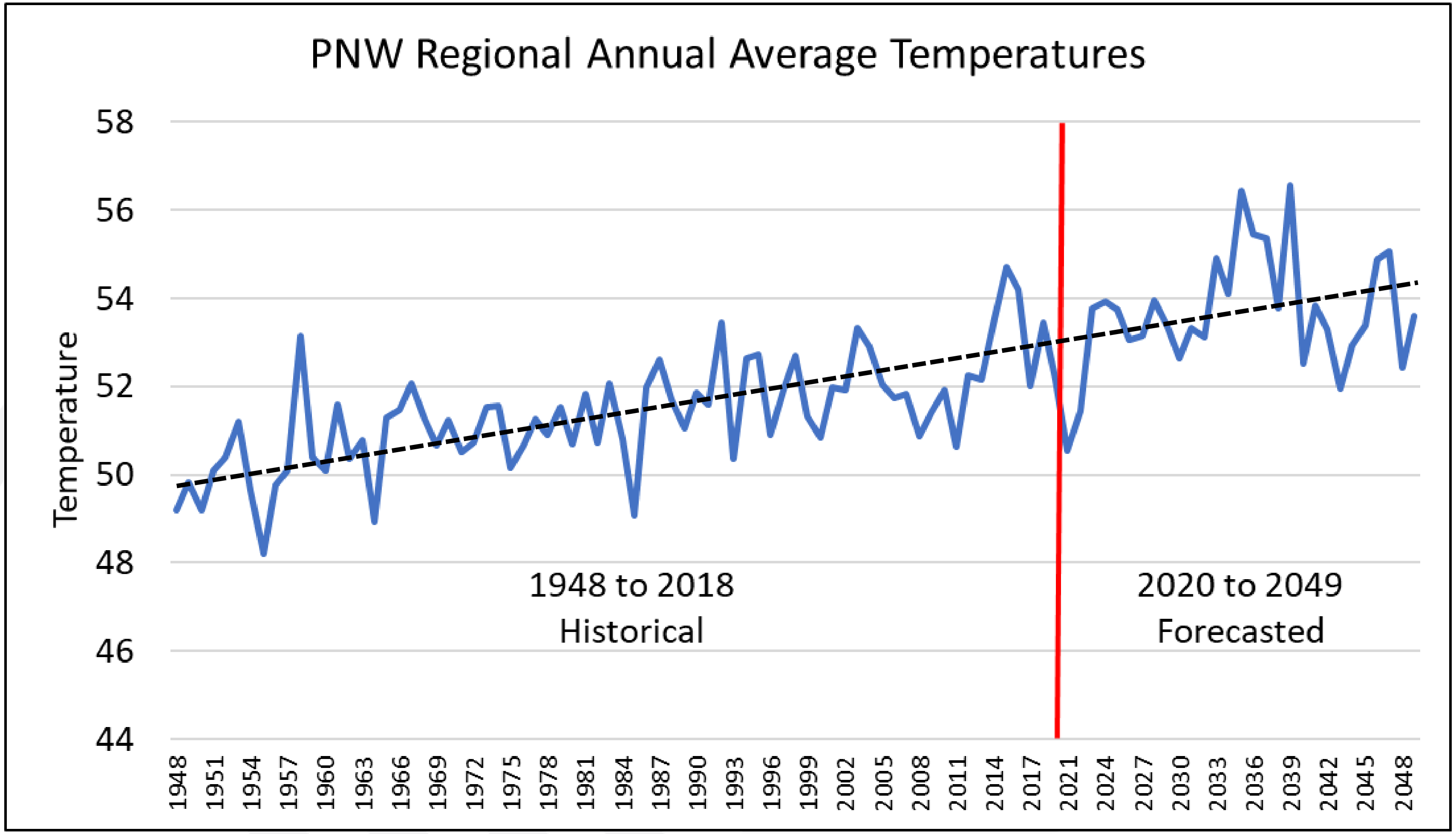


Transitioning from Historic to Climate Change Data

- Results from 10 General Circulation Model studies were downscaled for the Pacific Northwest region
- The River Management Joint Operating Committee (RMJOC), comprised of the Bonneville Power Administration, the Army Corps of Engineers and the Bureau of Reclamation in conjunction with the University of Washington and Oregon State University, performed the downscaling
- Utilities and other stakeholders participated through public meetings held extensively throughout the downscaling process
- 2 downscaling methods and 4 hydrological models were used to create 80 regional climate change scenarios
- RMJOC chose 19 representative scenarios for detailed power system modeling
- Council selected 3 of the 19 scenarios as representative of the entire ensemble

Long-term Trends in Temperature 1949-2049

Historic (observed) 1949-2018 and Forecasted 2020-2049[1,2]

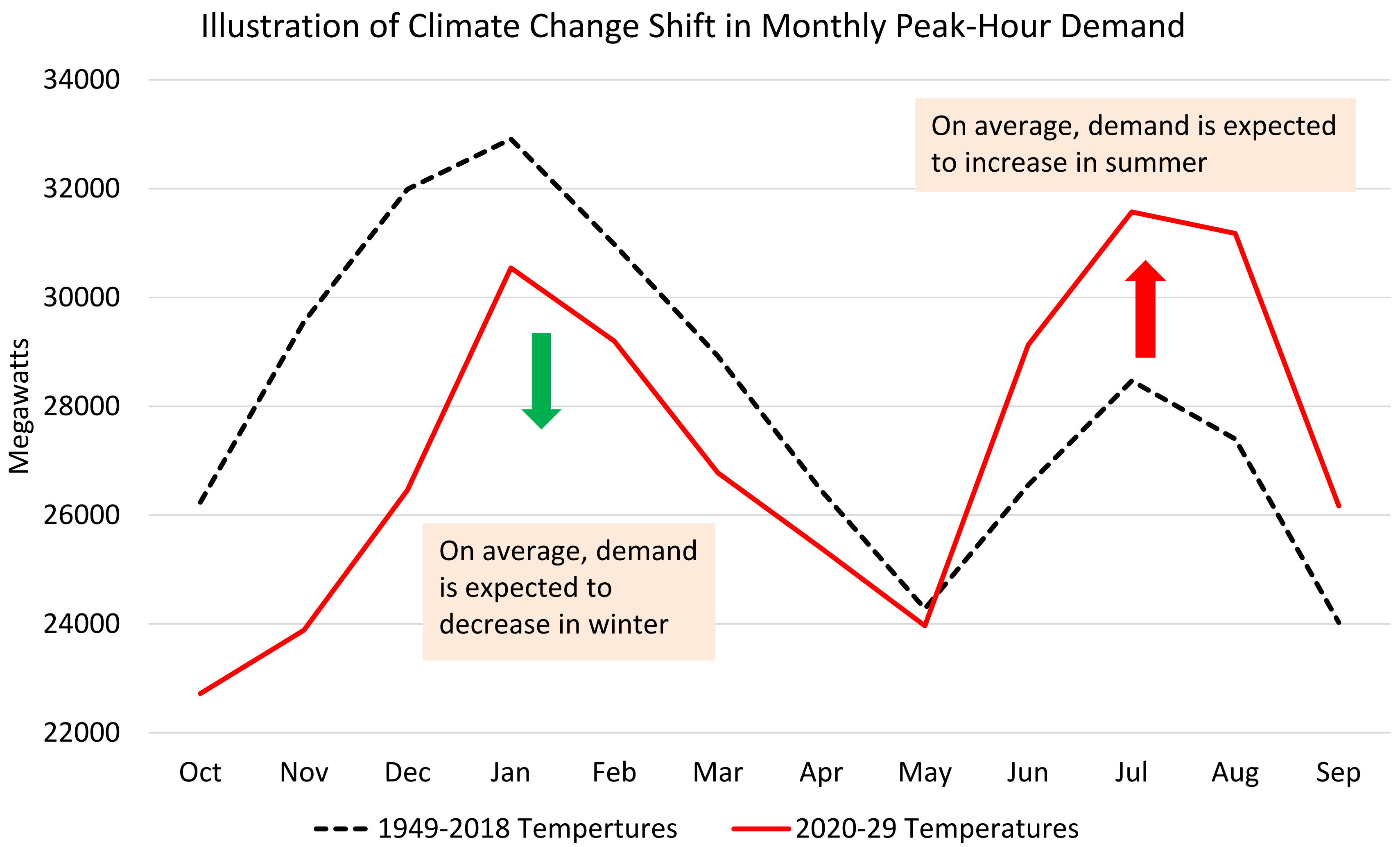


The data show a clear trend toward increasing annual temperatures without any indication of a discontinuity.

[1]Regional temperature is the weighted average temperature of the four largest cities in the region (Seattle, Portland, Boise and Spokane) based on electrical demand.

[2]Becasue this chart was created in 2019, historic temperatures for that year were not available.

Climate Change Shifts Seasonality of Electricity Demand



Dashed line represents monthly average peak-hour demand based on historic temperatures from 1949-2018.

Solid line represents monthly average peak-hour demand based on forecasted climate change temperatures for 2020-29.

[1]Because this chart was created in 2019, historic temperatures (and therefore demand forecasts) for that year were not available.

Long-term Trends in Temperature 1949-2049

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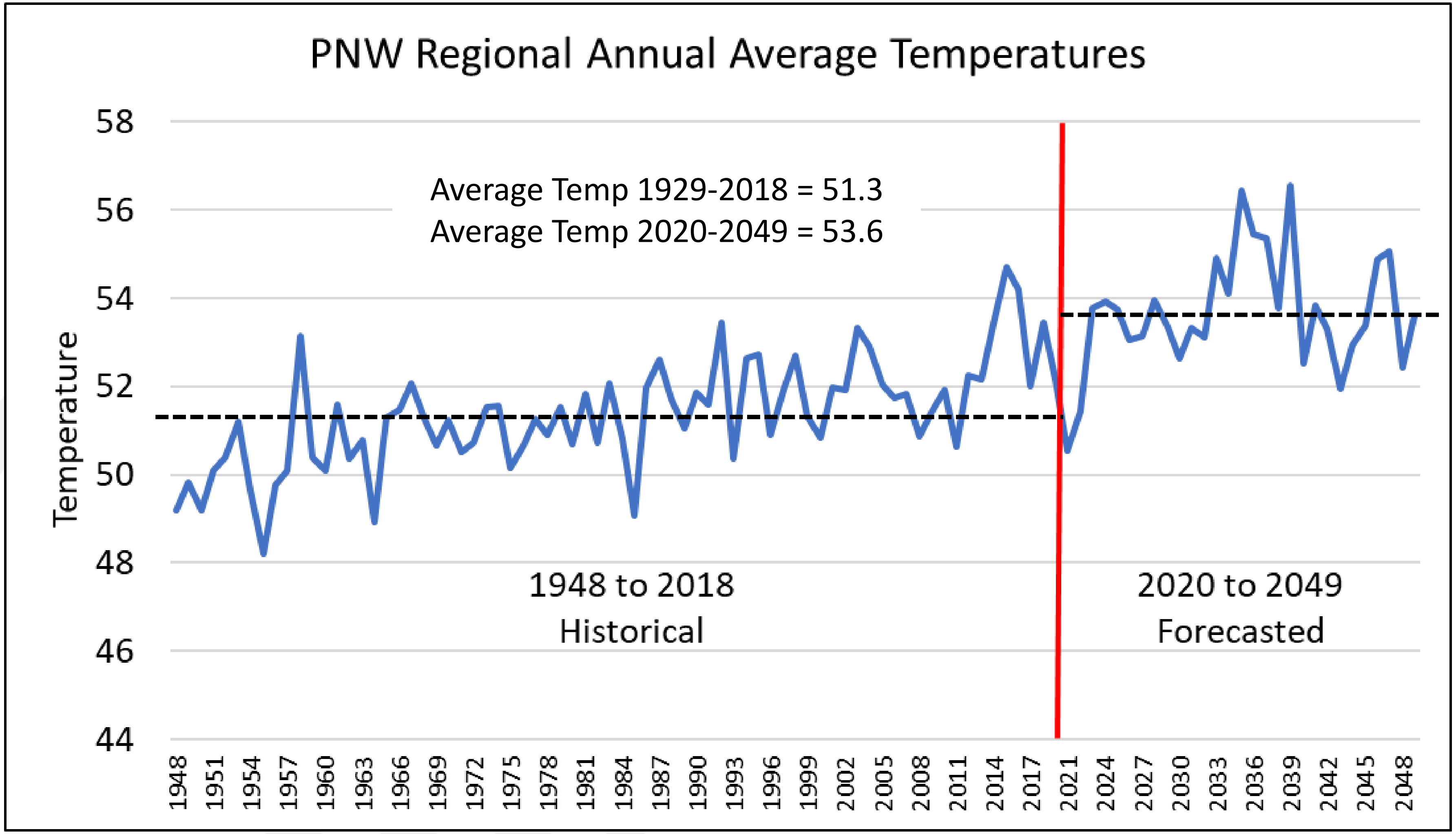


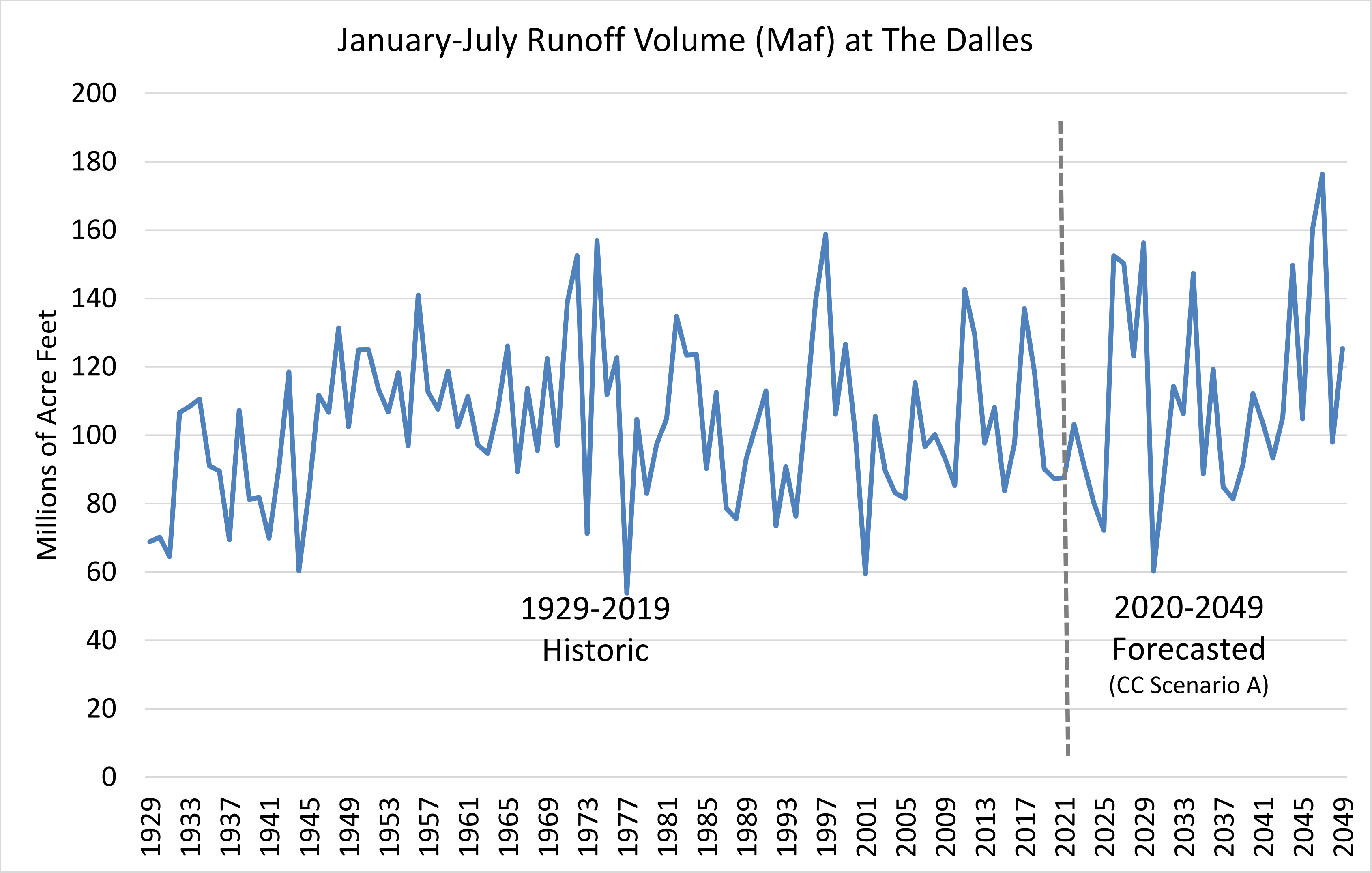
The large shift in monthly average peak-hour demand, shown on the previous slide, is partially due to different "normal" temperatures derived from the two time periods (1948-2018 and 2020-29) used in the Council's forecasting model.

[1]Regional temperature is the weighted average temperature of the four largest cities in the region (Seattle, Portland, Boise and Spokane) based on electrical demand.

[2]Because this chart was created in 2019, historic temperatures for that entire year were not available.

Long-term Trends in Natural Flows

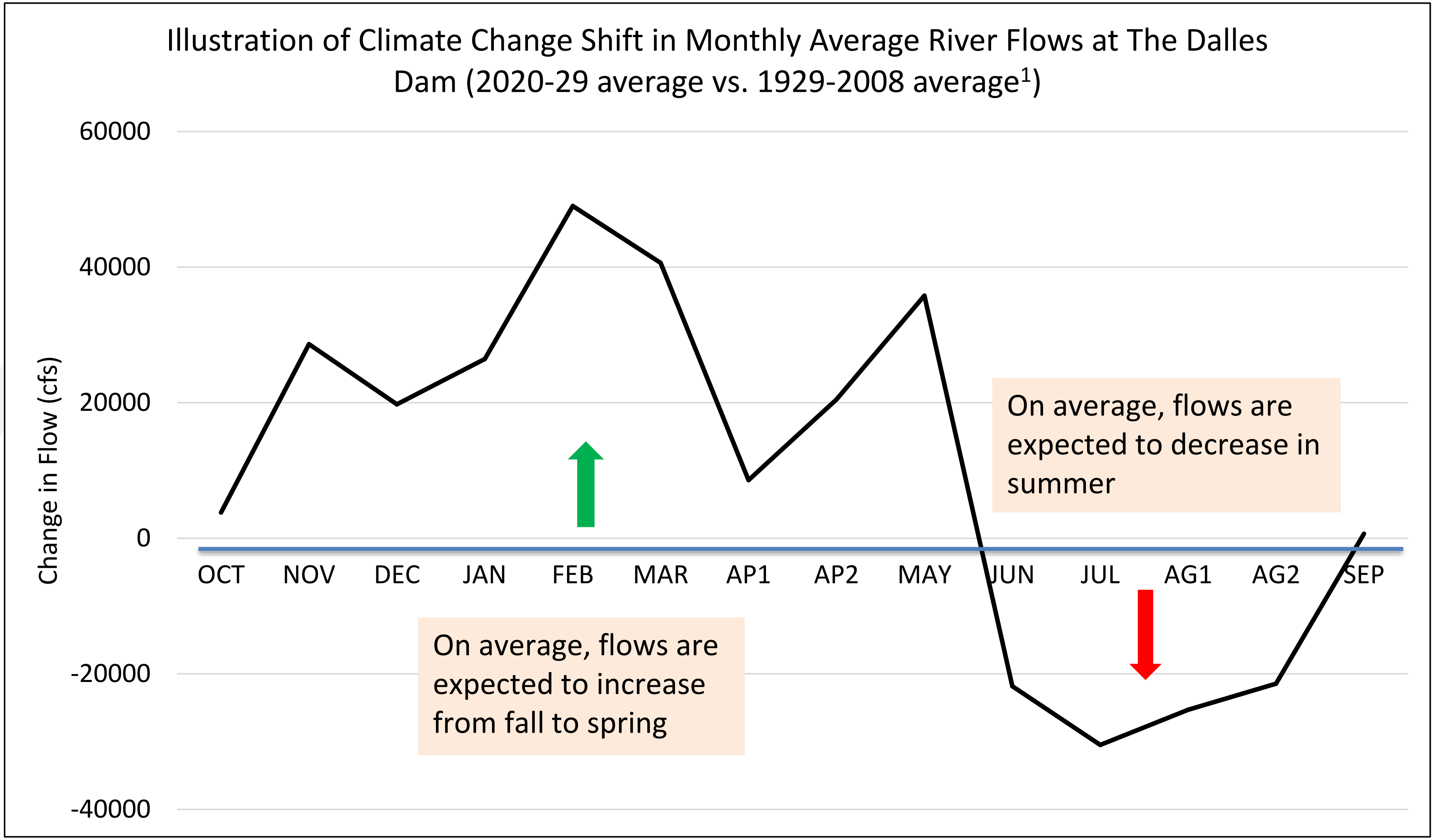
January-to-July River Flow Volume (Maf)



The data show no apparent trend in the January-to-July river flow volume.

However, seasonal volumes show a trend, with fall and winter volumes generally increasing and summer volumes decreasing (see next slide).

Climate Change Shifts the Seasonality of River Flows

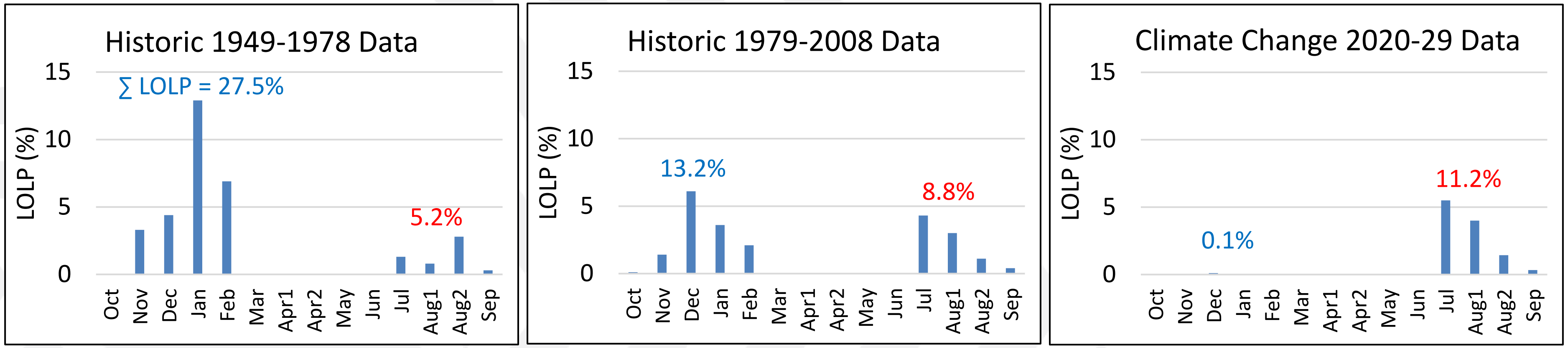


[1]Monthly average natural flows for 2009 to 2019 were not readily available.

Effect of Climate Change on Resource Adequacy

Seasonal Shift in Loss of Load Probability over Time

For illustration only – Not reflective of expected LOLP Values



For all studies, water year and temperature year (load) were in lockstep

- Left chart uses historical data from 1949-1978 (30 years)
- Middle chart uses historical data from 1979 to 2008 (30 years)
- Right chart uses climate change data for 2020-29 from three separate climate change scenarios (30 years total)

Over time, total winter LOLP declines and total summer LOLP increases

Ramifications of moving to Climate Change Data

- With expected higher temperatures, winter demand will generally decrease, and summer demand will generally increase
- At the same time, more precipitation will fall as rain in the winter thus increasing river flows and hydro generation but leaving the mountain snowpack smaller resulting in lower summer flows and lower summer hydro generation
- This shifts the stress on the power supply from winter to summer
- Using historical data for power system analyses will not capture this expected trend, possibly leading to acquisition of the wrong types and amounts of new resources

Questions states can ask

- What are the challenges to transitioning to forward-looking climate change projections for demand and resource availability?
- What confidence do planners and regulators have that climate change forecasts are a better predictor for planning purposes?
- Is there resistance to moving to climate change forecasts and if so, why?
- What effect do state clean-air laws and policies have on resource expansion planning?
- With the anticipated increase in variable energy resources, what can planners do to ensure that adequacy does not diminish?
- How can electricity market protocols be modified to maintain power supply adequacy?
- Moving toward electrification in all sectors of the economy can reduce GHG emissions but will significantly increase electricity demand. How will the increased demand be met without increasing emissions?

Resources for more information

- RMJOC report on downscaled GCM data for the PNW
  https://www.bpa.gov/p/Generation/Hydro/hydro/cc/RMJOC-II-Report-Part-I.pdf

- 2021 Pacific NW Power Plan
  https://www.nwcouncil.org/sites/default/files/Draft_2021PowerPlan_Doc%232021-5_0.pdf

- 2021 Power Plan – Supporting Material
  https://www.nwcouncil.org/2021powerplan_sitemap

- Northwest Power and Conservation Council
  www.nwcouncil.org

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