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

November 6, 2018

MEMORANDUM

TO: **Council Members**

FROM: **John Fazio, Senior Systems Analyst**

SUBJECT: **Briefing on the effect of compound climate events on adequacy in the Pacific Northwest**

BACKGROUND:

Presenter: John Fazio, Senior Systems Analyst, Sean Turner, Water Resources Management Modeler, and Nathalie Voisin, Regional Water-Energy Dynamics Research Lead, Pacific Northwest National Labs

Summary: The Council has the obligation to investigate possible effects of potential future changes in climate on the adequacy, reliability, efficiency and economy of the region's power supply. In Appendix M of its Seventh Power Plan, the Council described how it used available climate change data to analyze physical impacts to loads and river flows, and how those effects might alter the resource strategy in that power plan.

Council staff continues to monitor and participate in efforts to obtain and vet relevant climate change data and analyses. One part of those efforts includes staff's coordinated work with Pacific Northwest National Lab scientists to use more current data to assess how climate change could potentially affect the adequacy of the region's future power supply.

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

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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. But staff continues to work with others in the region to obtain more current climate change data and to update assessments of how climate change might affect the region's power supply.

Work Plan: Action Item COUN-11: Participate in efforts to update and model climate change data.

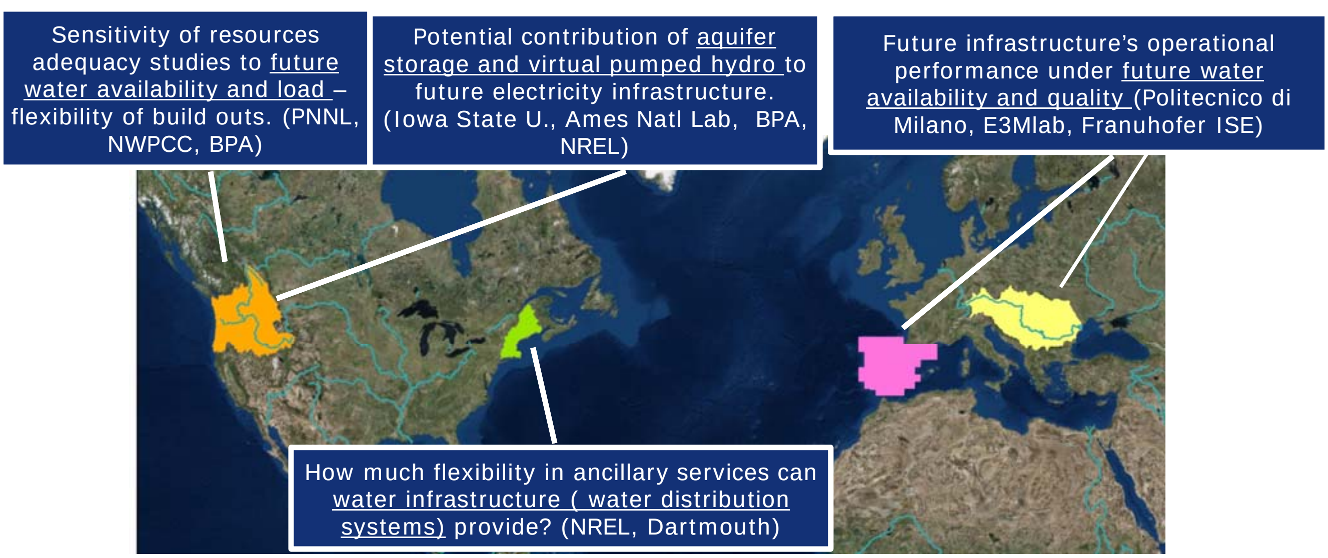
Background: Issues surrounding climate change, and more specifically its potential impacts to the region's power supply and electricity demand, have been discussed for decades. Through time, more robust data related to climate change have been collected and analyzed. The latest Intergovernmental Panel on Climate Change Report (issued in 2014) continues to show a general trend toward increasing global temperatures. The River Management Joint Operating Committee (RMJOC) is in the process of downscaling the data from the latest IPCC report for the Northwest region. Unfortunately, that data is not yet fully available (the Council will be briefed on the status of this work earlier in the day). In the meantime, Council staff has developed a method to approximate that data for use in its adequacy model (GENESYS). Staff, in conjunction with Pacific Northwest National Lab scientists, have used that data to assess potential impacts of climate change on the adequacy of the region's power supply. When the full downscaled RMJOC data is available, staff will reassess its findings.

More Info: Seventh Power Plan, Appendix M: Climate Change Impacts to Loads and Resources

US-EU Integrated Power and Water Systems Modelling

- *Joint effort between the European Commission and DOE Office of Energy Policy and System Analysis (EPSA).*
- *Objective: understand US and EU modeling frameworks and associated assumptions to represent key water-energy dynamics and inform operations, planning policy and other decision making.*

Explored Water-Energy Dynamics



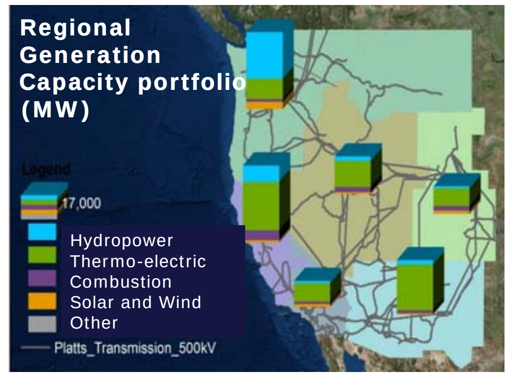
Flexibility and Regional Interactions in Water-Dependent Power System Operations: The US Pacific Northwest Case Study

PIs: Nathalie Voisin, Michael Kintner-Meyer, John Fazio, John Ollis, Ryan Egerdahl

Objectives:

1. Quantify the contribution of regional water availability to electric capacity expansion planning.

2. Quantify the sensitivity of the expansion plans to extra-regional markets (Southwest).



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Northwest Power and Conservation Council

Briefing on the effect of compound climate events on adequacy in the Pacific Northwest

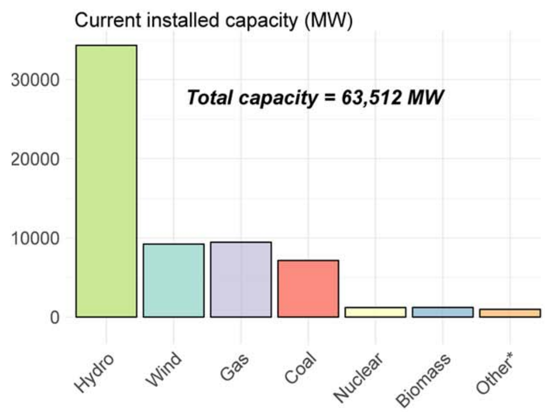
November 14, 2018

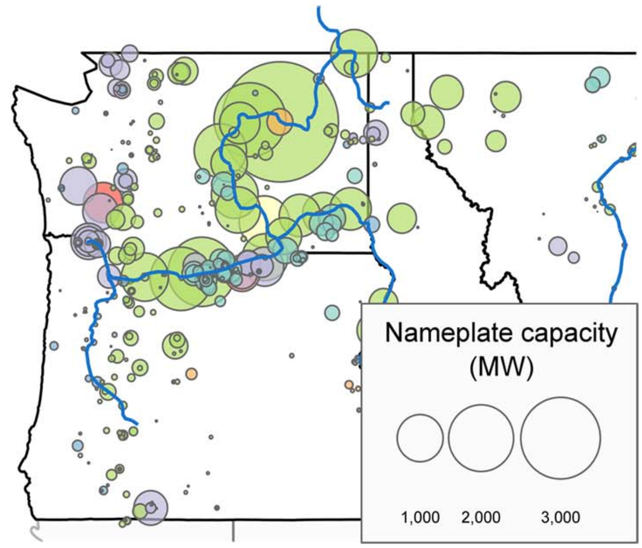
Nathalie Voisin, Sean Turner (PNNL)
John Fazio, Daniel Hua (NPCC)

U.S. DEPARTMENT OF ENERGY BATTELLE

PNNL is operated by Battelle for the U.S. Department of Energy

The Pacific Northwest relies on **hydropower**





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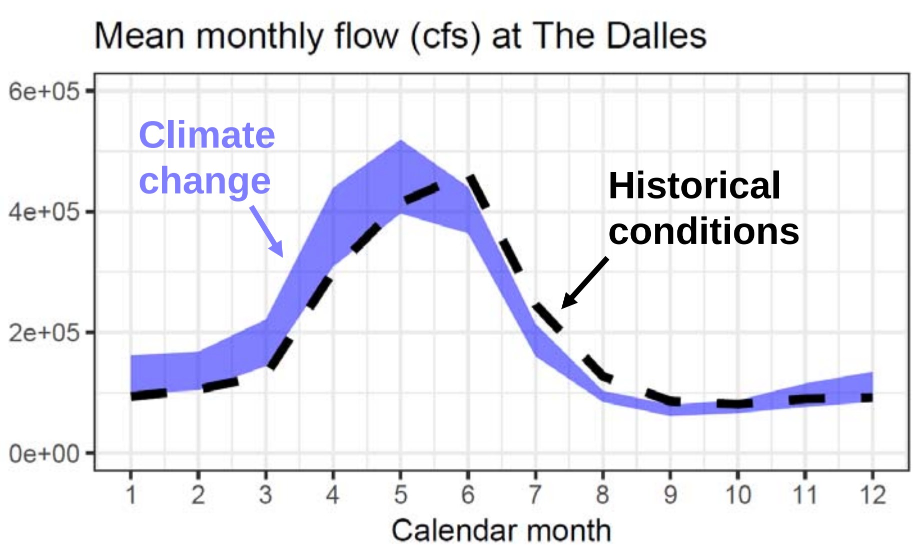
Hydropower is affected by **snowmelt timing**



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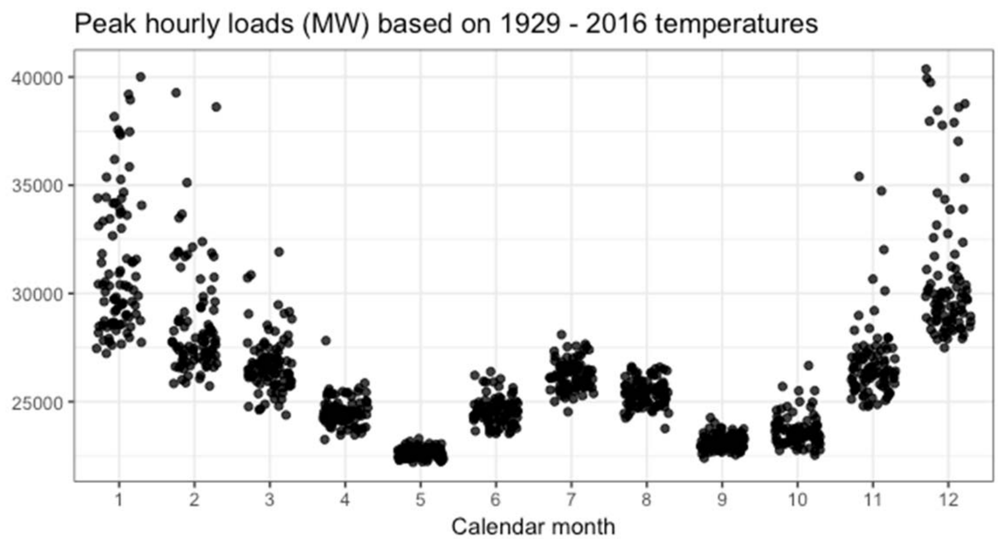
Peak loads occur mainly in winter



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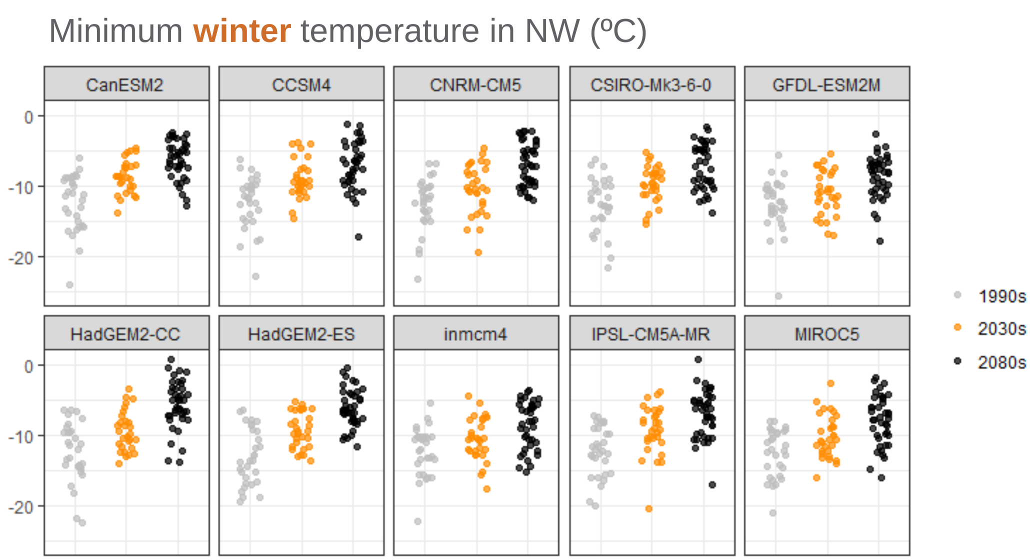
Warming may decrease winter peak loads...



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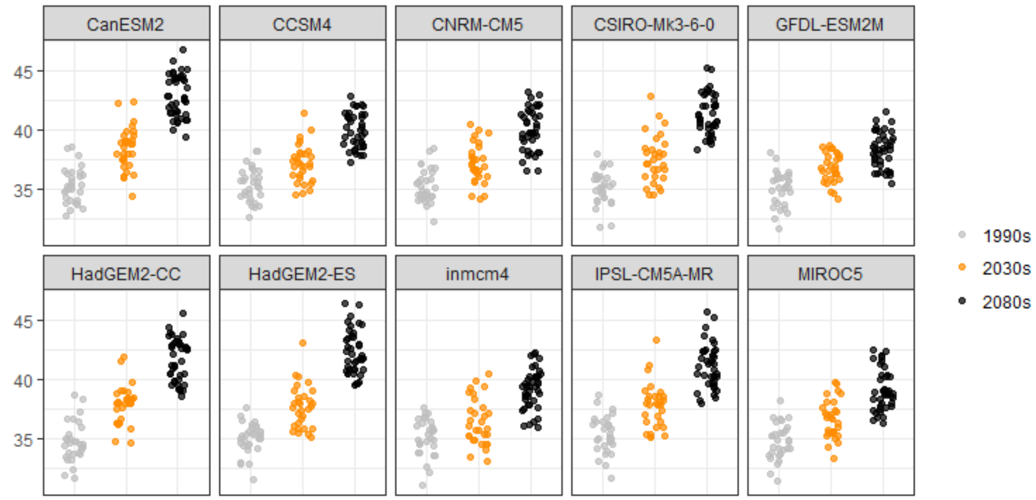
Warming may **decrease** winter peak loads... but **increase** summer peak loads

Maximum **summer** temperature in NW (ºC)



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Data, tools, and experimental setup

RMJOC2 climate scenario → VIC hydrology model → water availability profile → resampled water years → **GENESYS**

RMJOC2 climate scenario → temperature-load model → hourly load years → **GENESYS**

GENESYS → **Simulated shortfall record**

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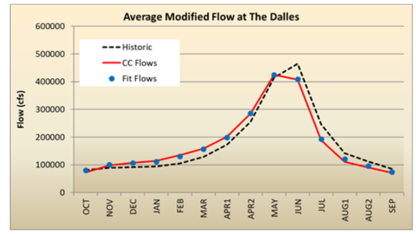
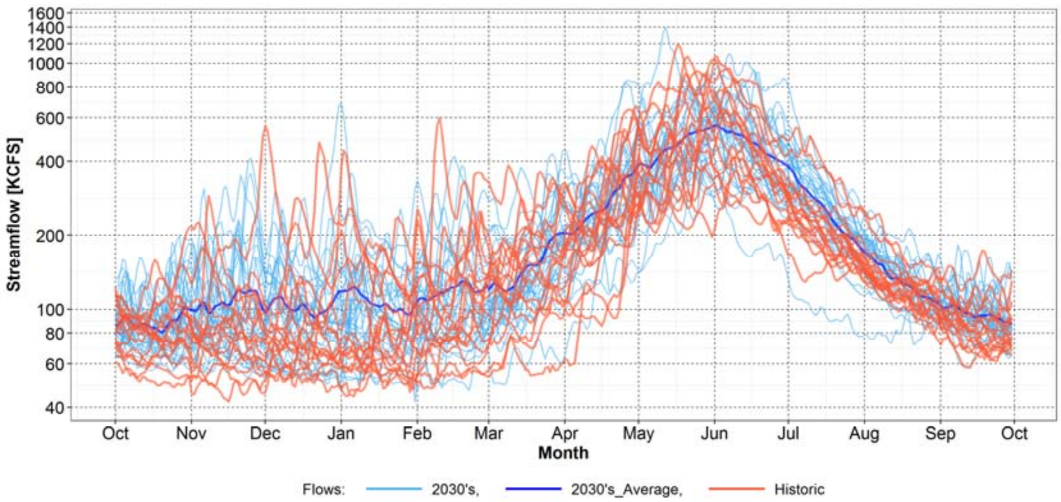
Water year resampling





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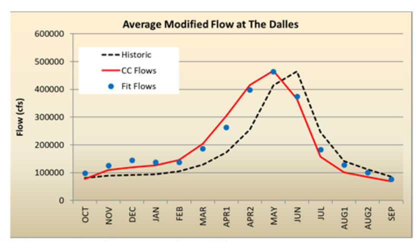
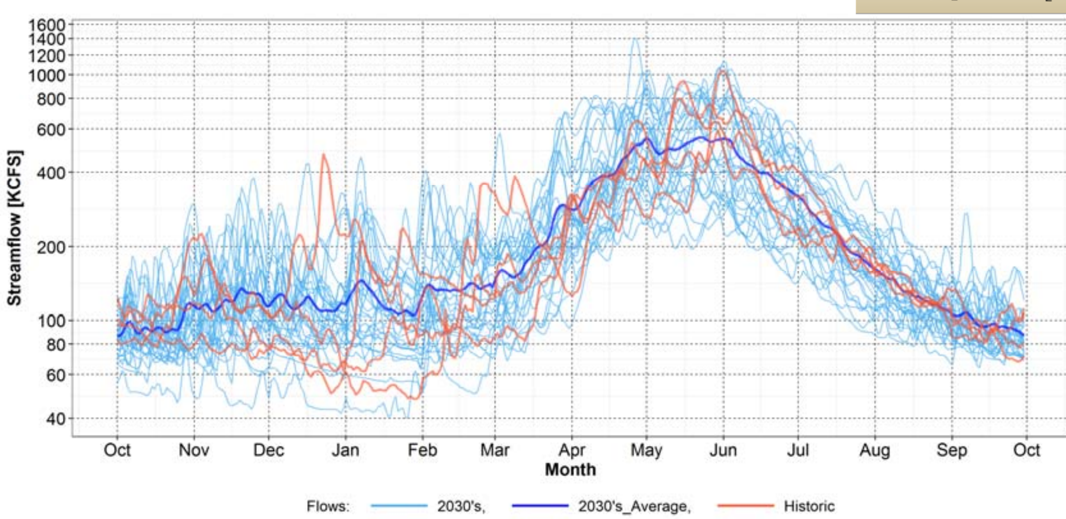
Water year resampling





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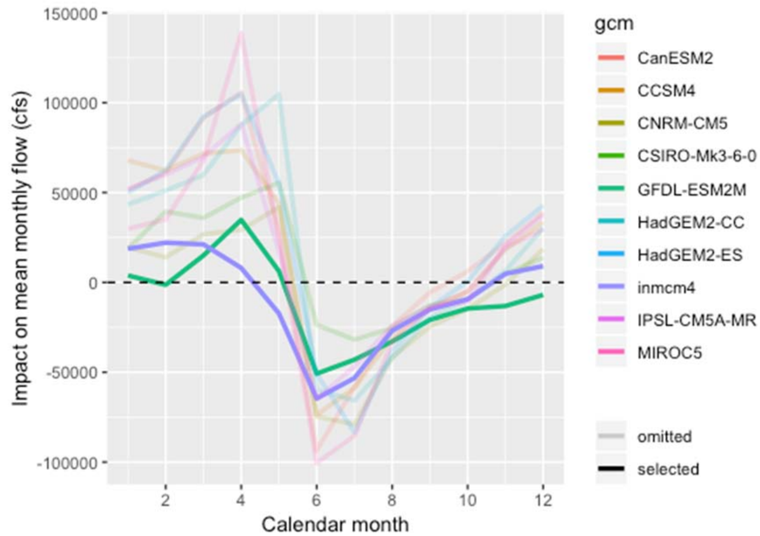
GCM choice



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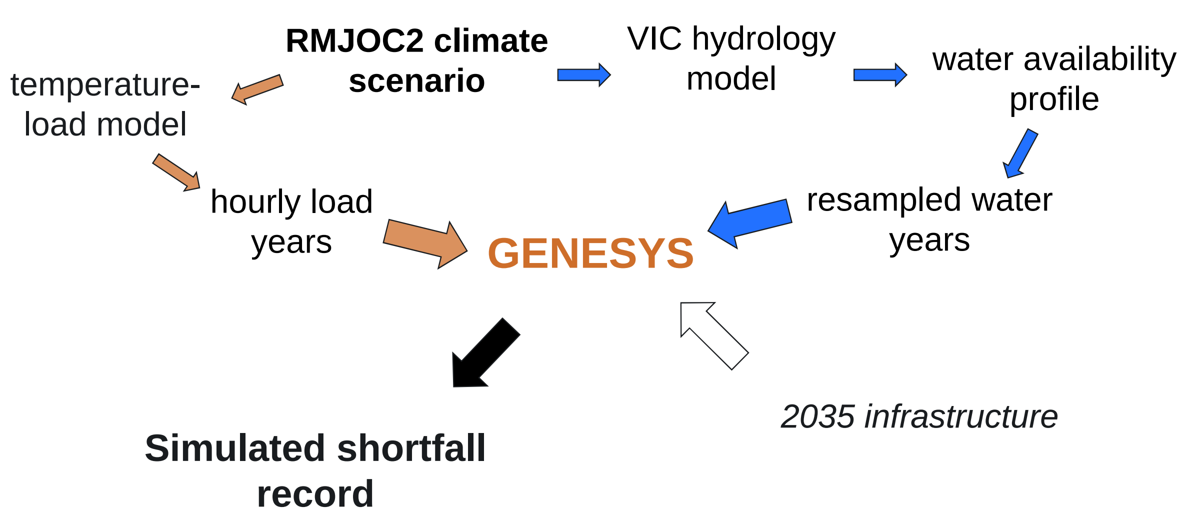
Data, tools, and experimental setup



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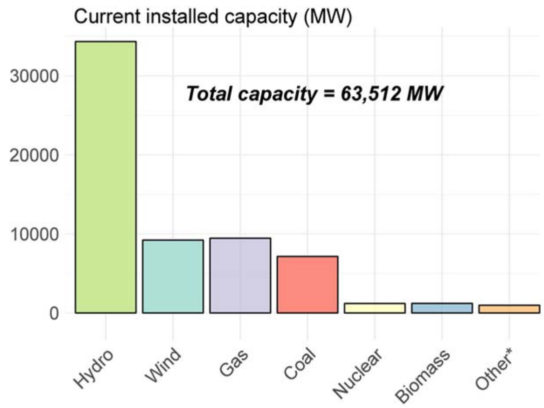
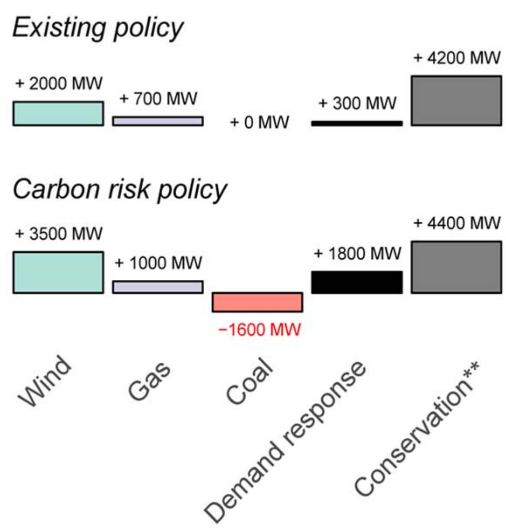
Infrastructures





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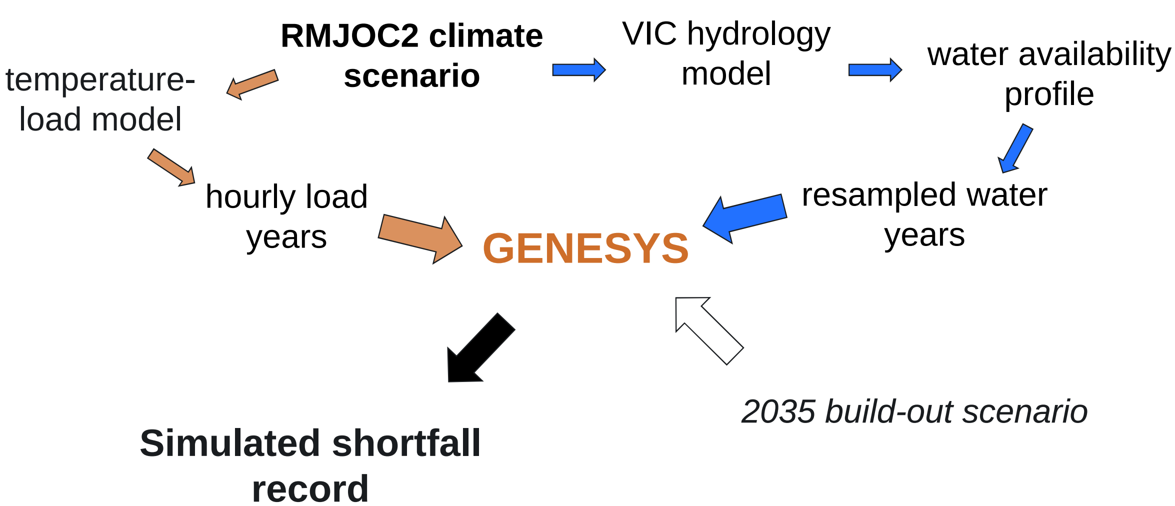
Data, tools, and experimental setup



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No climate change scenario

Observed climate time series

temperature-load model

hourly load years

GENESYS

historical water years

2035 build-out scenario

Simulated shortfall record

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Examining **shortfall risk**

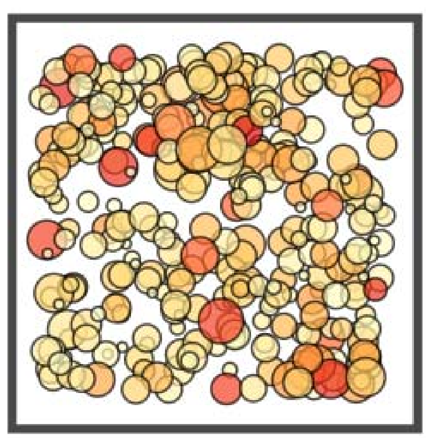
Metrics

Loss of Load Probability

Average Event Duration

Average Maximum Shortfall

Visualization



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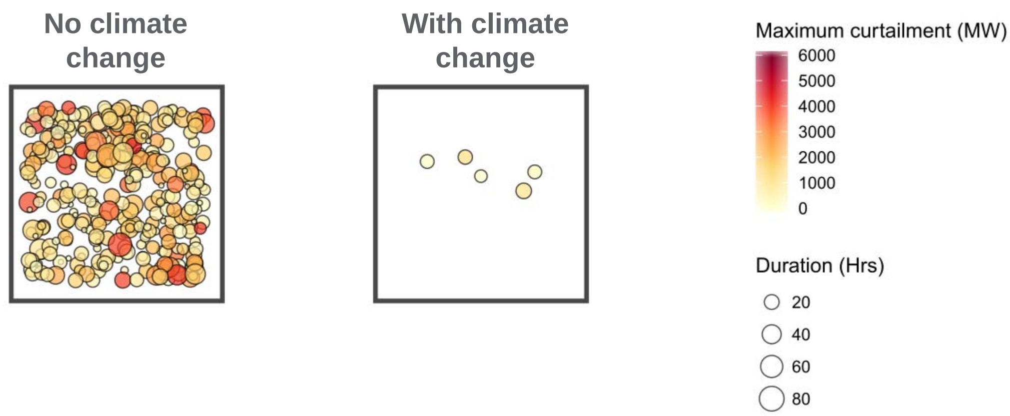
Climate change **reduces** winter shortfall risk...



Simulated winter shortfalls

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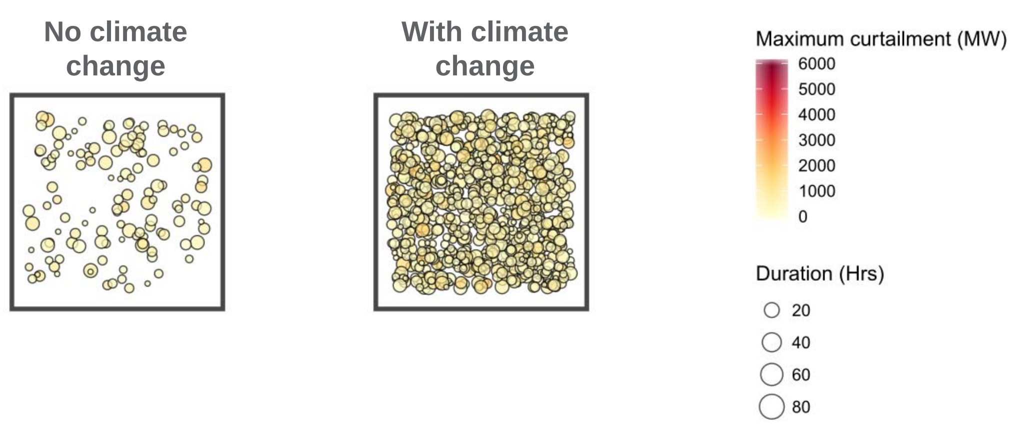
... but increases frequency of **summer shortfall**



Simulated summer shortfalls

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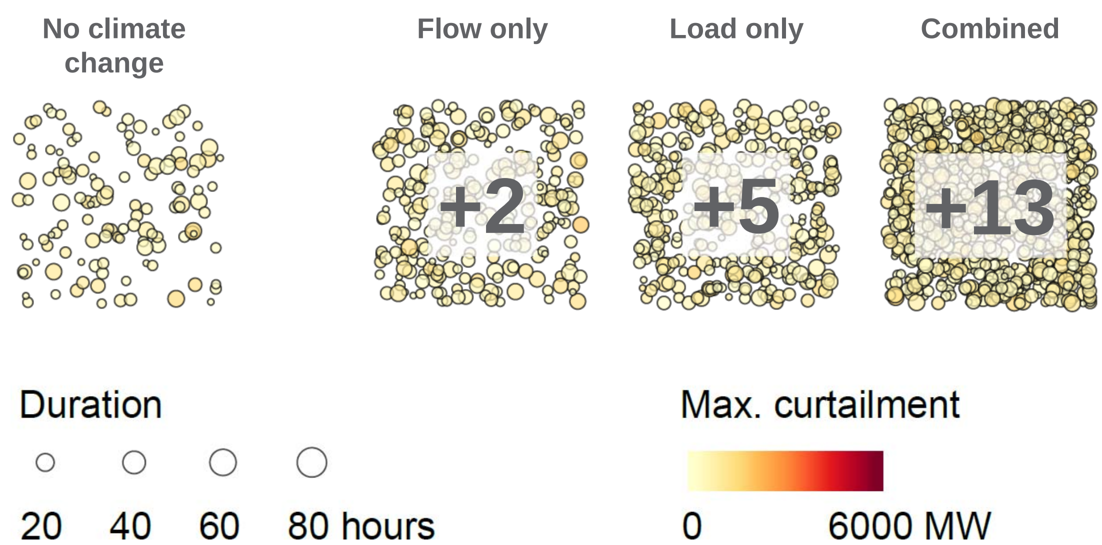
Summer risk is **compounded** by combined climate impacts on **hydropower** and **loads**



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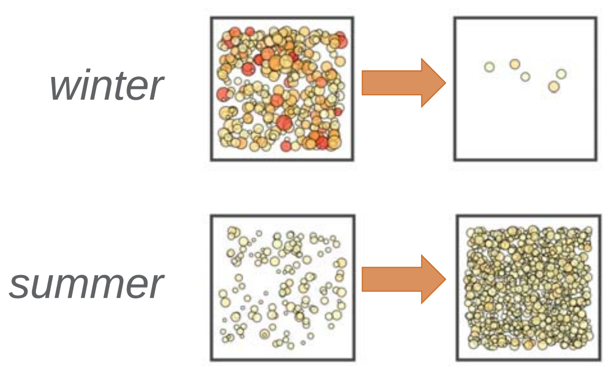
Conclusion: Planning assessments need to consider many climate impacts simultaneously



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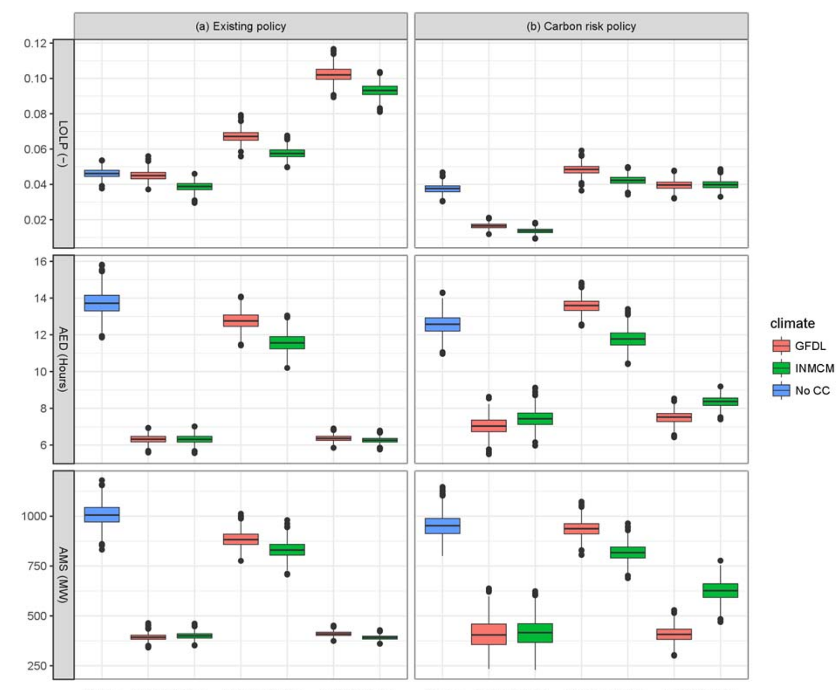
Additional information…

System performance metrics



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System performance metrics

	Current climate	*Loads only*	*Hydro only*	Combined impacts	*Loads only*	*Hydro only*	Combined impacts
LOLP (%)	4.6	*4.5*	*6.7*	10.2	*3.9*	*5.8*	9.3
EUE (MWh)	1192	*170*	*1497*	370	*136*	*1115*	337
LOLH (Hr)	1.04	*0.46*	*1.45*	0.97	*0.37*	*1.10*	0.92
AMS (MW)	1009	*393*	*886*	409	*400*	*829*	391
AED (Hr)	13.8	*6.3*	*12.8*	6.4	*6.3*	*11.6*	6.3

(b) Carbon risk resource expansion policy

		GFDL-ESM2M			INMCM4		
	Current climate	*Loads only*	*Hydro only*	Combined impacts	*Loads only*	*Hydro only*	Combined impacts
LOLP (%)	3.8	*1.6*	*4.8*	4.0	*1.4*	*4.2*	4.0
EUE (MWh)	1007	*84*	*1299*	213	*65*	*1098*	389
LOLH (Hr)	0.93	*0.19*	*1.30*	0.47	*0.15*	*1.16*	0.62
AMS (MW)	952	*415*	*935*	410	*424*	*816*	628
AED (Hr)	12.6	*7.0*	*13.6*	7.5	*7.4*	*11.8*	8.37