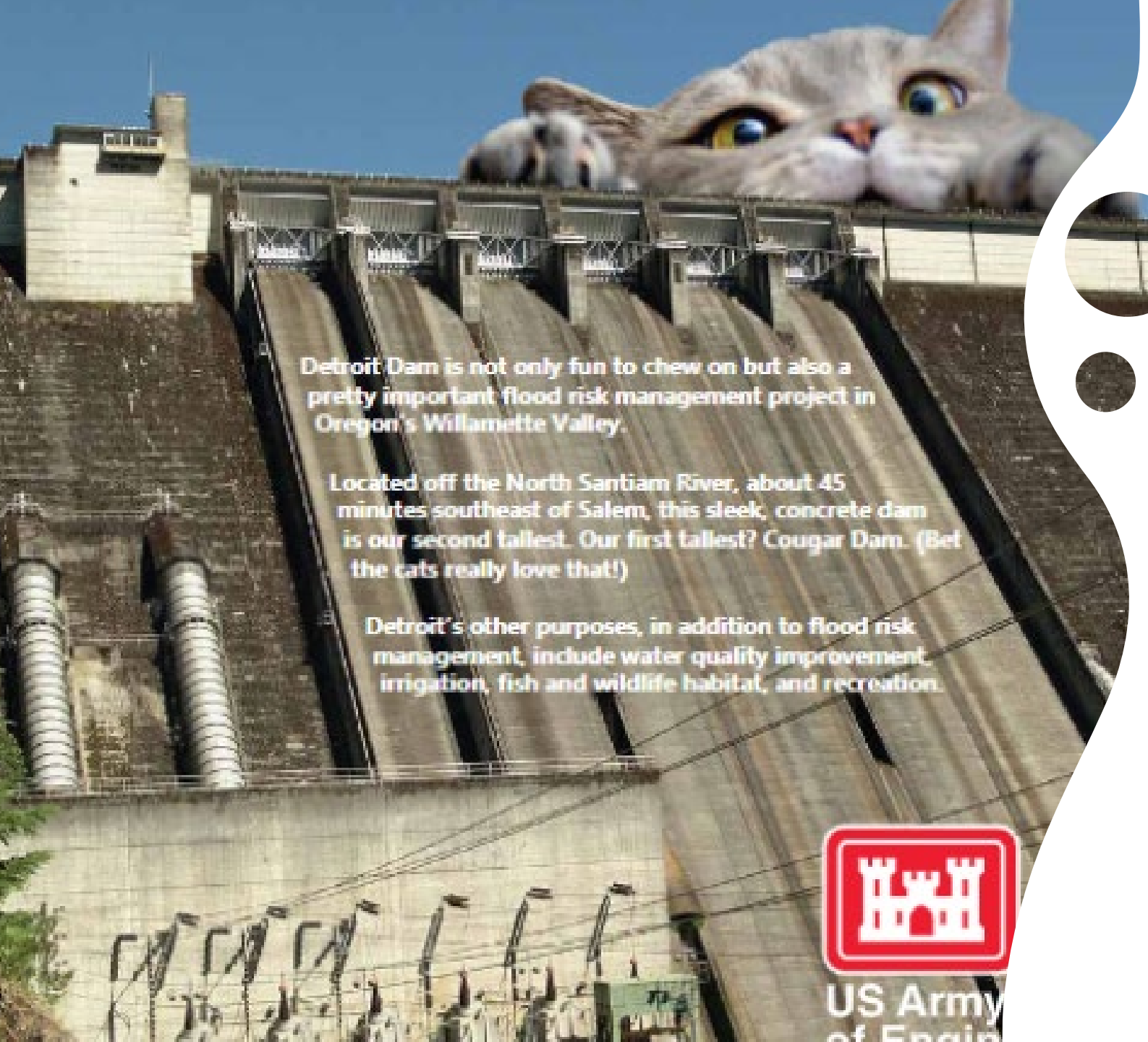


Hydropower and Grid Reliability

NASEO

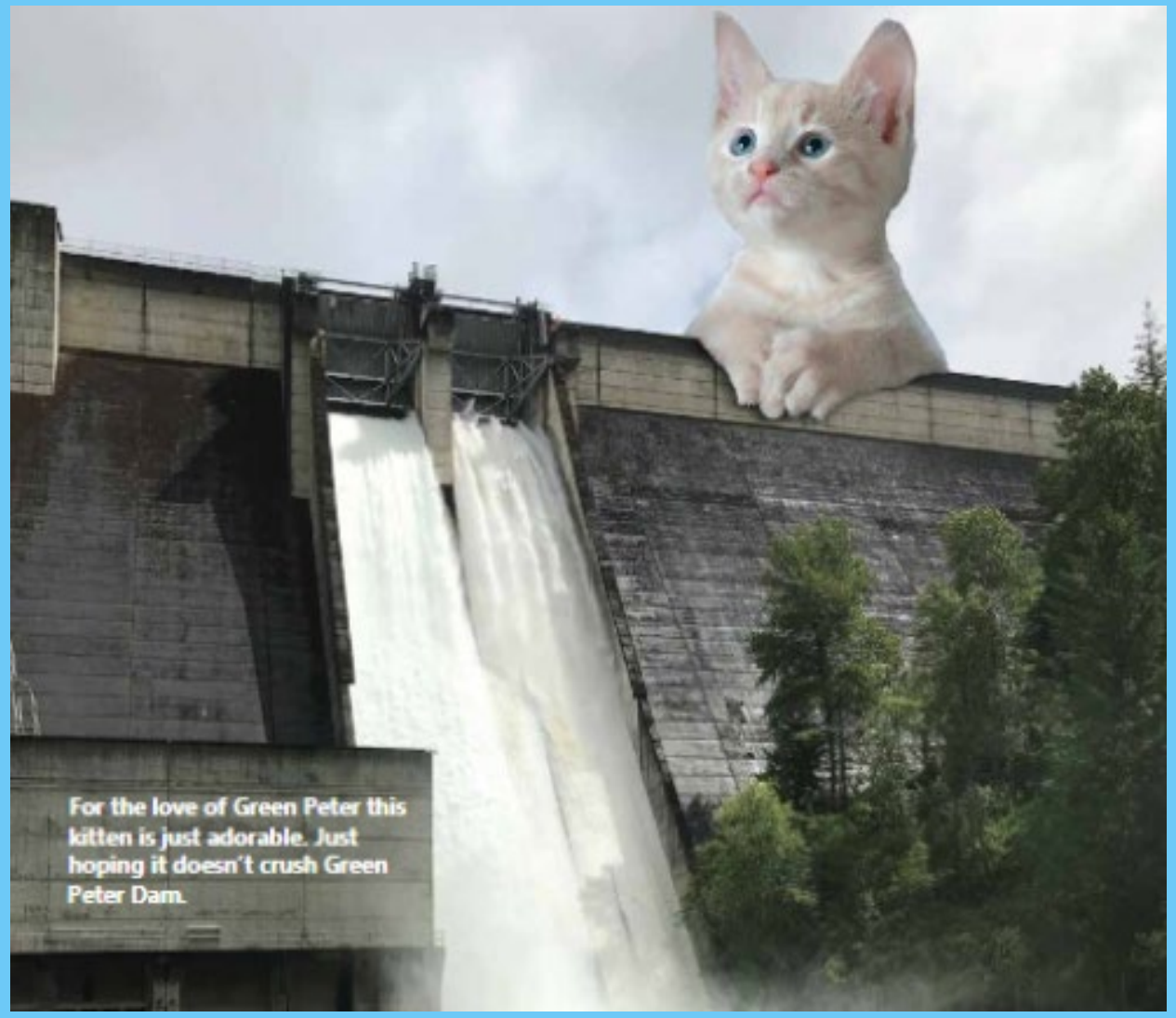
February 9, 2023

Alan Zelenka

Assistant Director for P&I

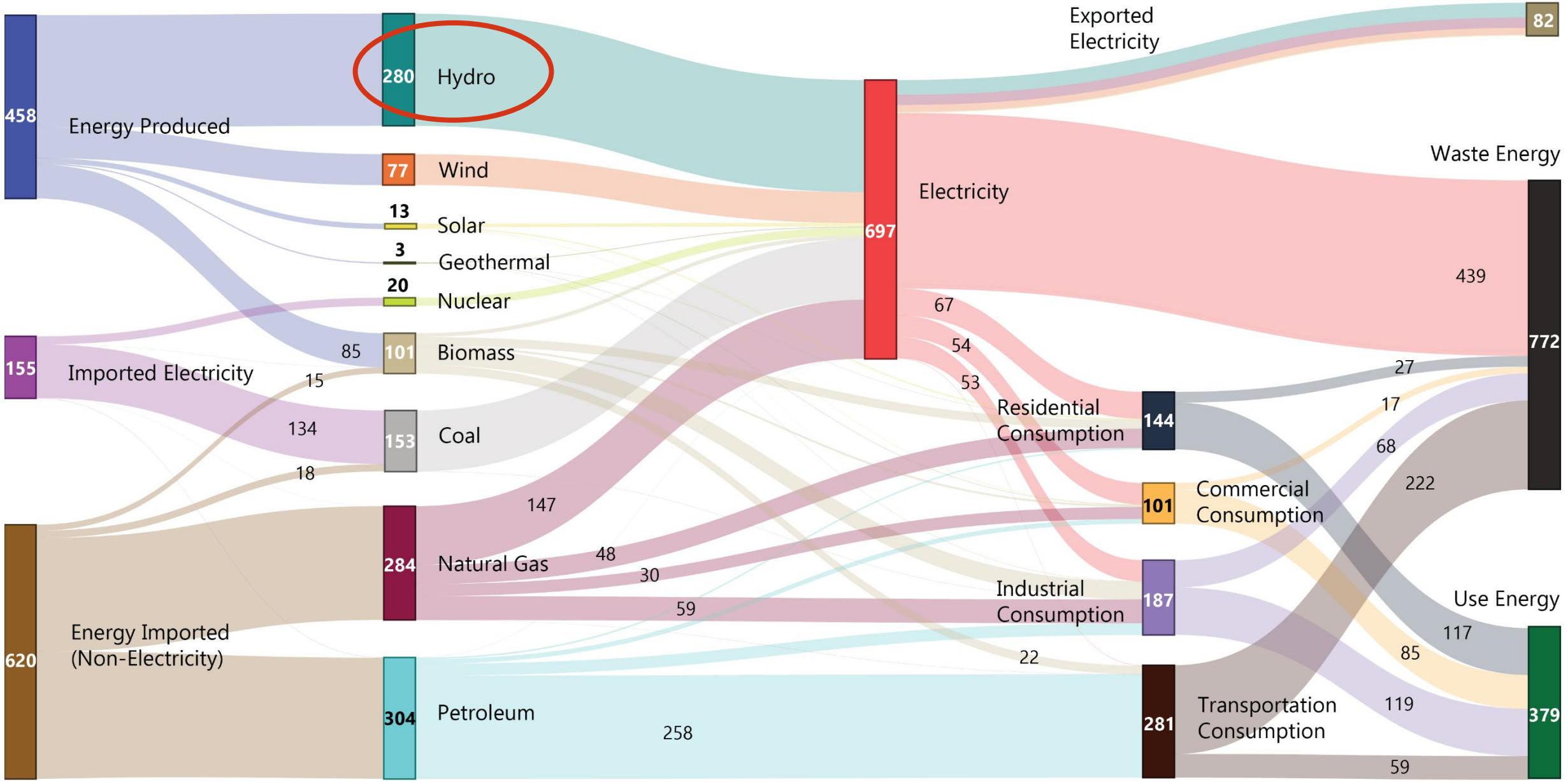
OREGON DEPARTMENT OF ENERGY

PNW has a lots of Hydropower



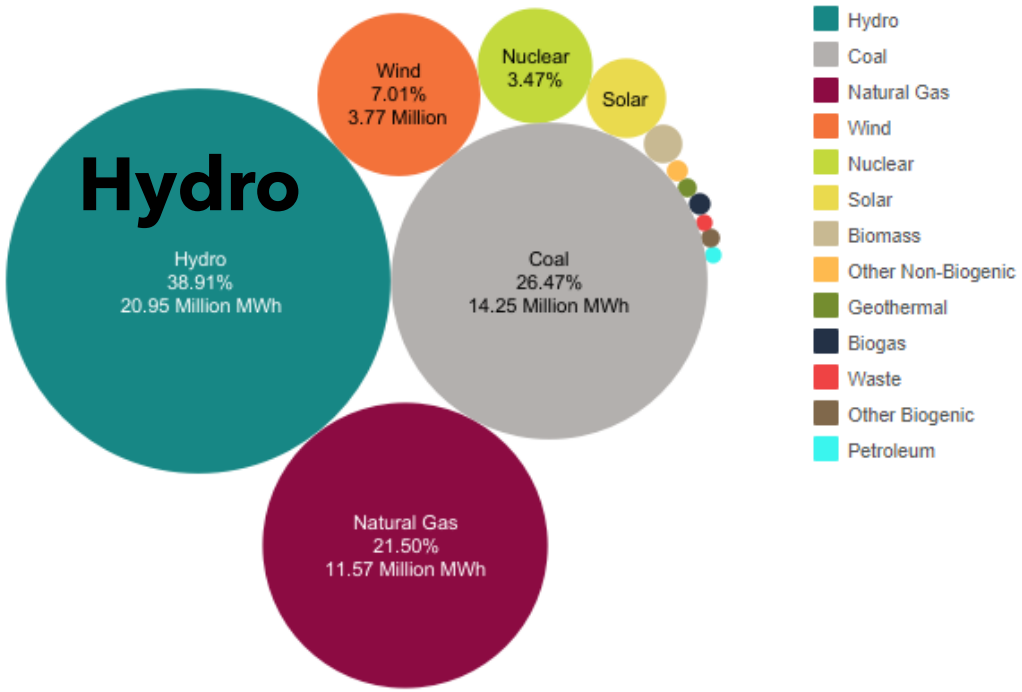
https://usace.contentdm.oclc.org/digital/collection/p16021coll11/id/5869/rec/1

Oregon's Energy Flow (ALL forms of energy)

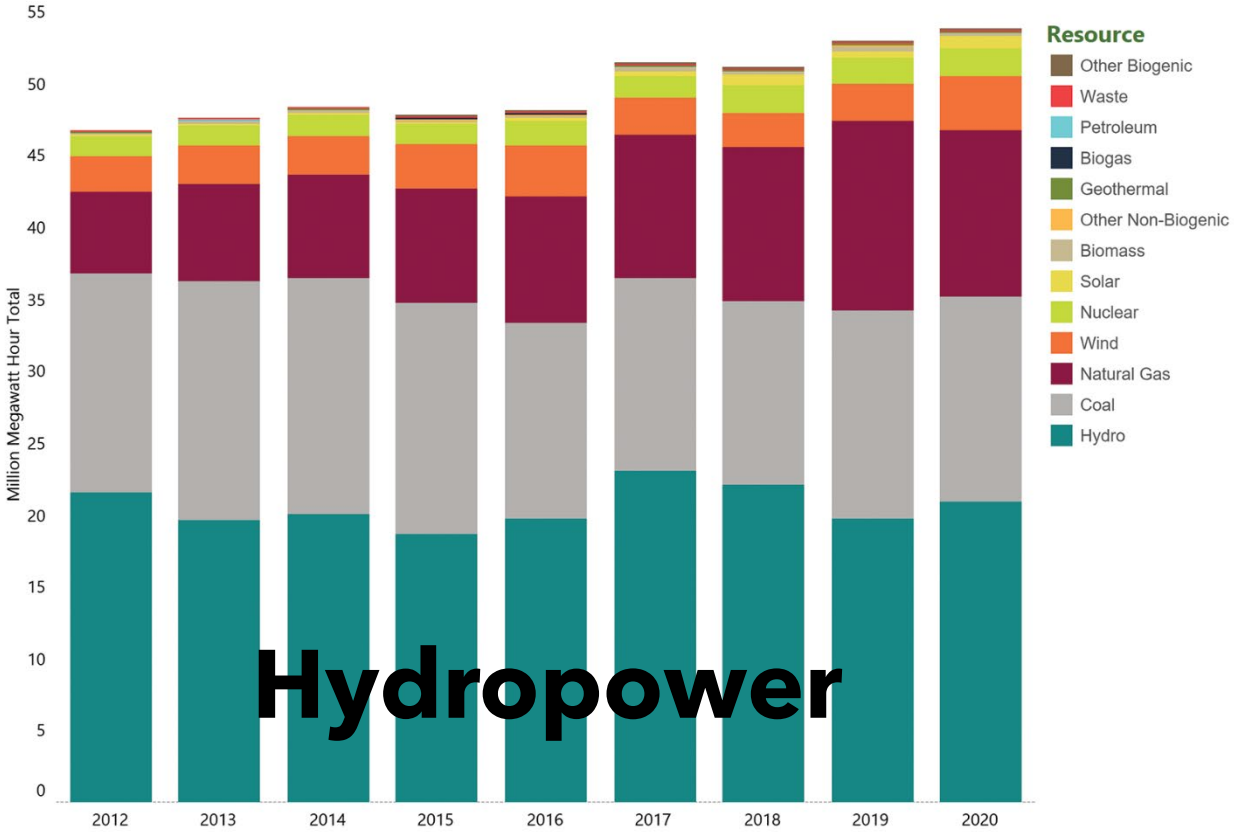


Numbers are in trillions of British thermal units (Btus)

Resources Used to Generate Oregon's Electricity (2020)



Resources Used to Generate Oregon's Electricity Over Time



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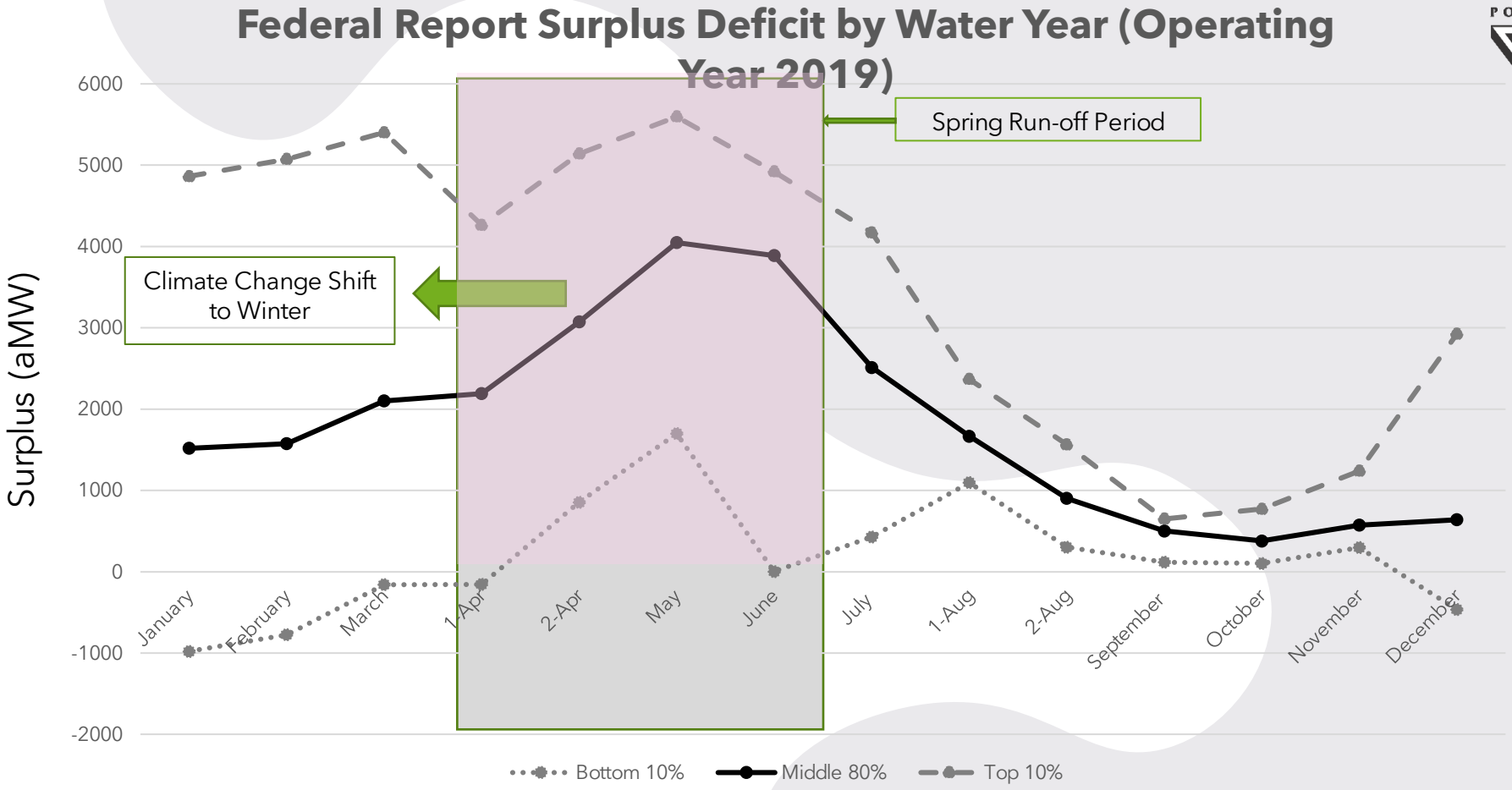
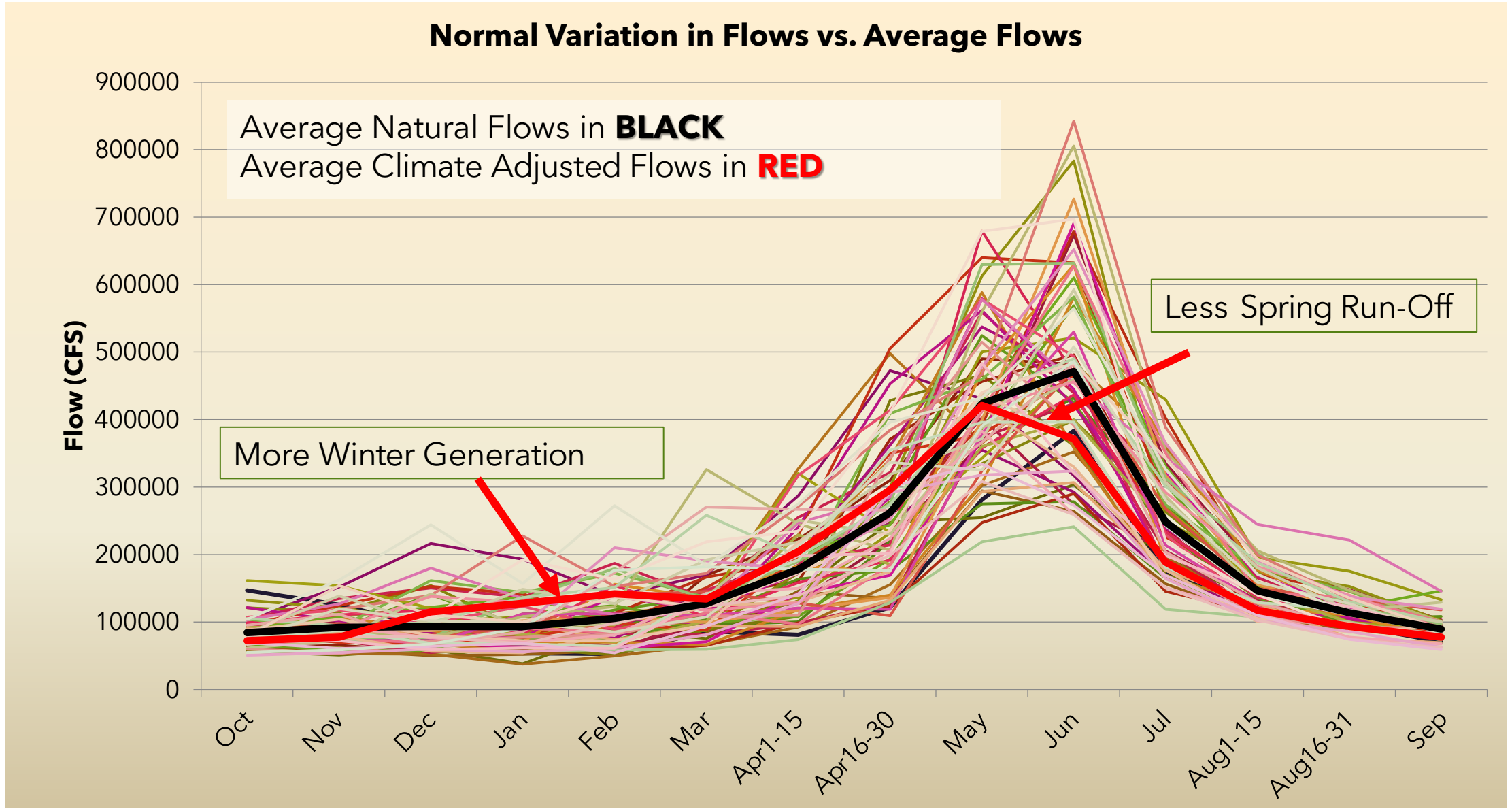
2022 BER - Energy by the Numbers | Pages 11-12

FCRPS Surplus Deficit by Water Year



https://www.bpa.gov/p/Generation/White-Book/wb/2017-WBK-Loads-and-Resources-Summary-20171218.pdf
(Exhibit 4-5: 80-Water Conditions Monthly Energy, data on p. 64)

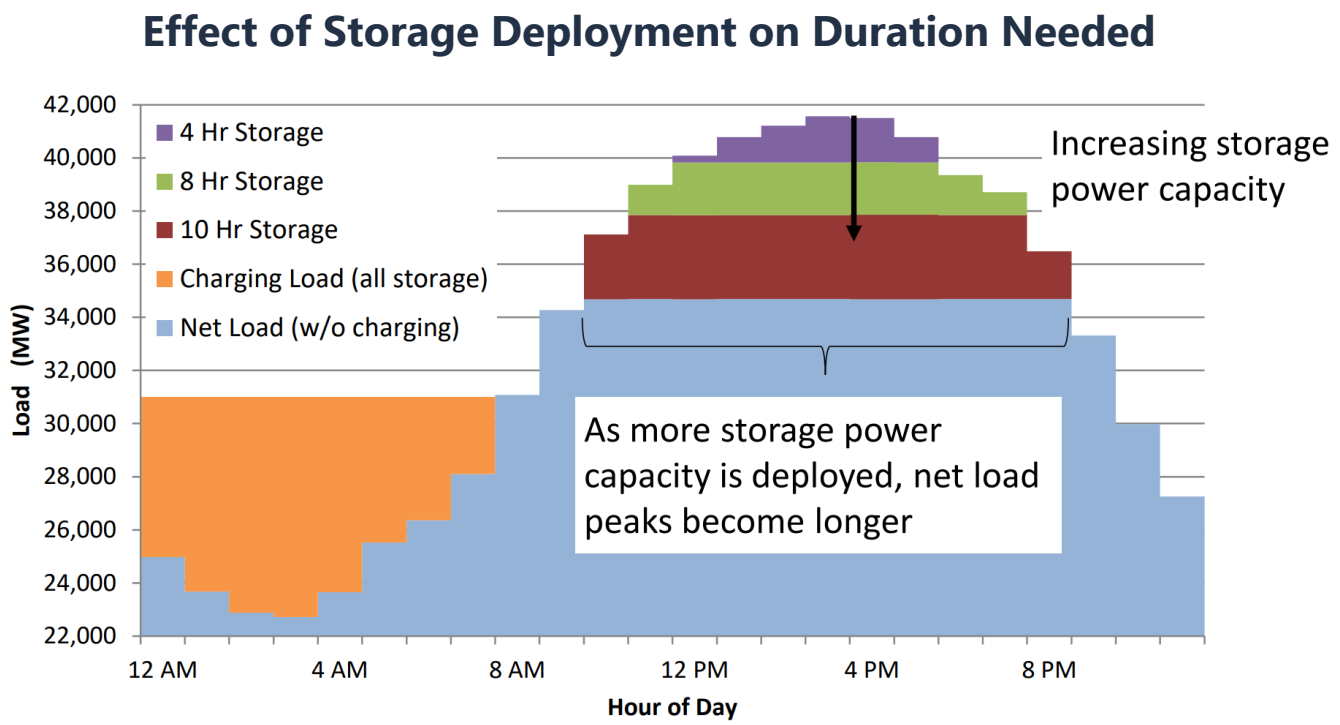
Seasonal Challenges in the Pacific NW



Long-Duration Energy Storage

Storage Type	Primary Technology	Economical Duration of Max Output
Standard storage	Lithium-ion batteries	2-hour, 4-hour, 6-hour
Long-duration energy storage	Pumped-storage hydro, hydrogen, flow batteries, gravity storage, compressed air, derated lithium-ion batteries, etc.	10- to 100-hour
Seasonal storage	TBD – hydrogen a likely candidate	More than 100-hour

- Considering **potential needs** for long-duration energy storage
- What **technologies** could provide LDES?
  - Novel battery technologies
  - Stacked 'short-duration' batteries
  - Pumped hydro storage
  - Renewable hydrogen
- **Next steps**:
  - Innovation and cost reduction
  - USDOE Long Duration Storage Shot



Electricity Storage

The most common types of electricity storage used in the U.S. are **batteries**, a type of electrochemical storage, and **pumped hydropower**, a types of mechanical storage. It requires energy to convert electricity into another form of energy for storage, and all forms of potential energy are subject to natural processes that slowly reduce the amount of energy stored.

Storage Form	Storage Type	Power (MW)*	Discharge Time	Energy Density (Watt-hour /Liter)	Maximum Lifetime	Efficiency
Mechanical	Pumped Hydropower	100 - 1000	4 - 12 hours	0.2 - 2	30 - 60 years	70 - 85%
	Flywheels	0.001 - 1	10 – 20 milliseconds	20 - 80	20K - 100K cycles	70 - 95%
	Compressed Air	10 - 1000	2 – 30 hours	2 - 6	20 - 40 years	40 - 75%
Electro-chemical	Lithium-Ion Batteries	0.1 - 100	1 min - 12 hours	200 - 400	1000 - 10,000 cycles	85 - 98%
	Flow Cell Batteries	1 - 100	2 – 10 hours	20 - 70	12,000 - 14,000 cycles	60 - 85%
Chemical	Hydrogen	0.01 - 1	mins - weeks	600 (at 200 bar)	5 - 30 years	25 - 45%
Thermal	Molten Salt	1 - 150	hours	70 - 210	30 years	80 - 90%

** Power rating is based on typical storage devices today. Devices like batteries and physical mediums like hydrogen are easily scalable, meaning a particular site may have a much higher power rating.*

There are no existing pumped hydropower systems in Oregon, but there are two proposed sites at
different stages of permitting and development.

Global demand for batteries is expected to grow rapidly in the next decade, and lithium-ion batteries will likely dominate the storage market through 2025.

2022 BER - Technology & Resource Reviews | Pages 46-48

Malcom Woolf - President and CEO National Hydropower Association

- Former chair of the NASEO
- Maryland Energy Administration and energy advisor to Governor Martin O'Malley
- Legislative package reducing carbon emissions by 30% saving over $8 billion
- His renewables project, Harvard's JFK School designated as "one of the top 25 innovations in American government"
- Led policy advocacy for renewables at Advanced Energy Economy (AEE) in Virginia
- Director of the National Governors Association's Natural Resources Committee
- Counsel to the U.S. Senate Environment and Public Works Committee
- Senior attorney with the U.S. Environmental Protection Agency
- Law degree and Masters in Public Administration from University of Virginia
- B.A. magna cum laude from Tufts University

GRID RELIABILITY AND HYDROPOWER
NASEO 2023 ENERGY POLICY OUTLOOK

NATIONAL HYDROPOWER ASSOCIATION

NASEO
National Association of State Energy Officials

The New York Times

California Leaders Credit Cellphone Alert for Sudden Conservation

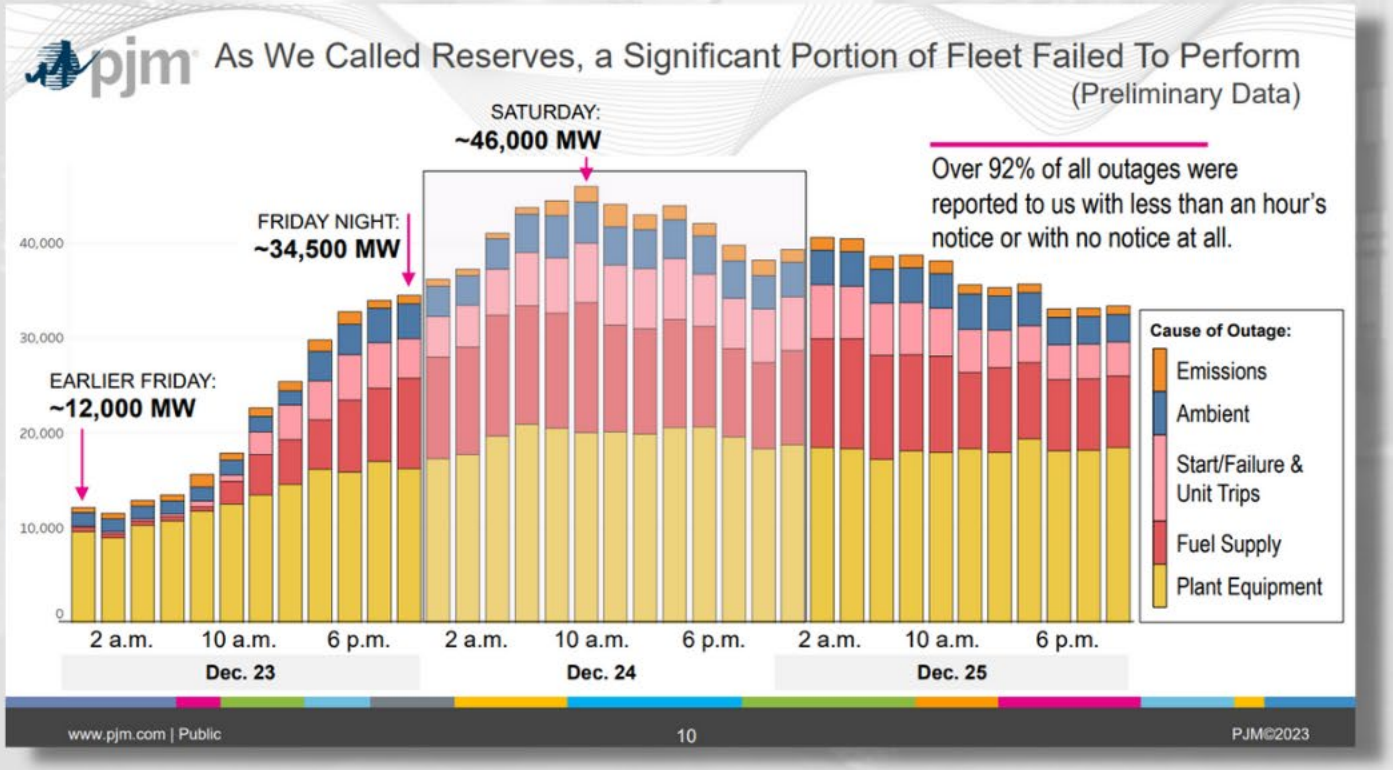
The jarring message warned millions of residents that blackouts could occur without immediate action.

Give this article 4

Power lines in Cathedral City, Calif., during the heat wave on Tuesday. Alex Welsh for The New York Times

CASE STUDY 1: CALIFORNIA'S ENERGY GRID CRISIS

CASE STUDY 2: PJM & THE POLAR VORTEX



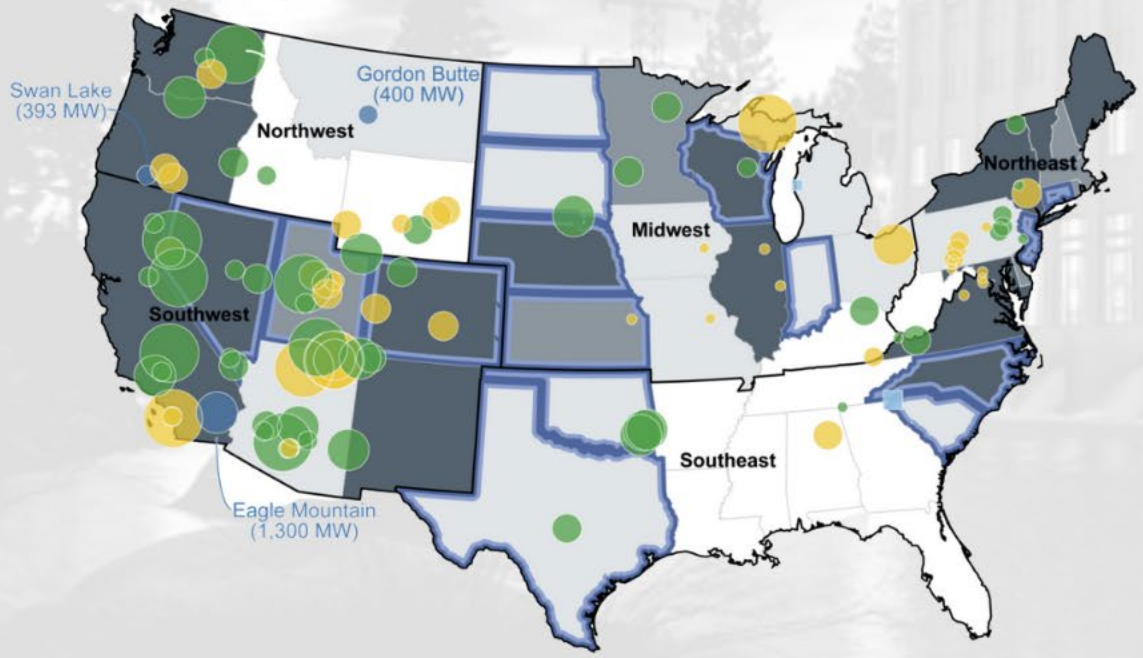
- PJM – Dec 24th: Polar Vortex
- PJM lost 46,000 MWs of generation
- Hydro asked to keep generating past midnight
- Moreover, PSH asked not to pump water to reduce load
- To my knowledge, little or none of 45 GW were hydro

STATE OF THE U.S. HYDROPOWER INDUSTRY IS STRONG

- Over 6% of all electricity generated
- 31% of U.S. renewable energy
- 94% of current U.S. electricity storage capacity
- 80 GW of hydropower capacity
- 22 GW of pumped storage hydropower capacity

HYDROPOWER IS POISED FOR GROWTH

US Pumped Storage Development Pipeline 2022



Stage of PSH Development

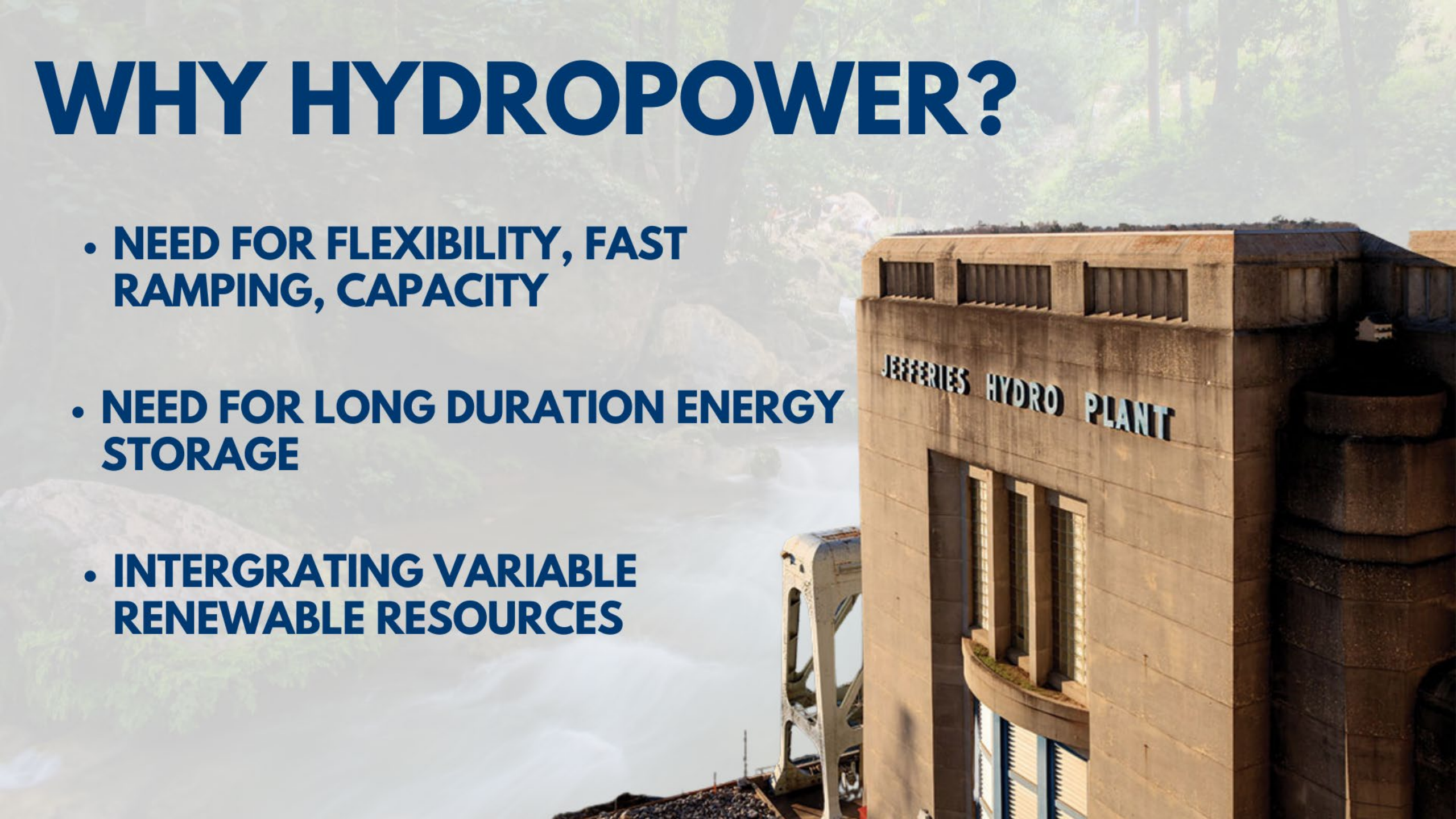
- Pending Preliminary Permit*
- Issued Preliminary Permit*
- Pending License**
- Issued License**
- Under Construction

- **3 Pumped Storage Hydropower projects fully licensed for construction**
- **At the end of 2021, 130 new hydropower projects with a combined capacity of 1,500 MW were in the development pipeline; non-powered dam retrofits accounted for 96%**

NHA

WHY HYDROPOWER?

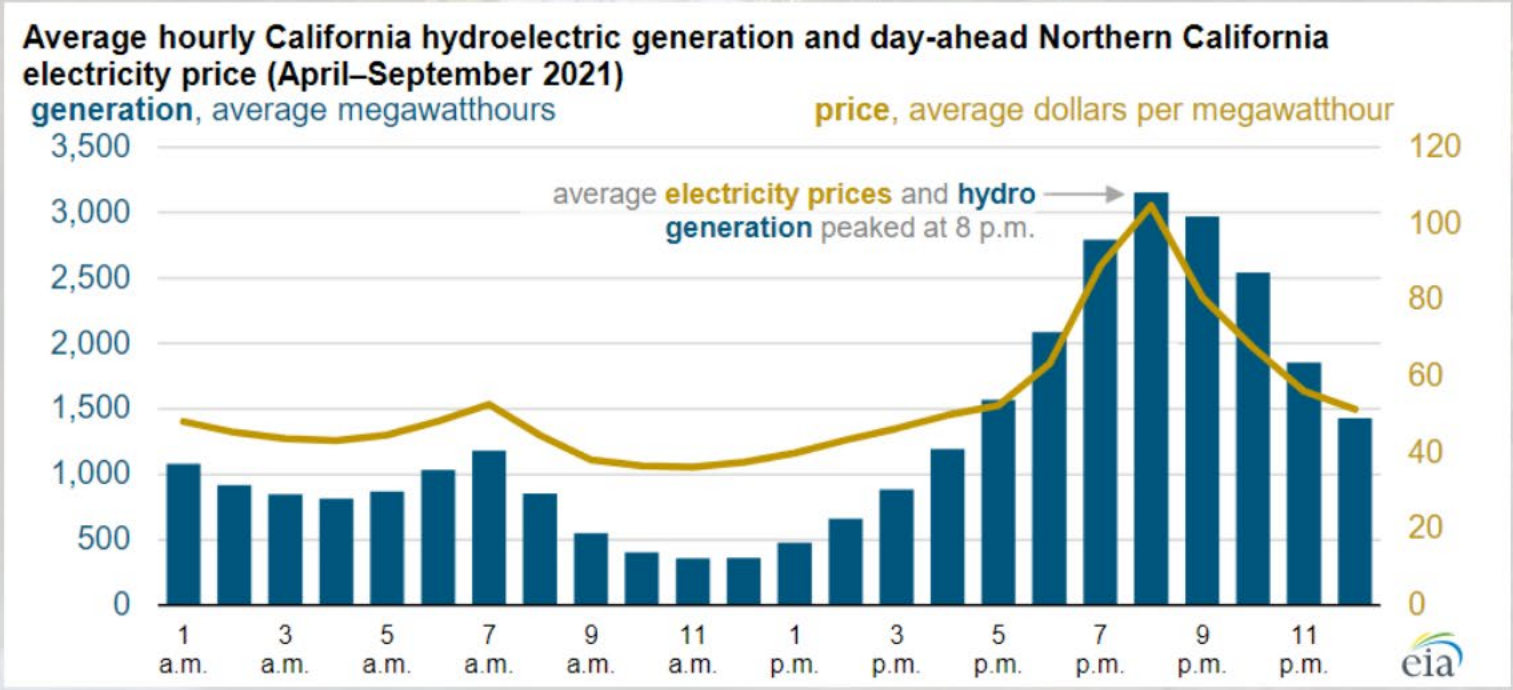
- NEED FOR FLEXIBILITY, FAST RAMPING, CAPACITY
- NEED FOR LONG DURATION ENERGY STORAGE
- INTERGRATING VARIABLE RENEWABLE RESOURCES



HYDROPOWER & RELIABILITY

Even during drought, hydro is still there when we need it the most.

The overall western hydropower fleet sustains about four-fifths of the average power generation during severe droughts.



UNCOMMON DIALOGUE

"U.S. Hydropower: Climate Solution and Conservation Challenge"

NORTHWEST PUBLIC BROADCASTING | PBS | npr

Environmental And Energy Industry Groups Commit To Working Together On (Some) Hydro Projects

By Courtney Flatt

The New York Times

Environmentalists and Dam Operators, at War for Years, Start Making Peace

Facing a climate crisis, environmental groups and industry agree to work together to bolster hydropower while reducing harm from dams.

ENERGYWIRE

THE T

RENEWABLE ENERGY

DOE-backed hydro group launches to cut CO2

David Iaconangelo, E&E News reporter

Published: Wednesday, October 14, 2020

CLIMATE & ENVIRONMENT

Los Angeles Times

Can hydropower help solve the climate crisis? This $63-billion plan is banking on it

HYDROPOWER + RIVER + CLIMATE

CLEAN ENERGY GRID AT RISK DUE TO POTENTIAL WAVE OF RETIREMENTS

- Licenses for 459 hydropower facilities, representing 17 GWs, are set to expire by 2035.
- Relicensing takes, on average, 7.6 years to complete
- Projects of greater than 10 MW reporting licensing costs exceeding $1M, and projects more than 100 MW reporting cost around $10M or more
- Survey: 36.4% of hydropower industry asset owners said that they were "actively considering" decommissioning a facility

CURRENT CHALLENGES

Lack of Support for Existing Hydropower

Antiquated Licensing Process

Market Design Failures


QUESTIONS?