2024 EmPOWERing Our Community: Q&A Topics | October 2024

- Future Role of Natural Gas
- Lower Snake River Dams
- Next Generation Nuclear
- WA State Clean Energy Policies & Global CO2 Perspectives
- Rooftop Solar
- Benton PUD Rates & Finances

BENTON P·U·D

Thank you

BENTON P·U·D

Future Role of Natural Gas

Future Role of Natural Gas

Natural Gas in the Northwest

2024

Pacific Northwest Gas Market Outlook

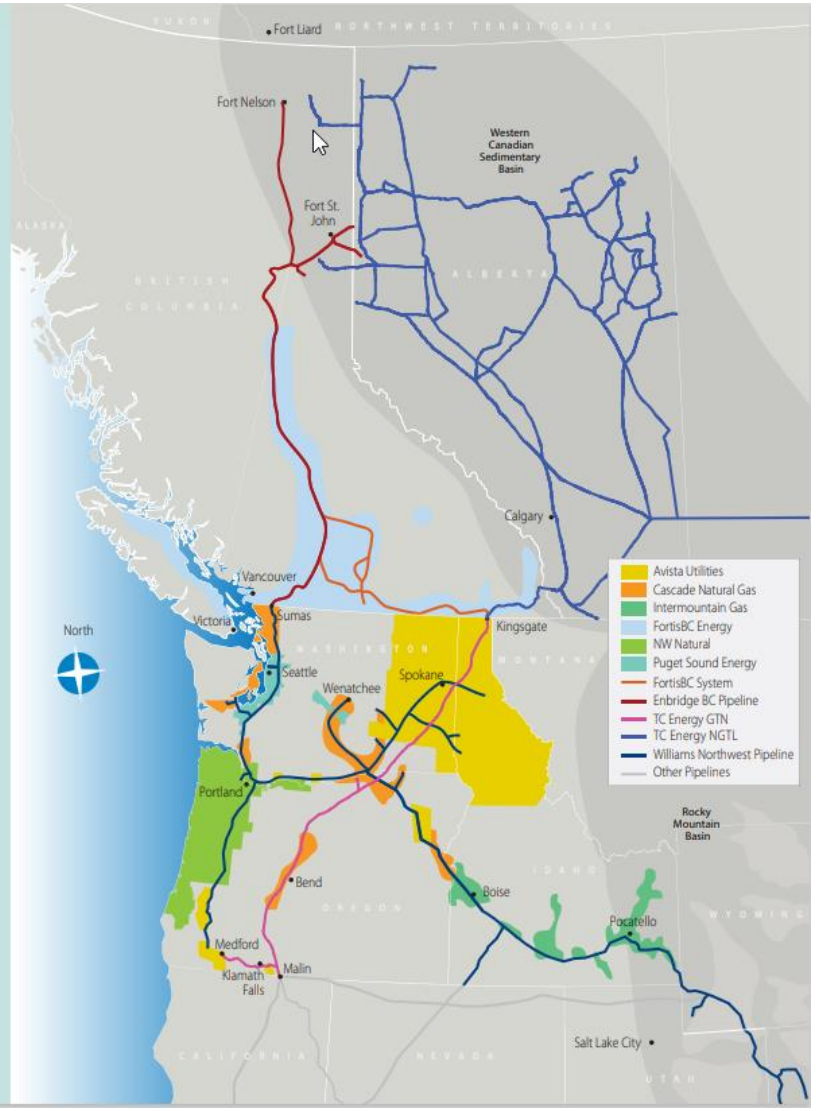
Natural Gas Supply, Prices, Demand and Infrastructure Projections through October 2033

This report, compiled by the Northwest Gas Association (NWGA), provides a consensus industry perspective on the current and projected natural gas supply, prices, demand and delivery capabilities in the Pacific Northwest through the 2032/33 heating year (Nov-Oct).

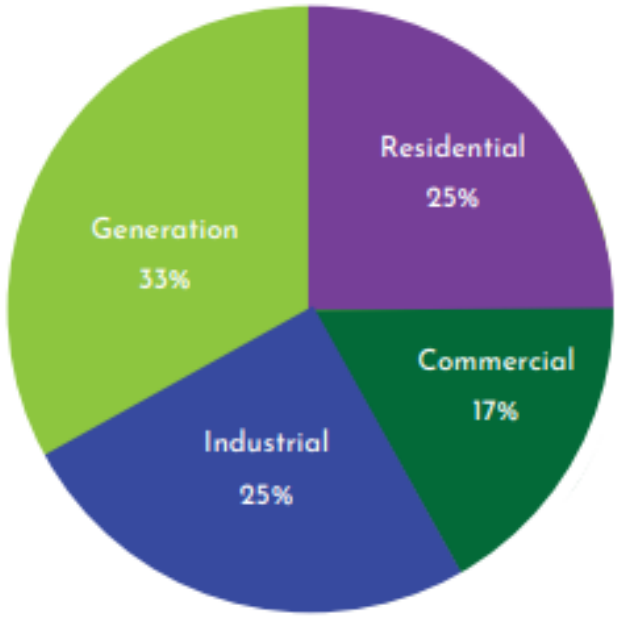
For purposes of this report, the Pacific Northwest includes British Columbia (BC), Idaho, Oregon and Washington.

Additional information can be found at www.nwga.org.

NWGA Northwest Gas Association



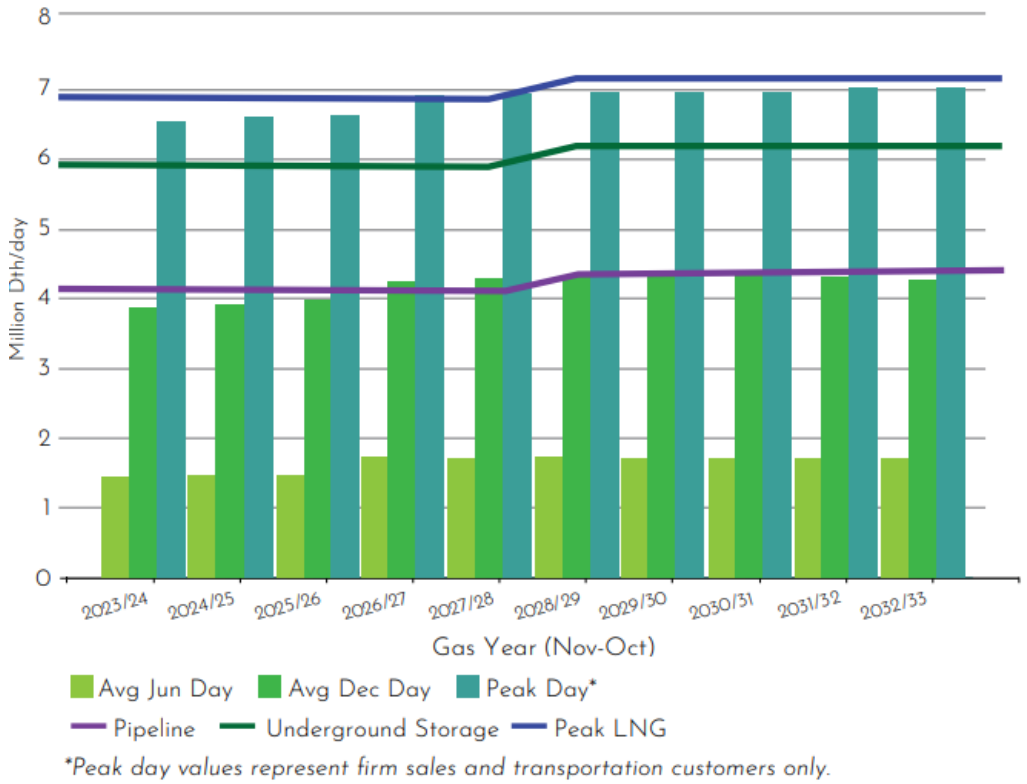
How Natural Gas is Used in the Pacific Northwest



More than half of the total energy consumed in the region — either used directly for space and water heat or in industrial processes, or as gas-generated electricity. (Excludes transportation uses.)

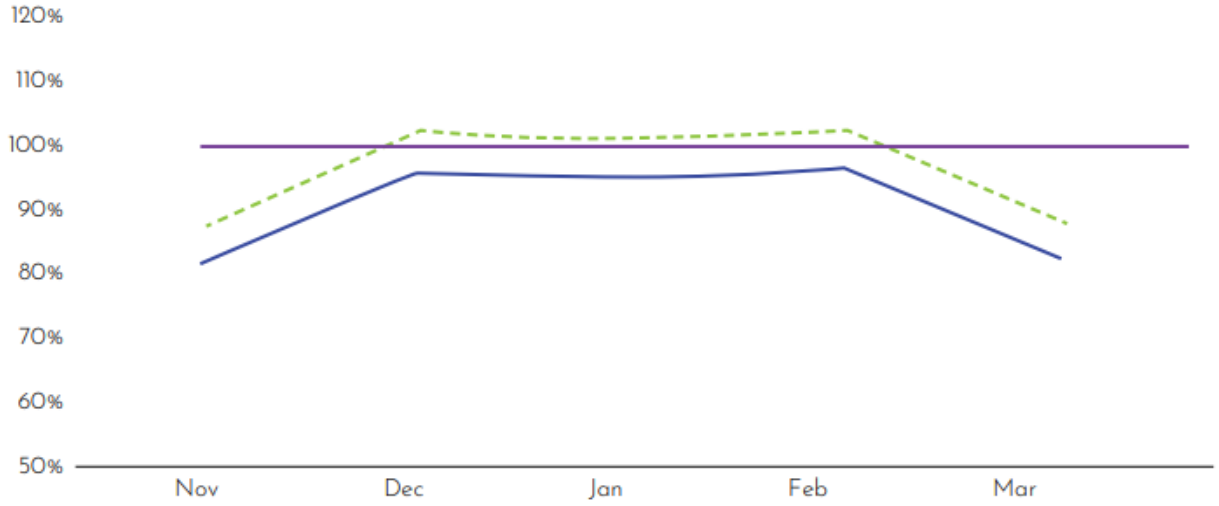
Natural Gas in the Northwest – Pipeline Capacity Maxed Out

FIGURE 11. Peak and Average Day Supply/Demand Balance



*Peak day values represent firm sales and transportation customers only.

FIGURE 12. Regional Pipeline Capacity Utilization



Note: *Historical utilization factors based on the average daily demand and pipeline supply capacity which does not include storage supply.*

"… the region's delivery system has very little excess capacity to serve peak loads, which can be challenging during an extended, region-wide, cold weather event…"

"The region's existing storage assets would not be able to make up the 90-day capacity deficiency if the region experiences a cold winter."

Natural Gas in the Northwest – Today & Future Forecast

FIGURE 6. Historic Regional Demand by Sector

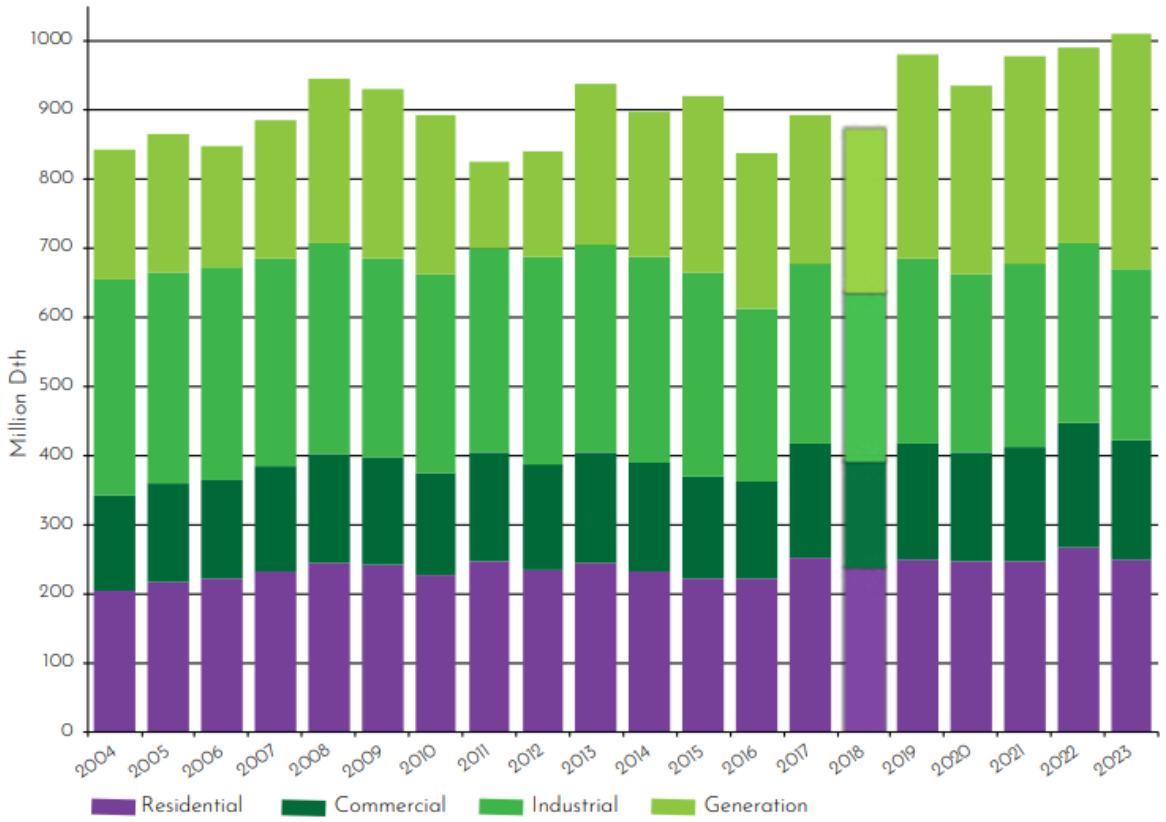
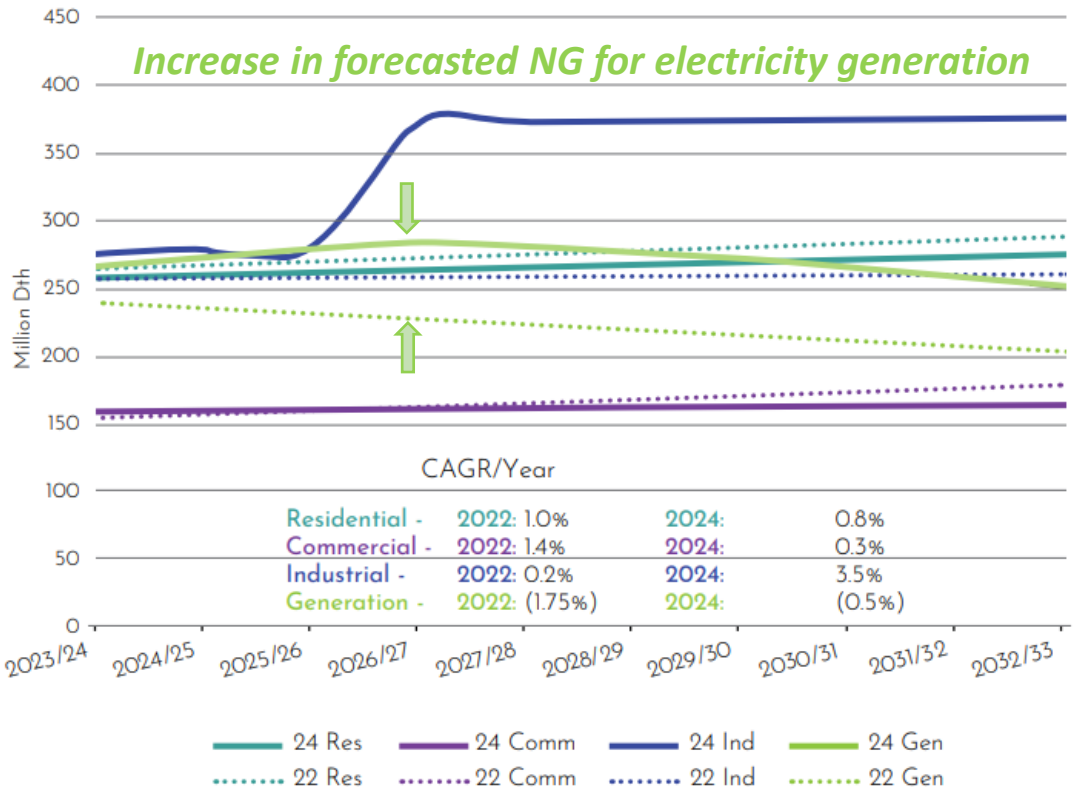


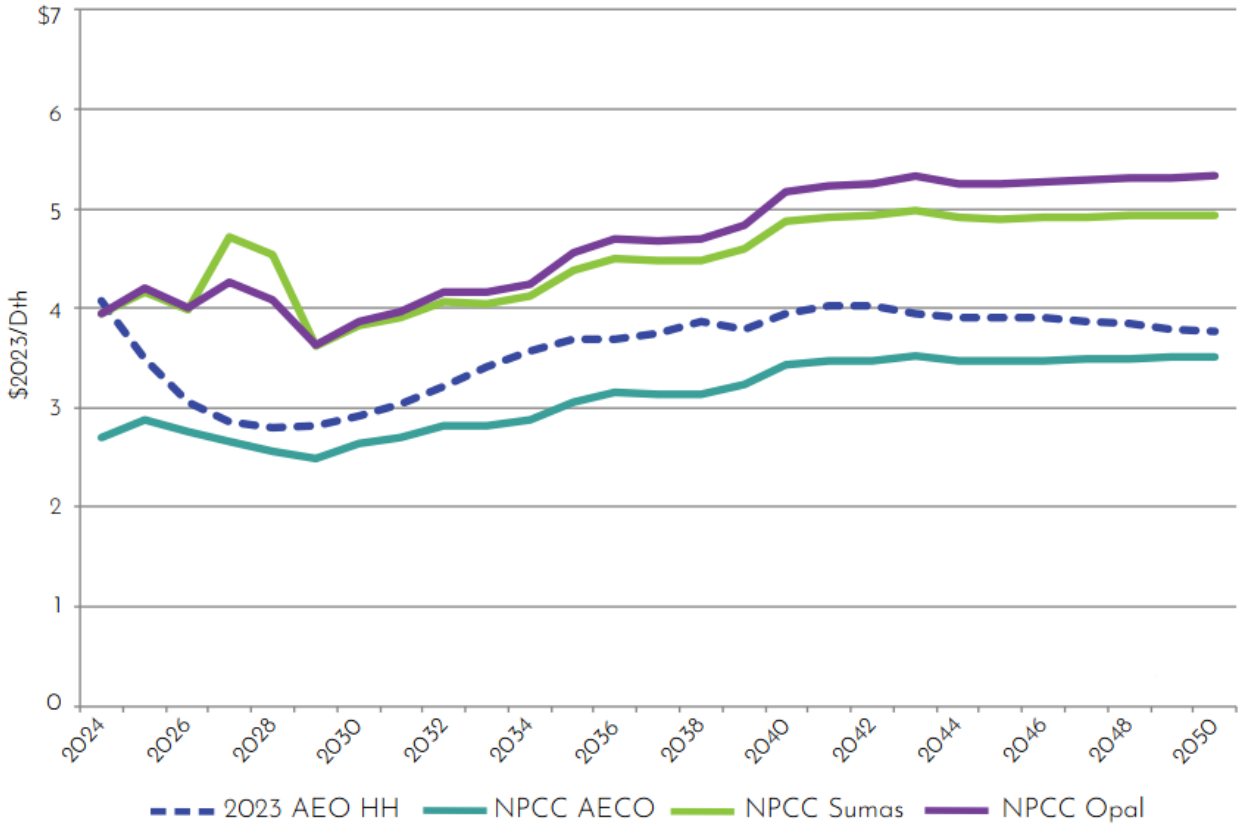
FIGURE 8. Expected Case Forecast by Economic Sector – 2022 to 2024 Comparison



- ✓ *replace power from decommissioned coal plants*
- ✓ *balance intermittent renewable sources*

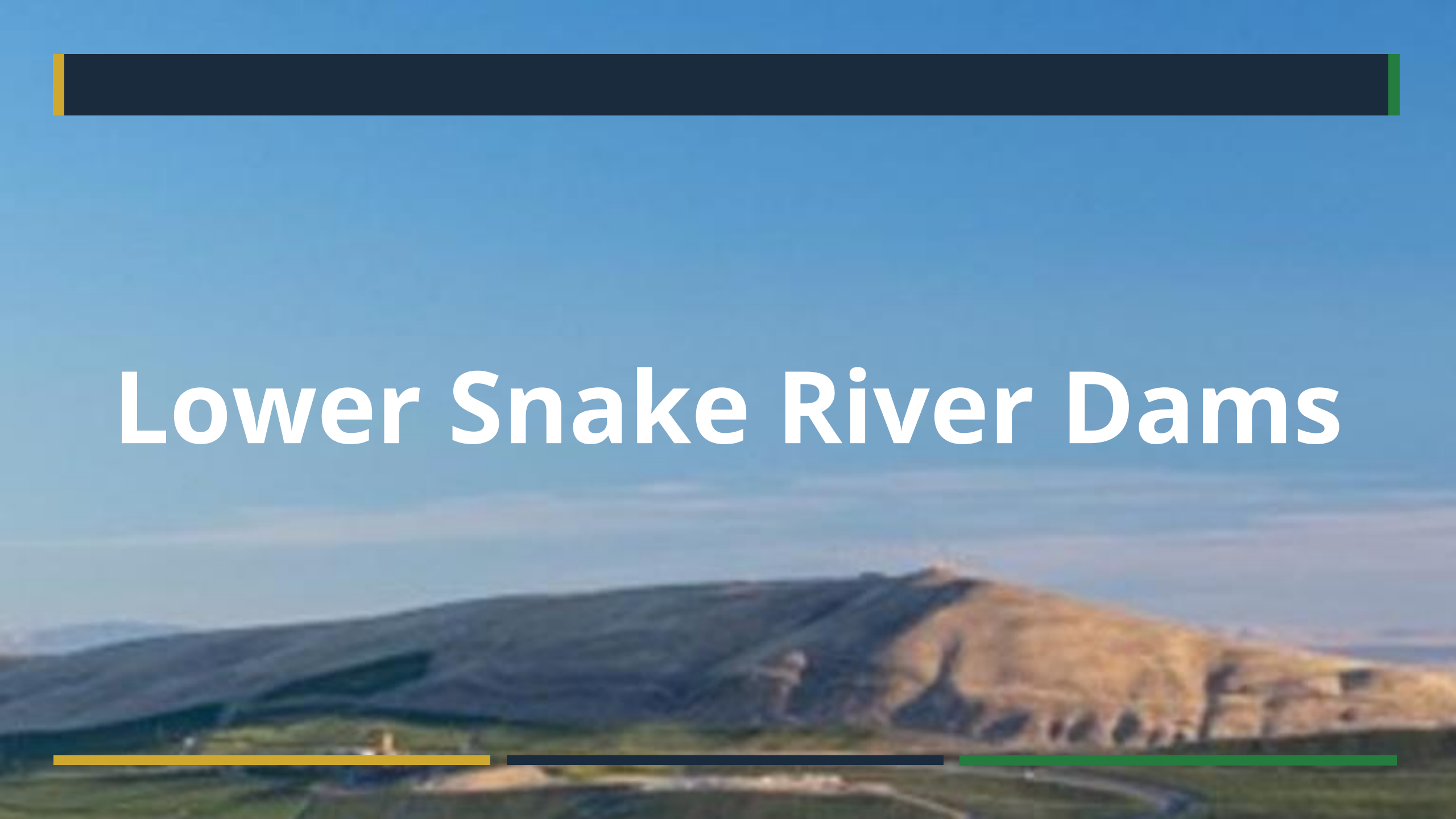
Natural Gas in the Northwest – Price Forecast

FIGURE 4. Natural Gas Price Forecast Comparisons



Sources: *EIA 2023 Annual Energy Outlook; NPCC Fuel Price Forecast, December 2023 Update*

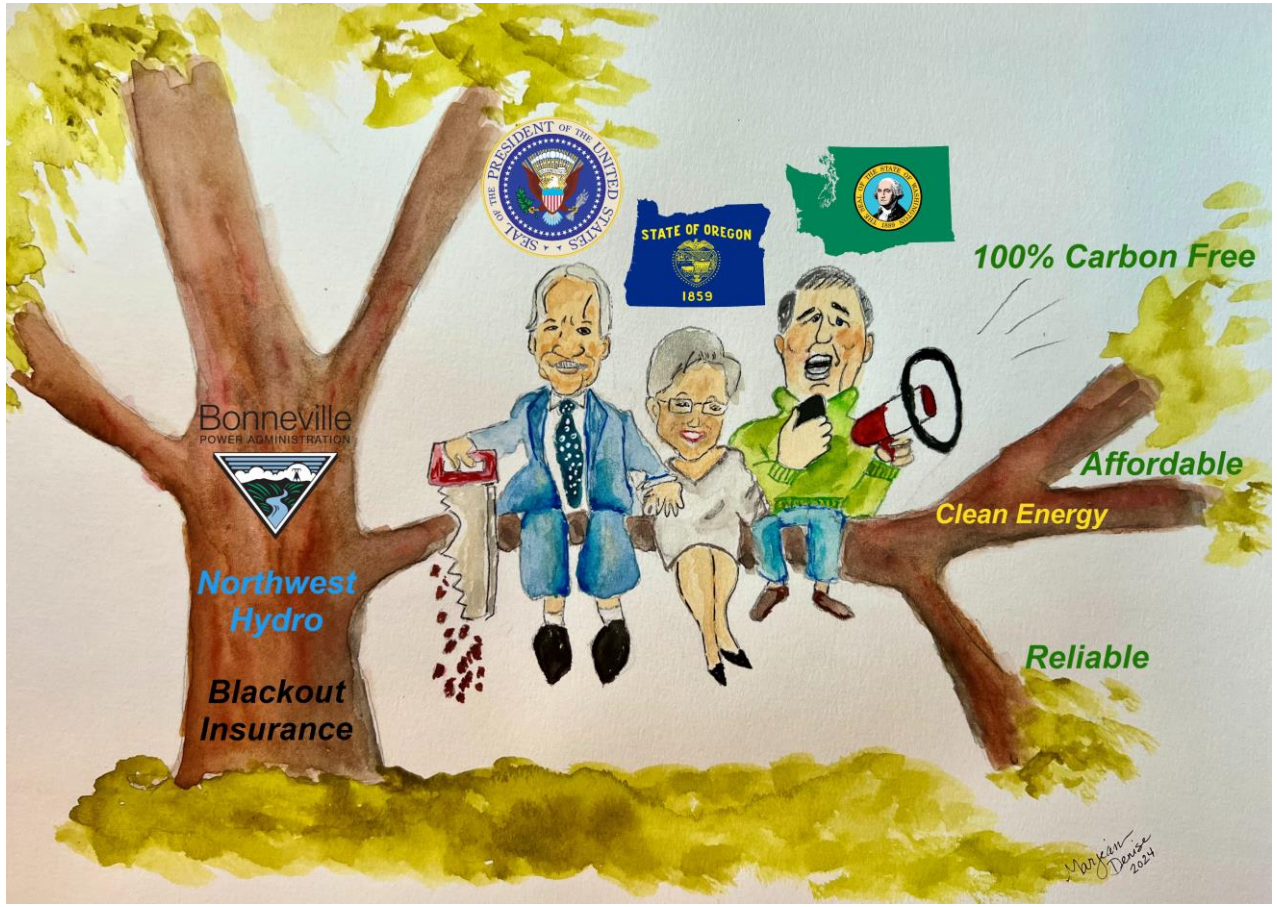
- ***Through 2024:** Regional gas prices will remain lower than Henry Hub (HH) prices, under the EIA's 2023 AEO forecast (dashed blue line in Figure 4).*
- ***After 2025: HH prices will drop below those of Sumas and Opal, reflecting the ongoing expectation for robust U.S. natural gas supplies throughout the forecast period (through 2033) and beyond.***
- ***HH prices will then slowly increase, per the EIA, driven by steady demand growth in the U.S. industrial (primarily LNG exports) and power generation sectors, but remain below those of Sumas and Opal.***



Lower Snake River Dams

Lower Snake River Dams

Lower Snake River Dam Breaching in the News



Sawing Off the Branch We're Sitting On and Deepening our Dependence on Northwest Hydro for 'Blackout Insurance'

Washington and Oregon have Teamed with the Federal Government to Undermine the Very Hydropower on Which 100% Clean Electricity Mandates were Based

RICK DUNN
JAN 13, 2024

- ✓ ***erosion of carbon-free hydroelectric generating capacity***
- ✓ ***risky and excessive spillway flows***
- ✓ ***broader than intended application of water temperature regulations included in the federal Clean Water Act***

DOE Studying LSRD Breaching Scenario

PNW Regional Energy Planning Project (PREPP)

GDO
GRID DEPLOYMENT OFFICE

Pacific Northwest
NATIONAL LABORATORY

PREPP will help regional utilities and energy planners optimize investments to address their individual needs most efficiently by:

- Allowing individual utility IRPs to contribute to and benefit from the regional study which can identify potential efficiency and optimization that could reduce overall costs and attract economic development.
- Exploring scenarios encompassing generation retirements, including coal plants, natural gas plants, and the potential for Lower Snake River Dam breaching, and the optimal resources capable of replacing those energy services.
- Finding ways to achieve enhanced reliability and resilience by including advanced modeling of extreme weather patterns, generation availability, increases in demand, and changing snowpacks and water flows.

BPA Hydropower: Foundation of Consumer-Owned Utility Supply

Bonneville
POWER ADMINISTRATION

Federal power marketer

- **31 hydroelectric dams**
- **Columbia Generating Station nuclear plant**

Consumer Owned Utilities & Hydropower

Customers	
Cooperatives	54
Municipalities	42
Public utility districts	28
Tribal utilities	3
Federal agencies	7
Investor-owned utilities	6
Direct-service utilities	1
Port districts	1
Total	142

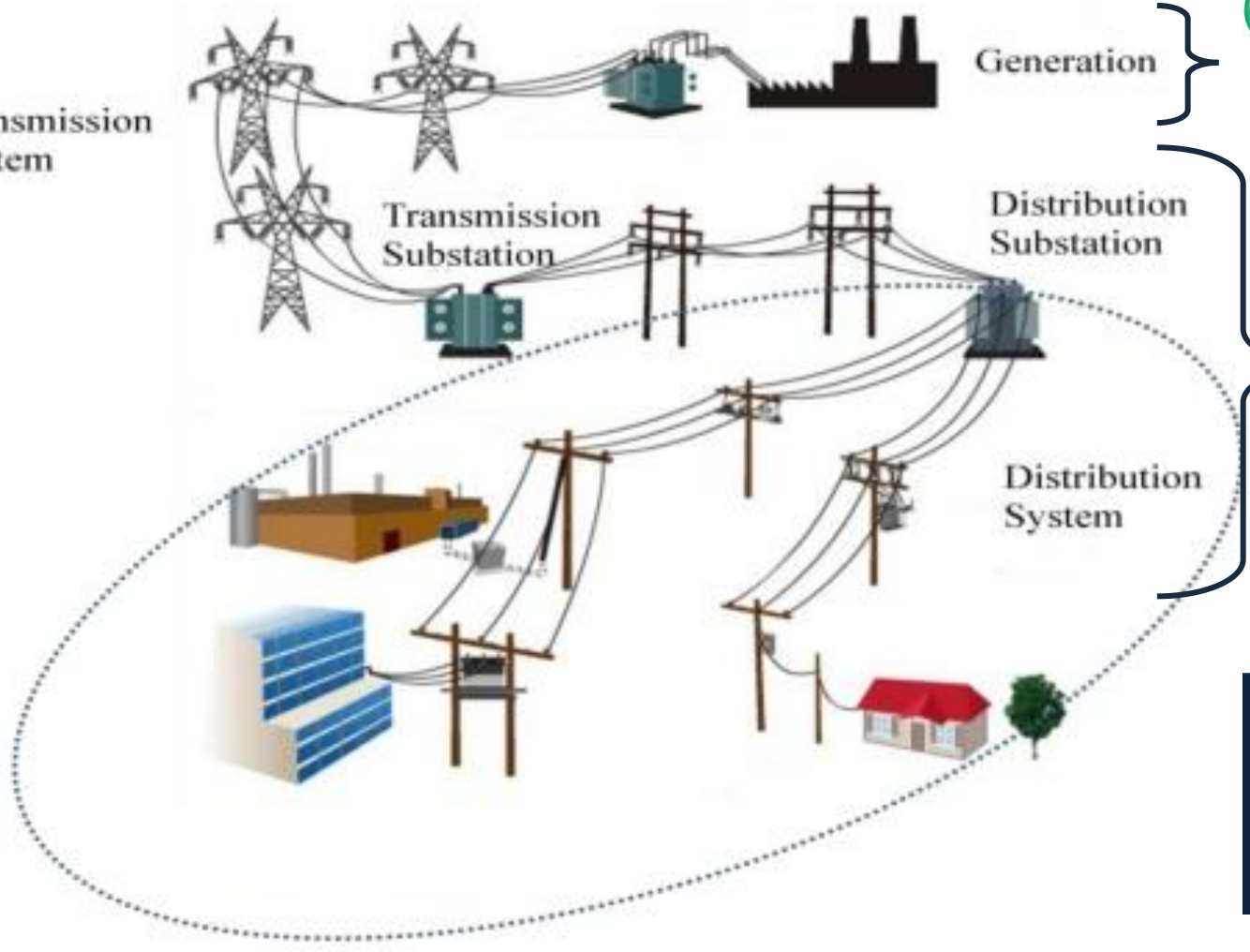
Consumer owned utilities **127**

Benton PUD is **1 of 6** consumer owned utilities in the Tri-Cities area

Consumer Owned Utilities Electricity Supply Chain

Bonneville Power Administration

Transmission System

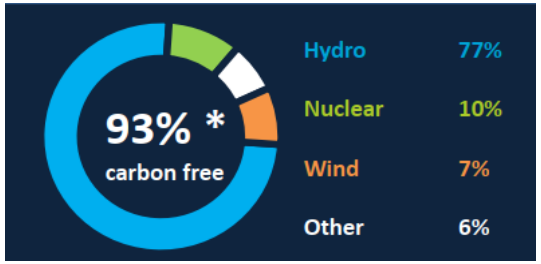


Energy Northwest

US Army Corps of Engineers

Bureau of Reclamation

Benton P.U.D



BPA Hydro: Firm Energy is Spoken For

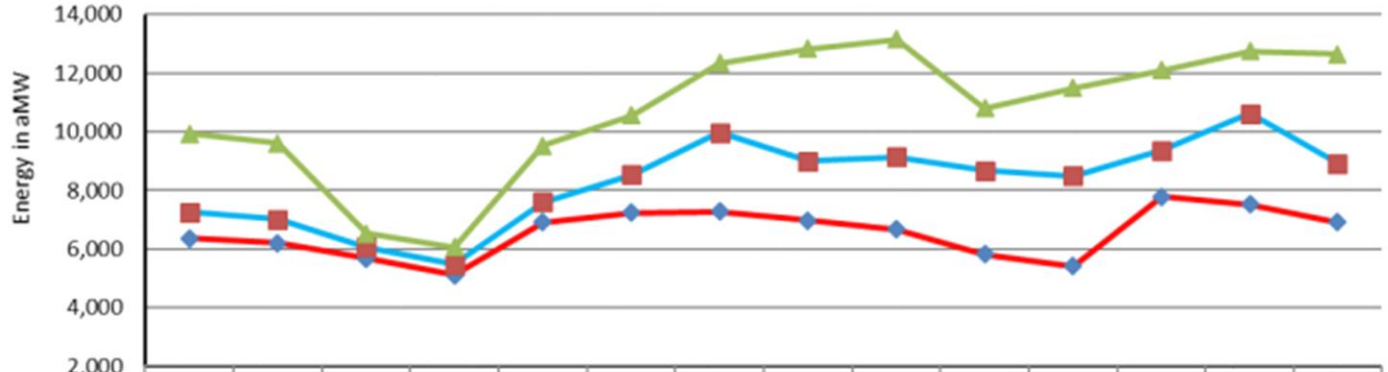
BONNEVILLE POWER ADMINISTRATION

2023 Pacific Northwest
Loads and Resources Study

April 2023

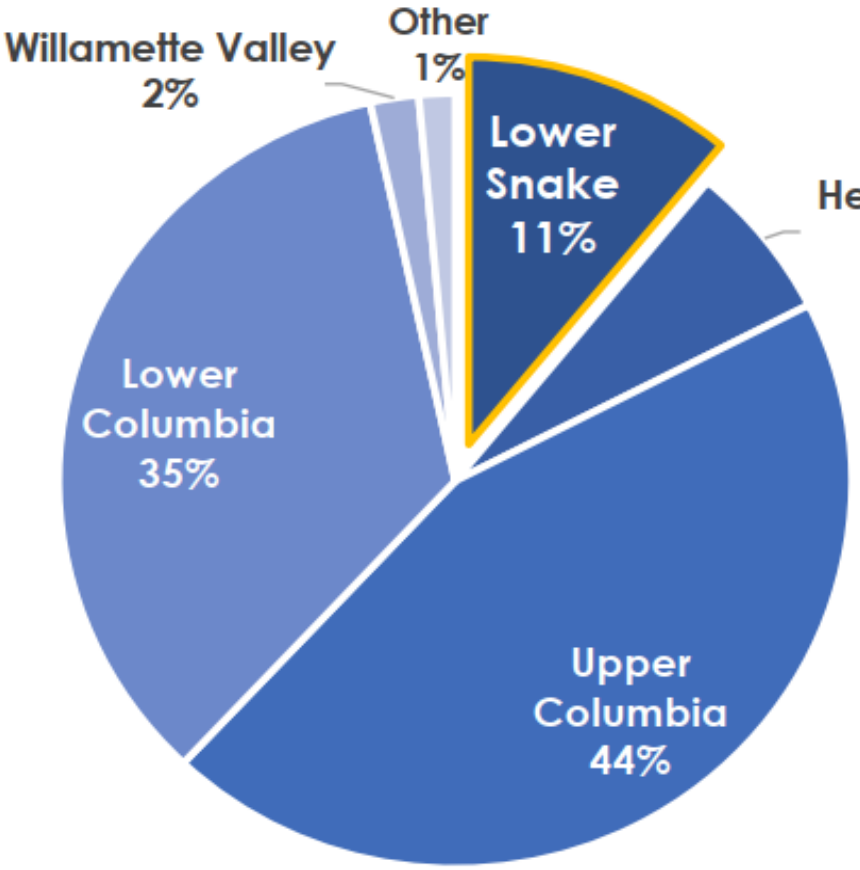
Table 2-9

Federal System
Variability of Monthly Hydro Generation
OY 2024 - Under Different Water Conditions



	Aug1	Aug16	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr1	Apr16	May	Jun	Jul
Firm Water (P10)	6,356	6,201	5,684	5,117	6,913	7,232	7,271	6,964	6,660	5,815	5,417	7,790	7,508	6,902
Median Water (P50)	7,251	7,008	6,052	5,472	7,600	8,535	9,960	8,991	9,144	8,677	8,492	9,353	10,608	8,910
High Water (P90)	9,938	9,597	6,521	6,069	9,515	10,565	12,340	12,833	13,149	10,796	11,494	12,086	12,741	12,646

LSRD by the Numbers



Average Annual Generation from the Federal Columbia River Power System

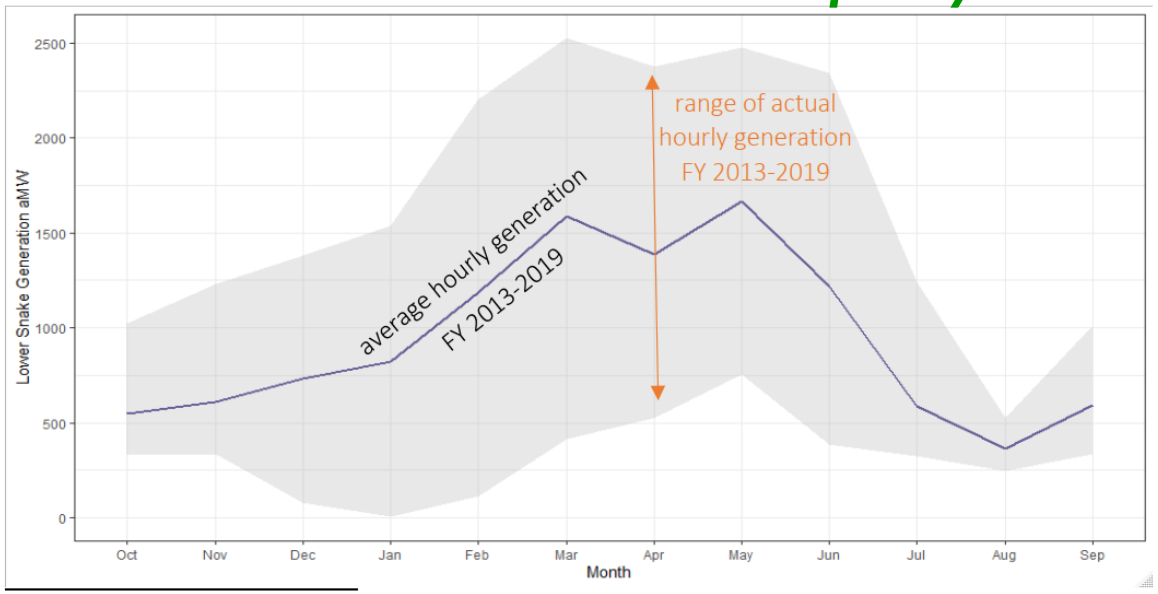
Project Basin	aMW
Lower Snake	940
Headwater *	559
Upper Columbia	3,814
Lower Columbia	2,958
Willamette Valley	169
Other	126
TOTAL	**8,567**

Increased spill has reduced LSRD to 790 aMW for OY2025

LSRD by the Numbers

Ice Harbor Dam	603 MW
Lower Monumental Dam	810 MW
Little Goose Dam	810 MW
Lower Granite Dam	810 MW
Total	**3,033 MW**

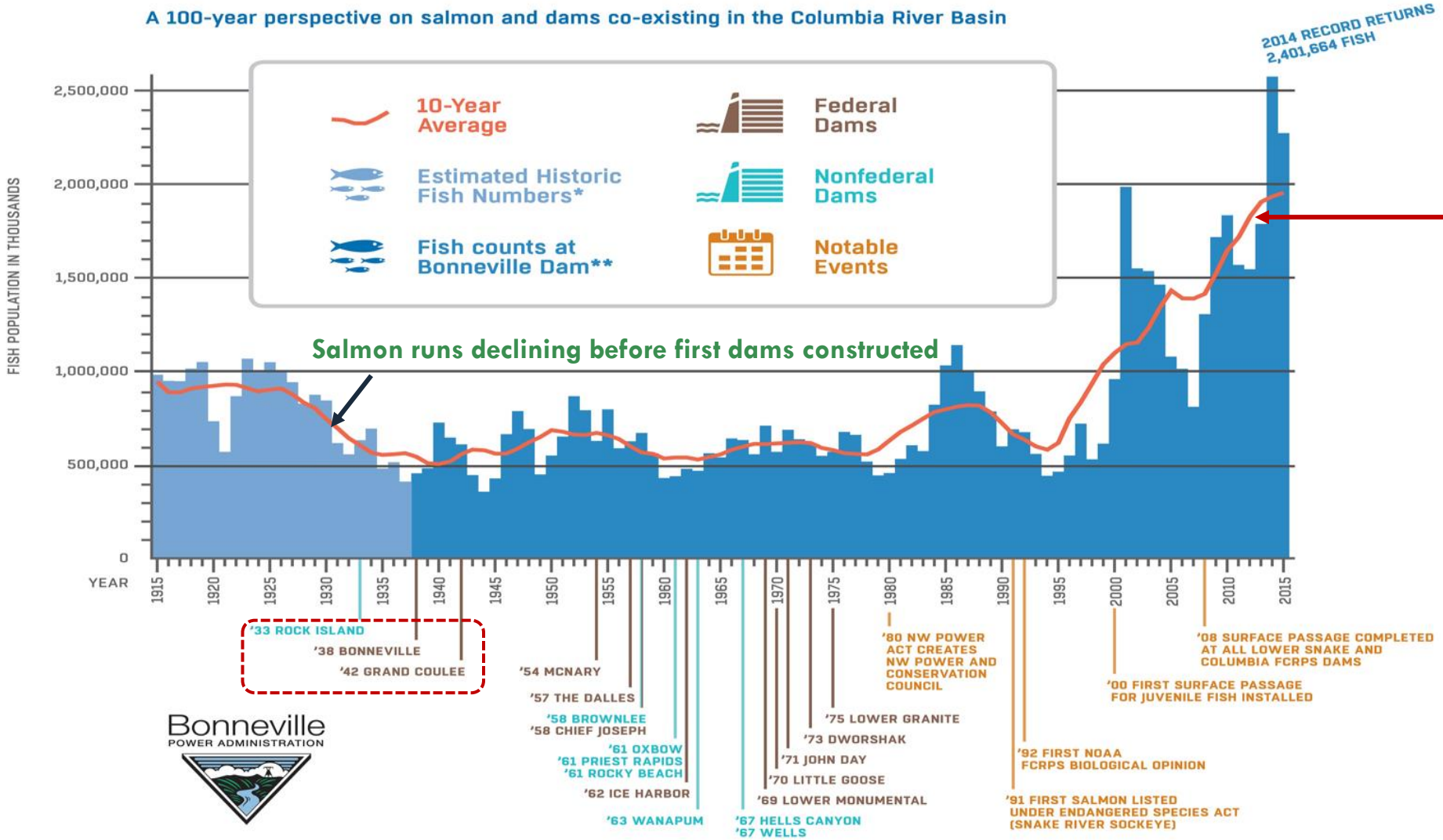
Controllable Effective Capacity



- LSRD's
  - Not Expensive (Hydro is least cost by far)
  - Not Outdated (world class fish bypass)
  - Not Surplus (+130 BPA Customer portfolios)
- As much as 25% of BPA Operating Reserves
  - Blackout Insurance
- We need every drop of hydropower we can get
  - 100% Carbon Free CETA Mandates

Source: USACE Water Control Data

Salmon Runs: Historical Data



Salmon runs improving with financial investments and management of:

- ✓ *Hydro*
- ✓ *Habitat*
- ✓ *Hatcheries*
- ✓ *Harvest*

Salmon Runs: Historical Data at Bonneville Dam

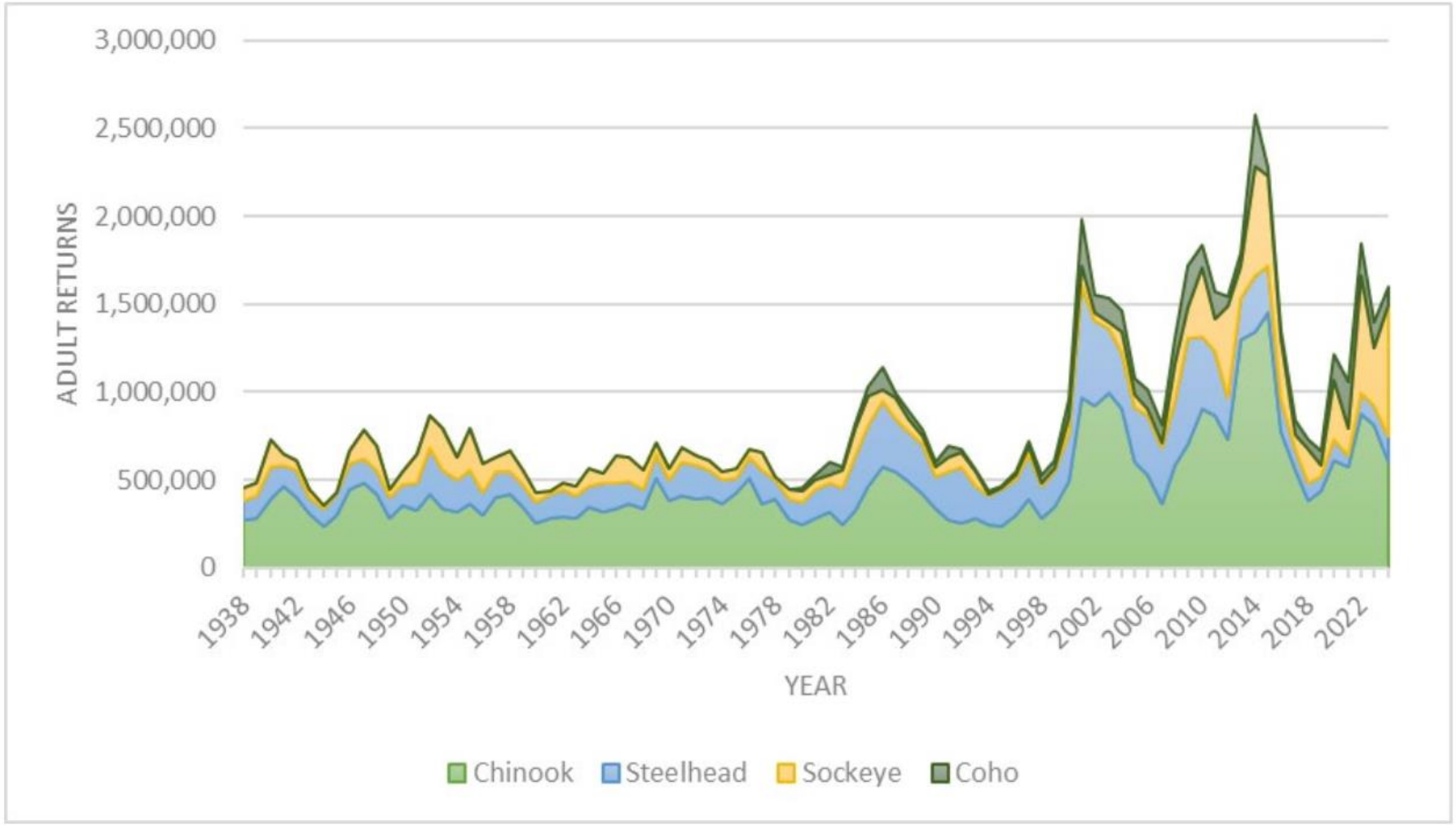


Figure 5. Returns Bonneville Dam for salmon and steelhead, 1938–2024. Chinook and Coho data account for adults and jacks. The steelhead data account for wild and hatchery fish. Calculated from Columbia River DART (University of Washington).

Salmon Runs: Historical Data at Bonneville Dam w/ Shad

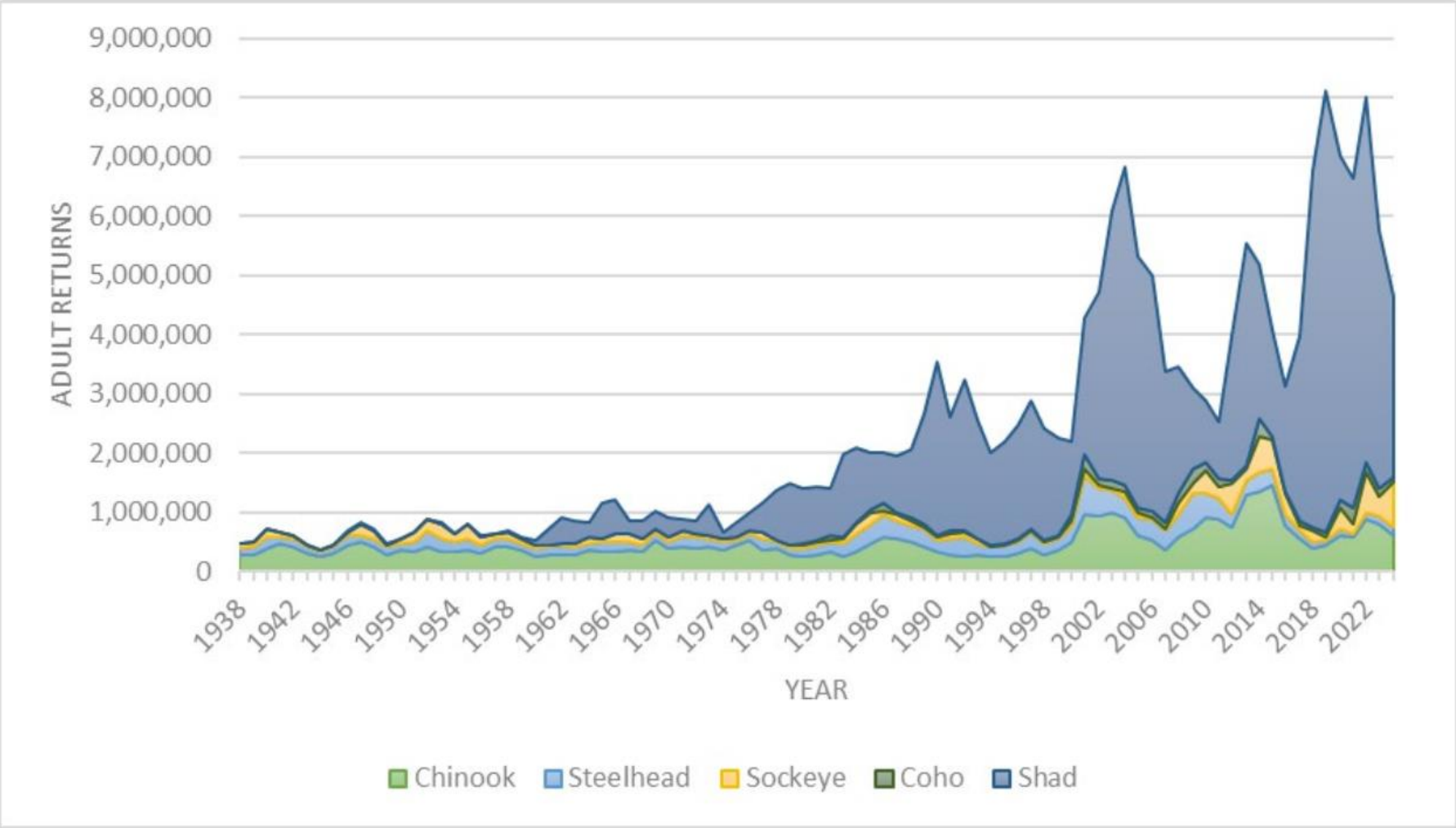


Figure 6. Returns Bonneville Dam for salmon, steelhead, and shad, 1938–2024. Chinook and Coho data account for adults and jacks. The steelhead data account for wild and hatchery fish. Calculated from Columbia River DART (University of Washington).

Salmon Runs: LSRD

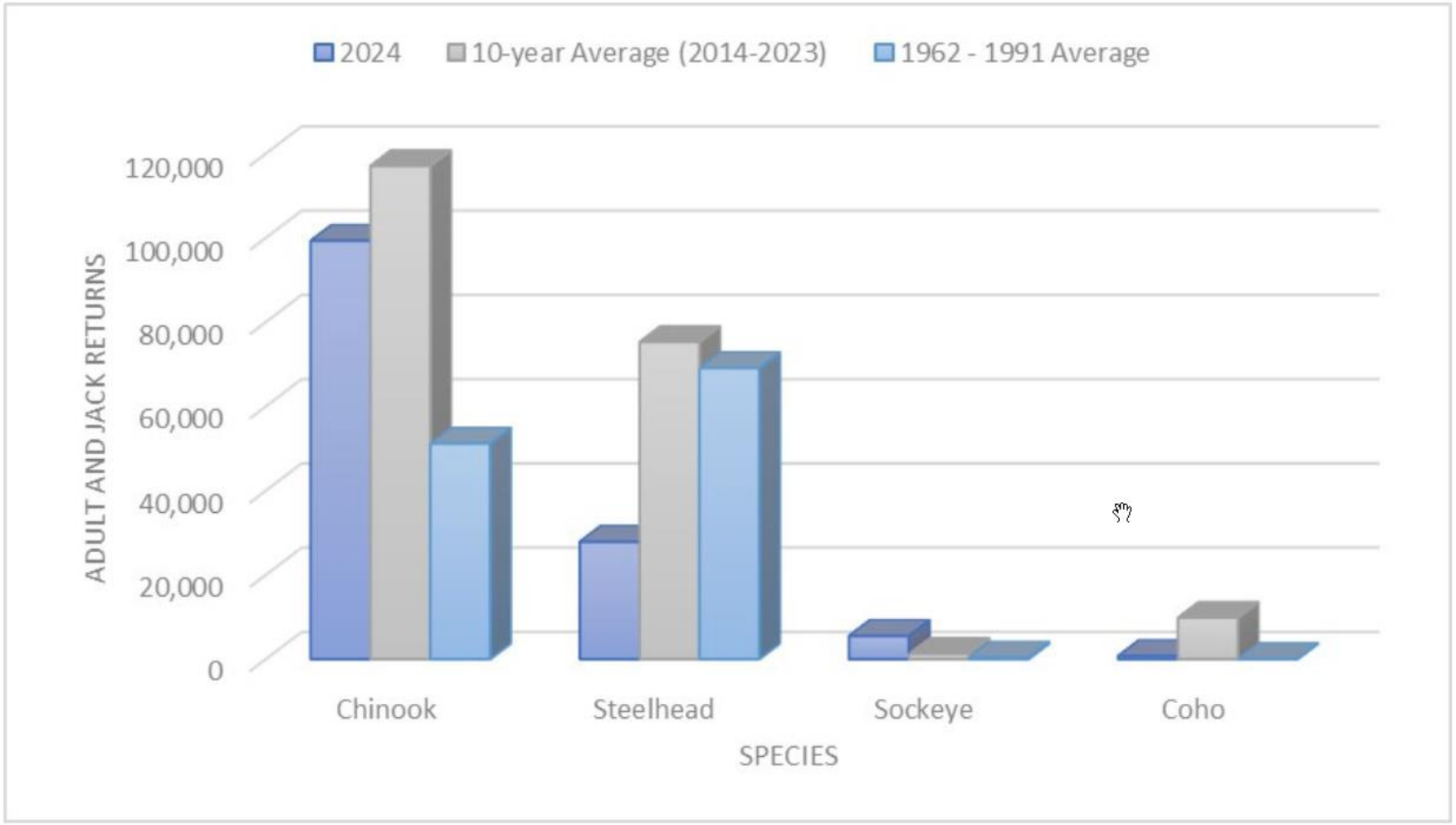


Figure 3. Returns to Ice Harbor Dam for salmon and steelhead. Chinook and Coho columns account for adults and jacks. The steelhead column accounts for wild and hatchery fish. Calculated from Columbia River DART (University of Washington).

Salmon Runs: LSRD w/ Shad

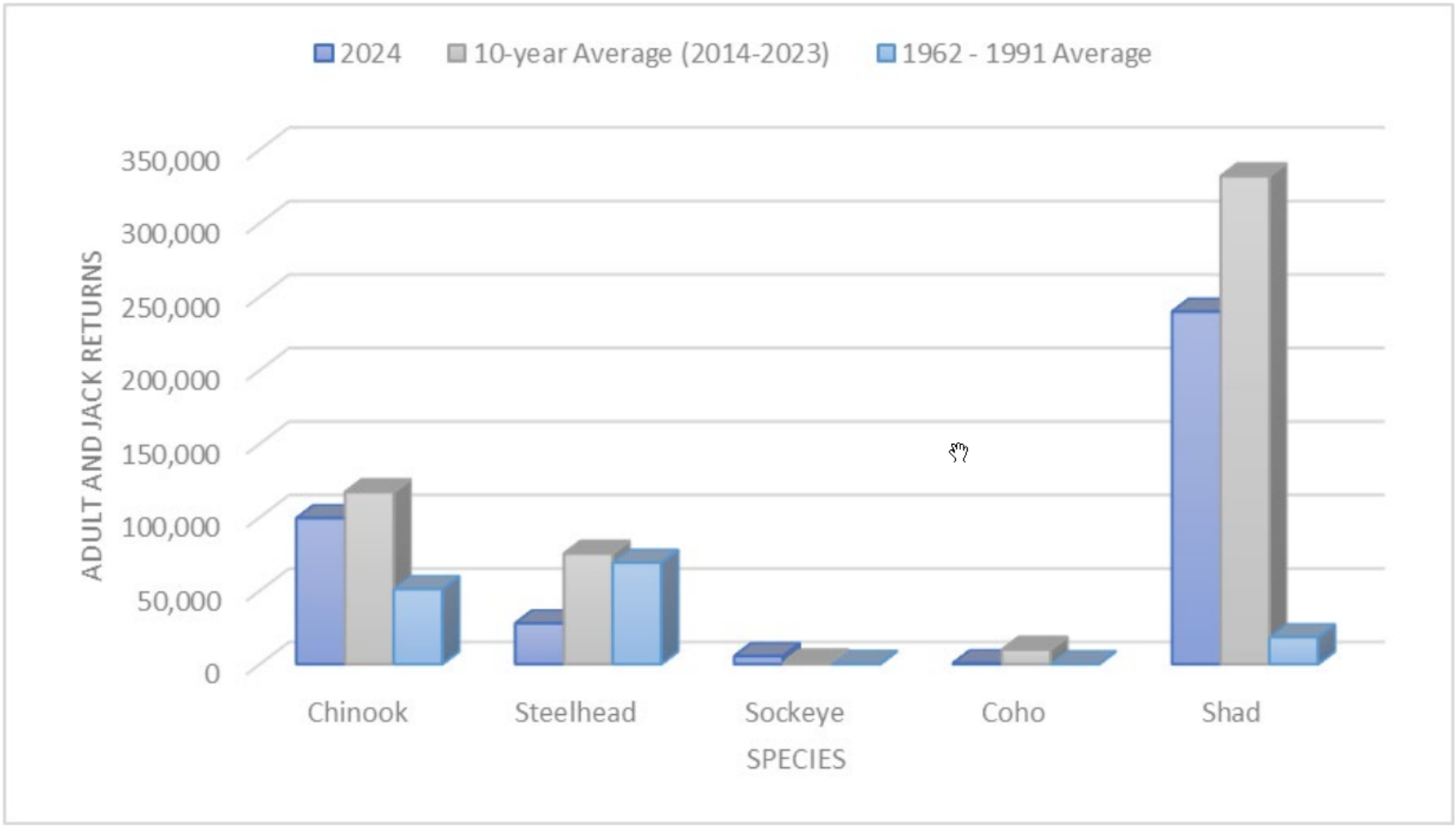
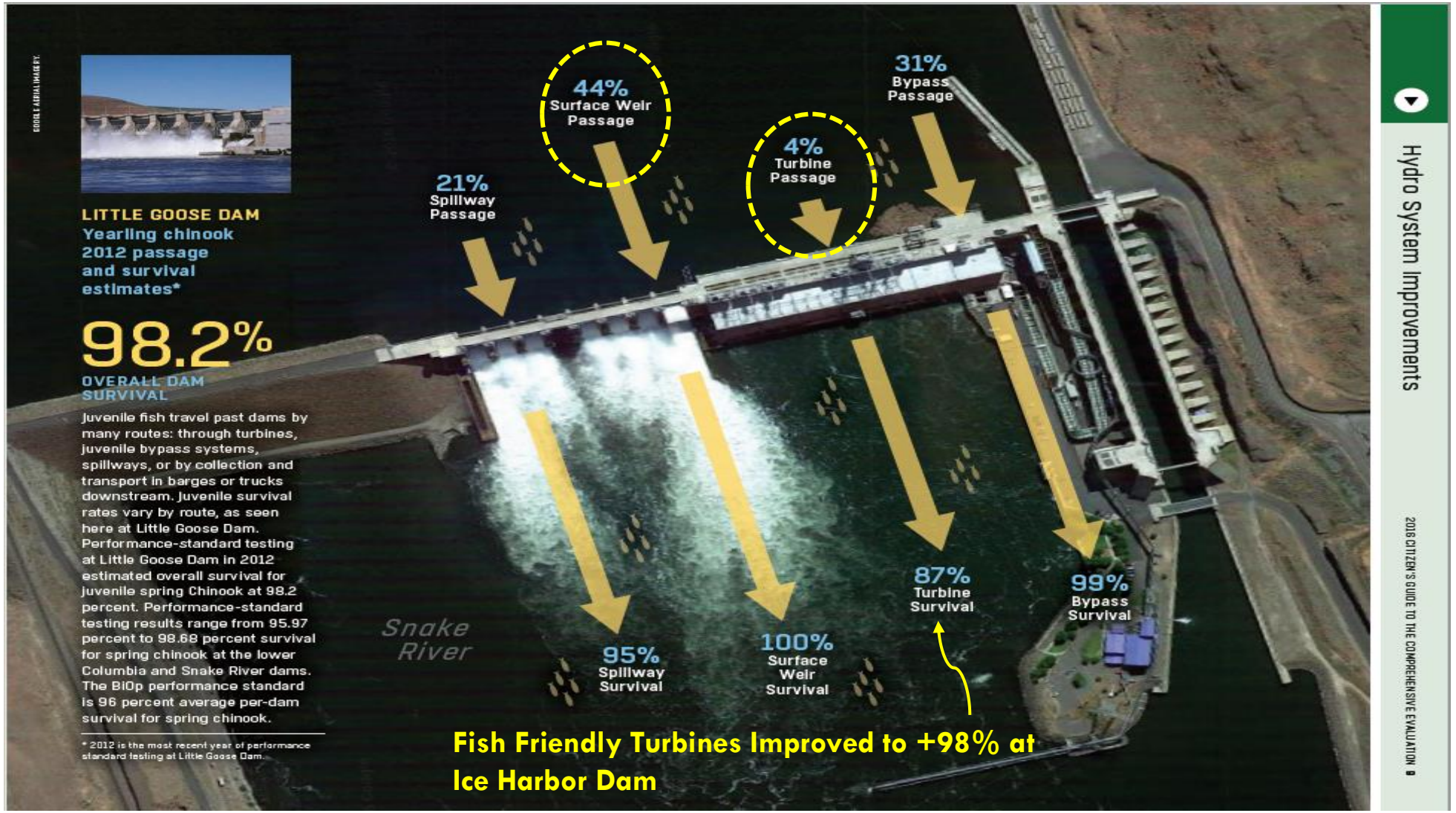
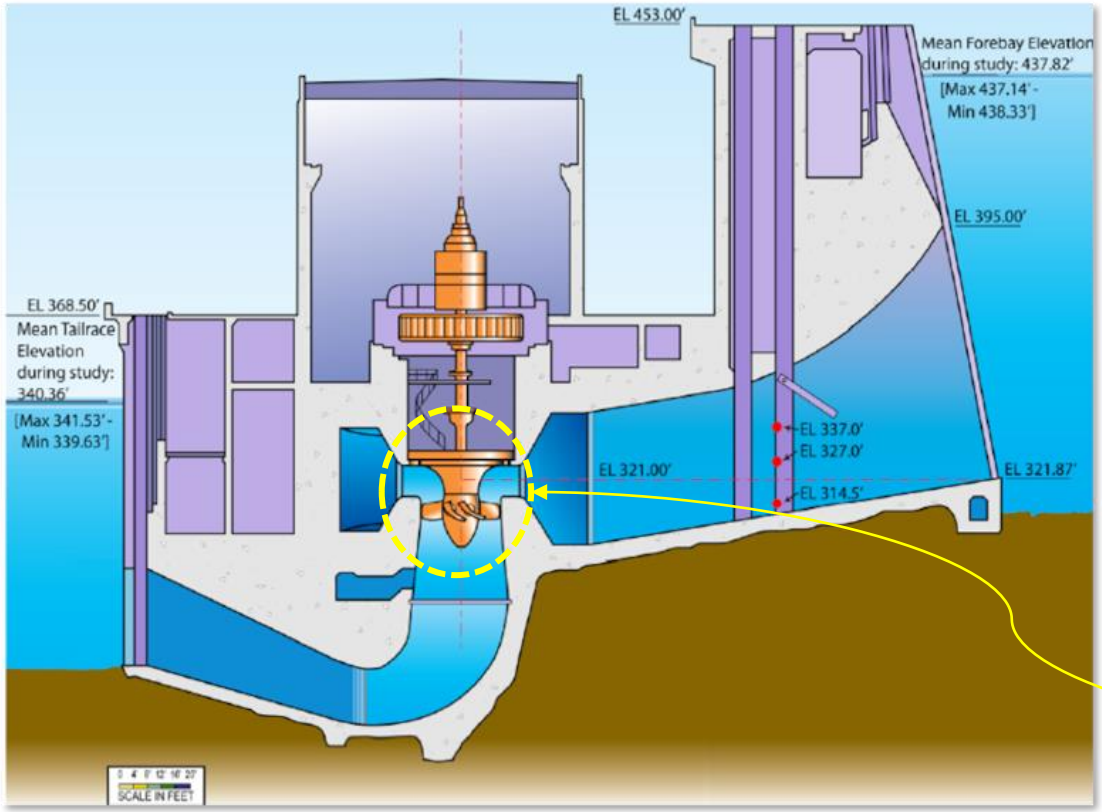


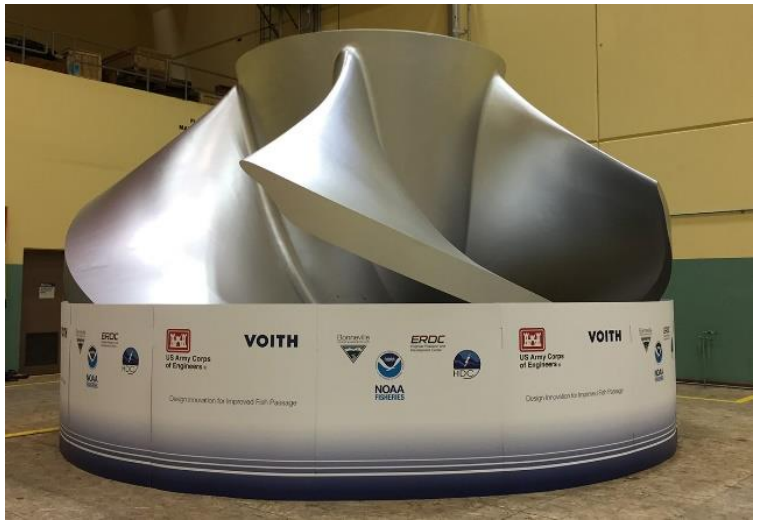
Figure 4. Returns to Ice Harbor Dam for salmon, steelhead, and shad. Chinook and Coho columns account for adults and jacks. The steelhead column accounts for wild and hatchery fish. Calculated from Columbia River DART (University of Washington).

Fish Bypass Technology Investments



Fish Friendly Turbine Design

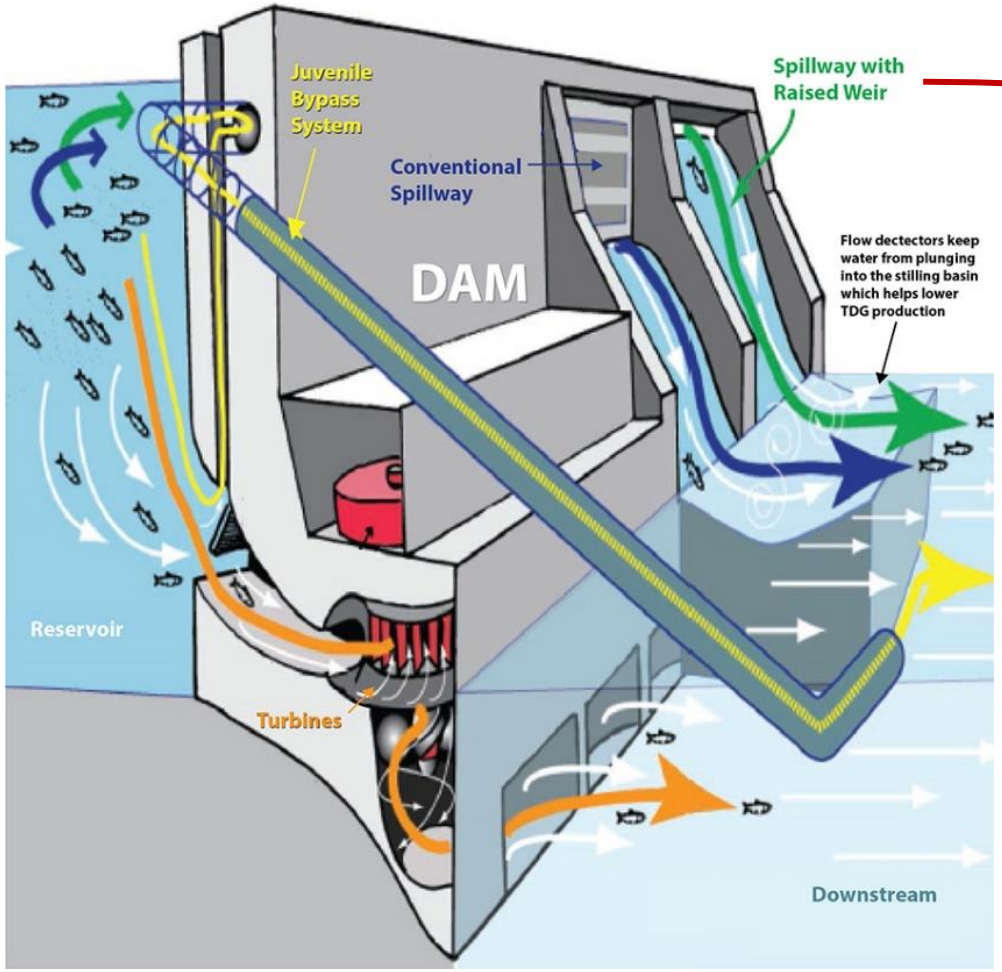


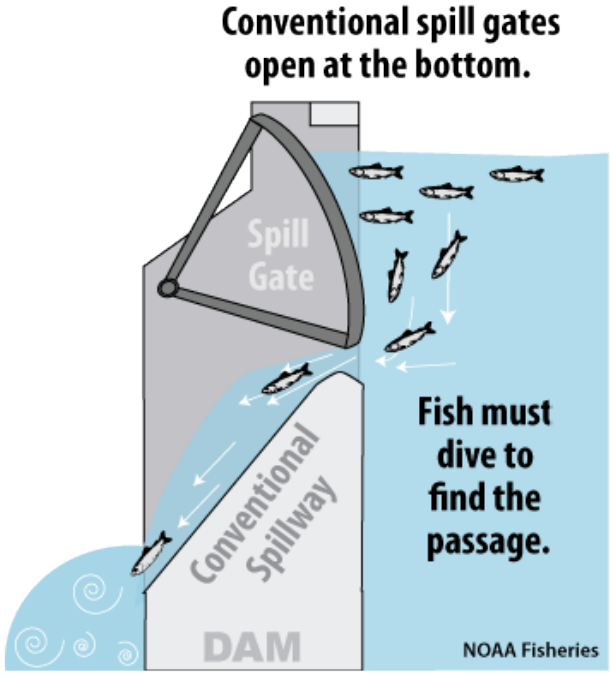


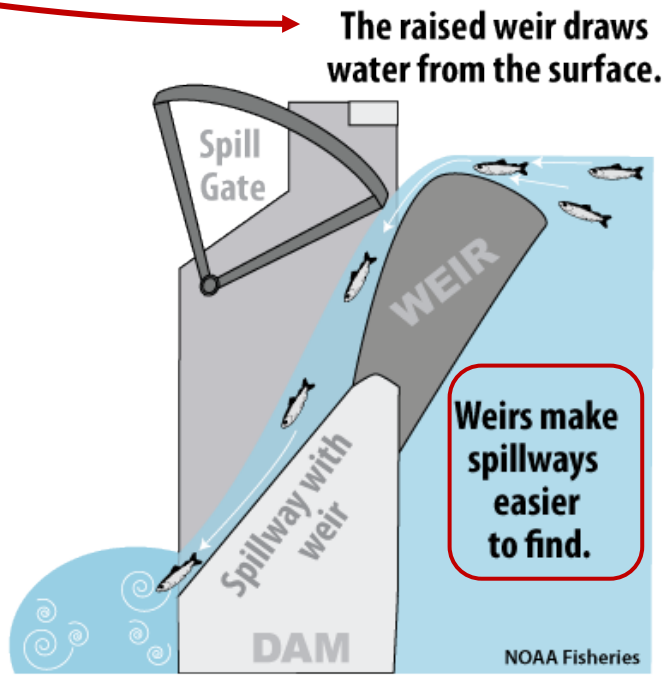
"...biological testing using balloon tagged fish in October 2019 resulted in a 98.25% direct survival rate."

https://www.nww.usace.army.mil/Media/News-Stories/Article/2991190/modernizing-hydropower-on-the-snake-river/

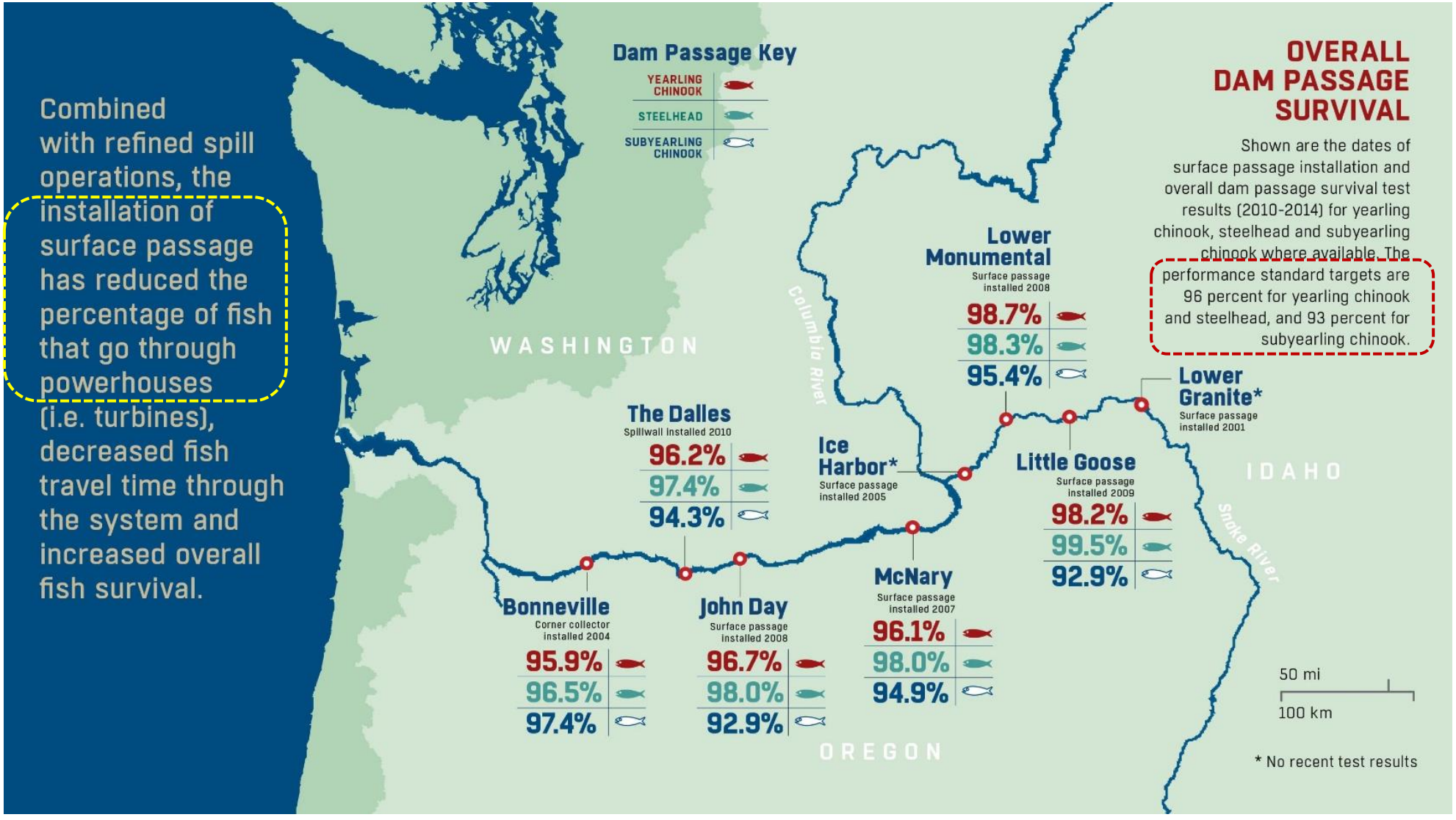
Raised Spillway Weirs



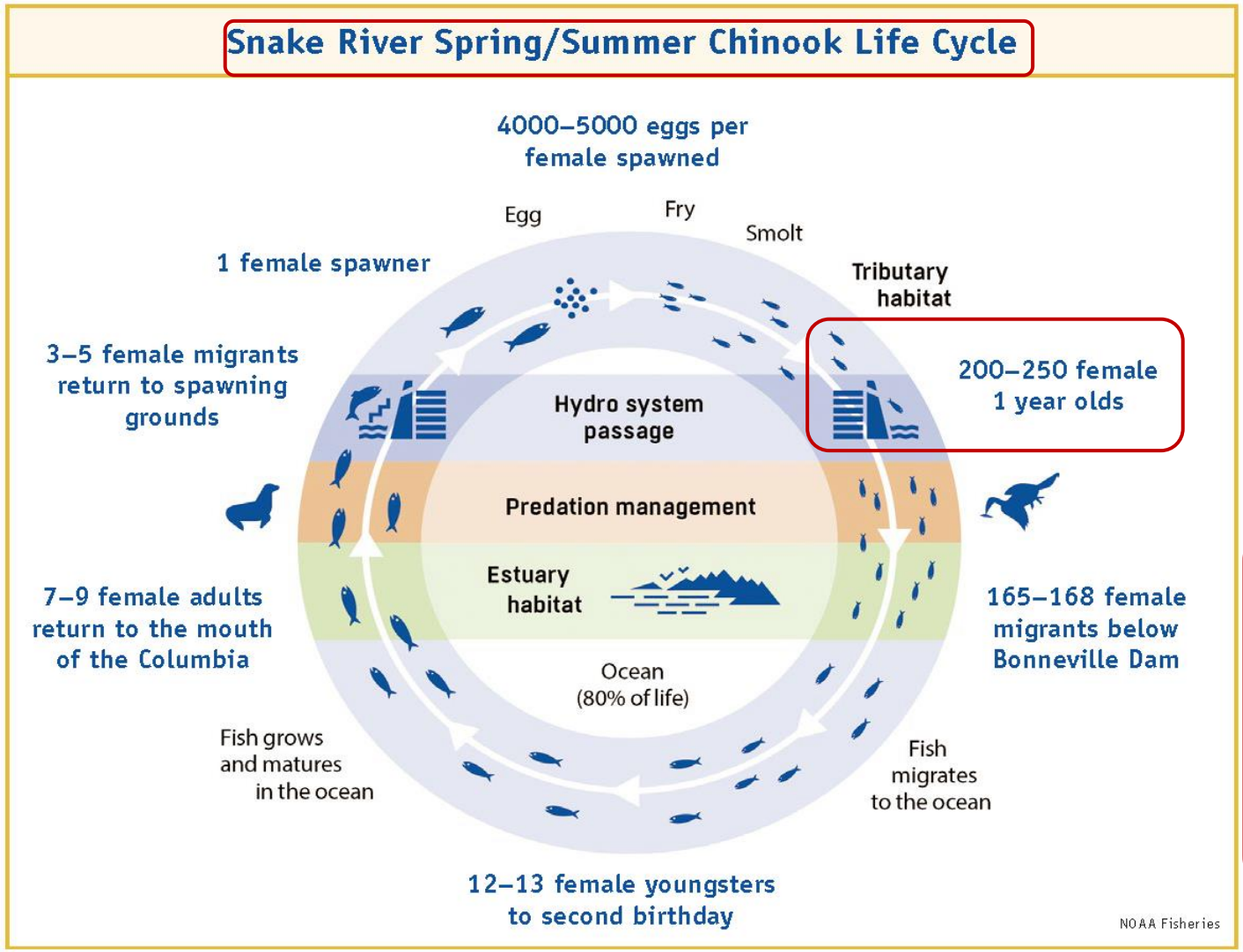




Dam Passage Fish Survival Rates



Chinook Salmon Life Cycle



- ✓ **Smolt take 10 to 50 days to travel rivers and get to the estuary/ocean**
- ✓ **Delayed mortality hypothesis is driving calls for LSRD breaching w/o scientific evidence**

7 July 2022 KINTAMA p. 1/8.

The Case for Snake River Dam Removal is Scientifically Dishonest

-David Welch, Ph.D. & President, Kintama Research Services.

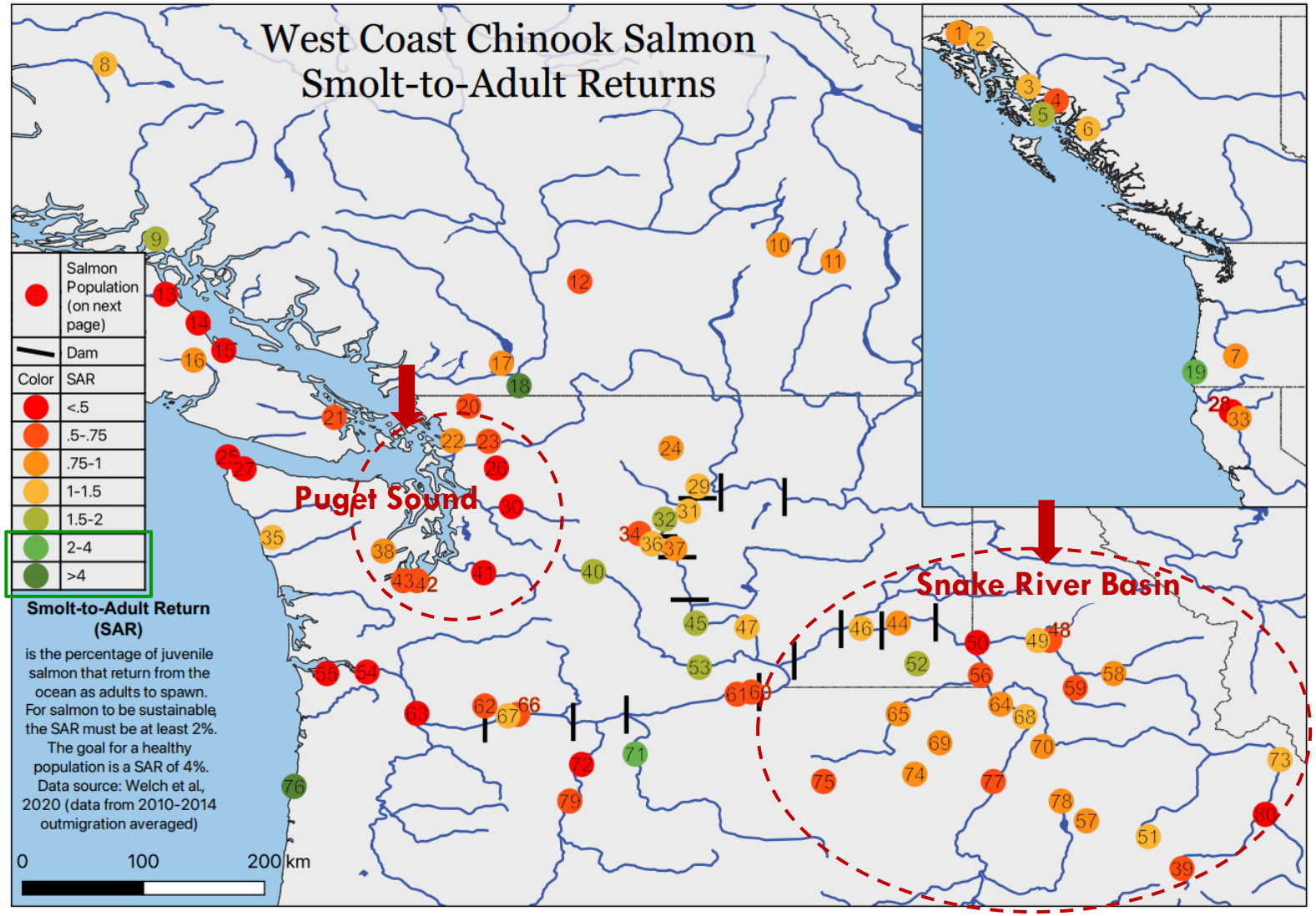
"If delayed mortality doesn't exist…then other approaches to getting more salmon should be considered".

West Coast Chinook Salmon Struggling

Whether river is dammed or not

Smolt-to-Adult Return

Sustainable runs >2%



Killer Whales and Snake River Chinook

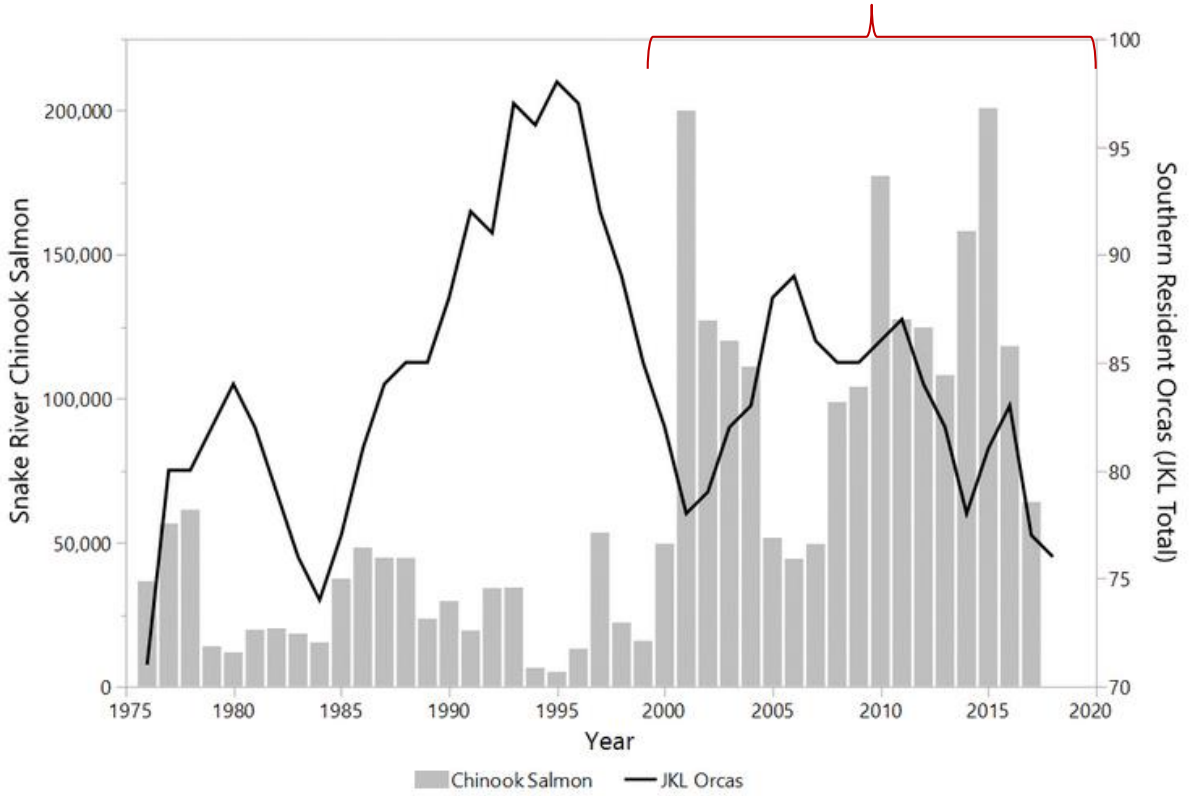
Abundance of Orcas Related to Snake River Chinook Salmon?

Published on August 14, 2018 Edit article | View stats

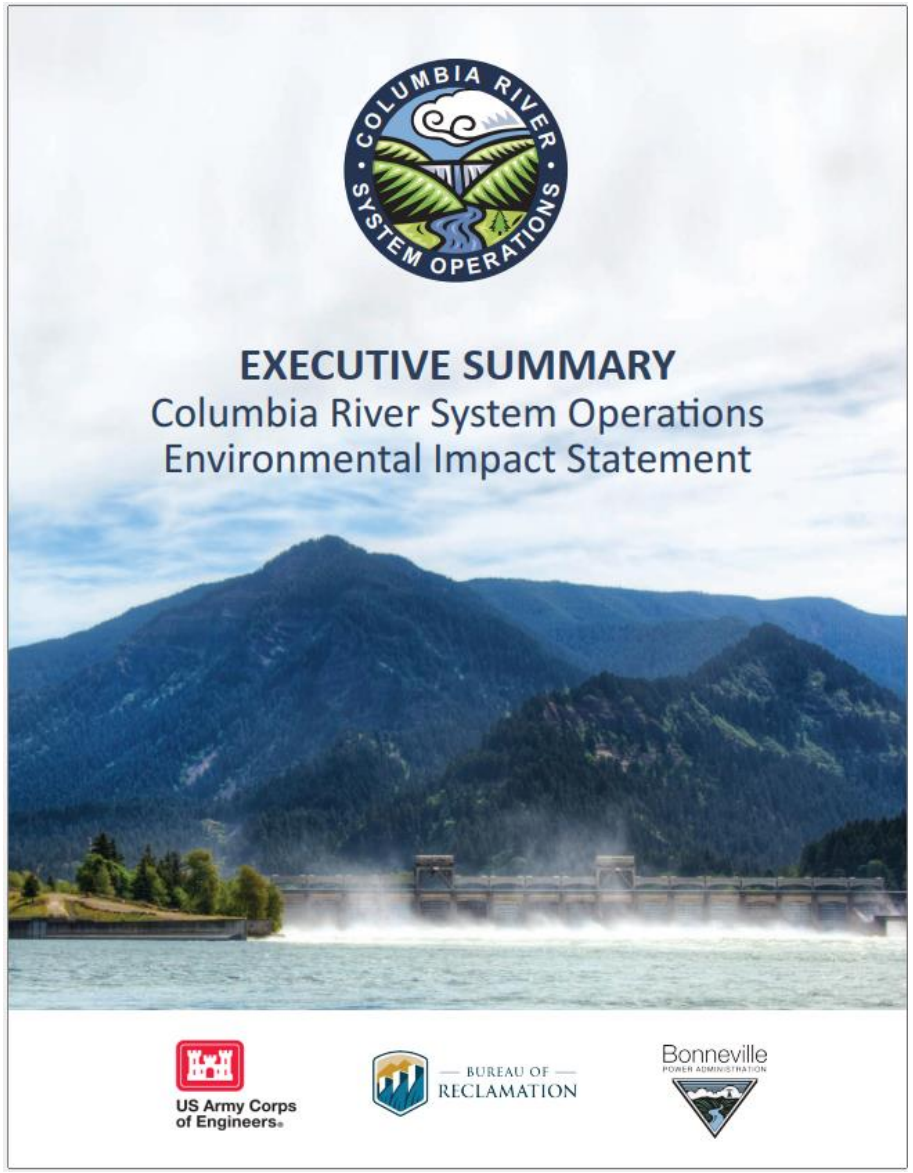
Photo by Leigh Calvez

Joshua Murauskas
Principal Scientist at Four Peaks Environmental Science & Data Solutions
6 articles

JKL Orca populations declined during time of increasing Snake River Chinook Salmon abundance



Hydro Operations: Lawsuits & High Spill



- Multiple Objective Alternative 4 (MO4)
- Highest volume and longest duration spill considered in EIS alternatives
- 125% total dissolved gas during spring & summer
- Average hydropower **decreases 1,300 aMW**
- Highest probability of power shortages
- **Blackouts or emergency conditions** in roughly **1 in 3 years**

Next Generation Nuclear

Next Generation Nuclear

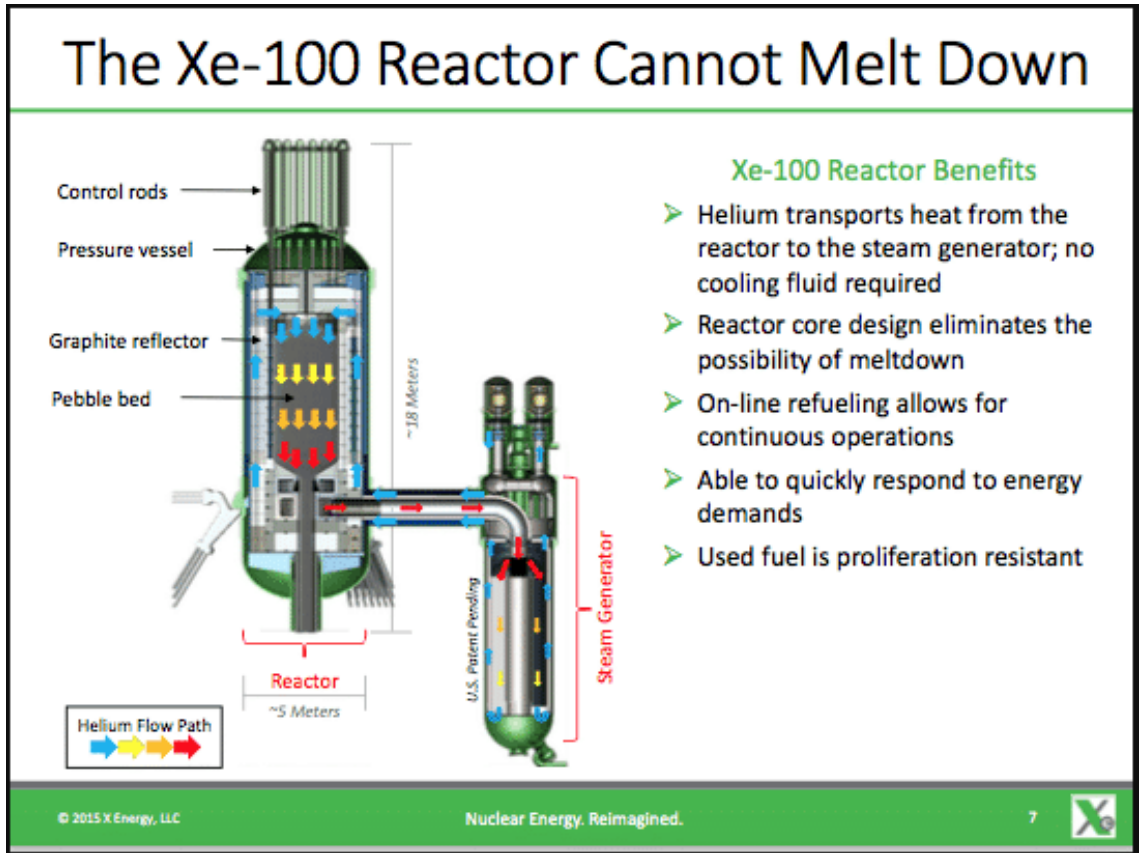
Energy Northwest: Site 1 Small Modular Reactor Project

XE-100

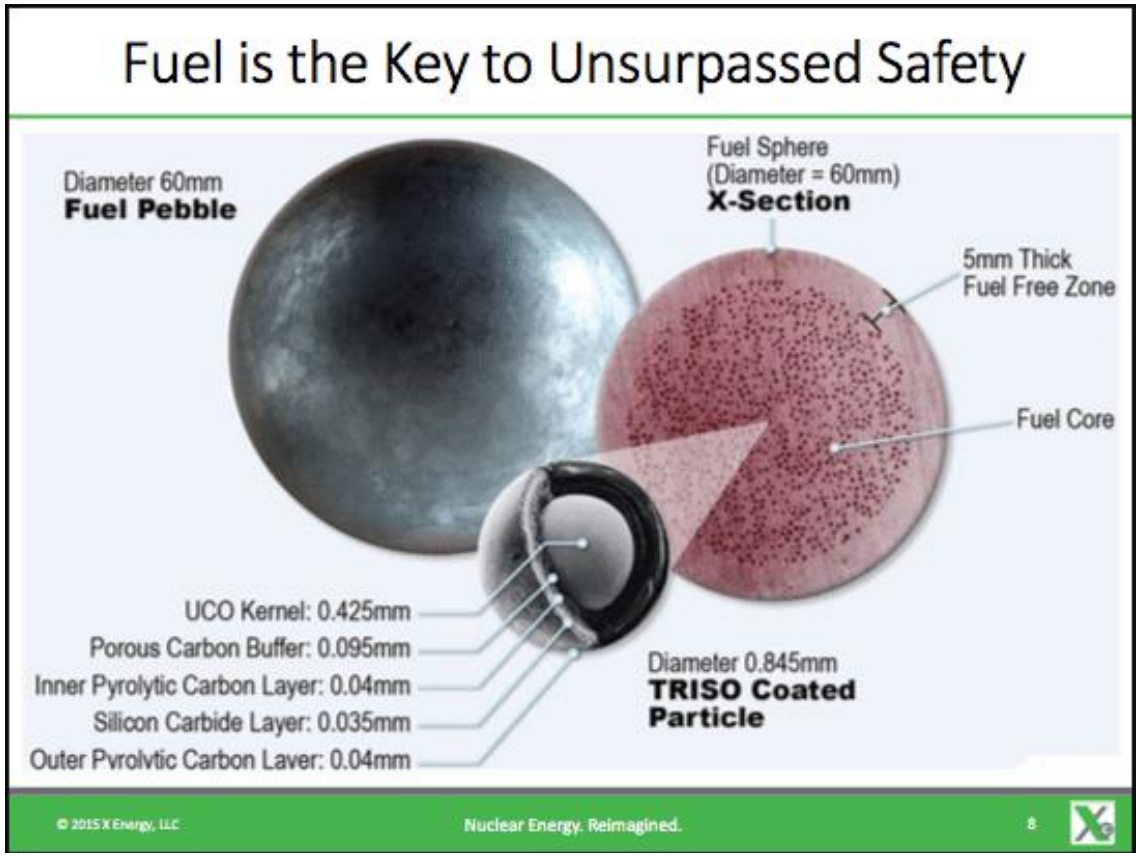
- *High Temperature Gas Reactor*
  - ***Helium cooled***
  - *TRISO fuel*
- *750^{0}C Helium Temperature*
- *870 psi Helium Pressure*
- *565^{0}C Steam Temperature*
- *3,393 psi Steam Pressure*
- ***80 Mwe/module (net)***
- *60-year design life,* ***100+ year asset***
- *Continuous on-line refueling*
- ***Modularized components*** *built off-site, transportable via rail/road*

Xenergy Small Modular Reactor Technology

Meltdown-Proof



Walk-Away-Safe



Terrapower Technology

Natrium®

The next generation of power is here – the Natrium® Reactor and Energy Storage System

Built for the 21st century grid, TerraPower's Natrium technology is one of the fastest and lowest-cost paths to advanced, zero carbon energy.

The Nuclear + Storage Solution

Unlike today's Light Water Reactors (LWR), the Natrium reactor is a **345-megawatt sodium fast reactor** coupled with TerraPower's breakthrough innovation—a molten salt integrated energy storage system, providing **built-in gigawatt-scale energy storage**. The Natrium reactor maintains constant thermal power at all times, maximizing its capacity factor and value. Molten salt energy storage is more resilient, flexible and cost-effective than current grid-scale battery technology.

THE NATRIUM TECHNOLOGY'S ADVANCED DESIGN ENABLES SIMULTANEOUS PRODUCTION OF CARBON-FREE ELECTRICITY, HEAT AND STEAM TO SUPPORT DECARBONIZATION OF POWER AND INDUSTRIAL SECTORS.

TerraPower Begins Construction on Advanced Nuclear Project in Wyoming

June 10, 2024

- ✓ 345 MW sodium-cooled fast reactor
- ✓ 500 MW with molten salt-based energy storage
- ✓ PacifiCorp is Utility Purchaser

Terrapower Technology

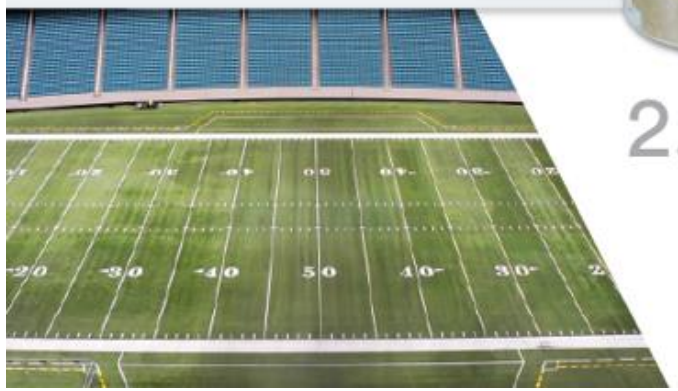
- ✓ Natrium reactors are not pressurized like existing plants and use sodium, instead of water, as a coolant.
- ✓ The reactor operates at a temperatures greater than 350 degrees Celsius (the equivalent of 662 degrees Fahrenheit) and far below the boiling point of sodium.
- ✓ Design capitalizes on natural forces, such as gravity and thermal convection, enabling passive cooling and significantly reducing safety-related costs compared to conventional reactors.

Spent Nuclear Fuel

5 Fast Facts on **Spent Nuclear Fuel**

1. Spent fuel is a solid and is typically made up of **ceramic pellets in metal rods.**

Spent fuel assemblies inside a dry storage cask. >>>



2. The U.S. has produced roughly **90,000 metric tons** of spent fuel. This could all fit on a football field at a **depth of less than 10 yards** if it could be stacked together.

3. Spent fuel from power reactors is safely and securely stored at more than **70 sites in 35 states.**

Underwater storage at Indian Point in Buchanan, NY

4. Spent fuel is safely transported across the U.S. with more than **2,500 cask shipments over the last 55 years.**

5. Spent fuel can be recycled. **More than 90% of its potential energy still remains in the fuel.**

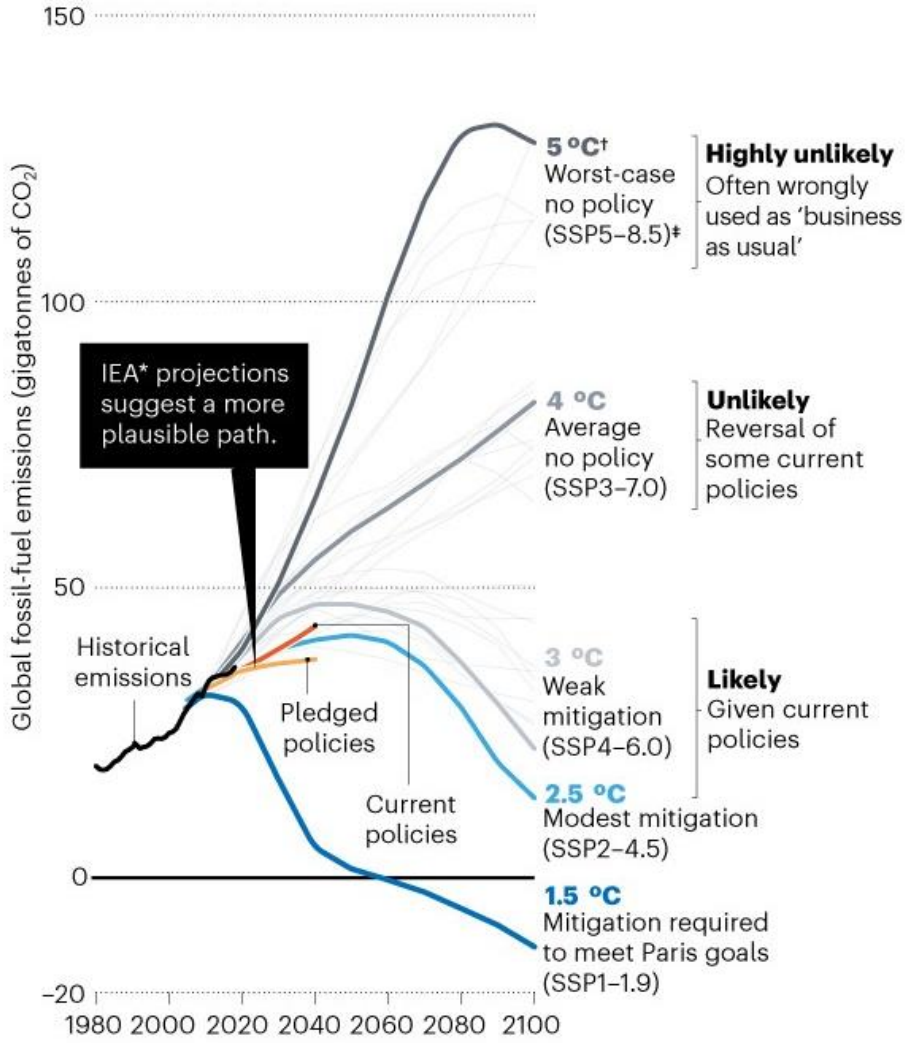
Dry storage casks at Dresden Generating Station. >>>

https://www.energy.gov/ne/articles/infographic-5-fast-facts-about-spent-nuclear-fuel

WA State Clean Energy Policies & Global CO_2 Perspectives

WA State Clean Energy Policies & Global CO2 Perspectives

Global CO_2 Emissions – Things to Consider (IPCC RCP8.5)



COMMENT | 29 January 2020

Emissions – the 'business as usual' story is misleading

Stop using the worst-case scenario for climate warming as the most likely outcome – more-realistic baselines make for better policy.

Zeke Hausfather & Glen P. Peters

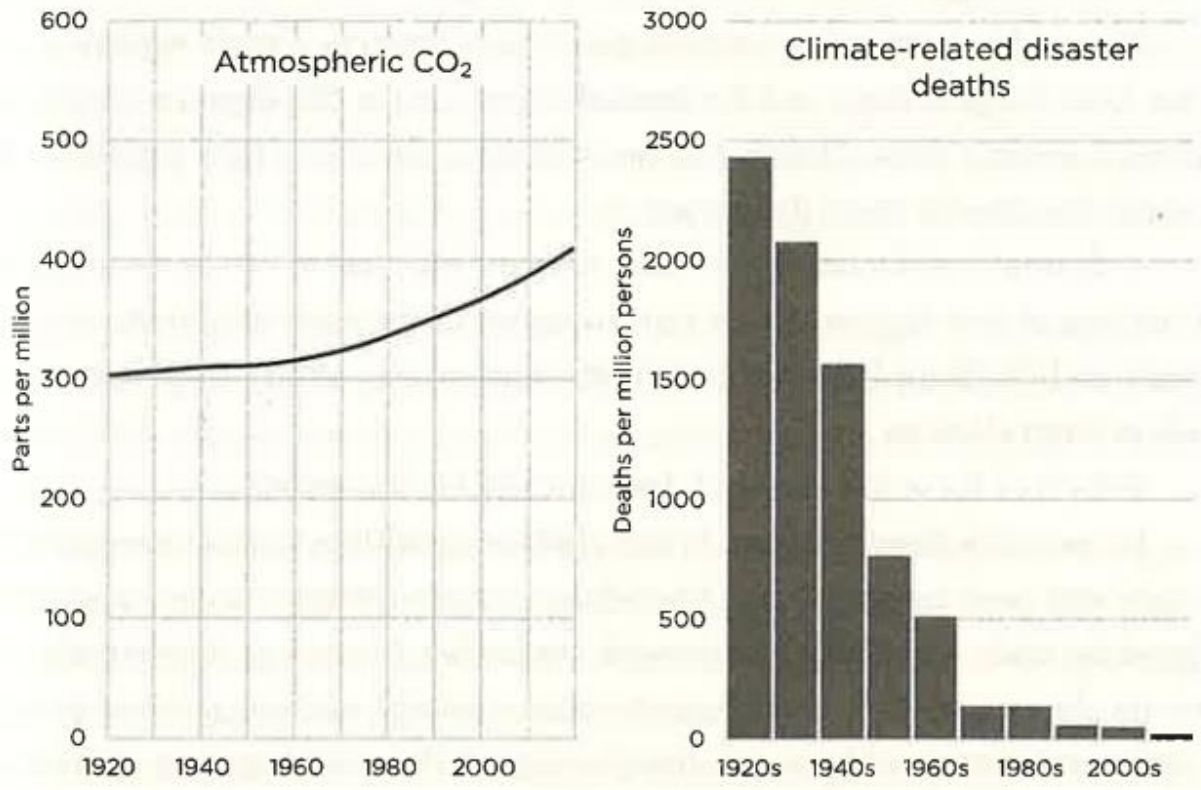
Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathways (RCPs)

RCP8.5 "… paints a dystopian future that is fossil-fuel intensive and excludes any climate mitigation policies, leading to nearly 5 °C of warming by the end of the century,"

"RCP8.5 was intended to explore an unlikely high-risk future. But it has been widely used by some experts, policymakers and the media as something else entirely: as a likely 'business as usual' outcome."

Global CO_2 Emissions – Things to Consider (Climate-disasters)

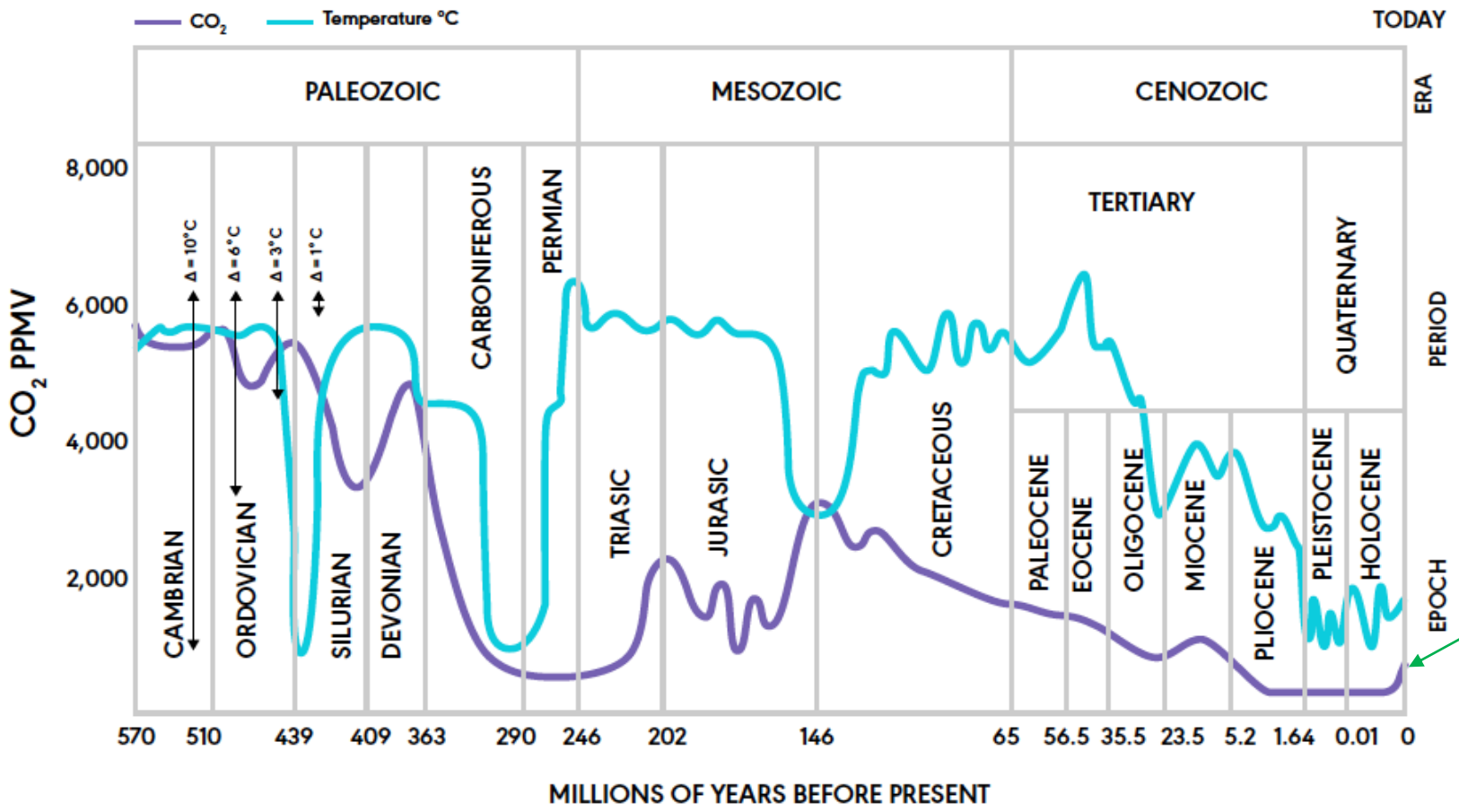
FIGURE 2.2 **More Fossil Fuel Use, Plummeting Climate-Related Disaster Deaths**



Sources: Scripps Institution of Oceanography; EM-DAT; World Bank Data; Maddison Project Database

- ✓ Rate of climate-related disaster **deaths has fallen by 98%** over the last century
  - Includes deaths from droughts, floods, storms, and extreme temperatures
- ✓ World **life expectancy has increased** from just over 30 years in 1900 to over 70 years today
- ✓ **What is role of human innovation and adaptation to changes in climate?**

Global CO_2 Emissions – Things to Consider (parts per million)



CO_2 Concentration

PPM = Parts Per Million

+5,000 PPM millions of years ago

420 PPM today

<280 PPM before industrial revolution

<200 PPM end of some plant life

<150 PPM end of all plant life

Global CO_2 Emissions – Things to Consider (Saturation)

Richard Lindzen
Professor of Earth, Atmospheric, and Planetary Sciences, Emeritus
Massachusetts Institute of Technology

William Happer
Professor of Physics, Emeritus Princeton University

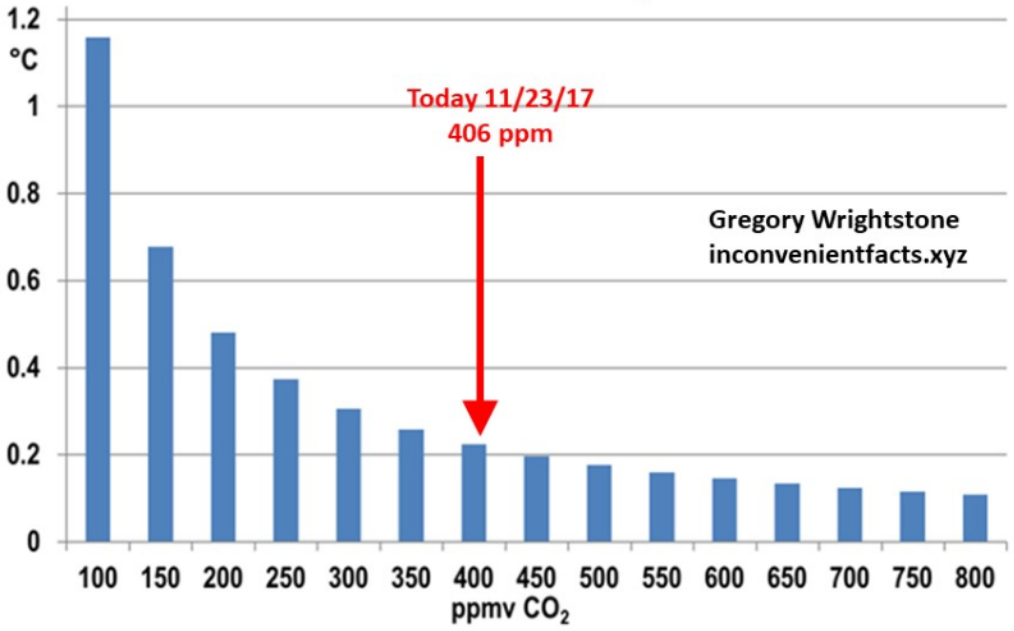
Steven Koonin
University Professor, New York University,
Senior Fellow at the Hoover Institution

FOSSIL FUELS AND GREENHOUSE GASES (GHGs) CLIMATE SCIENCE

April 2024

Each additional increase of CO_2 in the atmosphere causes a smaller and smaller change in "radiative forcing," or in temperature.

Figure I-3: Less global warming for each additional 50 parts-per-million-by-volume of CO_2 concentration



(Graph calculated using IPCC's formula $\Delta T_0 = \frac{5.35}{3.2} ln \frac{C}{C_0}$;
AR3, Ch. 6.1. Courtesy Monckton 2017)

Global CO_2 Emissions – Things to Consider (Climate Models)

"…models do not work, and bear no rational relationship to the reality they purport to represent."

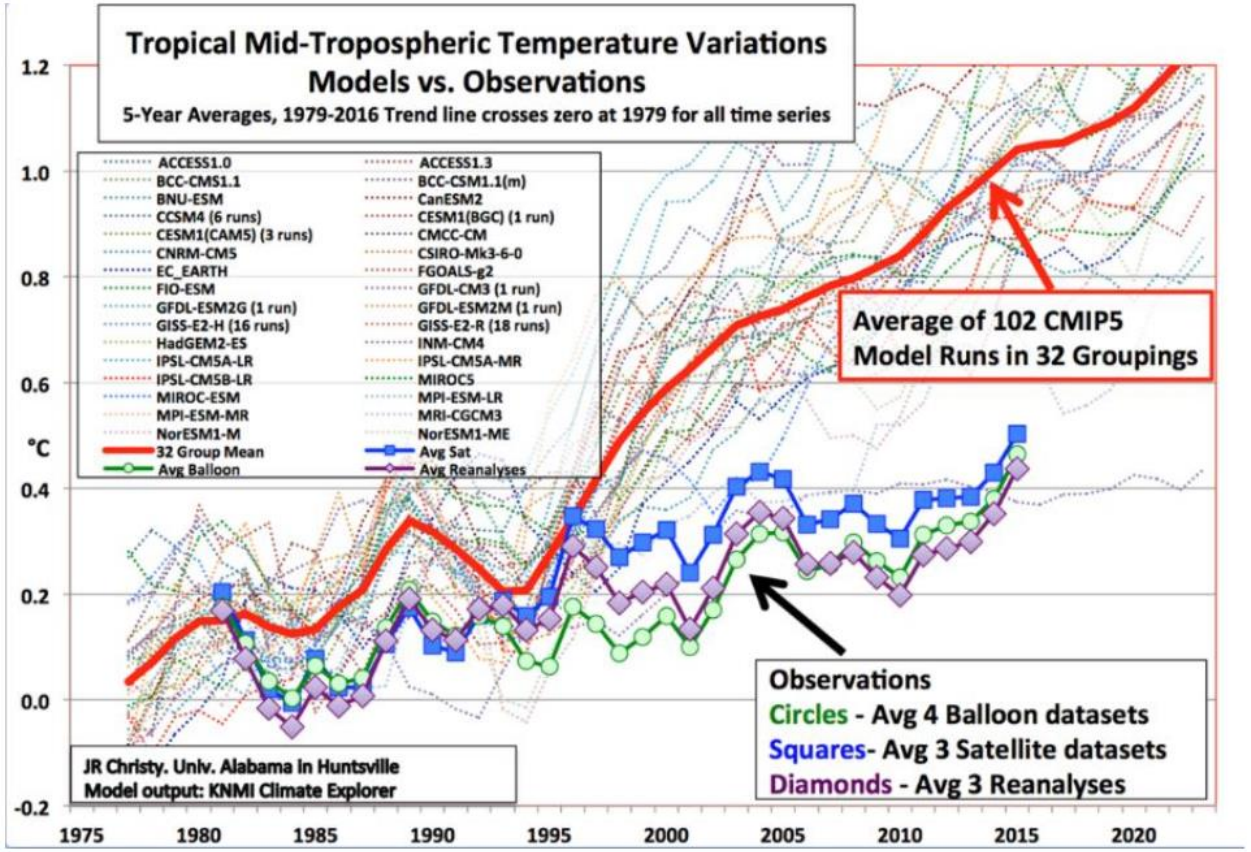
Richard Lindzen
Professor of Earth, Atmospheric, and Planetary Sciences, Emeritus
Massachusetts Institute of Technology

William Happer
Professor of Physics, Emeritus Princeton University

Steven Koonin
University Professor, New York University,
Senior Fellow at the Hoover Institution

FOSSIL FUELS AND GREENHOUSE GASES (GHGs) CLIMATE SCIENCE

April 2024



Global CO_2 Emissions – Things to Consider (Heat Waves)

Richard Lindzen
Professor of Earth, Atmospheric, and Planetary Sciences, Emeritus
Massachusetts Institute of Technology

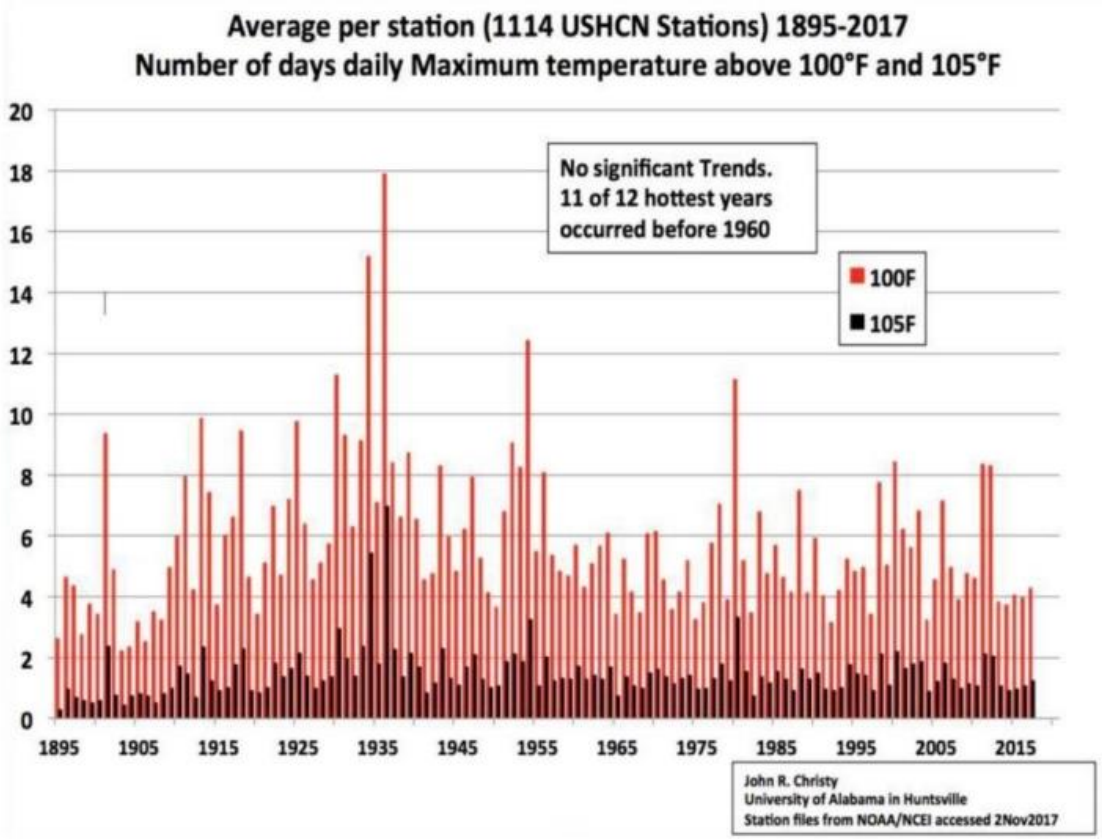
William Happer
Professor of Physics, Emeritus Princeton University

Steven Koonin
University Professor, New York University,
Senior Fellow at the Hoover Institution

FOSSIL FUELS AND GREENHOUSE GASES (GHGs) CLIMATE SCIENCE

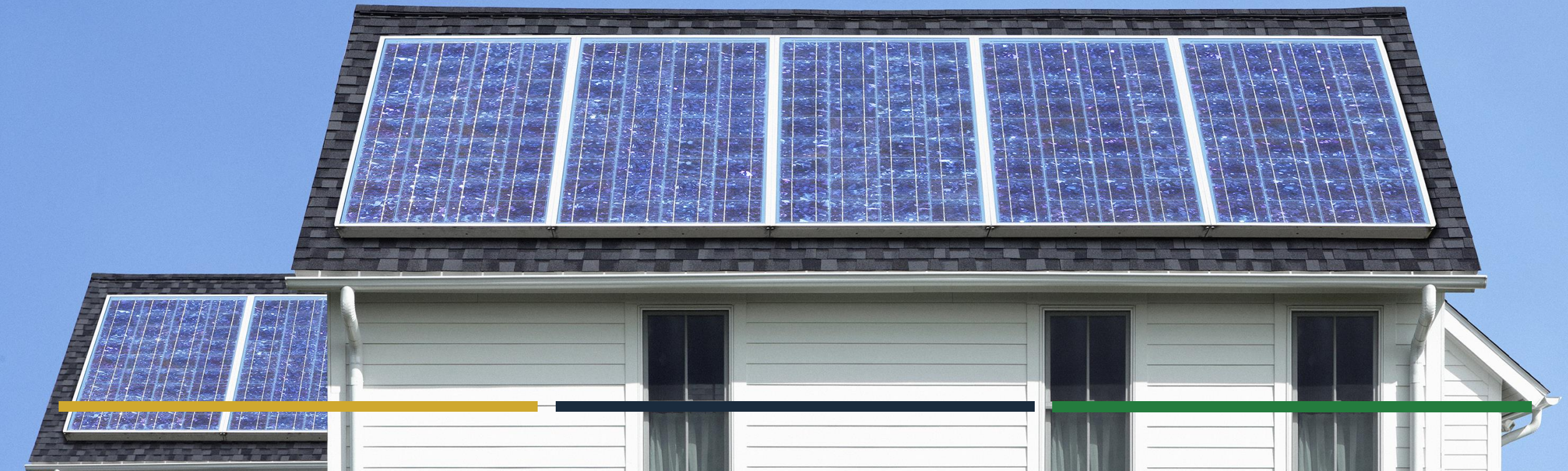
April 2024

The annual number of high temperature records set shows no significant trend over the past century, nor over the past 40 years.



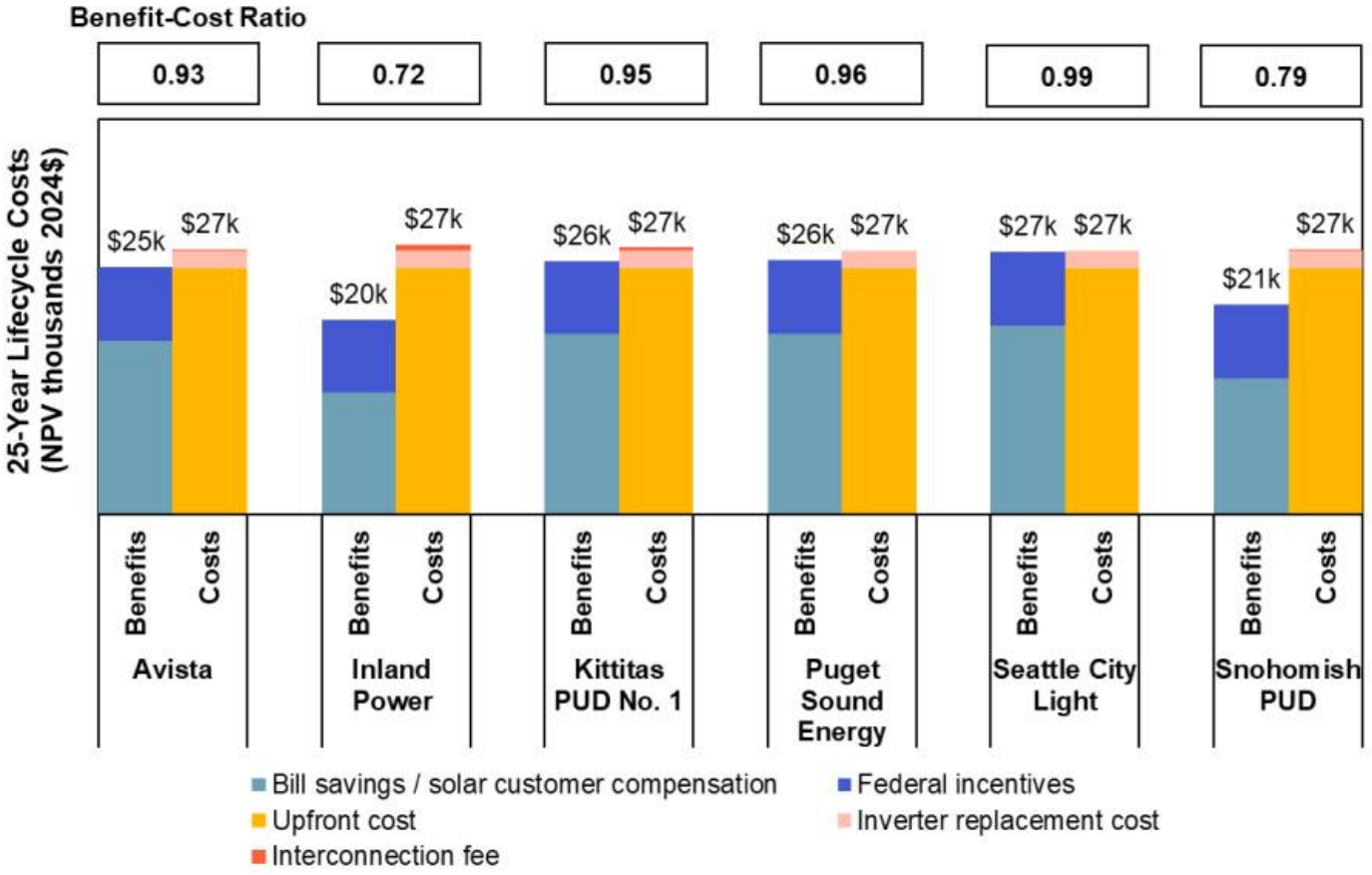
Rooftop Solar

Rooftop Solar

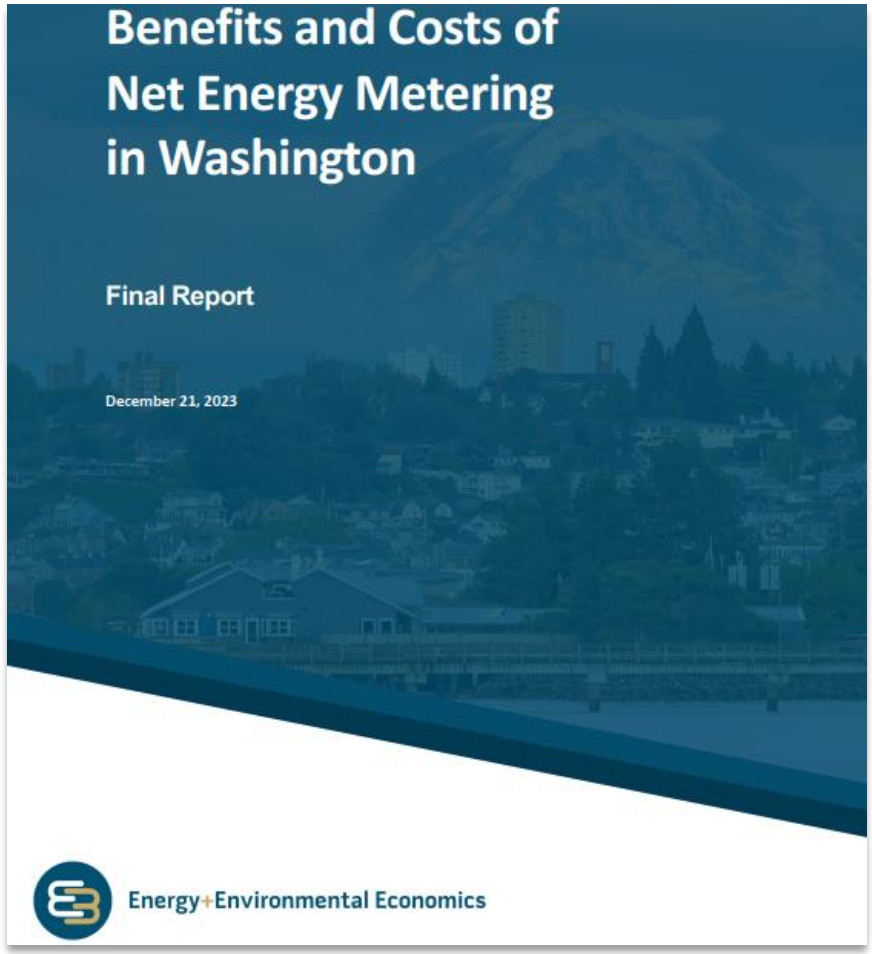


Rooftop Solar – Break Even Analysis

Figure 1. Participant Cost Test (PCT) by Utility for an Example 7 kW-AC System



Washington Public Utility Districts Association



Rooftop Solar – Break Even Analysis

- Benton PUD started collecting cost data in Jan 2023
  - Average reported cost per watt (DC) is $4.99

- Typical installed size in 2023 was approximately 9 KW
  - 12 KW would offset average annual residential home energy (kWh) charges

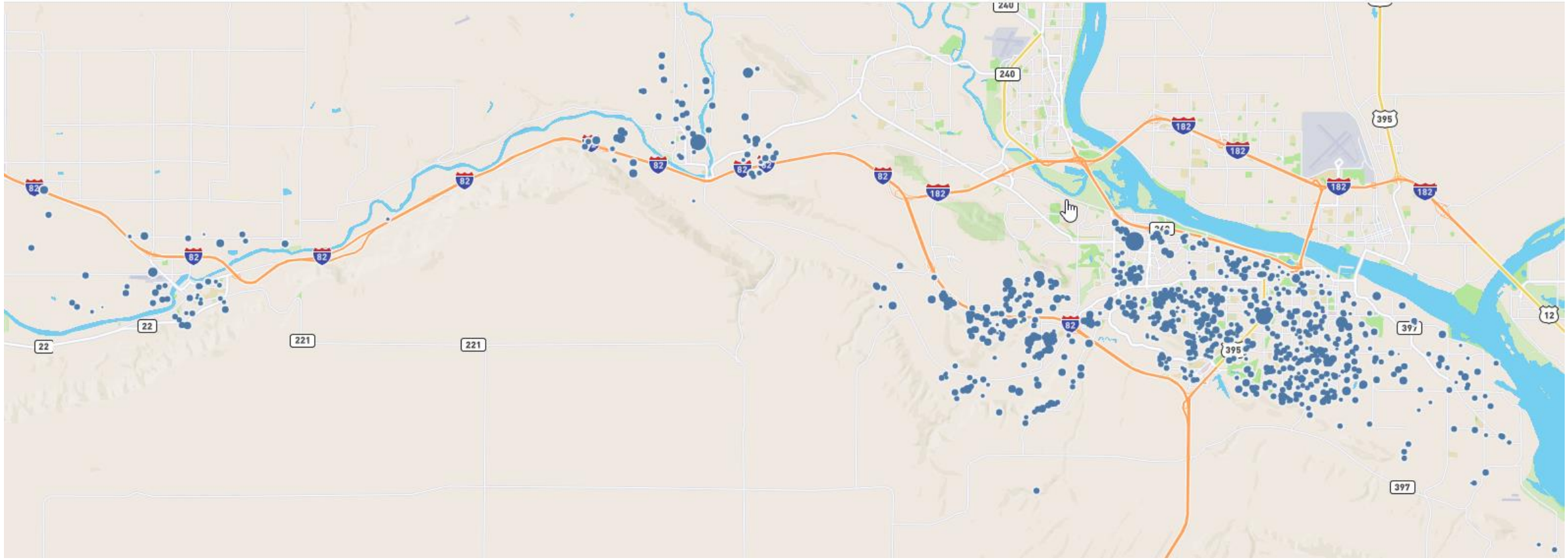
- What planet are we on financially speaking?
  - 12 KW system x $5 per KW = $60,000 up-front system cost
  - Average residential power bill is $120 per month or $1,440 per year
  - System cost equivalent to over 40 years of annual electricity bills

- Federal Investment Tax Credits currently 30%
  - 30% recently extended thru 2032
  - Applies to customer with tax liability

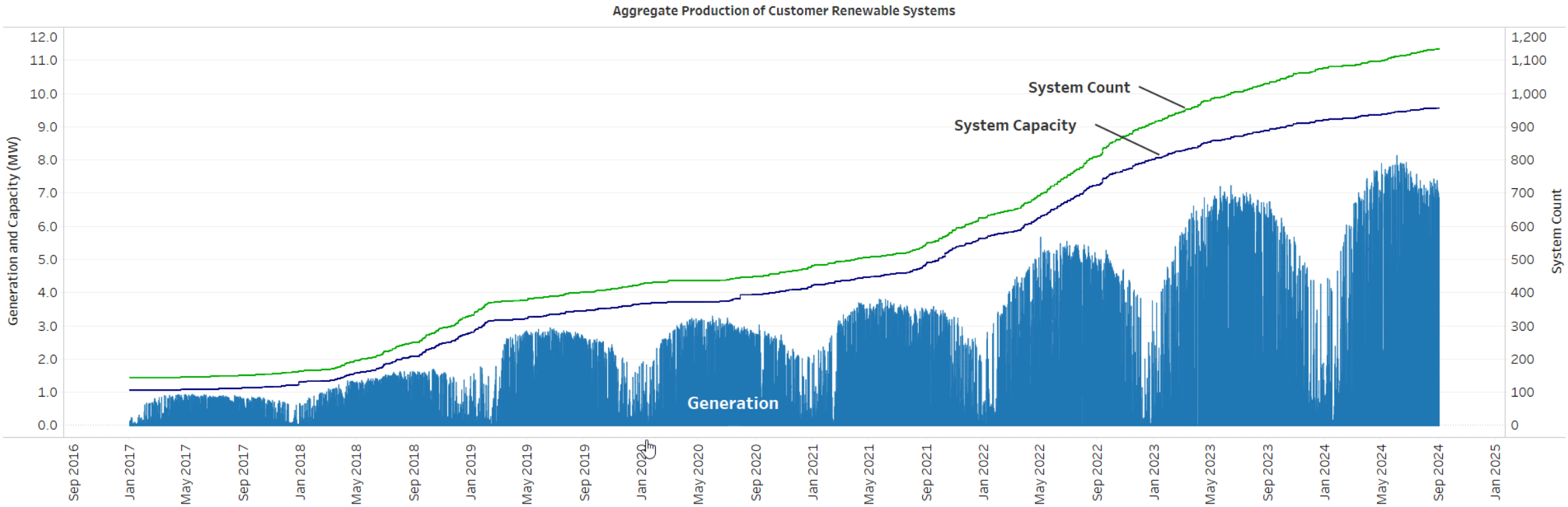
- No State incentives available

Rooftop Solar – Benton PUD Customer Solar

Solar Rooftop Map



Rooftop Solar – Benton PUD Customer Solar



End Date Time

1/1/2017 — 9/2/2024

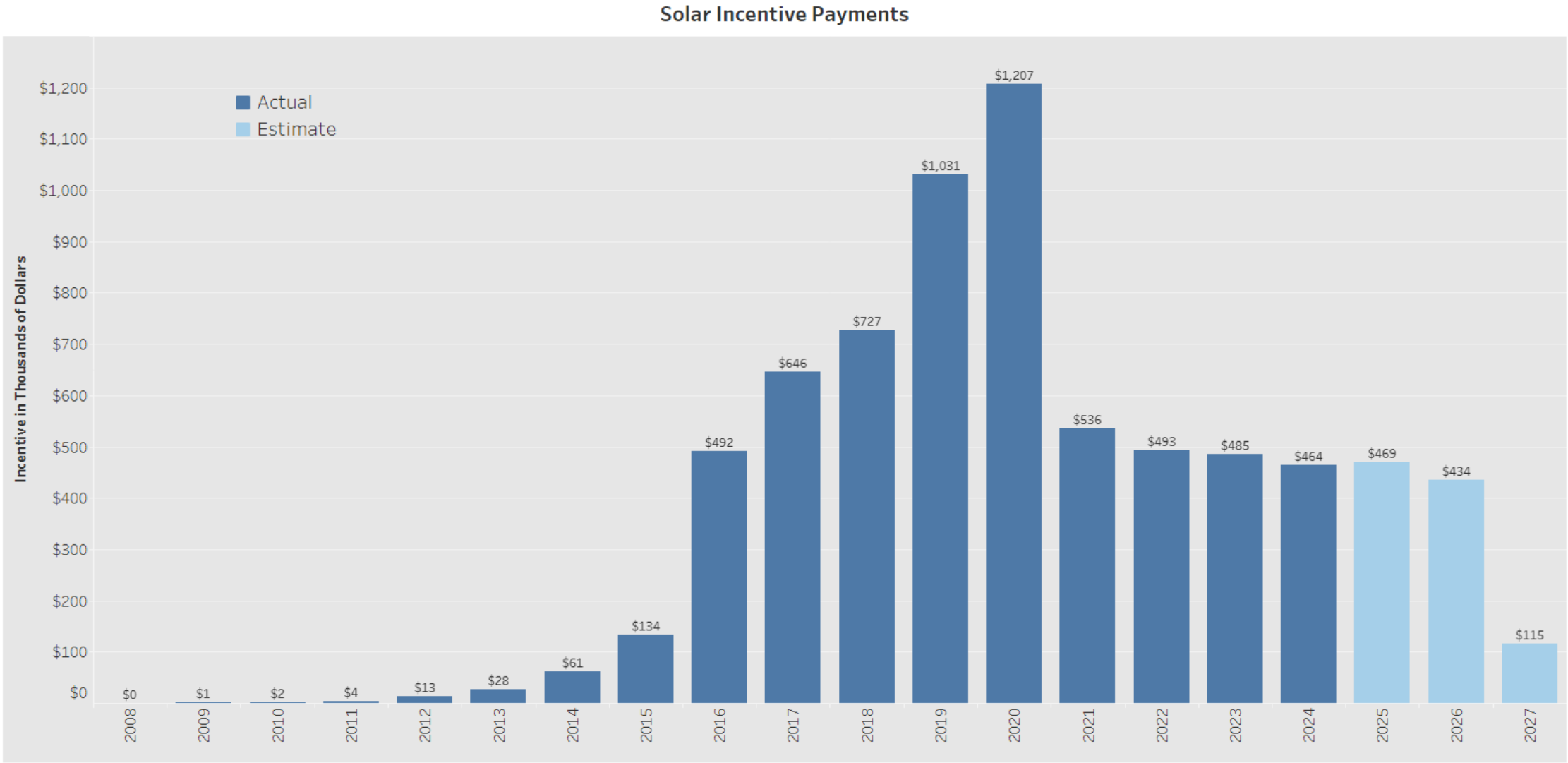
Maximums (Based on Date Range)	
Highest System Count	1,134
System Capacity (MW)	9.57
Highest Production (MW)	8.14
Mean Production (MW)	0.78
Capacity Factor	0.16

Rooftop Solar – Washington State Incentives

Customer-generated power applicable rates	Base rate (0.15) multiplied by applicable factor, equals incentive payment rate
Solar modules manufactured in Washington **Factor: 2.4** (two and four-tenths)	$0.36
Stirling converter manufactured in Washington **Factor: 2.4** (two and four-tenths)	$0.36
Solar or wind generating equipment with an inverter manufactured in Washington **Factor: 1.2** (one and two-tenths)	$0.18
Both solar modules and inverter manufactured in Washington **Factor: (2.4 + 1.2)** = 3.6 (three and six-tenths)	$0.54
Anaerobic digester or other solar equipment or wind generator equipped with blades manufactured in Washington **Factor: 1.0** (one)	$0.15
Wind generator equipped with both blades and inverter manufactured in Washington **Factor: (1.0 + 1.2)** = 2.2 (two and two-tenths)	$0.33
All other electricity produced by wind **Factor: 0.8** (eight-tenths)	$0.12

- ✓ ***Washington State Renewable Energy Cost-Recovery Incentive Program Established in 2013 for Customer-Owned Generation***
- ✓ ***Some of the most generous tax subsidies in the U.S.***
- ✓ ***Program terminated February 14, 2019, after reaching funding limit***

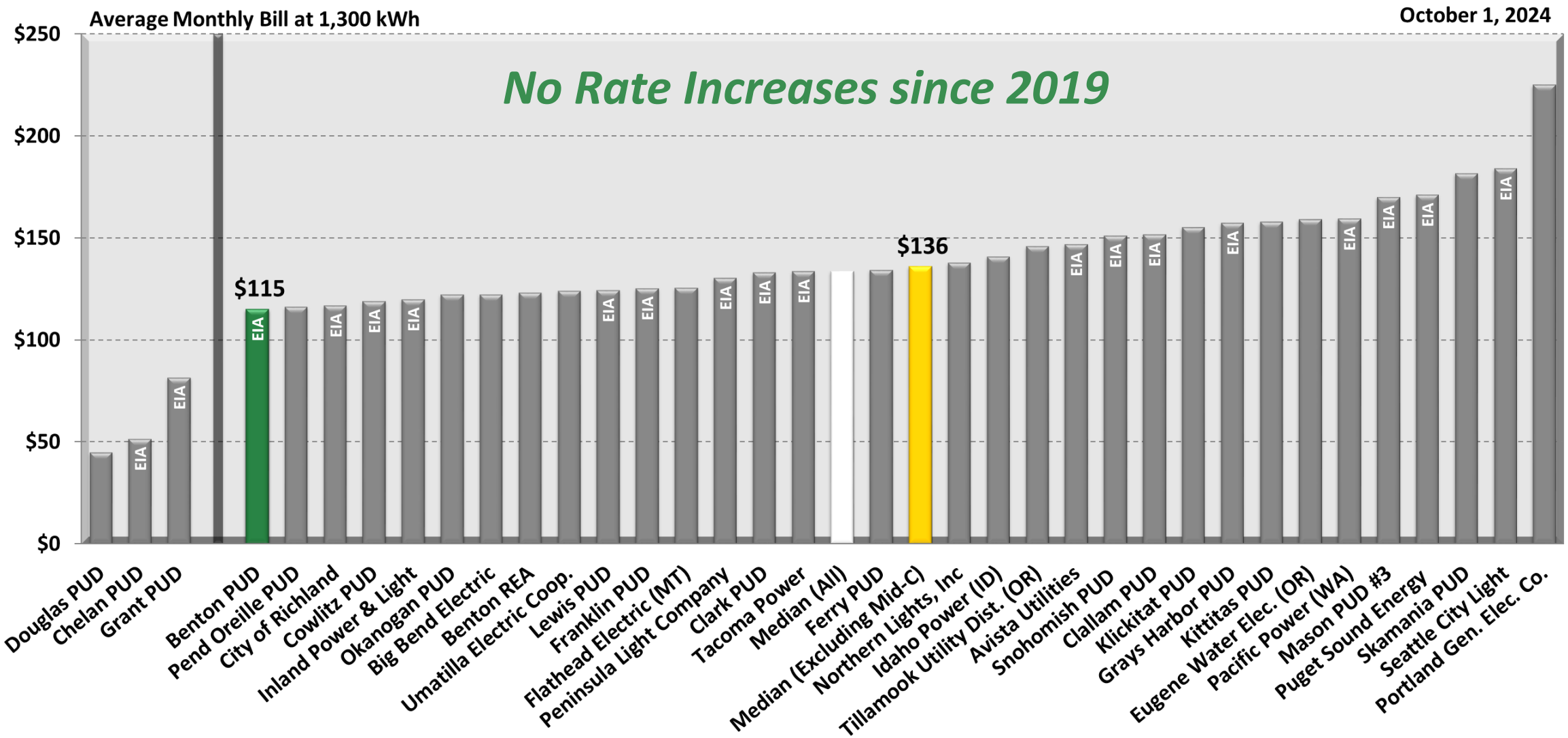
Rooftop Solar – Benton PUD Solar Incentive Payments



Benton PUD
Rates & Finances

Benton PUD
Rates & Finances

Benton PUD Average Customer Bill Compared to Others



2024 Preliminary Budget vs. 2023 Original Budget

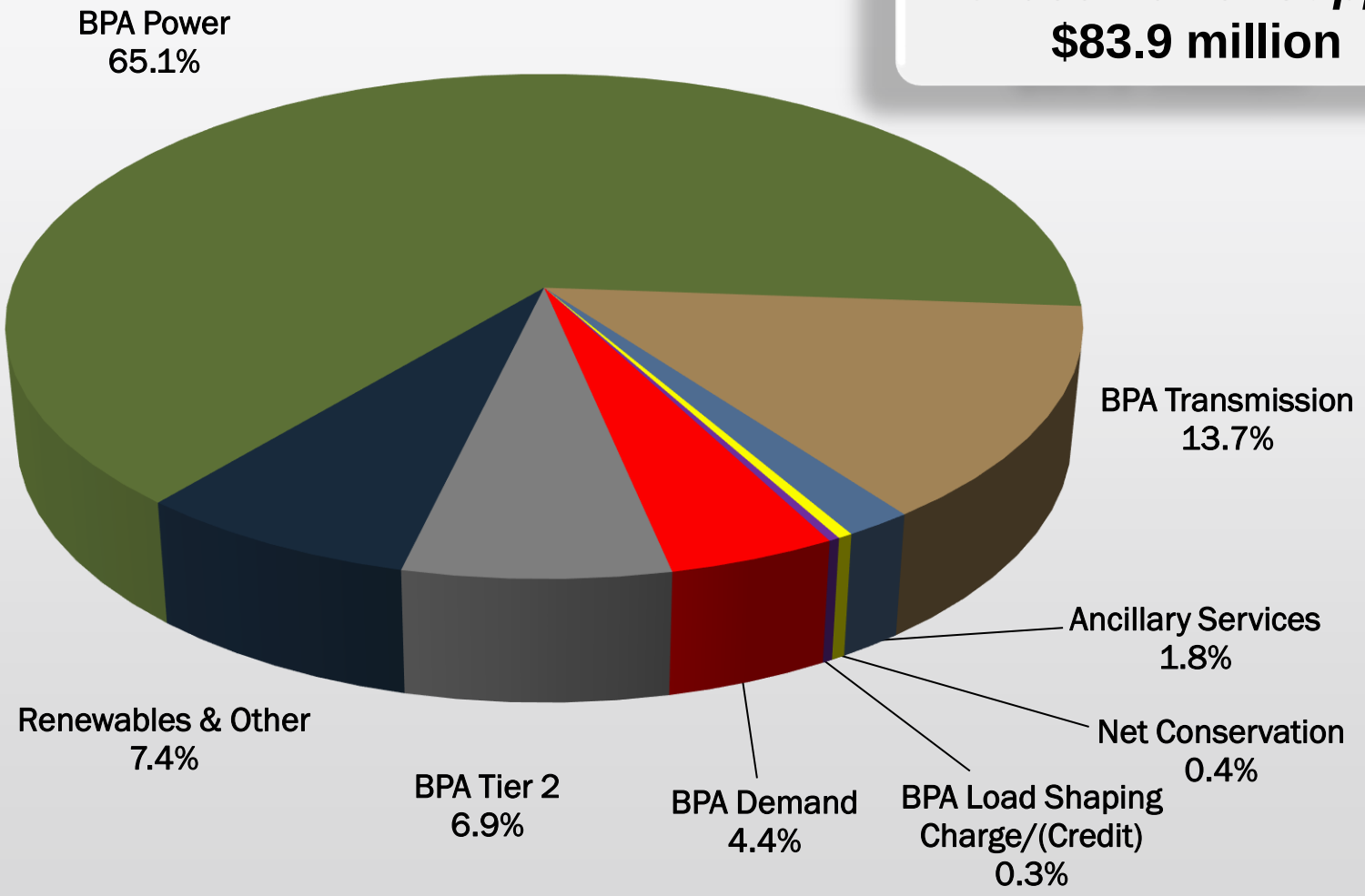
Five Budget Categories

Dollars in thousands	2024 Budget	2023 Original Budget	Increase/ (Decrease)	% Change
Revenues (excluding Secondary Market Sales)	**$143,281**	**$142,284**	**$997**	**0.7%**
Expenses (including Secondary Market Sales)				
Purchased Power	70,573	68,456	2,117	3.1%
Purchased Transmission & Ancillary Services	13,003	14,251	(1,248)	(8.8%)
Net Conservation	323	373	(50)	(13.4%)
Less: Secondary Market Sales	4,069	11,645	(7,576)	(65.1%)
Net Power Expenses	**$79,830**	**$71,435**	**$8,395**	**11.8%**
Transmission Operation & Maintenance	111	169	(58)	(34.3%)
Distribution Operation & Maintenance	14,052	13,371	681	5.1%
Broadband Expense	1,197	1,193	4	0.3%
Customer Accounting	5,043	4,995	48	1.0%
Administrative & General	9,475	9,222	253	2.7%
Subtotal before Taxes & Depreciation	**$29,878**	**$28,950**	**$928**	**3.2%**
Taxes	14,777	14,712	65	0.4%
Depreciation/Amortization	11,995	11,233	762	6.8%
Non-Power Operating Expenses	**$56,650**	**$54,895**	**$1,755**	**3.2%**
Gross Capital	31,918	29,869	2,049	6.9%
Less: Capital Contributions	3,571	3,113	458	14.7%
Net Capital Additions	**$28,347**	**$26,756**	**$1,591**	**5.9%**
Debt Service (including BABs Subsidy)	**$6,377**	**$5,088**	**$1,289**	**25.3%**

2024 Gross Power Supply Cost by Source

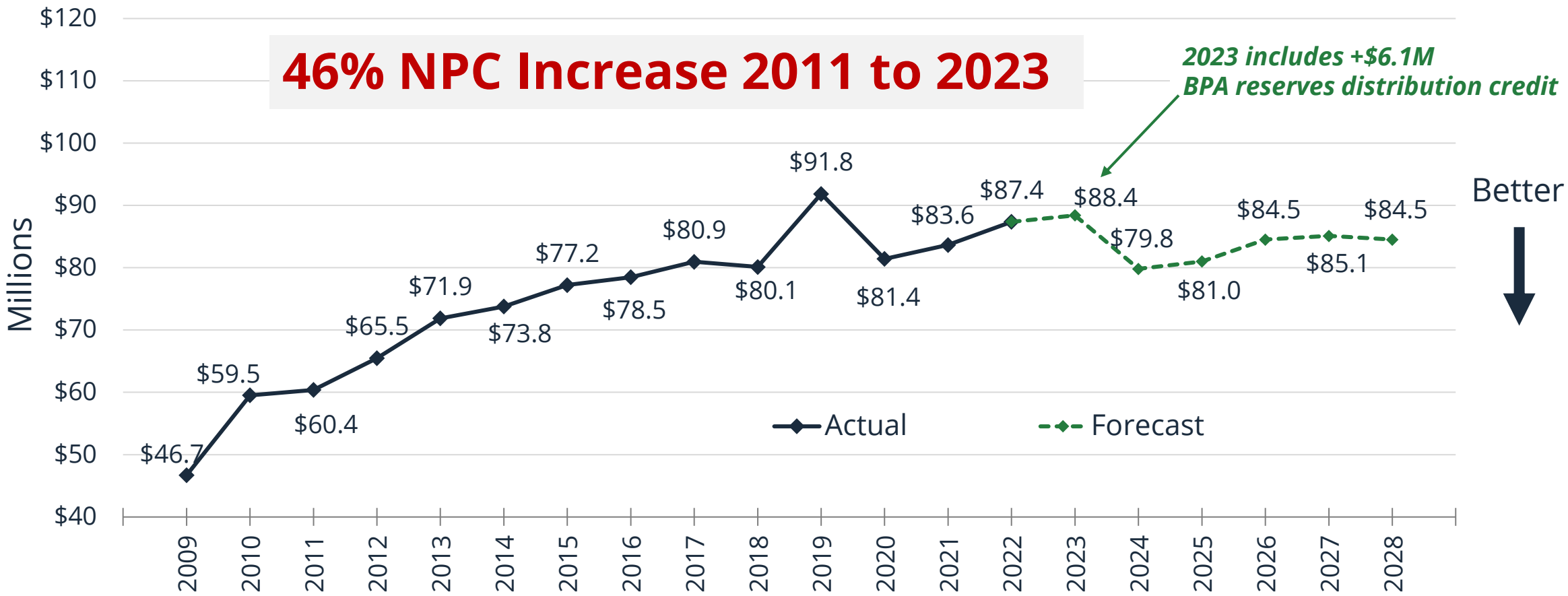
Description	Amount *Dollars in millions*
BPA Power	$54.7
BPA Tier 2	5.8
BPA Demand	3.7
BPA Load Shaping Charge/(Credit)	0.2
BPA Reserve Distribution Clause	0.0
BPA Transmission	11.5
Renewables & Other	6.2
Ancillary & Net Conservation	1.8
Gross Power Supply	**$83.9**
Less: Secondary Market Sales	(3.9)
Less: Transmission Sales	(0.2)
Net Power Expense	**$79.8**

Gross Power Supply
$83.9 million



Note: The District switched from a Block/Slice contract to a Load Following contract with BPA effective October 1, 2023. As a result, the District's gross power costs will be less, but so will the Secondary Market Sales. A Load Following contract will provide more price certainty.

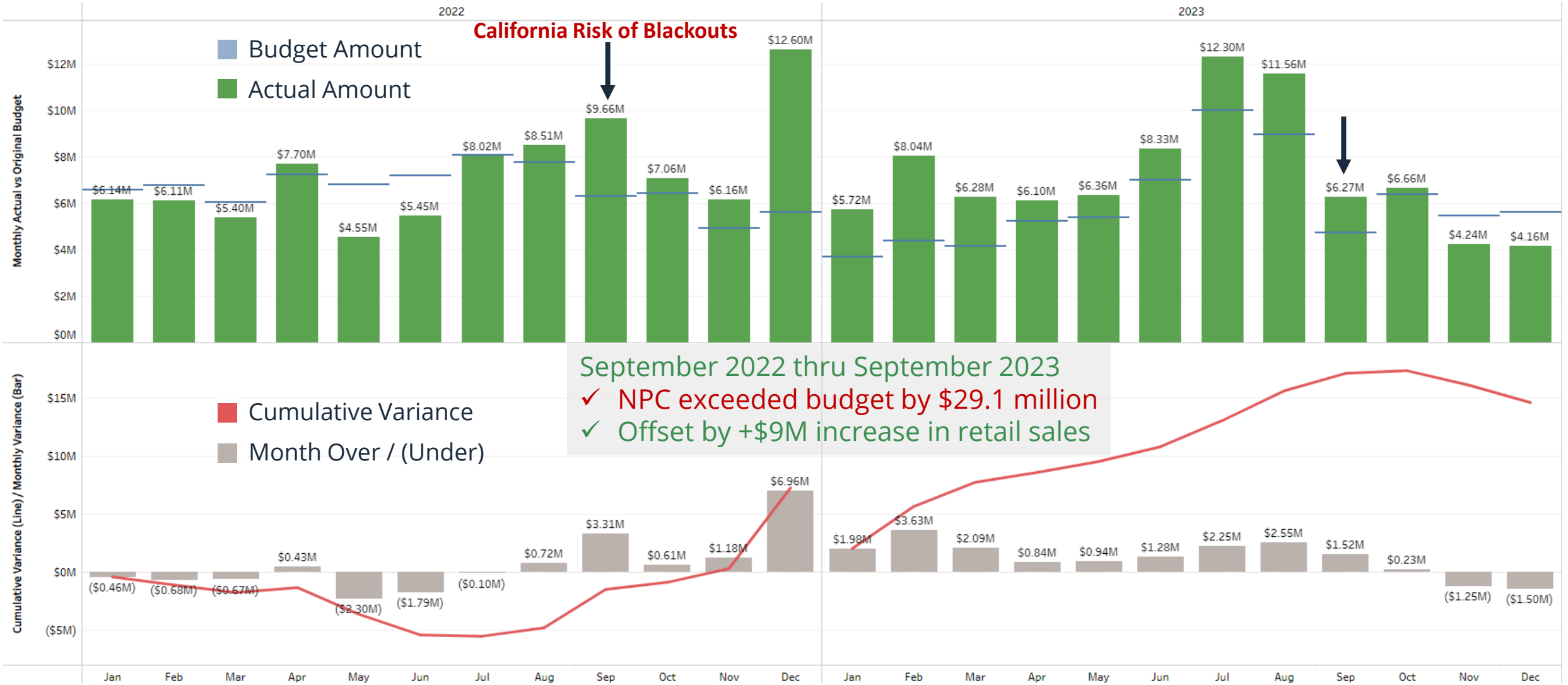
Net Power Costs*



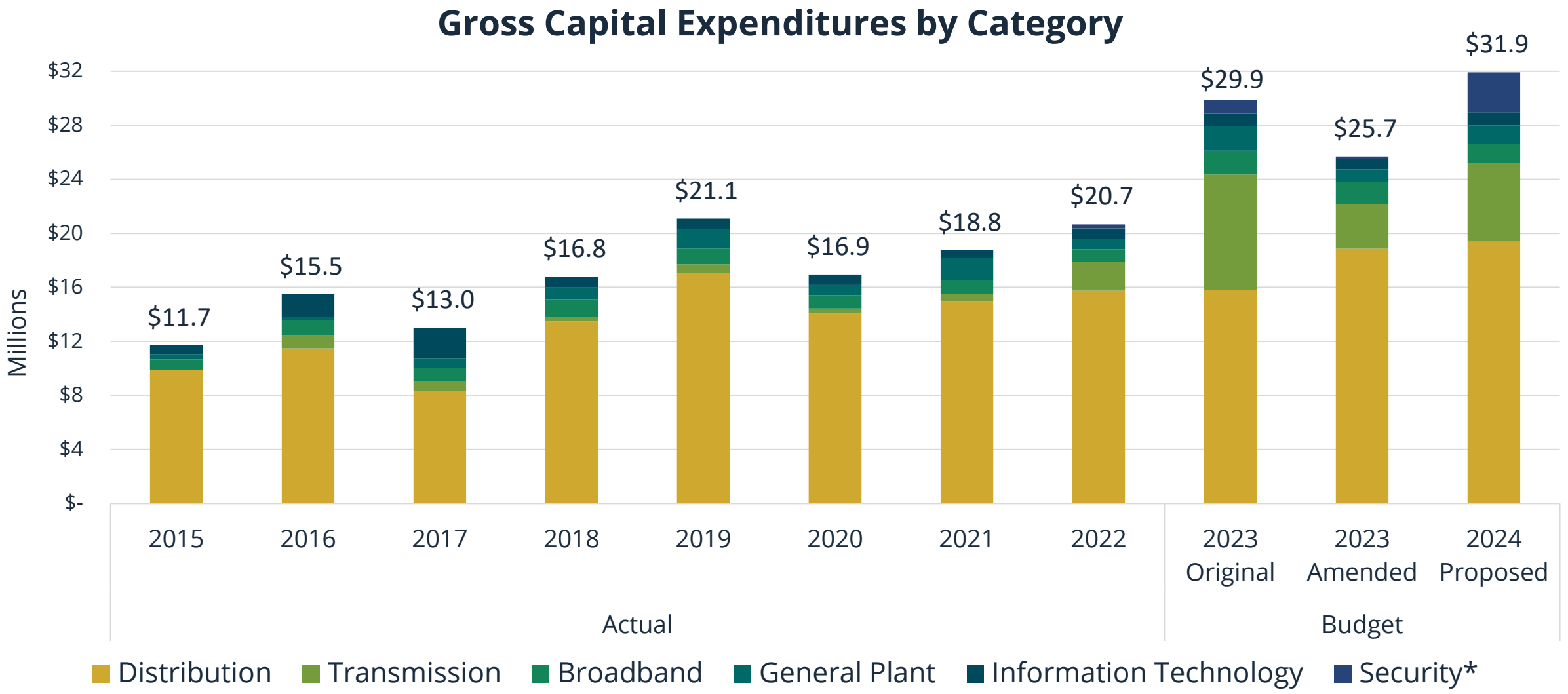
* Net power costs (NPC) = gross power costs (including power and transmission) less sales for resale.
NPC is based on the 25th percentile for 2022 & 2023 original budget and load following assumptions for 2024 – 2028.

Net Power Costs – Recent History

Cumulative Net Power Cost Budget vs Actuals (Original Budget Only): All



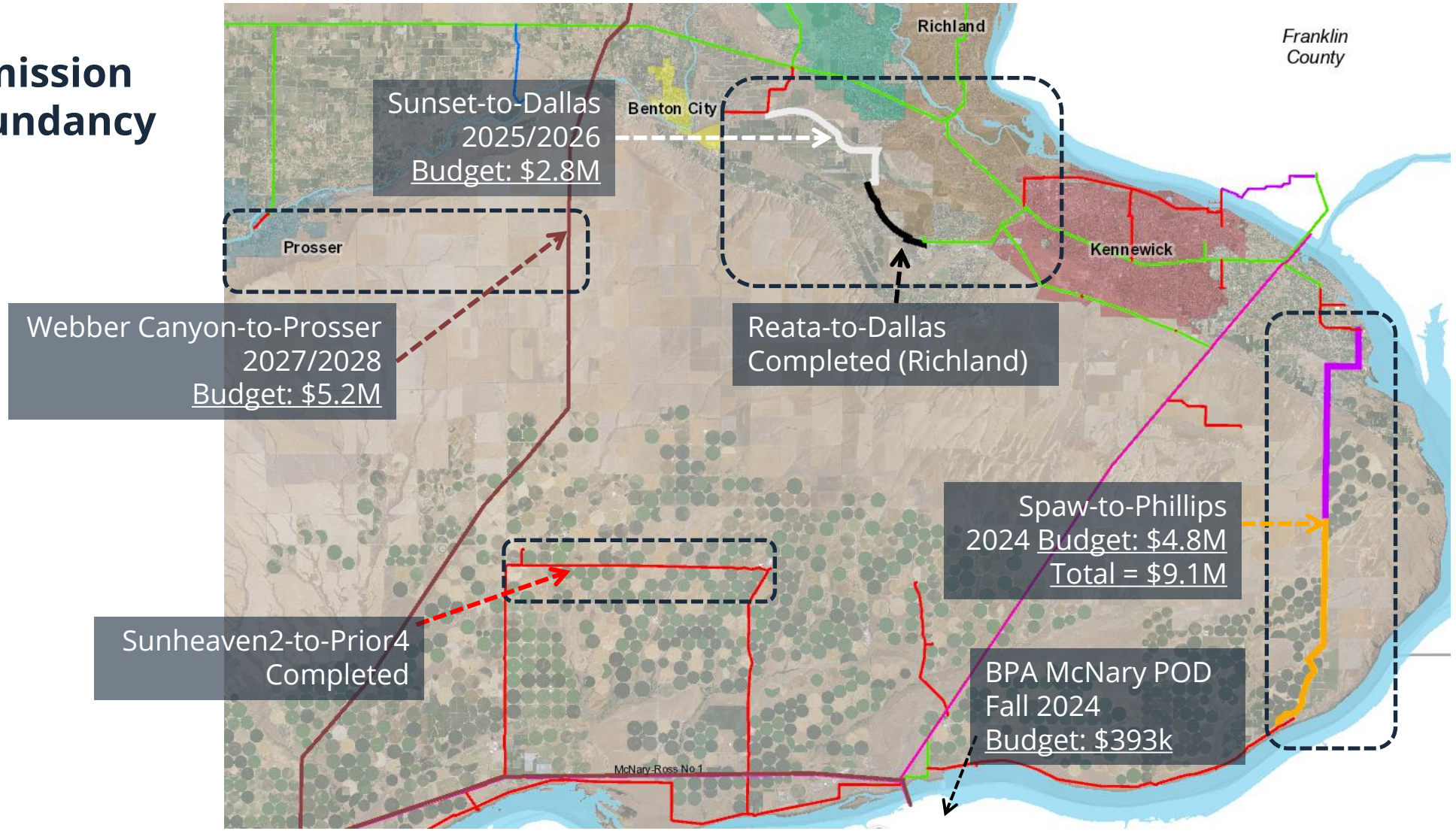
2015-2024 Gross Capital



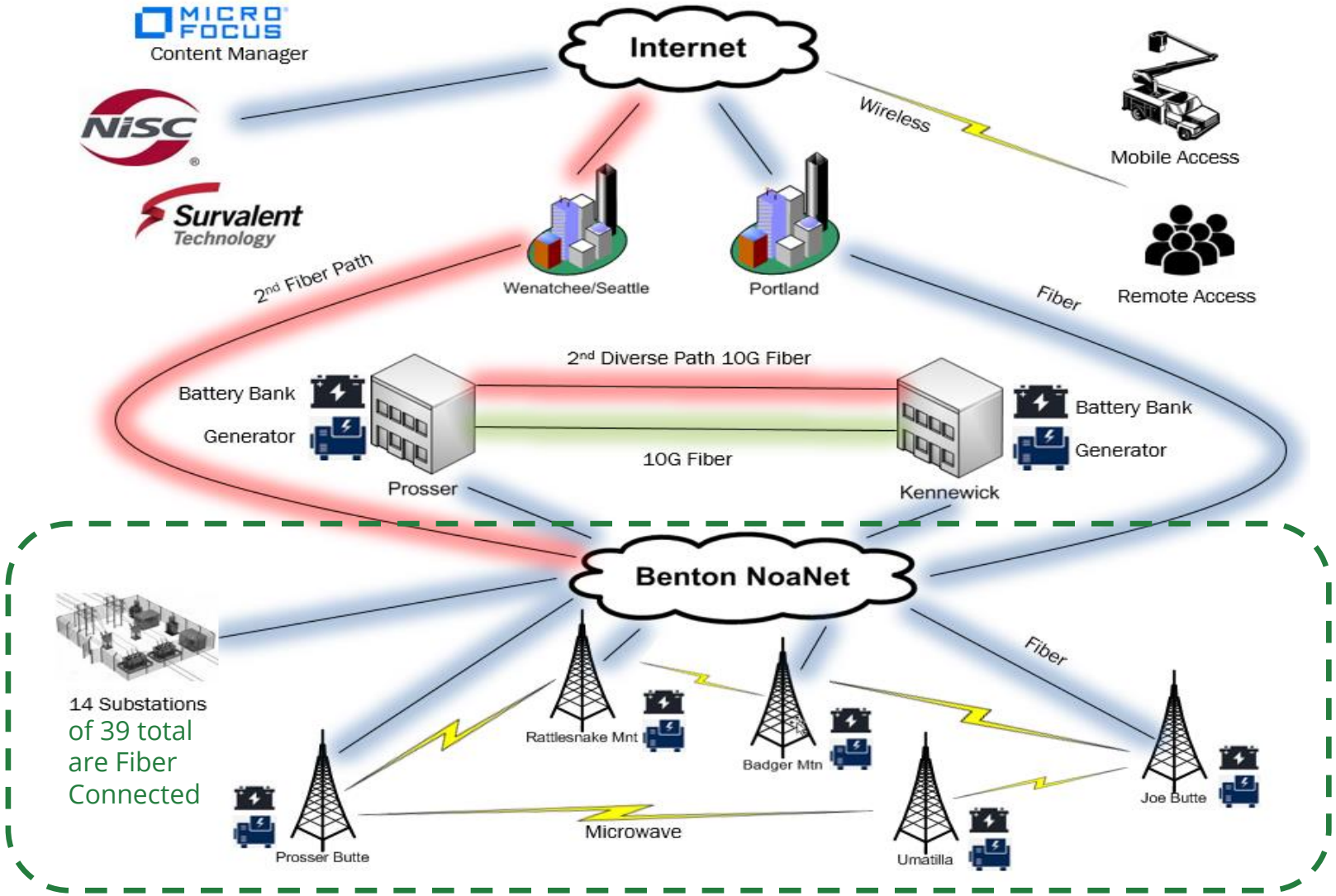
*new category added in 2021

Transmission Reliability Improvement Projects

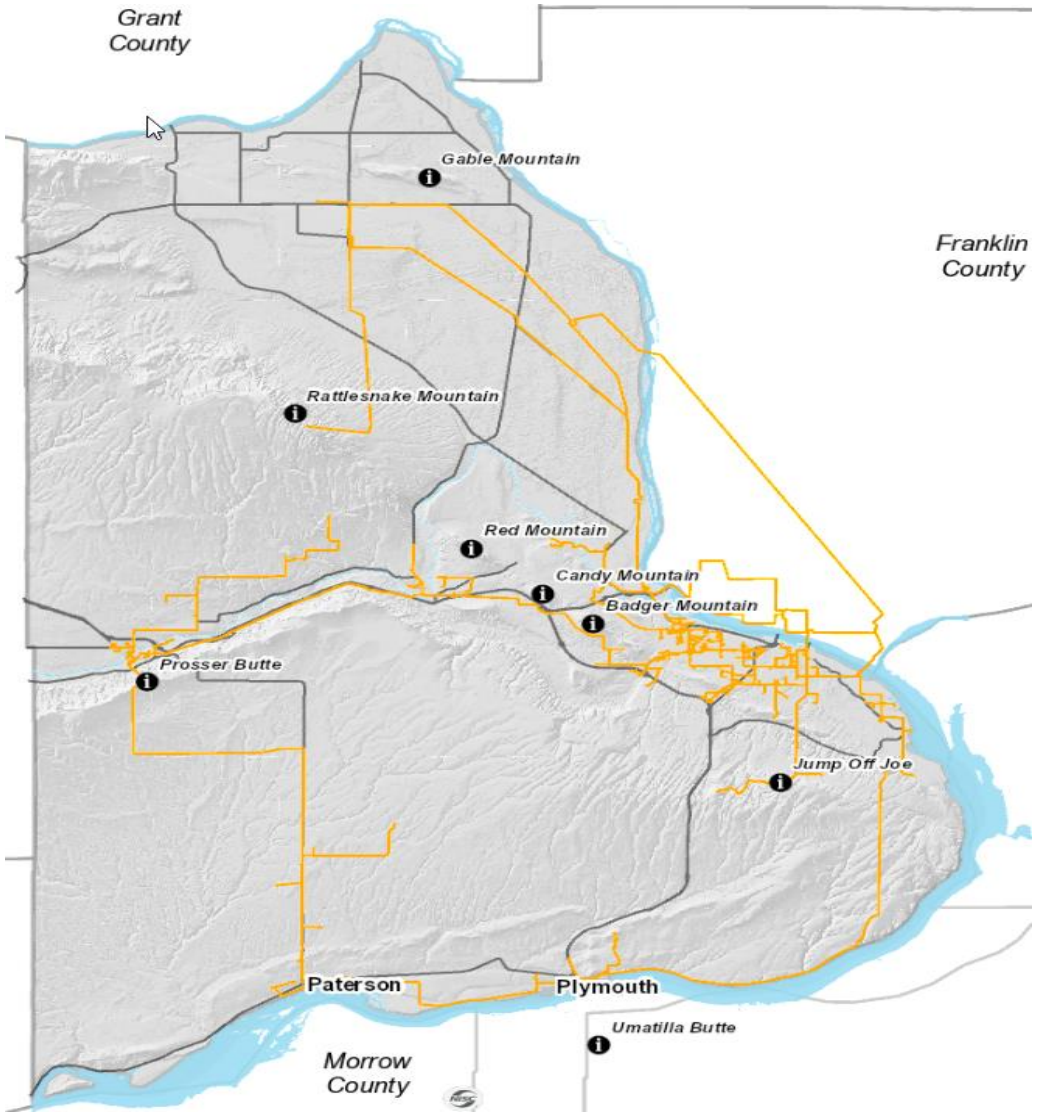
115-kV Transmission Lines for Redundancy



Next Generation SCADA: Communications



Next Generation SCADA: Fiber Optic System

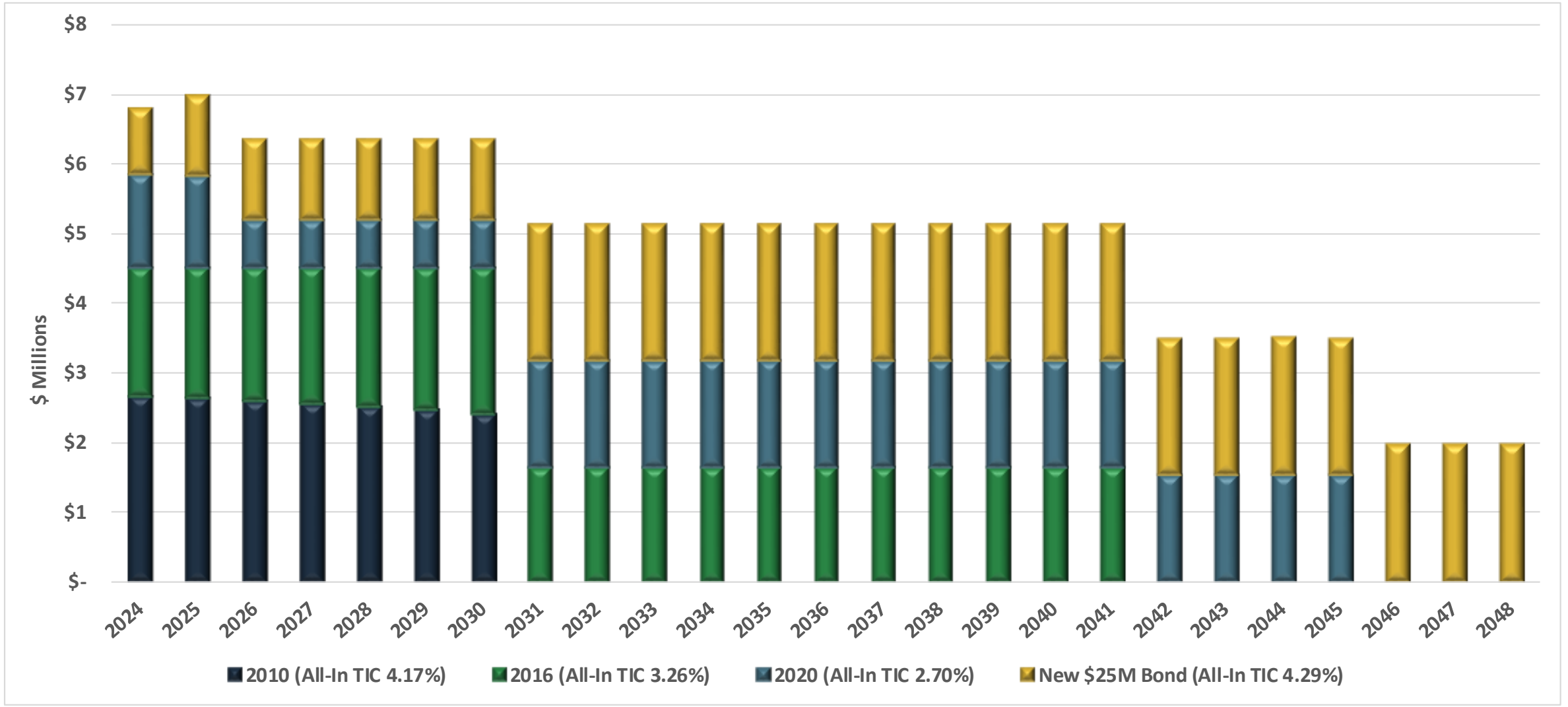


Fiber miles: **~519**

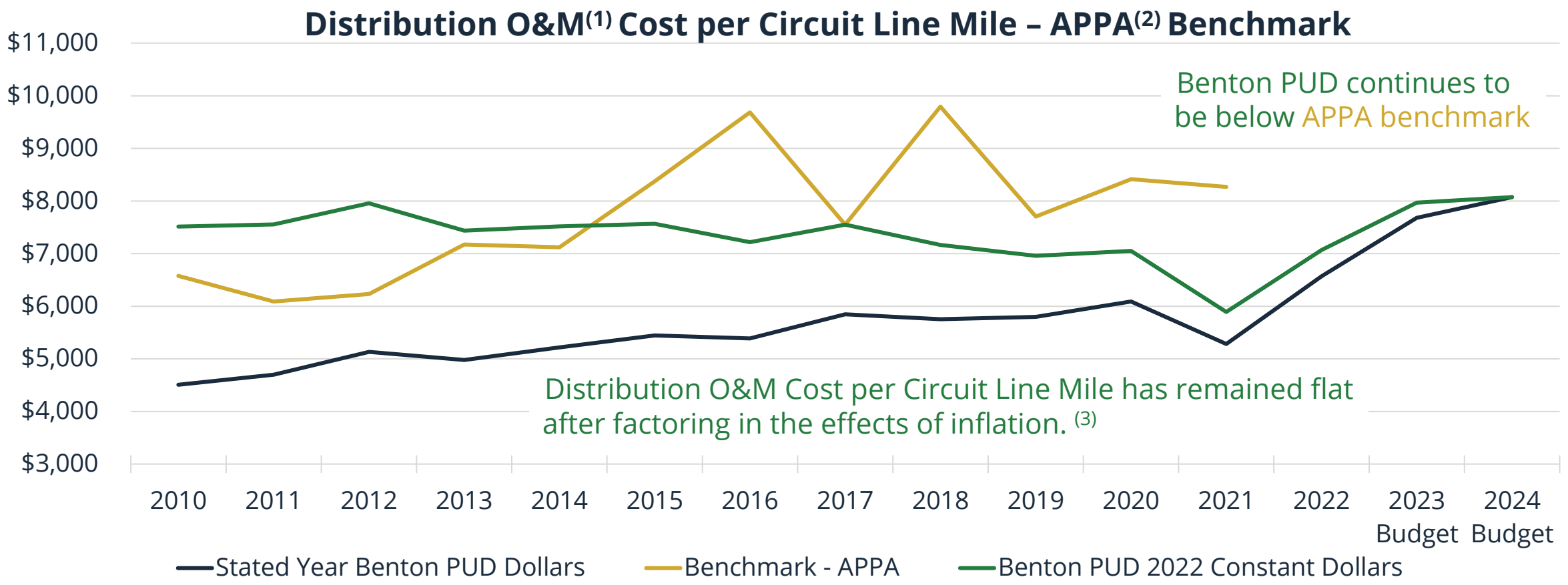
Fiber customers: **726**

Wireless customers: **74**

Benton PUD Debt Service



Distribution O&M



(1) Distribution O&M only. Excludes Broadband.

(2) American Public Power Association - 2021 median for West utilities.

(3) Inflation rate utilized comes from a producer price index for electric utilities, which on average has been slightly under 3%.