ENERGY NORTHWEST

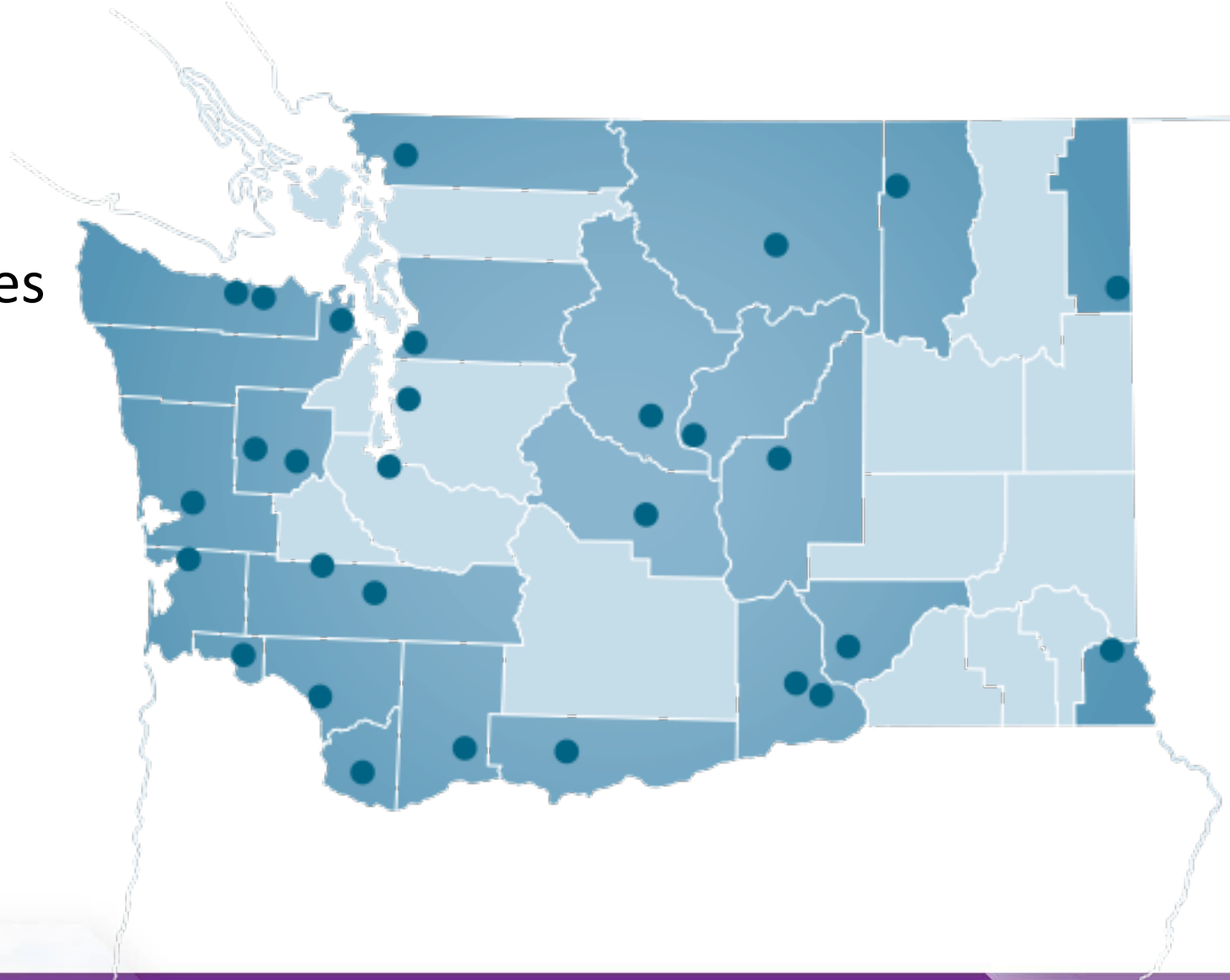
Greg Cullen
Vice President, Energy Services & Development

About Us

- Not-for-profit joint operating agency since 1957
- Own and operate hydroelectric, wind, solar, battery storage and nuclear energy facilities
- Facilities provide power to utilities in 6 states: Washington, Oregon, Idaho, Montana, Wyoming, California

Our Members

- 29 Washington public utilities and municipalities



Our mission

Providing our public power members and regional customers with safe, reliable, cost-effective, responsible power generation and innovative energy and business solutions.

100% Clean Generating Portfolio

Nine Canyon Wind Project (96 MW)

Columbia Generating Station (1,207 MW)

Horn Rapids Solar, Storage & Training Project (4 MW)

White Bluffs Solar Station (38 KW)

Portland Hydroelectric Project (37.5 MW)

Tieton Hydroelectric Project (15 MW)

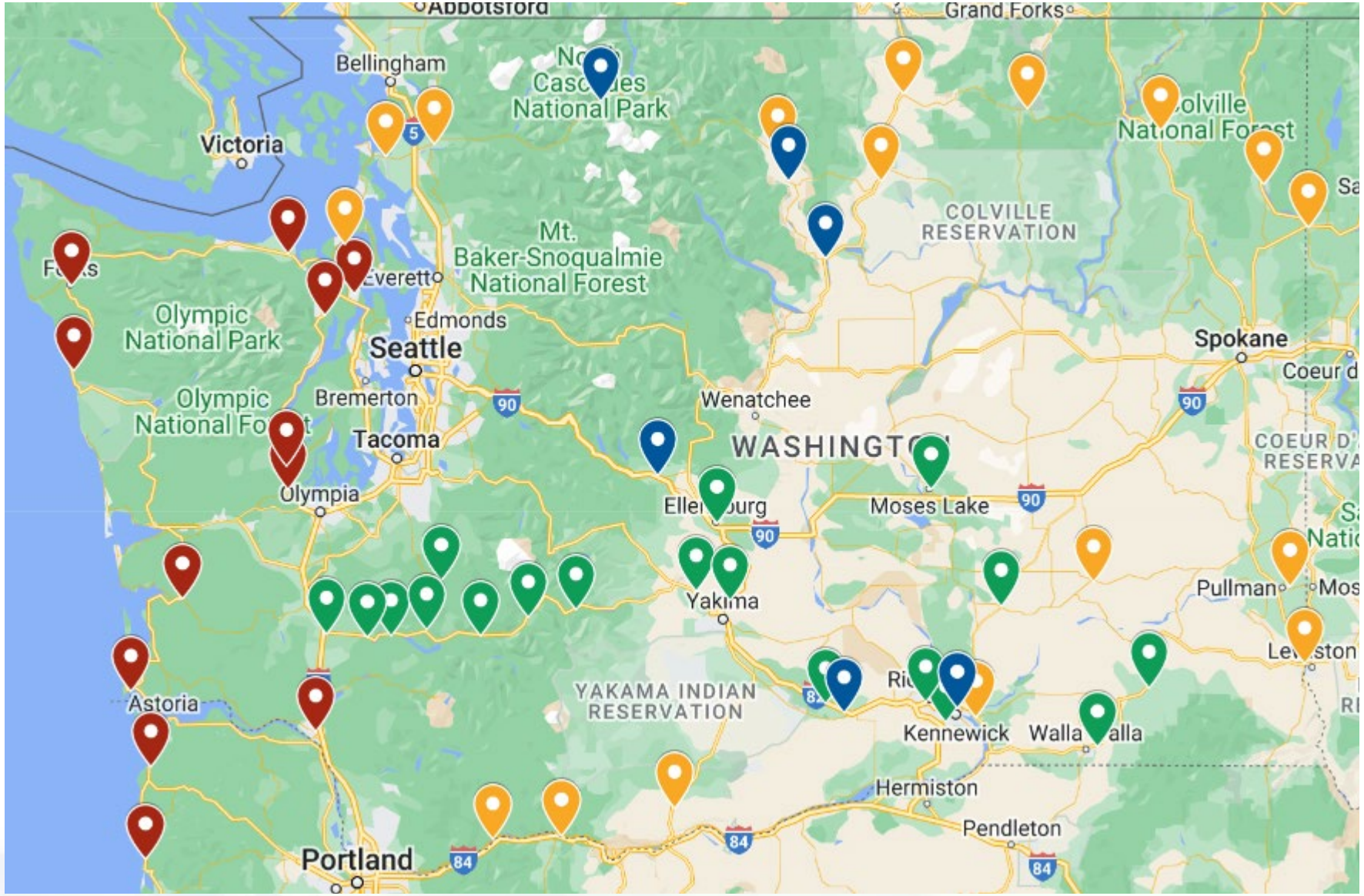
Packwood Lake Hydroelectric Project (27 MW)

Stone Creek Hydroelectric Project (12 MW)

Ruby Flats Solar Project (127 MW)

Other Programs and Services

- Electric Vehicle Charging Infrastructure
- Clean Energy and Resilience Grants Program
- Energy Storage
- Smart Grid/Demand Side Management
- Workforce Development
- Public Power Internship Program



EVITA Charging Network

EV Charging Station locations

- EN Owned (18)
- Customer Owned (6)
- Under Construction (17)
- Recently Awarded (12)

*Of the 29 locations being developed, 7 will be EN owned & 22 will be customer owned.

Columbia Generating Station

40 years of safe operations

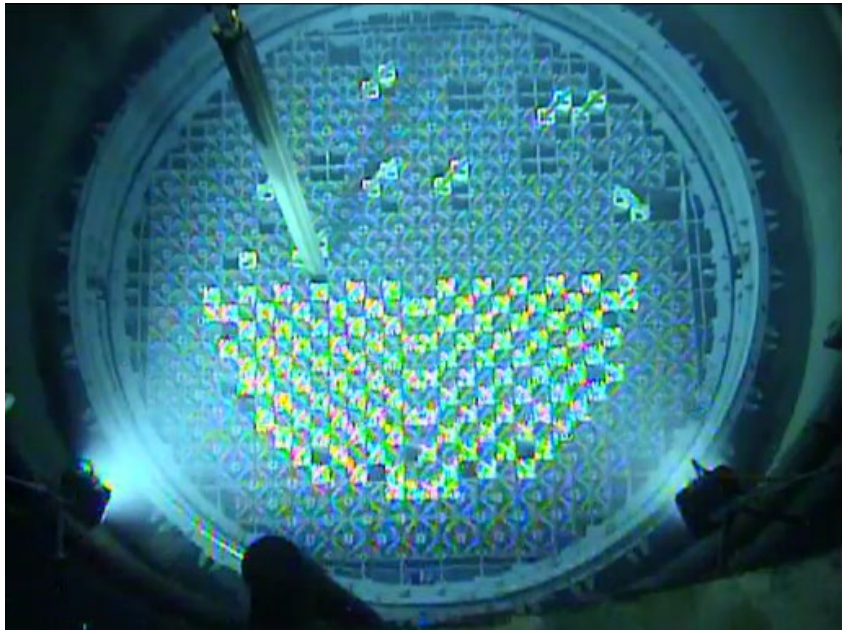
Columbia Generating Station

- GE Boiling Water Reactor
- 1,207 MWe
- Online Dec. 1984
- Licensed through 2043
- 6+ years without unplanned shutdown
- Next refueling April 2025

Uranium Fuel

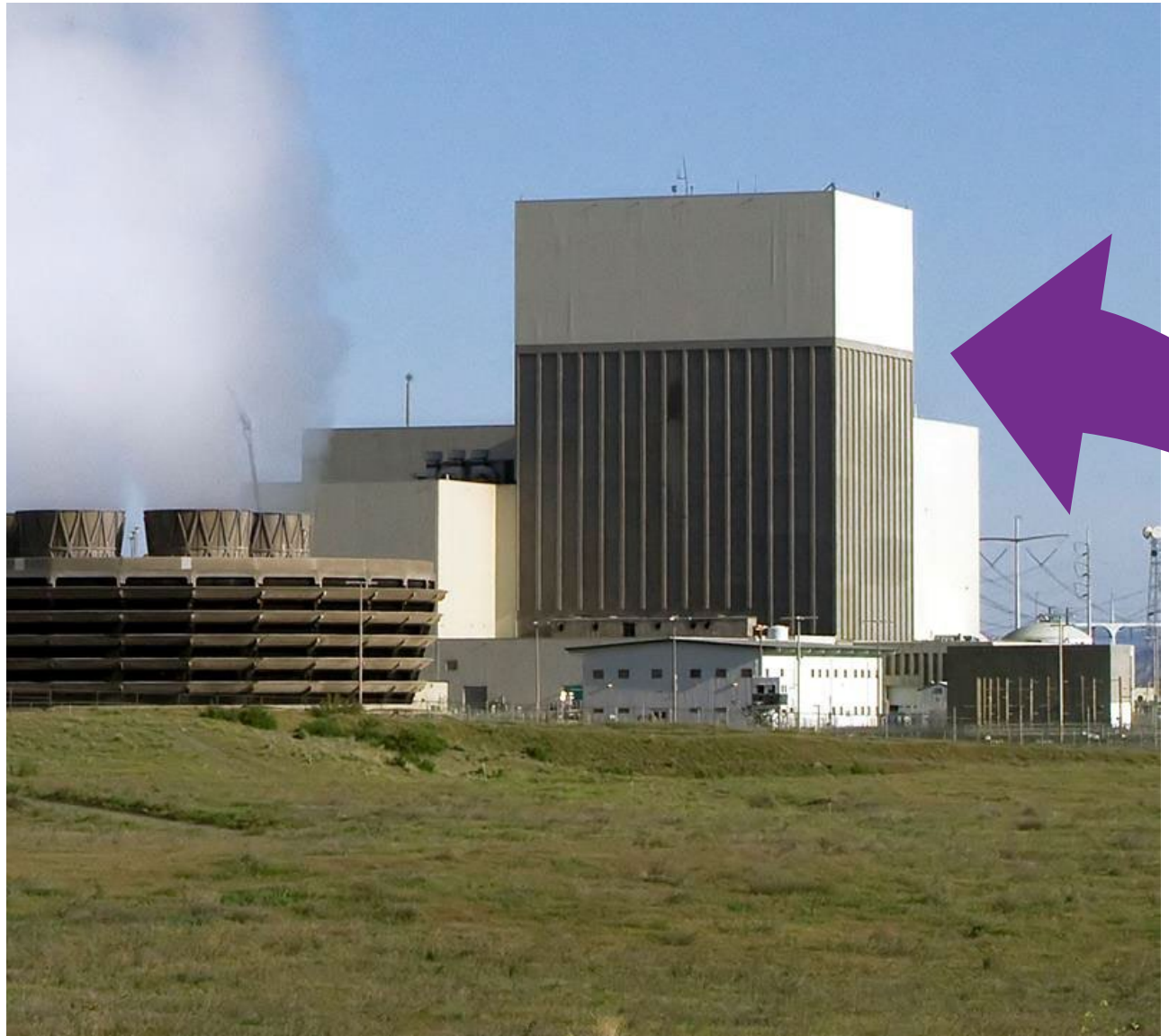
- Uranium 235 (enriched 3-5%)
- Manufactured at GE in North Carolina
- Fuel assembly ~15 feet long
- 764 fuel assemblies in the reactor core
- 6 years in the reactor core

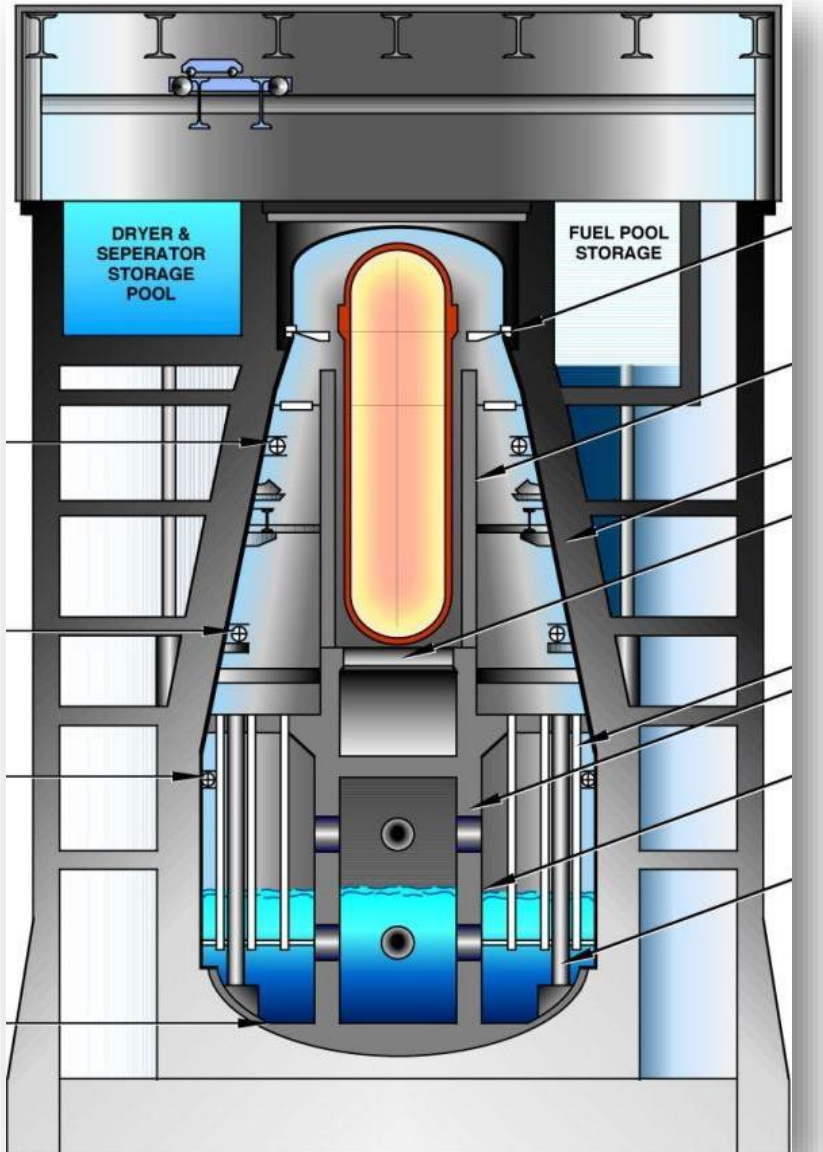
Uranium fuel pellets



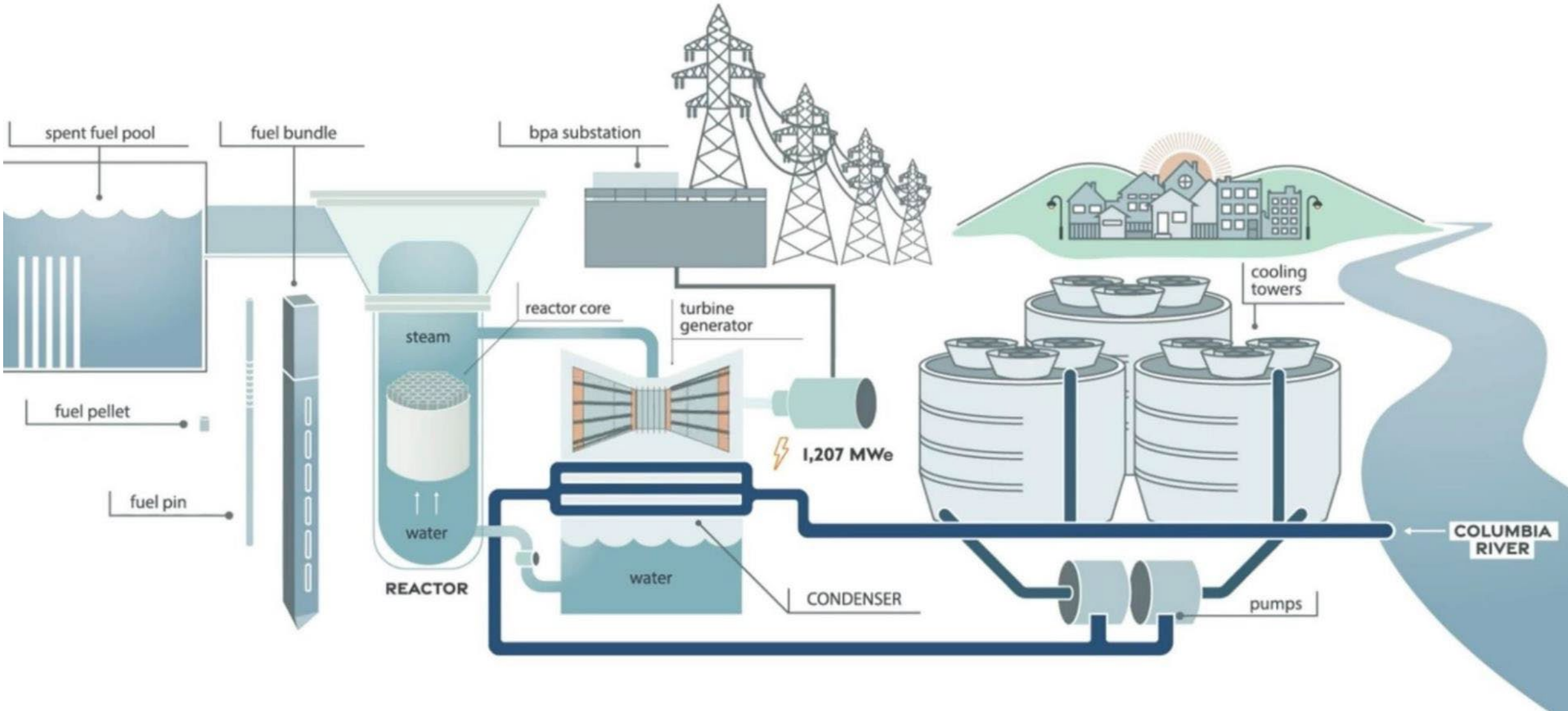
Reactor core during refueling outage

Reactor Building





Boiling Water Reactor Steam Cycle



Inside the reactor core

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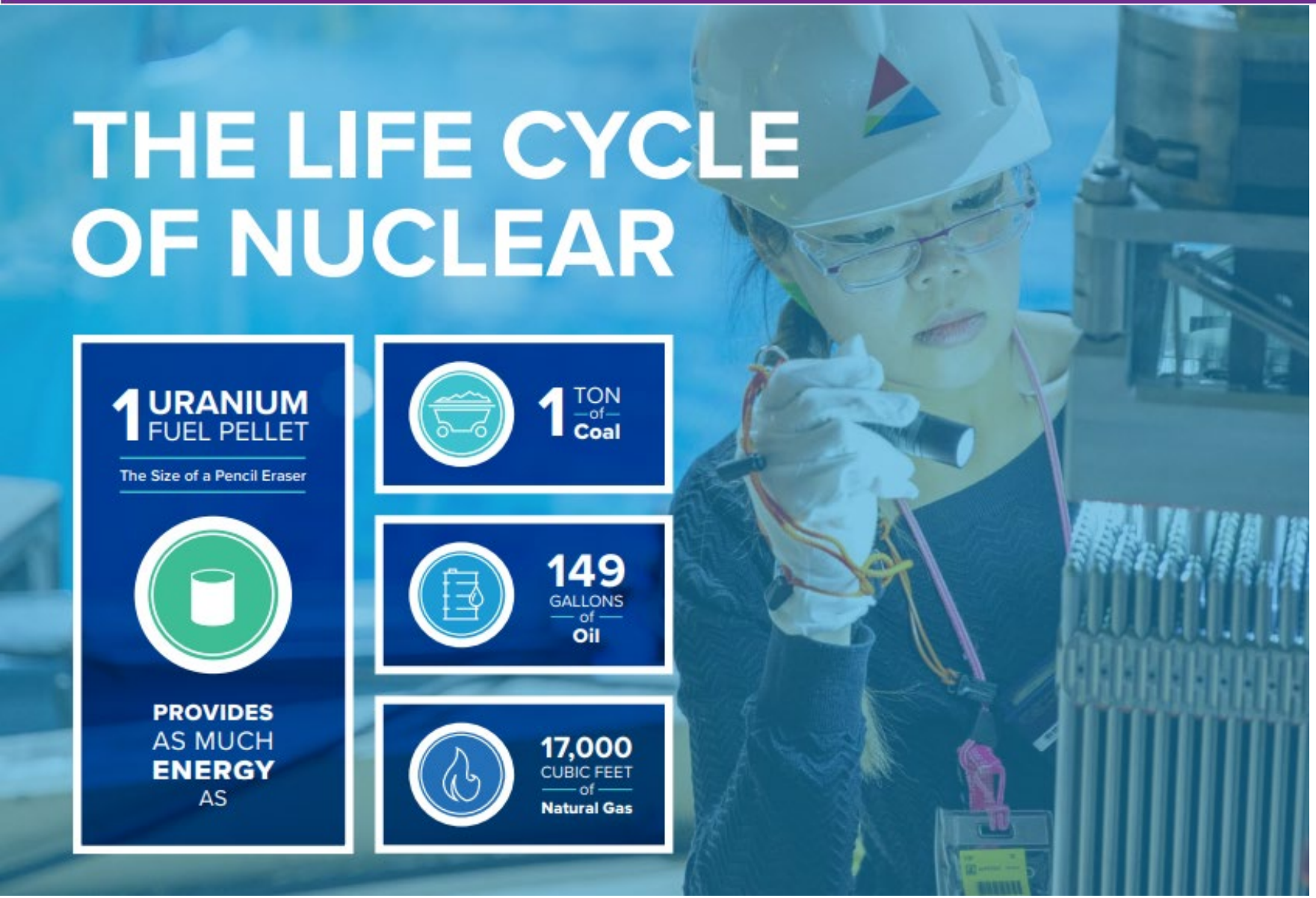


One uranium fuel pellet creates as much energy as…

- One ton of coal
- 149 gallons of oil
- 17,000 cubic feet of natural gas

Used Nuclear Fuel

- Dry casks stored at Columbia Generating Station

Hanford Tank Waste vs. Columbia Used Fuel

Used Fuel from 60 + years of U.S. Commercial Operation Could Fit on a Football Field

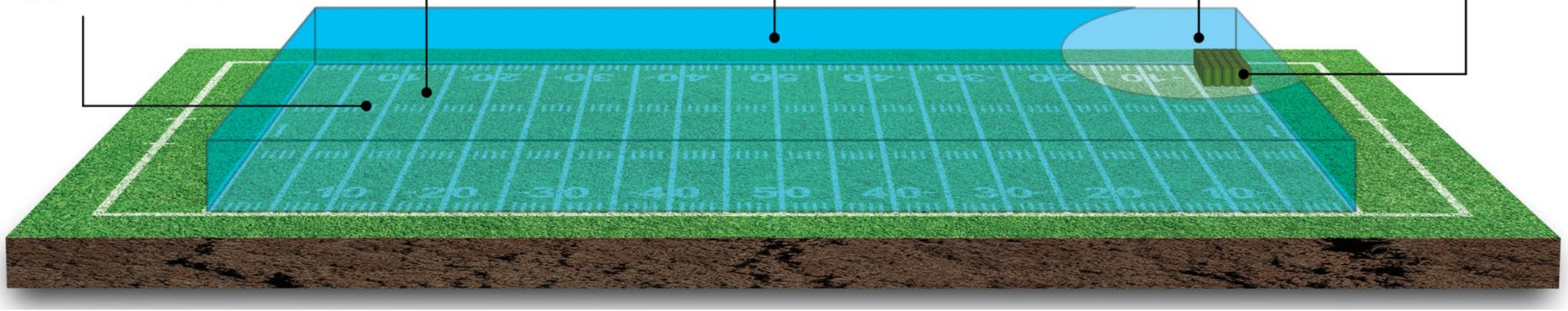
A standard football field is 360 ft. x 160 ft. = 57,600 sq. ft.

The entirety of the United States used fuel footprint would cover a football field 24' deep.

Number of casks currently loaded and fully processed at Columbia's ISFSI: 54

ISFSI currently covers an area that is approximately 342 ft. x 468 ft. = 160,056 sq. ft. ISFSI's security fence, which is what most people consider to be the ISFSI, covers an area that is 260 ft. x 390 ft. = 101,400 sq. ft. or roughly 1-3/4 football fields.

Number of fuel bundles per cask: 68 (total bundles currently stored at the CGS ISFSI: 68 x 54 = 3,672 used fuel bundles in dry storage)



*CGS = Columbia Generating Station
*ISFSI = Independent Spent Fuel Storage Installation (at CGS)

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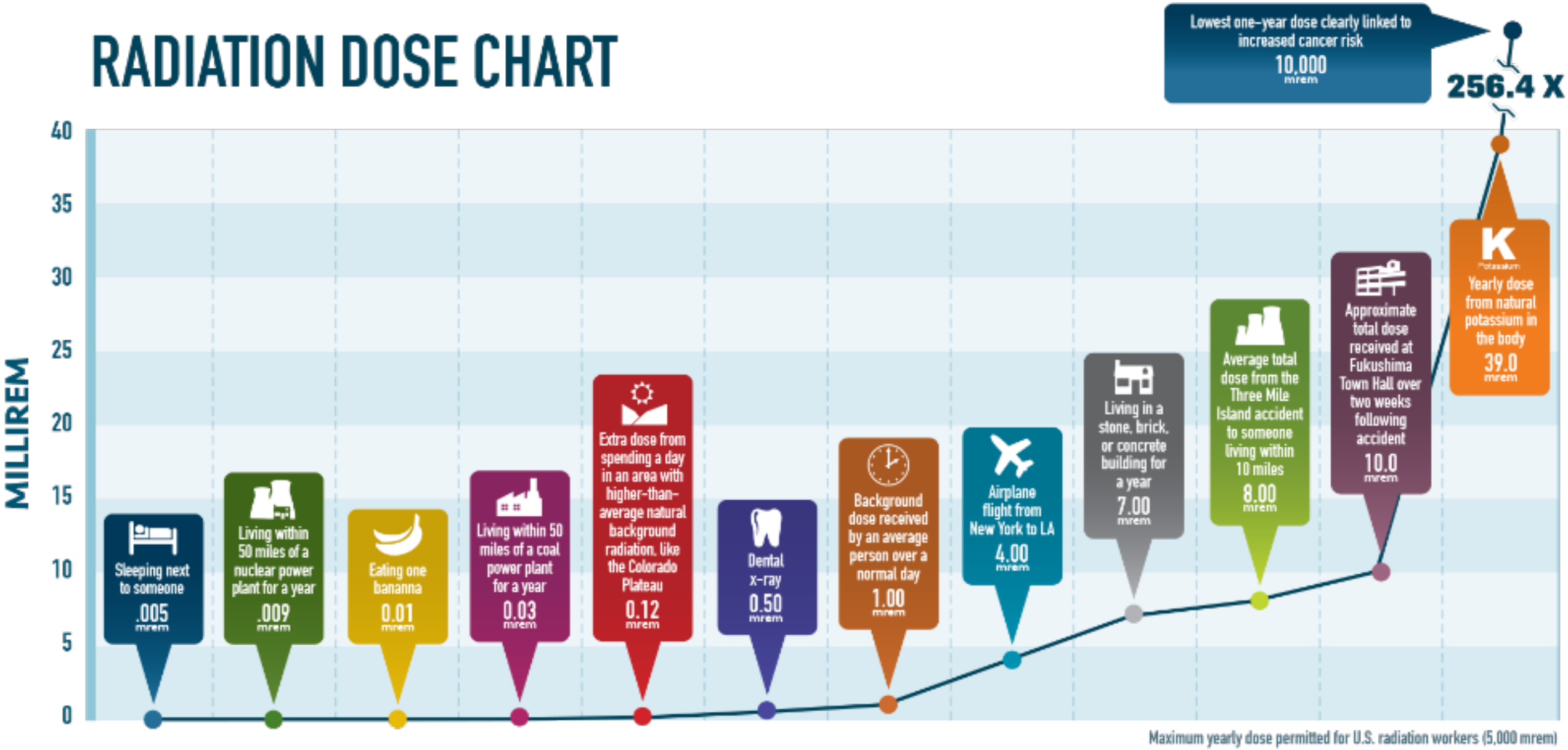
RADIATION DOSE CHART



Pathways to a Carbon-Free Grid

Transition in the Northwest Power Industry

Focus on carbon reduction

Increasing capacity challenges

Bonneville Power Administration contracts

Resource Adequacy in the Pacific Northwest

Serving Load Reliably under a Changing Resource Mix

January 2019

Arne Olson, Sr. Partner
Zach Ming, Managing Consultant

2018 Load and Resource Balance

	2018
Load (GW)	
Peak Load	43
PRM (%)	*12%*
PRM	5
Total Load Requirement	48

Resources / Effective Capacity (GW)	
Coal	11
Gas	12
Bio/Geo	1
Imports	3
Nuclear	1
DR	0.3
Hydro	18
Wind	0.5
Solar	0.2
Storage	0
Total Supply	47

Wind and solar contribute little effective capacity with ELCC* of 7% and 12%

Nameplate Capacity (GW)	ELCC* (%)	Capacity Factor (%)
35	*53%*	*44%*
7.1	*7%*	*26%*
1.6	*12%*	*27%*

*ELCC = Effective Load Carrying Capability = firm contribution to system peak load

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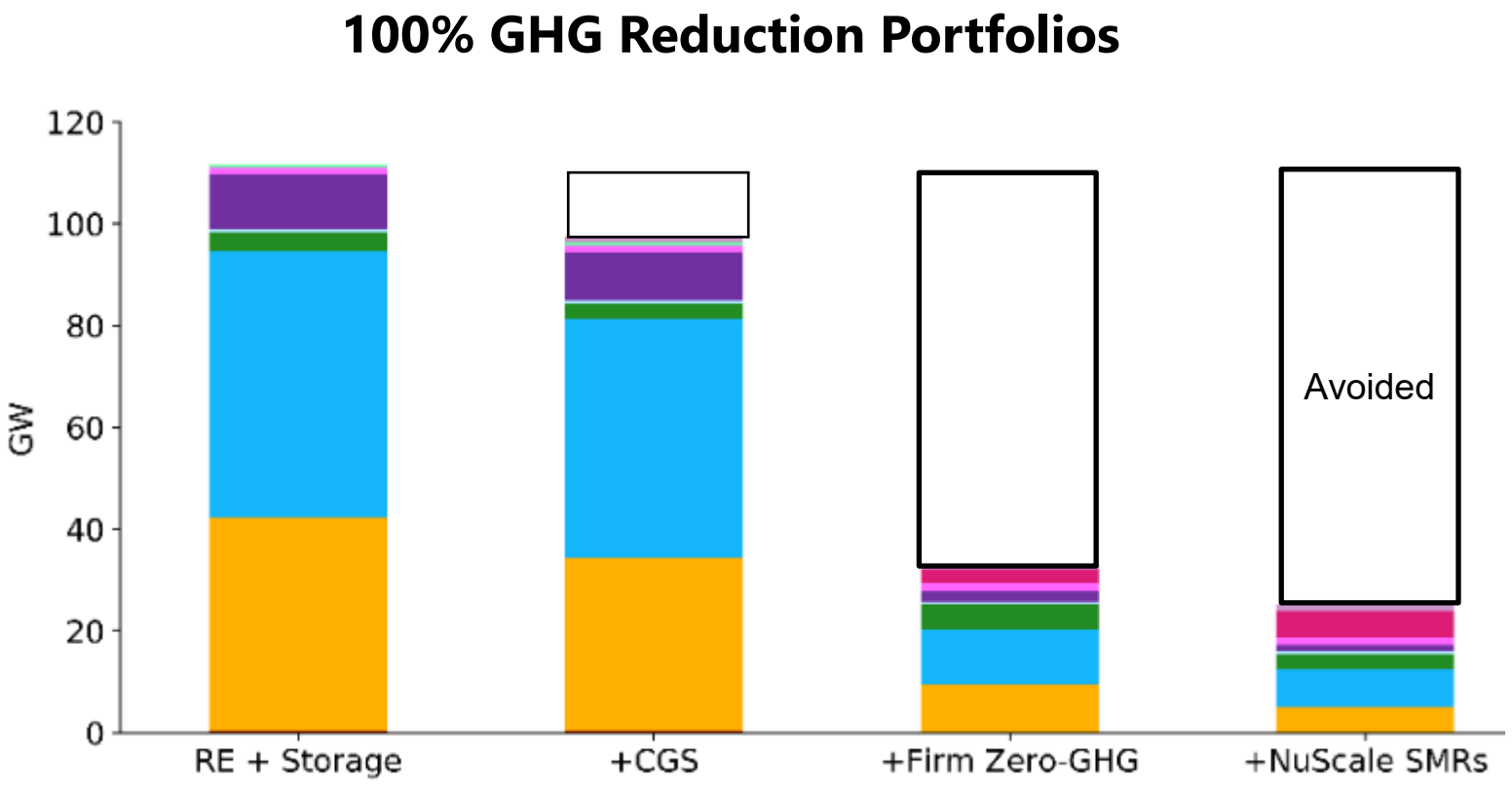
Energy+Environmental Economics

Pacific Northwest Zero-Emitting Resources Study

Dan Aas, Managing Consultant
Oluwafemi Sawyerr, Consultant
Clea Kolster, Consultant
Patrick O'Neill, Consultant
Arne Olson, Senior Partner

Benefits of zero-emitting firm capacity at 100% GHG reductions

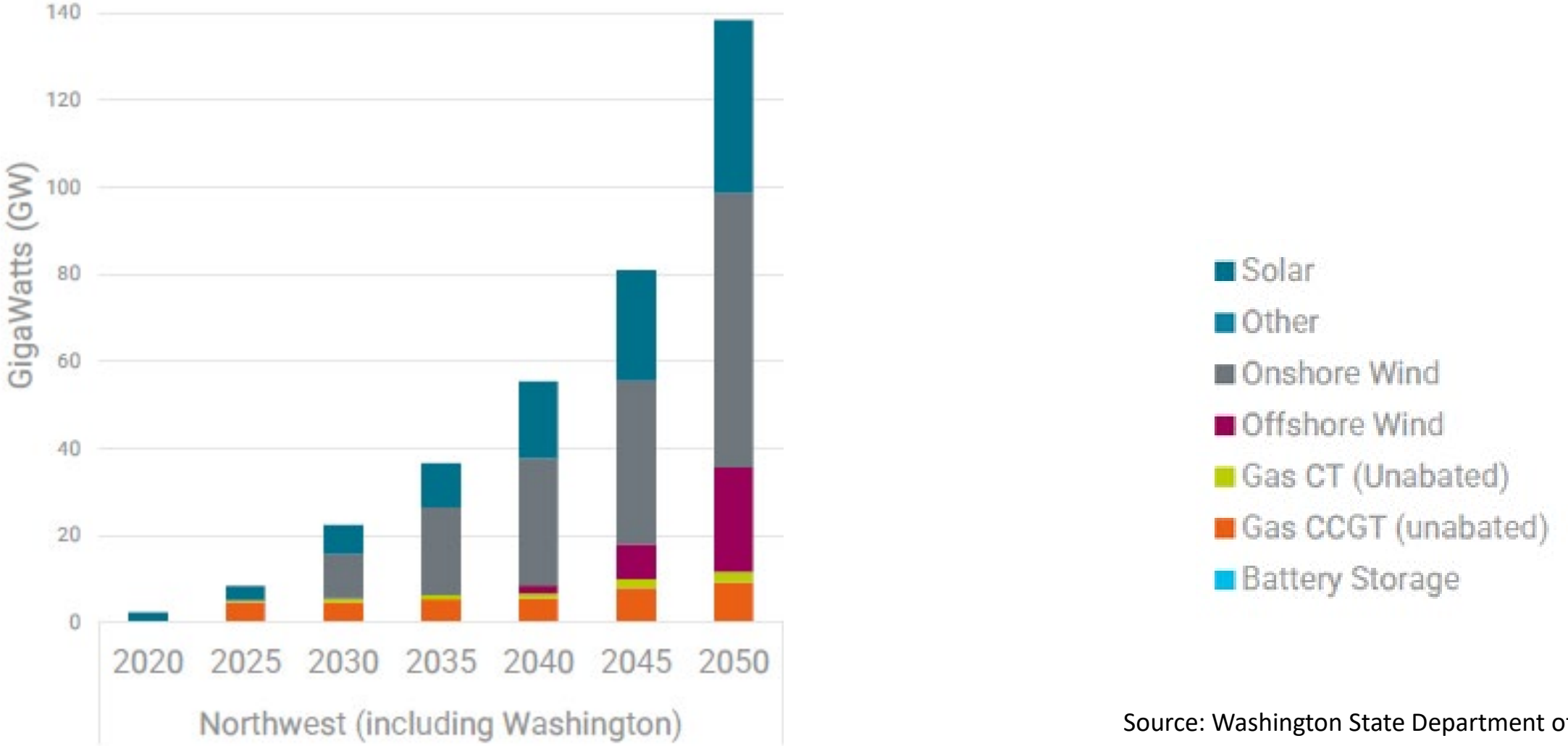


Adding	Avoids
+1.2 GW CGS	-9.5 GW Storage
+5.3 GW SMRs	-44.8 GW Wind
	-37 GW Solar
+6.5 GW Firm	-91 GW Non-firm

CGS + SMRs reduce system costs by almost $8B per year relative to RE + Storage

2021 State Energy Strategy

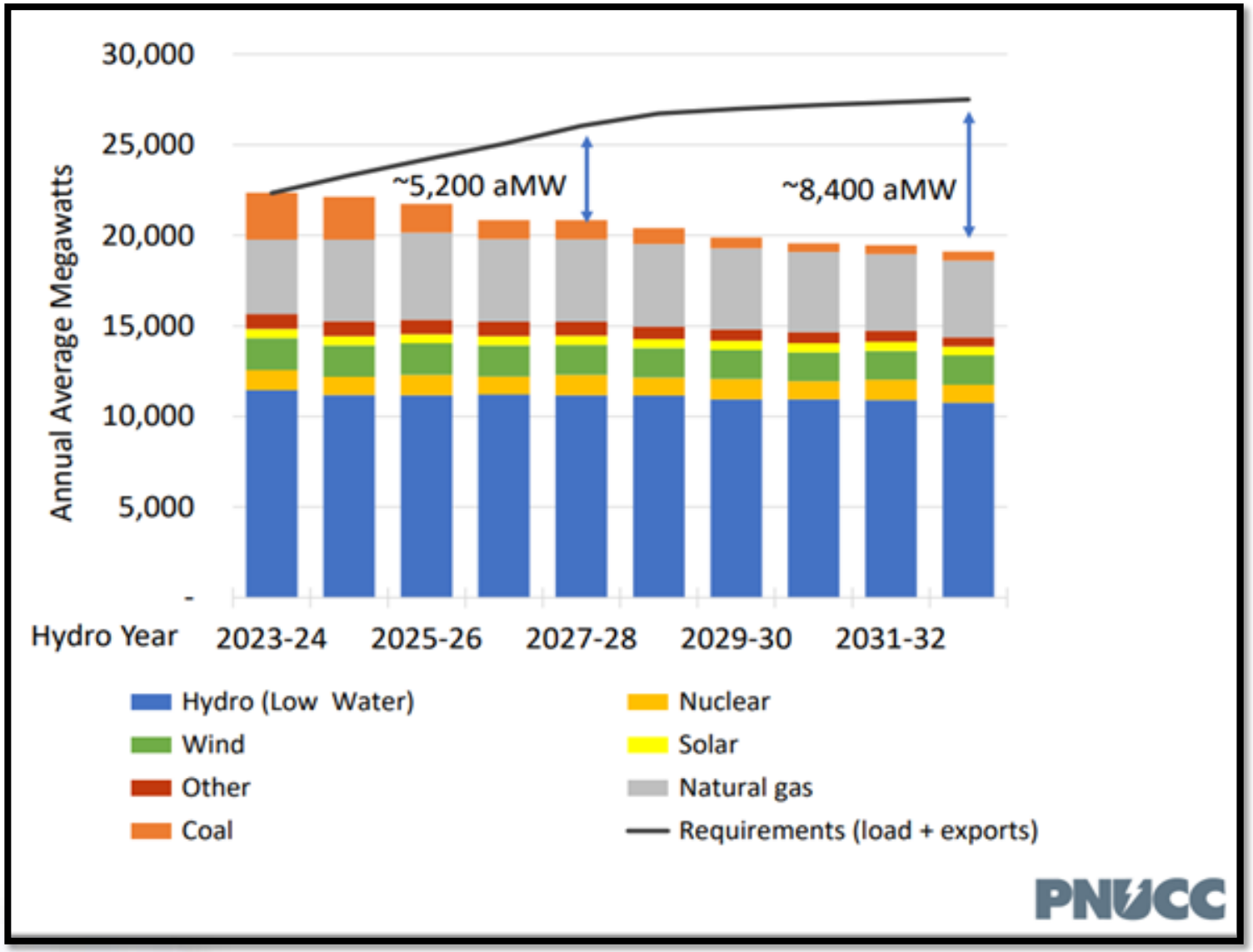
Electric capacity additions – electrification scenario



Source: Washington State Department of Commerce

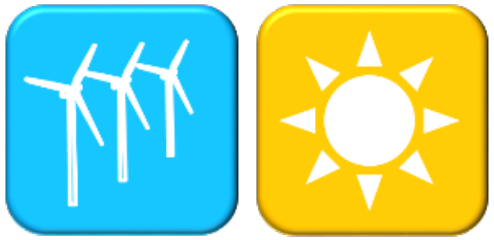
Projected Energy Shortfalls

- Aggregation of NW utility IRPs
- Projected capacity shortfalls are higher



https://www.pnucc.org/system-planning/northwest-regional-forecast/

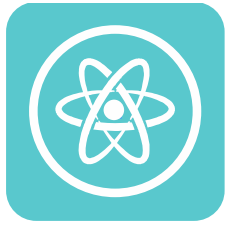
Optimal Resource Mix under CETA



Wind & Solar
(w/ storage)

Hydro

Existing Nuclear
(Columbia)



New Nuclear

New Developments

Project Funding Awards

- $33M in awards for electric vehicle charging stations
- $150K from the Washington State Department of Commerce Clean Energy Fund to study long-duration energy storage
- $150K from the Washington State Department of Commerce Clean Energy Fund to study a solar, storage, and hydro micro-grid

Federal Funding Coordination Program

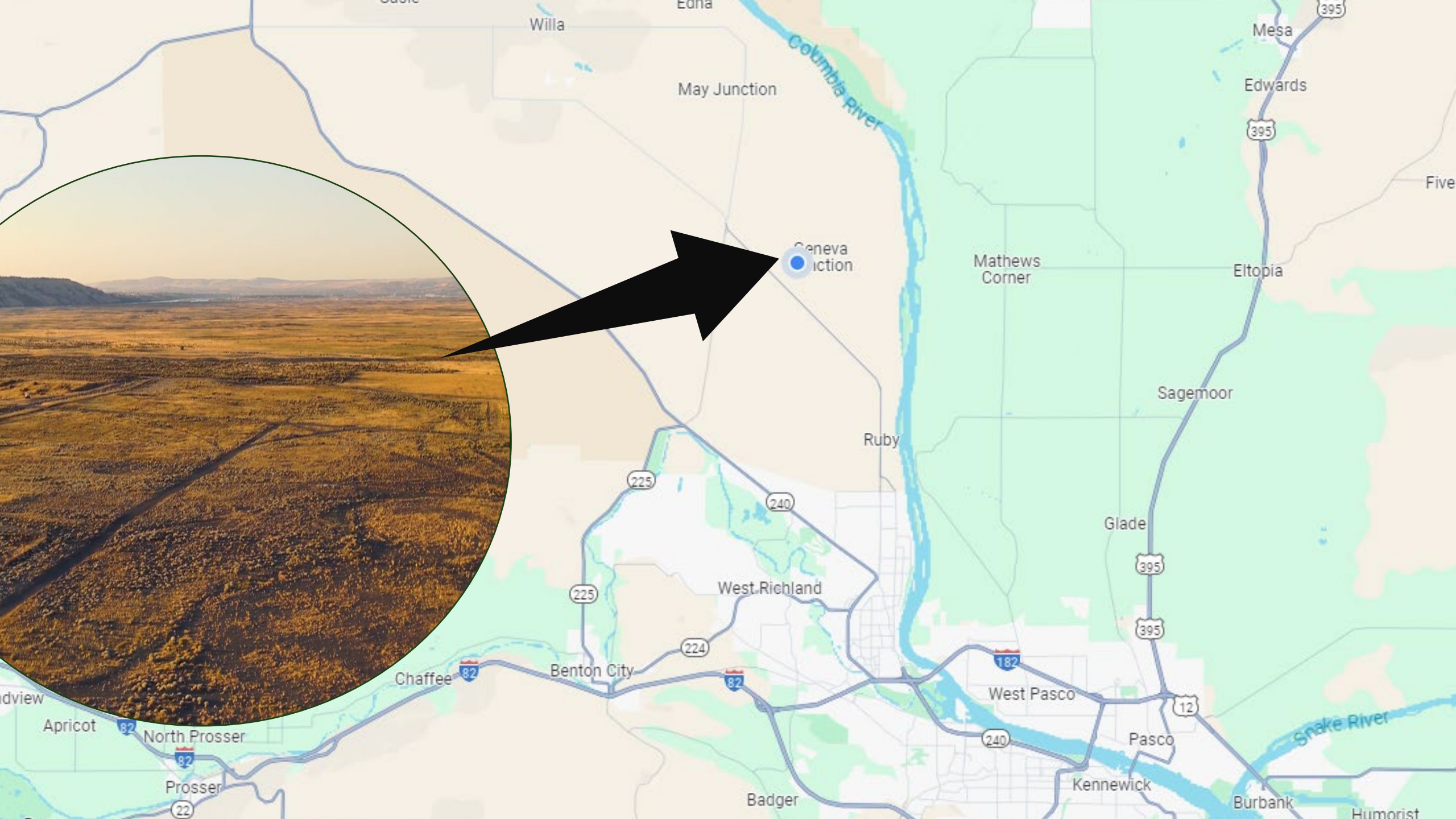
- $90M in total grant awards received for participating members

New Solar Project Developments

Ruby Flats Solar (127.5 MW)

- BPA interconnection in process (facilities study phase)
- Power Purchase Agreement (PPA) development
- Developer agreement

New Nuclear Development Project Information


Willa
Edna
May Junction
Columbia River
Mesa
Edwards
395
Five
Mathews Corner
Eltopia
Sagemoor
Ruby
225
240
Glade
West Richland
224
Benton City
Chaffee
82
182
West Pasco
12
Snake River
Pasco
Kennewick
Burbank
Apricot
North Prosser
Prosser
22
Badger

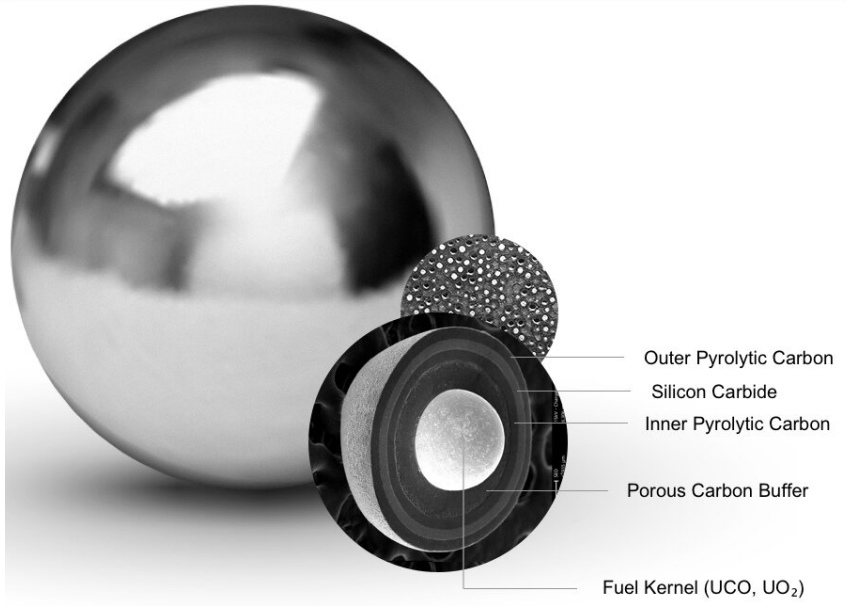
Xe-100 Reactor

- High Temperature Gas (Helium) Reactor (HTGR) technology
- 1-12 Modules
- Wet or Dry cooling
- 80 MW/reactor module
- 60-year design life; 100+ year asset
- Continuous on-line refueling

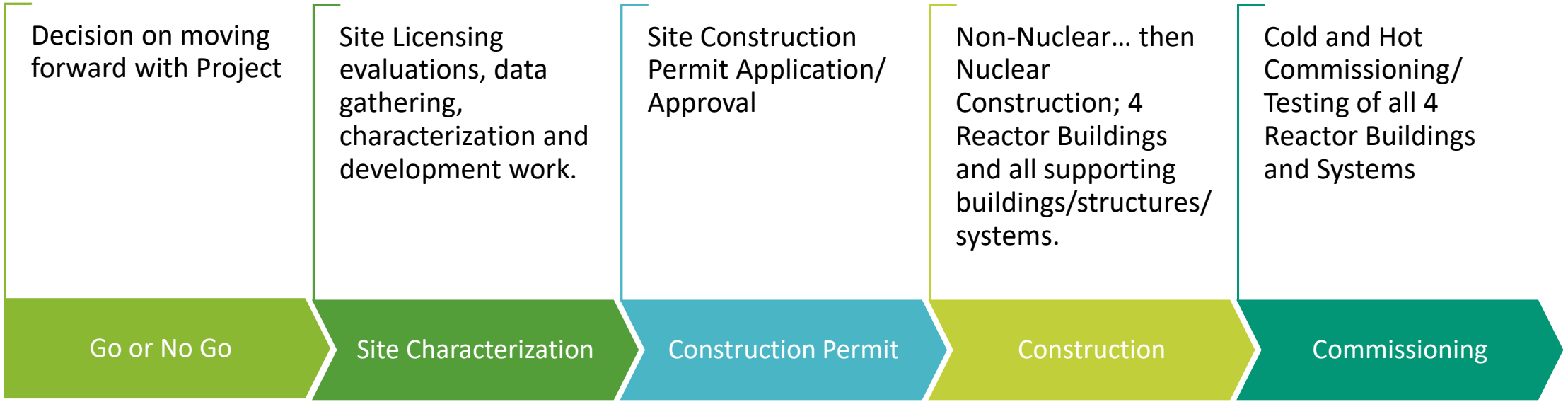
TRISO-X Fuel

Proprietary tri-structural isotropic (TRISO) coated particle fuel

- Unique manufacturing process ensures quality and decreases unusable scrap
- Cannot melt in the Xe-100 reactor
- The fuel is the reactor containment, locking in 99.999% of all fission products
- Simplifies the design and operations and fewer components



Project Pathway



New Nuclear Development

- Industry Benchmarking
- Tribal Engagement
- Federal Engagement
- Community Engagement

Funding

- $1M provided by public power utilities
- $10M provided by Puget Sound Energy
- $25M proviso included in Washington State Legislative budget
- Big tech investor interest

Project Financing

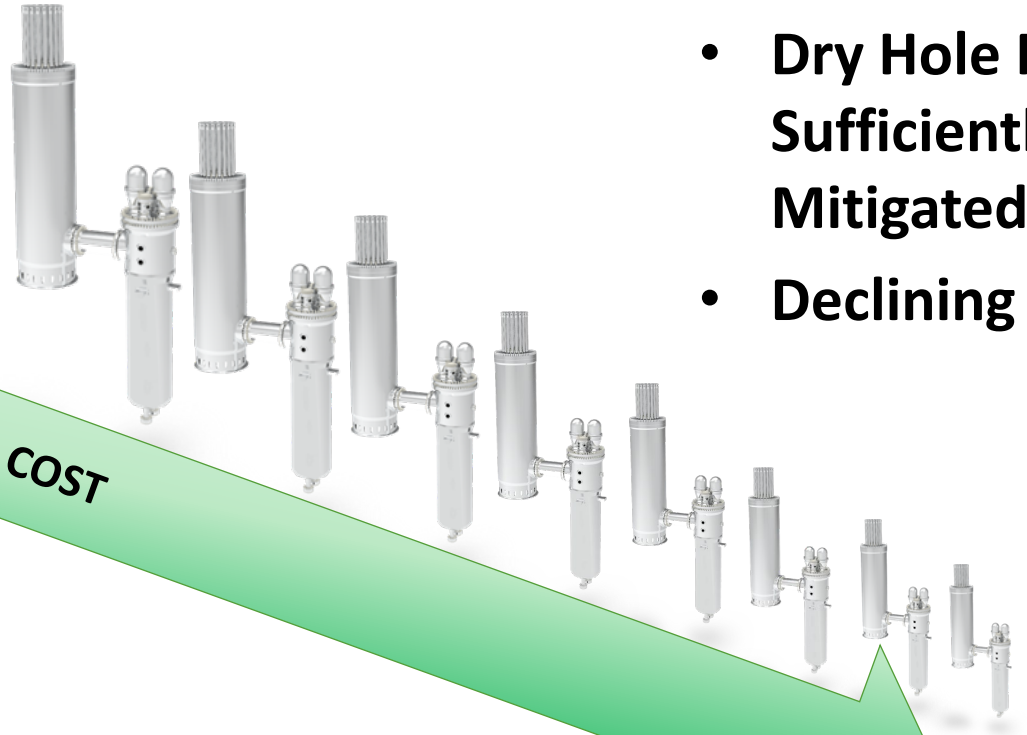
- DOE Loan Program Office (80%)
- Additional external financing (20%)

Pathway to Public Power Deployment

Phase 1

- Tech/Industrial Supported
- Dry Hole Risk
- Highest Cost
- Rights to future buildout

Phase 2



- Tech/Industrial, BPA, Utility
- Dry Hole Risk – Sufficiently Mitigated
- Declining Cost

RISK & COST

Questions?

Today's Tour

- Break
- Load Bus
- Horn Rapids Solar Storage & Training Project
- Columbia Generating Station
- Future Nuclear Site

What it costs to create equivalent value

Assumption: 95% capacity factor, 60-year life

Small Modular Reactor LCOE	Solar LCOE	Wind LCOE	Combined Cycle Natural Gas LCOE
$58-63/MWh	4 times the cost Eastern WA	5 times the cost Eastern WA	3 times the cost

LCOE= levelized cost of electricity
Source: Grant PUD, (Lazard Data v13.0 95% CapFac $25 LO $65 CO2 Penalty)

The cost of nuclear

With Nuclear

Lower system cost

Higher capacity

Less land impact

Less transmission buildout

Lower environmental impact

Mining

Waste disposal

Without Nuclear

Significant overbuild of renewables

Significant energy storage required

Significant transmission buildout

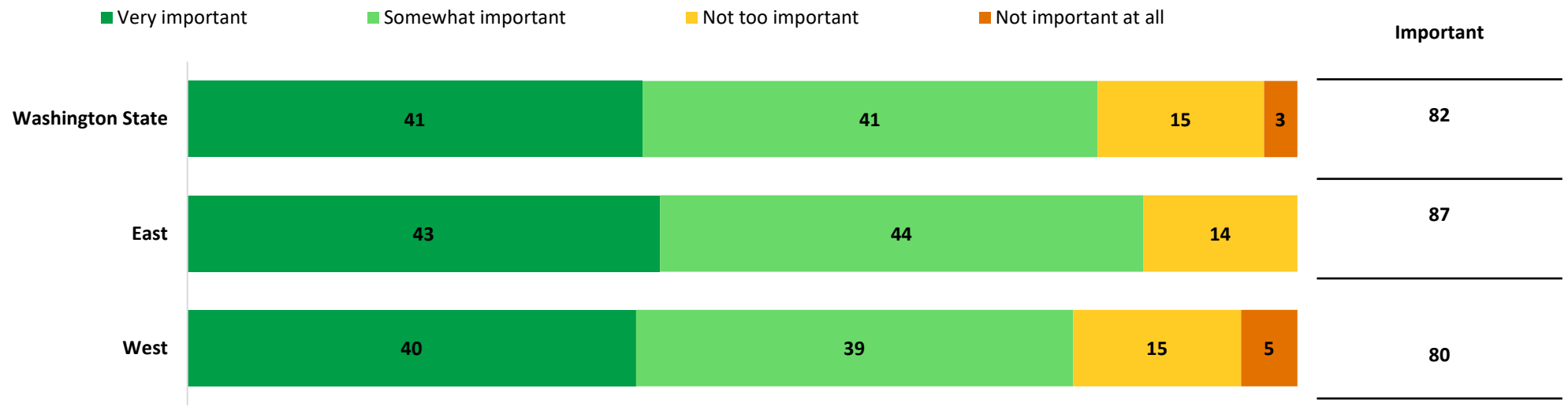
Dependence on the market during peak net load times

Hydrogen economy development

Statewide Favorability of Nuclear Energy

Nuclear Energy's Importance for Meeting Washington's Electricity Needs = 82%

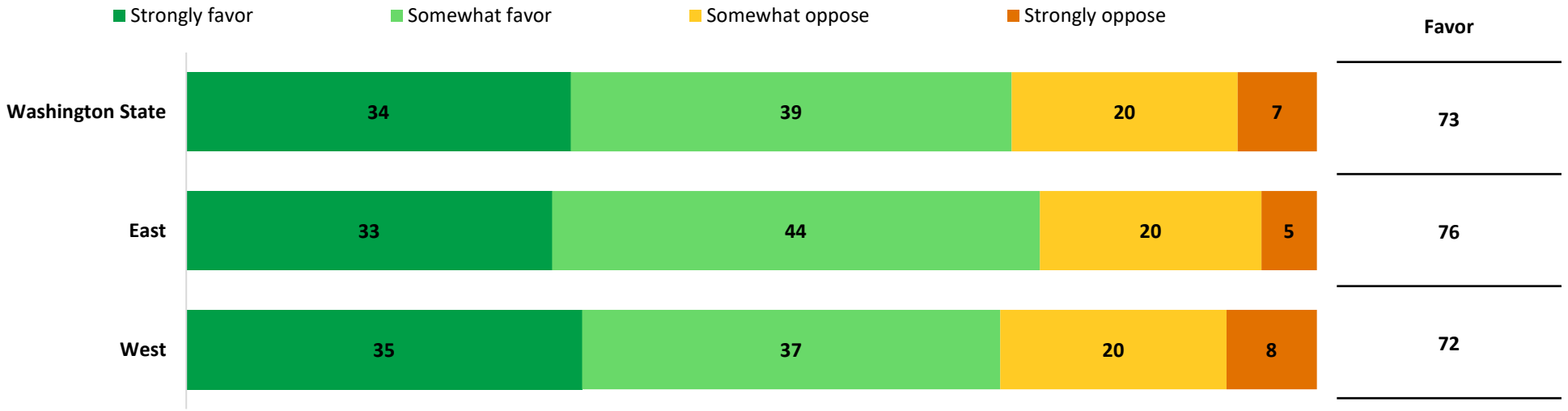
Q: How important do you think nuclear energy will be in meeting Washington state's electricity needs in the years ahead? (%)



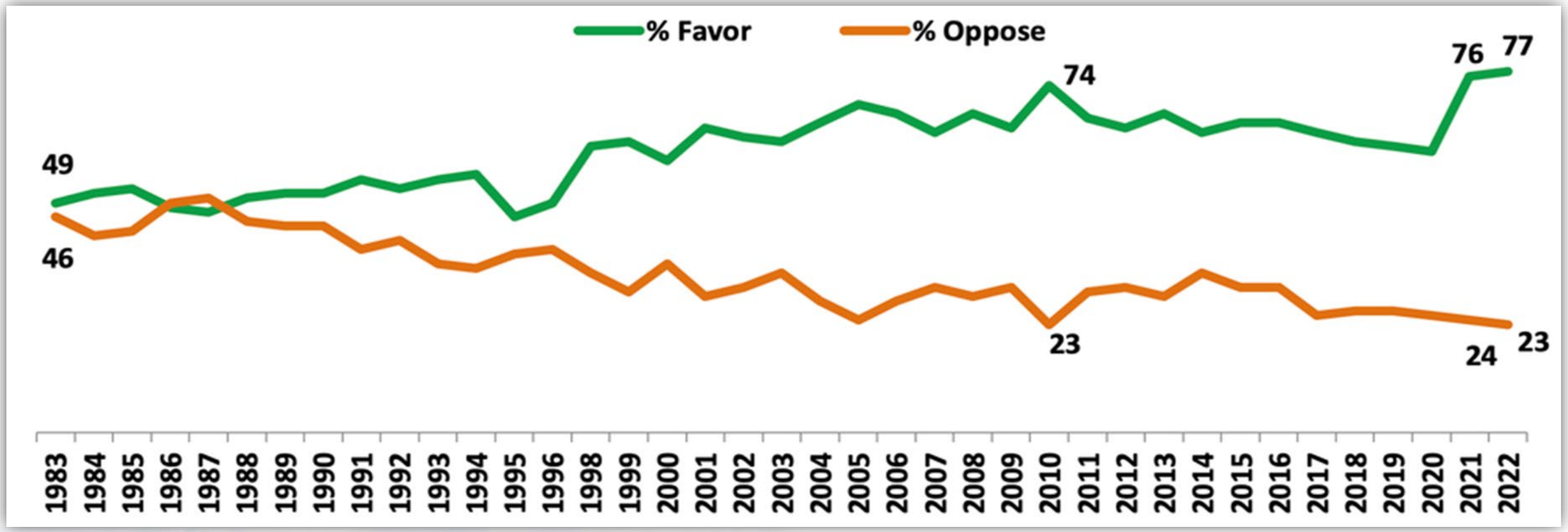
Statewide Favorability of Nuclear Energy

Nuclear Energy's 'favorability rating' in Washington State = 73%

Q: *Overall, do you strongly favor, somewhat favor, somewhat oppose, or strongly oppose the use of nuclear energy as one of the ways to provide electricity in Washington state? (%)*



Favorability of Nuclear Energy Nationally



Favorability to Nuclear Energy (%) 1983-2022