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January 5, 2022

MEMORANDUM

TO: Council Members

FROM: Gillian Charles

SUBJECT: Update on Annual GHG Emissions and Generation from the Power Sector

BACKGROUND:

Presenter: Gillian Charles

Summary: Staff will present the latest annual (2020) regional and national carbon dioxide emissions from the generation of electricity, including trends, observations, and takeaways. Staff will also provide a look ahead at what can be expected in terms of emissions over the next few years.

In addition, staff will provide a demonstration of the Council's power supply webpage, focusing on the visual and interactive tools we have curated as useful resources and references to not only the Council but the region as well.

<https://www.nwcouncil.org/energy/energy-topics/power-supply>

Update on Annual GHG Emissions and Generation from the Power Sector: Northwest and United States

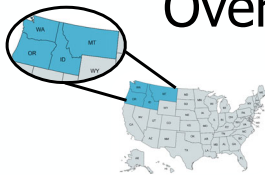
Gillian Charles
 Council Meeting
 January 12, 2022



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Overview of Today's Presentation



Pacific Northwest

- 2020 Greenhouse gas emissions from the power sector
- Generating resources - 2020 generation, changes in supply
- Trends, observations, and takeaways



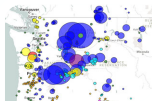
United States

- 2020 Greenhouse gas emissions from the power sector
- Generating resources - 2020 generation, changes in supply
- Trends, observations, and takeaways



Looking ahead

- Projection of 2021 greenhouse gas emissions from the power sector



Demo of Council's power supply webpage

- Interactive generating projects map
- Data, figures, and external resources
- Western Interconnect coal retirement map



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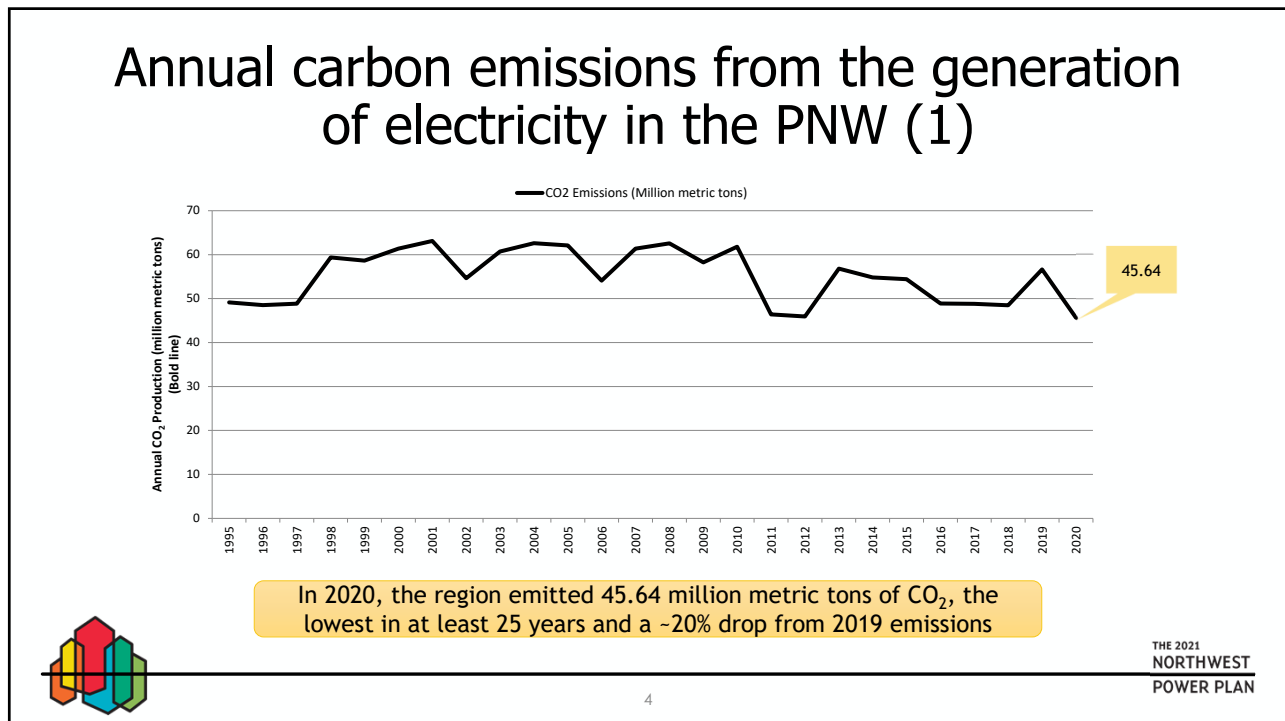
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Pacific Northwest

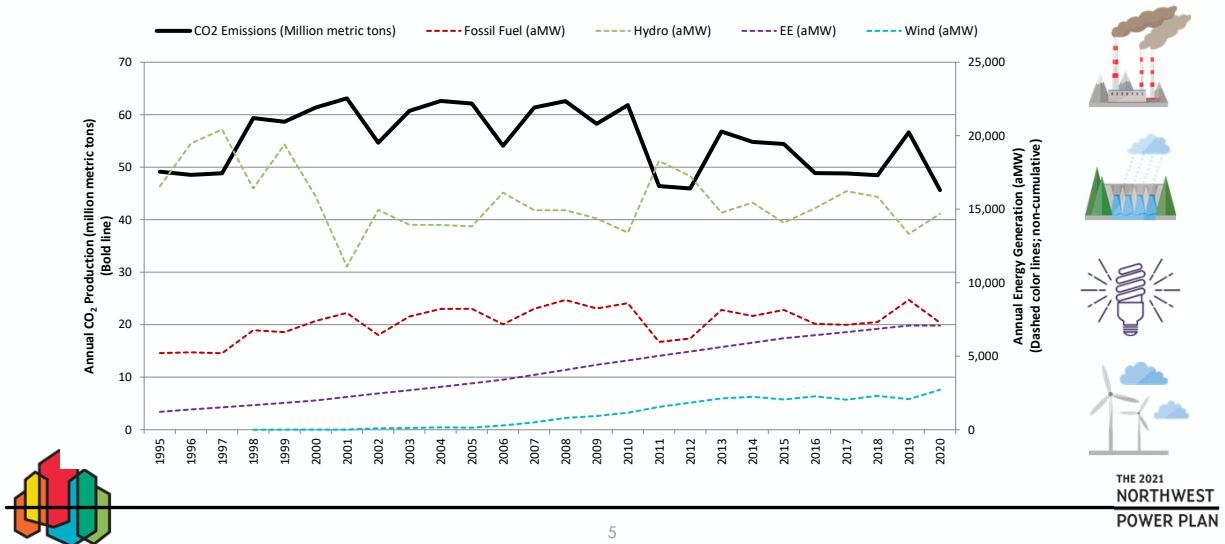
Emissions and the factors that influence them – resource mix, generation dispatch, resource additions and retirements, and policies

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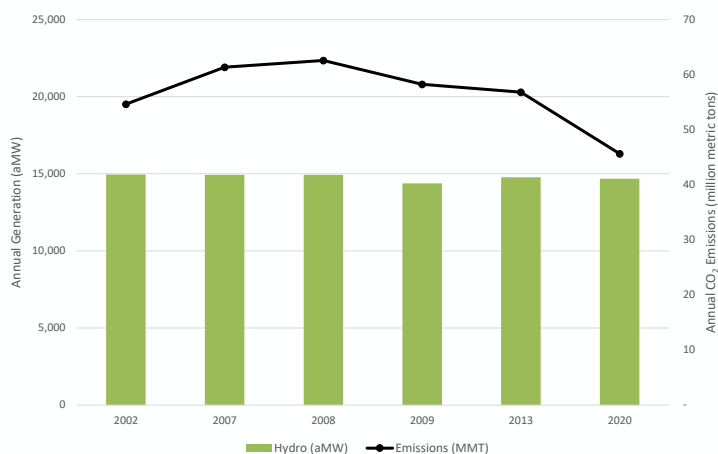
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Annual carbon emissions from the generation of electricity in the PNW (2)



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Comparison of annual emissions in similar hydro years*



Looking at historical annual hydro generation around 15,000 aMW, start to see a downward trend in annual CO₂ emissions in similar hydro years

In particular, emissions dropped ~20% from 2013 to 2020 in very similar water years

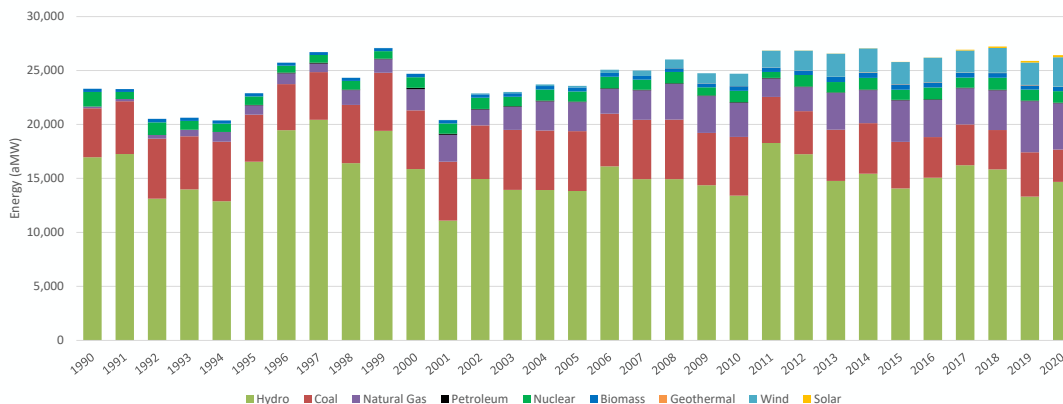
Downward trend is evident in consistent water years, so what else is at play to cause this reduction in emissions?



* A "normal" hydro year is ~16,000 MWA

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Annual regional generation by resource type



In addition to the strong relationship between hydro year and CO₂ emissions, there is also a strong dynamic between fossil fuel mix and CO₂ emissions that is contributing to the downward trend in annual emissions in the region

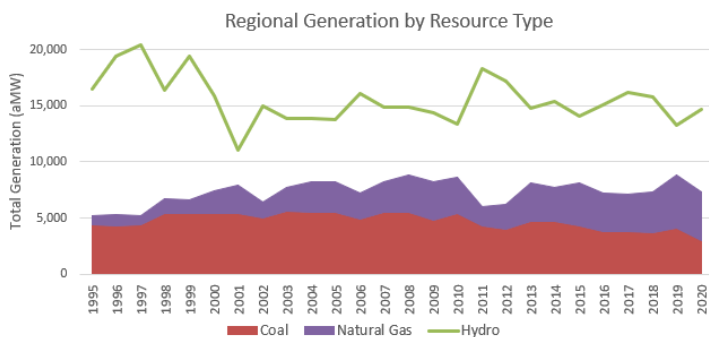


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Fossil fuel generation trends (1)



While fossil fuel (coal + natural gas) generation dispatch is correlated to hydro production, overall fossil fuel generation has increased over the past 25 years

On average, coal generation has been declining while natural gas generation has been increasing

(Coal + Nat Gas stacked area chart; Hydro is line chart)

Since 1995, over 7,700 MW new natural gas capacity has been brought online in the PNW - 80% of which was combined cycle combustion turbines



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Fossil fuel generation trends (2)



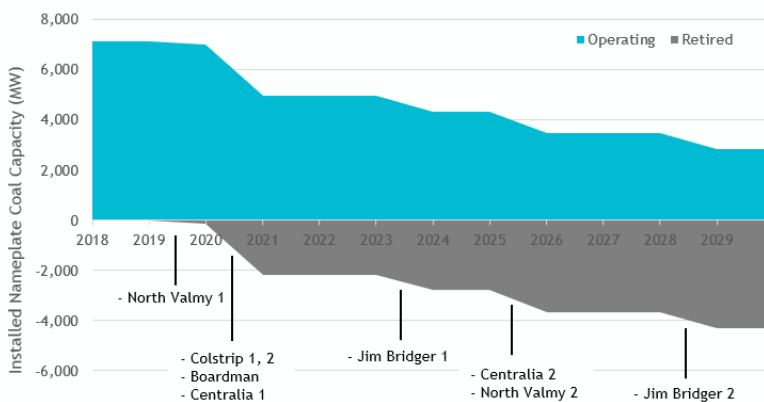
In 2018, annual natural gas generation surpassed coal generation for the first time - this dynamic has significant ramifications for annual emissions

Fuel Type	CO ₂ Emissions (lbs CO ₂ /MMBtu)
Coal	205 - 228
Petroleum/Oil	161
Natural Gas	117

On average, natural gas generation (at combustion) emits roughly half of the CO₂ emissions that coal generation emits. As gas dispatch increases (and coal decreases), this will contribute to lower future emissions from the fossil fuel fleet.



Regional coal retirements (announced as of April 2021)



Over the next decade, the region is set to lose about 4,400 MW of its coal capacity through planned coal unit retirements.

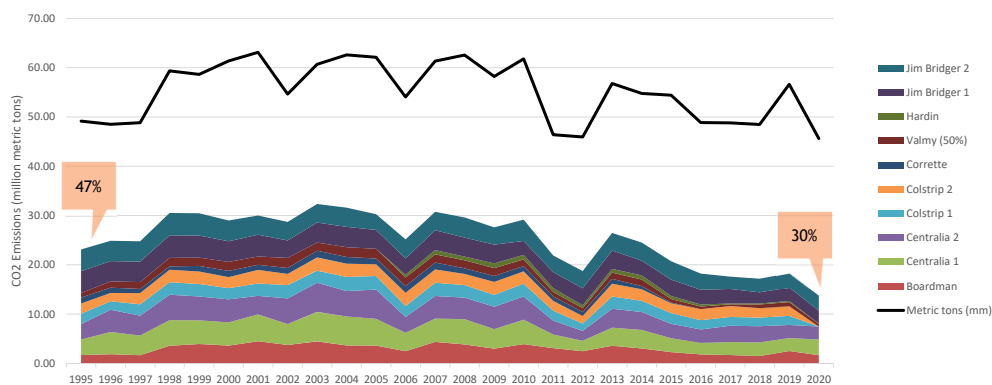
First major coal unit retirements in 2020:

- Colstrip 1 & 2 (Jan)
- Boardman (Oct)
- Centralia 1 (Dec)

Over the next decade, the region is set to lose about 4,400 MW of its coal capacity through planned coal unit retirements. Uncertainty remains over the future of the remaining coal fleet (Jim Bridger 3,4 and Colstrip 3,4).



Retiring* coal units account for about 45% of historical emissions since 1995

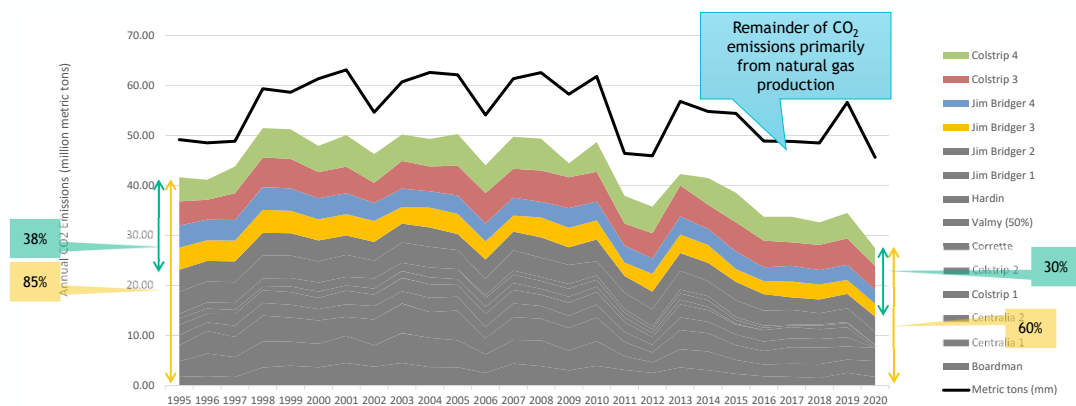


HOWEVER, actual future emissions depend on the **replacement resources!**

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* Closures and announced retirements

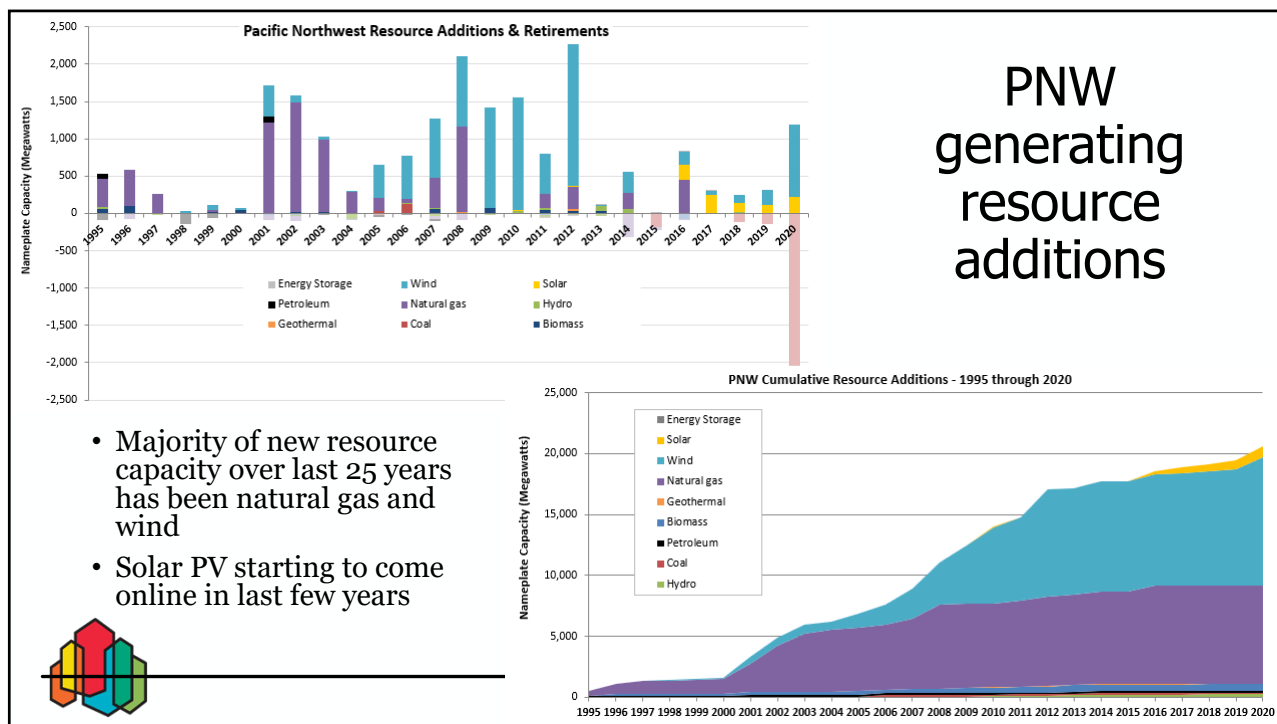
What about the remaining coal units?



Since 1995, coal has accounted for ~78% of the region's overall power plant CO₂ emissions, although that percentage has been decreasing. In 2020, coal accounted for ~60% of the annual emissions.



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Regional Takeaways

- Emissions from the generation of electricity (at the point of combustion) are beginning to trend downwards due to:
 - Coal unit retirements
 - Greater use of natural gas
 - Increase in renewable resources and energy efficiency (carbon-free resources)
- Variable, “jumpy” emissions from year to year continue due to the dominance of the hydropower system in the region
- Coal generation accounts for the majority of historical CO₂ emissions; however, as coal units retire, future emissions will be dependent on the replacement resources and dispatch of existing system resources

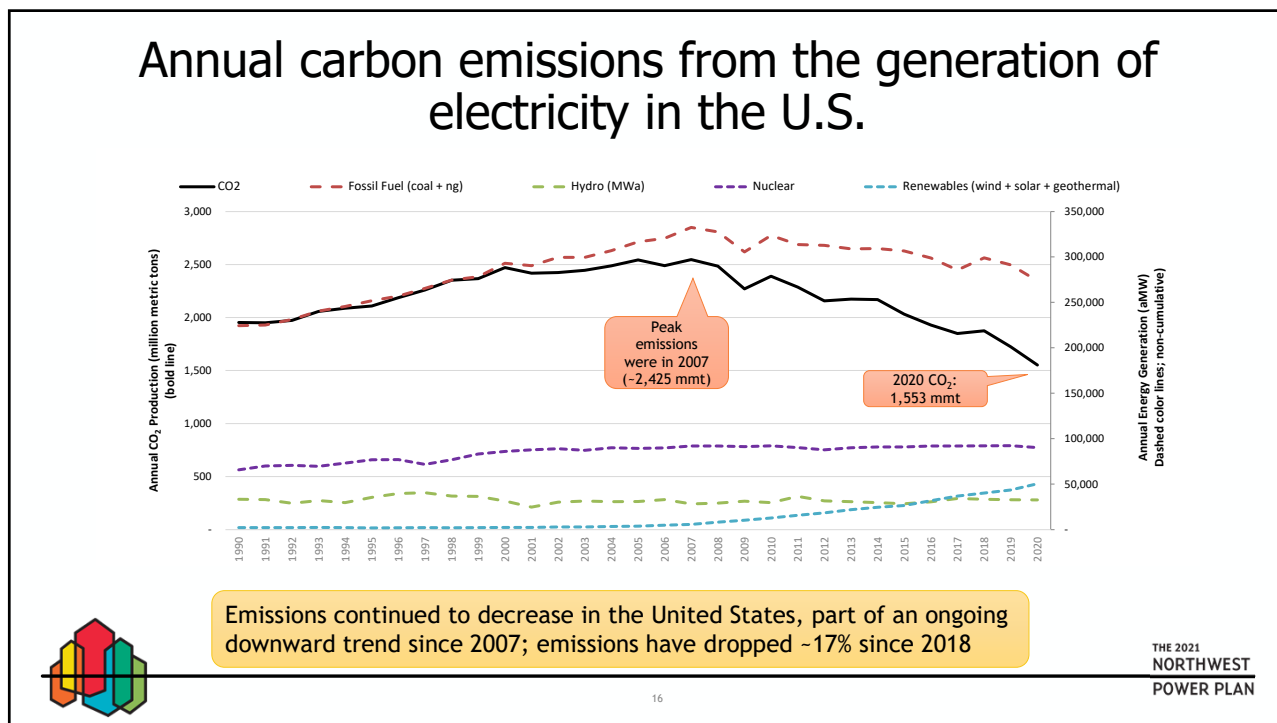
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United States

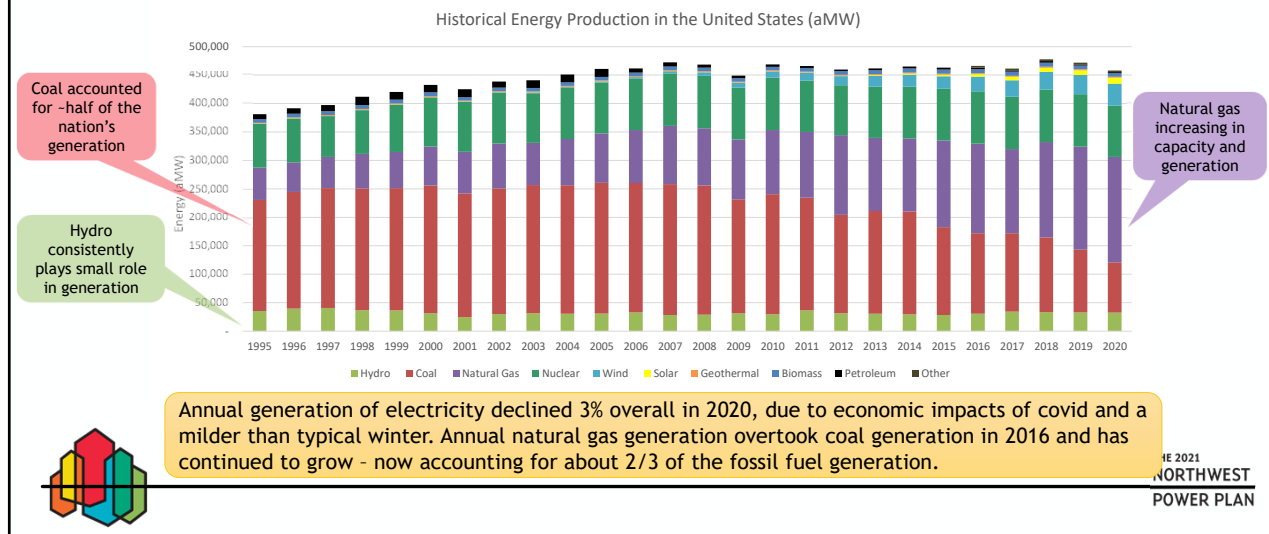
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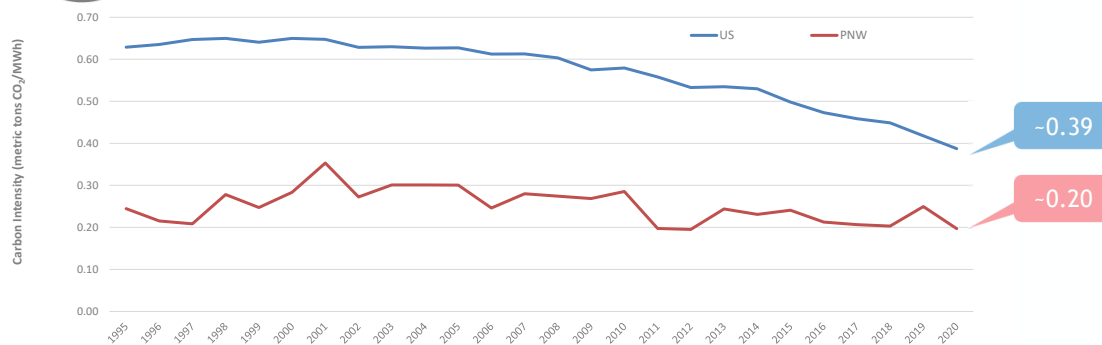
Trends in historical energy generation in the United States



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Carbon intensity is the amount of carbon emitted per unit of energy generated

Carbon intensity: PNW vs. United States



The carbon intensity of the United States' electricity mix has been steadily declining since the early 2000's; the PNW has always had a very low carbon intensity due to the hydropower system

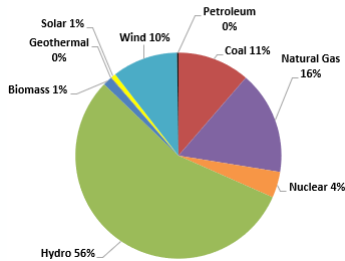


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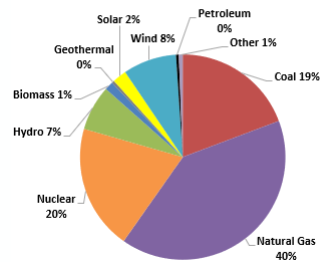
2020 annual generation: PNW vs. United States

PNW Generation - 2020



There are significant differences in the annual fuel mix between the region and the United States, which directly relate to the magnitude of emissions.

United States Generation - 2020

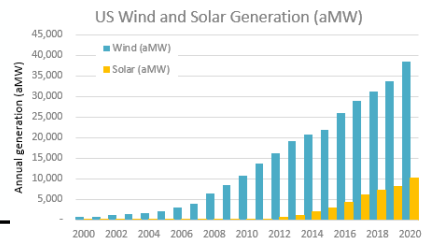
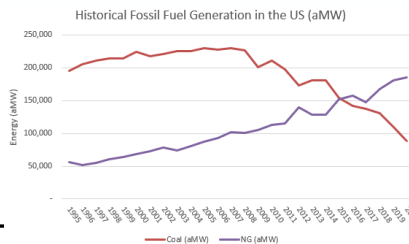


In the PNW, hydropower regularly accounts for over 50% of annual energy generation, whereas it only contributes 7% to the United States mix; coal + natural gas accounted for 60% of 2020 generation in the United States, but only 17% in the PNW



United States Takeaways

- Emissions from the generation of electricity (at the point of combustion) have been trending downwards since 2007 due to:
 - Changes in the fossil fuel mix (more natural gas dispatch, less coal)
 - Increase in renewable resources
- The carbon intensity of the United States electricity mix is greater than the region due primarily to the role of hydropower and reliance on fossil fuels

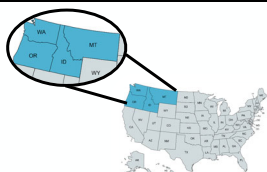




Looking ahead (or behind?!) to 2021 and future emissions

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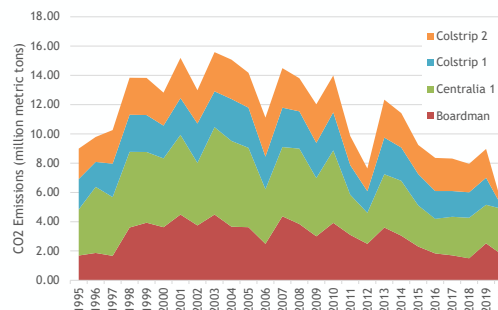


2021 Outlook: Pacific Northwest

While final data is not available until ~ Fall 2022, early analysis indicates

❖ 2021 emissions from the generation of electricity will likely be slightly lower than 2020

- While the 2021 water year was “near-to-below normal” (and looking lower than 2020) which could indicate an increase in emissions...
- The effect of the coal unit retirements in 2020 were not fully represented in the 2020 emissions due to the retirement dates (for example, Boardman didn't retire until October and Centralia 1 until December)



... although it all depends on replacement resources and dispatch!



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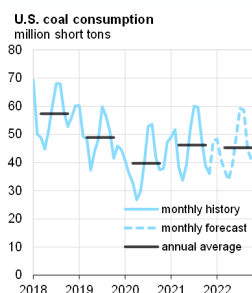
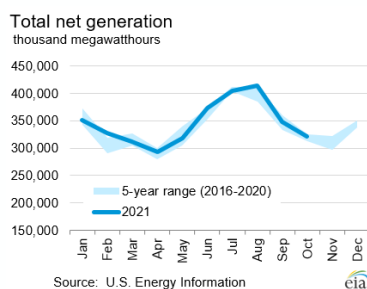
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2021 Outlook: United States

While final data is not available until ~ Fall 2022, early analysis indicates

- Emissions from the generation of electricity will likely increase in 2021
 - Economy picked up in 2021 compared to 2020 (even though pandemic continued) and overall annual generation increased
 - Coal generation increased, while natural gas generation remained steady



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2022 and Beyond



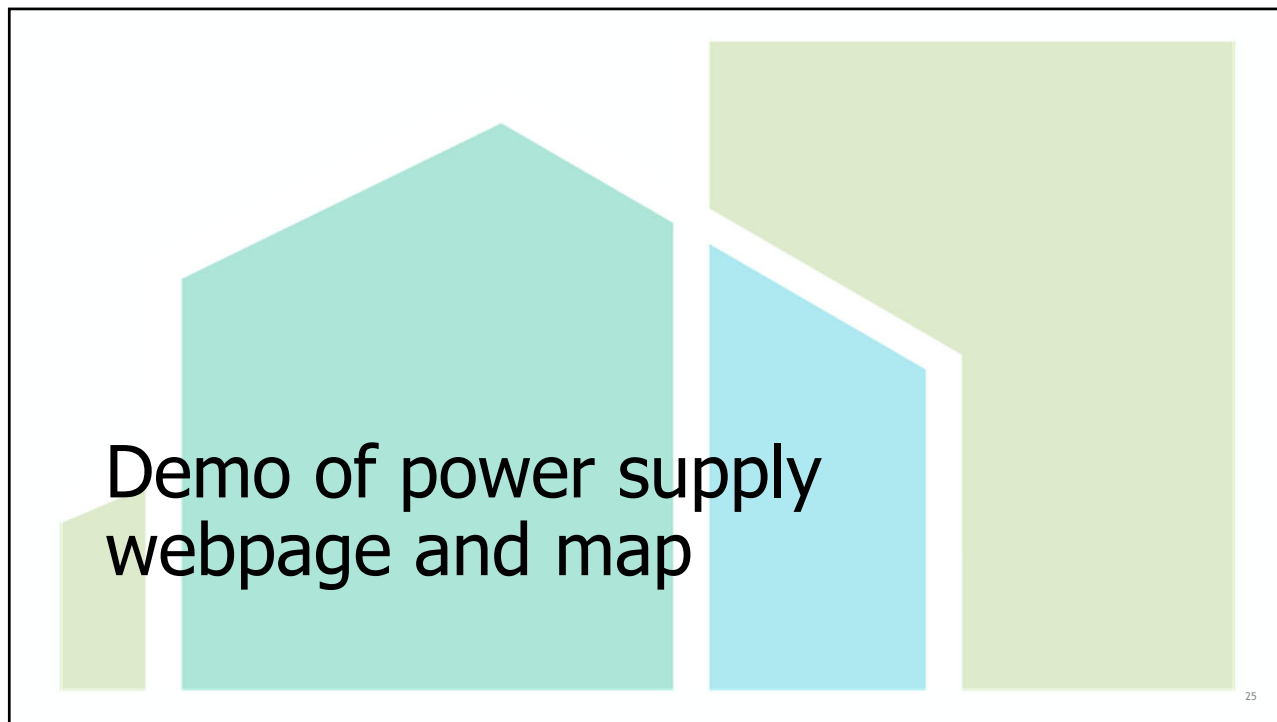
- Pacific Northwest emissions *will likely continue to decline* over the next few years
 - Additional coal unit retirements - the next unit planned is Jim Bridger 1 (and maybe 2) in 2023
 - A lot of uncertainty around the timing of the planned coal unit retirements as utility owners continue to evaluate needs in their integrated resource plans; in addition, uncertainty over the future of remaining coal units
 - Significant renewable development is expected, and thousands of megawatts of projects are in the pipeline
 - States, utilities, and communities work towards achieving clean policies and goals
 - Utilization and optimization of the existing system (e.g. hydro and natural gas) as the generation mix changes
- There may be years with stagnant emissions reductions (and even possible increases depending on hydro year and future electrification efforts), but overall trend toward carbon emission reductions in the region



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Power Supply

Existing and new/proposed power plants

Charts below are based on the Council's generating resources project database (Sep 2021 Excel file) of projects under construction, permitted sites, proposals, recently-completed projects and recent retirements. Email corrections/updates to Gillian Charles.

Pacific Northwest Generating Capacity: 64,340 MW*

Solar	0.1%	Biomass	1.3%
Geothermal	0.1%	Coal	0.1%
Wind	17.5%	Hydro	63.9%
Nuclear	0.1%		
Natural Gas Peaking	2.0%		
Natural Gas BaseLoad	11.8%		

Capacity is essentially the "horsepower" rating of power plants, or how much they are designed to produce at full load operation. Download chart as PNG
*Other includes geothermal, peaking, and solar

Pacific Northwest Generating Capability: 33,820 MW*

Solar	0.1%	Biomass	10.5%
Wind	10.5%	Coal	12%
Nuclear	0.1%	Hydro (average)	48.1%
Natural Gas Peaking	9.2%		
Natural Gas BaseLoad	18.1%		

Capability is the maximum amount of energy the plants are capable of producing over the course of an average year.

Maps

- Power Generation: Northwest power facilities by resource with detail for each facility
- Coal Retirements: US coal plant retirements by year
- Dam Guide: History and map of Northwest and BC dams

Power supply outlook

The outlook provides a daily snapshot of reservoir levels, water flows, and power flows in the Northwest.

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Questions?

Data sources: Council's generating project database, Energy Information Administration

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