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

February 4, 2020

MEMORANDUM

TO: **Power Committee**

FROM: **Gillian Charles**

SUBJECT: **Natural Gas Reference Plants for draft 2021 Power Plan**

BACKGROUND:

Presenter: Gillian Charles

Summary: As part of the development of inputs for the draft 2021 Power Plan, staff develops generating resource reference plants as resource options – along with energy efficiency and demand response – for the Council's power system models to select to fulfill future resource needs. A generating resource reference plant is a collection of characteristics that describe a realistic and likely implementation of a given technology within the region. It includes estimates of costs, operating and performance specifications, and developmental potential.

Staff presents reference plants for review and discussion with the Generating Resources Advisory Committee (GRAC) and incorporates feedback before bringing the reference plant to the Council for review.

At the February Council Meeting, staff will present the reference plants for natural gas technologies.

Relevance: Development of inputs for the 2021 Power Plan

Workplan: A.4.1 Develop generating resource reference plants for 2021 Power Plan

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Natural Gas Reference Plants for the 2021 Plan

February 11, 2020 -- Power Committee

Gillian Charles

THE 2021 NORTHWEST POWER PLAN
FOR A SECURE & AFFORDABLE ENERGY FUTURE

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Today's Agenda

- Proposed draft 2021 Power Plan reference plants for natural gas technologies
- Proposed draft 2021 Power Plan reference plant for conventional geothermal

❖ Today's presentations wrap up series of presentations to the Power Committee on the generating resource reference plants for the draft 2021 Power Plan

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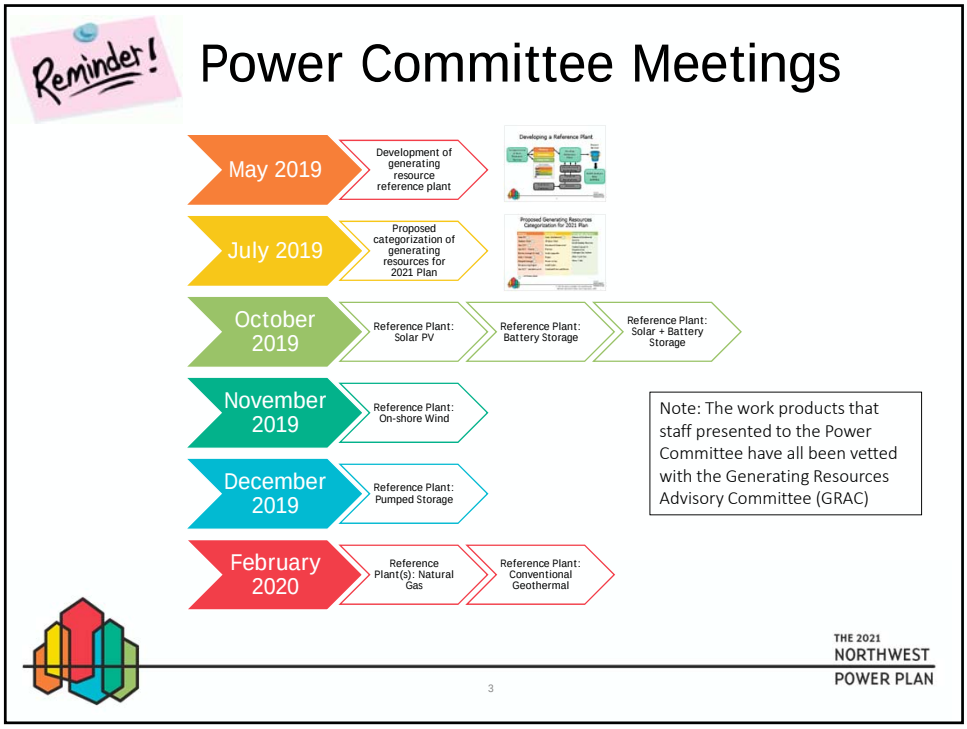
Reminder!
Power Committee Meetings
May 2019
Development of generating resource reference plant
July 2019
Proposed categorization of generating resources for 2021 Plan
October 2019
Reference Plant: Solar PV
Reference Plant: Battery Storage
Reference Plant: Solar + Battery Storage
November 2019
Reference Plant: On-shore Wind
December 2019
Reference Plant: Pumped Storage
February 2020
Reference Plant(s): Natural Gas
Reference Plant: Conventional Geothermal
Note: The work products that staff presented to the Power Committee have all been vetted with the Generating Resources Advisory Committee (GRAC)
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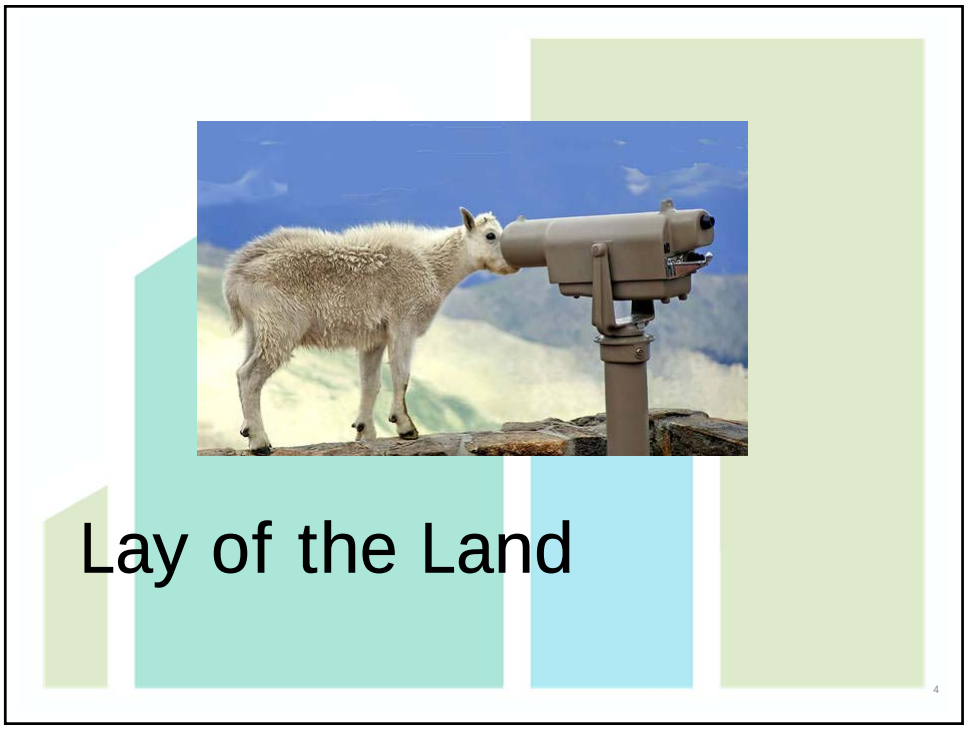
Lay of the Land
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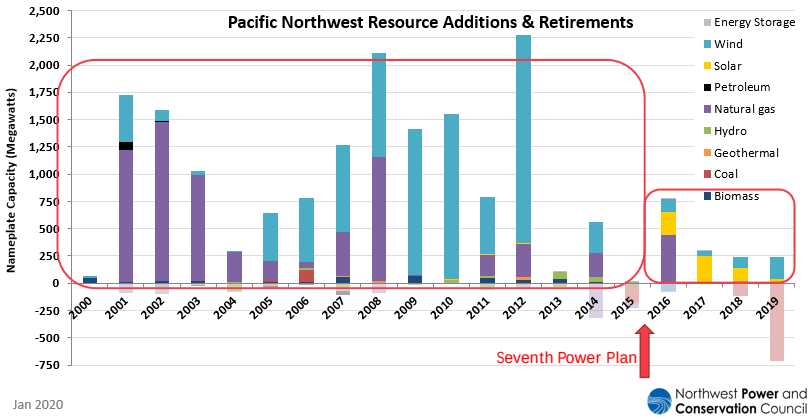
Resource Additions and Retirements



New gas and wind dominate resource additions pre-Seventh Power Plan

- West Coast Energy Crisis
- RPS enacted in 2005-2007
- Tax credits

Data source: Council's project database

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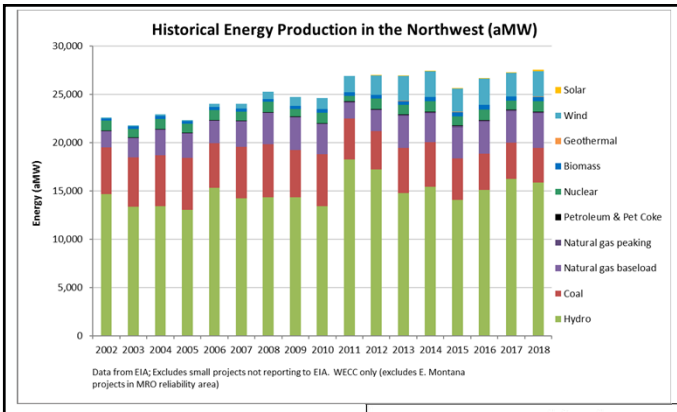
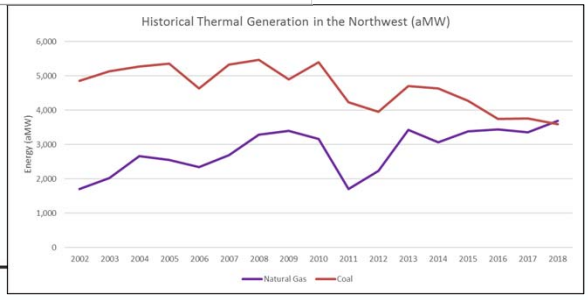


On average, coal generation has been declining while natural gas generation has been increasing

Fuel Type	CO_2 Emissions (lbs CO_2/MMBtu)
Coal	205 - 228
Petroleum/Oil	161
Natural Gas	117



Data source: Council's project database

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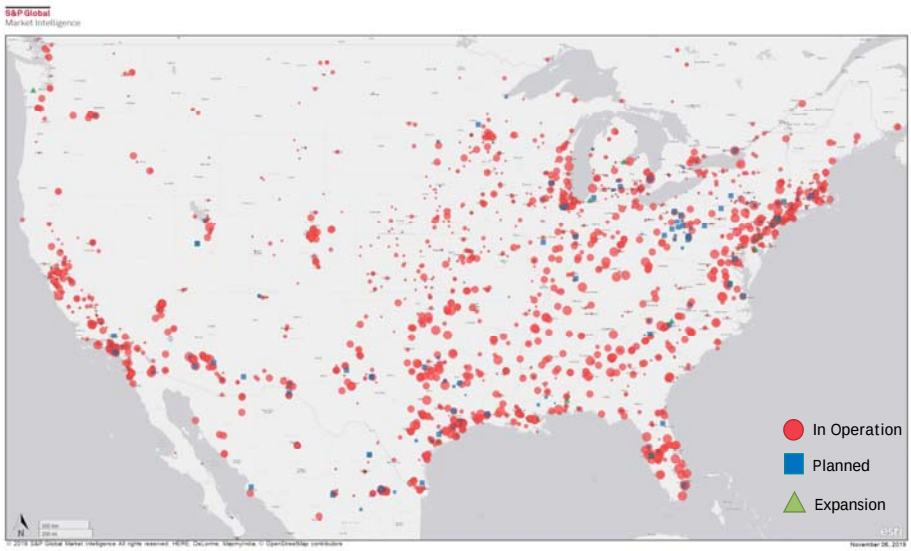
Natural Gas Plants in Operation and Planned



Data source: S&P project database

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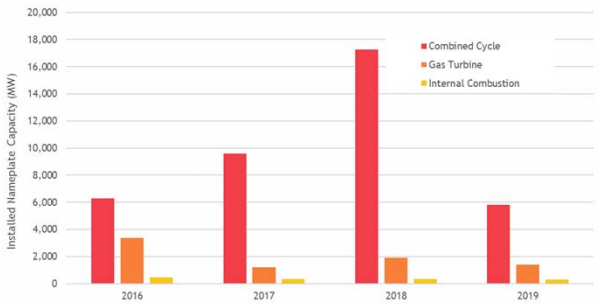
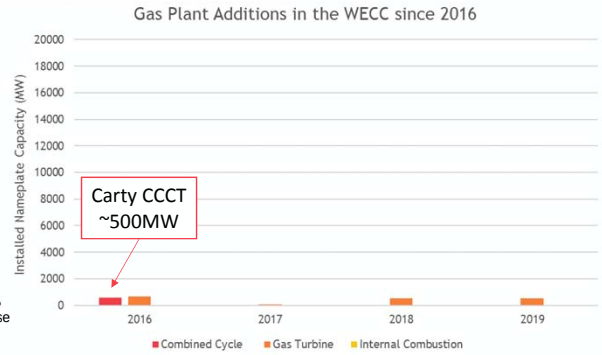
Gas Plant Additions in the US since 2016



- ~ 48,000 MW new installed capacity across the US over past four years
- Mostly CCCT, 53 plants (~160 units)

- ~ 2,400 MW new installed capacity in the WECC over the past four years
- Primarily gas peakers – LMS100 units in CA and AZ

Gas Plant Additions in the WECC since 2016



Data source: S&P project database

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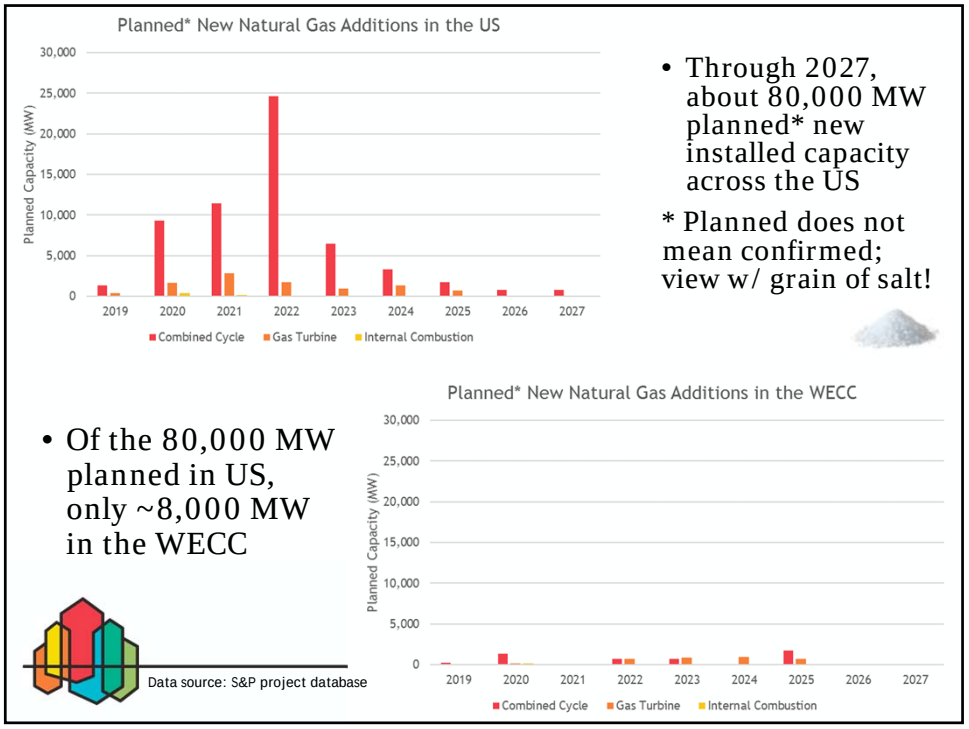
Planned* New Natural Gas Additions in the US
Planned Capacity (MW)
30,000
25,000
20,000
15,000
10,000
5,000
0
2019
2020
2021
2022
2023
2024
2025
2026
2027
Combined Cycle
Gas Turbine
Internal Combustion
• Through 2027, about 80,000 MW planned* new installed capacity across the US
* Planned does not mean confirmed; view w/ grain of salt!
• Of the 80,000 MW planned in US, only ~8,000 MW in the WECC
Planned* New Natural Gas Additions in the WECC
Planned Capacity (MW)
30,000
25,000
20,000
15,000
10,000
5,000
0
2019
2020
2021
2022
2023
2024
2025
2026
2027
Combined Cycle
Gas Turbine
Internal Combustion
Data source: S&P project database

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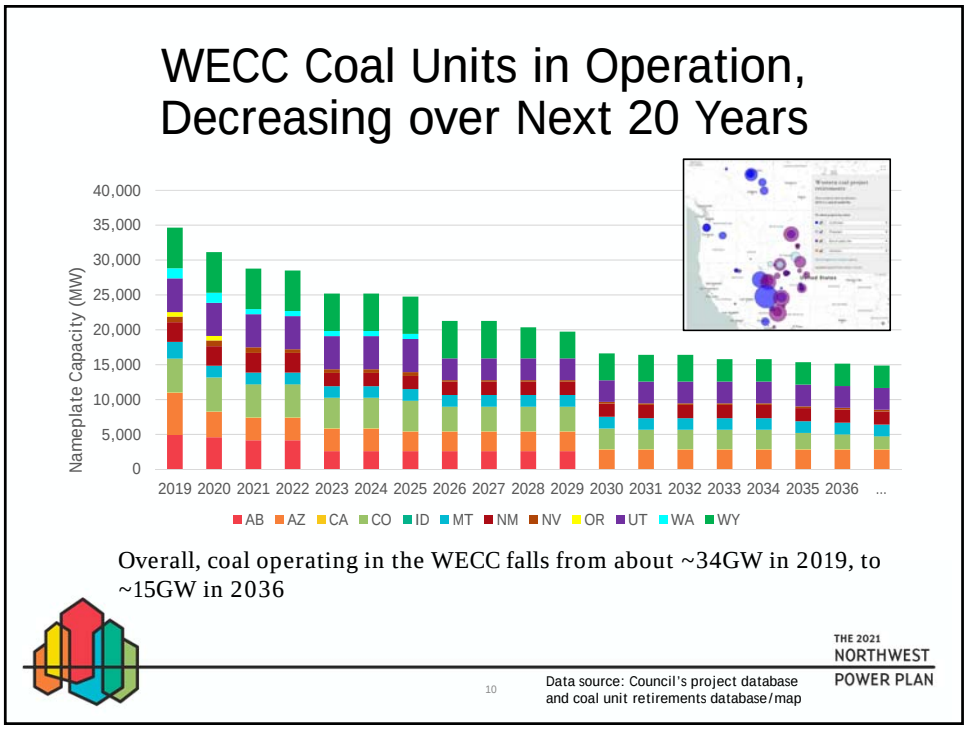
WECC Coal Units in Operation, Decreasing over Next 20 Years
Nameplate Capacity (MW)
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 ...
AB AZ CA CO ID MT NM NV OR UT WA WY
Overall, coal operating in the WECC falls from about ~34GW in 2019, to ~15GW in 2036
10
Data source: Council's project database and coal unit retirements database/map
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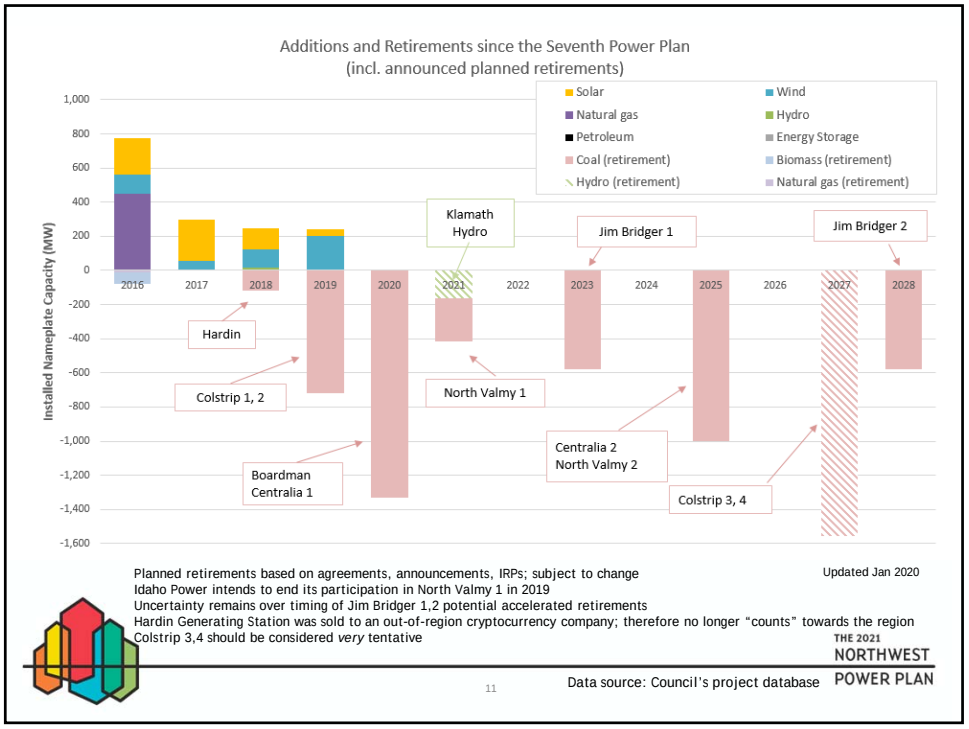
Additions and Retirements since the Seventh Power Plan
(incl. announced planned retirements)
Solar
Wind
Natural gas
Hydro
Petroleum
Energy Storage
Coal (retirement)
Biomass (retirement)
Hydro (retirement)
Natural gas (retirement)
Installed Nameplate Capacity (MW)
1,000
800
600
400
200
0
-200
-400
-600
-800
-1,000
-1,200
-1,400
-1,600
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
Klamath Hydro
Jim Bridger 1
Jim Bridger 2
Hardin
Colstrip 1, 2
North Valmy 1
Boardman
Centralia 1
Centralia 2
North Valmy 2
Colstrip 3, 4
Planned retirements based on agreements, announcements, IRPs; subject to change
Idaho Power intends to end its participation in North Valmy 1 in 2019
Uncertainty remains over timing of Jim Bridger 1,2 potential accelerated retirements
Hardin Generating Station was sold to an out-of-region cryptocurrency company; therefore no longer "counts" towards the region
Colstrip 3,4 should be considered very tentative
Updated Jan 2020
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Data source: Council's project database
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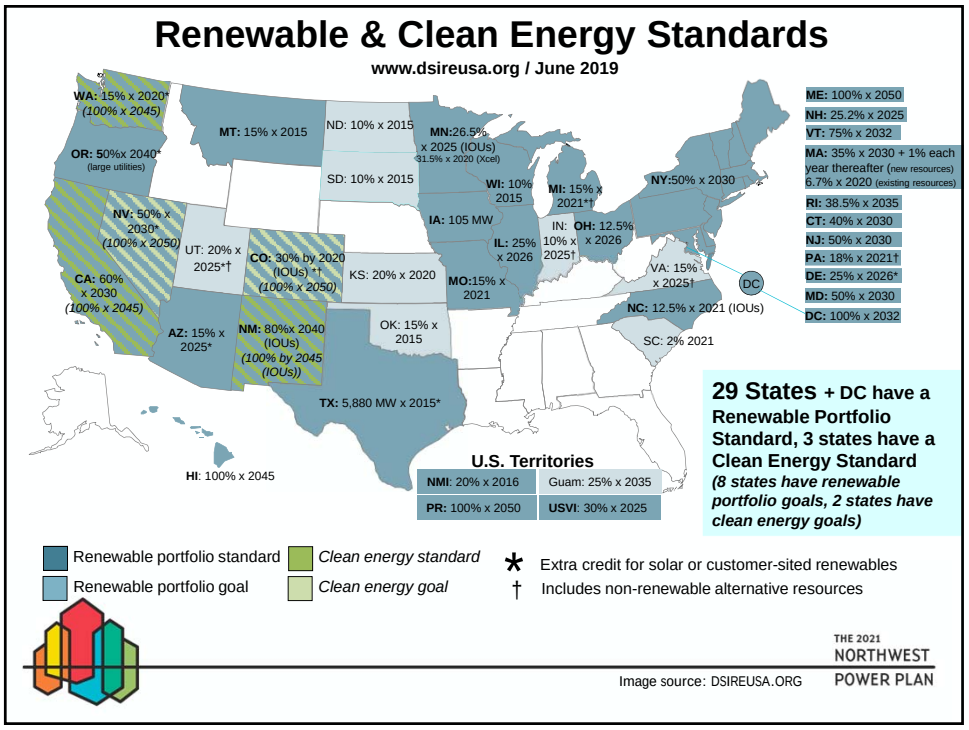
Renewable & Clean Energy Standards
www.dsireusa.org / June 2019
WA: 15% x 2020* (100% x 2045)
OR: 50%x 2040* (large utilities)
CA: 60% x 2030 (100% x 2045)
NV: 50% x 2030* (100% x 2050)
MT: 15% x 2015
ND: 10% x 2015
SD: 10% x 2015
MN:26.5% x 2025 (IOUs) 31.5% x 2020 (Xcel)
WI: 10% 2015
MI: 15% x 2021*†
IA: 105 MW
IL: 25% x 2026
IN: 10% x 2025†
OH: 12.5% x 2026
NY:50% x 2030
UT: 20% x 2025*†
CO: 30% by 2020 (IOUs) *† (100% x 2050)
KS: 20% x 2020
MO:15% x 2021
VA: 15% x 2025†
NC: 12.5% x 2021 (IOUs)
SC: 2% 2021
DC
AZ: 15% x 2025*
NM: 80%x 2040 (IOUs) (100% by 2045 (IOUs))
OK: 15% x 2015
TX: 5,880 MW x 2015*
HI: 100% x 2045
ME: 100% x 2050
NH: 25.2% x 2025
VT: 75% x 2032
MA: 35% x 2030 + 1% each year thereafter (new resources) 6.7% x 2020 (existing resources)
RI: 38.5% x 2035
CT: 40% x 2030
NJ: 50% x 2030
PA: 18% x 2021†
DE: 25% x 2026*
MD: 50% x 2030
DC: 100% x 2032
U.S. Territories
NMI: 20% x 2016
Guam: 25% x 2035
PR: 100% x 2050
USVI: 30% x 2025
29 States + DC have a Renewable Portfolio Standard, 3 states have a Clean Energy Standard
(8 states have renewable portfolio goals, 2 states have clean energy goals)
Renewable portfolio standard
Renewable portfolio goal
Clean energy standard
Clean energy goal
* Extra credit for solar or customer-sited renewables
† Includes non-renewable alternative resources
Image source: DSIREUSA.ORG
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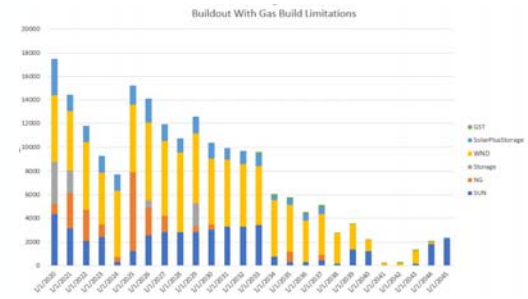
Council's latest electricity forecast – summary of gas builds w/ and w/o limitations

(From Nov 2019 presentation to Council)

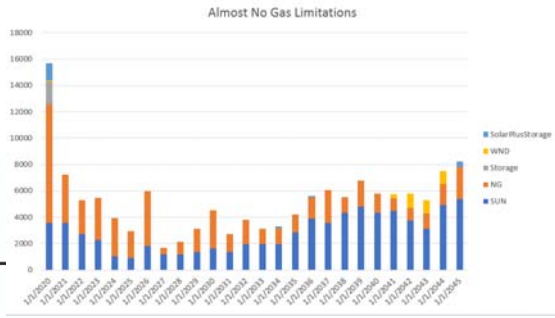
Observations:

Huge first year diverse renewable and storage build, followed by consistent investment in clean energy sources with some gas



Observations:

Huge first year gas build, followed by consistent investment in gas, lower renewable build



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Technology & Cost Trends

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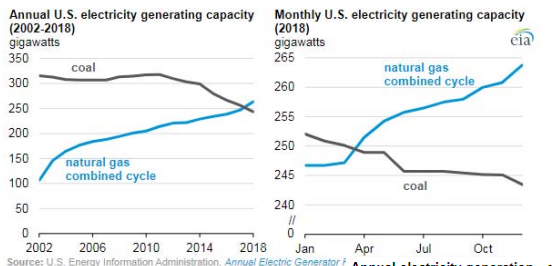
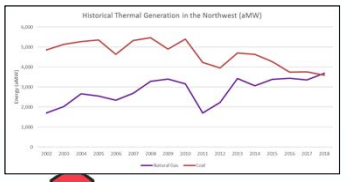
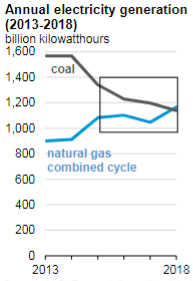
Nationwide Gas vs. Coal

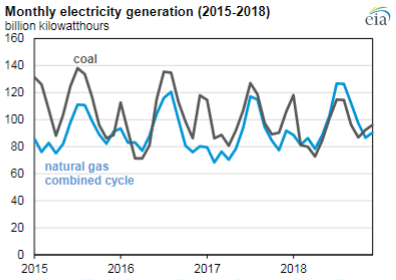
U.S. natural gas-fired combined-cycle capacity surpasses coal-fired capacity



Source: U.S. Energy Information Administration, *Annual Electric Generator Report* and *Preliminary Monthly Electric Generator Inventory*







Source: U.S. Energy Information Administration, *Annual Electric Generator Report* and *Preliminary Monthly Electric Generator Inventory*

- In terms of installed capacity, gas surpassed coal in April 2018
- Also in 2018, gas generation overtook coal generation for the first time (on an annual average) – although this first occurred monthly in 2015

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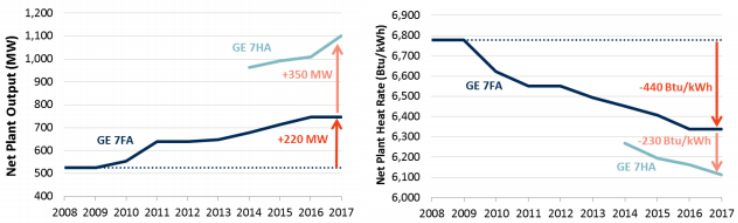
Technology Trends: Performance and Efficiency

Figure 3: Historical Performance of GE 7FA and GE 7HA in a 2×1 Combined-Cycle Configuration



Sources and notes:
Gas Turbine World, "2016–17 GTW Handbook," Volume 32.

- Net output (performance) has been increasing and heat rate has been declining (meaning efficiency is improving) - both within class and among classes
  - Leads to significant capital cost ($/kW) improvements

Figure 3: PJM Cost of New Entry, Combustion Turbines and Combined-Cycle Plants with June 1, 2022 Online Date (April 2018)

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Market & Cost Perspectives

- In general, 2019 cost estimates declined from slight increase in 2018
  - Continued low natural gas prices
  - Less demand for gas turbines as demand increases for renewable energy and storage… therefore manufacturers are competing for fewer bids
    - Leads to lower contracts, smaller profit margins
    - Caused surplus supply, leading to several major manufacturers to strategic corrective measures like temporary/permanent closures of factories
- Manufacturers chasing greater performance, efficiency, and importantly to the region/WECC, greater flexibility

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Proposed 2021 Plan Reference Plants

Gas Peaker(s), CCCT, recip

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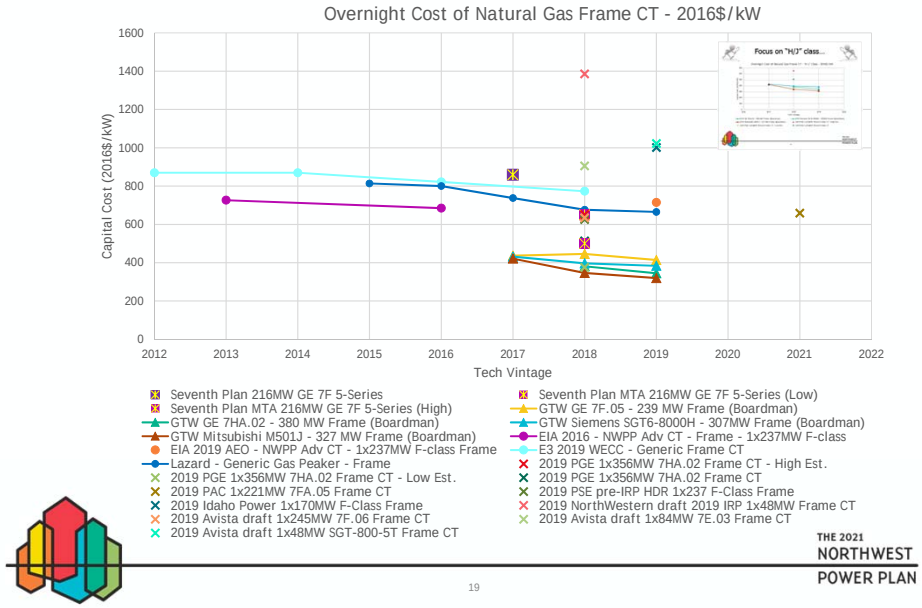
Overnight Capital Cost Plot: Frame Gas Peaker



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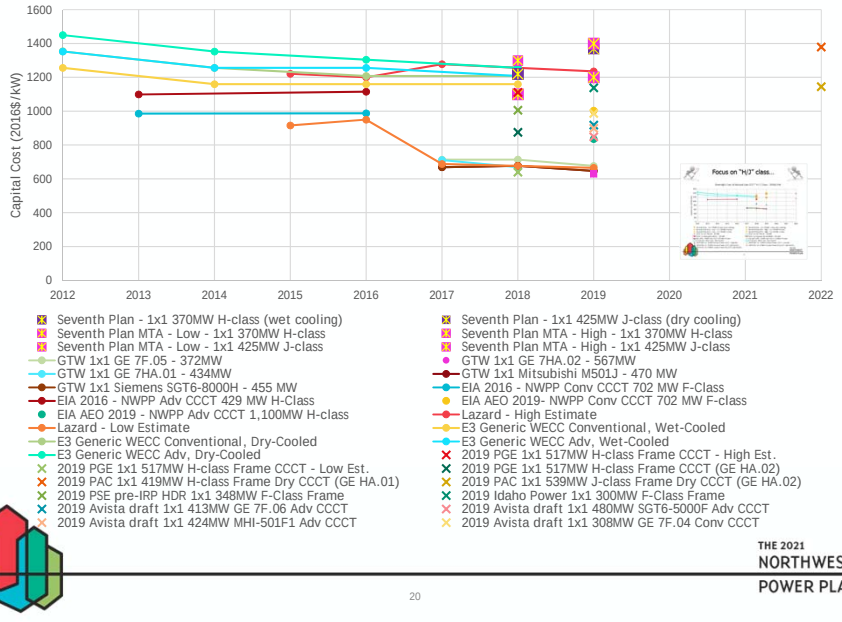
Overnight Capital Cost: CCCT



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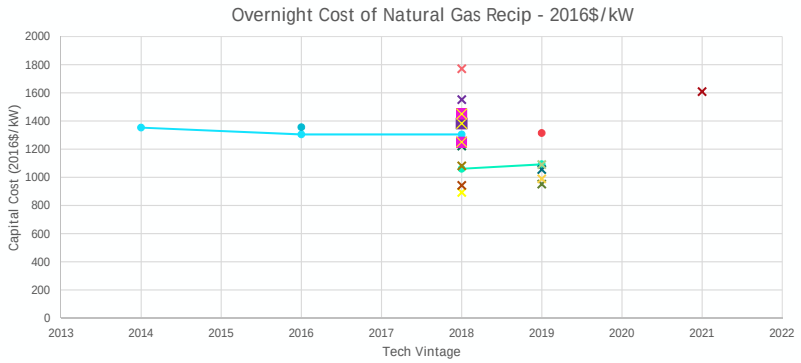
Overnight Capital Cost: Recip



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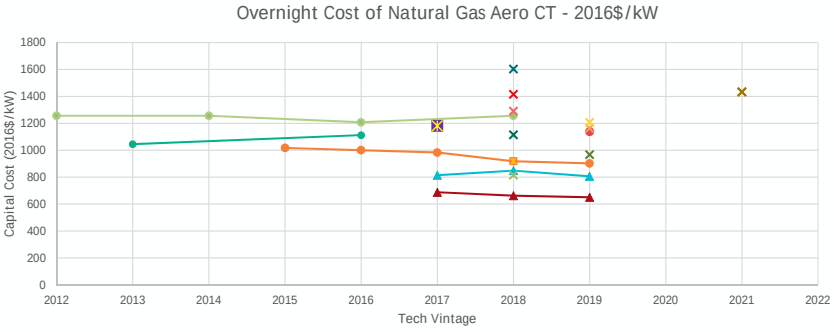
Overnight Capital Cost: Aeroderivative Gas Peaker



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2021 Plan Reference Plants: Natural Gas

	Gas Frame Combustion Turbine	Gas Combined Cycle Combustion Turbine	Gas Reciprocating Engine
Configuration & Technology	(1) General Electric 7HA.02 Frame	1x1 General Electric 7HA.02 Frame, Dry-cooling, Single Fuel	12x 18V50SG Wartsila gensets
Capacity (MW)	380 MW (ISO)	573 MW (ISO)	220 MW (ISO)
Heat Rate HHV (Btu/kWh)	8890 (ISO)	5973 (ISO)	8176 (ISO)
Location	East side	East-side	East side
Financial Sponsor	IOU	IOU	IOU
Economic Life (years)	30	30	30
Overnight Capital Cost ($/kW)	$550	$1,150	$1250
Fixed O&M Cost ($/kW-yr)	$5.50	$10	$5
Variable O&M Cost ($/MWh)	$6.50	$3	$5
Development Time (yrs)	2	2	1
Construction Time (yrs)	1	2	1
Earliest Commercial Online Date	2020	2021	2020

Remaining Considerations

- Determine which gas peaker reference plant(s) to include in the model
  - Qualitative analysis and cost estimates on all technology types will still be completed and included in the technical work of the power plan
- Maximum build-out potential
  - Informed by gas pipeline capacity

❖ GRAC meeting on February 27

Background Slides

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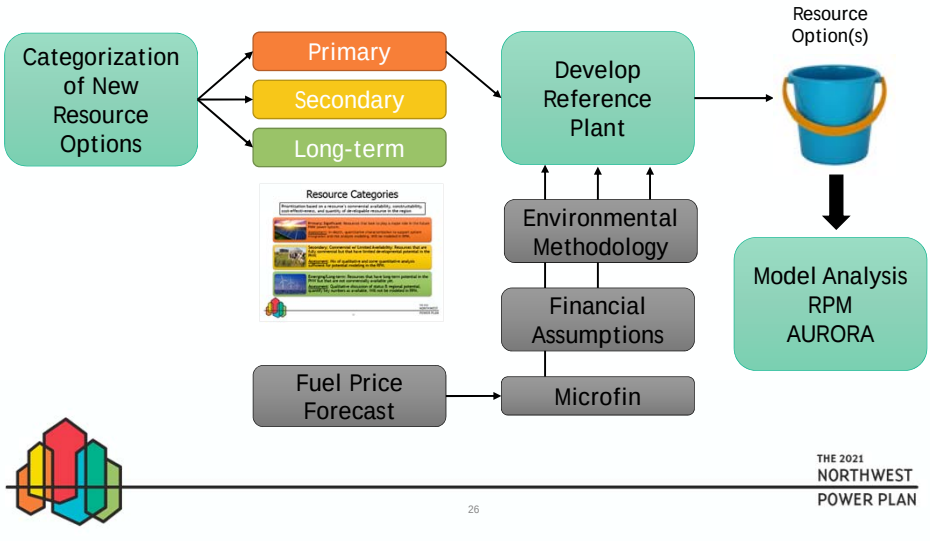
Developing a Reference Plant



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Resource Categories

Prioritization based on a resource's commercial availability, constructability, cost-effectiveness, and quantity of developable resource in the region

Primary; Significant: Resources that look to play a major role in the future PNW power system.

Assessment: In-depth, quantitative characterization to support system integration and risk analysis modeling. Will be modeled in RPM.

Secondary; Commercial w/ Limited Availability: Resources that are fully commercial but that have limited developmental potential in the PNW.

Assessment: Mix of qualitative and some quantitative analysis sufficient for potential modeling in the RPM.

Emerging/Long-term: Resources that have long-term potential in the PNW but that are not commercially available yet.

Assessment: Qualitative discussion of status & regional potential, quantify key numbers as available. Will not be modeled in RPM.

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Proposed Generating Resources Categorization for 2021 Plan

Primary	Secondary	Emerging/Long-term
Solar PV	Conv. Geothermal	Enhanced Geothermal Systems
Onshore Wind	Offshore Wind	Small Modular Reactors
Gas CCCT	Distributed Generation*	Carbon Capture & Sequestration
Gas SCCT – Frame	Biomass	Hydrogen Gas Turbine
Battery storage (Li-ion)	Hydro Upgrades	Allam Cycle Gas
Solar + Storage	Biogas	Wave, Tidal
Pumped Storage	Power-to-Gas	
Reciprocating Engine	Small Hydro	
Gas SCCT - Aeroderivative	Combined Heat and Power	

= reference plant

* DG will also be included in the load forecast
Omitted: Advanced nuclear, coal, large hydro, CAES

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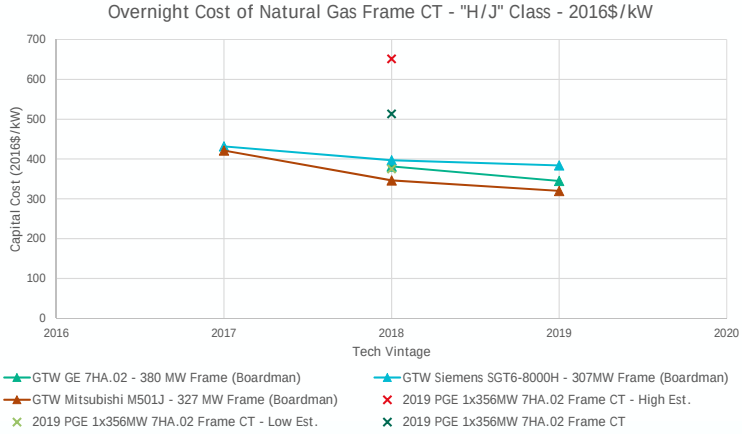
Focus on “H/J” class...



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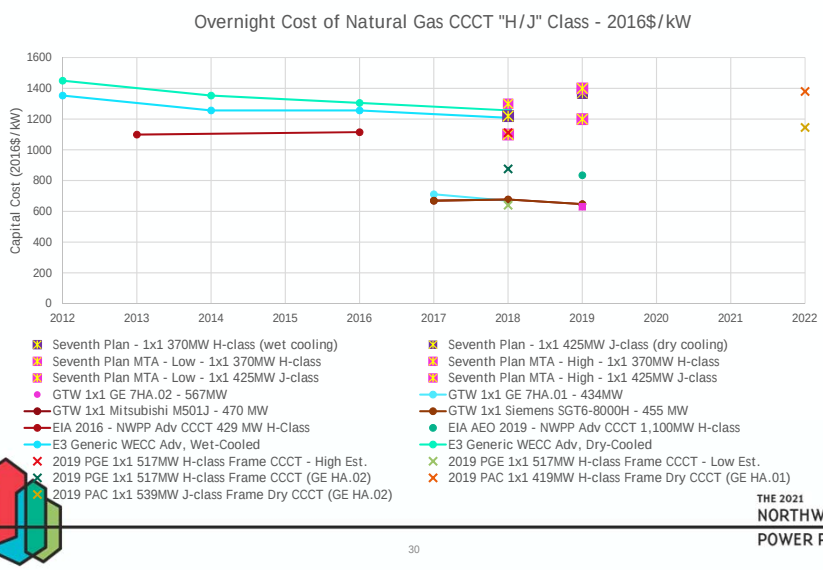
Focus on “H/J” class...



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