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

February 4, 2025

MEMORANDUM

TO: **Council Members**

FROM: **Annika Roberts**

SUBJECT: **Proposed Reference Plants for the Ninth Plan (Part 1)**

BACKGROUND:

Presenter: Annika Roberts, Resource Policy Analyst

Summary: A reference plant is a collection of characteristics that describe a resource technology and its theoretical application in the region. It includes estimates of typical costs, logistics, and operating specifications. These reference plants become resource options—along with energy efficiency, demand response and distributed energy resources—for the Council's power system models to select to fulfill future resource needs. The Council develops a defined set of reference plants that represent the range of resources to be considered in planning.

At the February Council meeting staff will start the process of reviewing proposed reference plants to be analyzed in the Ninth Plan. This initial presentation, of two on the topic, will cover the many components of a reference plant and the development process. Staff will also share out the proposed technologies to be covered by a reference plant for the plan. Council member questions on the methodology and feedback on the proposed technology options to be considered will guide our work as we seek to develop complete reference plants for discussion at the March meeting.

Relevance: The Power Act directs the Council in its power plan to put forth a general strategy for implementing conservation measures and developing generating resources. The Council uses reference plants as a means of characterizing generating resource options for modeling by representing the different attributes of different resources for the model to consider.

Workplan: B.2.3. Develop generating resource reference plants and related assumptions for plan analysis.

Background: Primer on generating resource reference plants presented to the Council in August 2024: https://www.nwcouncil.org/f/18846/2024_0813_10.pdf
Generating Resource Advisory Committee presentation: https://www.nwcouncil.org/meeting/generating-resources-advisory-committee-2025-01-31/

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Purpose

- Part I → **TODAY**
  - Defining a reference plant
    - What are the component pieces and how are they developed
  - Identifying which resources are built into reference plants
  - Brief discussion of how we handle the risk of generalization that the reference plant methodology requires
- Part II → **MARCH**
  - Defining the specific characteristics of each reference resource and how they fit into our modeling

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What is a reference plant?

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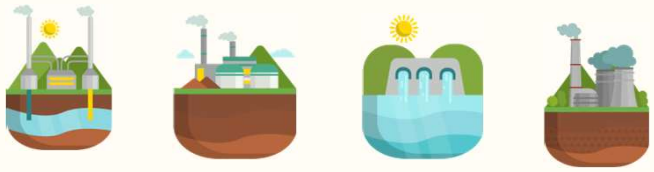
Defining a reference plant



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Components of a reference plant

Resource Attributes

- Technology Type
- Configuration (# of units x MW)
- Capacity (MW)
- Location(s)
- Operating Life (yrs)
- Development & construction schedule
- Earliest in-operation date (year)
- Transmission access

Financials

- Financial Sponsor (IOU, IPP)
- Overnight Capital Cost ($/MWh)
- Fixed O&M ($/kW-yr)
- Variable O&M ($/MWh)
- Fixed Fuel Cost
- Transmission Cost

Operating Characteristics

- Capacity Factor
- Heat Rate
- Generation Shape

Developmental Potential

- Location
- Transmission/Gas Pipeline Access
- Maximum Build-out

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Resource attributes: *How the technology/resource serves the grid*

Technology Type	Configuration	Capacity	Operating/ Economic Life	Timing	Transmission Access
	• The number of units (and installed nameplate capacity of each unit) that make up the complete reference plant. Also includes other plant specifications such as air emissions controls, cooling (wet vs. dry).	• Nameplate Capacity: the maximum amount of electricity a plant can generate when it is fully functional, in optimal conditions, and, if applicable, using the maximum amount of fuel. The manufacturer's rated output of the generator.	• The assumed useful operating life of the plant	• Construction Lead Time: Inclusive of the development period & construction lead time, the amount of assumed time for a project to come online from conception to commissioning. • Availability date	• Assumed transmission type (long-term firm, short term, IOU network etc.)

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Financials: *What the resource costs and how it's paid for*

Financial Sponsor	Overnight Capital Costs	Fixed O&M	Variable O&M	Fuel Costs	Transmission Costs
Different entities use different project financing mechanisms. These differing mechanisms and incentives available for some resources result in different total investment costs and annual capital service requirements for otherwise identical projects. (IOU, POU, IPP)	An estimate of the project development and construction cost. "Overnight" refers to what the cost would be if the plant were built instantly, or over one night. This cost constitutes the engineering, procurement, and construction (EPC) costs, owner's costs (costs incurred by the project developer – permits, licenses, land, project development costs, infrastructure, taxes, regulatory compliance costs, etc.), and decommissioning costs	An estimate of the fixed operation and maintenance cost for the reference plant, including operating and maintenance, labor and materials, and administrative overhead. Both routine maintenance, and major maintenance and capital replacement are assumed to be included.	An estimate of the variable operation and maintenance cost for the reference plant, including all costs that are a function of the amount of power produced. This includes consumables such as water, chemicals, lubricants, catalysts, and waste disposal.	The primary type of fuel burned (natural gas, oil, coal, etc.), its location of origin, and cost.	Cost of the assumed transmission type, incorporated into the cost of the resource.

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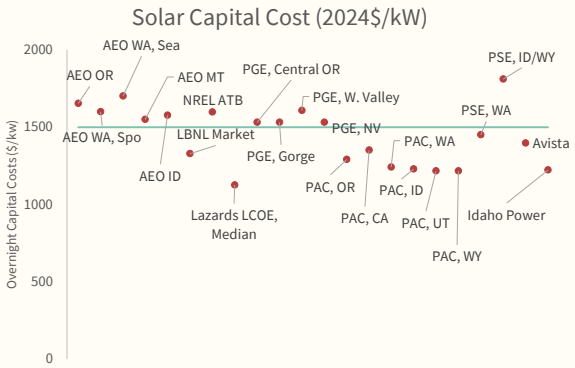
Financials: *Process*

- **Overnight capital costs and O&M**:
  - *Gather* analysis of available cost data from manufacturers, developers, PPAs, project-specific publicly available reported info, technical handbooks, reports from EIA, DOE, national labs, IRPs, etc.
  - *Normalize* the cost data to a consistent year dollars, configuration, capacity, heat rate, etc.
  - *Plot* the normalized data and look for trends and outliers – determine best estimate of current and future costs
- **Cost curves**:
  - Estimate costs through the 20-yr planning period
- **MicroFin**:
  - Financial revenue requirements model used to calculate levelized fixed cost and LCOE



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Operating characteristics: *How the technology works*

Capacity Factor	Capacity Factor Multiplier	Heat Rate	Heat Rate Multiplier	Generation Shape
An estimate of the ratio of actual annual output to nameplate capacity, can vary by location esp. for renewables	Built in assumptions of improved technology efficiency over time	A measure of the efficiency of which a generator converts fuel into electricity. The reference plant heat rates are based on full load, expressed as higher heating values (HHV).	Reflects assumed heat rate efficiency improvements of reference plants over the planning period	When a plant generates power, which can vary by time of day, time of year, location etc. 

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Developmental potential:
How the resource fits into the grid & works with other resources

Transmission/ Gas Pipeline Access	Maximum Buildout	Location
	The maximum amount of reference plant units (in megawatts) that the model can select over the 20-year planning horizon	The general geographic location of the reference plant, which is important in properly accounting for plant attributes (e.g. capacity factor, transmission access)

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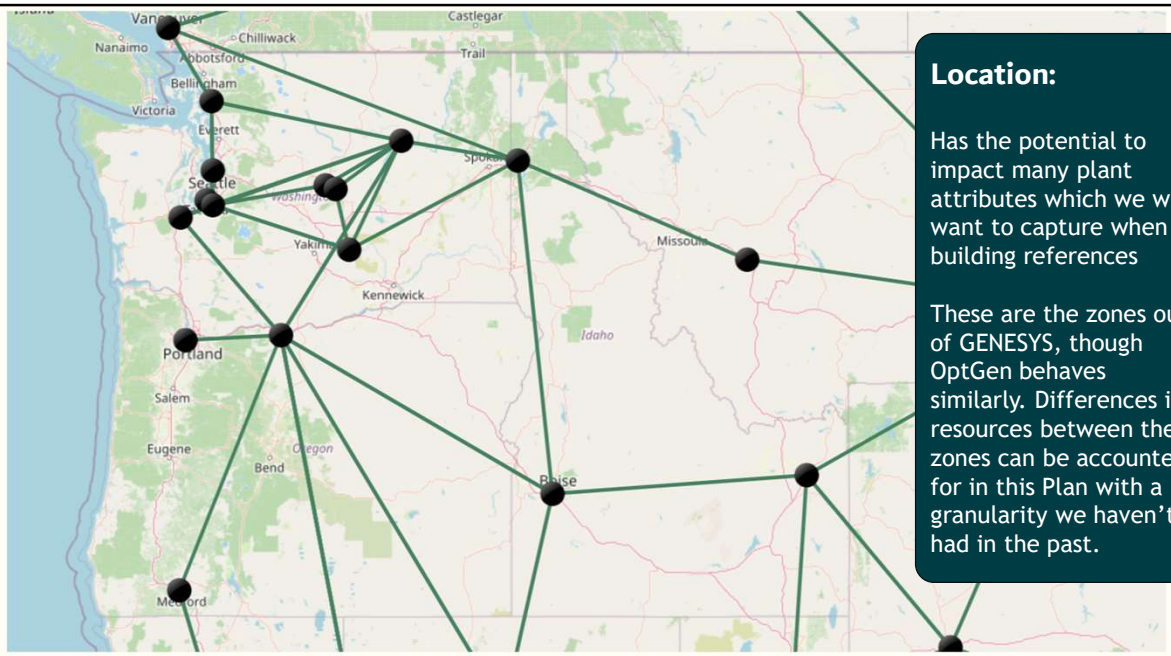

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Addressing uncertainty

- These reference plants are intended to serve as a representation of a **typical** given resource
  - They are imprecise and generalized (by definition)
- Given that, we have built in scenario analysis to test the impact of specific characteristics defined in a reference plant changing
  - Those sensitivities were described in the resource and transmission risk scenario

Resource and Transmission Risk Scenario

★ Broad scenario to explore uncertainty around resource availability, resource costs, and transmission availability

Proposed Sensitivities	DRAFT – Subject to Change
Constrained New Resource and Transmission Options	Exploring resource selection in a world with limited new transmission and significantly delayed/limited emerging tech resources
Evolving Federal Policy Landscape	Exploring implications of increase cost on supply side resources (changes to tax credits, tariffs) and some near-term delays in resource availability due to ongoing supply chain challenges
Changing Transmission Availability	Exploring changes in resource selection with more transmission availability (potentially two looks)
Changing Emerging Tech Resource Assumptions	Exploring changing to resource solutions with differing assumptions on emerging tech resource costs (increase and decrease) and delayed availability
Limited Short-Duration Storage Availability	Exploring resource selection in a world where short-duration storage is limited in the near-term
Slower Demand Side Resource Availability	Exploring resource selection if demand side resources have reduced availability

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Prioritizing & categorizing: Which resources get reference plants?

- The Council prioritizes and categorizes generating resources based on a resource's commercial availability, constructability, and quantity of developable potential in the Pacific Northwest during the 20-year planning period.
- It is time/cost prohibitive to model every resource, the goal of categorization is to provide a framework for thinking about the role of these resources in the regions and which will have the most impact

Primary Resources	Limited Availability Resources	Emerging Technology
• Significant resources that are deemed proven, commercially available, and deployable on a large scale in the region at the start of the study period • Resources expected to play a major role in the future regional power system	• Commercially available resources with limited development potential in the region	• Emerging resources that have a long-term potential in the region but are not commercially available or deployable on a large scale at the beginning of the study period
• In-depth, quantitative characterization to support system integration and risk analysis	• Mix of qualitative and some quantitative analysis, limit capacity available to be selected	• Qualitative discussion of status of regional potential, represent as proxies for future technology in analysis

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Resources Considered

Primary	Limited Availability	Emerging
Solar PV	Conventional Geothermal	Enhanced Geothermal Systems
Small Scale Renewables	Offshore Wind	Small Modular Reactors
Onshore Wind	Pumped Storage	Carbon Capture & Sequestration
Gas CCCT	Biomass	Hydrogen Gas Turbine
Gas SCCT—Frame	Hydro Upgrades	Allam Cycle Gas
Gas SCCT—Reciprocating Engine	Biogas	Wave, Tidal
Gas SCCT—Aeroderivative	Power-to-Gas	Long Duration Storage
Battery Storage (Li-ion)	Small Hydro	
Renewables + Storage	Combined Heat & Power*	

*Required by the Act, handled narratively

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Emerging technology methodology

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Why proxies?

Multiple proxies

Build multiple proxy reference plants that each fill a system need
- Clean Baseload
- Clean Peaker/medium duration storage
- Clean Long Duration Storage

+ Pros
- Speaks to a system need we believe technology will fill
- More representative

- Cons
- We cannot know the future, the need might not get filled, or it might get filled a different way

- The intention of the proxy approach is to avoid picking favorite resources or being overly prescriptive of a future technology that we just don't know
- By identifying these emerging technology resources as proxies, that are representative of a set of characteristics rather than a particular technology the hope is we have more space to test within those characteristics
  - Even if these technologies or these exact characteristics don't come to bear, these proxies will still tell us something about regional needs
- Available far enough out that we will have time to revisit any assumptions by the next Plan

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Emerging technology proxies

- What are the defining characteristics of the resource?
- What does this resource being selected tell us about the systems need?

Clean Long Duration Storage	Variable Resource Integration	Operational Flexibility	Seasonal & Daily Demand Shifting
Clean Baseload	Reliability	Firm Supply	
Clean Peaker w/load	High Peak Demand	Operational Flexibility	Daily & Hourly Demand Shifting

Hydrogen

Hydrogen resource options

Hydrogen-only new resource

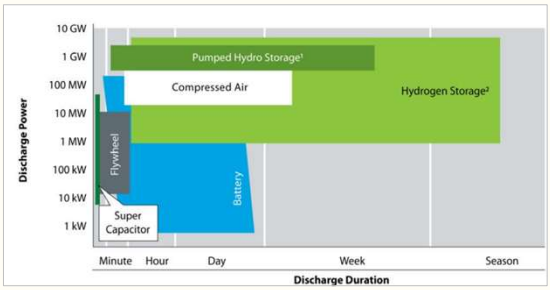
- Emerging technology proxy reference plant
  - One of three emerging tech options that fill different grid needs
  - An all hydrogen burning resource would fulfill the niche of a clean, mid-duration storage, peaker-style plant
  - Not available at the start of the action plan period, but at a realistic future date

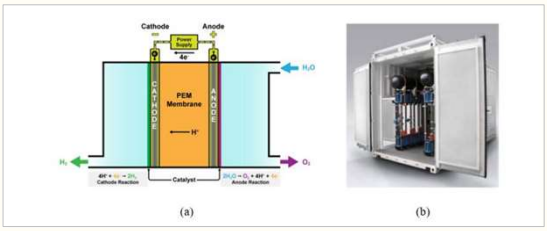
Natural gas plant upgrade

- An additional new natural gas reference plant that will be converted to hydrogen when technologically feasible and the model deliberates it is economical to do so
  - The conversion would include all emissions & cost implications at that upgrade year

Timing considerations

- There **is** a hydrogen hub in the PNW with 8 potential project nodes which will likely drive development
  - And hydrogen is showing up in regional IRPs
- However, there is no existing H_2 infrastructure and most forecasts don't show significant H_2 for power until the 2040s
  - Therefore hydrogen would have to be produced and stored on site

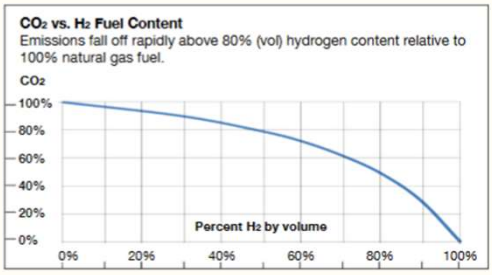




PEM Electrolyzers – a) schematic and b) Proton on-site electrolyzer. From DOE Energy Storage Handbook Chapter 11: Hydrogen.

Hydrogen conversion

- Why include this resource?
  - Many regional IRPs are assuming some conversion capability to utilize their existing gas fleet & still hit clean goals
  - Therefore, it's worth testing: are the costs and the emissions and the resource characteristics filling a gap in the region's system need
- Is it possible?
  - Gas plants are theoretically able to burn 100% hydrogen with some modifications with similar efficiency/heat rates
  - Gas pipes are incompatible with transporting hydrogen gas which creates infrastructural barriers (couldn't accomplish a direct gas → hydrogen transition)



- What's the proposal?
  - Additional simple cycle gas turbine reference plant that after a certain year can convert to burning hydrogen
  - At that point, the additional costs of having onsite hydrogen production and storage will be incorporated, as well as the change in plant emissions

Proposed reference plants

Proposed reference plants

Primary	Limited Availability	Emerging*
Utility Scale Solar PV	Pumped Storage	Long-Duration Storage (Iron Air Battery)
Onshore Wind	Geothermal (Conventional)	Clean Baseload Resource (Small Modular Reactor)
Gas (CCCT, SCCT—Frame, SCCT—Recip.)	Offshore Wind	Clean Peaker/Medium-Duration Storage (Hydrogen turbine w/ onsite production/storage)
Li-Ion Battery (4-hr)		
Solar + Storage		
Community Solar		

*Emerging Technology will be handled via proxy

Advisory Committee Feedback

- We shared the proposed reference plants and their categorization with the Generating Resource Advisory Committee in late January
- They were generally supportive of the list and our suggested treatment
- There were a few comments about additional emerging tech resources, and while there are some ongoing discussions on the topic, we believe that the proxy resources can be representative of the breadth of resources suggested.

Up next

- Presented reference plant proposals to the Generating Resource Advisory Committee in late January (materials linked in the packet)
- Still collecting feedback and input from that discussion from committee members
- Return next month with technology specific characteristics of each reference plant proposed for inclusion in the 9th Plan