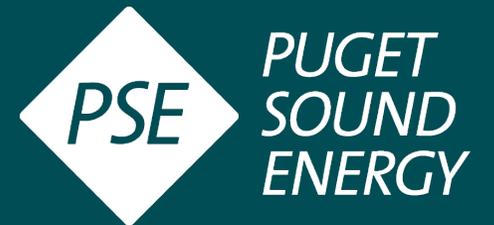


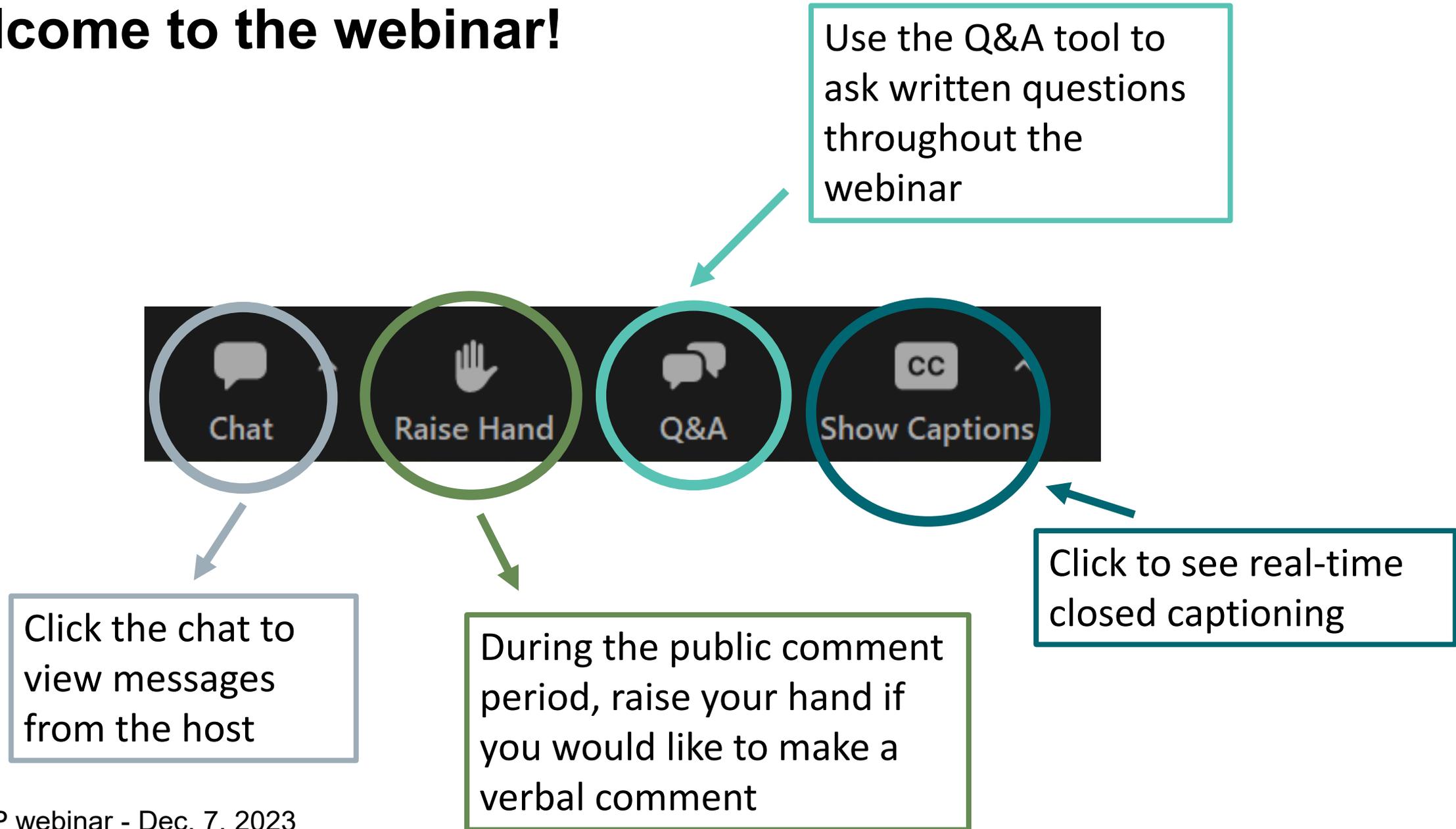
Emerging resources: hydrogen

Public webinar

December 7, 2023



Welcome to the webinar!



Facilitator requests

- Engage constructively and courteously towards all participants
- Respect the role of the facilitator to guide the group process
- Avoid use of acronyms and explain technical questions
- Use the Feedback Form for additional input to PSE
- Aim to focus on the webinar topic
- Public comments will occur after PSE's presentations

Safety moment

Winter holiday safety

- Never leave a burning candle unattended
- Don't overload circuits or "daisy chain" extension cords
- Plug space heaters directly into a wall outlet; do not use extension cords to power a space heater
- Never leave cooking or baking unattended
- Keep holiday plants like poinsettias away from pets and children

Today's speakers

Sophie Glass

Facilitator, Triangle Associates

Steve Schueneman

Development Manager, Strategic Energy Initiatives

Niecie Weatherby

Manager, Gas Systems Integrity

Jennifer Coulson

Manager, Operations and Gas Analysis

Today's objectives

- Learn about the basics of hydrogen: what it is, how it is used, and how we address safety concerns
- Learn how hydrogen can support PSE's clean energy goals
- How we incorporate hydrogen into the IRP
- Collect feedback related to the use of hydrogen

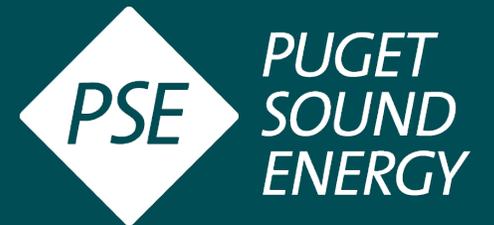
Agenda

Time	Agenda Item	Presenter / Facilitator
4:00 p.m. – 4:05 p.m.	Introduction and agenda review	Sophie Glass, Triangle Associates
4:05 p.m. – 4:20 p.m.	Hydrogen basics & use within the utility industry	Steve Schueneman, PSE
4:20 p.m. – 4:35 p.m.	Meeting PSE's clean energy goals safely with hydrogen	Niecie Weatherby, PSE
4:35 p.m. – 4:50 p.m.	Hydrogen in the IRP	Jennifer Coulson, PSE
4:50 p.m. – 5:00 p.m.	Next steps and public comment opportunity	Sophie Glass, Triangle Associates
5:00 p.m.	Adjourn	All

Hydrogen basics

Steve Schueneman, PSE

December 7, 2023



Definitions

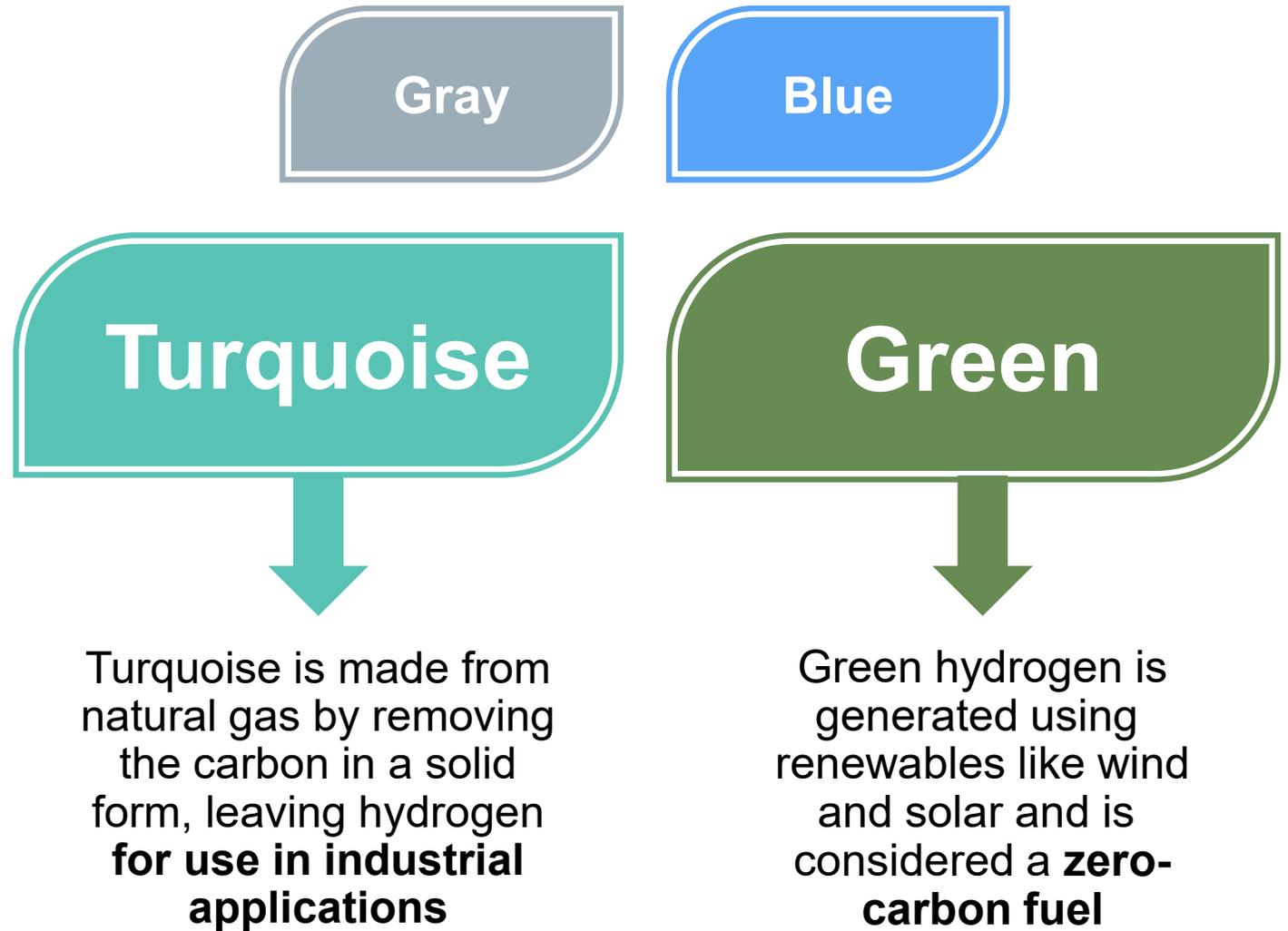
RCW 19.405

- (32) "Renewable hydrogen" means hydrogen produced using renewable resources both as the source for the hydrogen and the source for the energy input into the production process.
- (34) "Renewable resource" means: (a) Water; (b) wind; (c) solar energy; (d) geothermal energy; (e) renewable natural gas; **(f) renewable hydrogen**; (g) wave, ocean, or tidal power; (h) biodiesel fuel that is not derived from crops raised on land cleared from old growth or first growth forests; or (i) biomass energy.

Department of Energy

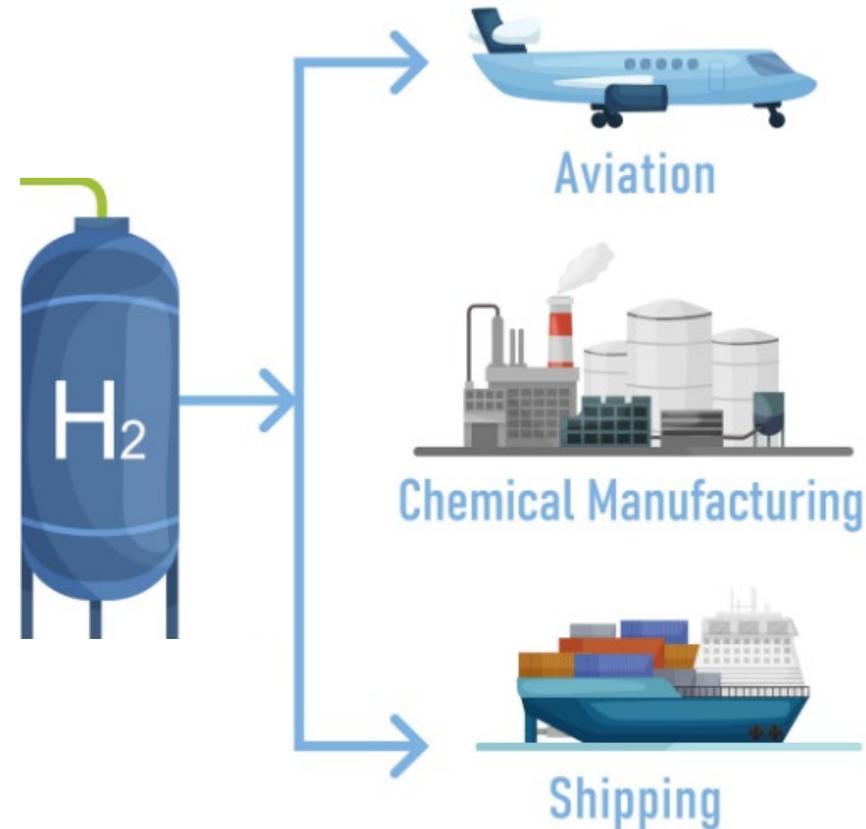
- "Clean hydrogen is defined as hydrogen produced with a carbon intensity equal to or less than 2 kilograms of carbon dioxide-equivalent produced at the site of production per kilogram of hydrogen produced."

Types of hydrogen fuel



Hydrogen uses

- ◇ Hydrogen is already fueling personal and industrial vehicles around the world, but it could also reduce emissions in the most carbon-intensive industries.



Hydrogen uses

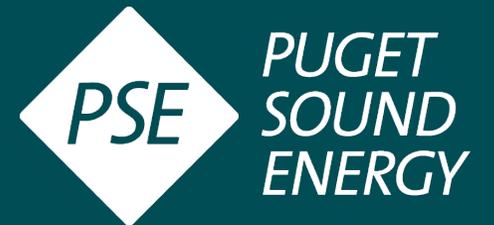


- ◆ Hydrogen has been used as a fuel source for decades – even by NASA in the 1950s
- ◆ Each year, the U.S. produces approximately 10 million tons of hydrogen to fuel:
 - ◆ Agriculture needs
 - ◆ Food production
 - ◆ Electronics manufacturing
 - ◆ Petroleum refining

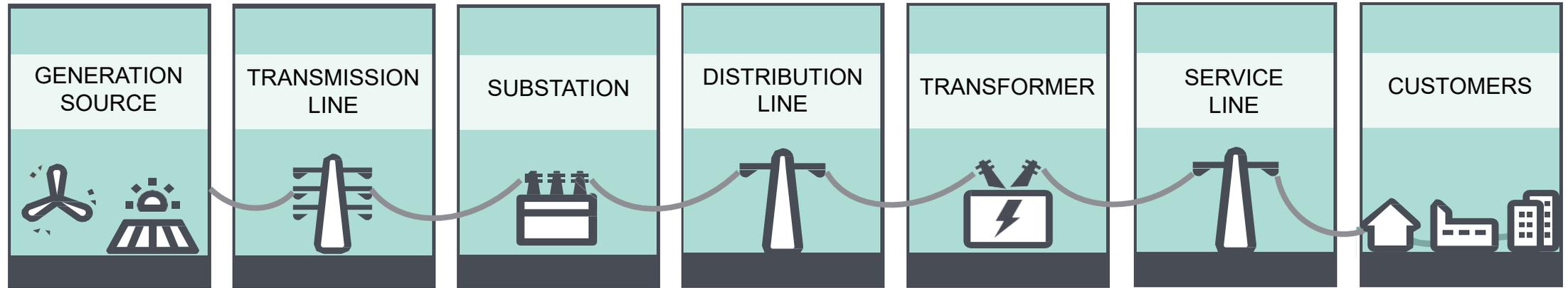
Meeting PSE's clean energy goals with hydrogen

Niecie Weatherby, PSE

December 7, 2023



How PSE could use hydrogen in the ELECTRIC system

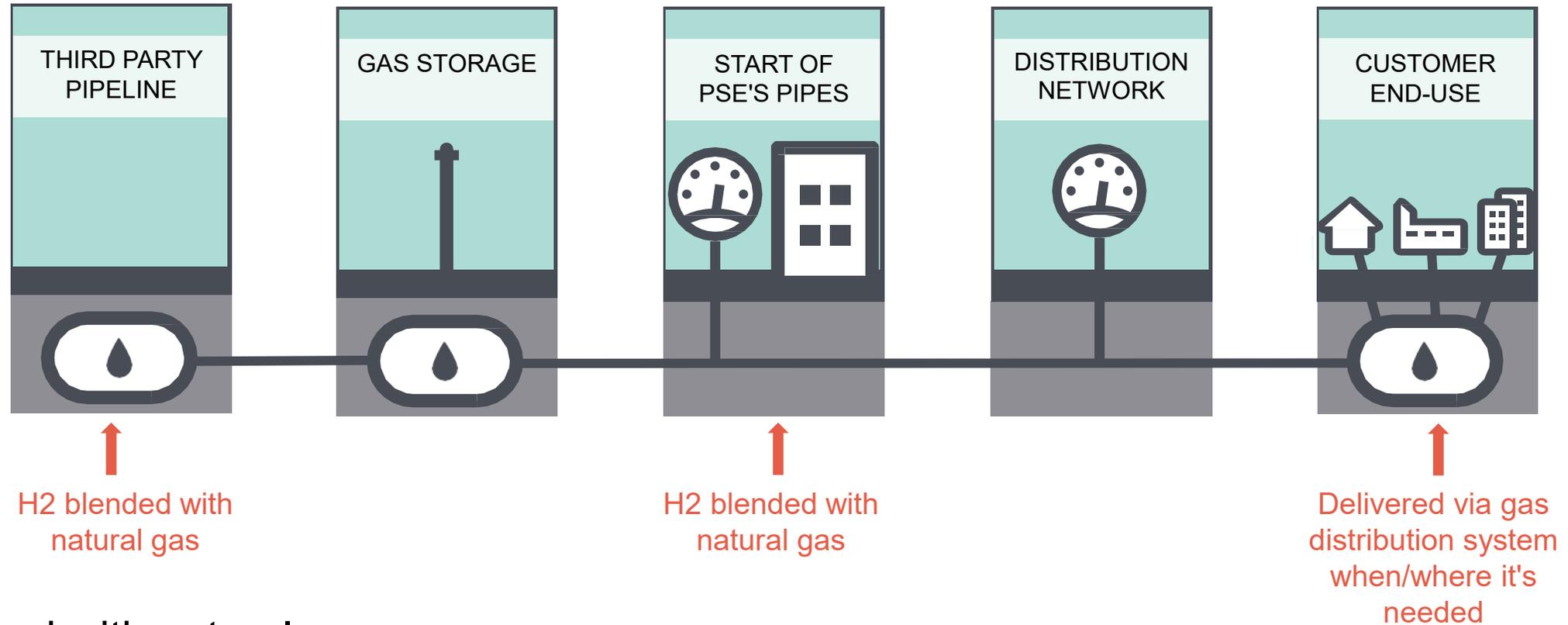


↑
H2 created
with renewables
and stored

↑
Added to the
grid when
needed

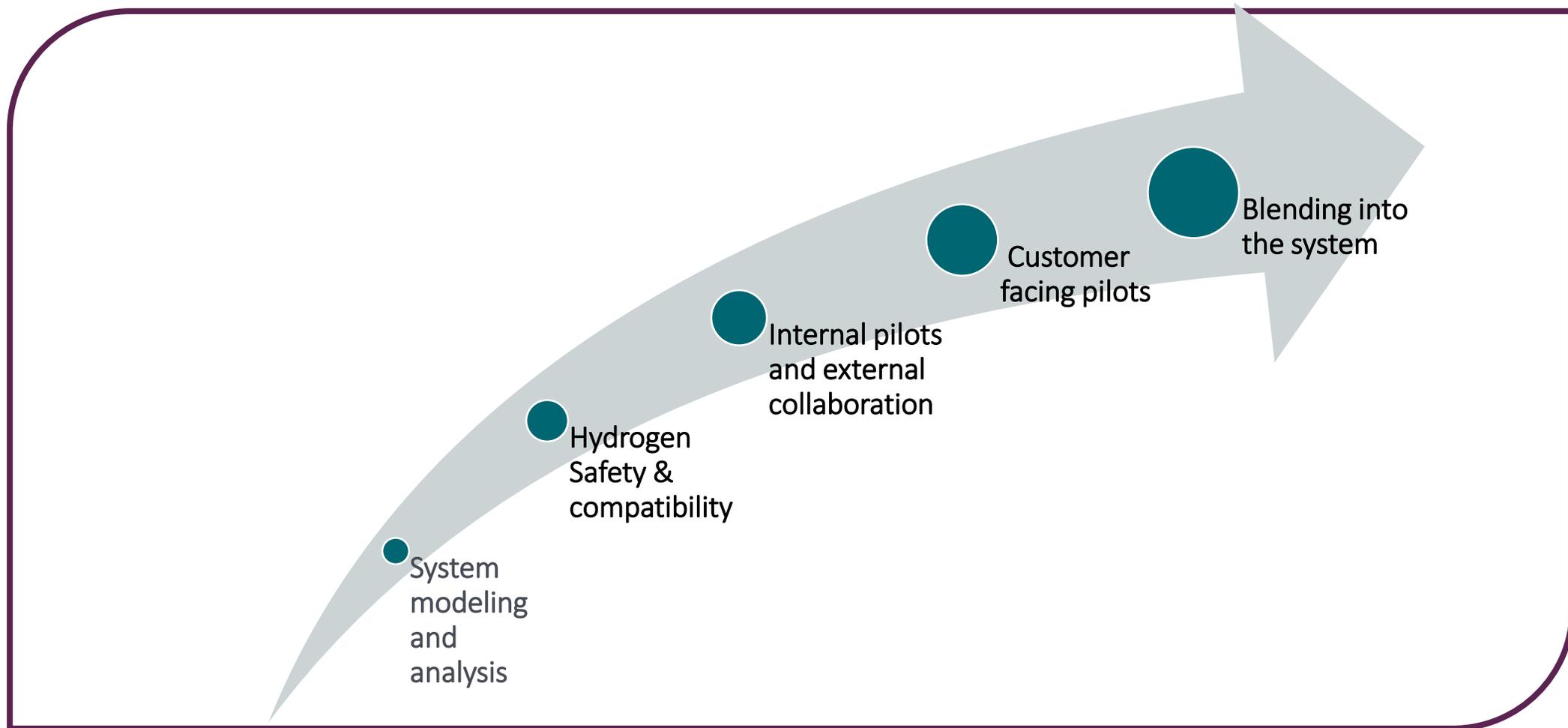
- ◆ Combust at a power plant, or use in a fuel cell, to generate electricity
- ◆ Use to supplement unpredictable renewables or as a “peaker” fuel during high demand

How PSE could use hydrogen in the NATURAL GAS system



- ◆ Blend with natural gas to lower carbon content

PSE's hydrogen injection strategy

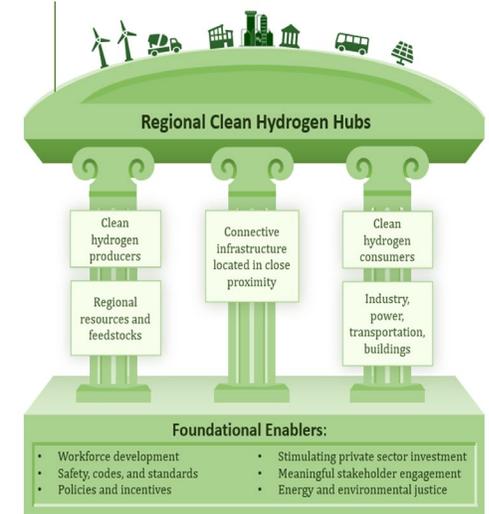


Safety concerns about hydrogen blending

- **Leakage/flammability**
- **Material compatibility**
- **End use appliances**
- **Accumulation of hydrogen in confined spaces**

PSE's hydrogen pilots and studies

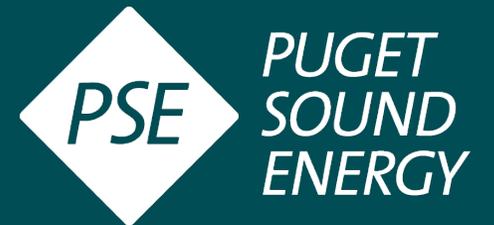
-  Pilot 1 – Customer Appliances: (completed)
Gain first-hand experience with a hydrogen blend in a closed piping system. Test typical residential appliance performance.
-  Pilot 2 – Common Natural Gas Components: (completed)
Test currently approved components compatibility with hydrogen in a small closed distribution system over 90 days for impacts.
-  Pilot 3 – Electrolyzer Operations: (in process)
Gain familiarity with an electrolysis unit, and use green hydrogen for electric generator cooling. Learn blending requirements including measurement and safety equipment.
-  Pacific Northwest Hydrogen Hub: (in process)
PSE is part of the consortium participating in the regional Hydrogen Hub. Currently in negotiations with DOE to determine final federal funding levels, scope and terms.



Hydrogen in the IRP

Jennifer Coulson, PSE

December 7, 2023



Clean Hydrogen in the 2025 IRP

Inputs

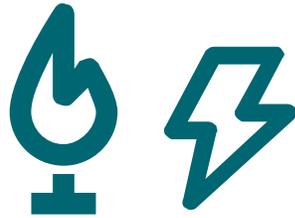


Est. Clean Hydrogen
Volume & Price



+ Other renewable
resources, capacity
resources and energy
efficiency potential

Analysis

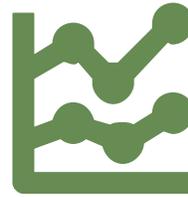


All resource
alternatives are
evaluated together
within PSEs Gas &
Electric Optimization
models

Some important things to consider:

- Hydrogen is not made available **within the models until 2030**
- **The Inflation Reduction Act provides an incentive** for leveraging the fuel, making it more cost effective within the 2030 timeframe. Over time, these incentives are likely to decrease/go away.

Outputs



The outputs of both
models are potential
volumes of least
cost resources to meet
customer demands

Out of Scope



If an IRP identifies a
need for a resource
within the next 3 yrs,
the company is
required to issue a
request for proposal.
Meaning the company
goes to the market and
asks if anyone can fill
the need.



There is an extensive
analysis that occurs to
ensure the acquisition
of a resource is right
for our customers.
Once that is
complete, eventually
that resource helps
power your
home/business.

Feedback related to clean hydrogen

2023 Gas Utility IRP

- Explored the use of alternative fuels including clean hydrogen and renewable natural gas (RNG)
- Captured key characteristics of alternative fuels such as price and availability
- Committed to further refine the assumptions for alternative fuels in future IRP cycles
- Interested parties expressed concerns about cost, availability and feasibility of hydrogen

2023 Electric Progress Report

- Explored the use of alternative fuels including green hydrogen and biodiesel for peaking facilities
- Assumed clean hydrogen and natural gas blending in peaking facilities starting in 2030
- Committed to further refine the assumptions for alternative fuels in future IRP cycles
- Interested parties expressed concerns about cost, availability and feasibility of hydrogen

Next steps

Sophie Glass, Triangle Associates

December 7, 2023



Upcoming activities

Date	Activity
December 12, 2023	RPAG meeting
December 14, 2023	Feedback form for Emerging Resources: Hydrogen public webinar closes
December 15, 2023	Revised IRP workplan due to UTC

Next steps

- During public comment and/or via the feedback form
 - Share questions about how hydrogen can support PSE's clean energy goals and current and future hydrogen pilots/studies
 - To what degree should PSE model blending hydrogen into the natural gas system as a way to decarbonize our gas system and bridge to electrification?
 - To what degree should PSE explore hydrogen for peak power production and distributed resource applications at this time?
- Observe future discussions with the RPAG as we develop specific assumptions and provide comments during the public comment period or via the feedback form

Public comment opportunity

Please raise your “hand” if you would like to make a comment



**PUGET
SOUND
ENERGY**

Thank you for joining us!



Appendix



Meets a key utility need



- ◆ The electric grid must always be in balance to operate safely
- ◆ Sometimes, renewables produce too much energy – or not enough
- ◆ Excess renewable energy can be used to create clean hydrogen for later use
- ◆ This gives utilities a carbon-free, dispatchable energy supply, whenever it's needed, to keep the lights on 24/7.

Customers benefit, too!

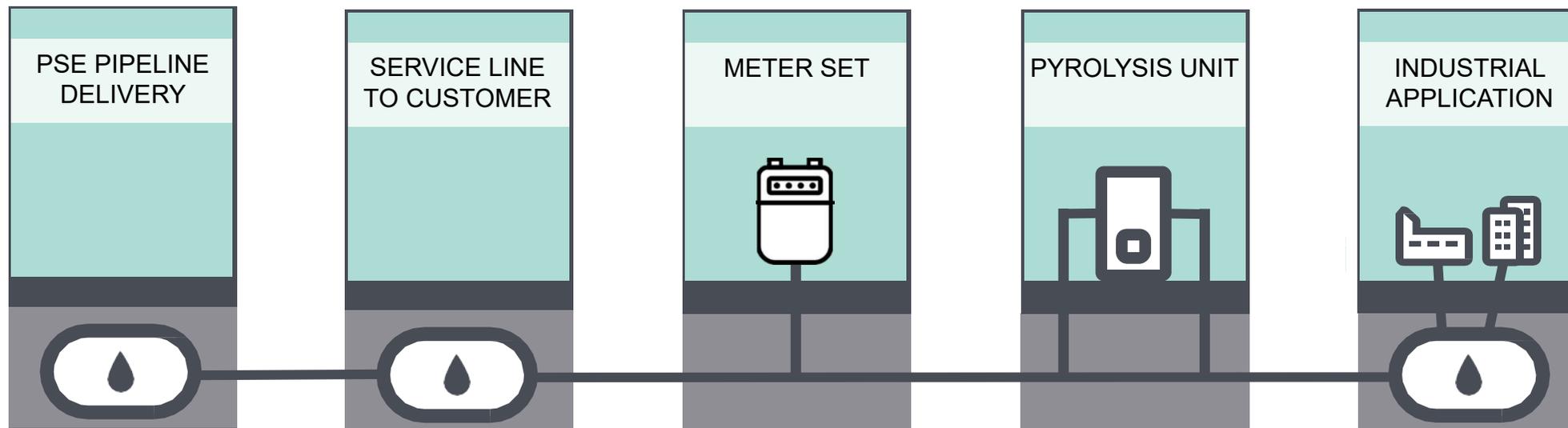


- ◆ This 24/7 supply helps ensure reliability for customers
- ◆ Plus, hydrogen can be stored for long periods of time, without losing any energy capacity
- ◆ This means a safe, clean, and continuous energy supply, particularly during times of peak demand (like winter nights), when customers need it most

Hydrogen Blended Natural gas used around the world

- ◆ Utilities across North America, Asia and Europe have been using hydrogen to decarbonize.
- ◆ Singapore and Hong Kong have towns operating above 50% blend
- ◆ Dominion Energy, ATCO, Enbridge and others have been piloting 5-20% blends with customers
- ◆ Hawai'i Gas has had hydrogen present in their fuel blend for decades



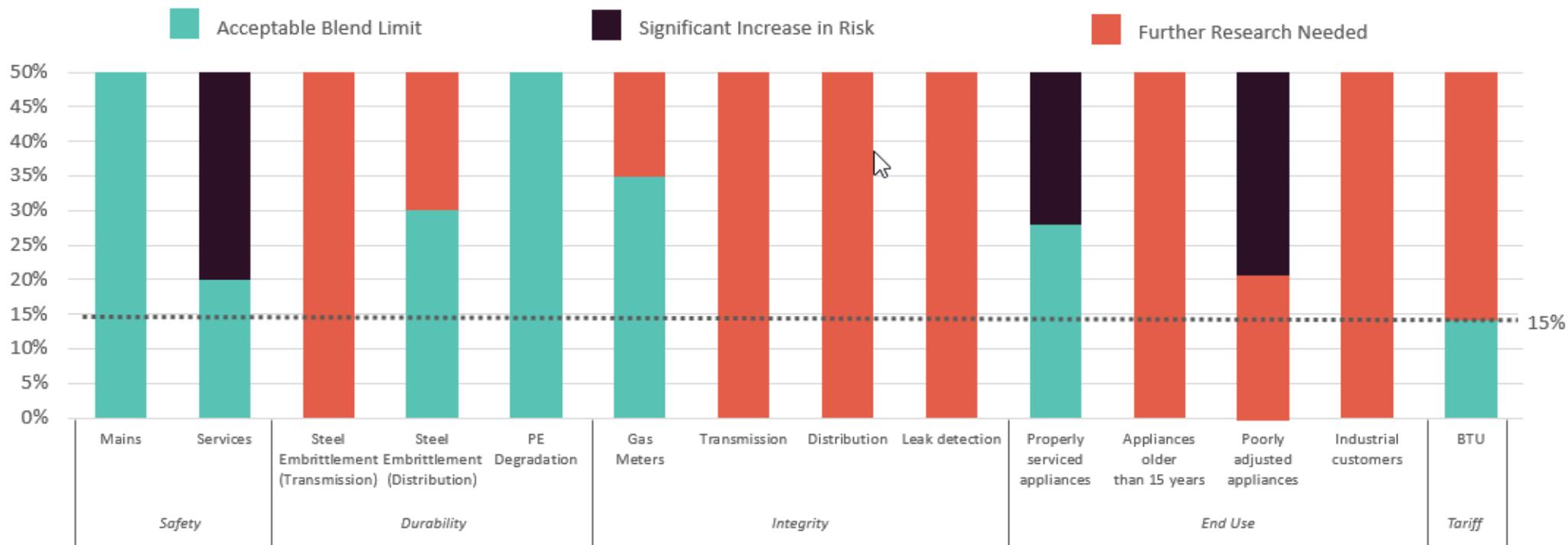


- ◆ Remove carbon at the point of use

↑
Clean Hydrogen is delivered, while the carbon is captured and repurposed

How PSE could use hydrogen for INDUSTRIAL decarbonization

Hydrogen Blending Limits



Potential Blending Limiting Factors

- Transmission and Distribution Integrity Management Programs should be re-evaluated end-to-end in greater detail.
- Industrial customers should be assessed on a case-by-case basis
- Each Transmission pipeline will be evaluated based on type of steel and pressure
- Assessing appliances older than 15 years and resolving poorly adjusted customer appliances

Additional Considerations

- Increased probability of gas ignition in the event of a gas leak
- Greater tendency to leak through fittings; should assess facilities in confined spaces
- Likely increase in inspection frequencies
- Leak detection or monitoring devices; no available odorant for hydrogen
- Assess gas chromatography technology for monitoring hydrogen levels in the pipeline
- Reduced pipeline capacity
- Assess for potential contaminants in hydrogen gas

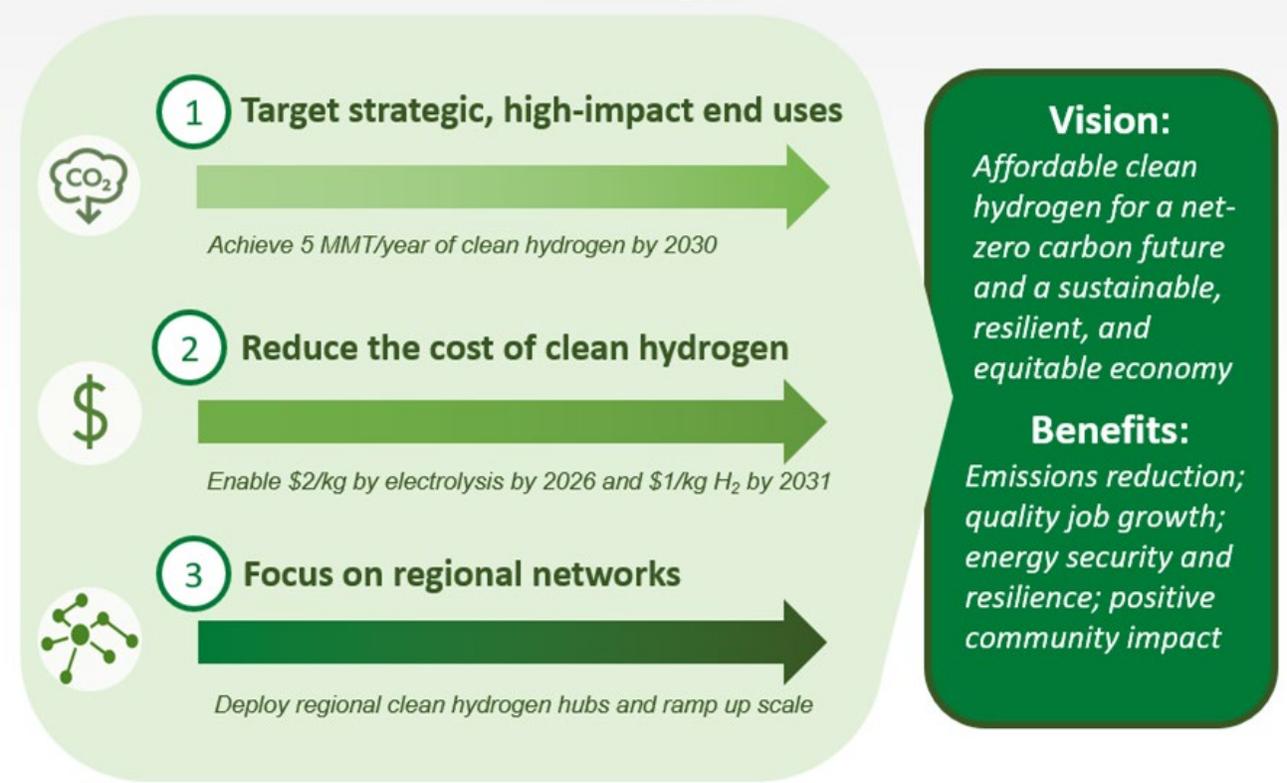


Pacific Northwest Hydrogen Hub

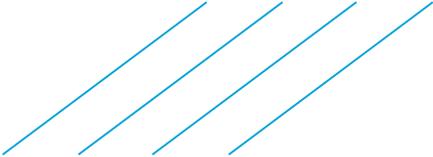
Overview

November 2023

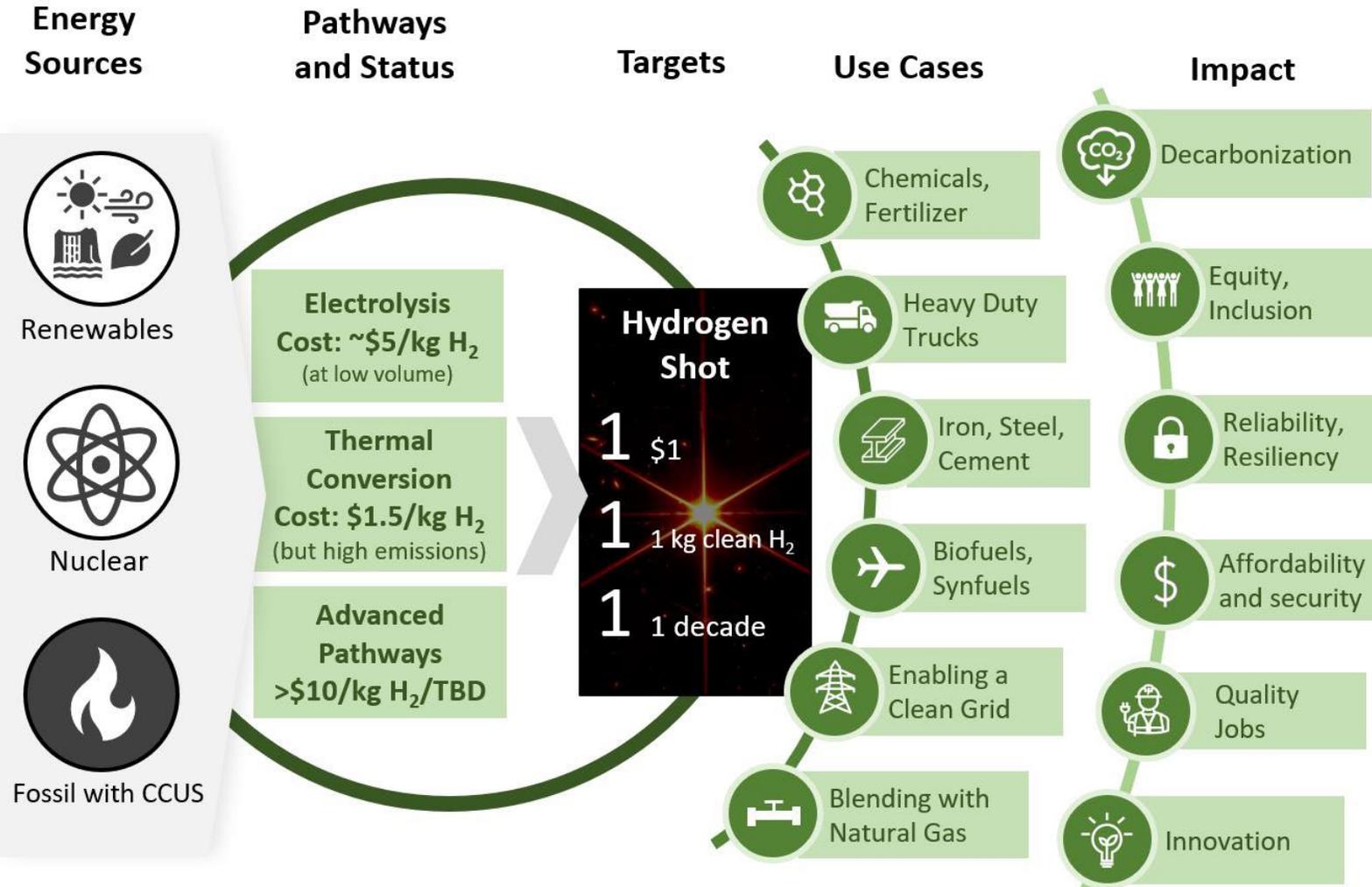
National Strategies for Clean Hydrogen & DOE Hydrogen Program Mission and Context



This graphic was originally created and published by the U.S. Department of Energy.



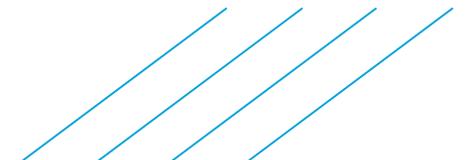
DOE Hydrogen Targets



The seven Regional Clean Hydrogen Hubs selected for award negotiations are expected to leverage multiple production technologies, become integrated into a broad spectrum of technologies, and provide positive benefits across many communities.

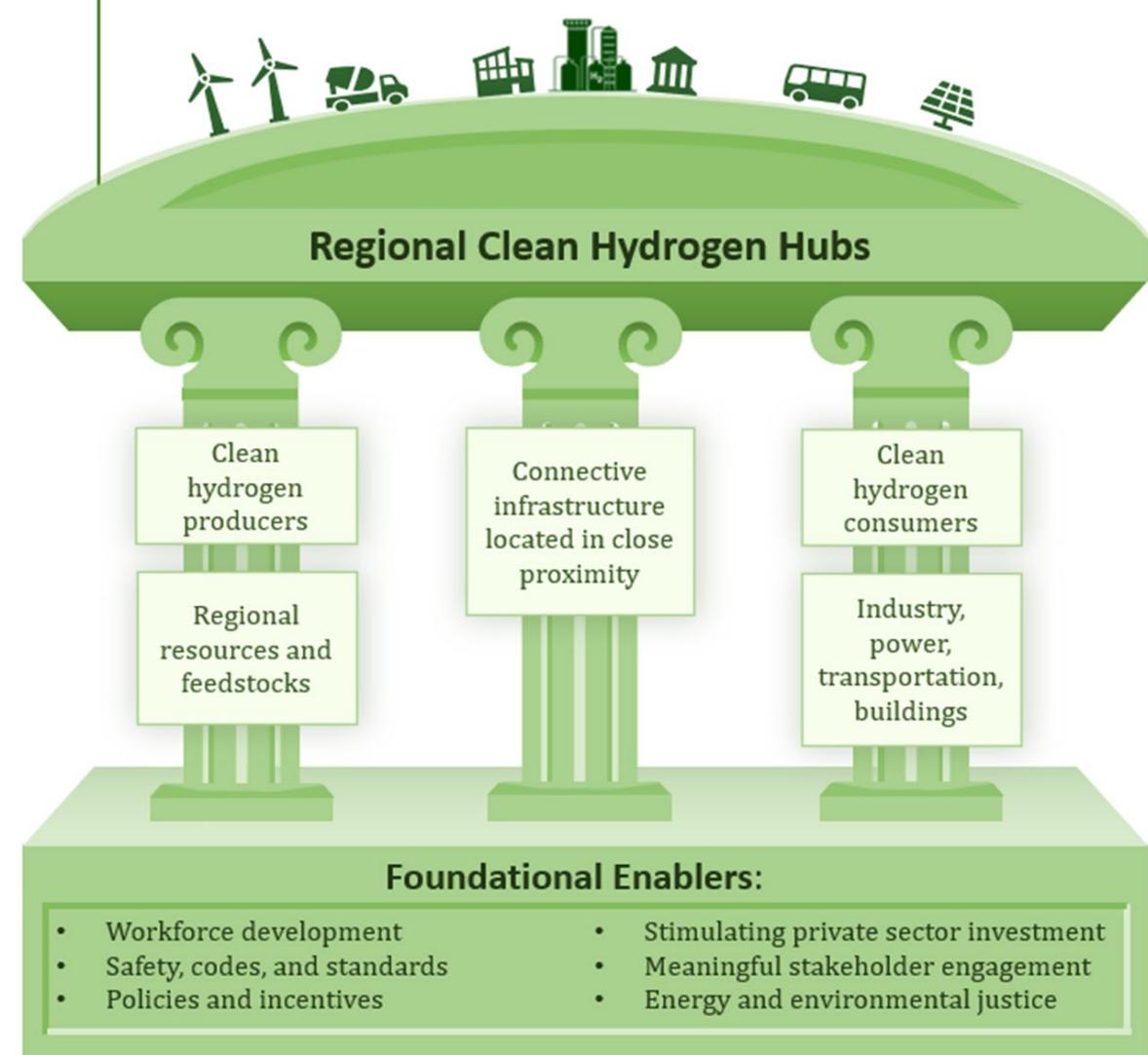
The Hydrogen Shot targets build on progress for a variety of pathways, enabling a range of use cases and impacts.

This [graphic](#) was originally created and published by the U.S. Department of Energy.

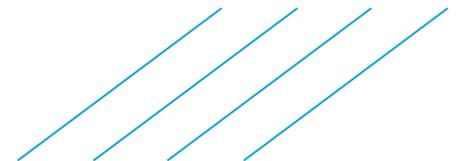


Benefits for Hub Regions

- › Clean hydrogen produced and used at scale
- › Carbon emissions and pollution reduction
- › New sustainable jobs, including good-paying union jobs
- › Clear benefits for disadvantaged communities
- › Exemplary models for skills training, diversity, equity and inclusion
- › Domestic manufacturing
- › Sustained economic growth and scaled-up hydrogen use
- › Additional and sustained private sector investment



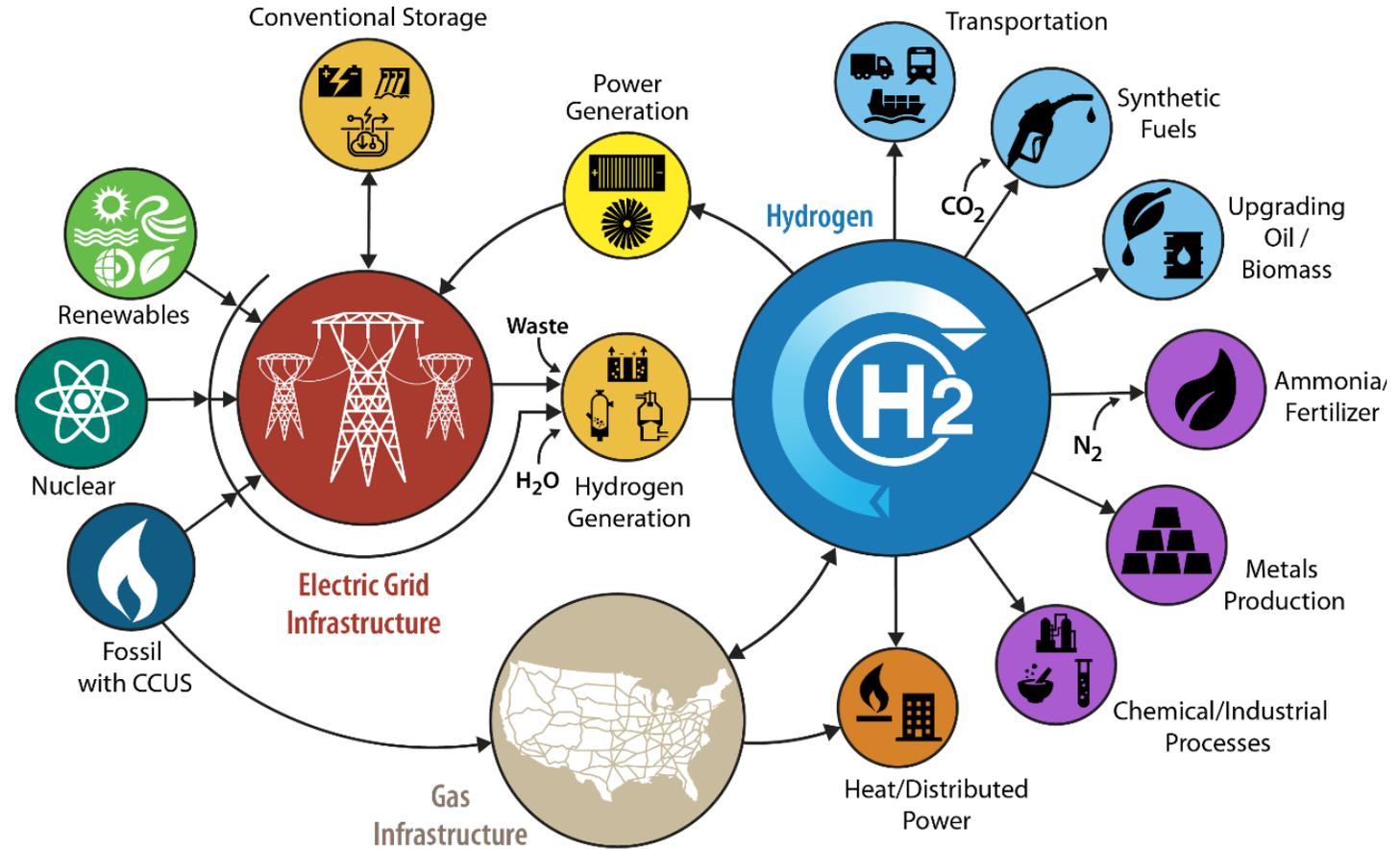
This [graphic](#) was originally created and published by the U.S. Department of Energy.



Pacific Northwest Hydrogen Hub

Vast Coalition Collaborating to Make a Difference

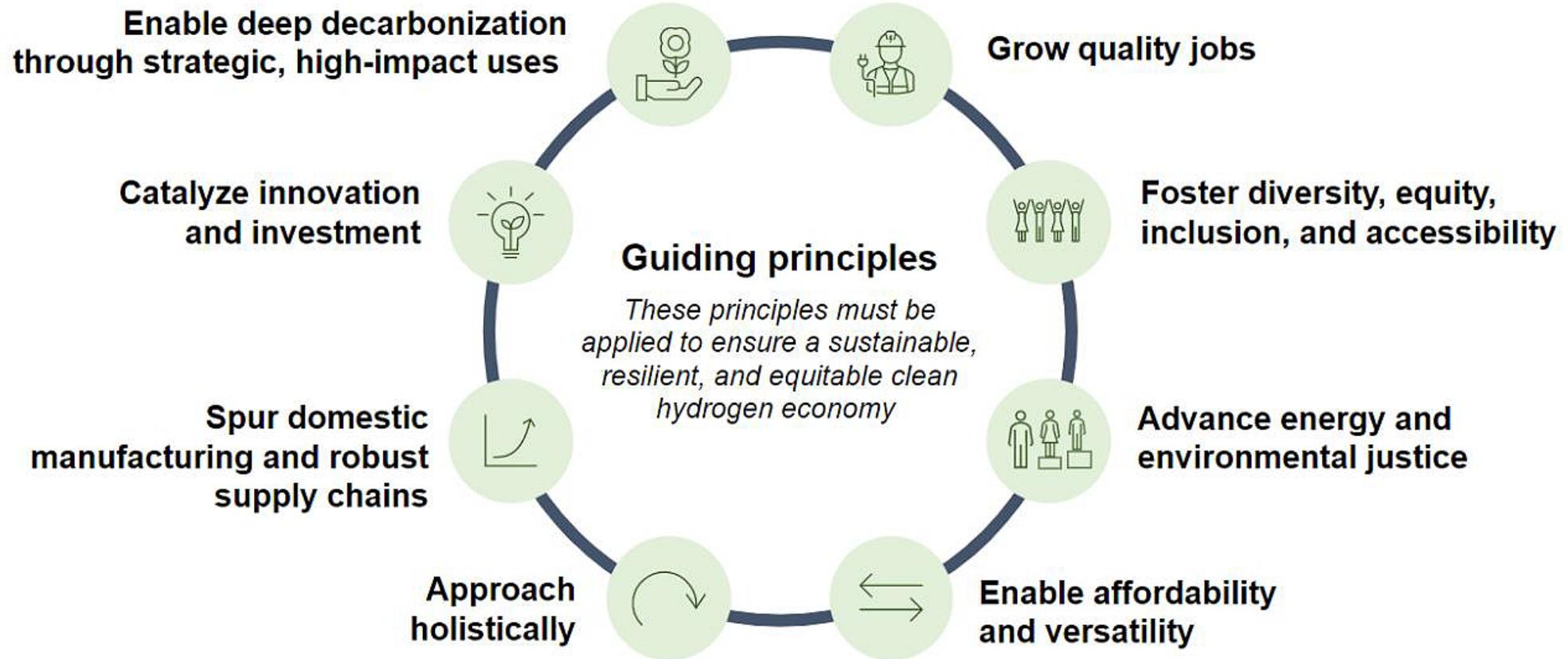
- › Energy Equity and Environmental Justice Plan
- › Workforce Development and Jobs Plan
- › Tribal Engagement
- › Community Engagement
- › Use of Mapping and Geospatial Tools & Data to Advance Equity
- › Domestic Clean Technology Manufacturing
- › Energy Emergency Management & Planning
- › Industry Cluster Development



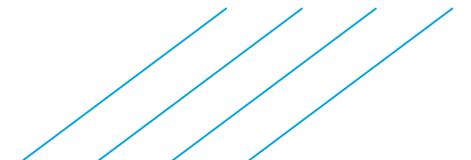
The U.S. Department of Energy's H2@Scale initiative to enable decarbonization across sectors using clean hydrogen.

Pacific Northwest Hydrogen Hub

Applying National Guiding Principles



This graphic was originally created and published by the U.S. Department of Energy.



Pacific Northwest Hydrogen Hub

Timeline

- › November 2022: PNWH₂ Hub submits concept paper to the U.S. Department of Energy (DOE) in response to the Regional Clean Hydrogen Hubs Program Funding Opportunity Announcement – **79 concept papers received**
- › December 2022: DOE “encourages” PNWH₂ Hub to submit a full application – **33 invited to submit full application**
- › April 2023: PNWH₂ Hub submits its full application to DOE
- › Summer 2023: DOE invites PNWH₂ Hub representatives to complete a pre-selection interview
- › Fall 2023: DOE OCED selects PNWH₂ Hub as one of seven for negotiation of award – **1 of 7 selected**
- › Fall 2023: Negotiations with DOE begin to determine final federal funding levels, scope and terms for each hub
- › Early 2024: Phase 1, detailed project planning, kicks off to refine projections submitted in the proposal and provide assurance to DOE that the overall hydrogen hub concept is technologically, financially, and legally viable, with buy-in from local stakeholders

