aps

APS RPAC Meeting

5/22/2024

MEETING AGENDA

Welcome & Meeting Agenda
Matt Lind
1898 & Co.

SRB Update
Ashley Kelly
APS

APS Sustainability Survey
Pamela Nicola
APS

Break

State of the Hydrogen Industry
Nick Schlag
E3

OEM Hydrogen Perspective
Nitin Luhar
Mitsubishi

APS Response to Stakeholder Comments – 2023 IRP
Mike Eugenis
APS

Next Steps & Closing Remarks
Matt Lind
1898 & Co.

aps

Meeting Guidelines

Member Engagement

RPAC Member engagement is critical. Clarifying questions are welcome at any time. There will be discussion time allotted to each presentation/agenda item, as well as at the end of each meeting.

Action Items

We will keep a parking lot for items to be addressed at later meetings.

Meeting Minutes

Meeting minutes will be posted to the public website along with pending questions and items needing follow up. We will monitor and address questions in a timely fashion.

Preliminary Content

Meetings and content are preliminary in nature and prepared for RPAC discussion purposes. Litigating attorneys are not expected to participate.

April Meeting Recap

- APS provided an overview of its position in the Western Market and announced its leaning towards SPP's Markets Plus Day-Ahead Market.
- APS discussed the 2023 All-Source RFP and provided an update on the status of its projects in negotiations.
- APS discussed its approach for responding to 2023 IRP Stakeholder Comments.
- APS previewed its 2024 Summer Preparedness presentation that was shared at the ACC on April 23rd.

Following Up

- Action Items from Previous Meetings: N/A
- Ongoing Commitments:
  - Distribute meeting materials in a timely fashion (3 business days prior)
  - Transparency and dialogue

System Reliability Benefit Mechanism

Ashley Kelly, APS

Agenda

- SRB Overview:
  - Overview of the SRB Mechanism
  - Qualifying Resources Definition
  - Stakeholder Process/Plans
    - Ongoing, Notice of Intent, Application
  - APS Stakeholder Meeting Cadence

System Reliability Benefit (SRB) Mechanism

CAPITAL TRACKING MECHANISM

PROVIDES FOR RECOVERY OF APS-OWNED GENERATION CAPITAL ASSETS BETWEEN RATE CASES

APPLICATION PROCESS INCLUDES PRUDENCY DETERMINATION

QUALIFYING RESOURCES WOULD BE TRANSFERRED TO RATE BASE IN SUBSEQUENT RATE CASE

SRB Qualifying Resources

- APS-owned facility
- Procured through All-Source RFP
- Minimum investment of $50 million
- Not already being recovered in rates

Customer Protections of the SRB

Competitive All-Source RFP

3% year-over-year cap

Earnings Test

Limit on number of resets between rate cases

Reduced return between rate cases

Asymmetrical balancing account

SRB Process Overview

RPAC Process

- RFP Identified
- Quarterly Stakeholder Meetings and Comment Opportunities

SRB Stakeholder Process

- Notice of Intent Filed, Customer Notice, & Stakeholder Meeting
- Opportunity for Intervention
- SRB Discovery Process
- SRB Application for Recovery of Qualifying Resource
- Stakeholder Meeting – Application
- ACC Staff Report and/or Request for Hearing
- Hearing (if applicable)
- Recommended Opinion and Order (if applicable)
- ACC Decision

SRB Stakeholder Process

Pre-Notice of Intent/Ongoing

- Quarterly public stakeholder meetings:
  - SRB Tables I-III
- Stakeholder comment periods and APS written response to comments

Notice of Intent (NOI)

- Notice on APS's website
- Customer bill message or a separate communication following the NOI filing
- Stakeholder meeting, technical conference and open house
- NOI in new docket and filed to most recent APS rate case docket
- NOI Includes SRB Tables I –III
- Interested parties can file Motion to Intervene within 60 Days

Application

- Additional Stakeholder Meeting

Stakeholder Meeting Cadence

Quarterly Meetings & aps.com updates

Tables I-III included in the plan of administration

Paired with RPAC but separate meeting notice

Formal comment period each quarter

Quarter	Meeting
Q1	April
Q2	July
Q3	October
Q4	January

First Quarterly Meeting will be held on July 23rd, 2024

Tables I-III

Table I – Initiated All-Source RFP

- All-Source RFPs which have been initiated and are in process.

Table II – Schedule of Planned Qualifying Resource Projects (Publicly Announced)

- Type (e.g. energy storage, wind, solar, natural gas, etc.)
- Size (MW)
- Location
- Estimated in-service month and year
- Other project descriptions

Table III – Completed Qualifying Resource Projects

- Project tracking number (if applicable)
- Type (e.g. energy storage, wind, solar, gas, etc.)
- Resource Name
- Size (MW)
- Location
- Actual in-service month and year
- Other project descriptions
- Total cost
- ACC jurisdictional cost

Publicly Available SRB Information

New section on APS.com Resources Page

- https://www.aps.com/resources

Available Information

- Meeting notices/information
- Presentations and meeting minutes
- PDFs with information regarding SRB qualifying resource projects
- SRB applications and links to the ACC docket (future)
- Contact Information

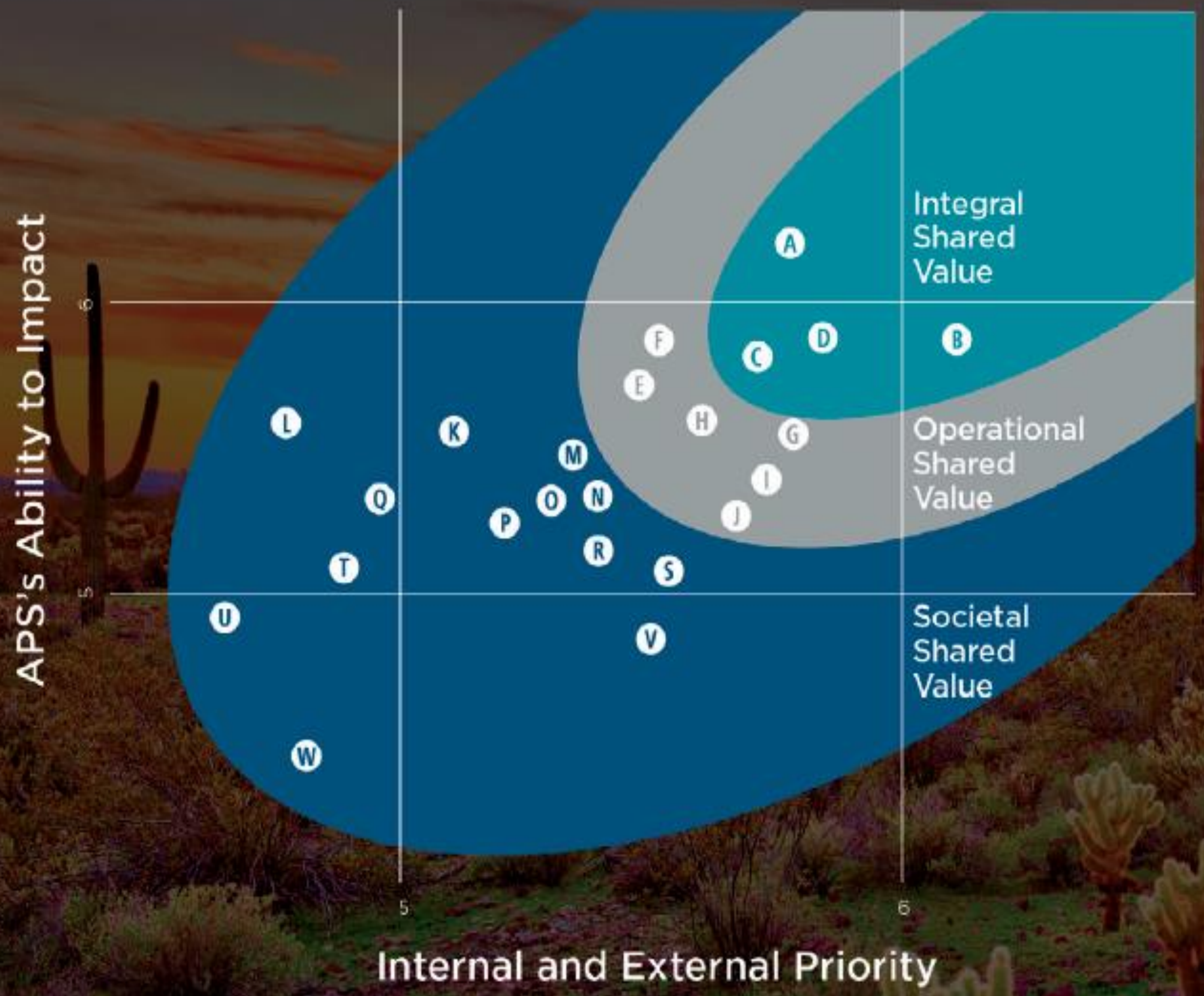
Corporate Sustainability Survey

Pamela Nicola, APS

Sustainability Issues Assessment

- Also known as a “Materiality Assessment”
- Designed to help us identify and understand the relative importance of specific issues and topics to internal and external stakeholders
- Industry best practice to identify areas of focus and refresh periodically

2020 Priority Sustainability Issues



Integral Shared Value

- A Clean Energy
- B Safety & Health
- C Customer Experience
- D Energy Access & Reliability

Operational Shared Value

- E Assets & Operations
- F Grid Modernization
- G Cyber & Physical Security
- H Financial Performance
- I Energy Affordability
- J Water

Societal Shared Value

- K ESG Transparency
- L Employee Experience
- M Skilled Workforce
- N Greenhouse Gas Emissions
- O Diversity & Inclusion
- P Innovation
- Q Strategic Governance
- R Public Policy Relations
- S Community Vitality
- T Waste
- U Supply Chain
- V Climate Change
- W Habitat & Biodiversity

2023-2024 Sustainability Issues Assessment Process

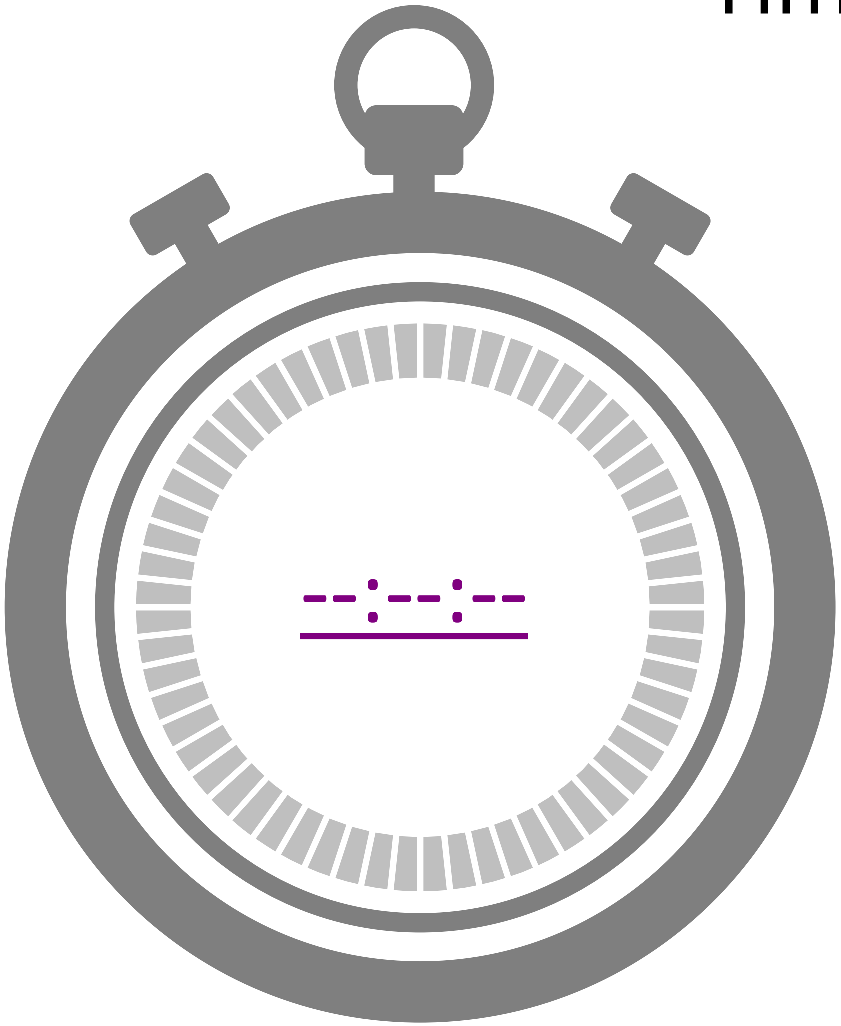
List and Define Sustainability Issues

Conduct Stakeholder Engagement

Review and Integrate Data

Break

Time for a Break



Break Duration 15 min.

Meeting will resume at hh:mm

State of the Hydrogen Industry

Nick Schlag, E3

State of the Hydrogen Industry

Arizona Public Service
Resource Planning Advisory Council

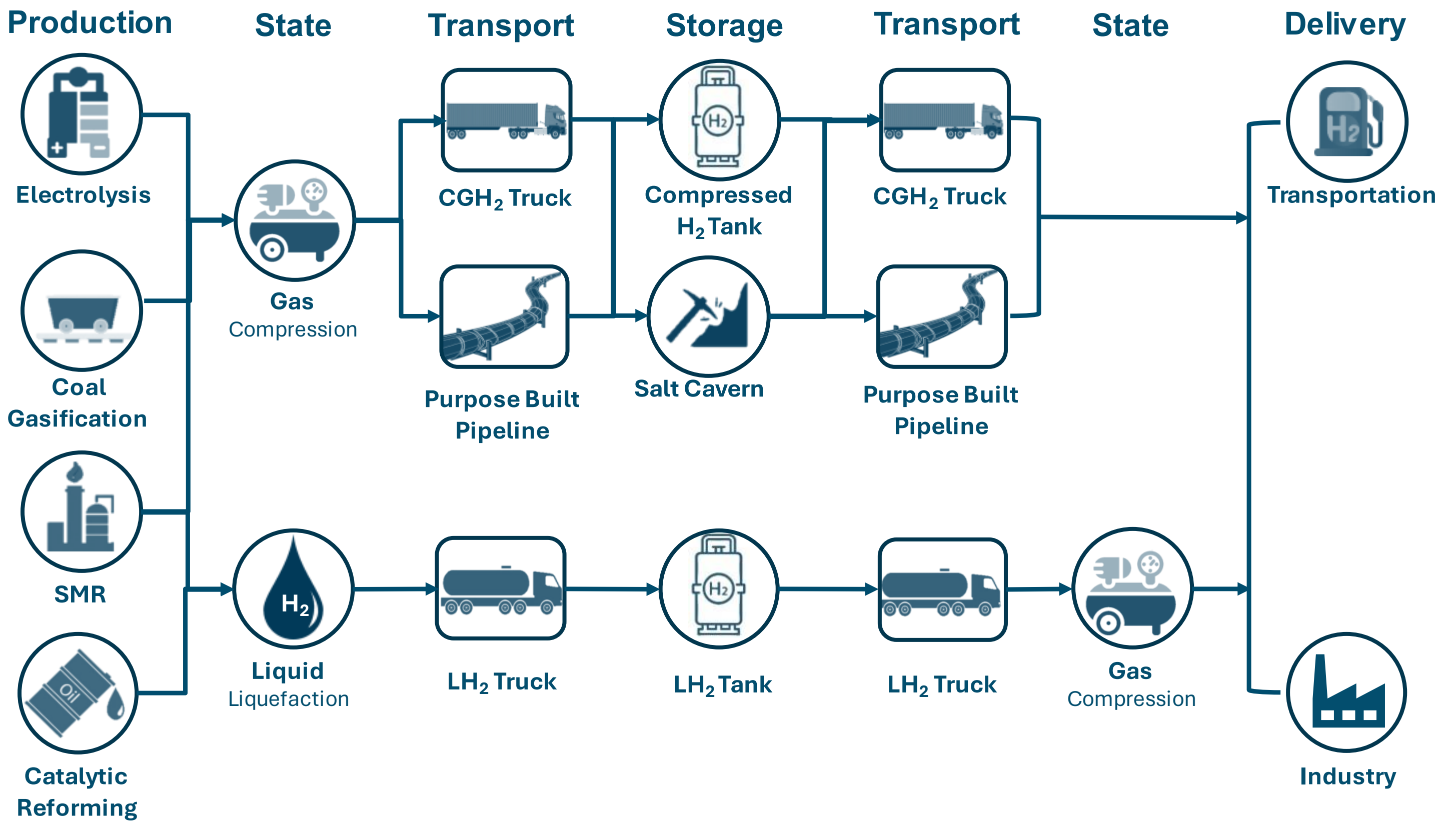
May 22, 2024

Energy+Environmental Economics

Nick Schlag, Partner
Jonathan Blair, Sr. Managing Consultant
Vignesh Venugopal, Sr. Managing Consultant

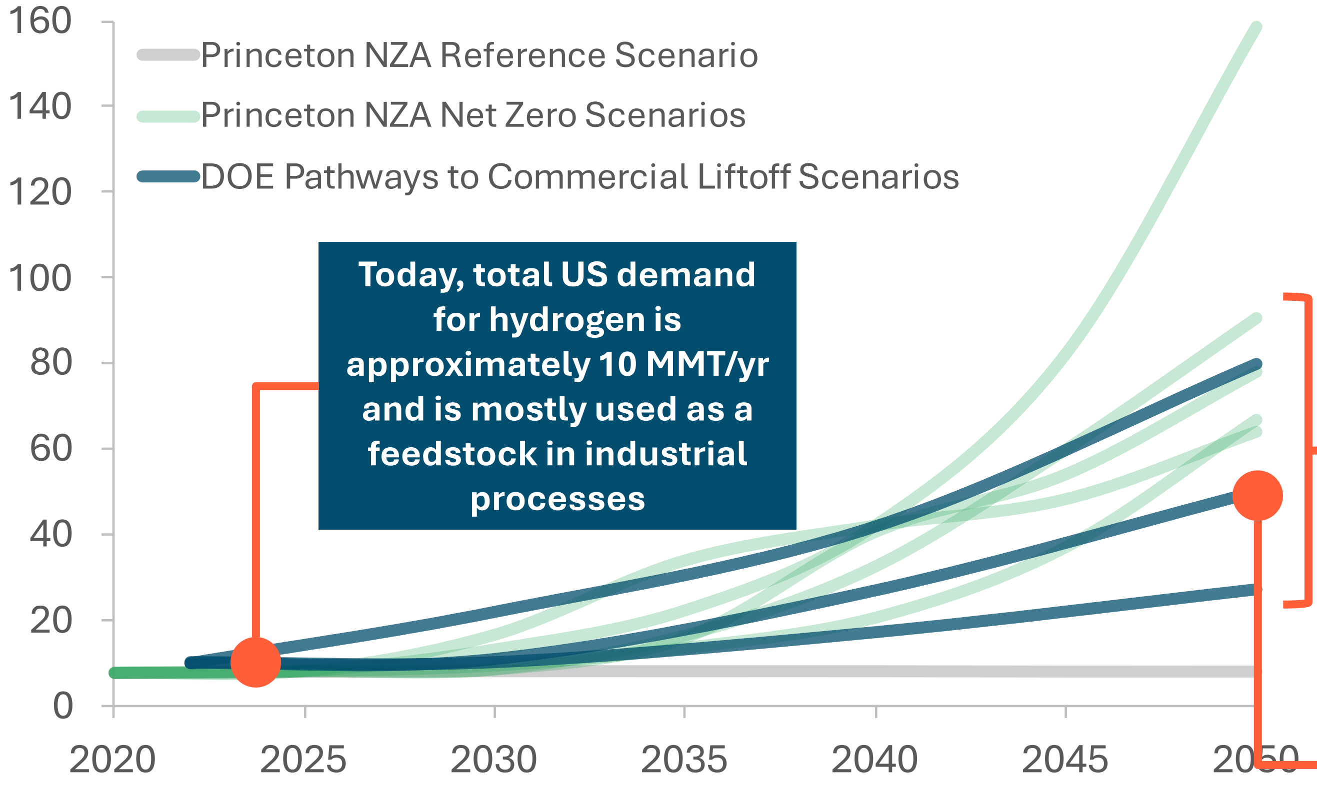
Agenda

+ Outlook for hydrogen demand
+ Role in electricity sector
+ Production pathways
+ Transportation & storage
+ Environmental considerations



Many potential applications for hydrogen – but size of future market is highly uncertain

US Domestic Demand for Hydrogen
(million metrics tons per year)



Today, total US demand for hydrogen is approximately 10 MMT/yr and is mostly used as a feedstock in industrial processes

By 2050, most projections of hydrogen demand span a range from 20-100 MMT/yr, with possible applications across many sectors:

Industry
- Ammonia
- Methanol
- Refining
- Steel

Buildings & Industry
- Heating

Transportation
- Aviation fuels
- Marine fuels
- Heavy duty vehicles
- Medium duty vehicles

Electricity
- Peaking/firm
- Long-duration storage

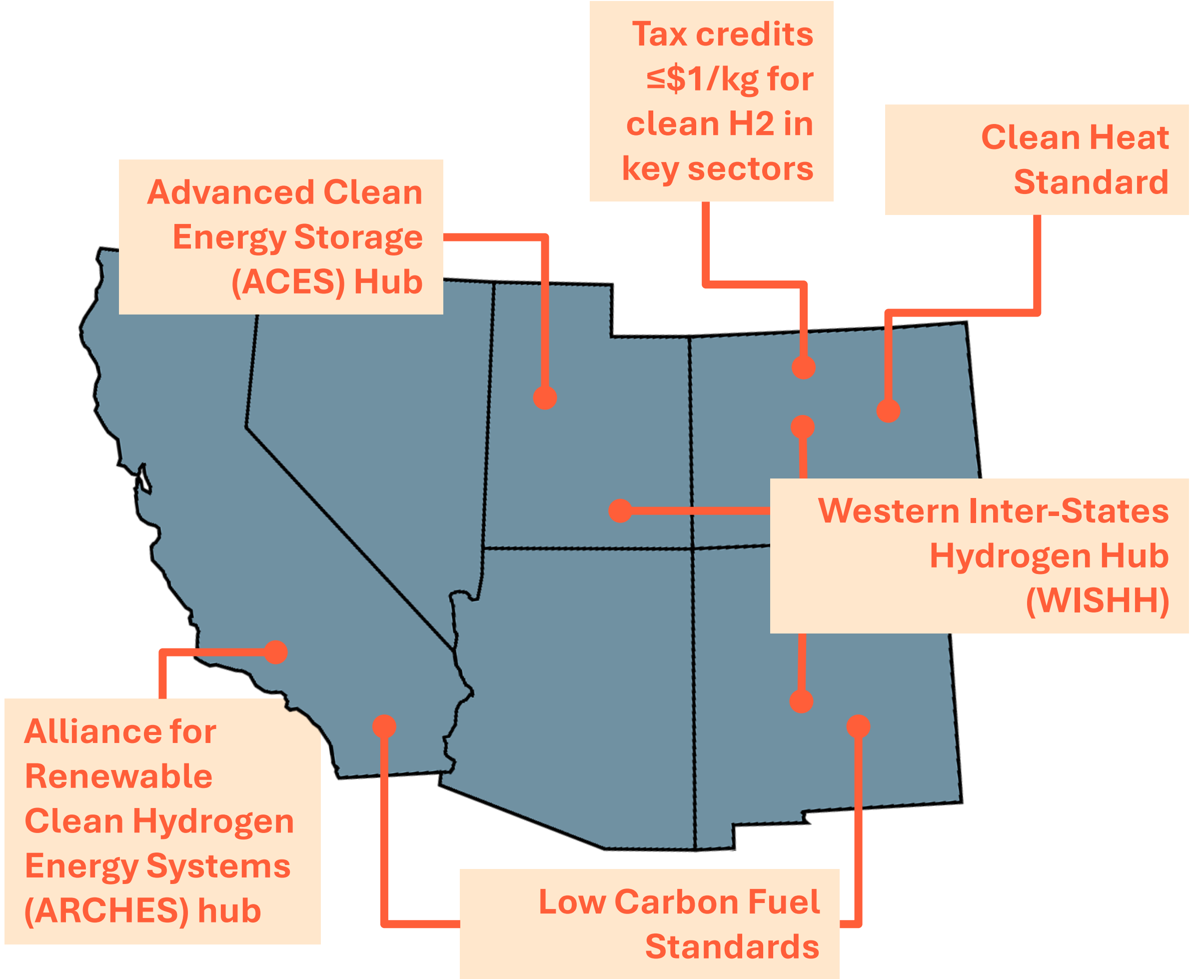
U.S. National Clean Hydrogen Strategy and Roadmap envisions opportunity for 50 MMT of domestic hydrogen demand by 2050

Recent federal policy has provided a catalyst for interest in hydrogen

- **Recent federal legislation has accelerated interest in development of hydrogen infrastructure**
  - **Inflation Reduction Act:** 45V tax credit for hydrogen production
  - **Bipartisan Infrastructure Law:** $8 billion federal funding for hydrogen hubs
  - **New Clean Air Act rules:** hydrogen as a potential compliance pathway for new natural gas resources
- **Department of Energy's (DOE's) Earthshots initiative has established ambitious goals for near-term advancements of hydrogen industry**

1 Dollar 1 Kilogram 1 Decade

- **States and regions developing complementary programs**



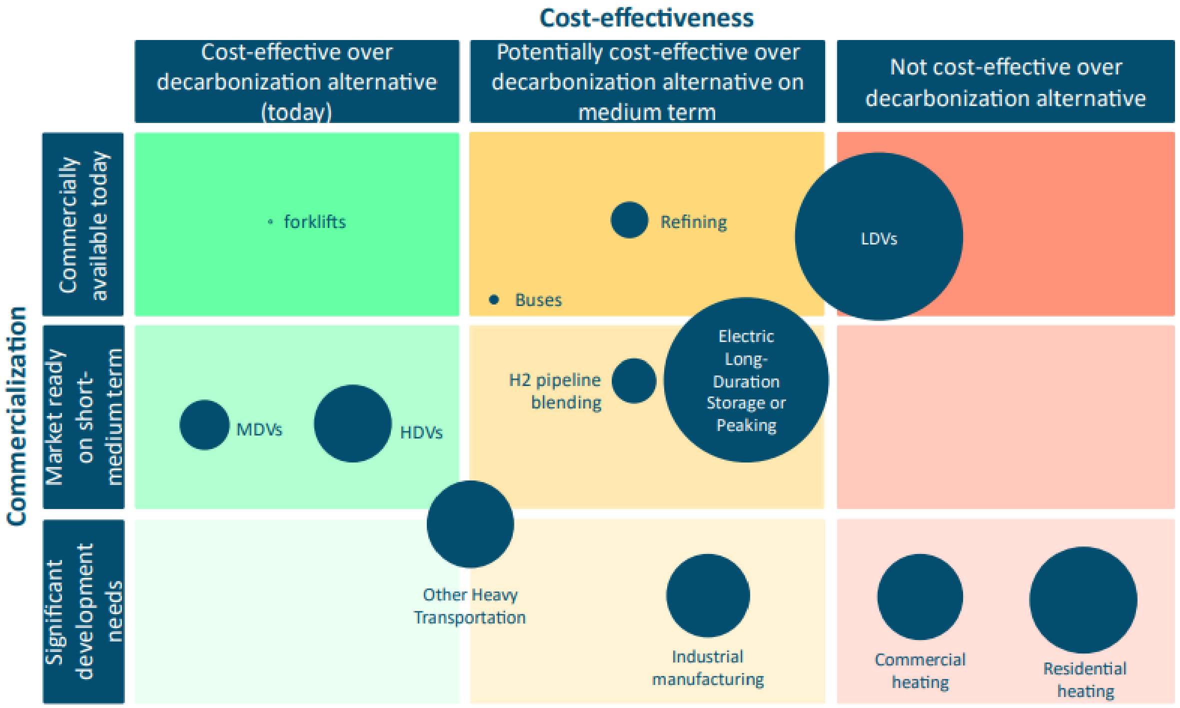
Attractiveness of hydrogen varies considerably across different applications

+ **Across applications, suitability of hydrogen as a substitute for existing fuels depends upon:**
  - Costs to produce, transport, and store hydrogen for specific application
  - Costs associated with current fuel supply (or future alternative)

+ **In most cases, anticipated hydrogen uses are coupled with clean energy policy objectives**

+ **In the power sector, the primary application for hydrogen is as a "clean firm" resource:**
  1. To supply peaking generation
  2. To serve as a medium for long duration storage

Conceptual categorization of hydrogen potential market opportunities



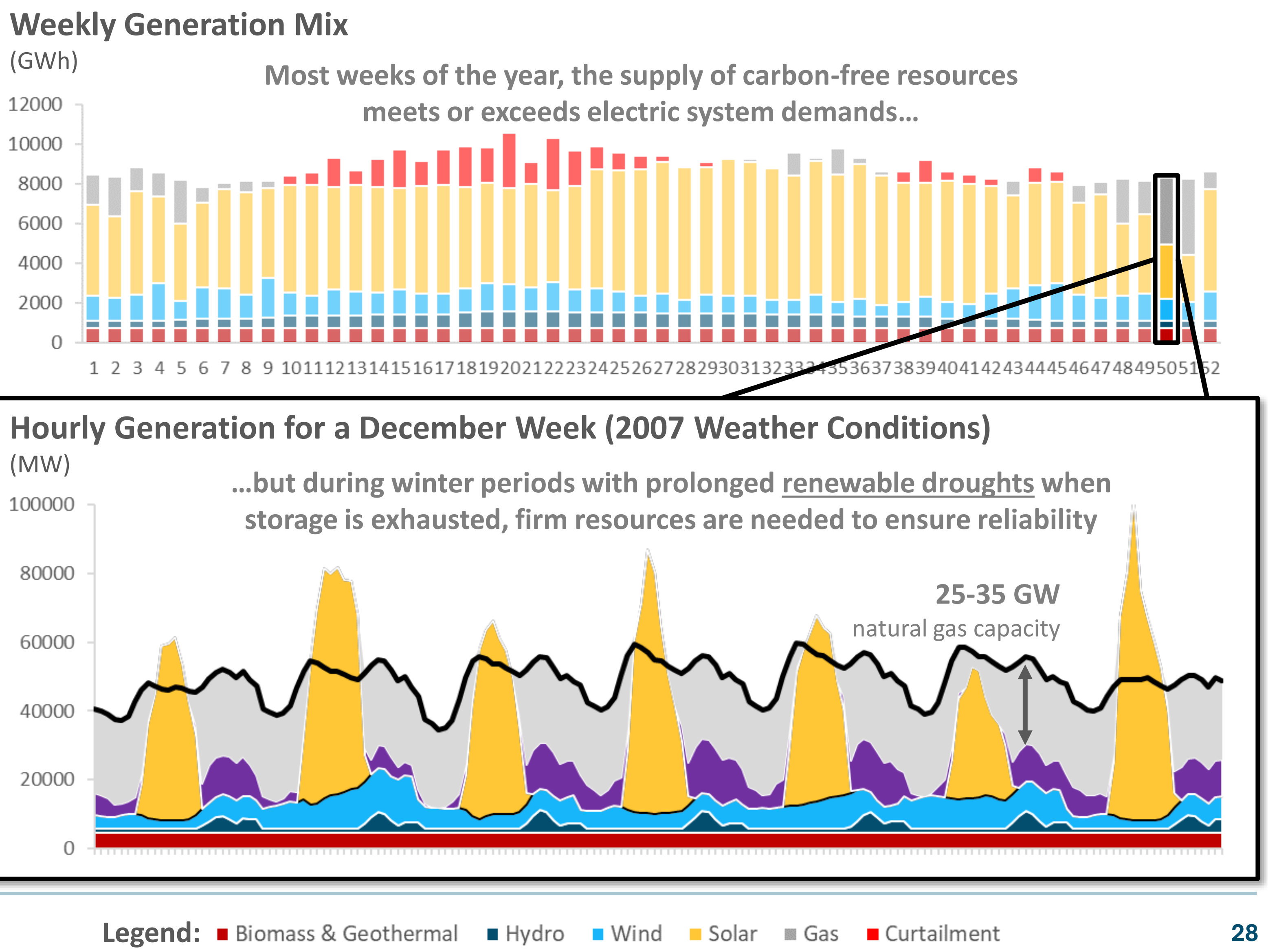
Conceptual overview for hydrogen opportunities from Opportunities for Low Carbon Hydrogen in Colorado: A Roadmap; results are generally indicative of relative attractiveness and size of markets in other geographies

Primary use for hydrogen in the power sector: a "clean firm" substitute for peaking natural gas generation

California in 2050 at a glance:

- **93 GW** peak demand
- **90%** carbon-free generation
  - 150 GW solar PV
  - 21 GW wind
  - 8 GW hydro
  - 5 GW geothermal
  - 75 GW energy storage
- **35 GW** reliability need for firm capacity (40% of peak)
- **90% GHG reduction** relative to 2005 levels

Statistics and visuals adapted from High Electrification scenario in Long-Run Resource Adequacy under Deep Decarbonization Pathways for California



Utilities are increasingly looking at hydrogen-ready thermal resources as a long-term option

H2-ready turbines are increasingly seen as an option to deploy a proven resource to meet reliability needs today while providing optionality to adapt to future circumstances (e.g., changes in policy, economics)

PSCo's 2022 All-Source RFP explicitly encourages natural gas resources to offer hydrogen capability

The Company is also taking affirmative steps to ensure that gas additions are compatible with our future goals and State energy policy objectives to the extent possible. We are encouraging bids in the Phase II competitive solicitation for new-build natural gas resources that are capable of combusting at least 30 percent hydrogen on a volumetric basis. While this is not a requirement, it is something we propose to consider in the bid evaluation process. Further, the Company will analyze obtaining any natural gas

A review of

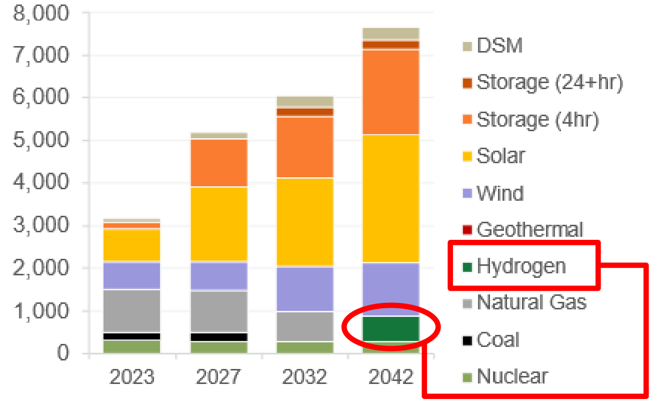
115

utility IRPs show

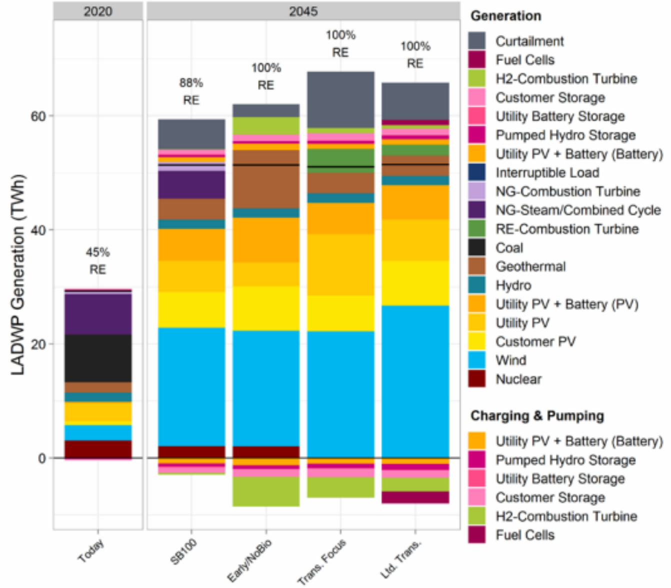
>**28%**

assessing hydrogen

Public Service Company of New Mexico identifies H2-ready gas turbines as a component of the "Most Cost-Effective Portfolio"



LADWP's current plans, informed by NREL's LA100 scenarios, rely on hydrogen for local reliability



LA100 Key Finding:
New in-basin, firm generation—using renewably produced and storable fuels, that can come online within minutes, and can run for hours to days—will become a key element of maintaining reliability.

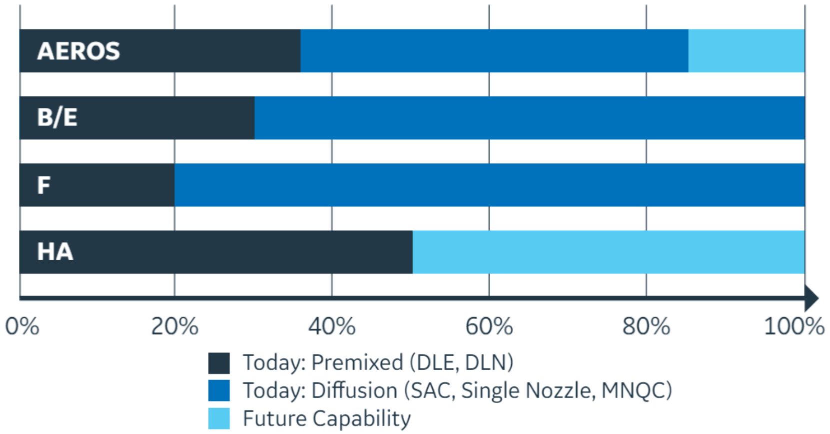
Many combustion turbines available today support hydrogen blending, with goals to allow 100% hydrogen operations by 2030

+ **Major natural gas turbine manufacturers offer hydrogen blending capability today:**
  - **GE:** most advanced turbines can burn a 50% mix of H2 and is also aiming to reach 100%
  - **Siemens Energy:** testing up to 75% mix of hydrogen and natural gas and are aiming to reach 100% by 2030
  - **Mitsubishi Power:** 30% (by vol) co-firing of H2 with natural gas today, aiming for 100% H2 combustion

+ **Blending hydrogen with natural gas reduces greenhouse gas emissions rates**
  - ~30% blending by volume results in ~10% emissions reductions
  - Difference due to lower energy density of hydrogen fuel

Project/Owner	State	Size (MW)	Summary
Long Ridge Energy Generation Project	OH	485	Completed 5% H2 by vol test in 2022 with GE turbines. Plans to upgrade turbine to burn 100% H2 over next decade
Intermountain Power Agency Project	UT	840	IPA planning to replace coal with Mitsubishi turbines burning 30% H2 in 2025 and 100% H2 in 2045
Scattergood Generating Station	CA	346	LADWP planning to replace current gas firing CCGT with H2-ready turbines. Targeting 30% H2 by 2029, 100% by 2035
Lincoln Land Energy Center Project	IL	1,100	Permit issued to the CCGT that is targeting 30% H2 upon COD and targeting 100% H2 by 2045
Magnolia Power Plant	LA	725	Expected COD in 2025 with GE turbines capable of 50% H2 co-firing

GE Gas Turbine Hydrogen Capability



Sources:
- https://www.gevernova.com/content/dam/gepower-new/global/en_US/downloads/gas-new-site/future-of-energy/hydrogen-overview.pdf
- https://www.siemens-energy.com/global/en/home/products-services/solutions-usecase/hydrogen/zehtc.html
- https://solutions.mhi.com/power/decarbonization-technology/hydrogen-gas-turbine/

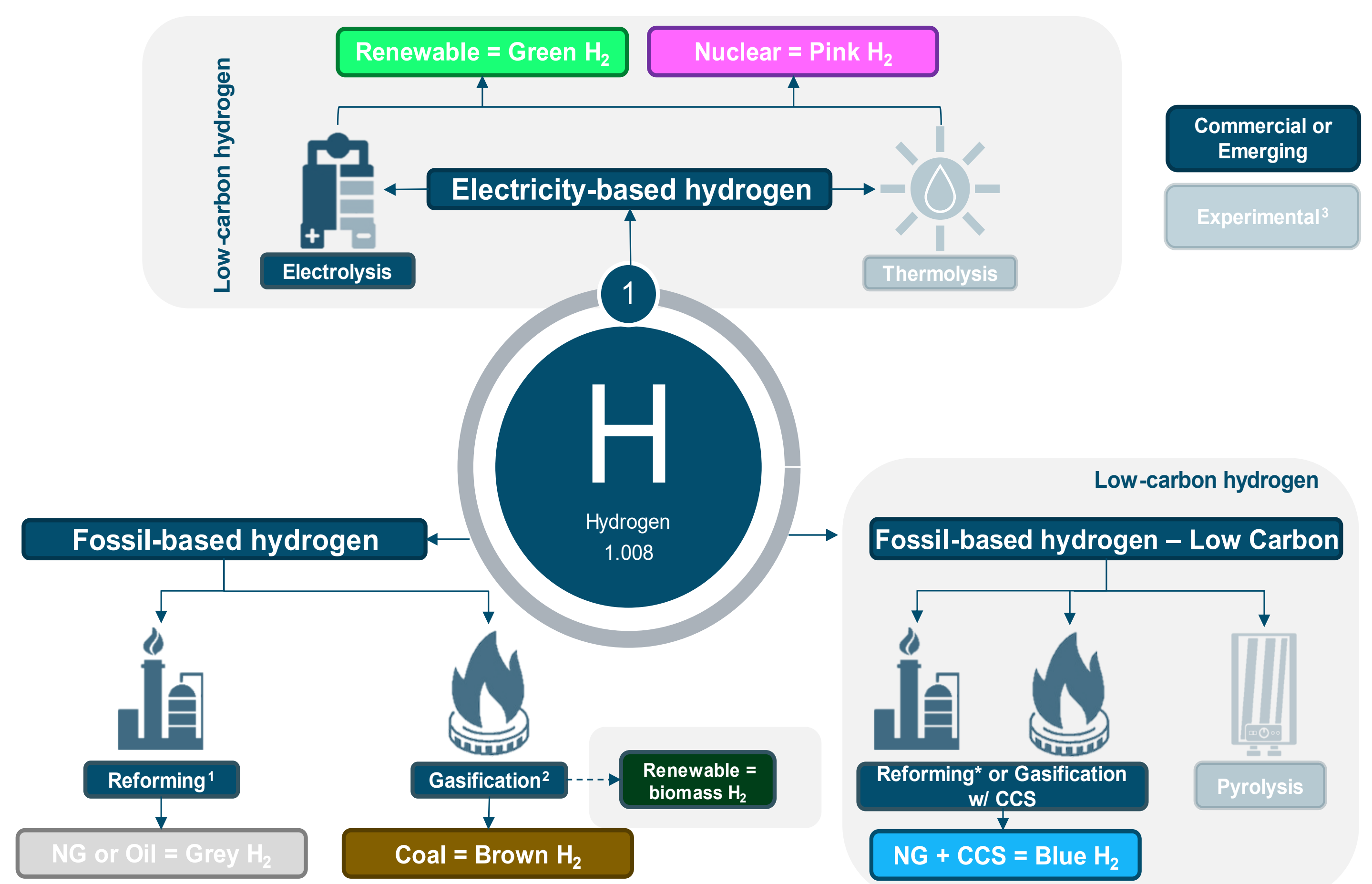
Hydrogen can be produced through a number of chemical processes – each with unique considerations

+ Fossil-based hydrogen w/out CCS

- Gray: H2 produced from hydrocarbons, the most common method being SMR
- Brown: H2 produced from coal and water through gasification, second most common internationally, but rare in North America

+ Fossil-based hydrogen w/ CCS

- Blue: H2 produced from hydrocarbons with CCS



[1]Includes catalytic reforming, SMR, ATR, and POX
[2]Hydrogen through gasification can be derived from bio feedstocks. This would be considered low-carbon hydrogen.
[3]There are multiple theoretical and experimental ways to break apart hydrogen. This overview includes commonly cited methods

+ Electricity-based hydrogen

- Green: H_2 produced from water by electrolysis using renewable electricity
- Pink: H_2 produced by water from electrolysis using nuclear energy

+ Renewable hydrogen

- All H_2 produced through renewable electricity or from biomass & waste through gasification

+ Low-carbon hydrogen

- Production with significantly reduced life-cycle GHG emissions.

Hydrogen is costly to produce today, but potential for cost reductions is significant

- **Most current estimates for green hydrogen range from \$4-7/kg (equivalent to \$30-50/MMBtu natural gas price)**

- **Key uncertainties impacting cost of green hydrogen:**
  - **Capital cost of electrolysis equipment** *(~25% of production cost today)*
  - **Cost of purchased power** *(~50% of production cost today)*
  - **Applicability of 45V tax credits** *(uncertainty pending final Treasury guidance)*

- **Aspirational targets set by *US National Clean Hydrogen Strategy and Roadmap* (\$2/kg by 2026 and \$1/kg by 2031) would require significant cost reductions**

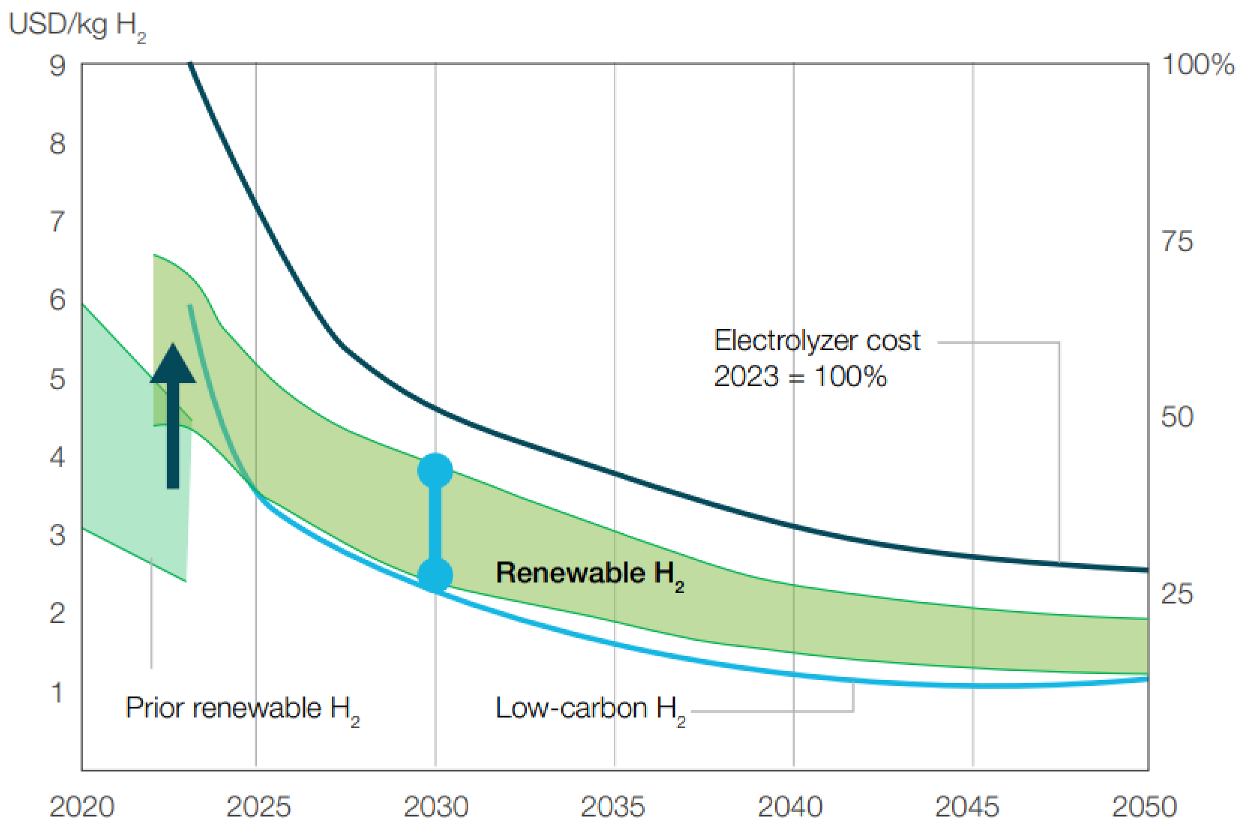


Image Source: Hydrogen Insights 2023, available at: https://hydrogencouncil.com/wp-content/uploads/2023/12/Hydrogen-Insights-Dec-2023-Update.pdf

IRA tax credits for hydrogen production vary based on carbon intensity of production

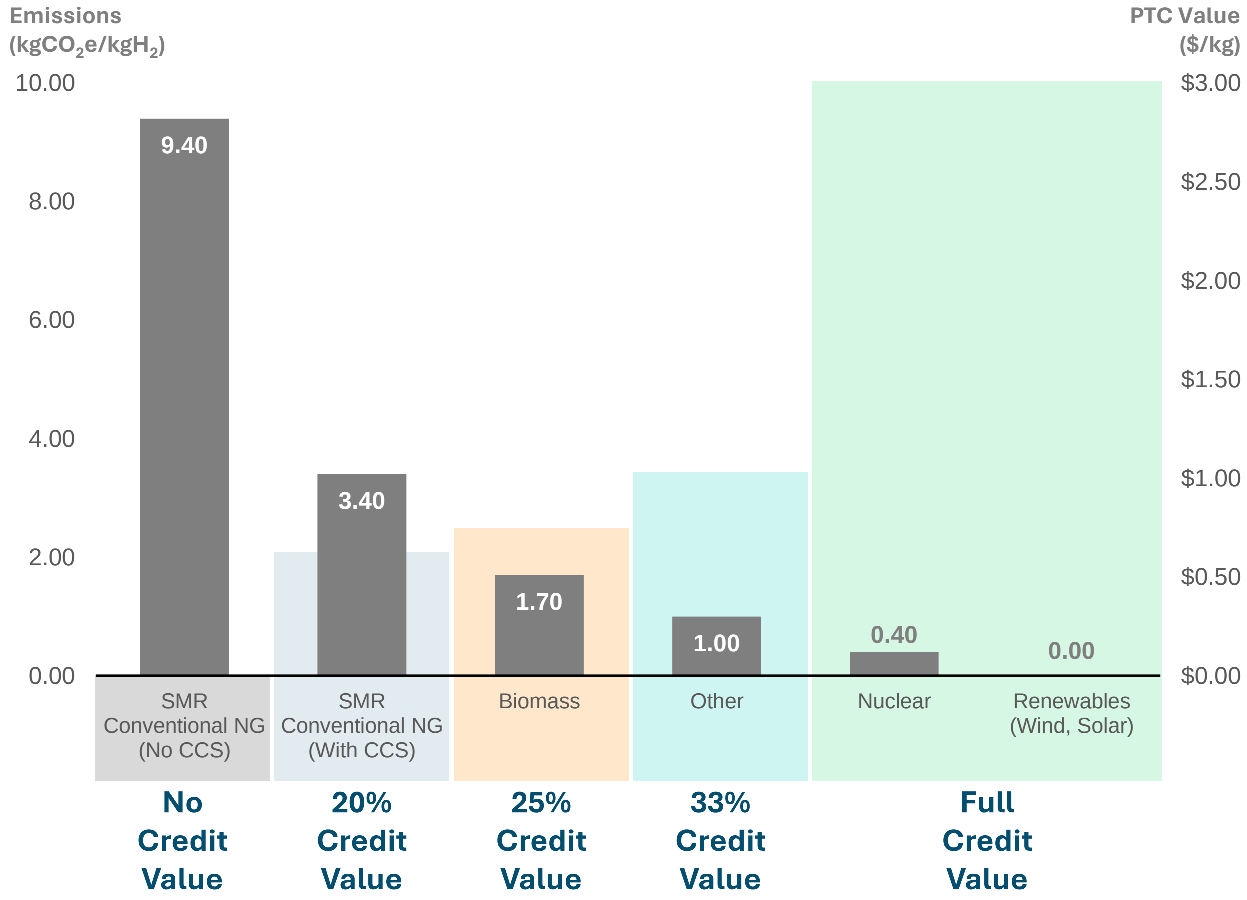
In the IRA, the Clean Hydrogen Fuel Credit (45V) provides a new 10-year PTC for facilities that begin construction before 2033 and for clean hydrogen produced from qualifying facilities. However, the exact value of the 45V credit depends on the lifecycle GHG emissions of the production pathway

Final guidance from Treasury on rules to determine the carbon content of grid-connected electrolyzers still pending

- **Full credit value:**
  \$3/kg for emissions less than 0.45 kg CO_2e/kg H_2
- **33.4% of full credit value:**
  for emissions between 0.45-1.5 kg CO_2e/kg H_2
- **25% of full credit value:**
  for emissions between 1.5-2.5 kg CO_2e/kg H_2
- **20% of full credit value:**
  for emissions of 2.5-4 kg CO_2e/kg H_2

Note: to receive these credits, the IRA's wage and apprenticeship requirements must be satisfied, otherwise facilities are only eligible to receive 20% of the above credits.

Production Lifecycle Emissions and Associated Hydrogen PTC Value



Source for Emissions: Argonne National Laboratory. GREET Model With Hydrogen User Interface Outputs (Default).

Inventory of proposed hydrogen projects is changing rapidly

- **Since passage of IRA, new projects with capacity to produce >10 MMT/yr have been announced**
  - Significant expansion of interest in electrolysis and green hydrogen
  - Treasury guidance on 45V tax credits and future greenhouse gas regulations are lingering uncertainties

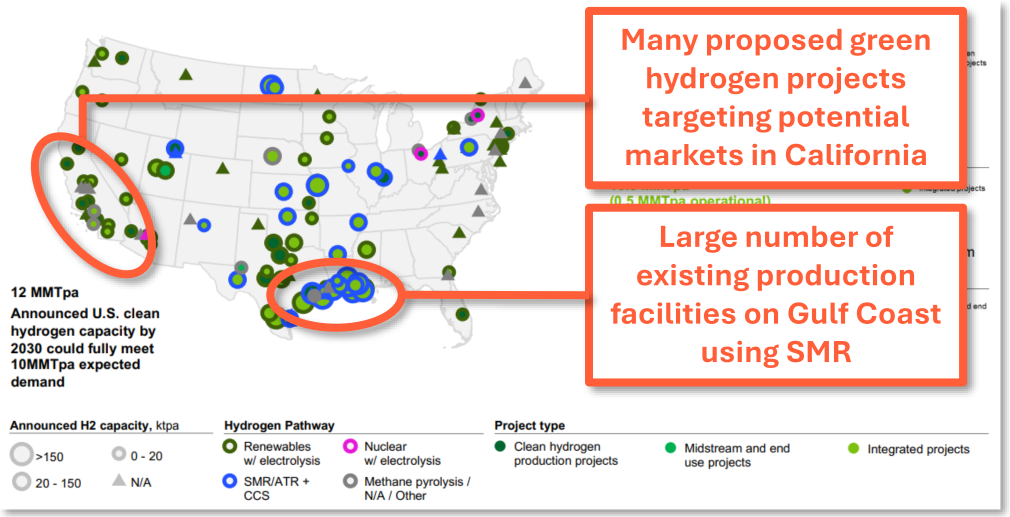
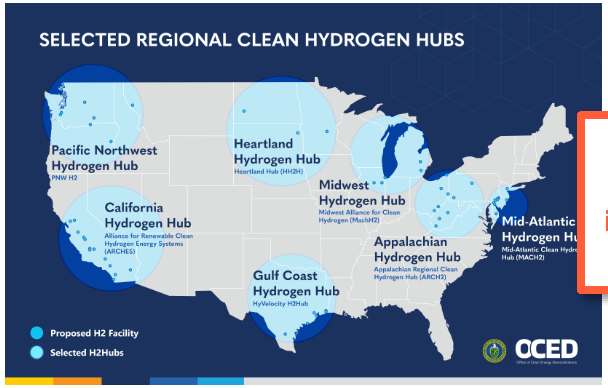


Image source: [DOE Pathways to Commercial Liftoff, Clean Hydrogen]

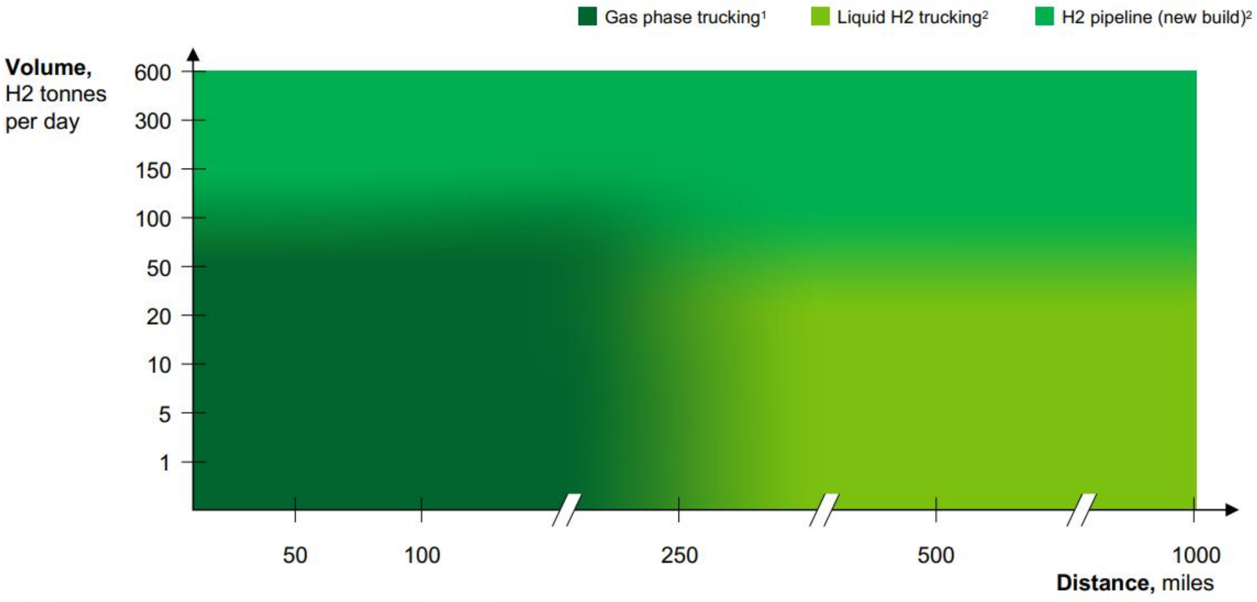
- **Bipartisan Infrastructure Bill (Feb 2022) allocates $8 billion in funding to establish hydrogen hubs, including the Regional Clean Hydrogen Hubs Program (H2Hubs)**
  - Federal funding intended to bring stability to an emerging industry



Transporting hydrogen to power plants will likely require dedicated pipelines

+ **Pipelines:**
    - Lowest cost option at high volumes and distances
    - Blending into existing natural gas pipelines limited to 20% by volume or 7% by energy
    - High upfront CAPEX and permitting challenges exist for new dedicated hydrogen pipelines
    - 1,600 miles of hydrogen pipeline exists in the US today, mostly concentrated in regions with petroleum refineries and chemical plants such as along the Gulf Coast
+ **Trucks:**
    - Both gas and liquid phase transport through trucks can be done
    - Lower CAPEX than pipelines but only cost-effective for shorter distances and smaller volumes given “boil-off” losses and low density of hydrogen
    - Liquefaction of hydrogen also requires substantial amount of energy

Preferred hydrogen distribution method by volume and distance



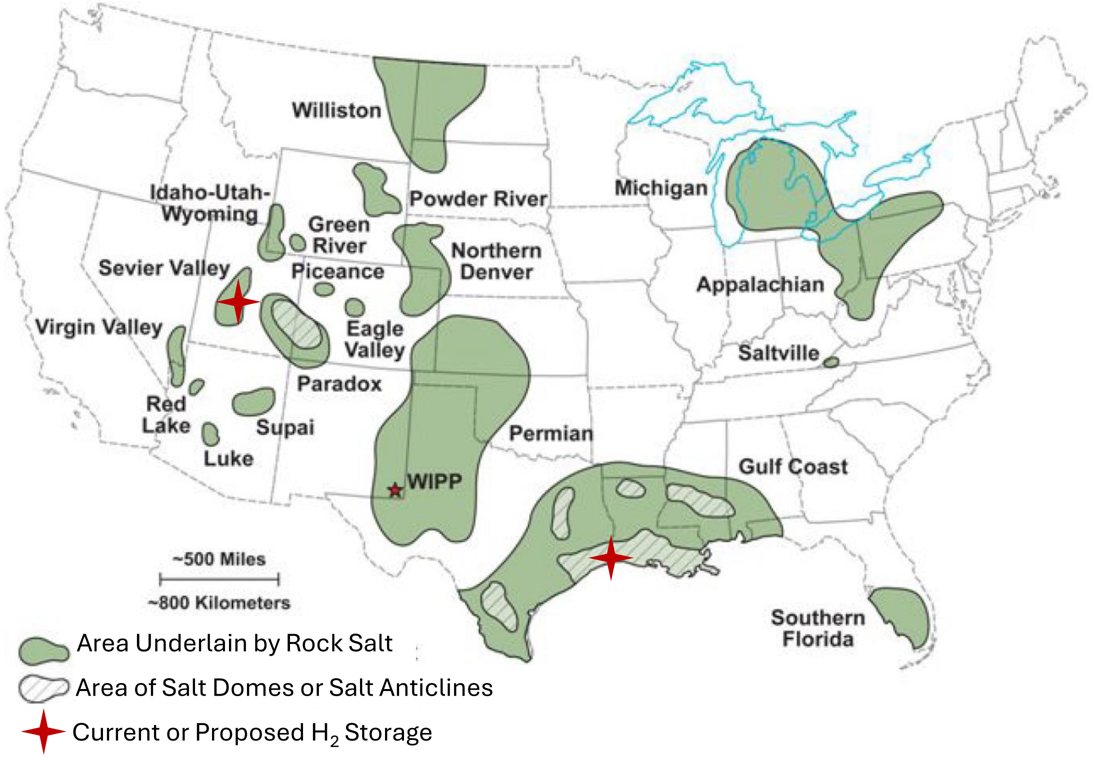
1 Assumes hydrogen is compressed to 500 bar and transported in 1100 kg truck
2 Includes liquefaction and liquid transport (fuel and labor)
3 Assumes hydrogen is compressed to 80 bar and transported in a newly built, dedicated H2 pipeline. These results do not consider leveraging existing pipelines

Source: Heatmap is based on data from the Hydrogen Council and the Hydrogen Delivery Scenario Analysis Model at Argonne National Laboratory, but left qualitative to highlight uncertainty in distribution methods and case-by-case variability

Underground storage of hydrogen is limited to locations with suitable geological formations

- **Salt caverns are to date the best form of large-scale, long-term storage of hydrogen although limited by geography**
  - Ability to store pure hydrogen with low losses and at the lowest price
- **Hydrogen storage currently has been built where there are hydrogen pipelines in the Gulf of Mexico and in Europe**
  - In 2017, Air Liquide commissioned Beaumont, Tx Spindletop Storage Facility, which is a pipeline-interconnected salt cavern storage facility that provides the hydrogen storage equivalent to about 30 days of a large SMR plant production
- **Magnum is developing a hydrogen storage facility in the Sevier Valley salt formation at the site of the Intermountain Power Plant in Delta, UT, which will be used to power the plant once it is repowered to burn hydrogen**

Map of Salt Deposits in the U.S.



Source: E3 Internal Resources; Sandia National Lab: Salt Disposal of Heat-Generating Nuclear Waste; E3 analysis; Air Liquide,Magnum

Questions around environmental impacts across the hydrogen lifecycle

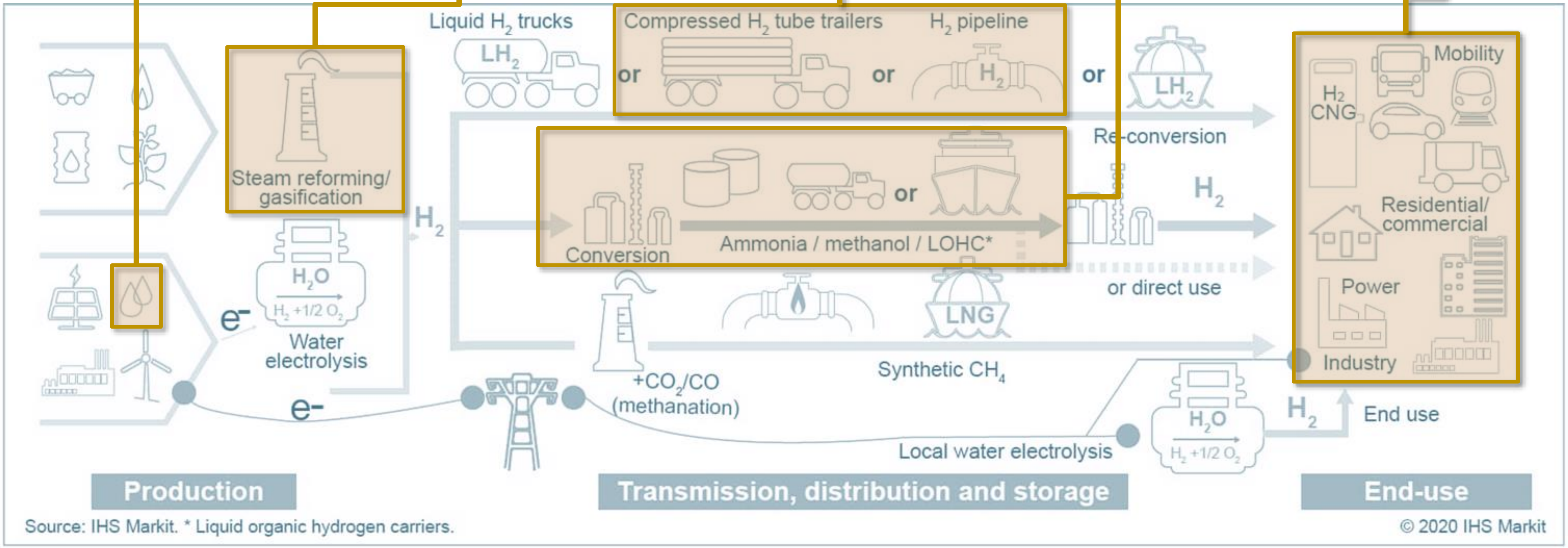
Requires availability of water as feedstock for electrolysis

CO2 emissions related to SMR must be captured and stored

Hydrogen leakage during transportation and storage acts as secondary GHG

Ammonia must be handled as toxic health hazard

NOx emissions from high-temperature combustion can produce smog, acid rain , and health problems



Sources for additional details: https://agage.mit.edu/publications/global-environmental-impacts-hydrogen-economy
https://azdeq.gov/nitrogen-oxide-nox-pollution

Early movers are taking steps to establish foothold for hydrogen in the Southwest

Zero-emissions transportation company Nikola recently partnered with global green energy company Fortescue to produce liquid green hydrogen in **Buckeye, Arizona**, for heavy-duty road transportation between Phoenix and southern California.

Heliogen is developing a green hydrogen production facility in **LaPaz County**, Arizona.

Development of the Phoenix Hydrogen Hub "will greatly strengthen **one of the country's first and most important hydrogen ecosystems**" and will support "the all-important local connective infrastructure to **accelerate the use of green hydrogen**."

-Mark Hutchison, CEO, Fortescue

As majority owner in Escalante H2 Power, Tallgrass is developing a first-of-its-kind hydrogen-to-power project by converting a retired coal-fired power plant in **Prewitt, New Mexico** to a clean hydrogen-fired power generation facility.

BayoTech, Inc., has plans to introduce New Mexico's largest clean hydrogen production hub with its facility in **Albuquerque, New Mexico**. The company creates hydrogen through SMR from pipeline natural gas for transportation and industrial use.

With a mission to "decarbonize hard-to-abate greenhouse gas emissions in aviation, ground transportation, and heavy industry," Universal Hydrogen, specializes in developing hydrogen storage capsules and drivetrain retrofit kits for aviation fuel. The company recently selected **Albuquerque, New Mexico** as the site for its manufacturing and distribution facility.

While potential role for hydrogen in the power sector is clear, many uncertainties remain to be resolved

Knowns

Significant need for firm generation alongside renewables and storage (due to aging plant retirements and rapid load growth)

Today's options for "clean firm" are limited

Unknowns

What developments in H_2 generation technologies will occur?

Will demand from other sectors catalyze the industry?

How & where will H_2 be produced? At what cost?

What effects will final rules for IRA tax credits & Clean Air Act have upon industry?

What transportation & storage infrastructure will be necessary?

How can safety & environmental concerns be mitigated?

What alternative clean firm technologies may emerge as competitors to hydrogen in the future?

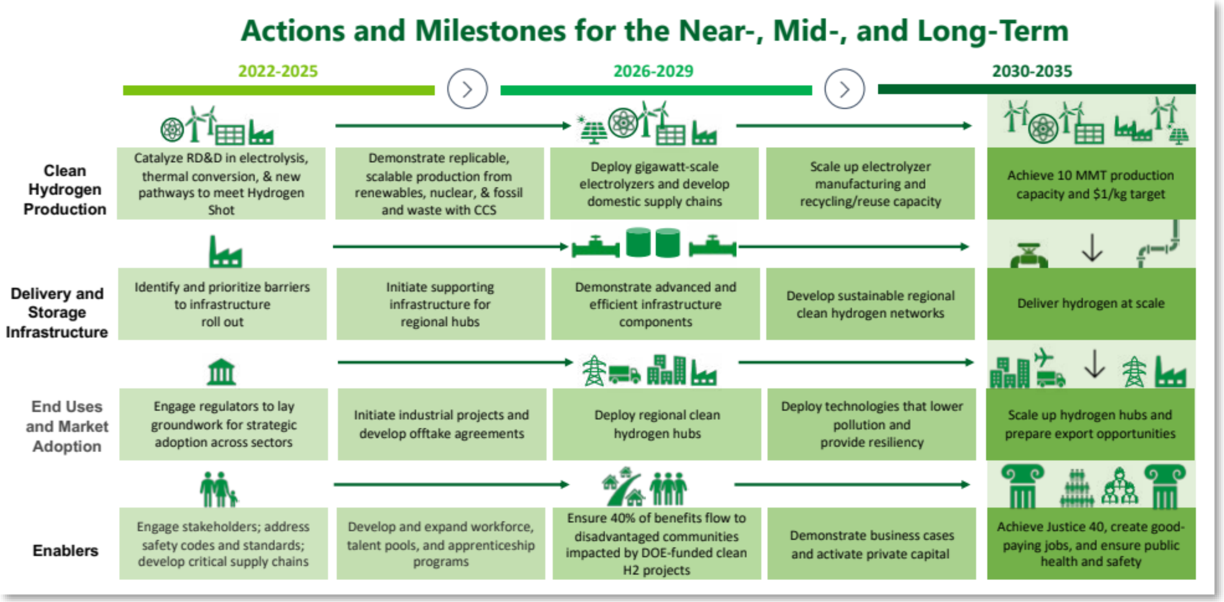


Image source: US National Clean Hydrogen Strategy and Roadmap at a Glance, available at: https://www.hydrogen.energy.gov/docs/hydrogenprogramlibraries/pdfs/clean-hydrogen-strategy-roadmap-at-a-glancee72a84ff4e104d9e9371a16ed7203f82.pdf?sfvrsn=c9276e16_6

OEM Hydrogen Perspective

Nitin Luhar, Mitsubishi

IRP Stakeholder Comment Responses

Mike Eugenis, APS

IRP Stakeholder Comment Responses

Docket No. E-99999A-22-0046

Topics to Address:

- Preferred Portfolio & Four Corners Early Exit Cases ✓
- Natural Gas Build into the Future
- Modeling Specifics
- Western Markets Discussion
- Timeline for Future IRPs & Modeling Licenses

Natural Gas Build into the Future

- The IRP shows indicative results and technologies that will be necessary to maintain reliability at the most affordable price to customers.
- Natural Gas buildouts relatively stable in sensitivities performed.

Actual resource amounts will be determined as a result of ASRFP bids.

Incremental Gas Build by The Numbers	
2025-2030	Eleven 41MW CTs (451MW)
2025-2038	1,451MW of incremental gas (net of retirements)
Preferred Plan includes 1,598MW of existing tolling capacity	

Modeling Specifics

Reliability Analysis

PCAP accounting

Public sources utilized for pricing

LTCE module

Western Markets in the IRP

- APS modeled access to a generic bilateral market.
- APS did not incorporate a specific day-ahead market structure in its modeling.

Regional Data Challenges

- Market Footprint
- Business practices regarding seams
- Transmission
- Resource accreditation
- Region load and resource mix

Timeline for Future IRPs

- RPAC meeting cadence will align with the progress of the regulatory proceedings relating to the 2023 IRP.
- APS supports providing base case information prior to filing, and any additional information once the IRP is complete.

Modeling Licenses

- "Companies shall negotiate licensing fees that permit up to 12 RPAC members and Staff the ability to perform their own modeling runs in the same software package as the load serving entities, and to provide all necessary data and support to fully utilize the models. The load serving entities shall absorb the cost of the licensing fees."
- APS does not anticipate changing current practices as it relates to providing modeling licenses.

Next Steps & Closing Remarks

Matt Lind, 1898 & Co.

Forward Plans and Meetings

Key Milestones

July RPAC Meeting: 7/23/2024
Time: 9:00am

LSEs responses filed: 5/31/2024