AzCaNE | CENTER FOR AN ARIZONA CARBON-NEUTRAL ECONOMY

Arizona's Hydrogen Future: Roundtable

ASU Tempe Campus,
BioDesign Building B,
Room B205A
October 1, 2024

CHATHAM HOUSE RULE

Participants in today's Roundtable are free to use the information received, but when speaking with others outside of the Roundtable, please do not reveal or identify the speakers or participants, or their affiliation. Thank you!

OBJECTIVES

- To actively listen, understand, and appreciate the range of perspectives in the room
- To ensure everyone has a voice "at the table"
- To explore water usage considerations if we produce clean hydrogen in Arizona
- To explore potential impacts of Treasury's proposed rules for the IRA 45V production tax credit
- To leave participants inspired and committed to continuing the conversation and collaboration after today's session

In the interest of embracing diverse viewpoints, learning from varied experiences, and committing to active listening and constructive dialogue

We kindly ask that you

1. Allow others to speak without interruption
2. Refrain from making direct attacks on someone's perspective or opinion
3. Acknowledge and build upon the ideas shared by others

ROUNDTABLE AGENDA

- Working Lunch
- Round the Room Introductions
- Sustainable Water Considerations: Presentation and Discussion
- Treasury's Clean Hydrogen Proposed Rules for the Production Tax Credit 45V Rules: Presentation and Discussion
- Open Roundtable

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SHARED GOALS, DIVERSE PERPSPECTIVES

Despite our differences, we share some key goals that guide our pursuit of a sustainable future

- **Climate Action:** Reduce GHG emissions
- **Energy Resilience:** Diversify energy resources for reliability and resiliency
- **Economic and Social Progress:** Stimulate growth and ensure equitable access
- **Renewable Integration:** Store and balance renewable energy
- **Water Sustainability:** Use Arizona's water resources responsibly
- **Immediate Action:** Take urgent steps to address challenges

We recognize diverse viewpoints; understanding them is key to progress

1. **Technology Pathways:** Disagreement over hydrogen's role
2. **Resource Allocation:** Differing views on prioritizing land, water, and energy.
3. **Investment Focus:** Differing priorities for short- vs. long-term solutions
4. **Local vs. Global:** Balancing local impacts with global climate goals
5. **Risk Tolerance:** Balancing speed with caution in action.

ROUNDTABLE INTRODUCTION GUIDELINES

- Please introduce yourself, including your name and affiliation and general connection to clean hydrogen and/or achieving a carbon-neutral economy
- What outcomes or insights are you hoping to gain from today's discussion?
- How knowledgeable are you on the topic of clean hydrogen?

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Water Considerations Related to Clean Hydrogen in Arizona

Arizona's Hydrogen Frontier:

Navigating Clean Energy and Water Sustainability

Written by:

Sarah Porter, Director of the ASU Kyl Center for Water Policy
Shane DePinto, Senior Water Analyst for Salt River Project
Ellen B. Stechel, Executive Director of AzCaNE
Cora Tso, Senior Research Fellow at ASU Kyl Center
Behshad Mohajer, Graduate Researcher at the ASU School of Sustainable Engineering and the Built Environment

Hydrogen and Water Sustainability in the Desert: A Path Forward for Arizona

- Clean hydrogen is one of many crucial pathways that can help us attain a decarbonized future, especially in hard-to-abate sectors like freight trucking
- By integrating clean hydrogen into these sectors, we can significantly lower carbon footprints and accelerate our progress towards sustainability goals

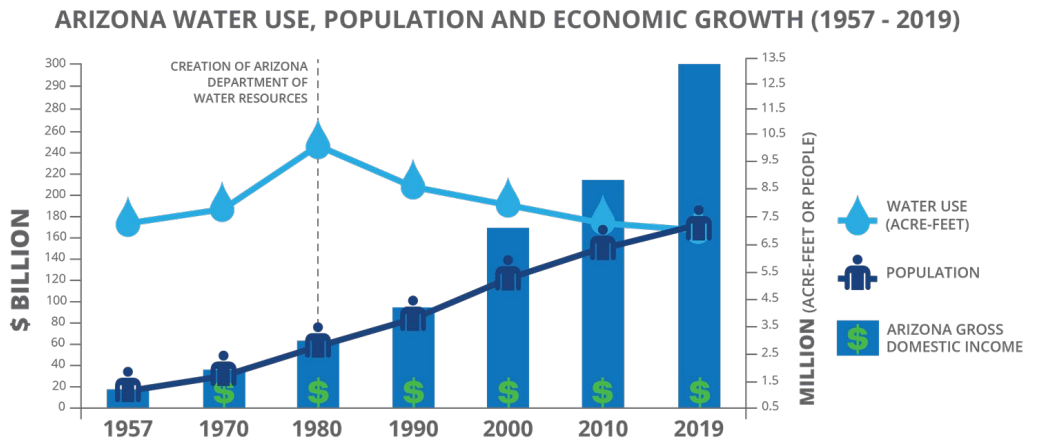
Concerns about Clean Hydrogen in the Desert

- Clean hydrogen (H2) can play a significant role in reducing carbon emissions, but there are concerns that arid regions--such as Arizona--cannot support a hydrogen economy
- This presentation is a look into how clean hydrogen can play a key role in meeting clean energy goals without compromising Arizona's water sustainability

Arizona Water Use vs Population

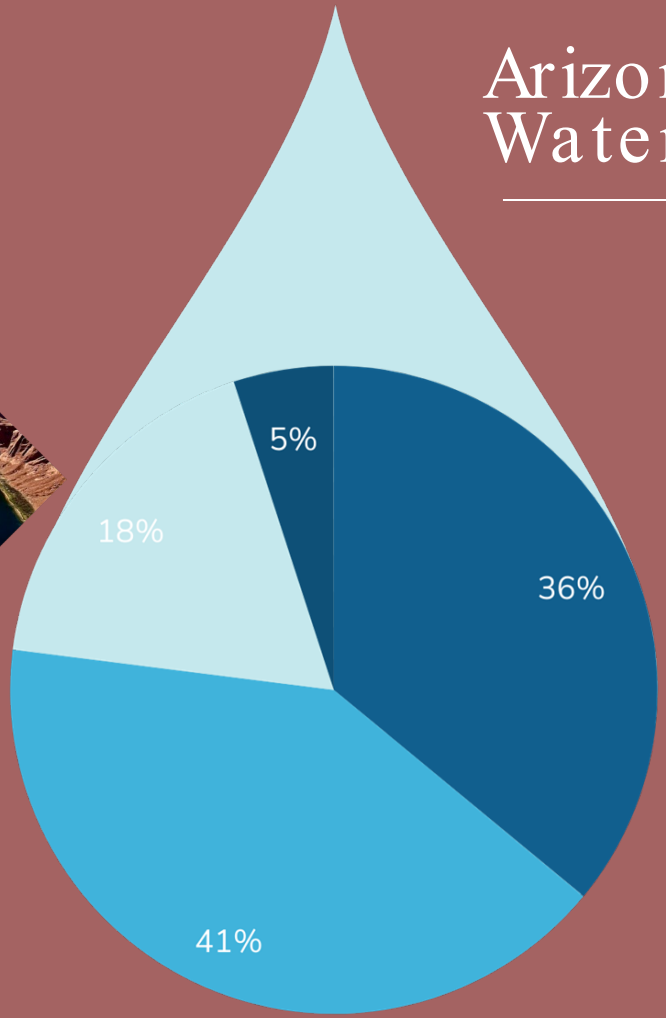
ARIZONA'S WATER MANAGEMENT SUCCESS

Since the 1980s, population and economic growth in Arizona have been decoupled from water demand. AZ's total water use statewide is now ~7 million acre-feet of water annually, down from its peak of ~11 million acre feet.



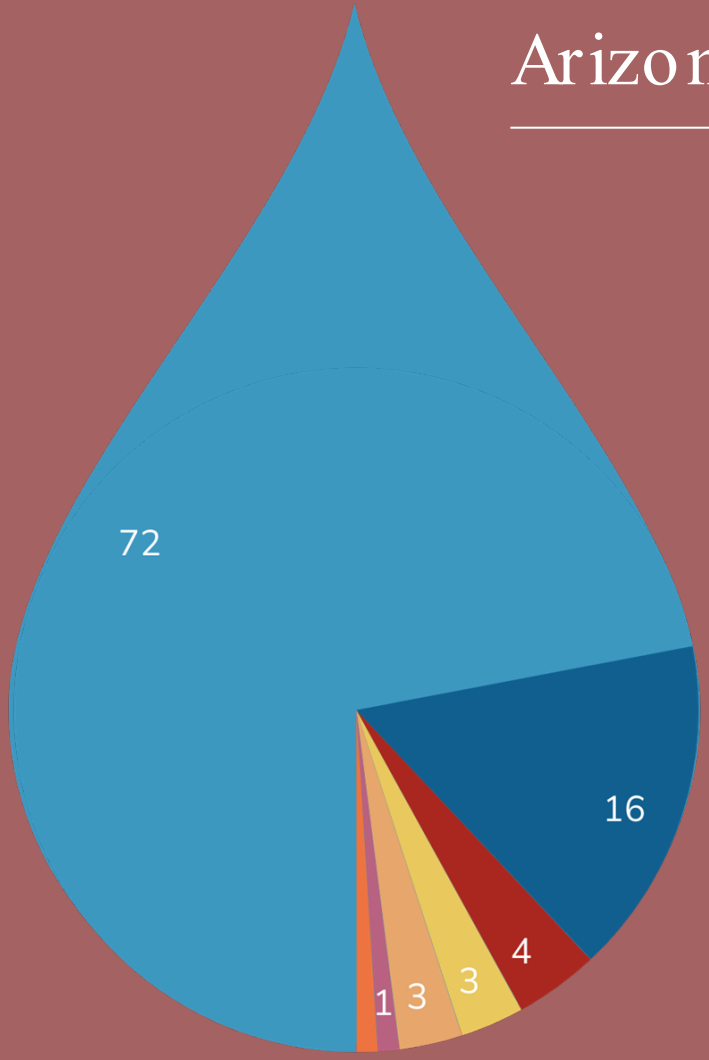
Source: ADWR, 2020

Arizona's Four Main Water Sources



- Colorado River (36%)
- Groundwater (41%)
- In-state Surface Water (18%)
- Reclaimed Water (5%)

Arizona's Water Use

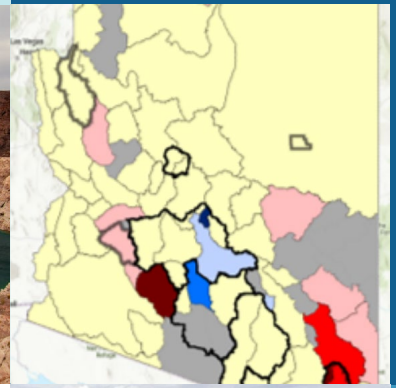


- Crop Irrigation (72%)
- Domestic (16%)
- Commercial (4%)
- Thermoelectric (3%)
- Golf (3%)
- Mining (1%)
- Other (1%)

Arizona's Water Supply Challenges

Diminishing Colorado River Supplies

Historic over-allocation combined with climate change will likely result in reduced Colorado River supplies in the future. CAP water users are likely to be most impacted.

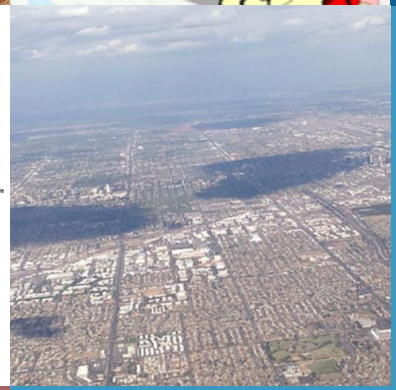


Over-reliance on Groundwater

In many parts of Arizona, groundwater is being withdrawn faster than it is replenished, resulting in depleted aquifers, subsidence and wells going dry.

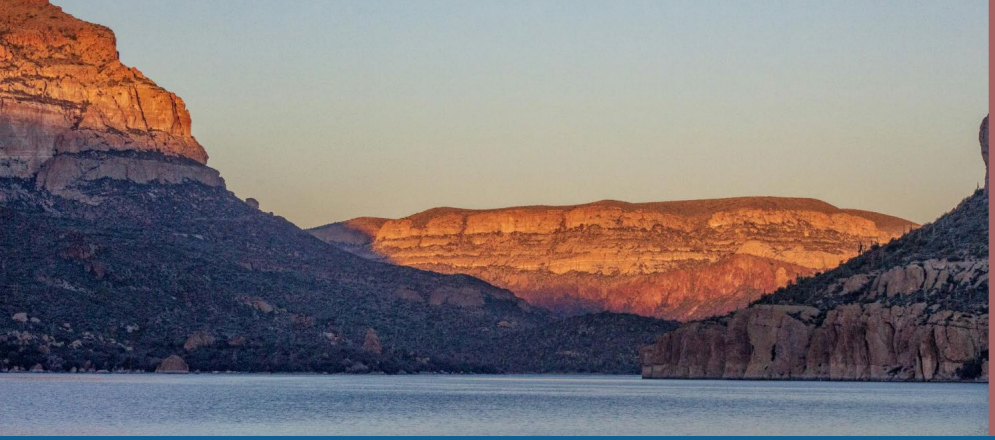
Uncertainty regarding Surface Water Rights

Until the state's two decades-long stream adjudications are completed, the rights to use water from the Little Colorado and Gila Rivers and their tributaries will remain uncertain.



Water for Peripheral Development

In many outlying areas of Phoenix and Tucson and in Pinal County, new sub-division development cannot occur until new renewable water supplies become available.



Water Solutions Underway

A look at relevant news stories on the efforts undertaken by Arizonans to address their water challenges

ARIZONA REPUBLIC azcentral.com PART OF THE USA TODAY NETWORK

Amid drought, one tribe seeks to offer water for lease, another moves to conserve more

Dec. 13, 2021

As Arizona tribal leaders prepare to take a greater role in a regional forum on Colorado River issues, a new bill to allow at least one tribe to lease water is making its way through Congress, while another tribe tries to forestall further cuts to water delivery.

abc 15 ARIZONA

Buckeye approves spending $80 million for water rights

February 3, 2023

The city of Buckeye approved purchasing $80 million worth of groundwater rights to support the growth of its water portfolio.

ARIZONA'S FAMILY 3 5

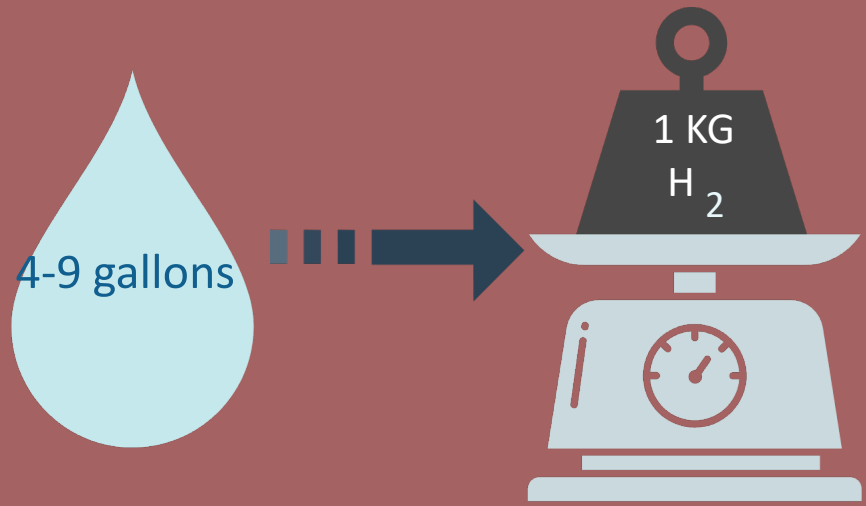
Queen Creek to receive Colorado River water from Cibola farm in controversial transfer

July 19, 2023

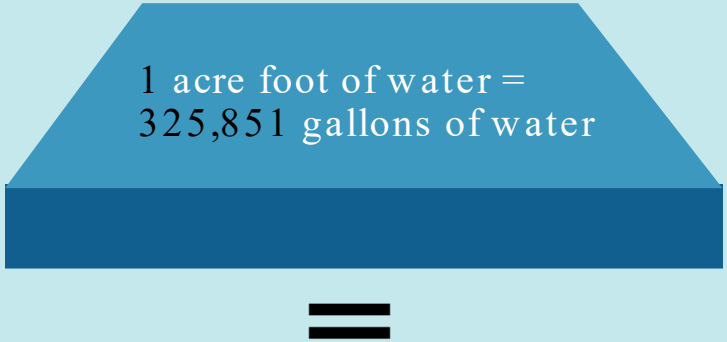
For the first time, Queen Creek is getting water from a property owner in the small town of Cibola, Arizona, in La Paz County. In some ways, experts say it's a first-of-its-kind transaction in Arizona, and the sale did not come without controversy.

Understanding Water Requirements for Hydrogen Production

- **4-9 gallons of water** is consumed to produce **1 kg** of hydrogen via electrolysis
  - Of this, **2.5-4 gallons** is needed for minimum feedstock
  - Of this, **1.5-5 gallons** is required for purification & cooling



What's In an Acre-Foot (AF) of Water?



How Clean Hydrogen Compares

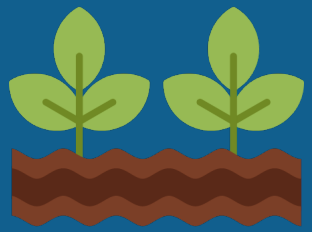
A comparison on some of the most common uses of water in Arizona vs clean hydrogen production, in acre-feet of water per year (AF/year)

Single Family Homes

3.5 single-family homes use **1 AF/year**

Agriculture

1 acre alfalfa uses **~6-10 AF / year**
1 acre cotton uses **~3-4 AF / season**



Golf Course

1 golf course uses **504 AF/year.**
All Arizona courses combined use **~120,000 AF/year**

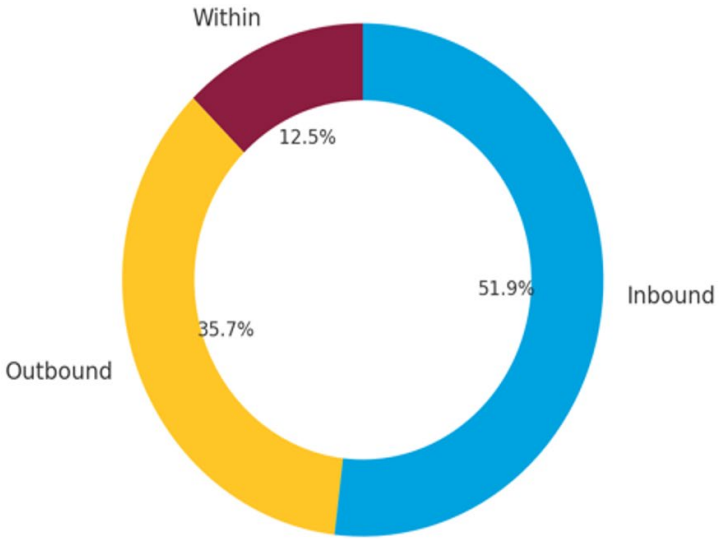
Data Center

1 data center (using efficient water cooling) uses **172 AF / year**

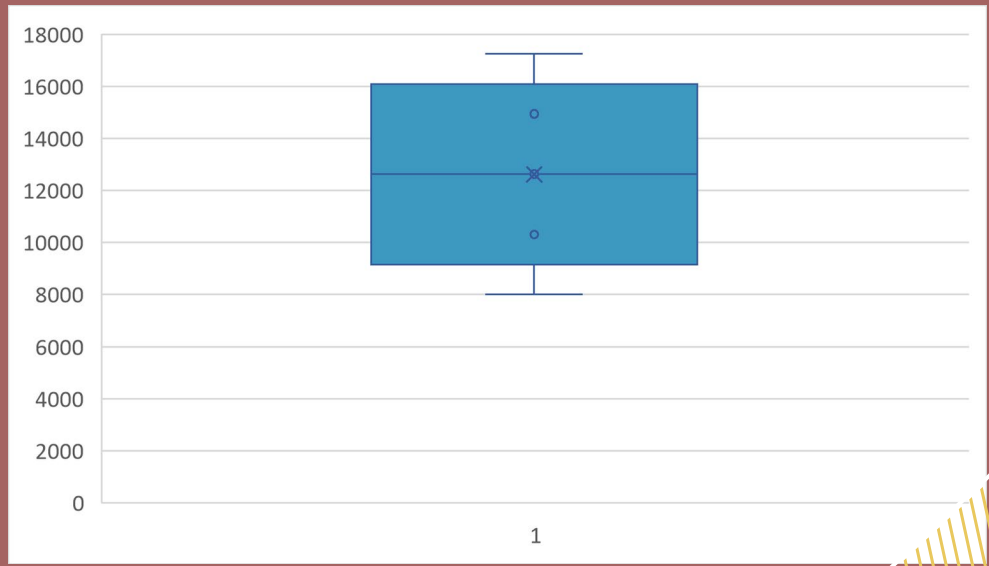
Water for H2 Freight Trucking

8,000–17,250 acre-feet of water is required annually to produce the 655,225 metric tons of hydrogen needed to support 100% of freight trucking in the state.

Projected Freight Trucking Distribution by Direction – Arizona 2050



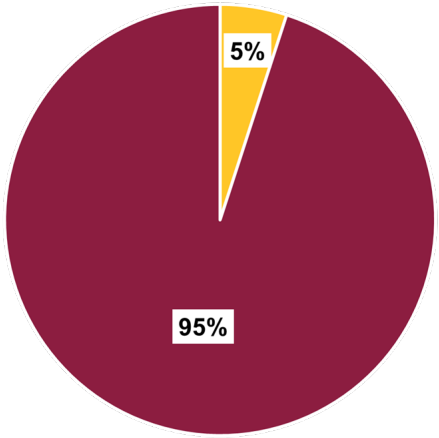
Total Water Use for H2 Powered Freight Trucking – Arizona 2050 (in acre-feet)



Water for H2 Electric Power

7,500-17,000 acre-feet of water is needed produce enough hydrogen to meet 5% of Arizona's projected energy demand in 2050

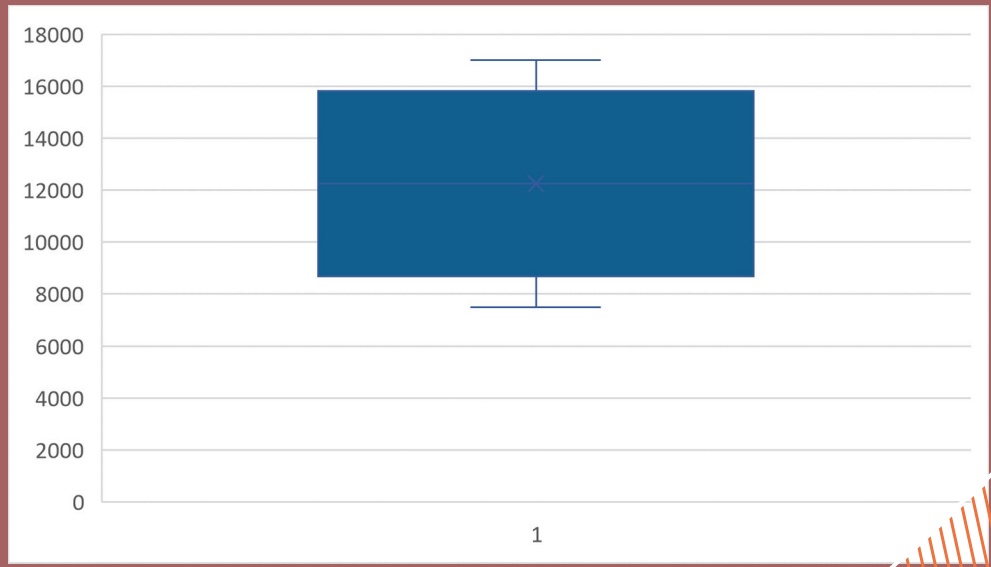
Projected Power Production



Projected 2050 demand = 163,000,000 MWh

- 100% hydrogen capable gas turbines fleet in 2050 (Mwh)
- Renewable resources, such as wind, solar and hydroelectric power (Mwh)

Hydrogen Production Water Use for 5% of Power 2050 (in acre-feet)

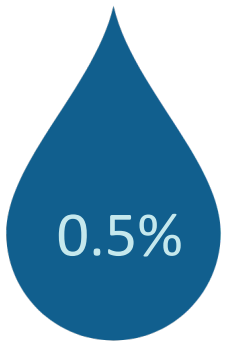


Total Annual Water Requirements for Clean Hydrogen by 2050

5% Electric Power (Peak Production)		100% of Freight Trucking		Total
7,500-17,000 acre-feet	+	8,000-17,250 acre-feet	=	15,500-34,250 acre-feet

The total projected volume of water needed to supply hydrogen powered freight trucking and 5% of electric power is 0.5% of Arizona's annual use.

=



5 Considerations for Ensuring a Sustainable Water Supply

1. Withdrawing groundwater for any use results in aquifer depletion unless the withdrawal is offset by recharge. In contrast, water from rivers and streams (surface water) and reclaimed wastewater are considered “renewable” water supplies.

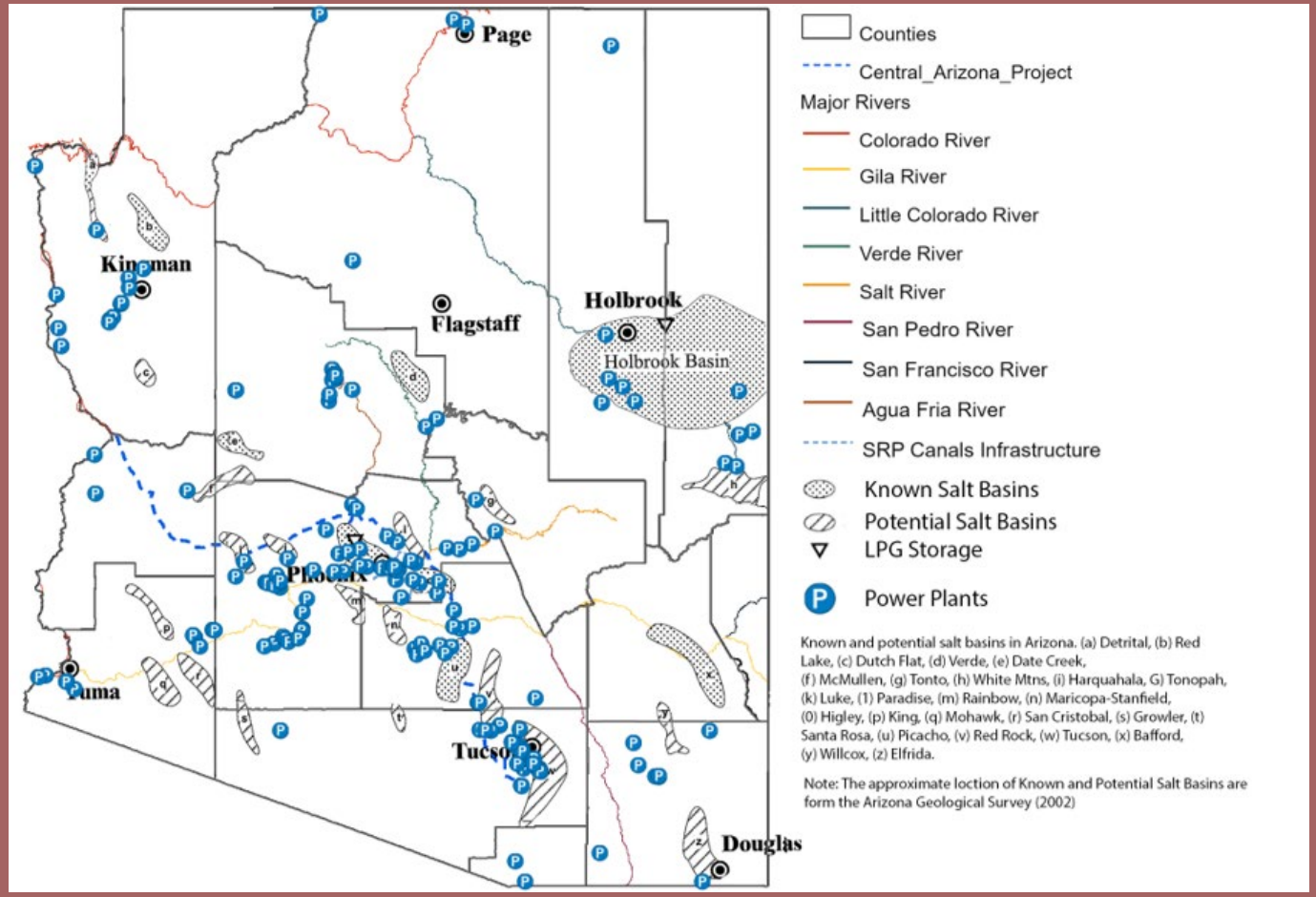
2. The sustainability of reallocating water from agricultural uses to clean hydrogen production depends primarily on the source of supply

3. Reclaimed water is expensive compared to other water supplies and in high demand

4. Even with relatively expensive sustainable water supplies, producing clean hydrogen may still be economically feasible

5. Arizona has natural and built infrastructure that may be helpful

Proximity to Salt Bodies



Known and potential salt basins in Arizona. (a) Detrital, (b) Red Lake, (c) Dutch Flat, (d) Verde, (e) Date Creek, (f) McMullen, (g) Tonto, (h) White Mtns, (i) Harquahala, G) Tonopah, (k) Luke, (1) Paradise, (m) Rainbow, (n) Maricopa-Stanfield, (0) Higley, (p) King, (q) Mohawk, (r) San Cristobal, (s) Growler, (t) Santa Rosa, (u) Picacho, (v) Red Rock, (w) Tucson, (x) Bafford, (y) Willcox, (z) Elfrida.

Note: The approximate loction of Known and Potential Salt Basins are form the Arizona Geological Survey (2002)

Final Thoughts

- Although Arizona faces potential reductions in its Colorado River supply, this source is just one component of a diverse array of water resources that are utilized daily to support the broader region.
- In comparison to other industries, the water demand for hydrogen production is relatively modest.
- Meeting this demand through voluntary reallocations of sustainable water supplies could contribute towards greater water sustainability while supporting the development of the clean energy transition.

Questions

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ROUNDTABLE WATER CONSID-ERATIONS DISUSSION GUIDELINES

- Please remind everyone of your name and affiliation
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Treasury's Proposed Rules for the Clean Hydrogen Production Tax Credit

AzCaNE's Perspective on 45V

Balancing Four Lenses: Environmental Integrity, Economic Feasibility, Energy Security, and Social Equity in Arizona

Presented by

Neha Chhetri, MS
Research Professional for the
Center for an Arizona Carbon-Neutral Economy.

Clean Hydrogen and the 45V Tax Credit Background

- The Infrastructure Investment and Jobs Act (IIJA) and **Inflation Reduction Act (IRA)** incentivize clean hydrogen production and infrastructure development
- The **45V Production Tax Credit (PTC)** offers up to $3/kg for low-carbon intensity hydrogen production
- The intent of such incentives is to decarbonize **difficult-to-abate sectors**, spur innovation, and encourage investment in clean hydrogen
- This intent aligns with global strategies from the **IEA** and **IPCC** to help the U.S. achieve a **carbon-neutral economy by 2050**

Four Lenses

Stakeholder Perspectives, Divergences, and Commonalities

Divergence

While the clean hydrogen industry, environmental groups, academia, the public, and governments share common goals, they hold divergent perspectives

Four Lenses Explained

Four main "lenses": environmental, economic, security, and societal, lead to diverse perspectives and approaches to clean hydrogen production

Common Goal

All lenses share the overarching target of accelerating deployment of low-carbon intensity technologies

Balancing Four Lenses

- **Environmental Lens:** Values the reduction of emissions and the preservation of ecological integrity and emphasizes the importance of stringent rules to ensure immediate environmental benefits.
- **Economic Lens:** Focuses on cost-effectiveness and financial sustainability, and is concerned about high compliance costs that may hinder industry growth
- **Security and Resiliency Lens:** Underscores the importance of integrating clean hydrogen into the energy mix to help maintain a resilient energy supply.
- **Social Lens:** Values job creation, community well-being, and equitable access to clean energy benefits, especially for disadvantaged communities.

Three Main Pillars of 45V

Additionality

Demands new carbon-neutral energy capacity (within 3 years of commissioning the H_2 production)

Temporality

Requires hourly match-ing of carbon-neutral energy sourcing and hydrogen production, with annual matching allowed through 2028

Regionality

Mandates local generation with pre-defined regions for the source of the low-carbon electricity

Viewing the Rules through the Lenses

GOAL OF THE 45V RULES

- Decarbonize the economy without increasing power sector's GHG emissions, both attributional and consequential
- Prevent displacement of low-carbon sources or the addition of fossil fuel capacity

PERSPECTIVE THROUGH EACH LENS

- **Environmental Lens:** Supports the stringency of the rules to ensure immediate and long-term emissions reduction
- **Economic Lens:** Concerned that the stringent rules could slow growth and hinder long-term decarbonization
  - ✓ Favors flexibility to avoid concentrating hydrogen production in limited regions, which would require long-distance transport
- **Security Lens**: Advocates for a balanced approach to ensure energy reliability
  - ✓ Supports rapid clean hydrogen deployment to diversify the energy mix and enhance security
- **Social Lens:** Emphasizes equitable access to the benefits of clean hydrogen production, including job creation and workforce development, particularly for marginalized communities

AzCaNE's Viewpoint

AzCaNE views Treasury's proposed rules for clean hydrogen PTC, as overly restrictive and not balanced.

Our Concerns Regarding the Rules

- Risks nationally hindering the development of clean hydrogen production--crucial achieving carbon net-neutrality by 2050
- Would lead to significant barriers in key regions like Arizona.
- Would likely limit deployment, raise costs and reduce efficiencies, contrasting with their original intent to support market growth

Our Recommendation

A **more balanced approach,** supported by research, that still aligns with the IRA's goal to support rapid market liftoff, while maintaining effective emissions control and decarbonization of hard-to-abate sectors

Potential Impacts of Treasury's Rules

The PTC incentive aims to stimulate clean hydrogen production, but the proposed rules' complexity and stringency may instead hinder industry growth by increasing costs and slowing deployment

Impacts Breakdown

Constrained Project Viability

Stringent reliability constraints ensures high environmental standards but also raises costs and limits viable projects to certain regions

Reliance on Off-Grid Facilities

Rules reduce transmission losses and grid dependency, but may require off-grid renewable energy, reducing capacity factors and efficiency

Loss of Grid Service Opportunities

Eliminates opportunity for grid services like demand response services at peak demand, making balancing supply and demand more complex and costly

Potential Impacts Continued

Impacts Breakdown

Low-Capacity Factors

Stricter rules align hydrogen production with renewable energy but reduce operational flexibility and efficiency.

Complex Verification Process

Proposed rules could add undue administrative burdens for assessing GHG emissions due to lack of a national hourly generation tracking system.

Regulatory Uncertainty

Lack of clear guidance on timelines and criteria creates uncertainty, risking delays in sector development and contributions to environmental and economic goals.

Potential Impacts Continued

Impacts Breakdown

Transmission Losses

Localized production minimizes transmission losses, but deliverability criteria could create infrastructure misalignment.

Regional Bias

Clean hydrogen production may concentrate in regions with high solar and wind potential, a bias that could affect competitive dynamics, leading to market disparities and necessitating costly, long-distance hydrogen transport.

Potential Market Disadvantages

High administrative costs and stringent rules may push stakeholders toward regions with more favorable regulatory landscapes, like Europe..

A Balanced Approach

A balanced evaluation of the proposed rules is crucial to assess their impact on clean hydrogen's viability, particularly for hard-to-abate sectors.

Risks of Strict Regulations

Overly stringent rules may reduce decarbonization opportunities

Incentivizing Clean Hydrogen

High costs and infrastructure needs drive the need for incentives

Effects of Easing Constraints

Easing constraints doesn't necessarily lead to higher emissions

Studies on Easing Constraints

- Hourly matching reduces emissions **only** if cost-effective clean electricity is available
  - ✓ May require overbuilding energy sources, raising costs
- Complex dynamics between deployment, costs, system effects, and emissions make modeling difficult
  - ✓ Suggests a need for future policy monitoring to mitigate emissions impacts

Examining the Three Pillars

Recent studies propose annual matching to avoid significant cost and operational barriers while maintaining environmental outcomes

Investigations reveal that strict additionality and temporality requirements may not significantly lower GHG emissions but will increase costs and reduce efficiency, likely slowing deployment

These increased costs risk nullifying the PTC's advantages, stalling industry progress, and undermining the goal of fostering a sustainable, secure energy future

The stringent requirements of the three-pillar approach to clean hydrogen contrasts with flexible incentives for other clean energy technologies like BEV tax credits, raising concerns about equity

Paths to Consider

Past Approaches: BEV

The evolution of BEVs shows the potential for clean hydrogen in decarbonization through ongoing advancements to reduce emissions, despite initial higher carbon intensity

Unintended Effects of Rules

- Strict rules may **nullify** the incentives intended to drive clean hydrogen production
- Rigid regulations could **hinder industry expansion**, particularly in difficult-to-abate sectors

Need a **more flexible U.S. framework** to maintain competitiveness and effectively incentivize clean hydrogen for decarbonization

Emulating the European Union's Balanced Approach

- The EU Provides a regulatory framework that supports industry growth while ensuring energy security
- Promotes a **diverse and resilient energy mix**
- Could serve as a model for the U.S. to follow that could strengthen the clean hydrogen industry and enhance long-term energy security

A More Nuanced Approach to the 45V Rules

Current rules risk prioritizing near-term environmental goals for the grid to the exclusion of environmental in hard-to-abate sectors, long-term emissions reductions, economic feasibility, and social equity.

A more balanced approach:

- Supports technology deployment and economic development.
- Enhances energy security and creates jobs
- Minimizes emissions over time, supporting economy-wide decarbonization by 2050.

Our Recommendations

Aim to align these rules with global standards of flexibility and innovation, maintaining U.S. competitiveness in the clean hydrogen market

Grandfathering Early Movers

Allow annual matching, expanded deliverability regions, and no additionality for projects before the end of 2028, with tax credits capped at the first 100 metric tons per day per plant

Relaxing Regionality Requirements

Implement a phased transition to hourly matching, starting with annual matching for all production prior to 2030 and for the first year of production through 2032

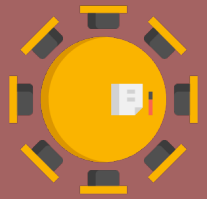
Transition Period from Annual to Hourly Matching

Implement a phased transition to hourly matching, starting with annual matching for all production prior to 2030 and for the first year of production through 2032

Clarification on Renewable Natural Gas

Provide guidelines on RNG use within the 45V framework, supporting deliverability and addressing additionality, book and claim, and eligibility ambiguity

Questions



ROUNDTABLE 45V PROPOSED RULES DISUSSION GUIDELINES

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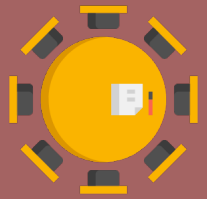

OPEN ROUNDTABLE DISUSSION GUIDELINES

- Please remind everyone of your name and affiliation
- What is a topic you would like to hear more about next time?
- What actions or safeguards would you like to see in place to ensure that any clean hydrogen developments in Arizona remain transparent and accountable with all voices heard and valued?

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THANK YOU FOR YOUR PARTICIPATION

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