



# Is Clean Hydrogen Production a Good Fit for Questa?

## Project Introduction

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# Disclaimer

- The following slides contain summary information and constitute an initial, high-level overview of key questions and considerations related to clean hydrogen production. Additional analysis will be required to determine whether or not clean hydrogen development and production is a good fit for Questa, specifically, based on the community's goals and priorities. This deck is intended for discussion purposes only and should not be the sole basis of future design or investment decisions.

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# Agenda

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- Introduction to Communities LEAP and the Questa Technical Assistance (TA) project
- What is clean hydrogen?
- Exploring the benefits, opportunities, and challenges of clean hydrogen production for Questa

# Communities LEAP Program Overview



- The Communities Local Energy Action Program (LEAP) Pilot Competitive Technical Assistance Opportunity aims to facilitate sustained community-wide economic empowerment through clean energy, improve local environmental conditions, and open the way for other benefits primarily through DOE's clean energy deployment work.
- This opportunity is specifically open to low-income, energy-burdened communities that are also experiencing either direct environmental justice impacts, or direct economic impacts from a shift away from historical reliance on fossil fuels.

# Map of LEAP Communities



# Questa Community Coalition & Technical Assistance Team

Community Coalition			Technical Assistance (TA) Providers		
Name	Title	Email	Name	Role	Email
John Ortega	Mayor, Village of Questa	<a href="mailto:jortega@villageofquesta.org">jortega@villageofquesta.org</a>	Elaine Hale	Community Lead (NREL)	<a href="mailto:elaine.hale@nrel.gov">elaine.hale@nrel.gov</a>
Jake Lafore	Project Manager, Village of Questa	<a href="mailto:jlafore@villageofquesta.org">jlafore@villageofquesta.org</a>	Chrissy Scarpitti	Community Lead (NREL)	<a href="mailto:chrissy.scarpitti@nrel.gov">chrissy.scarpitti@nrel.gov</a>
Chris DeFillippo	Village Attorney, Robles, Rael & Anaya	<a href="mailto:chris@roblesrael.com">chris@roblesrael.com</a>	Kevin Topolski	Hydrogen Infrastructure Analyst (NREL)	<a href="mailto:kevin.topolski@nrel.gov">kevin.topolski@nrel.gov</a>
Luis Reyes	CEO & General Manager, KCEC	<a href="mailto:lreyes@kitcarson.com">lreyes@kitcarson.com</a>	Haider Niaz	Hydrogen Infrastructure Analyst (NREL)	<a href="mailto:haider.niaz@nrel.gov">haider.niaz@nrel.gov</a>
Lynn Skall	Director, Questa Economic Development Fund	<a href="mailto:lynn@questaedf.com">lynn@questaedf.com</a>	Andre Fernandes	Economist (NREL)	<a href="mailto:andre.fernandestomonavelino@nrel.gov">andre.fernandestomonavelino@nrel.gov</a>
Christian Isely	Public Affairs Advisor, Chevron	<a href="mailto:cisely@chevron.com">cisely@chevron.com</a>	Patricia Sullivan	Associate Dean, Outreach and Recruitment, College of Engineering (NMSU)	<a href="mailto:patsulli@nmsu.edu">patsulli@nmsu.edu</a>
			Duncan Mcbranch	New Mexico strategy development for WISHH (LANL)	<a href="mailto:mcbranch@lanl.gov">mcbranch@lanl.gov</a>

**KCEC:** Kit Carson Electric Cooperative

**LANL:** Los Alamos National Laboratory

**NMSU:** New Mexico State University

**NREL:** National Renewable Energy Laboratory

**WISHH:** Western Interstate Hydrogen Hub

# Questa's Application

## What?

- Study whether it would be beneficial to reuse mine resources (i.e., land, water) to produce electrolytic hydrogen

## Why?

- Generate clean, reliable electricity at night (Kit Carson Electric Cooperative [KCEC])
- Create good jobs (Village of Questa)
- Attract more economic activity (Village of Questa)
- Put existing assets to beneficial use (Chevron)
- Decrease energy bills for customers (KCEC, Village of Questa)

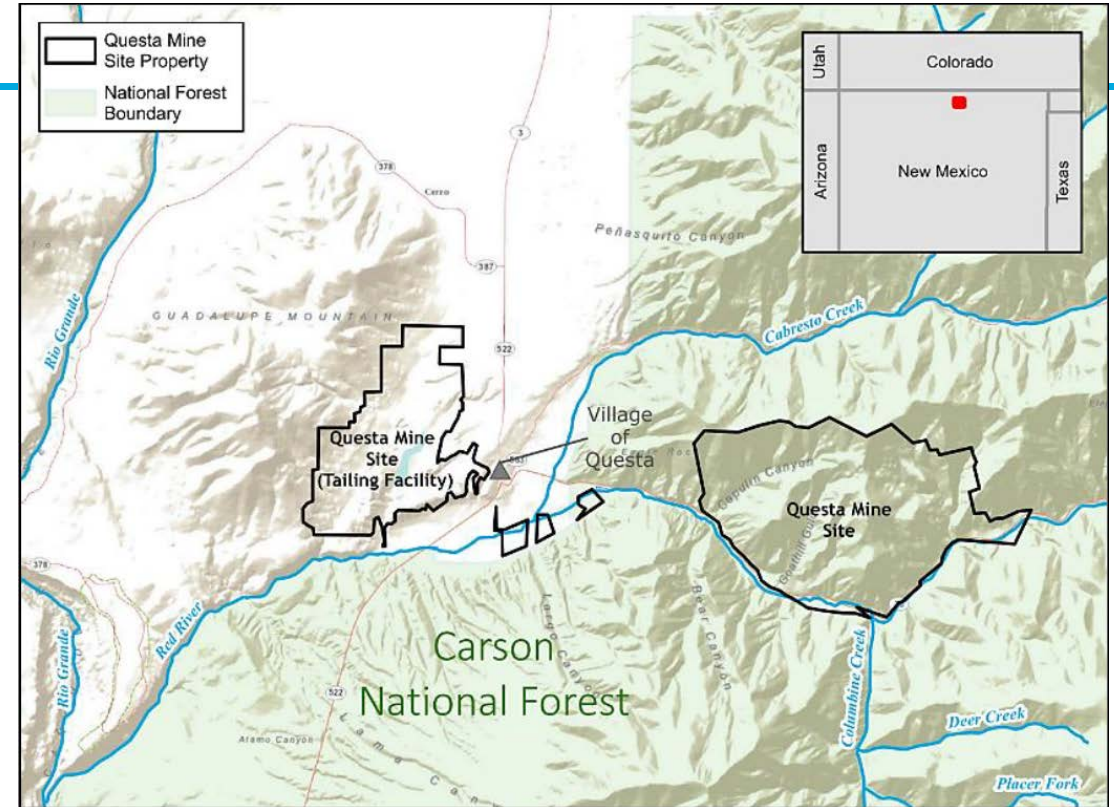


FIGURE 1-1 MAP OF THE SITE (MODIFIED FROM EPA 2010)  
[https://onrt.env.nm.gov/wp-content/uploads/2018/05/Final-Questa\\_RPEA\\_5.21.18.pdf](https://onrt.env.nm.gov/wp-content/uploads/2018/05/Final-Questa_RPEA_5.21.18.pdf)

**KCEC is looking beyond their 100% Daytime Solar goal**



Photo credit: <https://kitcarson.com/electric/100-daytime-solar-energy-by-2022/>

# Technical Assistance Approach for Questa

Activity	A. Hydrogen Techno-economic Feasibility Study	B. Economic & Workforce Development	C. Outreach
Effort (% , estimate)	40	30	30
Planned Tasks	<ul style="list-style-type: none"> <li>A1. Hydrogen end use market analysis</li> <li>A2. Regional feedstock analysis (renewable energy, water)</li> <li>A3. Regional infrastructure analysis (hydrogen storage, hydrogen transport, electricity transmission)</li> <li>A4. Hydrogen plant component cost assessment</li> <li>A5. Overall hydrogen plant cost assessment</li> <li>A6. Financial incentive identification</li> <li>A7. Emissions impact analysis</li> </ul>	<ul style="list-style-type: none"> <li>B1. Economic impact analysis</li> <li>B2. Workforce market and gap analysis with action plan</li> </ul>	<ul style="list-style-type: none"> <li>C1. Partnership development</li> <li>C2. Progress updates</li> <li>C3. Educational materials and presentations</li> </ul>



# Could clean hydrogen contribute to Questa's goals?

In what ways might clean hydrogen address Questa's goals? The proposed scope of work will help the coalition evaluate whether hydrogen:

- Could put retired mine land and water resources to beneficial use
- Could be part of the solution to meet KCEC's nighttime winter peak while complying with New Mexico's clean energy laws
- Could create jobs and drive economic activity in Questa
- Could expand local control of electricity generation for KCEC members and customers

The proposed scope of work will address the following questions to support decision making by the coalition:

- What inputs are required for different quantities of clean hydrogen?
- What are potential markets for clean hydrogen?
- What are the potential costs of and incentives for a hydrogen facility?
- How many jobs and how much economic impact might be generated?
- What are potential consequences, barriers, and challenges?
- How could the community pursue equitable clean hydrogen development?
- What would be needed to train a skilled hydrogen workforce?

# Questa TA Timeline



Engagement

## Contacts and Potential Partners

- ED: Environment Department
- EDD: Economic Development Department
- EMNRD: Energy, Minerals and Natural Resources Department
- LANL: Los Alamos National Laboratory
- LOECC: Land of Enchantment Clean Cities
- NMSU: New Mexico State University
- RETA: New Mexico Renewable Energy Transmission Authority
- WISHH: Western Interstate Hydrogen Hub

# What is Hydrogen (H<sub>2</sub>)?

- Hydrogen could be a clean alternative to methane, also known as natural gas. In short, a fuel that can be used for multiple purposes just like methane<sup>1</sup>.

- Heating homes & businesses
- Producing power using fuel cells, etc.
- Other industrial uses as shown in Figure 1.

- Natural gas vs Hydrogen**

**Burning natural gas** provides cheap energy, but a waste product alongside water is carbon dioxide, which when released into the atmosphere contributes to climate change. Whereas **consuming hydrogen** only produces water vapor as a waste product.

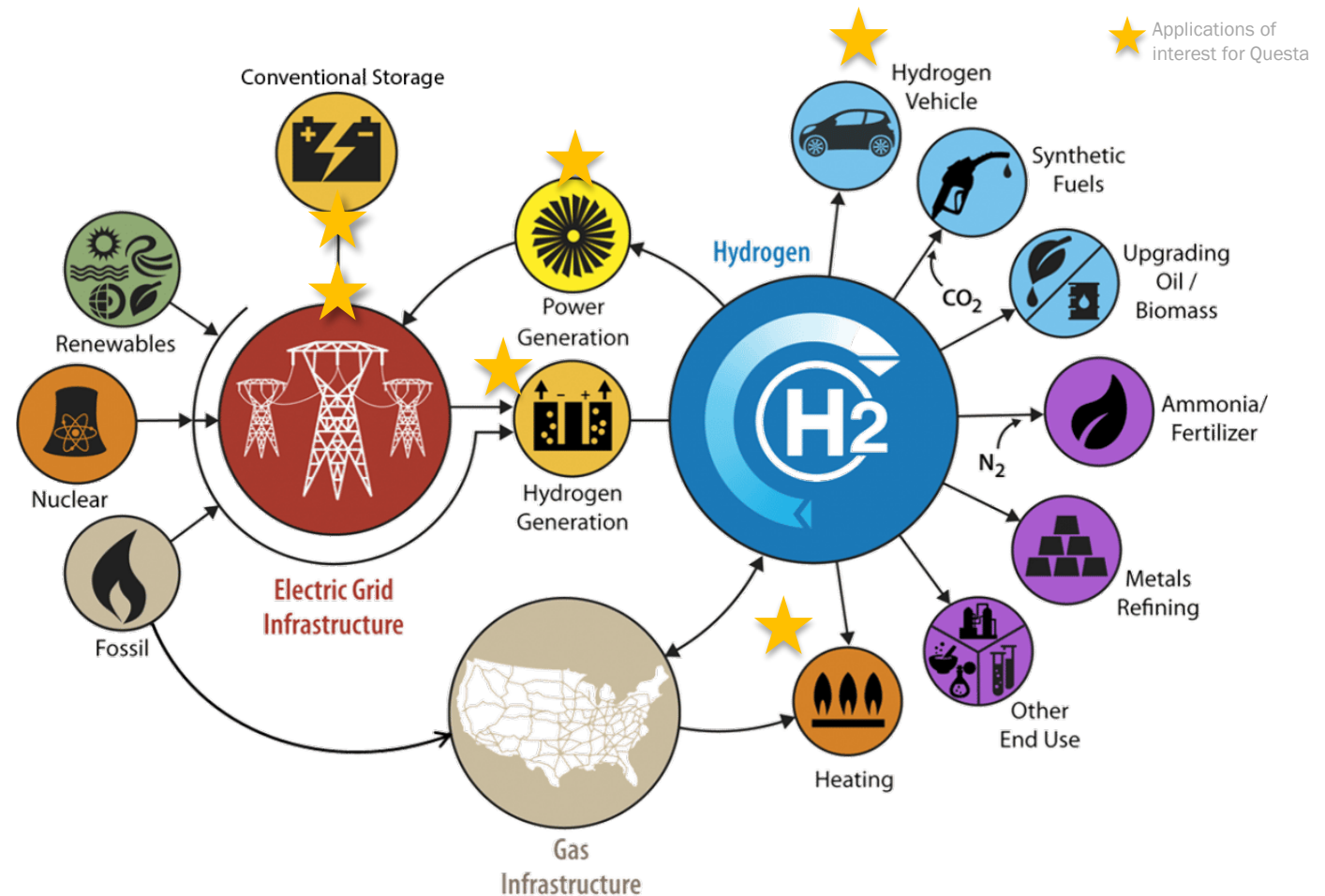


Figure 1. Various uses of hydrogen.<sup>1</sup>

<sup>1</sup>Ruth, M. F. et al. (2020). The Technical and Economic Potential of the H<sub>2</sub>@ Scale Hydrogen Concept within the United States (No. NREL/TP-6A20-77610). National Renewable Energy Lab.(NREL), Golden, CO (United States).

# What is Hydrogen (H<sub>2</sub>)?

- Hydrogen is a carbon-free energy carrier like electricity, but unlike electricity it can be stored, combusted (heat), reacted in a fuel cell (electricity), and used as a chemical feedstock.
- Electricity vs Hydrogen
  - Electricity from green energy sources can be used to decarbonize buildings and vehicles, but it **cannot be stored** without a separate storage system (e.g., batteries, pumped hydropower).
  - Hydrogen is an effective and **versatile energy storage option** suitable for long term storage & can be re-converted to electricity via fuel cells.

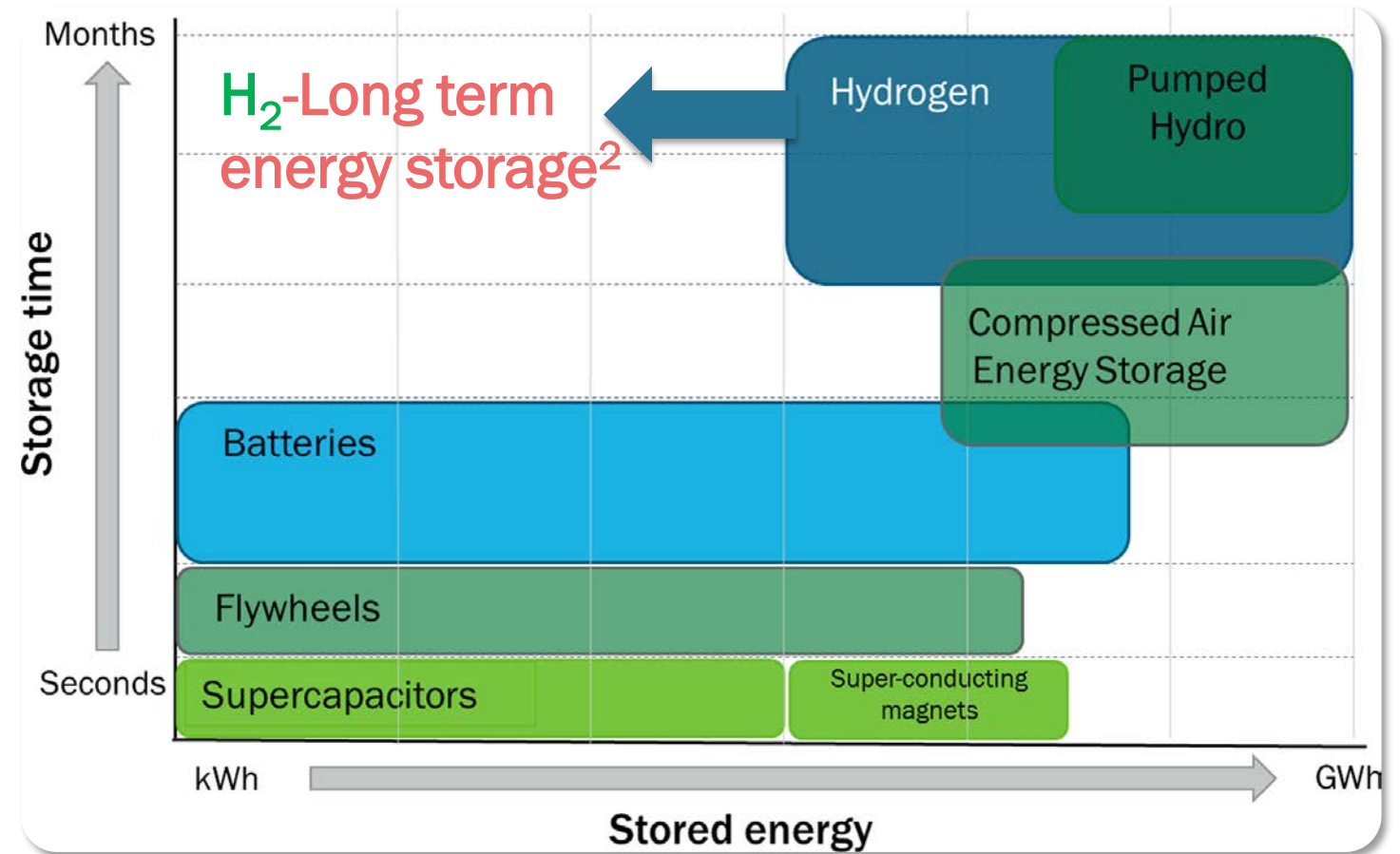
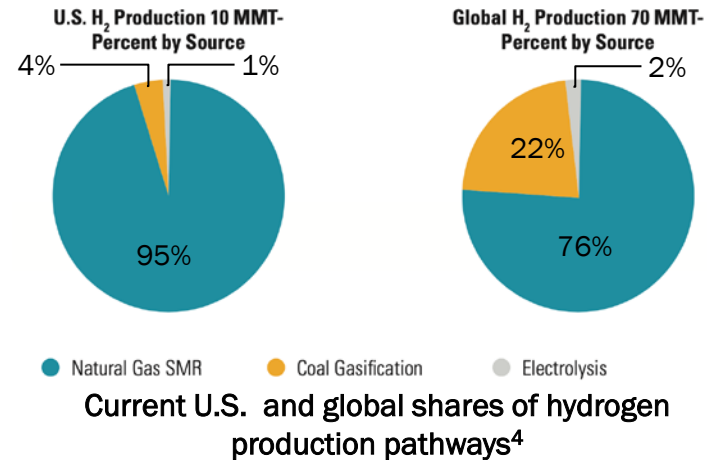


Figure 2. Hydrogen versus other energy storage options in context of amount of store energy and storage duration.<sup>2</sup>

<sup>2</sup>Wieliczko, M., & Stetson, N. (2020). Hydrogen technologies for energy storage: A perspective. MRS Energy & Sustainability, 7, E41.

# Hydrogen Production Pathways: Existing and Emerging

- Most hydrogen is produced from natural gas conversion without carbon capture (or "grey" hydrogen) and emits 9.4 kg CO<sub>2</sub>/kg H<sub>2</sub><sup>3</sup>
- Key low carbon hydrogen production pathways that are being explored include:
  - Hydrogen produced from renewable electricity via water splitting (electrolytic or "green" hydrogen)
    - Emits 0 kg CO<sub>2</sub>e/kg H<sub>2</sub><sup>3</sup>
  - Hydrogen from natural gas conversion with carbon capture (or "blue" hydrogen)
    - Emits 3.4 kg CO<sub>2</sub>e/kg H<sub>2</sub><sup>3</sup>
- Solar-powered electrolytic hydrogen may fit well in Questa, NM given its abundance of sunlight



Natural gas conversion w/o carbon capture<sup>5</sup>



## Emerging Hydrogen Production Pathways<sup>5</sup>

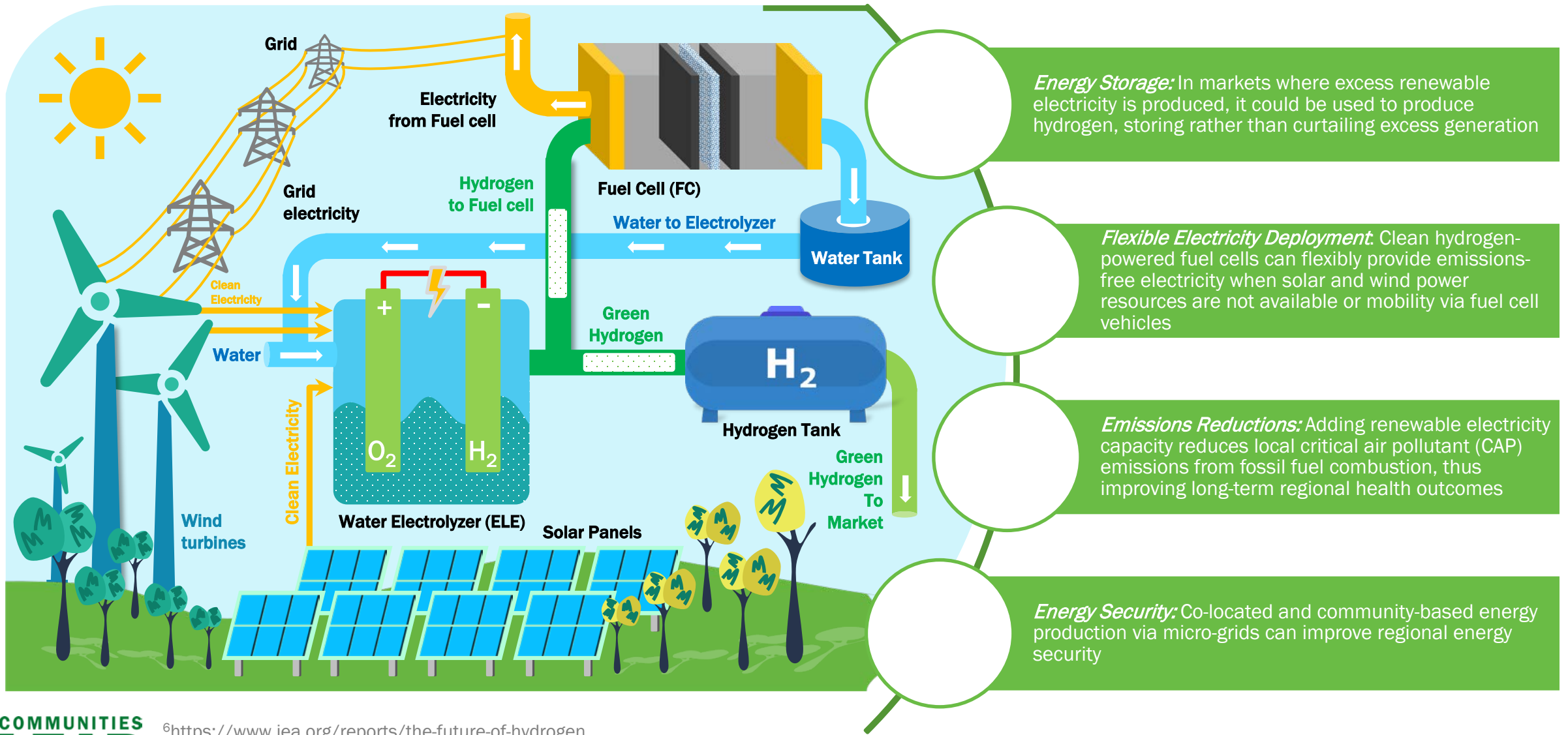
CCUS: carbon capture, utilization, and storage; SMR: steam methane reforming; ADG: anaerobic digester gas; STCH: solar thermochemical hydrogen; PEC: photoelectrochemical

<sup>3</sup>Elgowainey, A. et al. (2022) Hydrogen Life-Cycle Analysis in Support of Clean Hydrogen Production (No. ANL/ESIA-22/2). Argonne National Lab. (ANL), Lemont, IL (United States)

<sup>4</sup>Office of Fossil Energy (2020) Hydrogen Strategy: Enabling a Low-Carbon Economy. Washington, D.C. (United States)

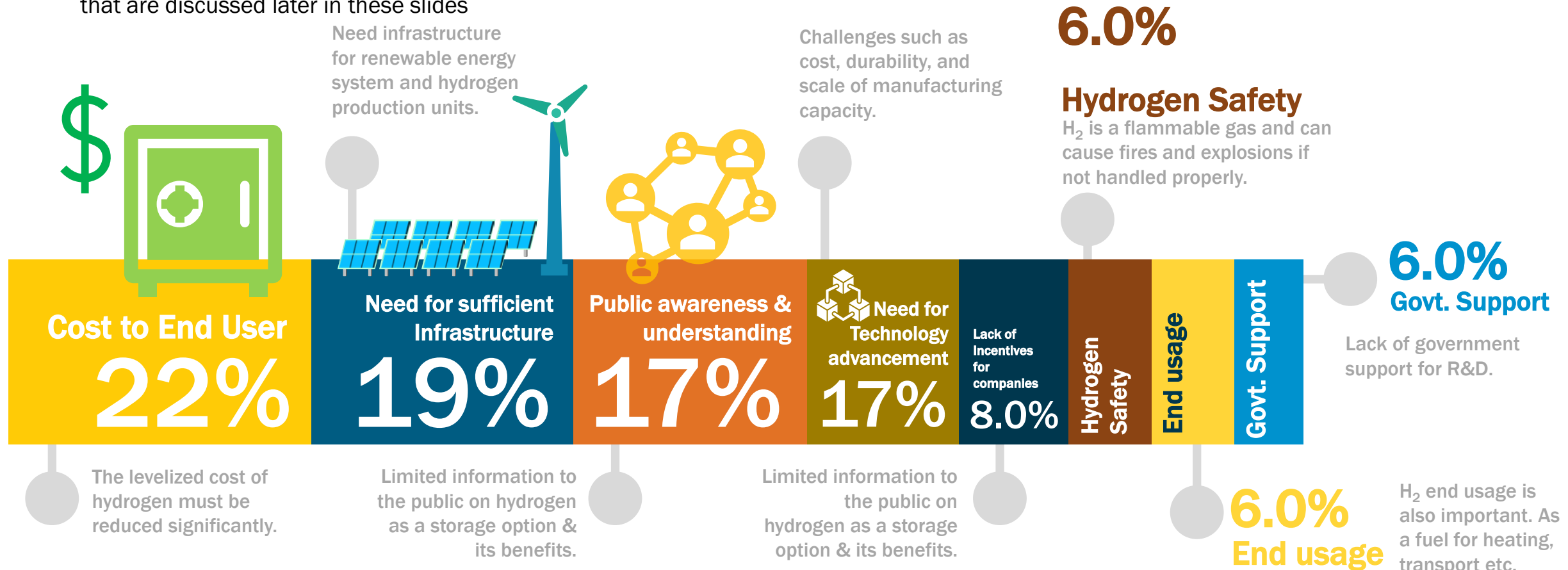
<sup>5</sup><https://www.energy.gov/eere/fuelcells/hydrogen-production>

# What are the potential benefits of clean hydrogen?



# What are the potential challenges associated with clean hydrogen?

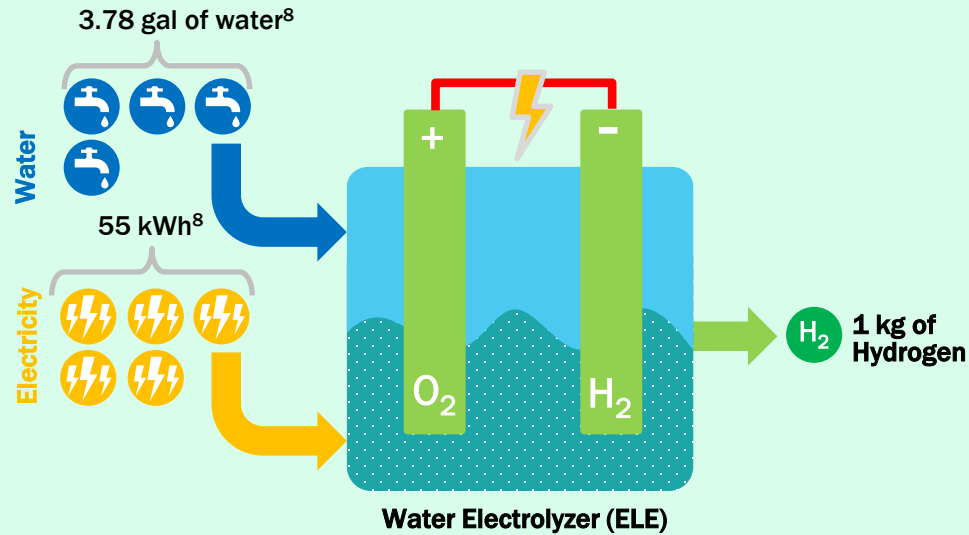
- In 2022 DOE released a National Clean Hydrogen Strategy and Roadmap <sup>7</sup> in which stakeholders identified and ranked potential barriers to widespread public acceptance and market adoption of hydrogen in the United States. These included end-user costs, current lack of hydrogen production infrastructure, lack of public awareness and understanding, and required advancements in manufacturing capacity, among others (see graphic below).
- The impact of several of these barriers (such as infrastructure, end user cost) may be mitigated by recently-passed federal and state policies that are discussed later in these slides



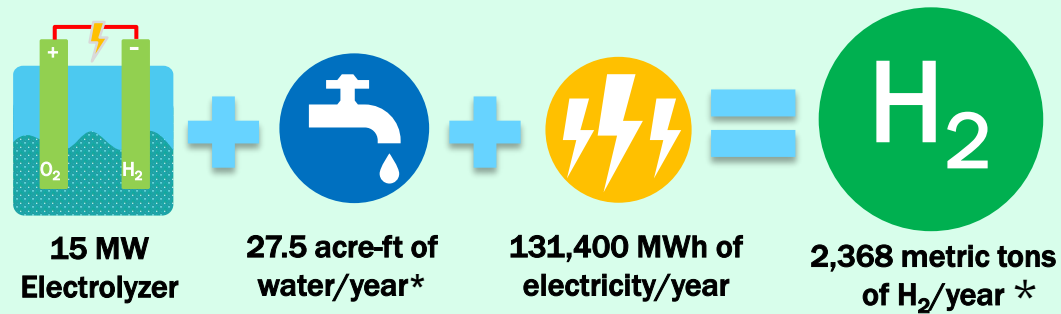
<sup>7</sup>Satyapal, S., Rustagi, N., Green, T., Melaina, M., & Mariya, K. (2022). DOE National Clean Hydrogen Strategy and Roadmap. U.S. Department of Energy.

# Basic clean hydrogen recipes

## (a) Small Scale Electrolyzer



## (b) Large Scale Electrolyzer



\*Only if the plant is operating at full capacity throughout the year.

+Assuming full H<sub>2</sub> conversion and water recovery from fuel cell exhaust.

### For General Reference

10kWh = Running AC for 2 hrs.

1 acre-ft = 1 year of water use for 2 households

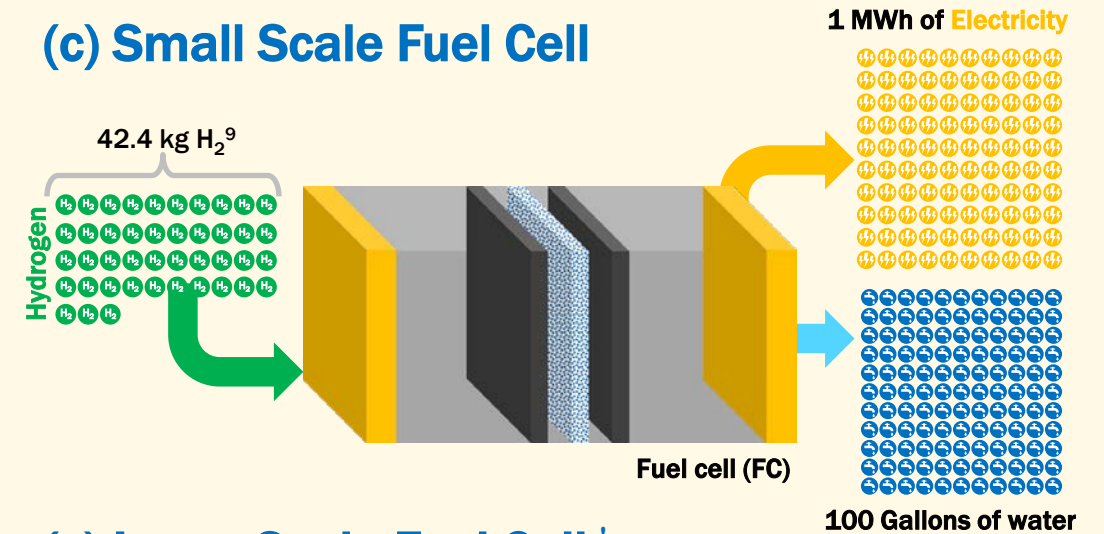
### Legend

= 1 gal

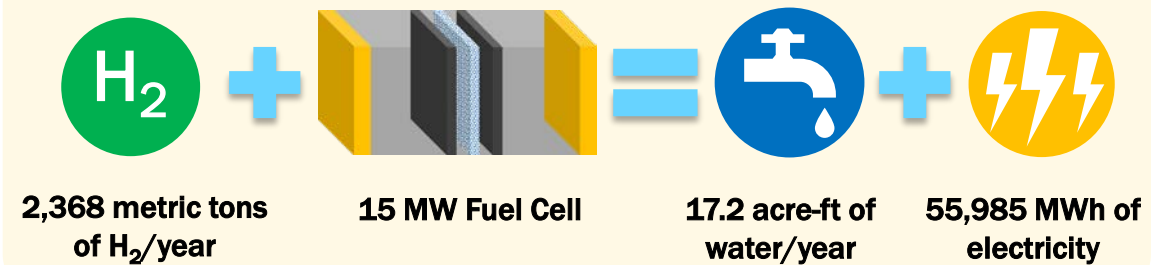
= 10 kWh

= 1 kg of H<sub>2</sub>

## (c) Small Scale Fuel Cell



## (c) Large Scale Fuel Cell<sup>+</sup>



<sup>8</sup>Penev. "H2A-Lite: Hydrogen Analysis Lite Production Model." September 2022. <https://www.nrel.gov/hydrogen/h2a-lite.html>

<sup>9</sup>DOE HFTO. "Fuel Cell Fact Sheet" November 2015.



# Exploring the benefits, opportunities, and challenges of clean hydrogen production for Questa

# Why is New Mexico incorporating hydrogen in their clean energy plans?

- New Mexico issued an executive order in 2021 to achieve 45% statewide greenhouse gas emissions reduction by 2030 relative to 2005 levels<sup>10</sup>
- This executive order was complemented by another in 2022 to establish a clean hydrogen development initiative to support clean energy goals<sup>11</sup>
- New Mexico is well positioned to serve a surge in H<sub>2</sub> demand as per the New Mexico Hydrogen Hub Roadmap<sup>12</sup>
  - Outstanding resource base for wind and solar, and in natural gas production and reserves
  - Well situated for hydrogen distribution in terms of pipelines, electrical transmission and interstate highways
  - End use opportunities in using hydrogen in long duration energy storage, freight transport and industry
  - Complementary state efforts in
    - Modernizing electrical grid
    - Retrofitting or replacing coal fired power plants
    - Reducing emissions from vehicle fleets and industry
    - Re-use of existing oil & gas infrastructure for hydrogen transport to major markets

<sup>10</sup>Executive Order 2021-003. (2021). [https://www.governor.state.nm.us/wp-content/uploads/2019/01/EO\\_2019-003.pdf](https://www.governor.state.nm.us/wp-content/uploads/2019/01/EO_2019-003.pdf)

<sup>11</sup>Executive Order 2022-013. (2022). <https://www.governor.state.nm.us/wp-content/uploads/2022/03/Executive-Order-2022-013.pdf>

<sup>12</sup>New Mexico Energy Prosperity et al. (2022). Defining and Envisioning a Clean Hydrogen Hub for New Mexico.

# Relevant Clean Hydrogen Questions for Northern New Mexico

- How much water will be needed and where will it come from?
  - Can non-freshwater be used?
  - What current uses of water might green hydrogen production replace?
    - Oil & gas production?
    - Thermal power plant cooling?
    - Mine operations?
  - Can water used for hydrogen production be reused?
    - Can electrolyzer water efficiency be improved (see Slide 16)?
    - Are some fuel cells designed for water recovery?
- How much renewable generation will be available and when?
  - Additional development of PV appears feasible
  - Will there be sufficient transmission and wind capacity to complement with wind generation?
- What are the alternatives?
  - For carbon-free electricity?
  - For carbon-free transportation?

# Possible Federal Funding Opportunities

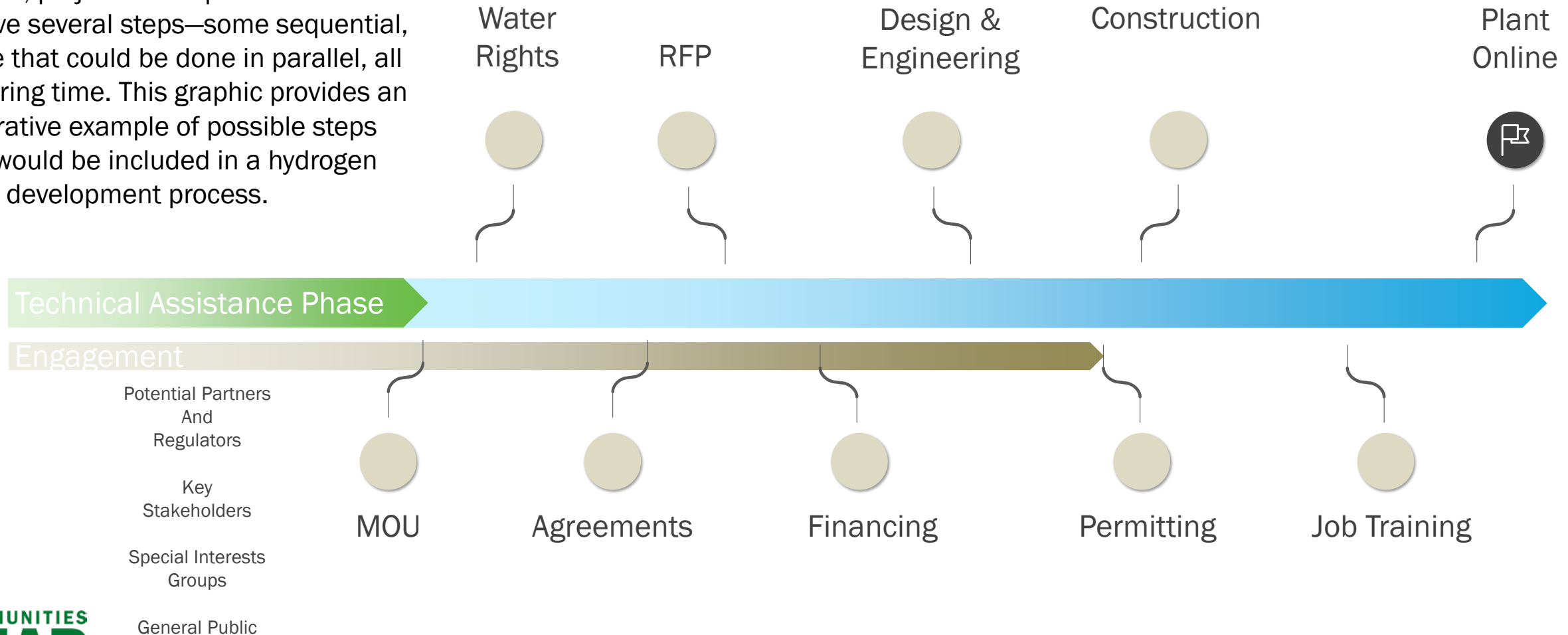
- Infrastructure Investment and Jobs Act/DOE
  - Regional Clean Hydrogen Hubs (FOA 2768)
  - Clean Energy Demonstration on Former Mines (FOA 2811)
  - Storage Demonstration (FOA 2777) (long duration)
  - Transmission Facilitation Program and Grid Upgrade for Reliability and Resilience (program)
- Inflation Reduction Act Tax Credits
  - 48 tax credit for supporting solar energy, energy storage
  - 45V tax credit for clean hydrogen
  - 48D tax credit, for electricity transmission
  - EV and FCEV Tax Credit (IRC 30D)
  - Support for reducing the carbon intensity of manufacturing
  - Support for rural clean energy development
  - Community-based support for mitigating pollution and climate impacts

# Potential State Support and Other Opportunities

- Energy, Minerals and Natural Resources Department
  - Grid Modernization and Grant Program
  - Solar Market Development Tax Credit
  - Renewable Energy Production Tax Credit
- New Mexico Environment Department
  - Rural Infrastructure Program
  - Clean Water State Revolving Fund
  - Brownfield Clean-up Revolving Loan Fund
- Economic Development Department
  - High Wage Jobs Tax Credit
  - Rural Jobs Tax Credit
  - Advanced Energy Deduction
  - Advanced Energy Tax Credit
  - Job Training Incentive Program

# What could a clean hydrogen project look like in Questa?

If the community coalition ultimately determines that a clean hydrogen project is viable and beneficial for Questa, project development will involve several steps—some sequential, some that could be done in parallel, all requiring time. This graphic provides an illustrative example of possible steps that would be included in a hydrogen plant development process.



# Considerations for Ensuring an Equitable Development Process

There are unprecedented opportunities for clean energy development through the Infrastructure Investment and Jobs Act (IIJA) and other federal, state, and local initiatives. However, reactive economic and/or energy development can result in unintended consequences. Awareness of potential pitfalls and consequences can help stakeholders mitigate them and make more proactive, strategic development decisions.

**“Without local-hiring commitments, communities can fail to gain from the economic benefits associated with additional and/or greater salaries in their neighborhoods.”**

**– U.S. Department of Energy**

## Sample Pitfalls to Avoid



<sup>14</sup><https://www.energy.gov/sites/default/files/2017/09/f36/CBA%20Resource%20Guide%20FAQs.pdf>

# Tools for Driving Local Benefits from Clean Hydrogen Development

Various mechanisms could be considered and deployed to ensure that any future clean hydrogen development or production in Questa directly benefits the local population.

These include **Community Benefits Agreements (CBAs)**, mutually beneficial strategic tools and binding agreements stipulating benefits to a community in exchange for project support. CBAs are:

- Lead and developed by the community likely to be impacted
- Rooted in equity principles and values
- Focused on the needs and priorities of under-resourced communities
- Intended to increase stakeholder and community involvement in the decision-making process

**Both developers and community members benefit when synergistic development models are employed”**

**– U.S. Department of Energy**

<sup>14</sup><https://www.energy.gov/sites/default/files/2017/09/f36/CBA%20Resource%20Guide%20FAQs.pdf>

## Sample CBA Stipulations:





# Considerations for Successful Community Benefits Agreements

- Anticipate when and how benefits flow to residents and provide actionable projects, programs, and policies
- Anticipate and mitigate potential negative impacts
- Leverage local and state mechanisms—such as requests for proposals, zoning or permitting approvals—to ensure implementation
- Transparently measure and report on performance



# Example CBA: Gordie Howe International Bridge Project - Overview

- Bridge in Windsor-Detroit area expected to open in 2024
- CBA to increase public participation, reduce impacts to nearby neighborhoods, ensure those directly impacted receive mitigation benefits, and increase local business and employment opportunities.
- Plan based in community engagement, spearheaded by Windsor-Detroit Bridge Authority (WDBA) and Bridging North America (BNA)
- Commitments in CBA:
  - employ \$250 Million (CDN) of total value of work complete during design-build phase within 100km
  - contract local businesses
  - support employment opportunities through training and apprenticeship program
  - provide for physical neighborhood improvements
- Other benefits include support of youth and small business and implemented through a network of delivery partners



<sup>15</sup><https://www.gordiehoweinternationalbridge.com/en/community-benefits-section>

# Example CBA: Gordie Howe International Bridge Project - Outcomes

- The Crossing Agreement, signed in 2012 by the Government of Canada and the State of Michigan, required the CBA.
- A six-month targeted engagement. 70 meetings were attended by over 1000 stakeholders <sup>14</sup>
- Local community group formed to oversee implementation of CBA
- As of June 2021, invested over \$1.1 million (CDN) for community investments including safety and connectivity, economic benefits, community partnerships, and neighborhood beautification
- Exceeded local workforce goal, plus 152 pre-apprentices and apprentices
- 184 local businesses provided goods and services
- A 16 member advisory group of local stakeholders oversees implementation and investment applications

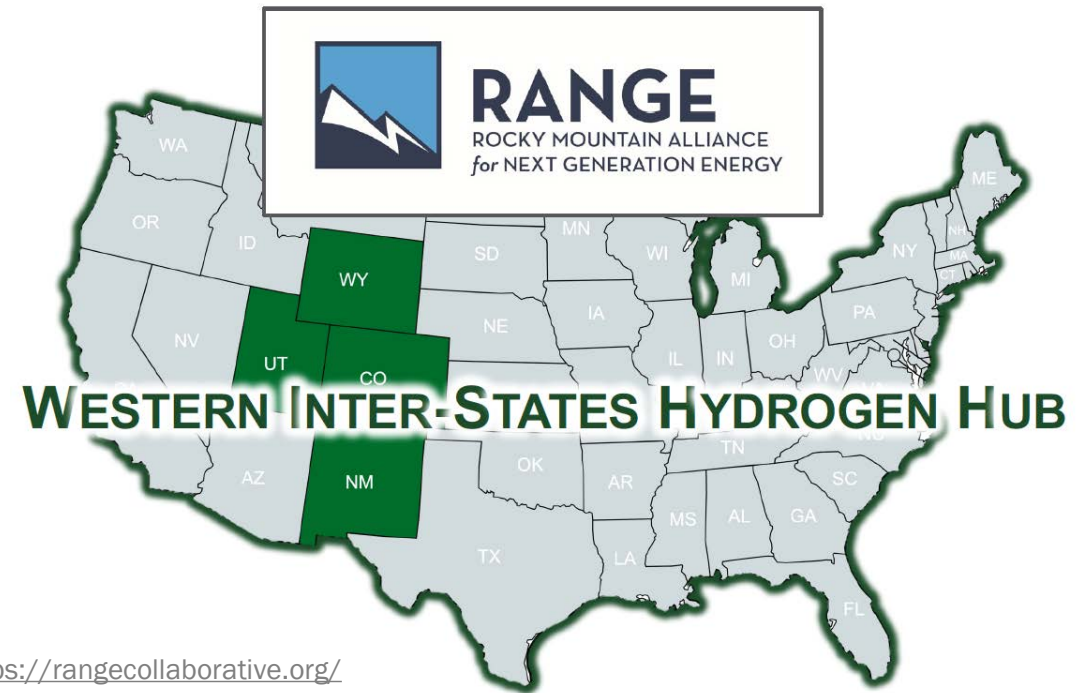


<sup>15</sup><https://www.michigan.gov/whitmer/news/press-releases/2019/06/14/community-benefits-plan-for-gordie-howe-international-bridge-project-announced>

<sup>16</sup><https://www.gordiehoweinternationalbridge.com/sites/default/files/documents/files/Community-Benefits/Quarterly-Reports/2021/Community-Benefits-Year-In-Review-2020-2021-07-26-Final.pdf>

# State and Regional Efforts to Facilitate Hydrogen Economy Partnerships

- The State of NM has prioritized clean power and transportation as sectors where hydrogen can play the greatest role in reducing or eliminating carbon emissions.<sup>12</sup>
- Community projects are being solicited to accelerate hydrogen adoption in these sectors as part of the Western Inter-states Hydrogen Hub (WISHH) proposal.<sup>17</sup>
- This will combine individual projects (e.g. Questa) with a regional strategy to balance production and end-use within the region.



# Resources

## Hydrogen

H2@Scale Report:

<https://www.nrel.gov/docs/fy21osti/78956.pdf>

H2A-Lite: Hydrogen Production Analysis Lite Model

<https://www.nrel.gov/hydrogen/h2a-lite.html>

## New Mexico's Clean Energy Plans

Executive Order 2021-003:

[https://www.governor.state.nm.us/wp-content/uploads/2019/01/EO\\_2019-003.pdf](https://www.governor.state.nm.us/wp-content/uploads/2019/01/EO_2019-003.pdf)

Executive Order 2022-013:

<https://www.governor.state.nm.us/wp-content/uploads/2022/03/Executive-Order-2022-013.pdf>

New Mexico Hydrogen Hub Roadmap:

<https://www.env.nm.gov/wp-content/uploads/2022/01/Defining-and-Envisioning-a-Clean-Hydrogen-Hub-for-NM.pdf>

## Relevant Federal and State Actions

Bipartisan Infrastructure Law Programs:

<https://www.energy.gov/bil/bipartisan-infrastructure-law-programs>

Inflation Reduction Act:

<https://www.congress.gov/bill/117th-congress/house-bill/5376/text>

New Mexico EDD Business Incentives:

<https://edd.newmexico.gov/choose-new-mexico/competitive-business-climate/incentives/>

New Mexico EMNRD Tax Incentives:

<https://www.emnrd.nm.gov/ecmd/tax-incentives/>

New Mexico EMNRD Grid Modernization Grant Program:

<https://www.emnrd.nm.gov/ecmd/grid-modernization-grant-program/>

New Mexico ED Funding Opportunities:

<https://www.env.nm.gov/funding-opportunities/#>

# Resources

## CBA and Justice 40

DOE's CBA Toolkit:

<https://www.energy.gov/diversity/community-benefit-agreement-cba-toolkit>

DOE CBA Frequently Asked Questions:

<https://www.energy.gov/sites/default/files/2017/09/f36/CBA%20Resource%20Guide%20FAQs.pdf>

DOE CBA Guide:

<https://www.energy.gov/sites/default/files/2017/09/f36/CBA%20Resource%20Guide.pdf>

DOE Guidance on Justice 40 Initiative:

<https://www.energy.gov/diversity/justice40-initiative>

Emerald Cities Justice 40 Playbook:

<https://emeraldcities.org/j40playbook/>

## Examples of CBAs in action

Example: Gordie Howe Community Benefits Plan

<https://www.gordiehoweinternationalbridge.com/en/community-benefits-section>

<https://www.gordiehoweinternationalbridge.com/sites/default/files/documents/files/Meetings/Community-Benefits-Announcement-June-2019/Community-Benefits-Public-Report-2019-06-12-FINAL-Electronic.pdf>

Example: Jobs to Move America CBA with Proterra and United Steelworkers Local 675

<https://jobstomoveamerica.org/resource/our-cba-with-electric-bus-builder-proterra/>

Example: Sibayne-Stillwater Good Neighbor Agreement

<https://northernplains.org/good-neighbor-agreement/>