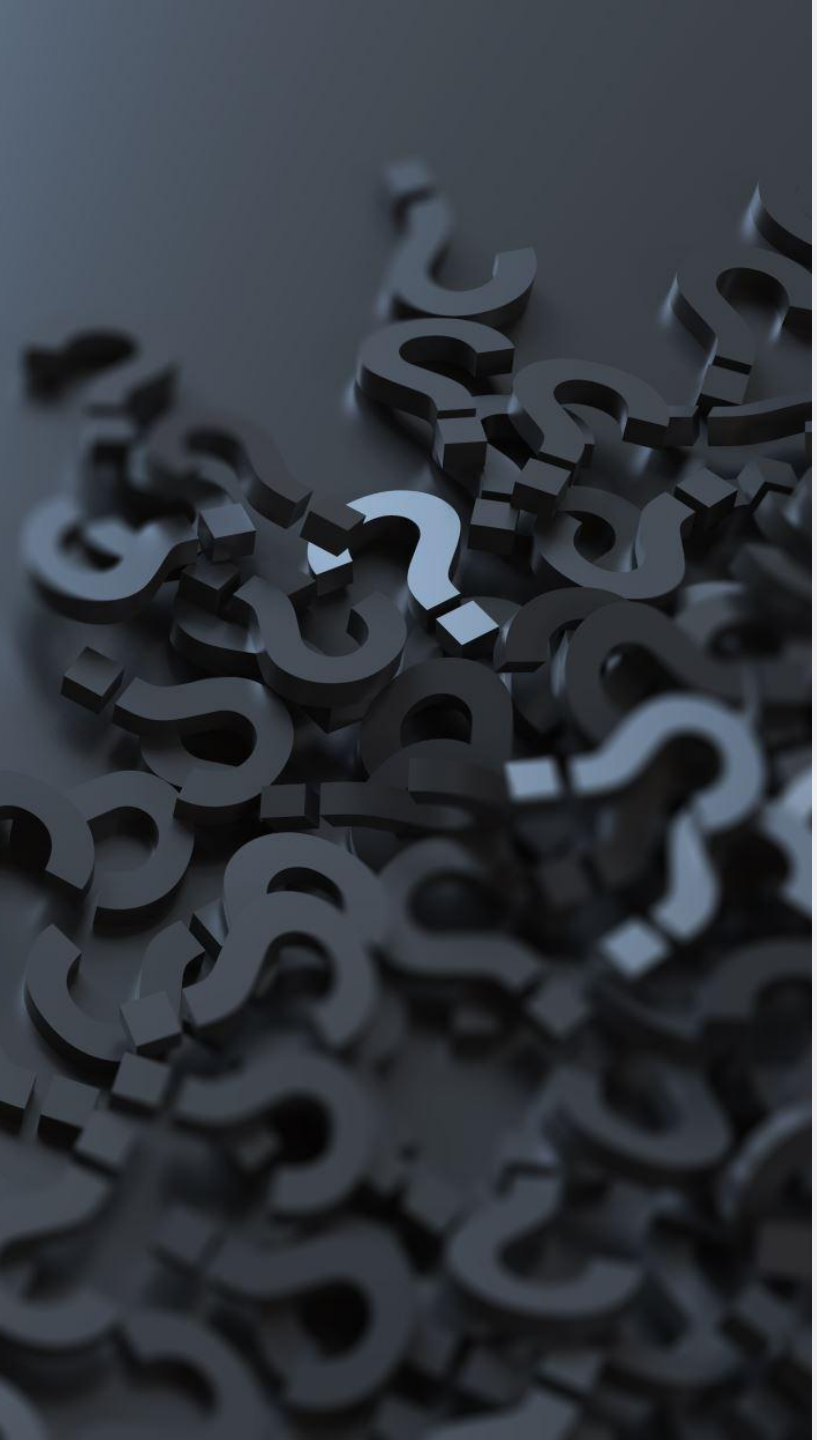
Alternative Energy: Hydrogen and Carbon Capture

Economic and Rural Development Committee

8.22.24

Mark Pedrotty & Senator William E. Sharer



Overview

- What is the PROBLEM?
- What are the SOLUTIONS?
- What is BEING DONE?
- What NEEDS to BE DONE?
- Question and Answers

The PROBLEM

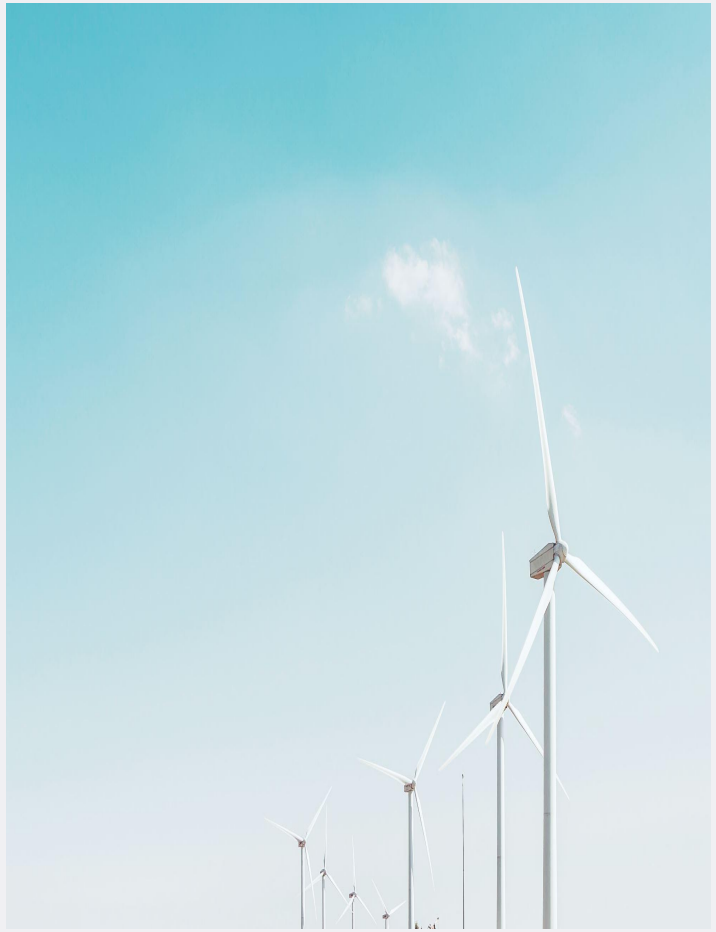
- Increasing global warming is causing significant climate change.
- There is a carbon budget that we need to stay within to prevent going past 2.7F (1.5C) global warming and catastrophic climate change. https://www.ipcc.ch/assessment-report/ar6/
- Many countries are working on reducing their use of fossil fuels (coal, natural gas, gasoline, etc.) to NET ZERO EMISSIONS by 2050 to prevent catastrophic climate change. https://www.ipcc.ch/assessment-report/ar6/
- The US is investing billions of dollars in developing alternative energy resources, including hydrogen, and technology to remove CO2 from industries difficult to decarbonize and the air.

DAC

Solutions – ALL are NEEDED

- Multiple actions are being done globally and, in the US, to combat global warming.
- Decrease use of fossil fuels in all sectors including power plants, building, transportation, and agriculture.
- Increase use of renewable energy such as solar panels, wind turbines, hydropower, battery storage, nuclear power, geothermal, and hydrogen.
- Build more efficient homes, appliances, and manufacturing processes and retrofit or renovate old buildings. Build Electric Vehicles (EV) and alternative fuel vehicles (e.g., hydrogen).
- Change behaviors to reduce CO2 emissions.
- Some industries are very difficult to do without fossil fuels, we can't replace fossil fuels fast enough with renewable energy, so it is important to catch CO2 at the source of emission and to capture the excess CO2 in the atmosphere.

NM HB 6 Clean Future Act 2022



- An act "relating to climate, enacting the clean future act; establishing greenhouse gas emissions (GHG) limits; requiring reporting, providing powers and duties; enacting new sections of the air quality control act; directing the environmental improvement board to adopt rules to reduce greenhouse gas emissions; direct the assessment of fees; creating a fund; making an appropriation"
- Section 3 A; statewide direct emission of GHG shall not exceed 50% of 2005 levels by 2030
- Section 3B total statewide GHG emissions shall achieve at least net-zero emissions by 2050, provided that total statewide direct emissions of GHG gases shall not exceed 10% of 2005 levels or any subsequent year thereafter.
- Section 4B requires an annual report on July 1 by the Energy Department and the EMRND on the state's progress toward meeting the GHG emissions limits established in section 3
- Possible resource to reduce GHG emissions: Climate Action in New Mexico – three sectors discussed in three separate briefs published by the NRDC

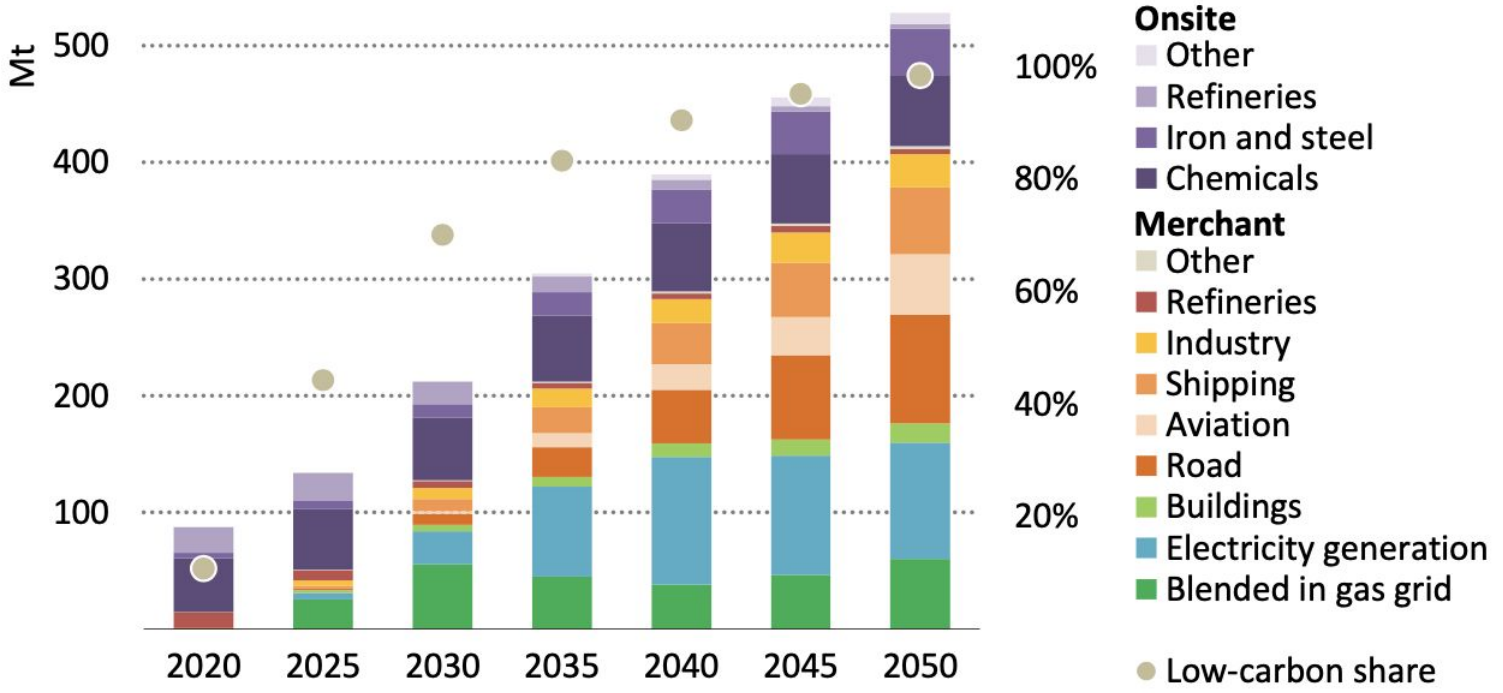
Why Hydrogen?

- Can be a stored source of energy to be used later
- Can replace coal and natural gas used in industrial processes
- We know how to safely transport hydrogen
- Can be blended into Natural Gas pipelines
- Offers an alterative when batteries are too heavy or cost-restrictive
- Can be used for transportation

Source: IEA

Potential for Hydrogen

Figure 2.19 ▷ Global hydrogen and hydrogen-based fuel use in the NZE

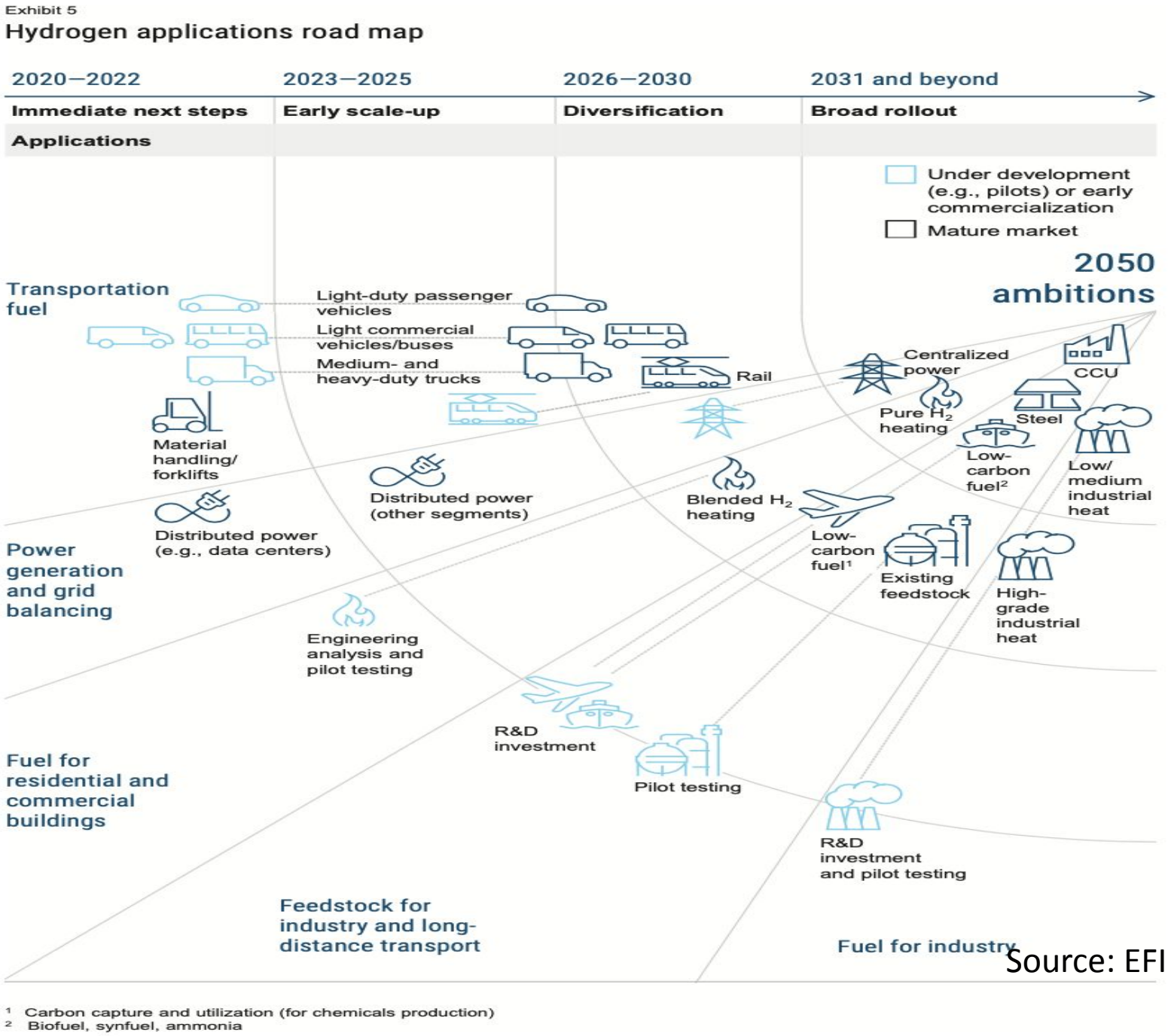


The initial focus for hydrogen is to convert existing uses to low-carbon hydrogen; hydrogen and hydrogen-based fuels then expand across all end-uses

Note: Includes hydrogen and hydrogen contained in ammonia and synthetic fuels.

Source: IEA

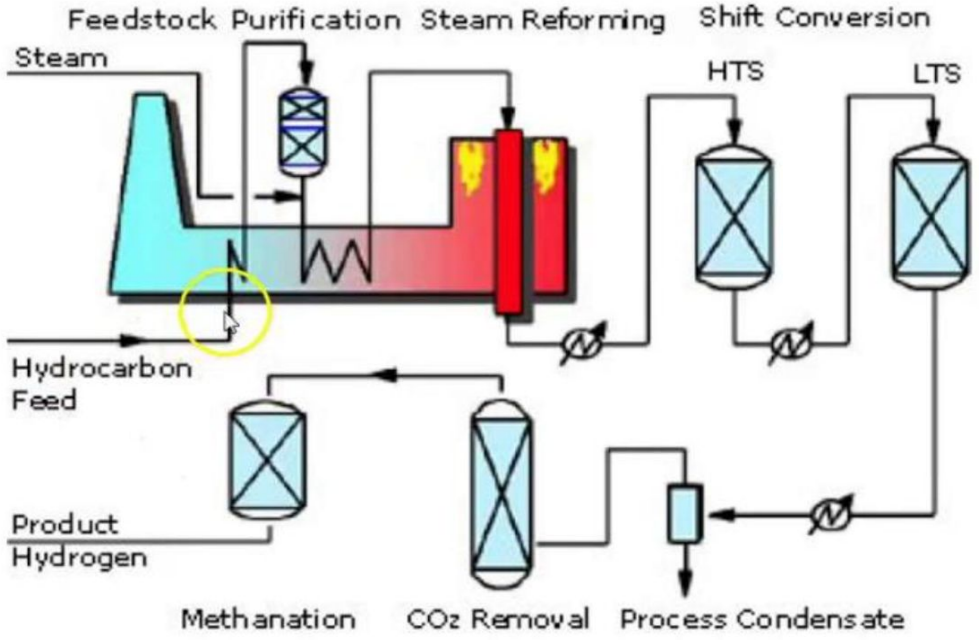
Uses of Hydrogen 2030-2050



Source: EFI

Steam Methane Reforming (SMR)

- Most hydrogen made today (about 60 million metric tons per year worldwide) is made from a process called Steam Methane Reforming, based mostly on natural gas.
- The process releases carbon dioxide from two sources:
  - Burners and boilers using fossil fuel to produce the needed steam and high temperatures in the reaction; and
  - Emissions from the chemical process that strips hydrogen from carbon molecules in the feedstock.
- This process works on biological sources of methane as well as fossil sources (e.g., digesters and landfill gas).



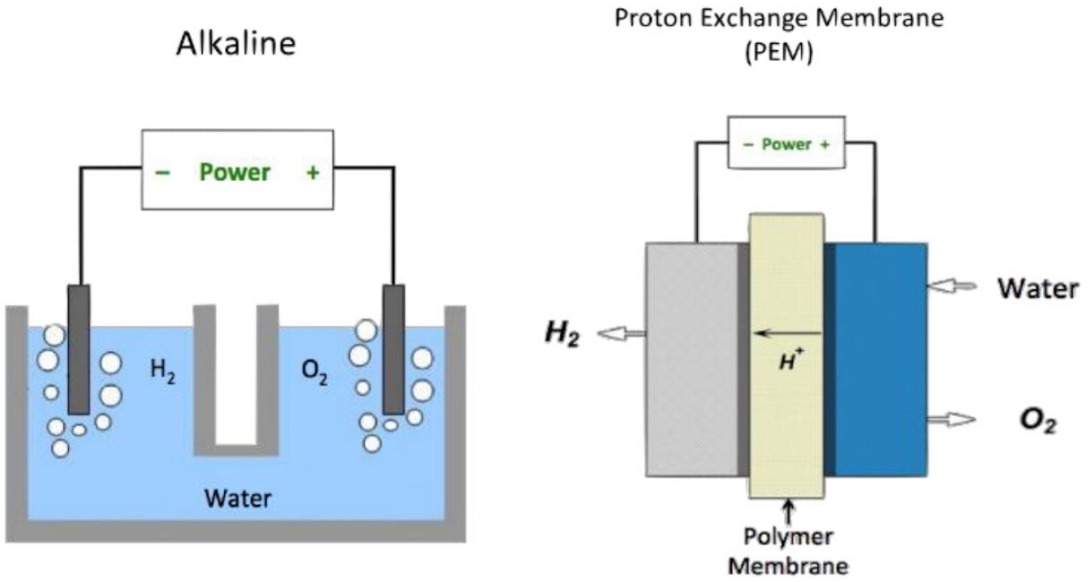
Source: Dragoon-Obsidian Renewables

Grey Hydrogen is from SMR while Blue Hydrogen adds CCS to capture the CO2

Electrolysis Green Hydrogen

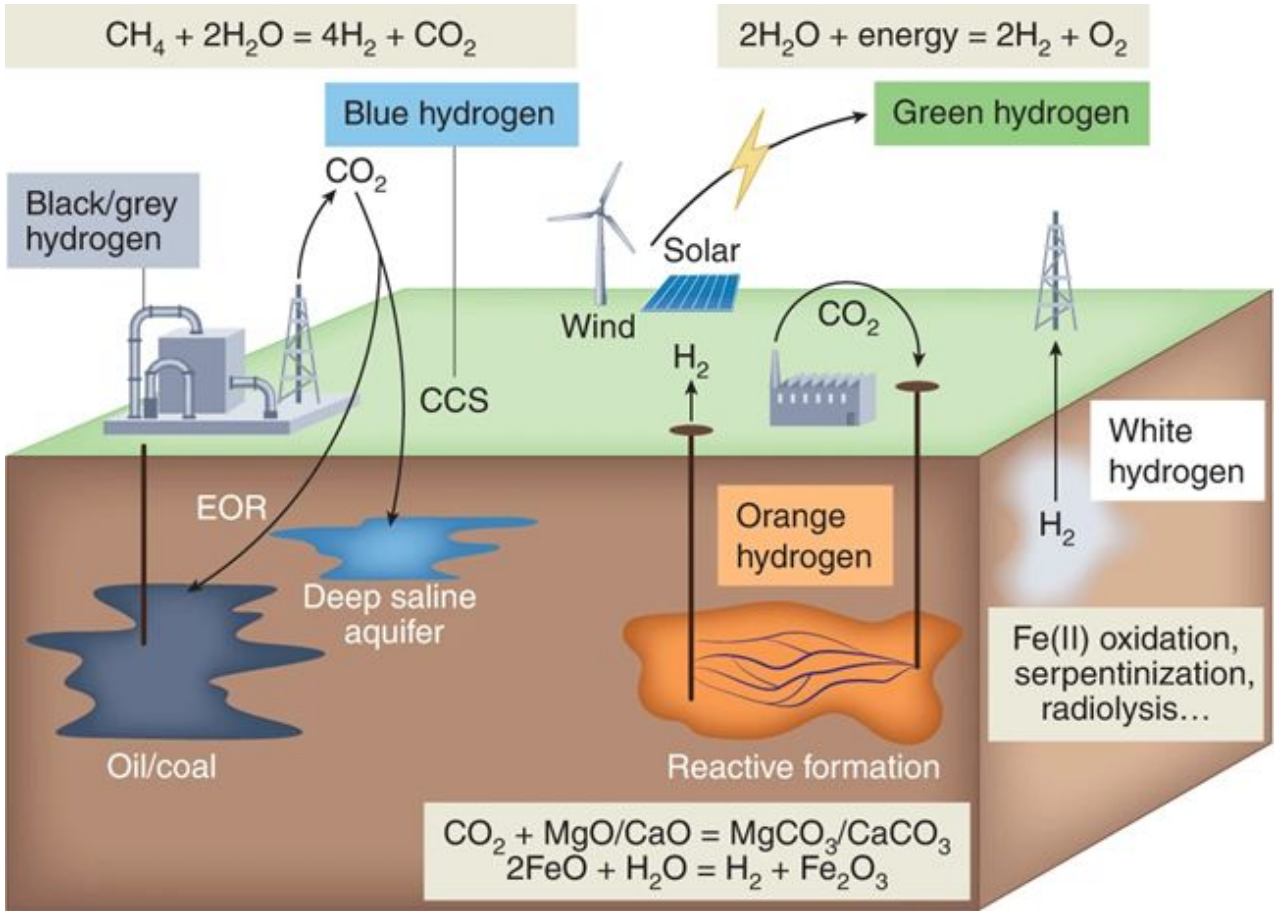
Electrolysis produces hydrogen by sending an electric current through water.

- The two most developed commercialized technologies for electrolysis are:
  - Alkaline
  - Proton Exchange Membranes
- More on these and other technologies under development later in the presentation.
- Efficiencies in the range of 60-70%, 50-57 kWh per kg of hydrogen.



Source: Dragoon-Obsidian Renewables

Five Processes to Create Hydrogen



Osselin, F., Soulaine, C., Fauguerolles, C. et al. Orange hydrogen is the new green. Nat. Geosci. 15, 765–769 (2022). https://doi.org/10.1038/s41561-022-01043-9
courtesy Dr. R. Balch, PhD NMT

What is a Hydrogen Hub?

05 GREEN HYDROGEN TECHNOLOGIES

Hydrogen has been a globally traded commodity for decades, and a robust hydrogen industry already exists. The components of hydrogen production, storage, and distribution are safe, well-understood, and commercially available today.

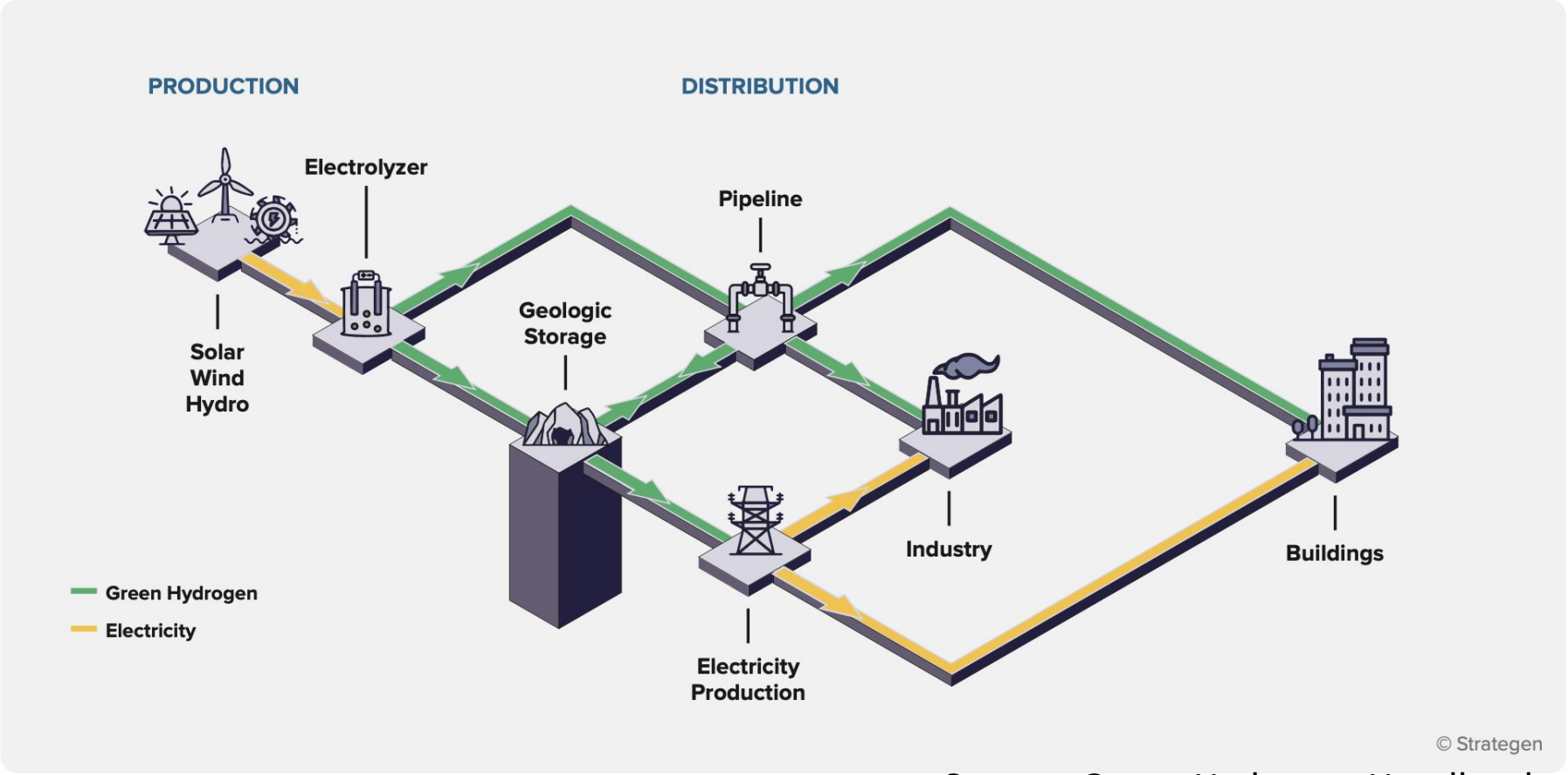
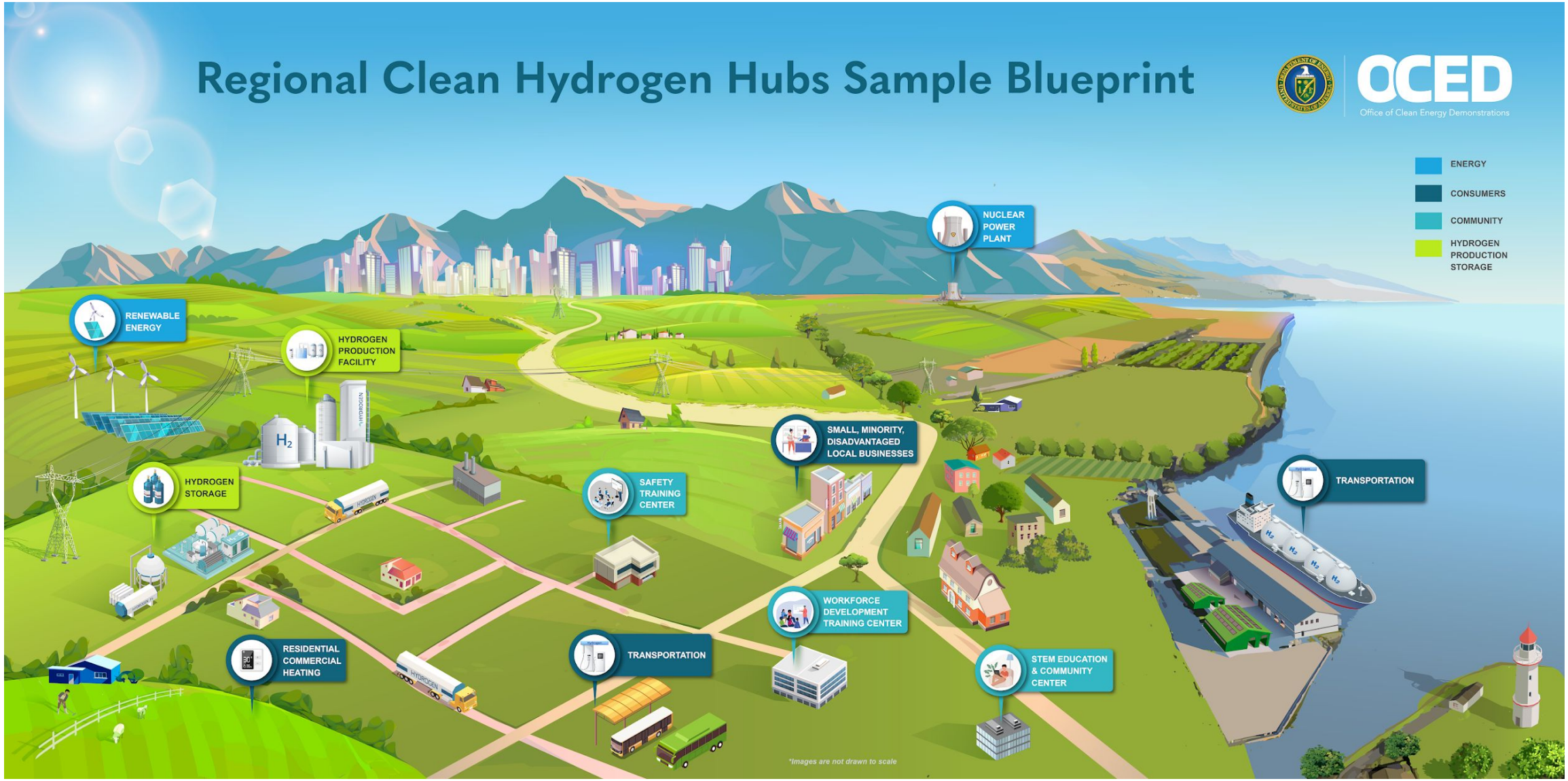


Figure 5 | Production and Distribution Pathway for Green Hydrogen – Electrolysis Example

Source: Green Hydrogen Handbook



https://www.energy.gov/oced/regional-clean-hydrogen-hubs-selections-award-negotiations

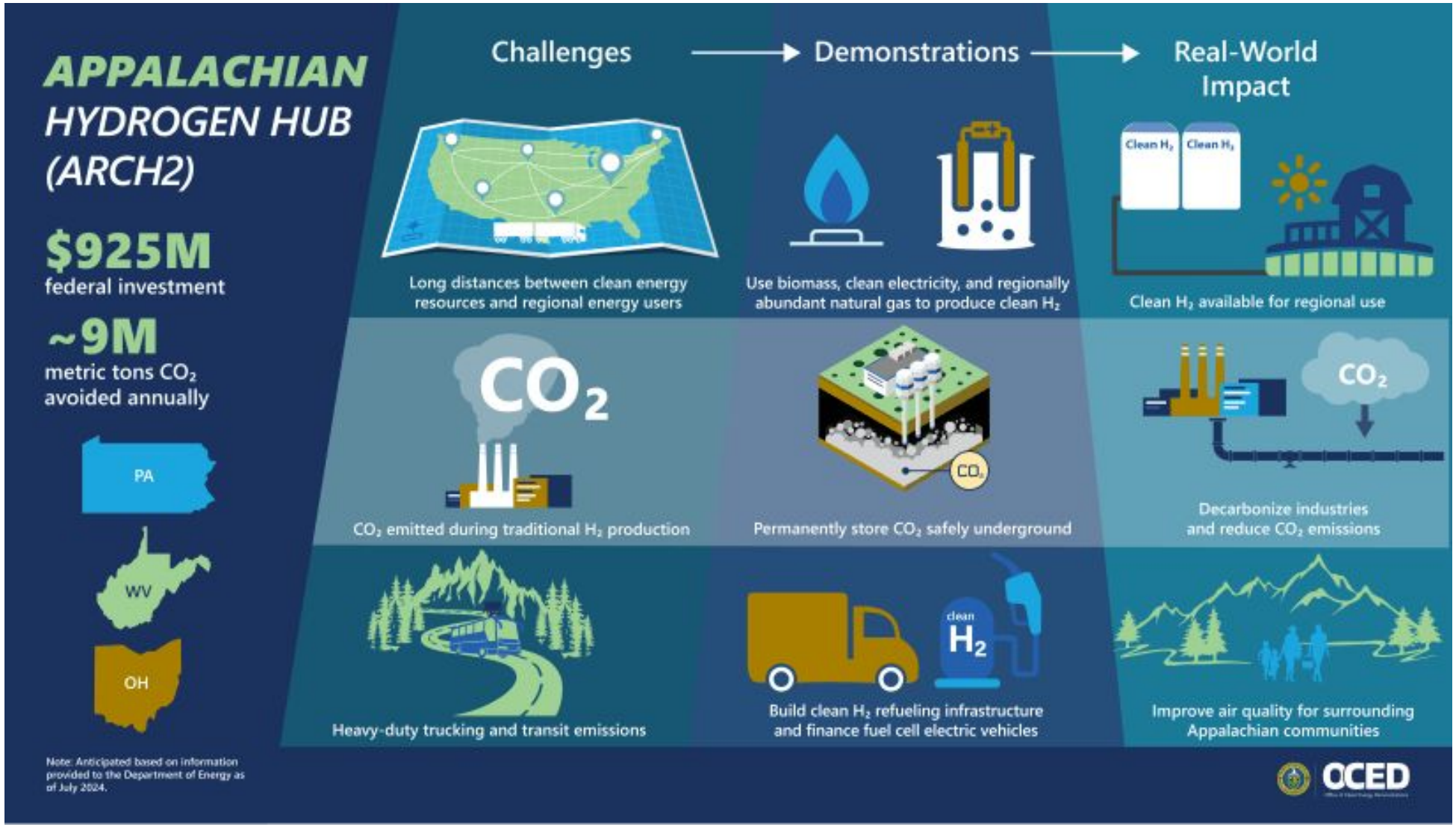
DOE 7 Hydrogen Hubs Selected

- Appalachian Hydrogen Hub
- California Hydrogen Hub
- Pacific Northwest Hydrogen Hub
- Gulf Coast Hydrogen Hub
- Heartland Hydrogen Hub
- Mid-Atlantic Hydrogen Hub
- Midwest Hydrogen Hub

- Average award is $1 Billion

- NM's application Western Interstate Hydrogen Hub (WISHH) was not selected.
- However, Tallgrass, NAPI, Avangrid, and Libertad Power Managing Partner remain committed to hydrogen in NM.*
- Hydrogen use is expected to grow sixfold from today's levels by 2050 (IEA)

- *https://www.env.nm.gov/wp-content/uploads/2023/10/2023-10-13-COMMS-Governor-New-Mexico-partners-remain-committed-to-hydrogen-hub-following-DOE-award-announcement-Final.pdf



https://www.energy.gov/oced/appalachian-hydrogen-hub-arch2

Elements of a Hydrogen Hub

- Co-location of companies interested in developing clean hydrogen supply and demand.
- Ideally near-term scalable demand with a diversity of use cases in the long term.
- Supporting infrastructure and suitable geography are also critical, including electricity transmission, multi-modal transport options, CO2 pipelines, and proximity to hydrogen and CO2 storage locations.
- Lastly, a supportive policy and regulatory environment is viewed as key, including incentives for companies to lower their emissions and the regulatory framework to enable them to do so using hydrogen.

Transition to Hydrogen

- Between now and 2050, the main ways to make clean hydrogen will likely be green and blue.
- Produce blue hydrogen in the near term to get decarbonization off to a fast start and at the same time establish a green hydrogen economy to further accelerate it.
- Blue also makes sense as a steppingstone to green because it can very quickly be produced at scale, which gives you the oomph to convert lots of consumers to hydrogen and build the hydrogen infrastructure. Then customers can switch seamlessly to green.
- By 2050, green will have the largest share, but blue will still have an important role to play (15-17%).

- Information above Courtesy of Rep M. Dixon.
- Connecticut's Department of Energy and Environmental Protection (DEEP) recently published a draft of a Clean Hydrogen Roadmap.
  https://www.dpuc.state.ct.us/DEEPEnergy.nsf/c6c6d525f7cdd1168525797d0047c5bf/12e610c93146358185258b64006f776d/$FILE/Draft%202024%20Connecticut%20Hydrogen%20Roadmap.pdf

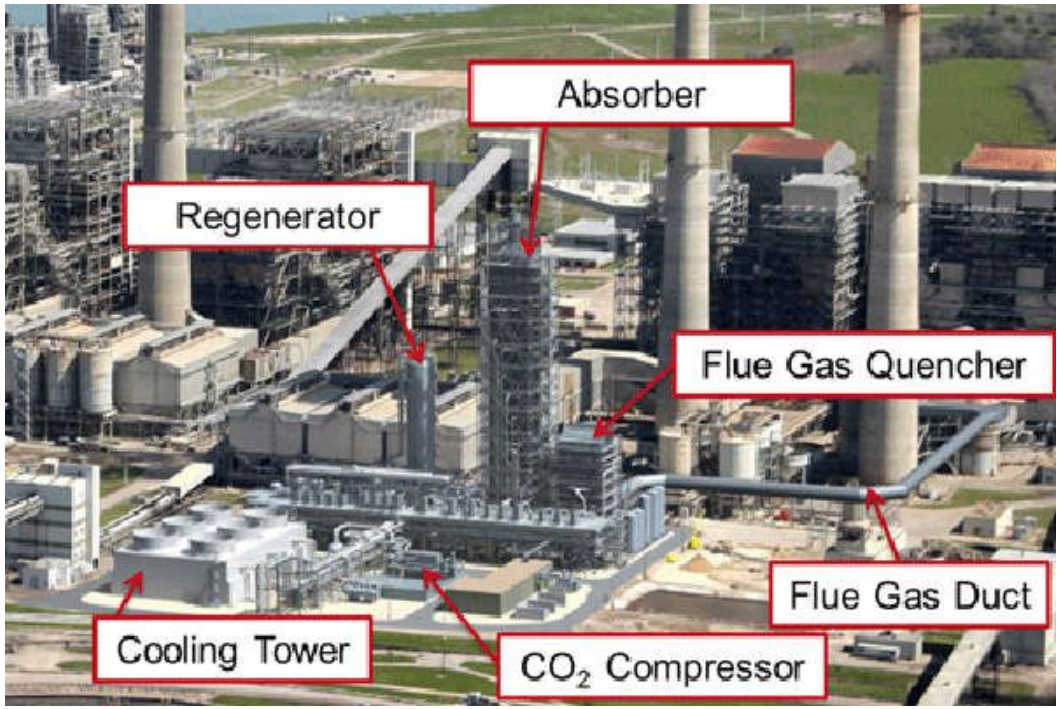
Carbon Capture

- Includes Carbon Capture and Storage (CCS), Carbon Dioxide Removal (CDR) and Carbon Capture Utilization and Storage (CCUS).
- There is funding through OCED and several DOE sources (e.g, CarbonSAFE, NETL, and FECM), to support various elements of carbon capture, storage and recycling.
- DOE NETL is working on making carbon capture affordable (e.g, $100/ton for DAC), building the carbon market, and providing at least a gigaton of CO2 storage by 2050 as part of the White House plan.
- https://netl.doe.gov/carbon-management/carbon-capture/cdr-map
- Carbon Capture Newsletter https://netl.doe.gov/advsearch?tid=130

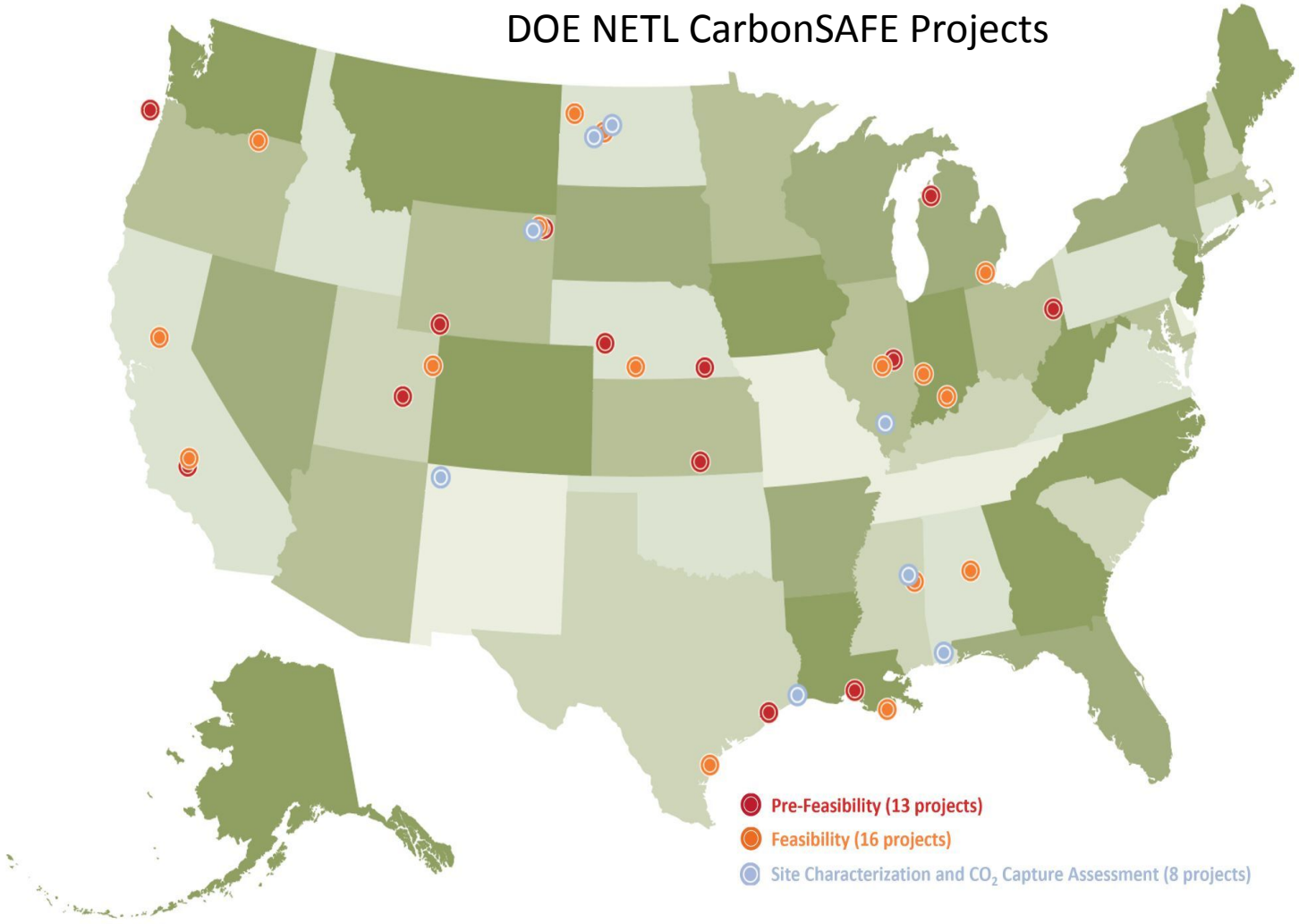
Carbon Capture: CCS (PoS)

- An essential part of stopping global warming by reducing the emission of CO2.
- Carbon Capture and Storage (CCS) captures CO2 as it is being emitted from the source, such as the power plant, where it is in a high concentration. The captured CO2 is then injected in deep saline geologic formations. It can also be injected into cement and disposed of or recycled in other ways.
- The Clear Air Act Section 111 provides carbon pollution standards for power plants to protect public health.*
- The Four Corners Power Plant plans to use CCS and the Navajo Transitional Energy Company and its partners will invest 6 -8 billion dollars into that project. 40% of the tribe's general fund comes from the mine and power plant.

*https://www.epa.gov/system/files/documents/2024-04/cps-presentation-final-rule-4-24-2024.pdf



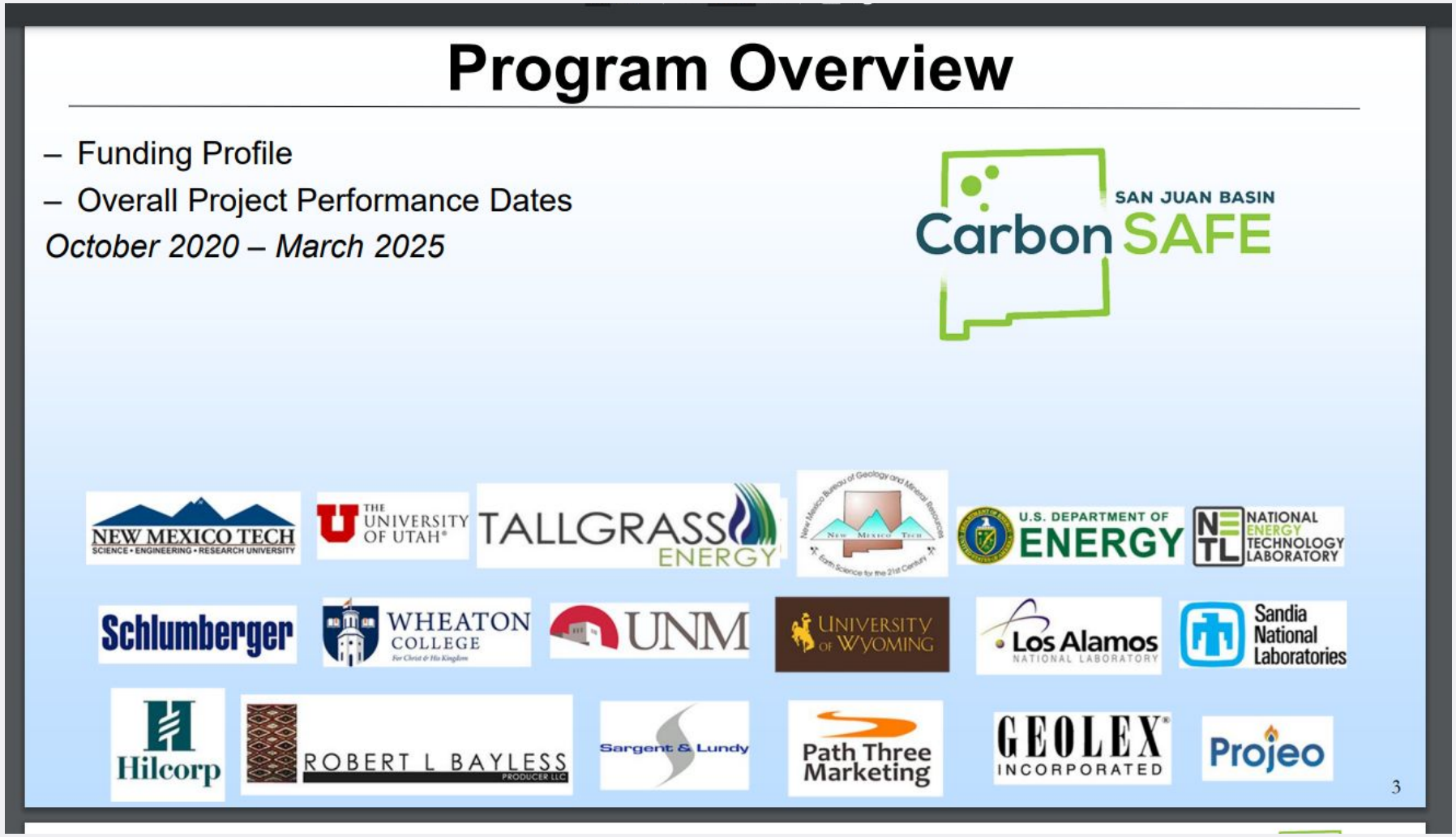
DOE NETL CarbonSAFE Projects



CarbonSAFE Initiative projects aim to permanently store hundreds of millions of tone of CO2 emissions every year. It will reduce technical risk, uncertainty, and the cost of commercial scale saline storage projects. Focus is on projects with capacities to store more than 50 million tons of CO2.
https://netl.doe.gov/node/12878

https://netl.doe.gov/carbon-management/carbon-storage/carbonsafe

San Juan Basin CarbonSAFE Phase III. DE-FE—31890, William Ampomah, PhD NMT



Slide courtesy of Dr. William Ampomah, PhD, NMT

Community Engagement

Commissioners approve carbon management agreement

New Mexico Tech will move ahead with carbon capture projects in the region

BY DAVID EDWARD ALBRIGHT
59-CITY RECORD

The San Juan County Commission on Tuesday unanimously approved a memorandum of agreement between New Mexico Tech and the San Juan County.

The agreement states that the county will provide support and engagement with the communities in the county.

William Ampomah, a research engineer from New Mexico Tech, gave a detailed slide presentation seeking cooperation from the county for its carbon capture and storage efforts.

According to the county staff summary report, the funding from the U.S. Department of Energy will be used to "accelerate the deployment of carbon capture and storage projects in the San Juan Basin in an equitable and environmentally responsible manner."

DAVID EDWARD ALBRIGHT/59-City Record

William Ampomah, a New Mexico Tech research engineer, presents a carbon management report.

It also states that New Mexico Tech will "engage a "multidisciplinary team with expertise in education, community engagement, carbon storage resource assessment, project management, monitoring, reporting and verification for CCS projects, CO2 pressure management and optimization, legal, regulatory, CO2 transportation and safety."

Ampomah, describing the geological features in the San Juan Basin, said there is a "salt-water invested formation" that will serve as the storage complex. He said there is a cap rock that will "seal that will more or less maintain the CO2 that has been injected" so that will prevent CO2 from leaking into the underground source of drinking water.

"The photic zone, euphotic zone, epipelagic zone, or sunlight zone is the uppermost layer of a body of water that receives sunlight, allowing phytoplankton to perform photosynthesis. It undergoes a series of physical, chemical, and biological processes that supply nutrients into the upper water column," according to Wikipedia.

Ampomah, emphasizing the safety considerations, said, "and that is a big deal for the EPA," he said, adding that "for us as scientists to make sure that we can store it successfully and safely."

Ampomah said they drilled an 8,800-foot-deep well in the San Juan Basin to collect more than 450 core samples and done a lot of experimental work to "support the analysis" that this area is a "strong basin to be able to store CO2."

Though not specific with amounts of funding from the U.S. Department of Energy, Ampomah said, it would allow "them to put in fiber in the well that will "record potential microseismic events that can happen as a result of injection."

It will measure temperature that will reveal movement of the CO2 and if it's coming up, he said.

New Mexico Tech plans to work on three sites to prove they can store CO2 in the San Juan Basin. They plan to store 50 million metric tons of CO2 within 10 or 15 years, he said.

Ampomah said they cannot do the project without support and must engage the community and are "mandated" to look at quality jobs and how many jobs will be created. He was unclear on how many jobs would be created when asked by the commissioners.

He said they are looking for support, including technical, from San Juan County as they plan to hire people from the area, based on "diversity, inclusion and accessibility." "Even though the budget hasn't started, I'm hiring people from the area," Amporah said. "We really want you to be engaged in this particular process."

He asked the commissioners to participate in their outreach programs and conferences and to hold them accountable.

Beckstead asked for clarification on the scale – the storage of 50 million tons of CO2 – of the project and the number of jobs that will be provided and what it would be worth to the community.

Ampomah said the first well they drilled was a $12 million project and the next two are estimated to be about $9 million each.

The San Juan County agreement

The county acknowledges the expertise and capabilities of New Mexico Tech's multidisciplinary team.

a. Support engagement with communities to implement the community benefit plan.

b. Provide training for various organizations, including universities, community colleges, and trade professionals.

c. Reevaluate and share CO2 storage resource and hazard assessment for the San Juan community.

d. Identify crosscutting opportunities for supporting the development of CO2 storage projects.

e. Offer technical assistance to both project developers and the community to ensure equitable deployment of multiple carbon storage projects in the San Juan Basin.

He said that all three projects, including a carbon transport pipeline, will create jobs in the community.

Commissioner Teri Fortner also asked about jobs, and Ampomah replied that he would have to look up the numbers, but there were 20 entities involved in the first well and that the majority of jobs are of a three-month duration during the drilling phase. He said that a number of other long-term maintenance and process control jobs are also created.

The question of water consumption was posed by commissioner Commissioner Steve Lanier. Ampomah said they work very hard to use "reused water," but he would have to cross check to get the actual number of gallons that was used on the first well project.

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Slide courtesy of Dr. William Ampomah, PhD, NMT

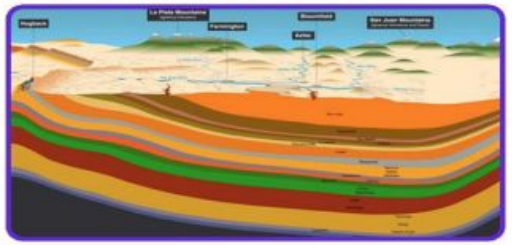
Project Facts Sheet

San Juan CarbonSAFE III

Site Characterization and Permitting

ABOUT THE PROJECT

The San Juan Basin CarbonSAFE Phase III project, led by the New Mexico Institute of Mining and Technology, aims to facilitate the safe subsurface storage of CO_2 in saline reservoirs as part of carbon capture and storage (CCS) efforts. By conducting comprehensive commercial-scale site characterization in northwest New Mexico, the project seeks to accelerate the deployment of integrated CCS technology at the San Juan Generating Station, a significant coal-fired electricity generation plant in the region.



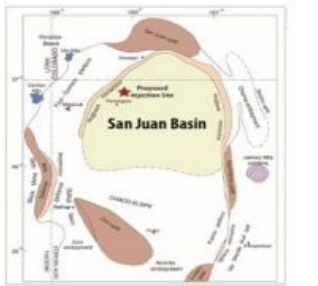
Project Objectives

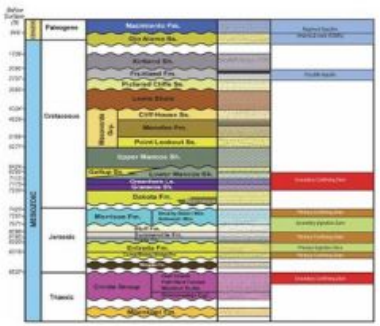
Site Characterization
Conducting thorough investigations to understand the geological conditions of the storage complex in northwest New Mexico. This involves assessing the suitability of saline reservoirs for CO_2 storage and identifying potential risks and challenges associated with the process.

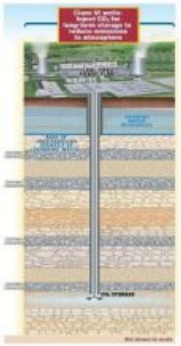
Regulatory Compliance
Preparing, submitting, and attaining a Class VI permit from the Environmental Protection Agency (EPA) for the construction of CO_2 injection wells. This regulatory approval is crucial for ensuring compliance with environmental standards and guidelines for geologic sequestration.

Carbon Capture and Storage
Capturing approximately 6 to 7 million metric tons of CO_2 per year from the San Juan Generating Station, with a portion of it (2 million metric tons per year) being stored at a site located around 20 miles away. The remainder will be sent to the Cortez pipeline for enhanced oil recovery (EOR) usage in the Permian Basin.

Technology Evaluation
Studying CO_2 capture technologies, particularly Mitsubishi Heavy Industry's KM CDR Process, to assess their feasibility and effectiveness in the context of the project. This involves evaluating the efficiency of these technologies in capturing CO_2 emissions from the power plant.







Overall, the project represents a significant step towards addressing climate change by reducing greenhouse gas emissions from coal-fired power plants through the implementation of CCS technology. It underscores the importance of interdisciplinary collaboration, regulatory compliance, and technological innovation in achieving carbon neutrality and mitigating the impacts of climate change.

Connect with us on http://www.prrc.nmt.edu

Slide courtesy of Dr. William Ampomah, PhD NMT

Carbon Capture: Carbon Dioxide Removal (CDR)

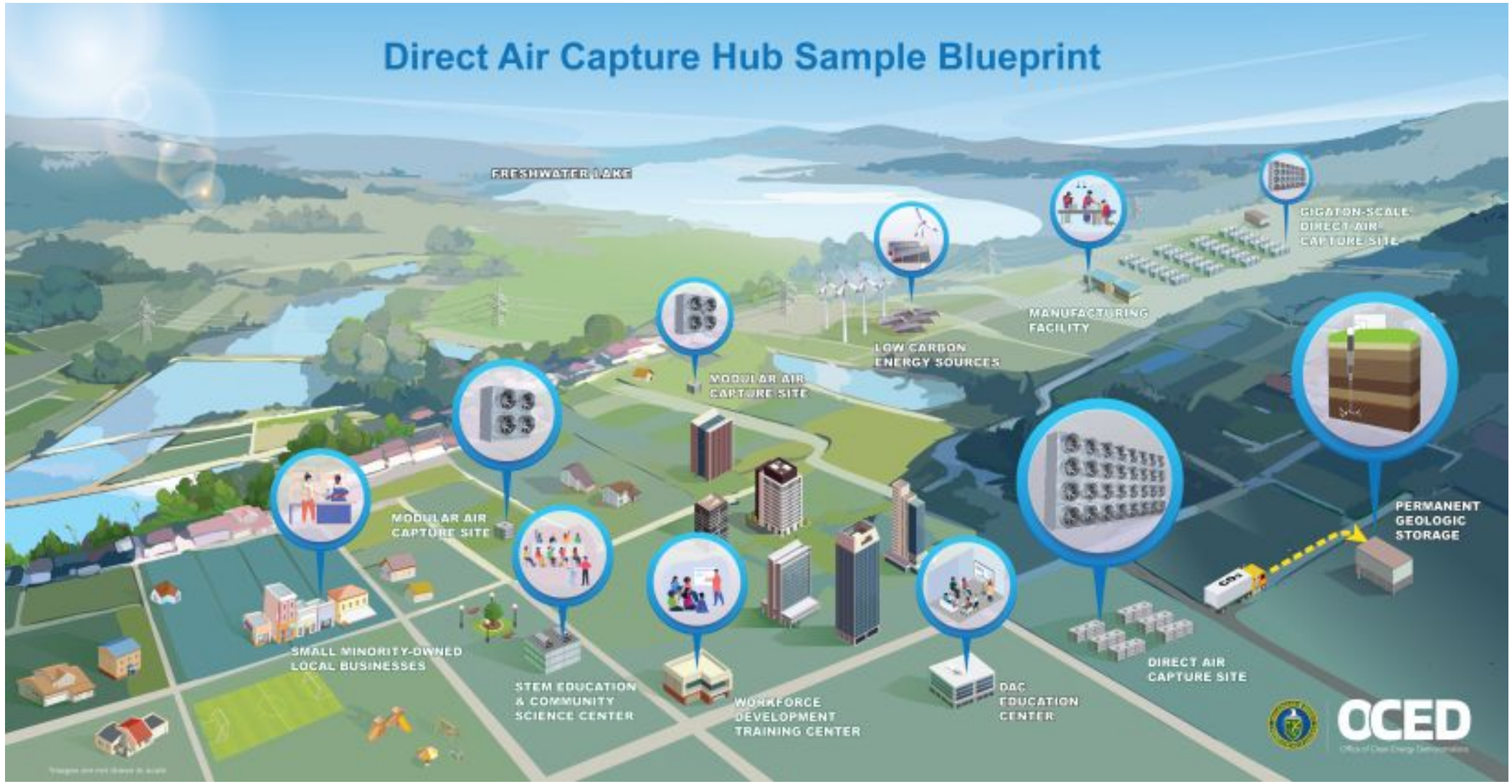
- Essential piece of the plan to limit global warming.
- Removes CO2 from the atmosphere.
- Several different technologies available: liquid solvent, solid sorbent, passive vs active, bipolar membrane electrodialysis, mineralization, weatherization, biochar, etc.
- Several companies are at commercialization level: Climeworks, Carbon Capture, Heirloom, 1pointfive, etc.
- Direct-air-capture (DAC) is a term used for some CDR.

Heirloom

Carbon Collect

Spiritus

Carbon Capture



https://www.energy.gov/oced/DACHubs

DOE DAC Hub Selections* and DAC Projects

- Project Cypress (LA) – Climeworks and Heirloom Carbon Technologies
- South Texas DAC Hub (TX) Occidental (1pointfive, Carbon Engineering), 1Mtons/annually injected into saline geologic CO2 storage site.

Artist rendering of STRATOS in TX

- SW DAC Hub (AZ, NM, UT) Carbon Collect (passive DAC), NMT is involved with locating the Class VI wells.

- *https://www.energy.gov/oced/regional-direct-air-capture-hubs-selected-and-awarded-projects

Coordinating Construction of Class VI Wells and Carbon Capture Plants is Essential

- Time = Money
- It takes 4-6 years to identify, characterize, drill, permit and make operational a Class VI well. It is crucial to safely increase the speed to do this. Home primacy will help speed up the process.
- It takes 3-5 years to complete a FEED study, build and make operational a DAC plant. It is crucial to safely increase the speed to do this. Engaging with communities early on will help speed up the process.
- If pipelines are needed it is important to safely permit and build these as quickly as possible.
- To minimize risk and cost and maximize investment and start up time it is essential to coordinate these two processes so that they are ready, as much as possible, at the same time.

What has NM Done to Date?

- Applied for Hydrogen Hub- see handout
- Applied for DAC Hub
- CUSP – Carbon Utilization and Storage Partnership of the Western States at NMT
- CarbonSAFE – see handout
- Research into renewable energies, battery storage, and carbon capture at SNL and NANL.
- Submit legislation to develop hydrogen and pore space
- Commit to net zero emissions by 2050
- Ebon Solar $942 million investment to build solar panels in NM
- Other

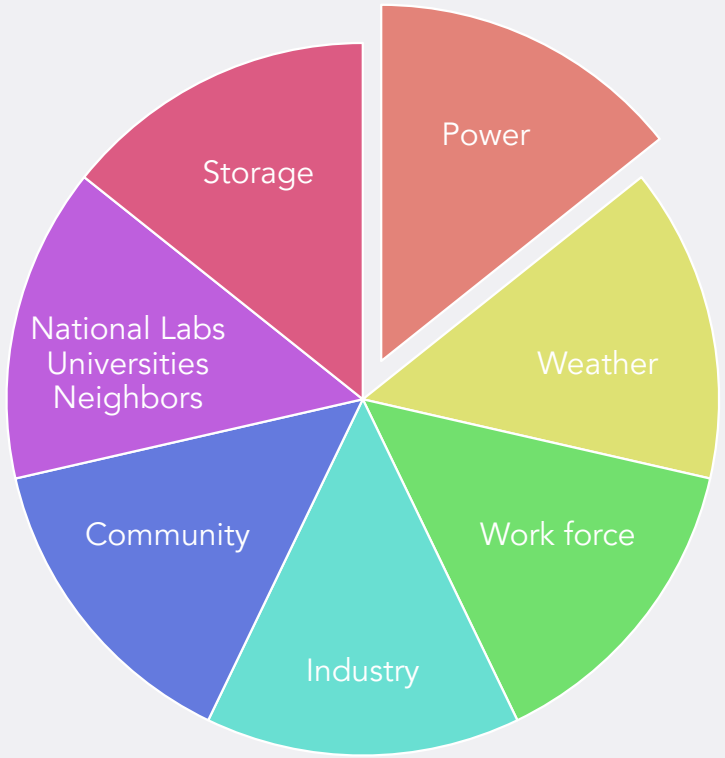
What Other States Are Doing

- Louisiana has home primacy for Class VI wells, is developing a DAC hub with DOE funding, is developing the workforce to build and operate the DAC hub
- North Dakota has home primacy for Class VI wells, has Class VI wells drilled, and is open for business
- Wyoming has applied for home primacy for Class VI wells, is developing a DAC hub, including 5 million tons of DAC beginning in 2030 using Carbon Capture technology at Project Bison (https://cowboystatedaily.com/2024/03/14/80m-raised-to-build-worlds-largest-direct-air-co2-scrubber-in-southwest-wyoming/).
- California is developing DAC hubs
- Arizona is the lead investigator in the Southwest DAC hub with DOE funding, invests in research and design in DAC including carbon collect, which is the DAC technology that will be located in NM, UT, and AZ
- Texas is developing a DAC Hub with DOE funding, Occidental Petroleum (1point five) is building two 500,000 DAC plants and will sequester CO2 deep underground.
- There are many other DAC hubs being proposed through DOE NETL funding.

Economic Development

- Hydrogen and Carbon Capture provide excellent jobs to build, maintain, and operate the plants. The Boilermakers Union supports these industries, and NM has invested in apprenticeship programs.
- NM already has an existing workforce that can easily transition to these industries.
- These industries are an excellent opportunity to transfer from fossil fuels and capitalize on our resources.
- Economic studies are needed to provide specific information for the economic benefits of each project that is proposed. Can review CT DEEP Hydrogen Roadmap.
- There are a variety of funding sources to support the development of these industries and markets.
- Important to work on decreasing the risk of investment in Class VI wells and Carbon Capture technologies.

Economic Development

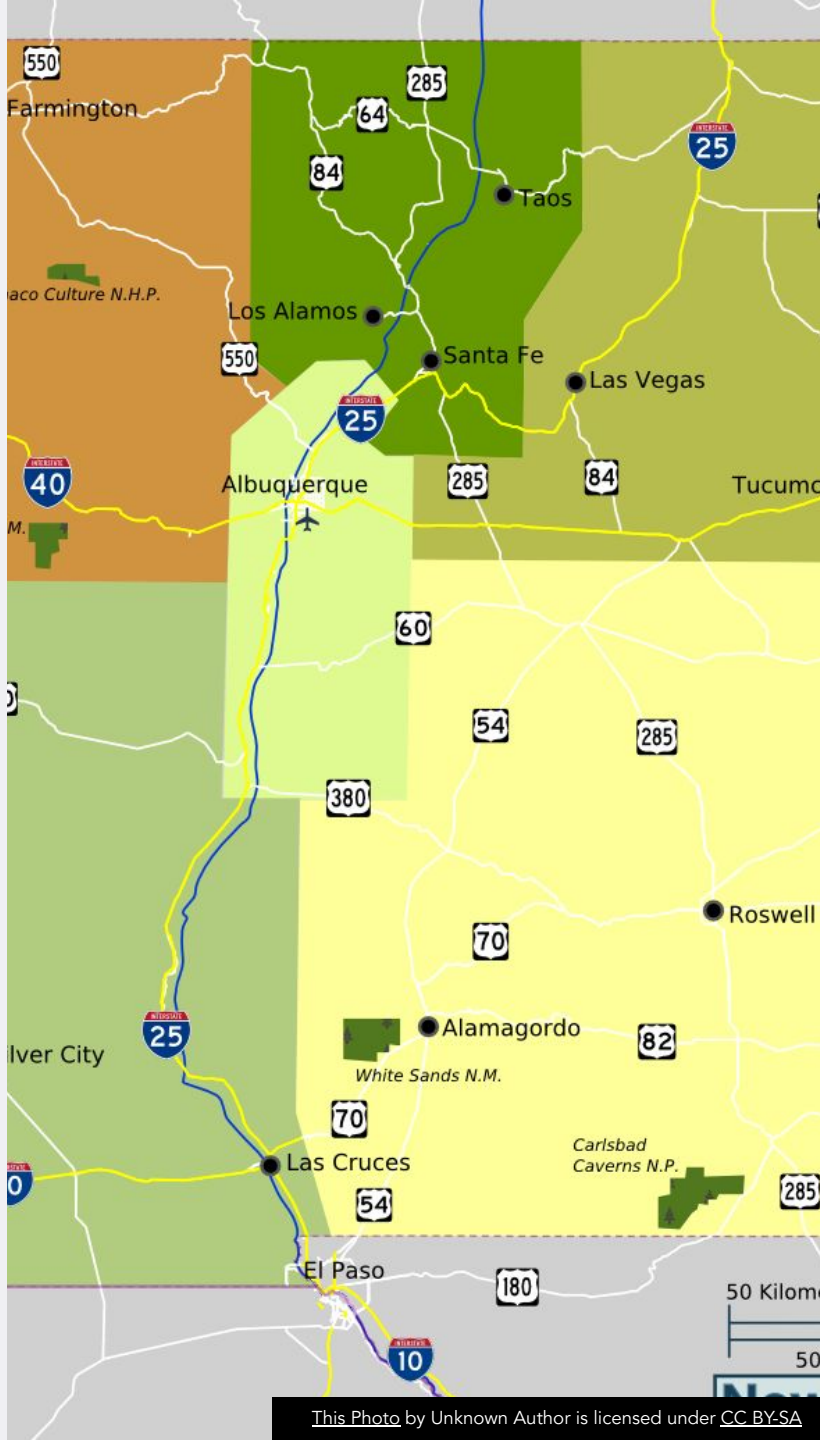


What is Needed

- To continue to invest in workforce development.
- To continue to support obtaining home primacy for Class VI wells.
- To continue to collaborate with the national labs, neighboring states, tribal nations, universities, the federal government, and private industry.
- To continue to develop plans with communities on the benefits of developing hydrogen and carbon capture and addressing environmental justice issues.
- To develop regulations for pore space rights and liabilities.
- To develop necessary and appropriate infrastructure, rules, and incentives in partnership with communities, neighboring states, tribal nations, and private industry to safely and quickly develop these industries.
- To safely SPEED UP these activities to limited global warming as much as possible.

Summary

- CO_2 and CO_2e emissions need to be drastically reduced quickly to avoid excessive global warming and catastrophic climate change.
- New Mexico has excellent resources to safely develop hydrogen and carbon capture and be a leader in these growing industries to get more good jobs and increase tax revenue.
- New Mexico is already developing these industries with the help of our two national labs, New Mexico Tech and other universities and partnerships with tribal nations and private companies.
- New Mexico needs to continue to develop the infrastructure and process to support these industries as quickly and collaboratively as possible.
- Hydrogen and Carbon Capture will be multi billion-dollar industries that provide good jobs.
- NM can learn from its neighbors who are already invested in developing these industries.



Thank You for Your Attention. Questions & Answers

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- Contact:
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