Center for Energy Regulation & Policy Analysis,
School of Energy Resources

WYOMING HYDROGEN

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ABOUT THE SCHOOL OF ENERGY RESOURCES (SER)

SER collaborates with stakeholders at the state, national and international levels to advance energy technologies and policies to grow and support Wyoming's robust energy sector. SER's mission is to promote energy-driven economic development for the state, and it leads the University of Wyoming's talent and resources for interdisciplinary research and outreach, fulfilling Wyoming's promise to be a global leader in a thriving and sustainable energy future.

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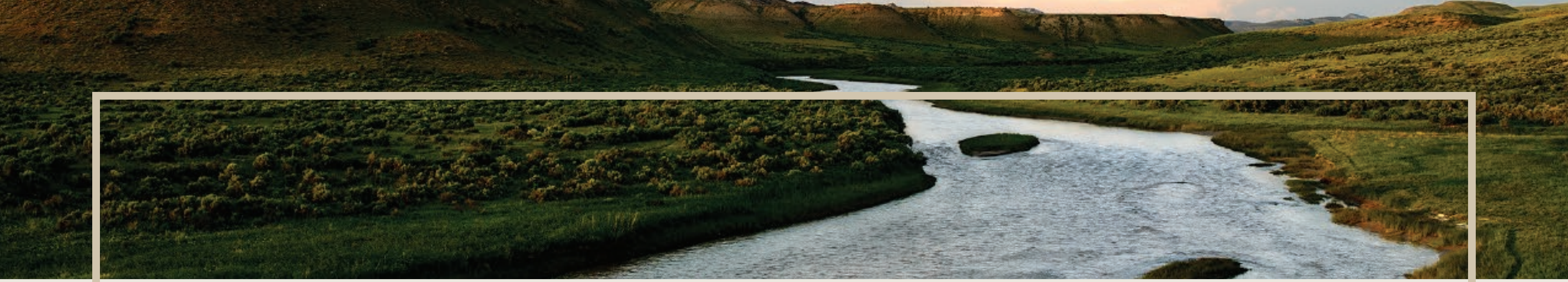


INTRODUCTION

Wyoming's use of its diverse energy resources and development expertise has made the State an energy leader. The State produces 12 times more energy than it consumes.[1] From the production of traditional energy sources such as oil, natural gas and coal to investments in emerging technologies such as nuclear energy and carbon capture, utilization and storage, the State continues to reinforce its role as the third-biggest net energy supplier in the United States. [2]

Evolving and ever-changing energy markets illustrate the need to stay engaged and continue innovating in order to remain a leader in the energy realm. Wyoming has recently been working to add nuclear power generation to its energy portfolio, and hydrogen production could be another prosperous addition.

Hydrogen is a colorless, odorless, tasteless, flammable gas.[3] To be produced, hydrogen typically relies on the use of other energy resources, such as natural gas and coal, to be separated from other compounds in order to be stored, transported, and used for a myriad of purposes, including energy. Production of hydrogen would allow the State to build upon existing energy sources in the development of a hydrogen economy.

Currently, the main industrial application of hydrogen is in ammonia production, which accounts for about two-thirds of the world's hydrogen consumption. It is also used for refining petroleum, producing fertilizer and explosives, treating metals, and processing foods. Hydrogen is additionally being considered for powering large vehicles and as an energy provider for electricity, including for artificial intelligence (AI) data centers.[4]

Global demand for hydrogen is "projected to rise from the current 97 million mt/year, which is primarily used in the industrial sector, to 119 million mt/year in 2030 and 265 million mt/year in 2050, according to S&P Global data" (Figure 1).[5]

[1] *Wyoming end-use energy consumption 2022, estimates,* U.S. Energy Information Administration (EIA) (June 20, 2024), United States - U.S. Energy Information Administration (EIA).

[2] *Ibid.*

[3] William Lee Jolly, Hydrogen chemical element, BRITANNICA (Jul. 8, 2025), https://www.britannica.com/science/hydrogen.

[4] *Diversified Energy, FuelCell Energy, and TESIAC collaborate to form an acquisition and development company to leverage coal mine methane and natural gas for off-grid data center power projects,* OIL & GAS 360° (Mar. 10, 2025), https://www.oilandgas360.com/diversified-energy-fuelcell-energy-and-tesiac-collaborate-to-form-an-acquisition-and-development-company-to-leverage-coal-mine-methane-and-natural-gas-for-off-grid-data-center-power-projects/.

[5] Santiago Canel Soria and Adriana Campos, *Geologic hydrogen attracts interest as a clean energy source,* S&P GLOBAL (Oct. 18, 2023), https://www.spglobal.com/commodity-insights/en/news-research/latest-news/energy-transition/101723-geologic-hydrogen-attracts-interest-as-a-clean-energy-source.

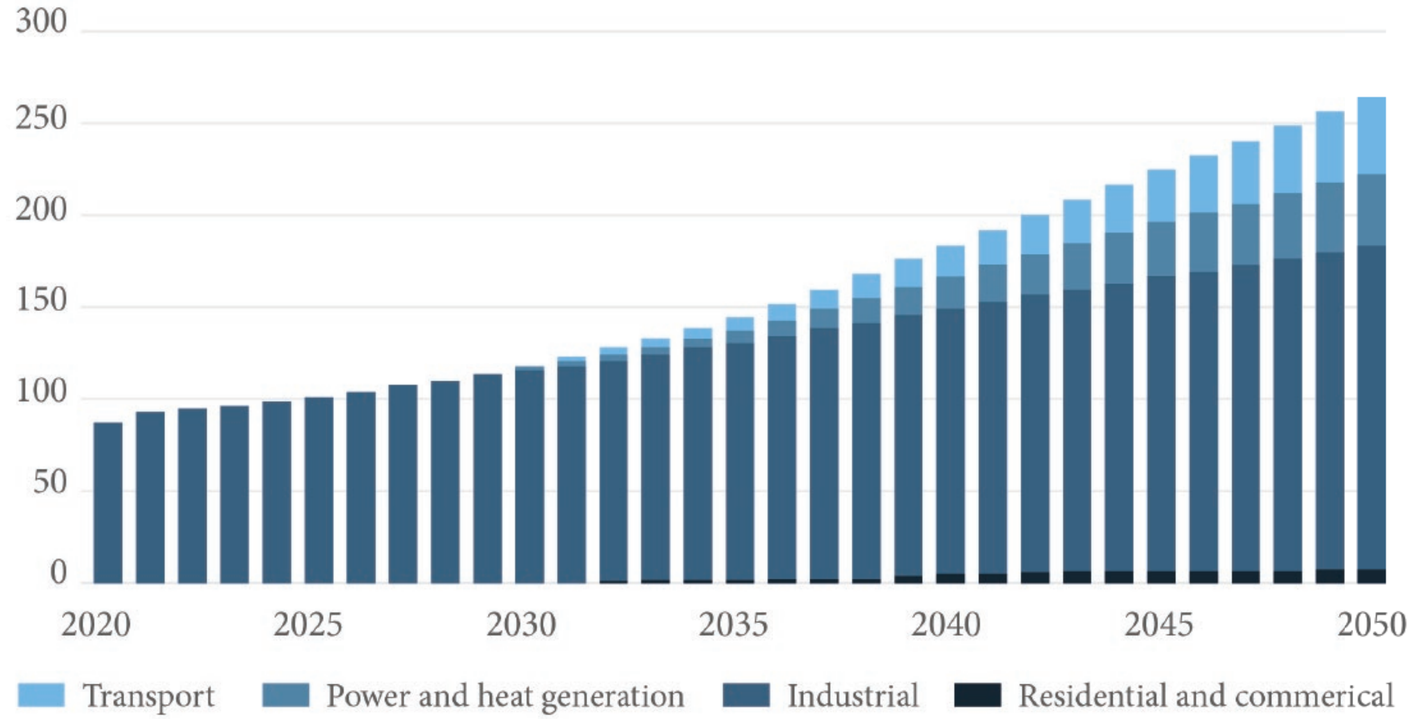


FIGURE 1. Global Hydrogen Demand in End-Use Sectors (million mt)[6]

Even though Wyoming's proposed hydrogen hub was not selected for funding by the U.S. Department of Energy (DOE), the State can be a leader in growing hydrogen markets through deployment of commercial scale hydrogen projects.

This paper provides a comprehensive report on the potential markets, economics, and policies associated with commercial scale deployment of hydrogen in Wyoming. This includes providing detailed descriptions and existing legal and regulatory frameworks associated with hydrogen production, transportation, and storage. The paper also contains an in-depth analysis of potential markets for Wyoming hydrogen and potential jobs and economic benefits, as well as policy recommendations and incentives to support the State's efforts to become a competitive hydrogen provider.

[6] *Ibid.*

HYDROGEN PRODUCTION METHODS

Hydrogen is produced in several ways utilizing different technologies and feedstocks. Currently, approximately 95% of all hydrogen produced in the U.S. is derived from natural gas.[7] The primary methods of producing hydrogen are steam methane reforming, coal gasification, and electrolysis. Pyrolysis is another form of hydrogen production that is still in the early stages of development. There is also naturally occurring hydrogen that can be found in geological formations and extracted from the earth; however, this is not yet a significant source of hydrogen. Substantial research is ongoing to explore the potential of several methods of hydrogen production, including pyrolysis and geologic hydrogen production.[8]

Steam Methane Reforming (SMR)

SMR is used to produce hydrogen from natural gas and is currently the most common commercial hydrogen production technology.[9] The process separates the hydrogen atoms from the carbon atoms in methane (CH_4). This is done through a three-step process (Figure 2):[10,11]

STEP 1: High temperature steam under pressure reacts with methane in the presence of a catalyst to produce hydrogen, carbon monoxide, and carbon dioxide (CO_2).

STEP 2: Water-gas-shift reaction where the carbon monoxide produced in the first step is reacted with steam over a catalyst to form hydrogen and CO_2. This step includes two stages, a high temperature shift (HTS) and a low temperature shift (LTS).

STEP 3: Pressure-swing absorption where CO_2 is removed and methanation is used to remove residual impurities from the gas stream, leaving pure hydrogen.[12]

[7] *Hydrogen Production: Natural Gas Reforming,* U.S. DEPARTMENT OF ENERGY (DOE) (last visited Apr. 2, 2025), https://www.energy.gov/eere/fuelcells/hydrogen-production-natural-gas-reforming.

[8] Additional methods of hydrogen production in the early stages of development include anion exchange membrane (AEM) electrolysis and photo-electrolysis.

[9] *See supra* note 7.

[10] *Ibid.*

[11] *Hydrogen Fact Sheet, Hydrogen Production – Steam Methane Reforming (SMR),* NEW YORK POWER AUTHORITY (last visited Aug. 7, 2025).

[12] *See supra* note 7.

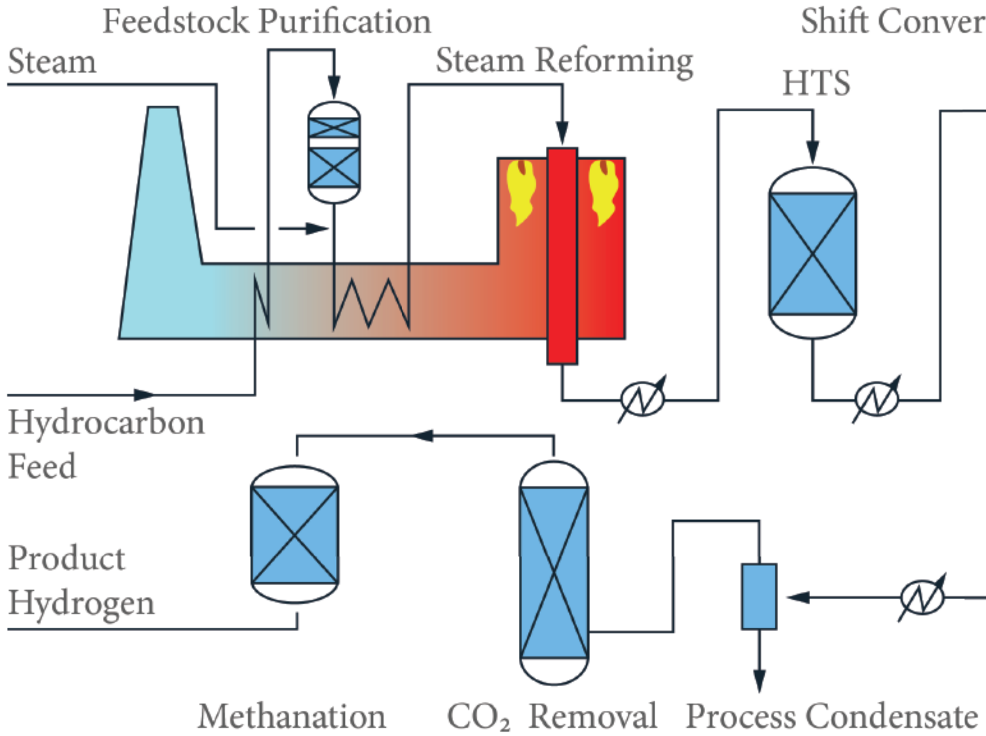


FIGURE 2. SMR Process[13]

The SMR process can also be used to produce hydrogen from fuels other than natural gas, including ethanol, propane, and gasoline.[14]

There are CO_2 emissions associated with the process, approximately 13kg of carbon dioxide equivalent (CO_{2e}) per kg of hydrogen produced; however, those can be ameliorated through the use of carbon capture technologies (which generally reduces emissions to 3kg of CO_{2e} per kg of hydrogen produced).[15] The captured CO_2 can either be stored, used to make other products, or for enhanced oil recovery (EOR). If carbon capture is used, the operators generally try to capture 90% or more of the CO_2 emitted throughout the SMR process.[16] This would work well in Wyoming where there is significant potential for geological CO_2 storage.

> The state's basins are replete with expansive saline sandstone and limestone reservoirs featuring high porosity and permeability. These reservoirs are often overlain by continuous layers of low-permeability rocks, such as shales, which serve as barriers to vertical fluid or gas migration.[17]

Many of these reservoirs fall within optimal pressure and depth conditions, aiding both the injection and storage of CO_2 (Figure 3).[18]

[13] *See supra* note 11.

[14] *See supra* note 7.

[15] *The Colors of Hydrogen Production: Emissions, Costs, and Concerns,* CLEAN ENERGY GROUP (May 2025), https://www.cleanegroup.org/wp-content/uploads/The-Colors-of-Hydrogen-Production-Fact-Sheet.pdf.

[16] *In the Hydrogen Spectrum, Every Color Tells a Story,* HYDROLITE (Aug. 12, 2024), https://www.hydrolite-h2.com/hydrogen-spectrum/.

[17] *Oil, Natural Gas, and CCUS Summary of 2023,* WYOMING STATE GEOLOGICAL SURVEY (Jan. 2024), https://www.wsgs.wyo.gov/products/wsgs-2024-OG-summary.pdf.

[18] *Ibid.*

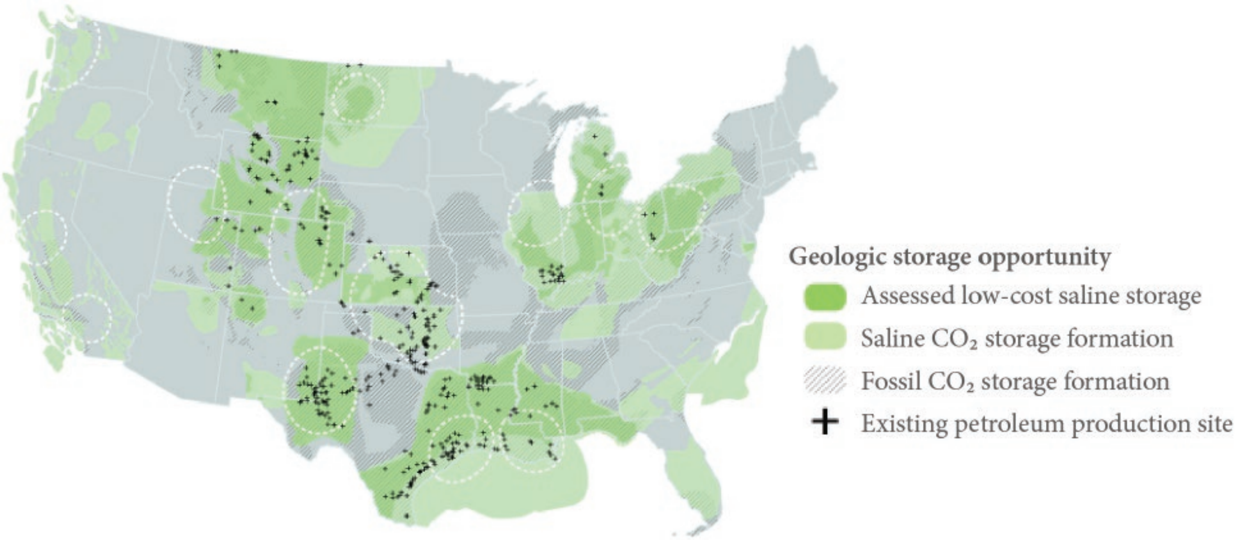


FIGURE 3. U.S. Geological CO_2 Storage Potential[19]

Autothermal Reforming (ATR)

ATR is a process of hydrogen production that uses a chemical reaction to generate the heat needed to produce hydrogen. The ATR process is comparable to SMR with CCS. This is done through a four-step process (Figure 8):[20]

STEP 1:

Partial oxidation

- Natural gas is mixed with steam and sent to a reformer where it is combined with oxygen.
- A partial oxidation reaction between the oxygen and methane happens in the reformer's combustion chamber which generates heat to obtain carbon monoxide, CO_2, and water.
- The partial oxidation reaction generates heat for the endothermic steam reforming reactions in the catalyst bed. Thus, autothermal processes self-heat and self-sustain without external heating.

STEP 2:

Steam reforming

- Natural gas and steam react under high temperature in the catalyst bed, and hydrogen and carbon monoxide are produced.
- The syngas leaves the reformer.

STEP 3:

Carbon monoxide shift reaction

- Carbon monoxide and steam react in the catalyst bed, and hydrogen and CO_2 are produced.

STEP 4:

Carbon capture

- Separation of CO_2 and hydrogen occurs.
- CO_2 is captured leaving pure hydrogen.[21,22]

[19] *An Atlas of Carbon and Hydrogen Hubs for United States Decarbonization,* Great Plains Institute (Feb. 2022), https://scripts.betterenergy.org/CarbonCaptureReady/GPI_Carbon_and_Hydrogen_Hubs_Atlas.pdf.

[20] Chingis Idrissov, *Autothermal Reforming: A Promising Technology for Blue Hydrogen,* IDTechEx (April 12, 2023), https://www.idtechex.com/en/research-article/autothermal-reforming-a-promising-technology-for-blue-hydrogen/29044.

[21] *Ibid.*

[22] *Autothermal reforming (ATR): reforming the future with low-carbon hydrogen,* Air Liquide (Nov. 5, 2024), https://www.airliquide.com/stories/hydrogen/autothermal-reforming-atr-reforming-future-low-carbon-hydrogen.

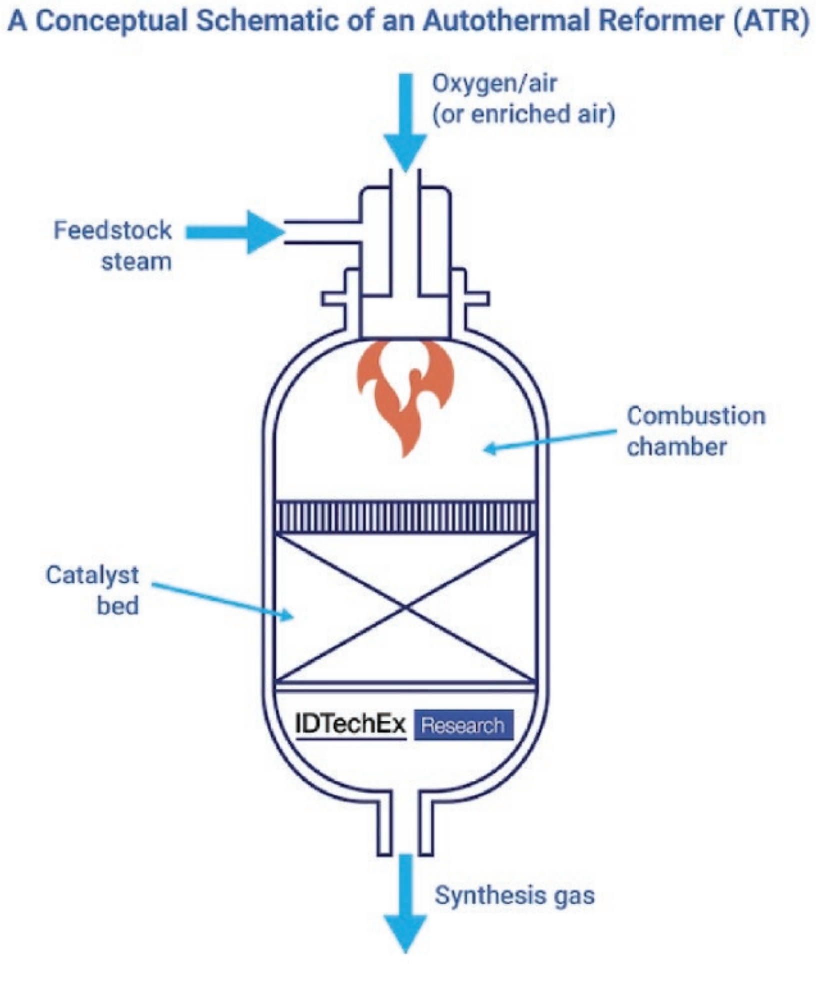
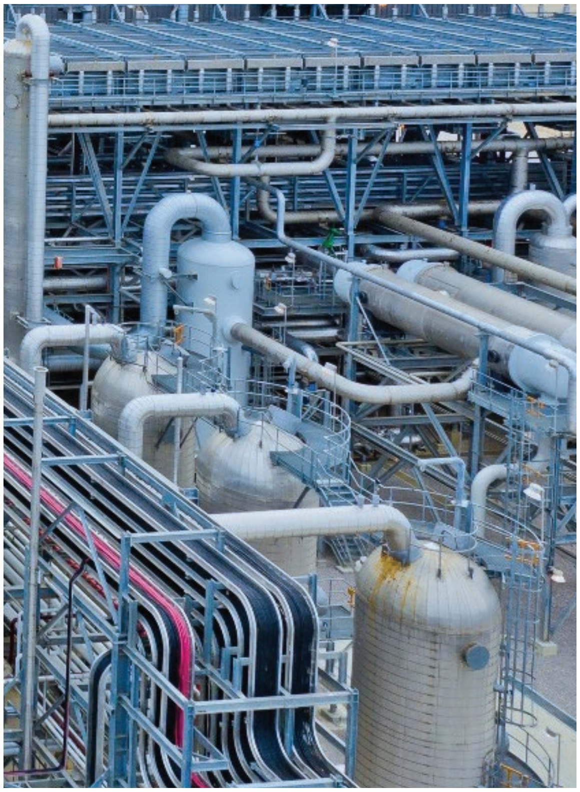


FIGURE 4. ATR Process[23]

The ATR process produces low-carbon hydrogen with 99% of carbon emissions being captured through CCS.[24] ATR-produced hydrogen can be used to help decarbonize energy-intensive chemical, mobility, and refining industries.[25]



[23] *See supra* note 20.

[24] *Ibid.*

[25] *Ibid.*

Coal Gasification

Currently, approximately 4% of U.S. hydrogen produced in the U.S. is made from coal.[26] Coal gasification involves converting coal into a hydrogen-rich gas (syngas) through a series of thermochemical reactions. This is done through a four-step process (Figure 4):

STEP 1: Coal is mixed with oxygen and steam in a gasifier (generally, a high temperature (typically 800-1600 degrees Celsius) and high-pressure vessel) to produce a syngas which primarily consists of hydrogen, carbon monoxide, and CO_2.

STEP 2: The syngas is cooled and cleaned to remove impurities, including particulates, mercury, and other trace elements, leaving a mixture of hydrogen, carbon monoxide, and CO_2.

STEP 3: The syngas is sent to a water-gas-shift reactor where the carbon monoxide is mixed with steam and converted to hydrogen and CO_2. This step is critical for enhanced hydrogen yield, making water the source of the majority of the hydrogen generated from a coal gasifier.

STEP 4: The syngas is separated into hydrogen and CO_2 through gas separation technologies (e.g., pressure swing absorption or membrane separation). Once the hydrogen is cleaned, it is ready for use. The CO_2 can either be captured and stored, used to make other products, or for EOR. [27,28]

[26] *Hydrogen Strategy Enabling a Low-Carbon Economy,* DOE OFFICE OF FOSSIL ENERGY AND CARBON MANAGEMENT (Jul. 2020), https://www.energy.gov/fecm/articles/hydrogen-strategy-enabling-low-carbon-economy.

[27] *Gasification Introduction,* NATIONAL ENERGY TECHNOLOGY LABORATORY (NETL) (last visited Apr. 16, 2025), https://www.netl.doe.gov/research/Coal/energy-systems/gasification/gasifipedia/intro-to-gasification.

[28] Saman Aryana, UNIVERSITY OF WYOMING COLLEGE OF ENGINEERING AND PHYSICAL SCIENCES (personal communication, Apr. 7, 2025).

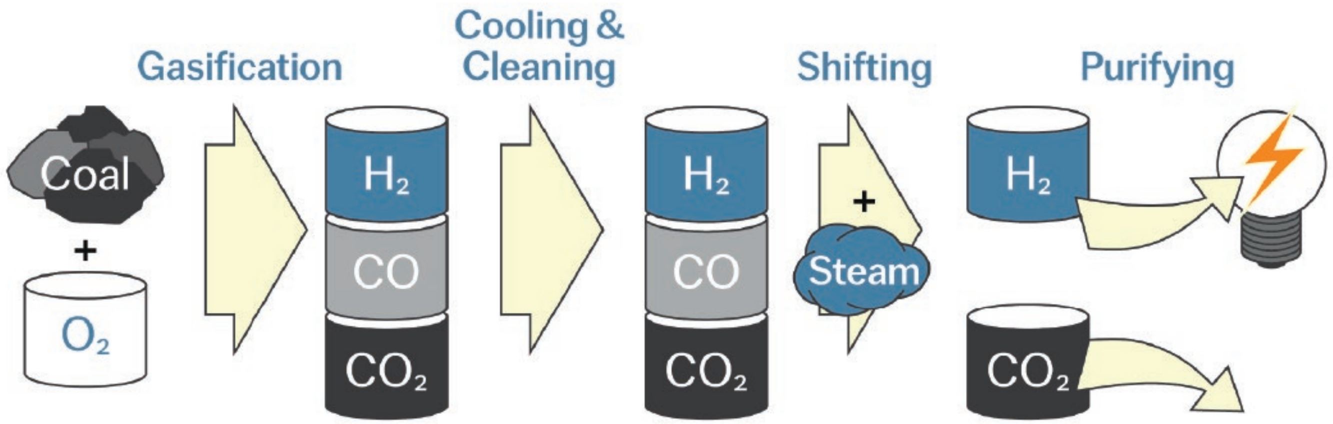


FIGURE 5. Coal Gasification Process[29]

The coal gasification process emits a large amount of CO_2, approximately 19kg of CO_{2e} per kg of hydrogen produced; however, adding carbon capture technologies would significantly reduce the carbon emissions associated with hydrogen production from coal. [30]

Electrolysis

Currently, approximately 1% of hydrogen produced in the U.S. is done through electrolysis, which is a process that uses electricity to split water into hydrogen and oxygen.[31] Electrolysis can be powered by different types of energy, including traditional fossil sources, wind, solar, hydroelectric, or nuclear. The electrolysis process does not emit CO_2.

The process takes place in electrolyzers which range from small, appliance-size equipment for small-scale hydrogen production to large-scale, central production facilities.[32] While different electrolyzers function in different ways, they all consist of an anode and a cathode separated by an electrolyte and the general chemical reaction is the same, namely, splitting water into hydrogen and oxygen.[33,34]

[29] Fadhilah Shikh Anuar, *Fig 16 Coal gasification process,* RESEARCHGATE (last visited Apr. 16, 2025), https://www.researchgate.net/figure/Coal-gasification-process-82_fig16_258424044.

[30] *See supra* note 15.

[31] *See supra* note 26.

[32] *Hydrogen Production: Electrolysis,* DOE (last visited Apr. 7, 2025), https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis.

[33] *Ibid.*

[34] *Exploring the Basics of Hydrogen Electrolysis,* STARGATE HYDROGEN (Dec. 14, 2023), https://stargatehydrogen.com/blog/basics-of-hydrogen-electrolysis/

Currently, the three primary types of electrolysis are alkaline electrolysis, proton exchange membrane (PEM) electrolysis, and solid oxide electrolysis:

1. **Alkaline electrolysis**
Alkaline electrolysis relies on an alkaline electrolyte solution to enhance conductivity, making it suitable for stable and continuous hydrogen production.[35] Alkaline electrolyzers consist of multiple cells assembled into a unit to produce hydrogen on a large scale.[36] Each cell is comprised of an anode, cathode, and electrolyte separator which are submerged in the alkaline electrolyte solution (Figure 5).[37]

When an electric current is passed through the electrolyte solution, the following reactions occur:

- ☑ At the anode, oxidation of water molecules occurs, leading to the release of oxygen.
- ☑ At the cathode, reduction of water molecules occurs, leading to the production of hydrogen.[38]

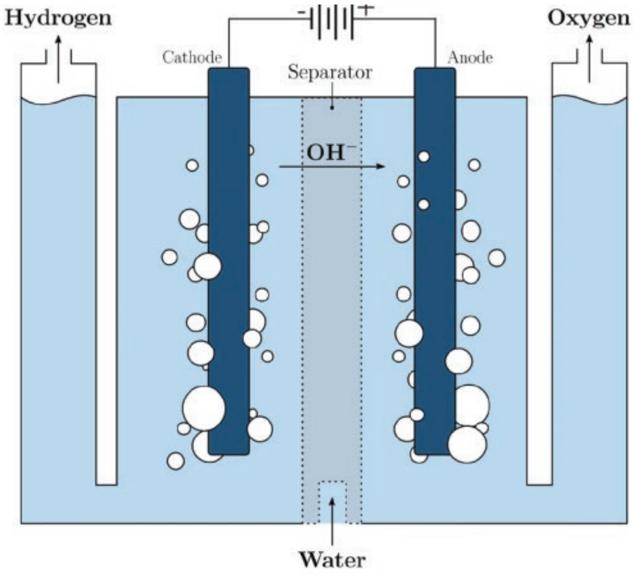


FIGURE 6. Alkaline Electrolysis[39]

The alkaline electrolysis method provides a straightforward, efficient solution of hydrogen production for industrial applications, such as chemical production, steel manufacturing and energy storage.[40] Alkaline electrolyzers have been commercially available for many years.[41]

[35] *Alkaline Electrolysers 101: Everything You Need to Know About the most reliable hydrogen production technology,* STARGATE HYDROGEN (Dec. 19, 2024), https://stargatehydrogen.com/blog/alkaline-electrolysers-101/.

[36] *Ibid.*

[37] *See supra* note 34.

[38] *Ibid.*

[39] *Ibid.*

[40] *See supra* note 32.

[41] *Ibid.*

2. **Proton Exchange Membrane (PEM) electrolysis**
PEM electrolysis is another way in which electricity is used to split water into hydrogen and oxygen. A PEM electrolysis cell consists of an anode and a cathode separated by a solid polymer electrolyte membrane (Figure 6).[42]

Electricity passed through the PEM electrolyzer, causes the following to occur:

- ☑ Water oxidation takes place at the anode forming oxygen and positively charged hydrogen ions (protons).
- ☑ Electrons flow through an external circuit and the hydrogen ions move across the electrolyte membrane to the cathode. The membrane is crucial in that it only allows the passage of hydrogen ions and prevents hydrogen and oxygen gases from being mixed.
- ☑ At the cathode, hydrogen ions combine with electrons from the external circuit and produce hydrogen gas.[43,44]

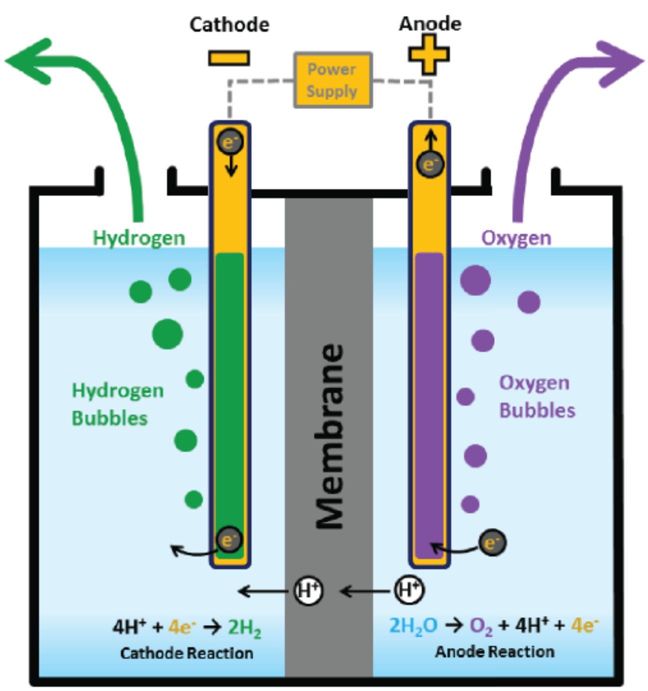
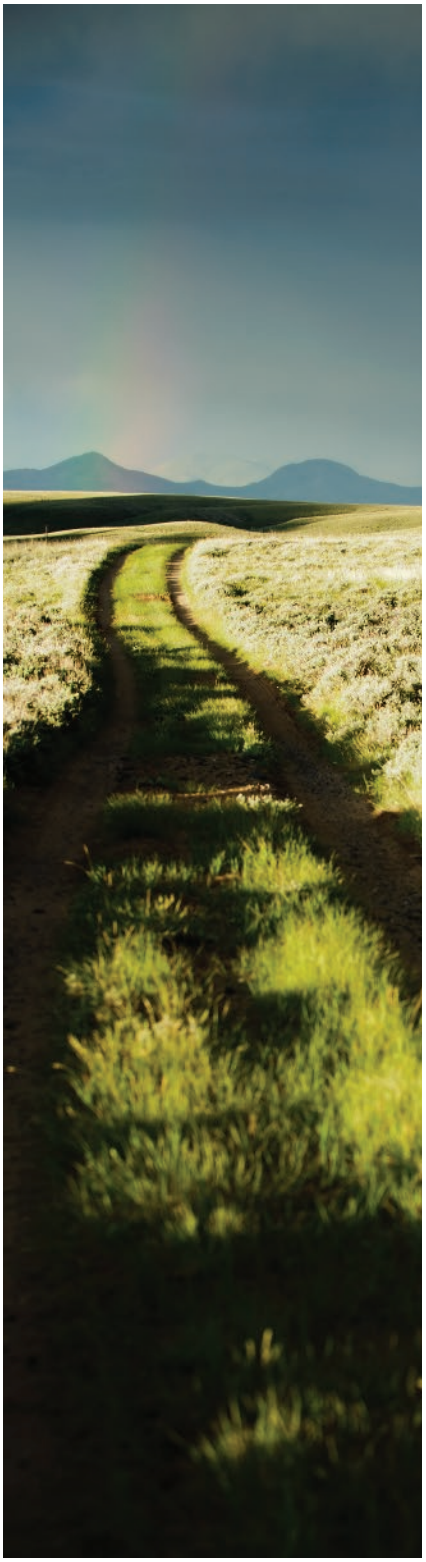


FIGURE 7. PEM Electrolysis[45]

PEM electrolyzers are efficient, however, they are smaller than alkaline electrolyzers and, therefore, better suited for small scale applications.[46]



[42] *See supra* note 34.
[43] *Ibid.*
[44] *See supra* note 32.
[45] *Ibid.*
[46] *See supra* note 34.

3. **Solid oxide electrolysis**
Solid oxide electrolyzers use an electrolyte made of a solid ceramic material to selectively conduct negatively charged oxygen ions at elevated temperatures (700 – 800 degrees Celsius) to produce hydrogen (Figure 7).[47] The use of heat at elevated temperatures decreases the amount of electricity needed to produce hydrogen from water.[48]

The solid oxide electrolysis process occurs as follows:

- ☑ Steam at the cathode combines with electrons from the external circuit to form hydrogen gas and negatively charged oxygen ions.
- ☑ The oxygen ions pass through the ceramic membrane and react at the anode to form oxygen gas and generate electrons for the external circuit.[49]

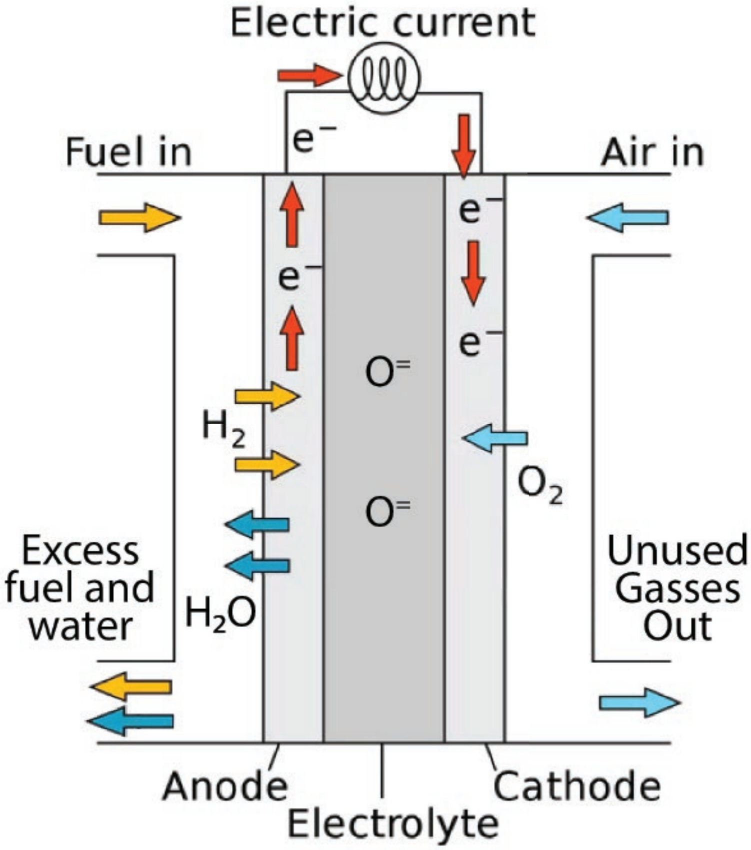


FIGURE 8. Solid Oxide Electrolysis[50]

Solid Oxide electrolysis is a less-developed technology than alkaline and PEM electrolysis.[51] While the process has been developed and demonstrated on a laboratory and demonstration plant scale, it has not yet been fully commercialized.[52]

47 *See supra* note 32.

48 *Ibid.*

49 *Ibid.*

50 *See supra* note 34.

51 Erik Eikeng, Ashkan Makhsoos, and Bruno G. Pollet, *Critical and strategic raw materials for electrolysers, fuel cells, metal hydrides and hydrogen separation technologies,* INTERNATIONAL JOURNAL OF HYDROGEN ENERGY (Jun. 19, 2024), https://www.sciencedirect.com/science/article/pii/S036031992401783X?via%3Dihub.

52 *Ibid.*

Methane Pyrolysis

Methane pyrolysis is a process of hydrogen production in the early stages of development that splits methane into hydrogen and solid carbon. The pyrolysis process does not emit CO_2 and consumes seven times less energy than electrolysis.[53] The solid carbon can be used in a variety of industrial applications, including the production of car tires, coatings, plastics and batteries.[54]

The pyrolysis process uses natural gas as a feedstock and electricity for heating (Figure 9):

- ☑ Natural gas is superheated to separate the carbon and hydrogen atoms.
- ☑ The carbon atoms cluster together to form a solid carbon.
- ☑ A filter unit separates the hydrogen from the carbon.[55]

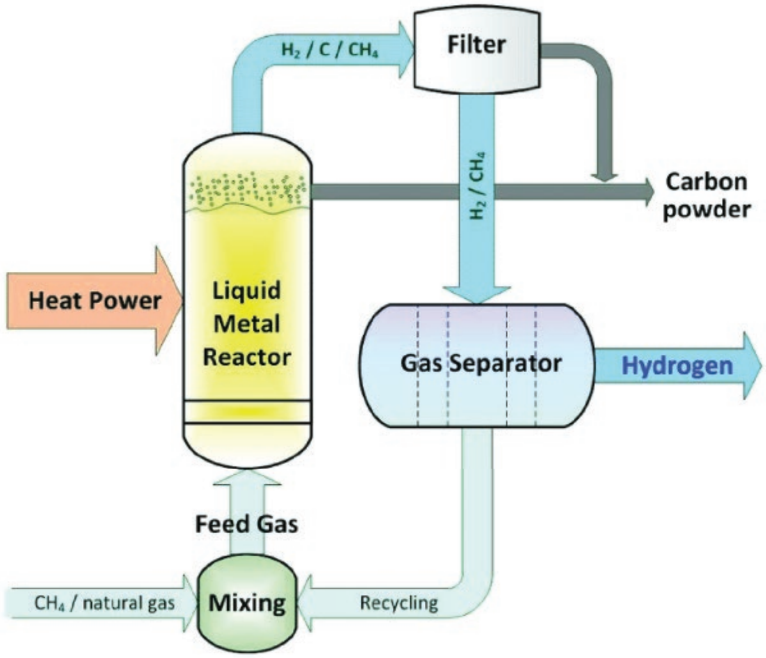


FIGURE 9. Methane Pyrolysis Process

Methane pyrolysis has yet to be commercialized. The IEA has graded "existing methane pyrolysis technology designs from three to eight on its technological readiness level (TRL) scale" with a score of nine implying commercial readiness.[57]

[53] Susan Coleman, *Turquoise Hydrogen: The Future of Hydrogen Energy,* ANSYS (Feb. 21, 2024), https://www.ansys.com/blog/future-of-energy-is-turquoise.

[54] *Ibid.*

[55] Andrea Willige, *Achieving net zero: What is turquoise hydrogen?* SPECTRA (Jun. 8, 2021), https://spectra.mhi.com/achieving-net-zero-what-is-turquoise-hydrogen#what-is-turquoise-hydrogen.

[56] Leonid Stoppel, Tristan Fehling, Tobias Beiβler, and Egbert Baake, *Carbon dioxide free production of hydrogen,* IOPSCIENCE (Jul. 2017), https://www.researchgate.net/figure/Process-flow-diagram-1_fig1_318890424.

[57] Doug Vine, *Methane pyrolysis: the case for cleaner hydrogen with existing infrastructure,* CENTER FOR CLIMATE AND ENERGY SOLUTIONS (Oct. 24, 2024), https://www.c2es.org/2024/10/methane-pyrolysis-the-case-for-cleaner-hydrogen-with-existing-infrastructure/#:~:text=Generally%2C%20the%20International%20Energy%20Agency,of%20nine%20implying%20commercial%20readiness.

Geologic Hydrogen

Geologic hydrogen is not produced or manufactured through an industrial process. It is found in geological formations and extracted from the earth. This is not yet a significant source of hydrogen, but substantial research is ongoing to explore its production potential, with U.S. exploration projects currently taking place in Nebraska, Arizona and Kansas.[58]

Geologic hydrogen exploration employs many of the same strategies and technologies that are used in oil and natural gas exploration, including use of the same drilling and completion equipment.[59] However, due to hydrogen's small molecular size, production from reservoirs requires materials specifically designed to safely transport it.[60,61] Hydrogen exploration and production occurs through the following process:

1

Rotary drilling rigs drill wells into the ground to access underground reservoirs where hydrogen has accumulated.

2

Once the hydrogen is reached, sensors are used to gauge its concentration and purity levels.

3

The hydrogen is piped to the surface and stored in secure facilities.[62]

Known natural hydrogen reserves exist in Mali, Russia, France, South Australia, Tanzania and Albania. Regarding hydrogen potential in the U.S., the U.S. Geological Survey (USGS) published a report in January 2025 with prospectivity mapping for where geologic hydrogen is likely to occur.[63] The report includes a map where the areas that are likelier to contain geologic hydrogen are depicted in deep blue on the map (Figure 10).[64]

58 Fred Pearce, *Natural Hydrogen: A Potential Clean Energy Source Beneath Our Feet,* YALE ENVIRONMENT 360 (Jan. 25, 2024), https://e360.yale.edu/features/natural-geologic-hydrogen-climate-change.

59 *The Potential for Geologic Hydrogen for Next-Generation Energy,* USGS (Apr. 13, 2023), https://www.usgs.gov/news/featured-story/potential-geologic-hydrogen-next-generation-energy.

60 *Ibid.*

61 Angela Linders, *Understanding Natural Hydrogen and its Global Energy Potential,* HYDROGEN FUEL NEWS (Mar. 8, 2025), https://www.hydrogenfuelnews.com/natural-hydrogen-global-energy/8569957/.

62 *Ibid.*

63 Sazrah E. Gelman, Jane S. Hearon, and Geoffrey S. Ellis, *Prospectivity Mapping for Geologic Hydrogen,* USGS (Jan. 2025), https://pubs.usgs.gov/pp/1900/pp1900.pdf.

64 USGS Communications and Publishing, *USGS releases first-ever map of potential for geologic hydrogen in U.S.,* USGS (Jan. 16, 2025), https://www.usgs.gov/news/national-news-release/usgs-releases-first-ever-map-potential-geologic-hydrogen-us.

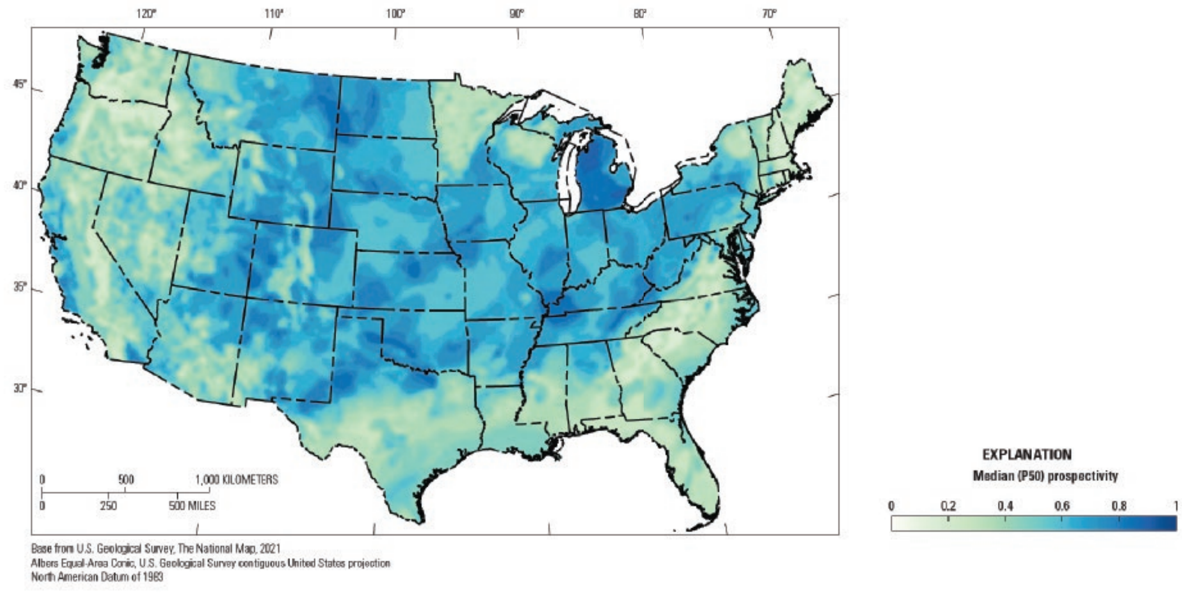


FIGURE 10. USGS map showing prospectivity of geologic hydrogen in the U.S.[65]

While the USGS report estimates a large potential for the amount of hydrogen reserves, they maintain there is also a large amount of uncertainty associated with it and do not predict how or where the hydrogen is distributed in the subsurface.[66] The authors "calculate the energy content of this estimated recoverable amount of hydrogen to be roughly twice the amount of energy in all the proven natural gas reserves in the earth"; however, they also believe "much of it is likely too deep, too far offshore or in accumulations too small to be economically recoverable" at this time. [67]

EXISTING LEGAL, REGULATORY AND POLICY ENVIRONMENT (HYDROGEN PRODUCTION)

The existing legal and regulatory framework associated with hydrogen production is complex and fragmented.[68] It consists of federal and state regulations and safety standards related to hydrogen production, transportation and storage, and involves multiple governmental agencies.[69] (See Appendix A for the Wyoming Hydrogen Permitting Flowchart).

65 *Ibid.*

66 *Ibid.*

67 *Ibid.*

68 Jess Wymer and Veronica Saltzman, *Regulatory Framework for Hydrogen in the U.S.,* CLEAN AIR TASK FORCE (Jan. 21, 2025), https://www.catf.us/resource/regulatory-framework-hydrogen-us/#:~:text=This%20document%20outlines%20a%20non-exhaustive%20list%20of%20existing,to%20different%20parts%20of%20the%20hydrogen%20value%20chain.

69 *Ibid.*

The following regulatory requirements are related to hydrogen produced or manufactured through an industrial process, not the exploration and production of geologic hydrogen. In Wyoming, geologic hydrogen falls within the definition of natural gas. As such, leasing and permitting of geologic hydrogen are governed by the State's oil and gas rules and regulations.[70]

Production

Regulatory requirements regarding hydrogen production depend upon the feedstock from which it is produced, permitting requirements, and project specifics, such as scale and location.[71,72] Hydrogen production facilities are required to monitor and report their GHG emissions, waste, and water usage to federal and state regulatory agencies.[73] For example, SMR hydrogen production must meet emissions reporting requirements under the Clean Air Act if wastewater from the process will be discharged, and those projects that incorporate carbon capture and storage are subject to additional regulatory requirements.[74] Production through electrolysis may require a federal permit under the Clean Water Act, and any production method that triggers a federal nexus would require environmental review under the National Environmental Policy Act (NEPA).[75]

There are several Environmental Protection Agency (EPA) regulations governing hydrogen production that regard hydrogen as a byproduct of fossil fuel and chemical production processes (Table 1).[76] Hydrogen production facilities are required to monitor and report their GHG emissions, and while they are not subject to federal air pollution standards or GHG emissions limits, they are not exempt from air pollution standards under Wyoming Air Quality Standards and Regulations (WAQSR).[77] In this vein, hydrogen production facilities that emit 25,000 MT of CO_2-equivalent emissions must comply with EPA's Greenhouse Gas Reporting Program (GHGRP) emissions reporting and monitoring requirements.[78] Also, EPA's effluent discharge limitations apply only to discharges from hydrogen production as a refinery byproduct.[79]

[70] Esther Wagner, *Wyoming Leasing & Permitting Rules & Regulations for Natural Hydrogen Exploration & Production,* UNIVERSITY OF WYOMING SCHOOL OF ENERGY RESOURCES, CENTER FOR ENERGY REGULATION AND POLICY ANALYSIS (2025), https://www.uwyo.edu/ser/research/centers-of-excellence/energy-regulation-policy/_files/snapshot25-hydrogenleasing4.pdf

[71] *Harnessing Hydrogen: A Key Element of the U.S. Energy Future,* NATIONAL PETROLEUM COUNCIL (Apr. 2024), https://harnessinghydrogen.npc.org/downloads.php.

[72] *See supra* note 68.

[73] *Ibid.*

[74] *See supra* note 71.

[75] *Ibid.*

[76] *Ibid.*

[77] *Ibid.*

[78] *Ibid.*

[79] *Ibid.*

Regulation/Statute	Purpose
Clean Air Act Title I	New Source Review Permit must be obtained before construction of a hydrogen facility, which requires the installation of modern pollution control technologies to limit emissions.
Clean Air Act Title V	Title V permits are required for any major source that has actual or potential emissions at or above the major source threshold for an "air pollutant."
Hydrogen Production, 40 CFR Part 98 Subpart P	Requires owners/operators of facilities that produce hydrogen to report emissions from production on an annual basis.
Risk Management Program, 40 CFR §68.10	Requires facilities holding more than a threshold quantity of a regulated substance in a process to develop a Risk Management Plan and submit that plan to EPA.
Resource Conservation and Recovery Act (RCRA), 40 CFR §30.16	Requires permits for hazardous waste generation, storage and disposal.
Greenhouse Gas Reporting Program (GHGRP), 40 CFR §98.1	Facilities emitting a threshold quantity of CO_2 or other GHGs are required to report emissions.

TABLE 1. EPA Regulations Governing Hydrogen[80]

Hydrogen production facilities are subject to compliance with OSHA safety standards, and additional requirements would be necessary for projects taking place on federal lands. EPA's new source performance standards for new, modified, reconstructed, and existing sources in the oil and gas sector do not extend to hydrogen.[81]

Hydrogen production facilities are also subject to state regulations and permitting requirements (Table 2).

[80] *See supra* note 68.

[81] *See supra* note 71.

Agency	Permit
Wyoming Department of Environmental Quality (WDEQ) Air Quality Division	New Source Review Permit issued under Title I of the Clean Air Act (WAQSR Chapter 6, Section 2) Air Quality Operating Permit issued under Title V of the Clean Air Act (WAQSR Chapter 6 Section 3)
EPA	Air Quality GHG Part 98
EPA Region 8 per Section 112r of CAA and 40 CFR part 68	Accidental Release Prevention/Risk Management Plan (for pipeline facilities) Wyoming Pollutant Discharge Elimination System (WYPDES) permit for wastewater discharges WYPDES Construction and Industrial Stormwater permits Underground Injection Control (UIC) Class I, Class V
WDEQ Water Quality Division in Coordination with the Wyoming Oil and Gas Conservation Commission	UIC Class VI (for carbon capture storage)
WDEQ Solid and Hazardous Waste Division	Solid Waste Processing Facility Permits Hazardous Waste Generator Requirements

TABLE 2. State Hydrogen Permitting Requirements.[82]

In 2022, the Inflation Reduction Act (IRA) provided an incentive for companies to develop clean hydrogen projects in the form of a production tax credit (PTC).[83] On January 10, 2025, the Internal Revenue Service (IRS) and Department of the Treasury released the final regulations for the clean hydrogen PTC under Section 45V of the Internal Revenue Code.[84] In general, the tax credit provides a dollar amount per kilogram of clean hydrogen produced during a 10-year period beginning on the date the hydrogen facility is placed in service. The amount of the credit is based on the lifecycle GHG emissions of the production process not to exceed 4kg of CO_{2e} per kilogram of hydrogen produced (Table 3).[85]

[82] Nancy Vehr, WYOMING DEP'T OF ENVIRONMENTAL QUALITY (personal communications, May 23, 2025 to Sep. 23, 2025).

[83] H.R.5376 – 117th Congress (2021-2022), *Inflation Reduction Act of 2022,* Pub. L. No. 117-169 (Aug. 16, 2022), *https://www.congress.gov/bill/117th-congress/house-bill/5376/text.*

[84] 90 Fed. Reg. 2224 (Jan. 10, 2025).

[85] Barbara de Marigny, Michael Bresson, Mona Dajani, George Fibbe, Ellen Friedman, Elias Hinckley, Tom Holmberg, Steen Marcus, Renn Neilson, Shailesh Sahay, Katie McEvilly and Jared Meier, *Final Section 45V Clean Hydrogen Production Tax Credit Regulations: A Closer Look*, BAKER BOTTS (Feb. 3, 2025), Final Section 45V Clean Hydrogen Production Tax Credit Regulations: A Closer Look | Thought Leadership | Baker Botts.

Emissions Intensity (kg of CO_{2e} per kg of H_2)	Maximum Credit ($/kg$H_2$)
0 - .45kg	$3.00
.45 – 1.5kg	$1.00
1.5 – 2.5kg	$0.75
2.5 – 4kg	$0.60

TABLE 3. Section 45V Credit Amounts[86]

While the regulations do not mandate the technology or feedstock to be used to produce the hydrogen, hydrogen produced by renewable sources would qualify for the highest credit.[87] Hydrogen produced from natural gas through an SMR with CCS would receive the lowest credit. Hydrogen produced by coal gasification or SMR without CCS would not be eligible to receive a 45V PTC.

This is similar to 45Q which incentivizes the permanent storage of CO_2 that would otherwise be released into the atmosphere. Through the IRA, 45Q provided a tax credit of $85/ton for CCS and $60/ton for EOR. Under the 45V regulations, hydrogen produced by an SMR with CCS can claim either a 45V or a 45Q PTC, but not both.[88] Companies need to decide which tax credit would be more advantageous for them, typically based on upstream natural gas emissions rates and the production facility's CO_2 capture rate.[89]

In order to qualify for the 45V PTC, the IRA and subsequent IRS and Department of the Treasury regulations specified that hydrogen projects would need to commence construction before January 1, 2033.[90] On July 3, 2025, Congress passed its final budget reconciliation bill, subsequently signed by President Trump as the One Big Beautiful Bill Act (OBBBA) on July 4, 2025, changing the construction commencement date to before January 1, 2028.[91] The OBBBA also provided parity for 45Q tax credits with $85/ton of CO_2 for both CCS and EOR.[92]

86 *Ibid.*

87 Jason Lindquist, *Danger Zone – Changes to 45V Tax Credit Would Deal a Major Blow to Low-Carbon Hydrogen,* RBN ENERGY DAILY ENERGY BLOG (Jun. 5, 2025), https://rbnenergy.com/danger-zone-changes-to-45v-tax-credit-would-deal-a-major-blow-to-low-carbon-hydrogen.

88 *Ibid.*

89 *Ibid.*

90 90 Fed. Reg. 2224 (Jan. 10, 2025).

91 H.R.1 – 119th Congress (2025-2026), *One Big Beautiful Bill Act,* Pub. L. No. 119-21 (Jul. 4, 2025), https://www.congress.gov/bill/119th-congress/house-bill/1/text.

92 *Ibid.*

Transportation

Hydrogen can be transported in a gaseous, liquified or solid state. Currently, hydrogen is transported in either a gaseous or liquified state by truck or pipeline. There is potential for hydrogen to also be transported via rail or marine vessel. Transportation of hydrogen comes with some unique challenges making it a contributing factor to the difficulties of a hydrogen industry buildout. First, hydrogen's small molecular size creates concerns related to the safety and viability of all modes of transportation. Furthermore, the economic feasibility of each mode of transportation is situation-dependent, meaning that factors such as distance, demand for hydrogen (i.e. volume of hydrogen being transported) and geographic location can play significant roles in the economic feasibility of one mode of transportation over the other.

Transportation of hydrogen by truck, rail and pipeline falls under the purview of several federal and state agencies, with each mode being best suited for certain situations.

1. Truck Transportation

Trucks are used to transport hydrogen over shorter distances where pipeline use is either not economically justified or not available.[93] Hydrogen truck transportation is subject to federal safety regulations under the Pipeline and Hazardous Materials Safety Administration (PHMSA) and the Federal Motor Carrier Safety Administration (FMCSA), as well as state and local regulations.

PHMSA regulations classify compressed, liquefied, and blended hydrogen as Class 2 (gas), Division 2.1 (flammable gas), and lists hydrogen under the Hazardous Materials Transportation Act (HMTA) which is administered by PHMSA.[94] PHMSA regulations govern the preparation and construction of tank cars carrying hydrogen, the handling of hydrogen, how long hydrogen can be held in one place, the markings to be displayed on containers holding hydrogen, the storage temperature for liquefied hydrogen, and the positioning for cylinders containing liquefied hydrogen.[95]

The FMCSA regulates the trucking industry and imposes regulations on the transportation of hydrogen, including routing of hydrogen across roadways.[96] States can develop their own plans for the routing of hazardous materials but must follow FMCSA standards.[97] Wyoming does not have State regulations specific to the transportation of hydrogen.

Use and Economics of Hydrogen Truck Transportation

Hydrogen can be transported via truck in both liquid and gaseous forms, with different costs associated with each method. For hydrogen transportation over short distances, especially in the early to mid-stages of the building out of a hydrogen industry in Wyoming, utilizing trucks can be a suitable and economically viable choice. This is especially true for areas without the necessary infrastructure to facilitate rail or pipeline transportation.

[93] *See supra* note 71.
[94] *Ibid.*
[95] *Ibid.*
[96] *Ibid.*
[97] *Ibid.*

Hydrogen transportation via truck is only economically feasible under specific circumstances. According to a paper studying the different modes of point-to-point hydrogen transportation, liquid hydrogen (LH) is the only viable way to transport hydrogen via truck while remaining cost-competitive when compared to other modes of transportation. This is simply because it is less costly to create a vessel to transport liquid hydrogen than it is to transport gaseous hydrogen – the exception to this being through pipelines.[98] Still, the only way LH truck transportation becomes truly cost-competitive is when rail infrastructure is unavailable. When pipelines are still in the mix, LH truck transportation is only cost-competitive when the flowrate is below approximately 25 mt/day, with this being true for all distances tested as shown in Figure 11.[99]

Without a fully connected pipeline network, hydrogen transportation via truck will almost certainly be needed to some degree regardless of the economics involved. Hydrogen transported by rail would need to be delivered directly to its destination for truck transportation to be unnecessary. This is not to say that eliminating the need for truck transportation is not possible, but rather that it is likely that trucks, and specifically LH truck transportation, will be a part of the transportation dynamics for a Wyoming hydrogen industry.

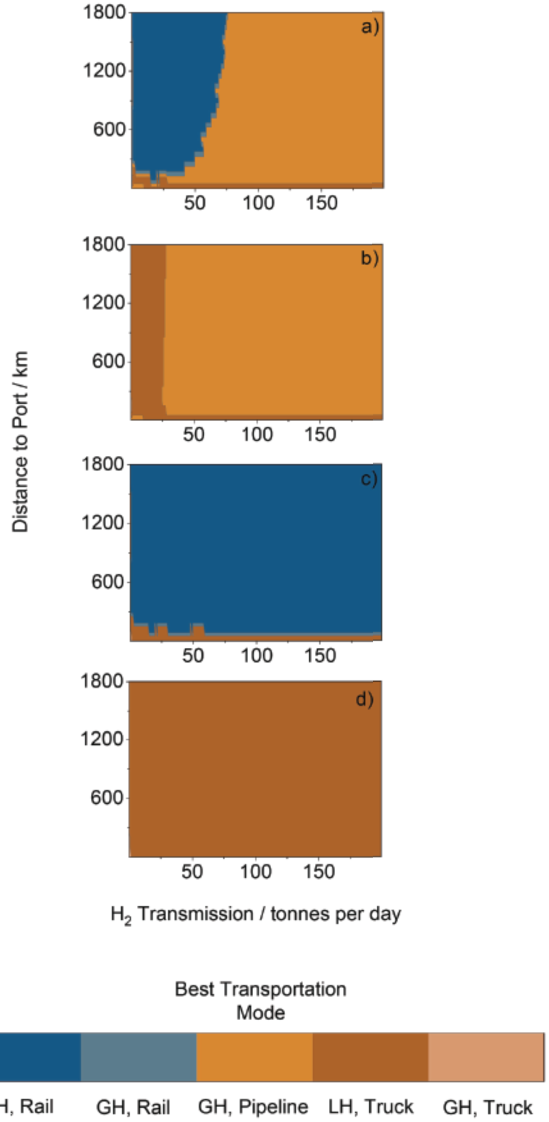


FIGURE 11. Determination of the most economic land-based transportation for a variety of scenarios. For all scenarios here, the rail depot distance was a constant 10 km. a) All modes available, b) Rail unavailable, c) Pipeline unavailable, d) Pipeline and Rail unavailable.[100]

[98] Borsboom-Hanson, T., et al., *Point-to-point transportation: The economics of hydrogen export*, INTERNATIONAL JOURNAL OF HYDROGEN ENERGY, 47(74), 31541-31550 (2022). https://doi.org/10.1016/j.ijhydene.2022.07.093.

[99] *Ibid.*

2. Rail Transportation

Rail is a potential mode of transportation for hydrogen, likely in liquid form, along medium distances where pipelines are not economically justified or not available.[101] Transportation of hydrogen by rail would be subject to the HMTA by PHMSA as well as state and local regulations.[102] PHMSA would regulate delivery, preparation and construction of tank cars, handling, the duration that hydrogen could be held at one place, and the markings to be displayed on containers of hydrogen.[103]

The economic aspects of interstate transportation of hydrogen by rail would be subject to oversight by the Surface Transportation Board (STB) under the Interstate Commerce Commission Termination Act (ICCTA).[104] This would include authority over the construction and abandonment of rail lines, as well as rates and terms of service.[105]

Use and Economics of Hydrogen Rail Transportation

Wyoming has a well-established rail network, providing an opportunity to transport hydrogen both in-state and throughout the rest of the country. Transporting hydrogen by rail can occur in a gaseous or liquified state. [106] Each way requires a different type of rail car designed specifically to store each form of hydrogen, hence, these two forms of hydrogen transportation via rail are not equal in terms of cost-competitiveness. In the paper studying the different modes of point-to-point hydrogen transportation discussed in the previous section, it was concluded that no scenario made gaseous hydrogen (GH) rail transportation cost-competitive compared to any of the other modes of transportation. However, when flowrates of hydrogen are below 60 mt/day, LH transportation is cost-competitive at all tested distances as shown in Figure 11.[107]

This reaffirms that rail will likely be a pragmatic option for hydrogen transportation in the early stages of a Wyoming hydrogen industry, especially when considering the State's existing rail network. It will also be a viable mode of transportation for low volumes of hydrogen for intermediate transportation to demand centers.

100 *Ibid.*
101 *See supra* note 71.
102 *Ibid.*
103 *Ibid.*
104 *Ibid.*
105 *Ibid.*
106 *See supra* note 98.
107 *Ibid.*

3. Pipeline Transportation

Pipelines are generally the most efficient mode of transporting hydrogen over medium and long distances. Today there are approximately 1,600 miles of pipelines in the U.S. that carry hydrogen, including two interstate pipelines, all of which serve refineries and ammonia plants in the Gulf Coast Region. [108, 109] Pipeline transportation of hydrogen faces challenges associated with cost, technical concerns, and regulatory uncertainty.

The existing hydrogen pipelines in the U.S. carry unblended hydrogen but the cost of new hydrogen pipeline construction poses a significant barrier to pipeline expansion.[110] In the hope of finding a cost-effective solution, other options are being considered for transporting hydrogen by pipeline, but each comes with challenges.

One option being considered is blending hydrogen with natural gas for transport in existing natural gas pipelines; however, there are significant limitations associated with this option:

A Research has shown that a very small amount of hydrogen in a natural gas/hydrogen blend (.0005%) can embrittle the steel and welds used to fabricate natural gas pipelines.[111] One way to address this is to use lower operating pressures, similar to what is used for natural gas distribution within a municipality; however, these lower pressures are unlikely to be an option for use in large-diameter interstate pipelines.[112]

B Hydrogen molecules are smaller than natural gas molecules, which increases the potential for permeation and leaks.[113]

C There are uncertainties associated with separating hydrogen from the blended stream and a lack of demand for blended hydrogen.[114]

108 *See supra* note 68.

109 Kieran McMullen, Lily Simon, Trace English and Jacob Schneider, *Hydrogen Storage Final Essay,* UNIVERSITY OF WYOMING, SCHOOL OF ENERGY RESOURCES (May 3, 2023).

110 *Hydrogen Pipelines,* DOE (last visited May 2, 2025), https://www.energy.gov/eere/fuelcells/hydrogen-pipelines.

111 *Wyoming Energy Authority – Hydrogen Pilot Program Williams Southwest Wyoming Hydrogen Hub Final Report,* THE WILLIAMS COMPANIES, INC. and UNIVERSITY OF WYOMING SCHOOL OF ENERGY RESOURCES (Oct. 2023), https://wyoenergy.org/wp-content/uploads/2023/10/Williams-H2-Hub-Combined-1.pdf.

112 *Ibid.*

113 *See supra* note 71.

114 *Ibid.*

Interstate natural gas pipelines transporting blends of hydrogen and natural gas are regulated by the Federal Energy Regulatory Commission (FERC) under the Natural Gas Act (NGA). FERC regulates the gas quality specifications of NGA pipelines, including how much hydrogen is permitted.[115] Operators must obtain a certificate of public convenience and necessity (CPCN) from FERC before they can construct, expand, or operate an interstate natural gas pipeline.[116] This includes converting a pipeline from one that carries only natural gas to one that carries natural gas blended with hydrogen.[117] Obtaining a CPCN can be a complicated and lengthy process that requires review under NEPA. It provides an operator with the federal right of eminent domain and preempts requirements of state or local agencies that conflict with the terms of the CPCN.[118]

Another option being considered for transporting hydrogen via pipeline is using ammonia, methanol or other substance as a medium to more easily transport the hydrogen and then chemically isolating it following delivery.[119] Yet another option is repurposing legacy oil, gas, or products pipelines into hydrogen pipelines.[120] Converting an interstate pipeline from natural gas to hydrogen would require a pipeline to obtain FERC authorization to abandon natural gas service; however, once converted, there are conflicting views of which agency has jurisdiction to regulate interstate pipelines transporting unblended hydrogen.[121]

All existing hydrogen pipelines were sited pursuant to the state regulations through which they were built and secured through eminent domain authority.[122] None of them are regulated by a federal agency.[123] There is one hydrogen pipeline that crosses the state line between Texas and Louisiana that received CPCNs from each state.[124] While this is an option that can work for other interstate pipelines, a single state rejection of a construction permit could impede the development of a pipeline planned to cross a state line.[125]

115 *Ibid.*

116 *Ibid.*

117 *Ibid.*

118 *Ibid.*

119 *Ibid.*

120 *Ibid.*

121 *Ibid.*

122 *Ibid.*

123 *See supra* note 109.

124 Joan Dreskin, *H2IQ Webinar: Regulation and Permitting of Hydrogen and Natural Gas Pipelines,* DOE (Aug. 29, 2024), https://www.energy.gov/sites/default/files/2024-09/h2iqhour-08292024.pdf.

125 *See supra* note 71.

It is unclear who has the authority to regulate the rates and siting of interstate pipelines transporting unblended hydrogen, whether it be FERC under the NGA or the Interstate Commerce Act (ICA), or the Surface Transportation Board (STB) under the ICCTA.

A

Under the NGA, FERC has jurisdiction over interstate pipelines that transport natural gas or natural gas blended with artificial gas.[126] Hydrogen is not included in the NGA's definition of natural gas and is generally considered to be a manufactured gas. For unblended hydrogen to be regulated by FERC under the NGA, the NGA's definition of natural gas would need to define hydrogen as a natural gas.[127]

Regulating hydrogen under the NGA would include siting, construction, storage, transportation rates, certain transactions, and other activities. The NGA requires just and reasonable rates and prohibits undue discrimination in pipeline transportation from one state to another.[128]

B

Under the ICA, FERC regulates interstate pipeline rates for oil, which includes petroleum products and natural gas liquids. Further, under the ICA, FERC does not have the authority to regulate the siting of pipelines or their entry or exit from the market, except pipelines that cross an international border or are part of the Trans-Alaska Pipeline System. Pipelines are subject to siting requirements of all states through which they are built and must secure eminent domain, and a state rejection of a construction permit can impede development of pipelines planned to cross state lines. There is no required CPCN approval process, and no federal agency review is required prior to construction or commencement of service.[129, 130]

C

Under the ICCTA, the STB regulates interstate pipeline rates for commodities other than oil or gas. Like the ICA, the ICCTA does not regulate siting of pipelines, and they are, instead, subject to siting requirements of all states through which they are built and must secure eminent domain. There is no required CPCN approval, and no federal agency review is required prior to construction or commencement of service. Here again, a single state rejection of a construction permit can impede development of pipelines planned to cross state lines.[131, 132]

126 Michelle Castaline, Thomas Donadio, Lorrie Marcil and Dan Mullen, *Federal and Texas Jurisdiction Over Hydrogen Pipeline Transportation: A Comprehensive Analysis and Pathways for Enhancement,* STEPTOE (Oct. 2024), https://www.steptoe.com/a/web/vN3tJXrrXjv7F4oQNRjEhk/hydrogen-pipeline-transportation-jurisdiction.pdf.

127 *Ibid.*

128 *See supra* note 71.

129 *Ibid.*

130 *See supra* note 109.

131 *Ibid.*

132 *See supra* note 71.

Some believe that interstate pipelines transporting unblended hydrogen would be subject to regulation by the STB under the ICCTA. Others believe FERC should regulate unblended hydrogen pipeline rates under the ICA, particularly given that FERC regulates transportation of commodities that have energy uses. This same conflict previously occurred with regard to pipeline transportation of ammonia which was originally regulated by FERC under the ICA as oil because it is a petrochemical made from hydrogen; however, FERC disclaimed jurisdiction over ammonia transportation on the grounds that it is not used for energy purposes. Interstate pipelines carrying ammonia are now regulated by the STB under the ICCTA.[133]

States generally regulate intrastate pipeline transportation. States also broadly regulate the siting, rates, and commercial terms and practices of local distribution companies providing natural gas to commercial and residential end users. The Wyoming Public Service Commission (WPSC) has the authority to issue CPCNs for intrastate gas transmission lines and high-pressure distribution lines that are operated by a utility.[134] The WPSC has basic siting authority over hydrogen facilities that are a utility, otherwise local cities and counties have authority over the routing and siting of intrastate natural gas pipelines in their respective jurisdictions.[135]

In the case of siting hydrogen pipelines on federal lands, it is unclear which regulations govern. Under the Mineral Leasing Act (MLA), the Department of the Interior (DOI) grants rights-of-way (ROWs) for pipelines carrying "oil, natural gas, synthetic liquid or gaseous fuels, or any refined product produced from them" which could include hydrogen.[136] Under the Federal Land Policy Management Act (FLPMA), DOI or the U.S. Department of Agriculture (USDA) grants ROWs for pipelines for the transportation of commodities other than those in the MLA. No clarification is provided for where hydrogen would fall within these two categories.[137]

All regulated pipelines crossing a navigable water (i.e. a river or stream) must secure Clean Water Act Section 401 and Section 404 Certifications from the State or the Environmental Protection Agency (EPA), which the State must act on within one year. NEPA review is also required for approval of pipelines on federal lands.[138]

133 *Ibid.*

134 Wyoming Public Service Commission: Pipeline Industry, WYOMING PUBLIC SERVICE COMMISSION (last visited May 13, 2025), https://psc.wyo.gov/pipeline.

135 Perry McCollum, WYOMING PUBLIC SERVICE COMMISSION (personal communication Jul. 15, 2025).

136 43 CFR §2881.5 (2025).

137 *See supra* note 71.

138 *Ibid.*

Pipelines are subject to federal safety regulations under PHMSA; however, PHMSA's authority does not apply to intrastate pipelines located in states that regulate the same conduct, and which have submitted a certification to the Secretary of Transportation verifying that it has adopted the same or more stringent standards.[139] Most of PHMSA pipeline safety and construction requirements treat hydrogen pipelines the same as other gas pipelines.[140]

In Wyoming, PHMSA has delegated some of their regulatory oversight and authority to the WPSC for intrastate natural gas pipelines, but not for pipelines that transport hazardous materials.[141] With regard to hydrogen pipelines, the WSPC would have regulatory oversight and authority over hydrogen in a gaseous state; however, regulatory oversight and authority for intrastate pipelines transporting liquid hydrogen would fall to PHMSA.[142]

The Transportation Security Administration (TSA) regulates the security of pipelines, including cybersecurity, and issues security guidance for pipeline operators to follow.[143]

Use and Economics of Hydrogen Pipeline Transportation

Pipelines are generally the most efficient mode of transportation for large volumes of gases over medium to long distances, and hydrogen is no exception.[144] The Gulf Coast region has a proven track record transporting hydrogen via pipelines that serve refineries and ammonia plants primarily in that area (Figure 12).[145] Beyond this, the demand for hydrogen in the region has also justified investment in short distance pipelines to connect demand centers, decreasing the need for alternative short to medium distance transportation methods such as trucks or rail.[146]

139 *Ibid.*

140 *Ibid.*

141 *See supra* note 135.

142 *Ibid.*

143 *See supra* note 71.

144 *Ibid.*

145 *See supra* note 110.

146 *See supra* note 71.

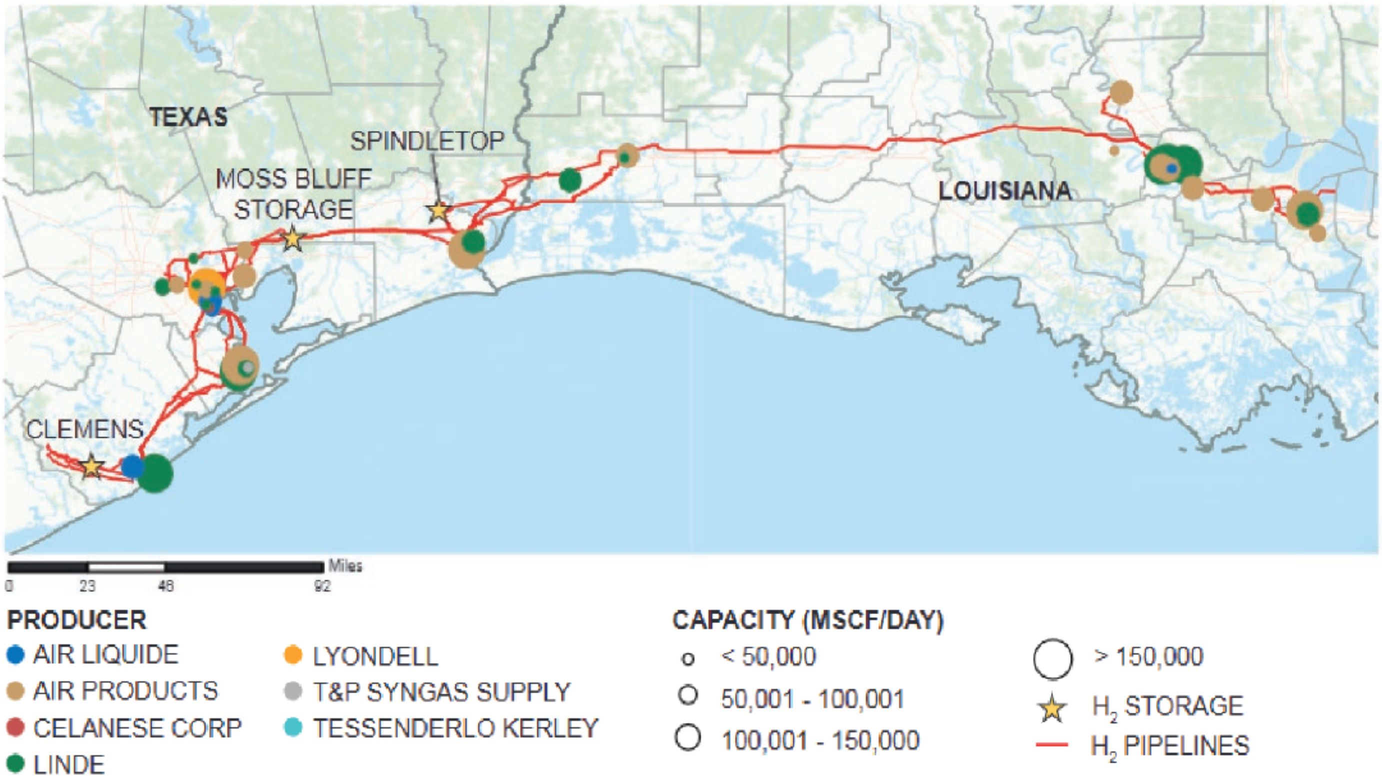


FIGURE 12. Map shows hydrogen (H_2) production, pipeline, and geological storage infrastructure in the Gulf Coast.[147]

The cost of hydrogen pipelines plays a critical role in their deployment for transporting hydrogen in a given region. A study conducted by ICF International (ICF) as a part of the NPC's Harnessing Hydrogen report analyzed the cost of potential hydrogen pipelines by region. The analysis concluded that for the U.S. central and mountain region, the cost of pipeline construction would amount to an estimated average of $156,817 per inch-mile in 2021 dollars.[148, 149] Also considered in this analysis were compression costs, denoted by dollars per horsepower (HP). For the same region, this amounted to an estimated $3,095 per HP in 2021 dollars.[150] To compare this to a region with well-established pipeline infrastructure, the South-Central region, encompassing the Gulf Coast, had estimated average costs of $181,077 per inch-mile and $3,095 per HP, in 2021 dollars.[151]

147 *Ibid.*

148 *Harnessing Hydrogen: A Key Element of the U.S. Energy Future, Appendix N – ICF Report on Pipeline and Compression Cost Study,* National Petroleum Council (April 23, 2024). https://harnessinghydrogen.npc.org/files/H2-Appendix_N-2024-04-23.pdf

149 An inch mile is a unit used to measure a pipeline, taking into account both the diameter and mileage of a pipeline. For example, a pipeline 200 miles in length with a diameter of 30 inches would be 6,000 inch-miles.

150 *See supra* note 148.

151 *Ibid.*

It should be noted that though the ICF analysis consisted primarily of historical data from oil and gas pipeline construction, it gives a framework that allows for cost calculations to be made based on length, diameter and compression requirements, all of which are vital variables when considering investment in pipeline infrastructure. It should also be noted that this analysis considered exclusively new pipeline construction costs. While it is more likely that the buildout of a Wyoming hydrogen industry would require new pipeline construction, repurposing oil and gas pipelines could prove to be less costly than new construction. Still, there are safety and technical challenges with repurposing oil and gas pipelines for the use of transporting hydrogen which raise questions regarding the feasibility of doing so.

Another consideration when looking at potential investment in hydrogen pipelines is the effect of economies of scale with the growth of a hydrogen industry. As discussed above, the Gulf Coast region has been able to justify investment in both long- and short-distance hydrogen pipeline infrastructure due to the high demand for hydrogen in the region. The ability to use the full capacity of the pipeline allows the per-unit cost of hydrogen transportation to be reduced, making it more cost-competitive compared to other modes of transportation such as truck or rail. A study examining the various point-to-point hydrogen transportation methods found that pipelines were the least expensive method for all distances that were tested when the flowrate of hydrogen was above 150 mt/day as shown in Figure 11.[152] When the flowrate (i.e. the demand for hydrogen) is lower than this, other modes of transportation become more cost-competitive at various distances as discussed in the truck and rail transportation sections. It is likely that a hydrogen industry in Wyoming would first adopt and use pipeline infrastructure exclusively for long distance transportation until the growth of localized demand for hydrogen changes the cost-competitiveness of pipelines relative to truck and rail.

[152] *See supra* note 98.

HYDROGEN STORAGE

Storing hydrogen has proven to be a significant challenge for widescale deployment of the resource. Hydrogen requires large scale storage similar to what is used in the natural gas industry; accordingly, several methods of geological storage have been considered viable solutions for both long and short-term storage. This section describes three methods of geological natural gas storage used in Wyoming that could be tested for hydrogen storage – salt caverns, depleted natural gas reservoirs, and saline aquifers. Understanding these hydrogen storage methods and their relevance and feasibility in Wyoming is important for the deployment of a hydrogen industry in the State.

Salt Caverns

Salt caverns are man-made geological structures resulting from solution mining in formations that are rich with salt. Depending on the geology of the formation, salt caverns come in two forms; 1) domal salt caverns and 2) bedded salt caverns (Figure 13).[153] A study analyzing the economic feasibility of different methods of hydrogen storage in the Intermountain-West region, which includes Arizona, Colorado, Montana, New Mexico, Utah and Wyoming, found the levelized cost of hydrogen storage using salt caverns is approximately $2.50 per kg of hydrogen.[154]

[153] Chen, Y., et al., *Capacity assessment and cost analysis of geologic storage of hydrogen: A case study in Intermountain-West Region USA*, International Journal of Hydrogen Energy, 48(24), 9008-9022 (2023). https://doi.org/10.1016/j.ijhydene.2022.11.292.

[154] *Ibid.*

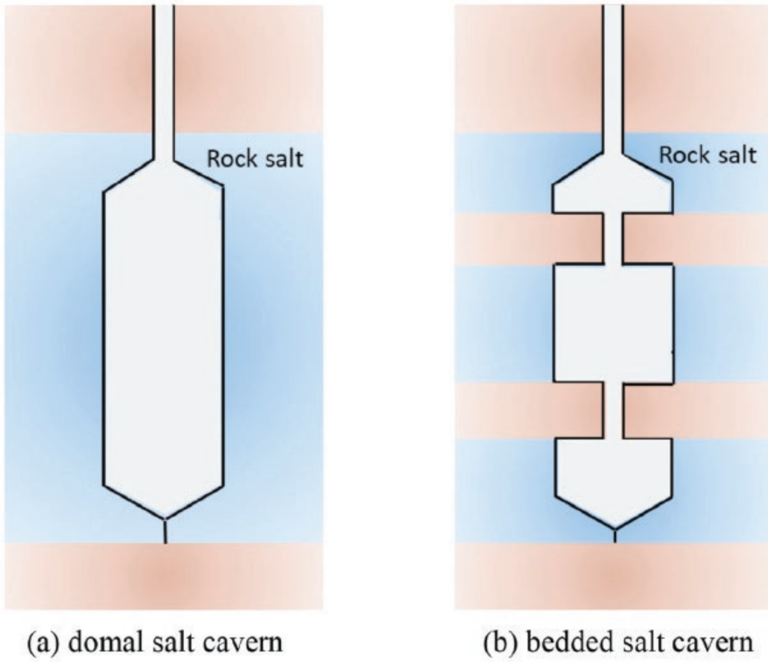


FIGURE 13. Schematic figure of (a) domal salt cavern and (b) bedded salt cavern. The blue region represents the rock salt layer. The white region is the salt cavern. A domal salt cavern has an integrated cavity created in a thick rock salt layer, while a bedded salt cavern has a compartmental cavity due to the discontinuous rock salt layers.[155]

Advantages
There are several advantages to using salt caverns to store hydrogen. First and foremost, as the primary means of hydrogen storage on the Gulf Coast, salt caverns are already well-proven at a commercial scale. Also, salt cavern storage provides higher injection and withdrawal rates of hydrogen relative to the other methods discussed. The ability to inject and withdraw hydrogen at faster rates allows its distribution to more readily meet demands, making the use of salt cavern storage more economical over time.[156] Lastly, salt caverns provide excellent containment and a chemically inert environment for hydrogen storage, thus maintaining high hydrogen purity after withdrawal and low losses during storage.[157]

Disadvantages
There are some disadvantages to using salt caverns to store hydrogen. A specific geology is required to form salt caverns, which creates clear constraints for where storage can be sited. This can cause difficulties collocating storage with the points of hydrogen production or demand resulting in additional infrastructure costs for pipeline and electric interconnection. Arguably the largest downside to salt cavern storage is the relatively small storage capacity when compared to depleted natural gas reservoirs and saline aquifers. While limited storage capacity contributes to the advantage of fast injection and withdrawal rates, it may limit its applications. The need for large amounts of water and the disposal of the brine during the construction process of salt caverns also adds to the overall capital costs of this storage method.[158] This high initial water use could likely be a deterrent to salt cavern storage in Wyoming.

155 *Ibid.*

156 *Ibid.*

157 *Ibid.*

158 *Ibid.*

Depleted Natural Gas Reservoirs

Wyoming has historically produced large amounts of natural gas, providing ample opportunity to repurpose depleted natural gas reservoirs for storing hydrogen. The previously discussed study analyzing the economic feasibility of different methods of hydrogen storage in the Intermountain-West region found the levelized cost of hydrogen storage using depleted gas reservoirs is approximately $1.50 per kg of hydrogen.[159]

Advantages

The first obvious advantage in using depleted natural gas reservoirs to store hydrogen is the potential to repurpose otherwise retired natural gas fields, providing a second life for these assets. This, coupled with the potential that the operational and capital costs of repurposing depleted natural gas reservoirs can be low relative to other storage methods, makes it a promising approach for hydrogen storage. Compared to the other forms of hydrogen storage discussed, this method is the most cost-competitive on a per kg of hydrogen basis.[160] Beyond the cost, the geological formations where natural gas is extracted are well understood and are inherently well-suited for storage of hydrogen, even with its small molecular structure. Wyoming's rich history in oil and natural gas production and fundamental understanding of the State's geology provides a significant advantage for pursuing this form of storage in the State, making technical barriers much easier to overcome relative to other states where this kind of geology is less understood. In terms of storage capacity, this method offers large volumes of storage with long-term viability of weeks to months of effective storage.[161]

Disadvantages

Though competitive on a levelized cost basis, there are some factors that should be considered when deciding if depleted natural gas reservoirs are the best-suited method for hydrogen storage in Wyoming. First, there is potential for microbial reactions to occur when hydrogen is injected into depleted natural gas reservoirs, which can lead to a loss of hydrogen during storage.[162] The residual gases found in these depleted reservoirs can also cause contamination during storage. These factors would likely create a need for post withdrawal processing to ensure hydrogen purity, further increasing costs.[163]

Another barrier to consider is that hydrogen storage in depleted natural gas reservoirs is yet to be a proven technology at scale despite the well understood nature of their geology. This could be a substantial deterrent for investment as first-of-a-kind technology tends to be much more difficult to garner capital despite the relatively low levelized costs. Lastly, hydrocarbon fields are large storage formations meaning that the charging and discharging cycle of hydrogen may be infrequent compared to smaller storage sites. Infrequent cycling and usage could impact the economics of storage over time using this method.[164] Still, all factors considered, this method of hydrogen storage is very promising.

159 *Ibid.*

160 *Ibid.*

161 *Ibid.*

162 *Ibid.*

163 *Ibid.*

Saline Aquifers

Saline aquifers are naturally occurring, deep underground geological formations that contain salt-rich water.[165] These formations are porous in nature and capable of storing hydrogen at a large scale. The previously discussed study analyzing the economic feasibility of different methods of hydrogen storage in the Intermountain-West region found the levelized cost of hydrogen storage using saline aquifers is approximately $3.27 per kg of hydrogen.[166]

Advantages

Saline aquifers are abundant in nature and are often found in the absence of both salt caverns and natural gas reservoirs, rendering them a potentially useful option for hydrogen storage. Compared to the other two methods discussed, saline aquifers provide the largest theoretical capacity for hydrogen storage, making them the best option simply in terms of storage capacity.[167] Though untested at scale, saline aquifers can be lined to prevent losses due to subsurface reactions, providing high purity hydrogen after withdrawal. This, of course, is advantageous compared to the other discussed options, but it comes with increased capital costs, contributing to the high levelized cost of hydrogen storage previously stated.[168]

Disadvantages

While abundant, saline aquifers are constrained by their geological location. This creates challenges, similar to salt caverns, in terms of the inability to collocate with production or demand centers, leading to increased infrastructure costs to facilitate hydrogen storage using this method.[169] Unlike salt caverns, saline aquifers are yet to be a proven technology at scale, making this a significant barrier like that of using natural gas reservoirs for hydrogen storage; first-of-a-kind technology is often more difficult to attract capital investment. Also, as discussed above, the cost of lining saline aquifers, though limiting microbial reaction and other hydrogen losses, adds to the high levelized costs of saline aquifer hydrogen storage.[170]

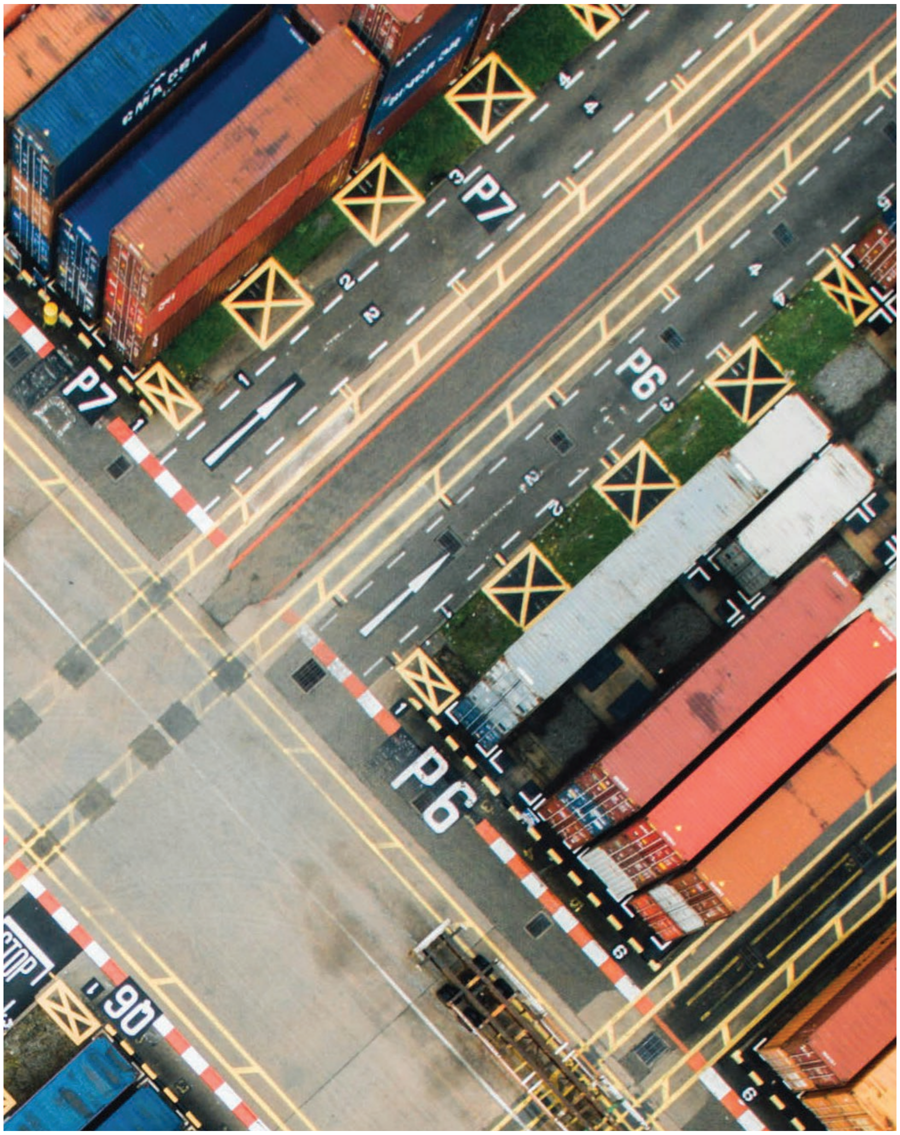
Storage Method	\$/kg of H_2
Salt Caverns	$2.50
Depleted Gas Reservoirs	$1.50
Saline Aquifers	$3.27

TABLE 4. Levelized Cost of Hydrogen Storage by Method in the Intermountain-West Region.[171]

164 *Ibid.*
165 *Ibid.*
166 *Ibid.*
167 *Ibid.*
168 *Ibid.*
169 *Ibid.*
170 *Ibid.*
171 *Ibid.*

Solid-State Storage and Transportation

Solid-state hydrogen storage is a technology that has yet to reach maturity, hence why it is not being compared on a levelized cost basis in this analysis. That said, it would provide a unique opportunity for both storage and transportation of hydrogen if proven to be technically and economically feasible at scale. Put simply, solid-state hydrogen is created through reacting hydrogen with metals or alloys to produce a metal hybrid that ultimately stores the hydrogen in a solid-state.[172] Currently, solid-state hydrogen as a storage method is still being developed, with more research being conducted to better understand the technical and economic feasibility of the technology. Although it serves primarily as a storage method for hydrogen, this technology would also enable the transportation of hydrogen via more conventional transportation methods. As such, solid-state hydrogen is a promising solution for overcoming two of the largest hurdles slowing down the buildout of a hydrogen industry – the technical and economic challenges of storing and transporting hydrogen; however, more research needs to be conducted before it can be adopted at a commercial scale.



Discussion

Without more research and consideration for non-cost factors, it is difficult to determine the best method of hydrogen storage for Wyoming. The above-mentioned advantages and disadvantages of each storage method can be just as important as overall storage cost when considering factors such as siting, proximity to the point of consumption, and other relevant factors that may affect this decision-making process. Nonetheless, when looking simply at the levelized costs of hydrogen storage as shown in Table 4, depleted natural gas reservoirs provide the cheapest form of storage in the Intermountain-West Region.

[172] Chen, G., et al., *Review of Hydrogen Storage in Solid-State Materials,* Energies 2025, 18(11), 2930 (June 3, 2025). https://doi.org/10.3390/en18112930

EXISTING LEGAL, REGULATORY AND POLICY ENVIRONMENT (STORAGE)

As is the case with hydrogen production and transportation, the existing legal and regulatory framework for hydrogen storage is complex, making it difficult to implement large scale hydrogen projects.[173] There are numerous steps associated with hydrogen storage permitting which fall under the purview of a myriad of federal and state agencies. Regulations and permitting requirements for hydrogen storage are based on several factors, such as the storage method (i.e., compressed gas storage, geologic storage, liquid hydrogen storage, etc.), whether it will be located on or under federal, state or private land, and the geological characteristics of the area.[174, 175]

Federal agency oversight includes:

- ☑ EPA regulates and permits all methods of aboveground and underground storage of pure hydrogen, including compressed gas storage, liquid hydrogen storage, geological storage, or material-based storage (i.e. conversion into other chemicals such as ammonia).[176]
- ☑ EPA requires that entities seeking to store 10,000 or more pounds of hydrogen must submit a Risk Management Program that includes the potential effect of an accidental release, precautions that will be taken to prevent such a release, and an emergency response plan.[177]
- ☑ OSHA enforces regulations regarding the structural components and operations of gaseous and liquid hydrogen storage and delivery, including the type of containers suitable for hydrogen storage, use of safety systems, materials suitable for hydrogen systems, how those systems should be assembled and where facilities can be located.[178, 179]
- ☑ PHMSA administers safety regulations applicable to hydrogen, including underground storage facilities.[180]
- ☑ The Federal Aviation Administration (FAA) regulates the separation distance requirements for storage of liquid hydrogen and any incompatible energetic liquids, and the requirements on storage and handling of hydrogen at airports.[181, 182]

173 *See supra* note 71.
174 *Ibid.*
175 *See supra* note 68.
176 *Ibid.*
177 *See supra* note 71.
178 *Ibid.*
179 *See supra* note 68.
180 *Ibid.*
181 *Ibid.*
182 *See supra* note 71.

The Safe Water Drinking Act (SWDA) regulates the injection of fluids and gases into underground wells and would apply to the underground storage of hydrogen. EPA or a state agency that has been granted primacy by the EPA, as is the case with Wyoming, would issue an underground injection control (UIC) permit under the SWDA for injecting hydrogen into underground wells.

Wyoming has primacy in approving and regulating all six classes of UIC permits which are issued by the WDEQ (Class I, III, IV, V and VI) and the Wyoming Oil and Gas Conservation Commission (WOGCC) (Class II). Class IV wells (disposal of hazardous waste into or above any usable aquifer) are currently prohibited in Wyoming. Hydrogen storage would most likely be required to have a Class V permit but could possibly be required to have a Class I permit instead. Class V permits cover those categories that are different from all the other classes, including injection activities for non-hazardous commercial, industrial, or municipal waste directly into or above a usable aquifer. A Class V permit would make the most sense if the hydrogen being stored is determined as non-hazardous.[183] The determination of hazardous or non-hazardous is regulated by the Resource Conservation and Recovery Act (RCRA).[184] Class I permits cover the injection of hazardous or non-hazardous industrial, commercial, or municipal waste beneath the lowermost formation containing an underground source of drinking water. This permit would work for hydrogen, even though hydrogen is not considered to be "waste".[185] WDEQ determines which permit is necessary based on project specifics. A Class VI UIC permit would be required for hydrogen projects with CCS. Class VI permits are issued by WDEQ in conjunction with the WOGCC which provides pore space unitization orders.

Other permits from the WDEQ that may need to be secured for a hydrogen storage project include:

- ☑ Hazardous Waste Management Permit under RCRA
- ☑ Clean Water Act (CWA) Section 402 – Wyoming Pollutant Discharge Elimination System (WYPDES) permits for stormwater runoff that may occur during construction and from industrial facilities, and individual permits for wastewater discharges to the surface.
- ☑ CWA Section 404 permit from the U.S. Army Corps of Engineers if the project will have dredge and fill activities on wetlands or surface waters that are Waters of the United States (WOTUS).
- ☑ CWA Section 401 certification from the WDEQ for any activities requiring Section 404 permits.
- ☑ State permit coverage from WDEQ for any dredge and fill activities on waters that are not WOTUS but are waters of the state.
- ☑ New Source Review permit issued by WDEQ under Title I of the Clean Air Act (WAQSR Chapter 6 Section 2).
- ☑ Air Quality Operating permit issued by WDEQ under Title V of the Clean Air Act (WAQSR Chapter 6 Section 3).[186, 187]

183 *See supra* note 109. *See also* WDEQ Underground Injection Control, https://deq.wyoming.gov/water-quality/groundwater/uic/.

184 *See supra* note 109.

185 *Ibid.*

186 *Ibid.*

187 *See supra* note 82.

As is the case with hydrogen transportation and production siting, hydrogen storage projects taking place on federal lands would require a Title V ROW permit under FLPMA and be subject to NEPA review.[188] Any storage projects occurring on land included in the National Register of Historic Places, would also require Section 106 consultation under the National Historic Preservation Act (NHPA).[189]

ECONOMIC IMPACT ANALYSIS OF A WYOMING HYDROGEN INDUSTRY

A hydrogen production industry in Wyoming would be an advantageous addition to the State's existing energy industry, working towards the goals of diversifying energy production and the State's economy. This industry would positively benefit the State's labor force, tax revenue streams, and contributions to the U.S. gross domestic product (GDP).

To establish what a Wyoming hydrogen industry could look like, assumptions were made to provide several hydrogen production scenarios for the State. Using the forecasted production scenarios for the U.S. provided in the NPC's Harnessing Hydrogen report, a methodology was established for deriving a forecast for future Wyoming hydrogen production. The NPC provides an annual hydrogen production forecast from 2020 to 2050 under current stated U.S. hydrogen policies. Because of the stagnate growth in the U.S. hydrogen market and the desire to maintain a forward-looking aspect for this analysis, the NPC production forecast was shifted forward by five years to now range from 2025 to 2055 with all other assumptions held equal. The NPC's U.S. hydrogen production forecast with this five-year shift is presented in Figure 14.

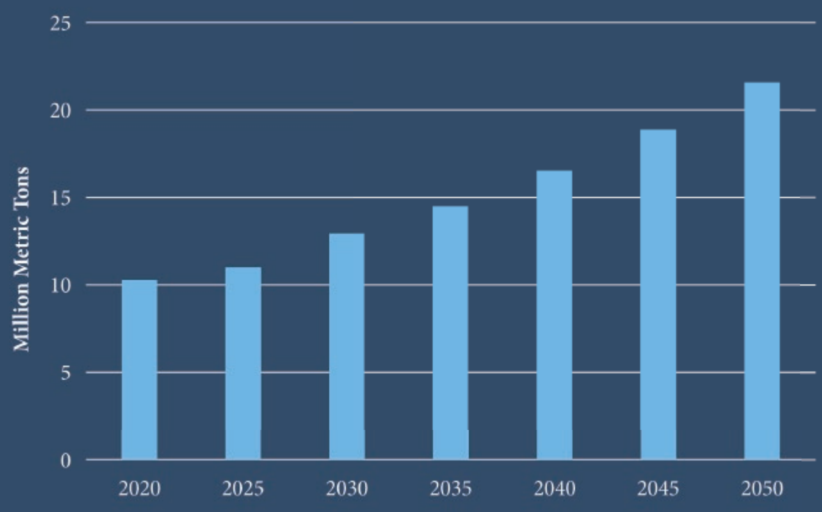


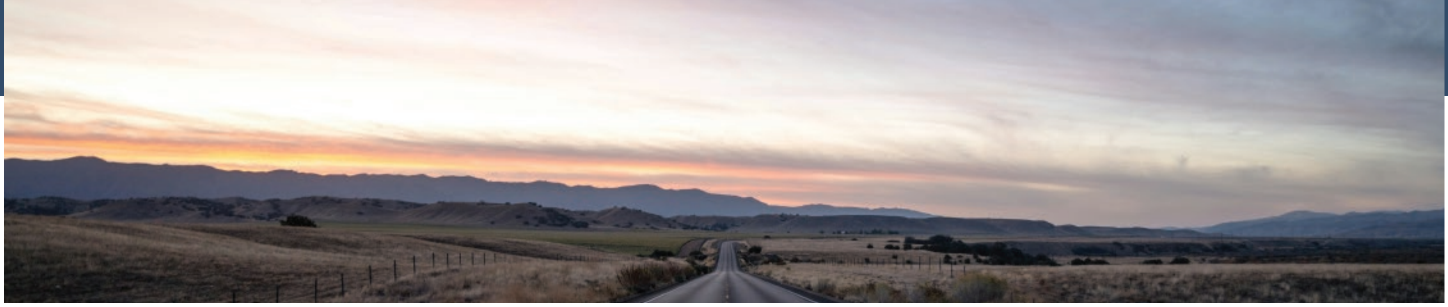
FIGURE 14. NPC U.S. Hydrogen Production Forecast (2025-2055)[191]

[188] *Ibid.*

[189] *Ibid.*

[190] *Harnessing Hydrogen: A Key Element of the U.S. Energy Future, Appendix G – Compendium of Modeling Results,* National Petroleum Council, (April 23, 2024). https://harnessinghydrogen.npc.org/files/H2-Appendix_G-2024-04-23.pdf

[191] *Ibid.*



In the creation of this hydrogen production forecast for the U.S., the NPC used assumptions and made considerations in its model, outlined in its report. These assumptions and considerations include, but are not limited to, forecasts for necessary infrastructure buildout, electricity generation buildout and associated costs, federal and state policy and incentives tied to hydrogen production technologies and their influence on cost and future adoption, permitting limitations, and environmental, safety, and societal impacts.[192]

With this timeframe established, three production scenarios were selected – 1%, 3%, and 5% of total U.S. annual hydrogen production – as a hypothetical representation for future Wyoming hydrogen production. These Wyoming hydrogen production scenarios were then used to conduct further analysis of potential economic impacts of a Wyoming hydrogen industry. Figure 15 shows the three production scenarios. These scenarios are not intended to be treated as a forecast for future hydrogen production in Wyoming. Instead, this analysis should be viewed as hypothetical and used simply as a study of the economic impacts of these scenarios if they were to come to fruition.

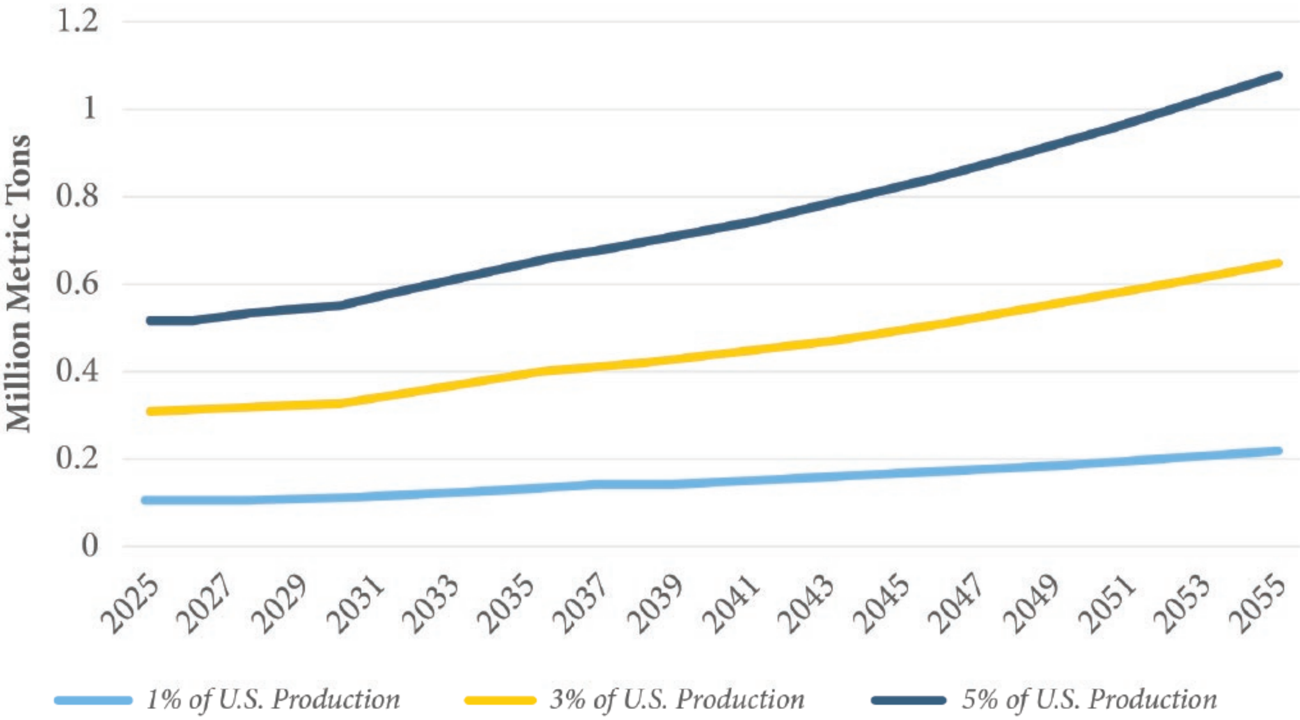


FIGURE 15. Wyoming Hydrogen Production Scenarios (2025-2055)

[192] *Harnessing Hydrogen: A Key Element of the U.S. Energy Future, Chapter 2 – LCI Hydrogen at Scale,* National Petroleum Council, (April 23, 2024). https://harnessinghydrogen.npc.org/files/H2-Ch_2-LCI_Hydrogen_Production-FINAL.pdf

Next, the annual production value of this produced hydrogen needs to be established to further analyze the economic impacts of a Wyoming hydrogen industry. An assumption was made that the cheapest form of hydrogen production would be the market preference and therefore the price of this hydrogen could be used to derive annual production value. The current lowest levelized cost of hydrogen (LCOH) is unabated, fossil fuel derived hydrogen via SMR which is approximately $2 per kilogram.[193] By using this LCOH as a proxy for price, the annual production value under each scenario could be derived, adjusted for annual inflation. It should be noted that using a cost for a proxy of price is not ideal for this analysis, but the lack of available hydrogen price data makes this the next best option that is within reason. Figure 16 shows each Wyoming production scenario's given production values.

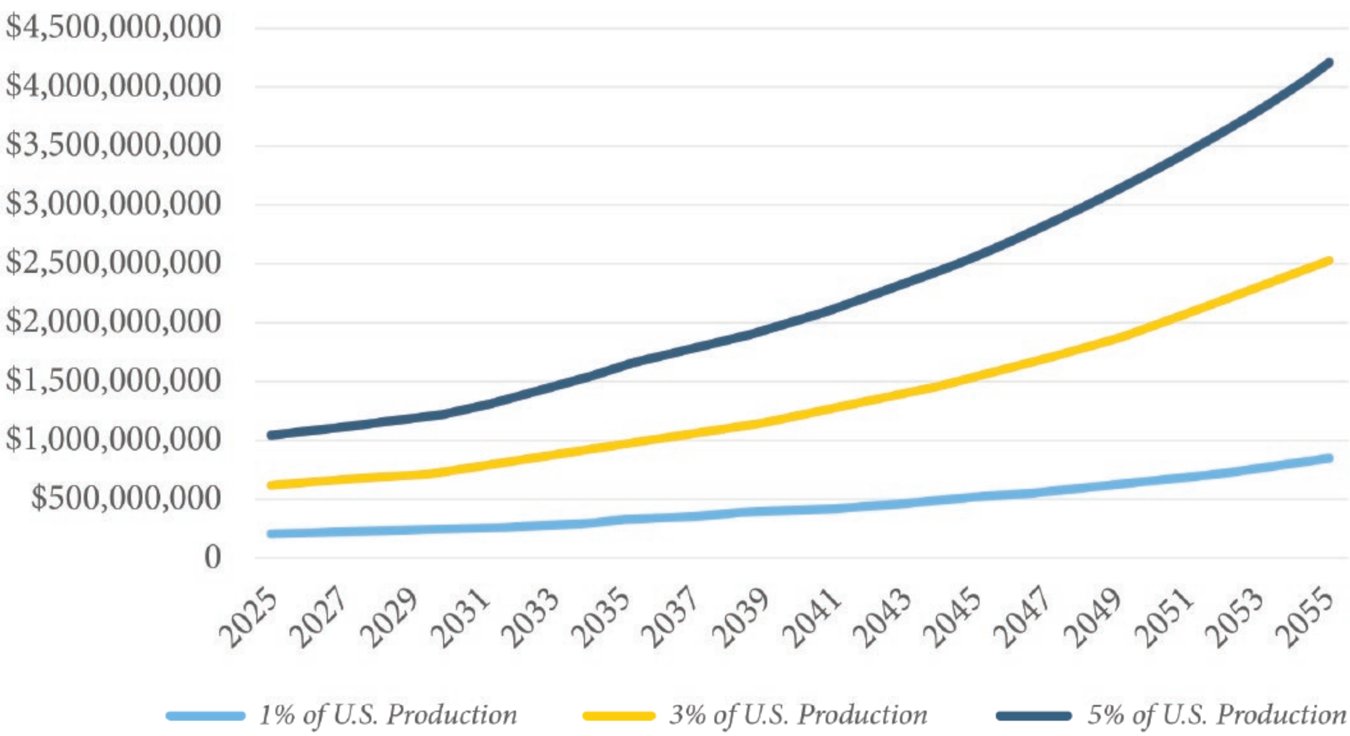


FIGURE 16. Production Value for Wyoming Hydrogen Under Each Scenario (2025-2055)

Using these forecasted hydrogen production values, further analysis could be conducted to estimate the total output, value added, employment, and tax revenue impacts between 2025 and 2055 for each production scenario.

[193] *LCOE Levelized Cost of Energy +*, Lazard (June 2024). https://www.lazard.com/media/xemfey0k/lazards-lcoeplus-june-2024-_vf.pdf

IMPLAN ANALYSIS

For the economic impact analysis of the established production scenarios, the economic modeling software IMpact Analysis for PLANning (IMPLAN) was used. By using the estimated annual hydrogen production between 2025 and 2055 given in the production scenarios that were established for this analysis, the economic impacts – output, value added, employment, and tax revenue – were derived, giving the annual averages for each type of impact.

Please note this analysis solely focuses on produced hydrogen and does not include consideration of geologic hydrogen extraction which would be assessed severance and ad valorem taxes, and royalties in accordance with Wyoming statutes.[194]

OUTPUT

In this economic analysis, output refers to the total value of production by an industry within the study area. That is, the total impact that hydrogen production has on the immediate geographical area, which in this case is the entirety of Wyoming. Output can also be defined by this equation:

$$\text{Output} = \text{Intermediate Inputs} + \text{Value Added}$$

In other words, economic output is the 1) intermediate inputs, or the things used to make a given good, plus 2) the value added, or the additional value created with that intermediate input by workers, machines, or businesses.

It should also be noted that each impact in this analysis is categorized by direct, indirect, or induced impacts. Direct impacts are the impacts that can be directly attributed to the output of the industry being analyzed (the focus industry). Indirect impacts can be attributed to industries that are part of the supply chain of the focus industry while induced impacts are related to consumer spending as a result of the focus industry's output (e.g. employees spending money in the community).

194 Esther Wagner, *Leasing and Permitting Rules and Regulations for Natural Hydrogen Exploration and Production*, University of Wyoming School of Energy Resources (March 14, 2025). https://www.uwyo.edu/ser/_files/docs/research/publications/cerpa-hydrogenleasing-snapshot.pdf

The estimated average annual direct, indirect, and induced output from the Wyoming hydrogen industry between 2025 and 2055 given each production scenario can be seen in Table 5 below.

Impact	1% U.S. Production	3% U.S. Production	5% U.S. Production
Direct	$402,636,114	$1,207,908,341	$2,013,180,569
Indirect	$195,318,315	$585,954,946	$976,591,577
Induced	$39,560,974	$118,682,921	$197,804,869
Total	$637,515,403	$1,912,546,209	$3,187,577,014

TABLE 5. Average Annual Output Under Given Wyoming Hydrogen Production Scenarios (2025-2055)

VALUE ADDED

In IMPLAN, value added essentially represents the contributions to gross domestic product (GDP) by a given industry or project.[196] It can be looked at as the value added between converting inputs to outputs through whatever industry event is being analyzed. Simply put, value added is a way of measuring how much an industry or project contributes to the economy. For this analysis, this represents the value added between the inputs in the hydrogen production process and the final output which is hydrogen. Value added can also be defined using this equation:

Value Added = Output – Intermediate Inputs

Table 6 shows the estimated annual average direct, indirect, and induced value added for each production scenario between 2025 and 2055.

Impact	1% U.S. Production	3% U.S. Production	5% U.S. Production
Direct	$128,846,544	$386,539,631	$644,232,718
Indirect	$90,241,689	$270,725,068	$451,208,446
Induced	$22,201,687	$66,605,060	$111,008,433
Total	$241,289,919	$723,869,758	$1,206,449,597

TABLE 6. Average Annual Value Added Under Given Wyoming Hydrogen Production Scenarios (2025-2055)

[195] IMPLAN Data Team, *IMPLAN Glossary* (June 27, 2017). https://support.implan.com/hc/en-us/articles/115009668388-Output

[196] IMPLAN Data Team, *Glossary,* IMPLAN Support (June 27, 2017). https://support.implan.com/hc/en-us/articles/115009498847-Value-Added

[197] *Federal Reserve Economic Data,* Real Gross Domestic Product: All Industry Total in Wyoming, Federal Reserve Bank of St. Louis, (June 27, 2024). https://fred.stlouisfed.org/series/WYRQGSP

These potential annual average value-added scenarios would all have substantial impacts on Wyoming's economy. Wyoming's real gross state product (GSP), or the State's contribution to U.S. real GDP, was approximately $40.5 billion in 2024.[197] Under the above scenarios, the impacts attributable to the Wyoming hydrogen industry would contribute an estimated 0.6%, 1.8%, and 3.0% of 2024 Wyoming GSP on an average annual basis between 2025 and 2055 assuming steady economic growth.

EMPLOYMENT

Employment, as defined in IMPLAN, is the total number of jobs, including both full-time and part-time, that were added because of a given event.[198] For this analysis, employment should be viewed as the total number of jobs supported by the hydrogen production level under each scenario. Because this analysis covers the years between 2025 and 2055, the average annual employment for each production scenario was used. Table 7 shows the estimated average annual direct, indirect, and induced employment under the given hydrogen production scenarios.

Impact	1% U.S. Production	3% U.S. Production	5% U.S. Production
Direct	234	701	1,169
Indirect	502	1,506	2,510
Induced	234	703	1,172
Total	**970**	**2,910**	**4,851**

TABLE 7. Average Annual Employment Under Given Wyoming Hydrogen Production Scenarios (2025-2055)

Using the most recent estimates of annual employment, average monthly employment in Wyoming during 2023 amounted to 278,582.[199] Though the above estimates for employment impacts from the hydrogen industry seem relatively small, additional direct employment for the 5% U.S. production scenario would be similar to industries such as natural gas extraction which had a monthly average employment of 1,447 in 2023.[200]

[198] Candi Clouse, PhD, *IMPLAN Glossary,* IMPLAN Support (June 27, 2017). https://support.implan.com/hc/en-us/articles/115009668668-Employment

[199] *Wyoming Labor Market Information,* Wyoming Department of Workforce Services, Research and Planning, (June 18, 2024). https://doe.state.wy.us/lmi/#:~:text=Wyoming's%20average%20monthly%20employment%20in,4.9%25)%20compared%20to%202022.

[200] *Quarterly Census of Employment and Wages (QWEC), 2023 Annual Averages,* Wyoming Department of Workforce Services, Research and Planning (April 2024). https://doe.state.wy.us/lmi/2023_QCEW/t32_2023.htm

TAX REVENUE IMPACTS

Next, the impacts of tax revenue derived from Wyoming hydrogen production were calculated through the IMPLAN economic impact analysis. Tax revenue in this analysis included direct, indirect, and induced tax revenue from Wyoming hydrogen production, meaning tax revenue from all aspects of the economic impacts of the introduction of this industry were considered. This includes property tax, sales and use tax, social security tax, income tax (specifically federal income tax as Wyoming does not impose an income tax), and upstream severance taxes among others.

It should be noted that Wyoming does not directly impose a tax on produced hydrogen though its sale as fuel does fall under the purview of "alternative fuel taxes" under current state statutes.[201] Regardless, IMPLAN only applies taxes relevant to the region being studied and therefore should be consistent with active State and Federal policy.

COUNTY TAX REVENUE

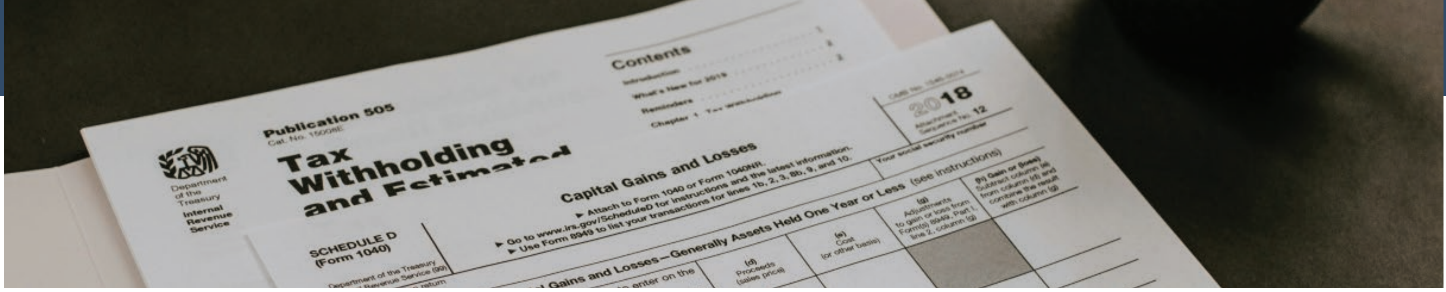
In IMPLAN, county tax revenue is simply defined as the county-level portion of tax revenue generated by a given economic activity.[202] This includes taxes such as sales tax, property tax, motor vehicle tax, and other taxes relevant at the county level. Table 8 shows the estimated annual average direct, indirect, and induced county tax revenue generated under each hydrogen production scenario given in this analysis.

Impact	1% U.S. Production	3% U.S. Production	5% U.S. Production
Direct	$594,531	$1,783,594	$2,972,656
Indirect	$856,377	$2,569,130	$4,281,884
Induced	$226,940	$680,819	$1,134,698
Total	$1,677,848	$5,033,543	$8,389,238

TABLE 8. Average Annual County Tax Revenue (2025-2055)

201 WYO. STAT. ANN. §39-17-301 (2025).

202 Michael Nealy, *Tax Results,* IMPLAN Support (September 8, 2023). https://support.implan.com/hc/en-us/articles/18626179073179-Tax-Results



STATE TAX REVENUE

Like county tax revenue, IMPLAN defines state tax revenue as the state-level portion of tax revenue generated through a given economic activity.[203] This includes sales tax, property tax, motor vehicle license revenue, and severance tax among others. Notably, property tax in Wyoming is allocated to county and local governments as well as K-12 education. Table 9 shows the estimated annual average direct, indirect, and induced state tax revenue generated under each hydrogen production scenario given in this analysis.

Impact	1% U.S. Production	3% U.S. Production	5% U.S. Production
Direct	$4,704,658	$14,113,974	$23,523,290
Indirect	$6,454,145	$19,362,434	$32,270,724
Induced	$1,711,746	$5,135,239	$8,558,732
Total	$12,870,549	$38,611,647	$64,352,745

TABLE 9. Average Annual State Tax Revenue (2025-2055)

FEDERAL TAX REVENUE

Lastly, IMPLAN defines federal tax revenue as the federal-level portion of tax revenue generated through a given economic activity.[204] With this, tax revenue from excise tax, social security tax, and federal income tax among others is included in this analysis. Table 10 shows the estimated annual average direct, indirect, and induced federal tax revenue generated under each hydrogen production scenario given in this analysis.

Impact	1% U.S. Production	3% U.S. Production	5% U.S. Production
Direct	$15,228,030	$45,684,091	$76,140,151
Indirect	$10,917,818	$32,753,454	$54,589,089
Induced	$2,841,161	$8,523,482	$14,205,804
Total	$28,987,009	$86,961,026	$144,935,044

TABLE 10. Average Annual Federal Tax Revenue (2025-2055)

[203] Candi Clouse, PhD, *Taxes on Production & Imports Net of Subsidies* (TOPI), IMPLAN Support (June 27, 2017). https://support.implan.com/hc/en-us/articles/115009667528-Taxes-on-Production-Imports-Net-of-Subsidies-TOPI

[204] *Ibid.*

SUMMARY OF IMPACTS

Table 11 provides a summary of all the above-mentioned impacts from the IMPLAN economic impact analysis under each Wyoming hydrogen production scenario. This includes all direct, indirect, and induced impacts on an average annual basis between 2025 and 2055.

Impact	1% U.S. Production	3% U.S. Production	5% U.S. Production
Output	$637,515,403	$1,912,546,209	$3,187,577,014
Value Added	$241,289,919	$723,869,758	$1,206,449,597
Employment	970	2,910	4,851
Total Tax Revenue	**$43,535,405**	**$130,606,216**	**$217,677,027**
County	*$1,677,848*	*$5,033,543*	*$8,389,238*
State	*$12,870,549*	*$38,611,647*	*$64,352,745*
Federal	*$28,987,009*	*$86,961,026*	*$144,935,044*

TABLE 11. Summary of Average Annual Direct, Indirect and Induced Impacts from the IMPLAN Economic Impact Analysis (2025-2055)

EXISTING AND PROPOSED INVESTMENTS IN A WYOMING HYDROGEN INDUSTRY

Despite the hydrogen industry being relatively in its infancy nationally, there are existing uses for hydrogen in Wyoming as well as proposed investments that would further develop the hydrogen industry in the State. In contrast with the previous analysis which gives purely hypothetical scenarios of a buildout of a Wyoming hydrogen industry, it is useful to get an understanding of the current hydrogen investments in Wyoming and the proposed hydrogen investments that could come to fruition in the foreseeable future. It should be noted that there are likely other existing and proposed investments in the Wyoming hydrogen industry that are either proprietary or yet to be disclosed to the public. Therefore, the following discussion should not be used as a comprehensive list of existing and proposed investment but rather as a baseline for what the Wyoming hydrogen industry is and what it could be.

Existing

Currently, there are several cases in the State for the use of hydrogen. This includes HF Sinclair Corporation's use of hydrogen in petroleum refining and synthetic fuel production, Simplot Phosphate LLC's production of fertilizer and ammonia, and Dyno Nobel's production of explosives. These existing uses are further discussed below. Note that the hydrogen consumed at these facilities is likely produced on-site, as shown in Figure 17, to limit the need for transportation infrastructure.

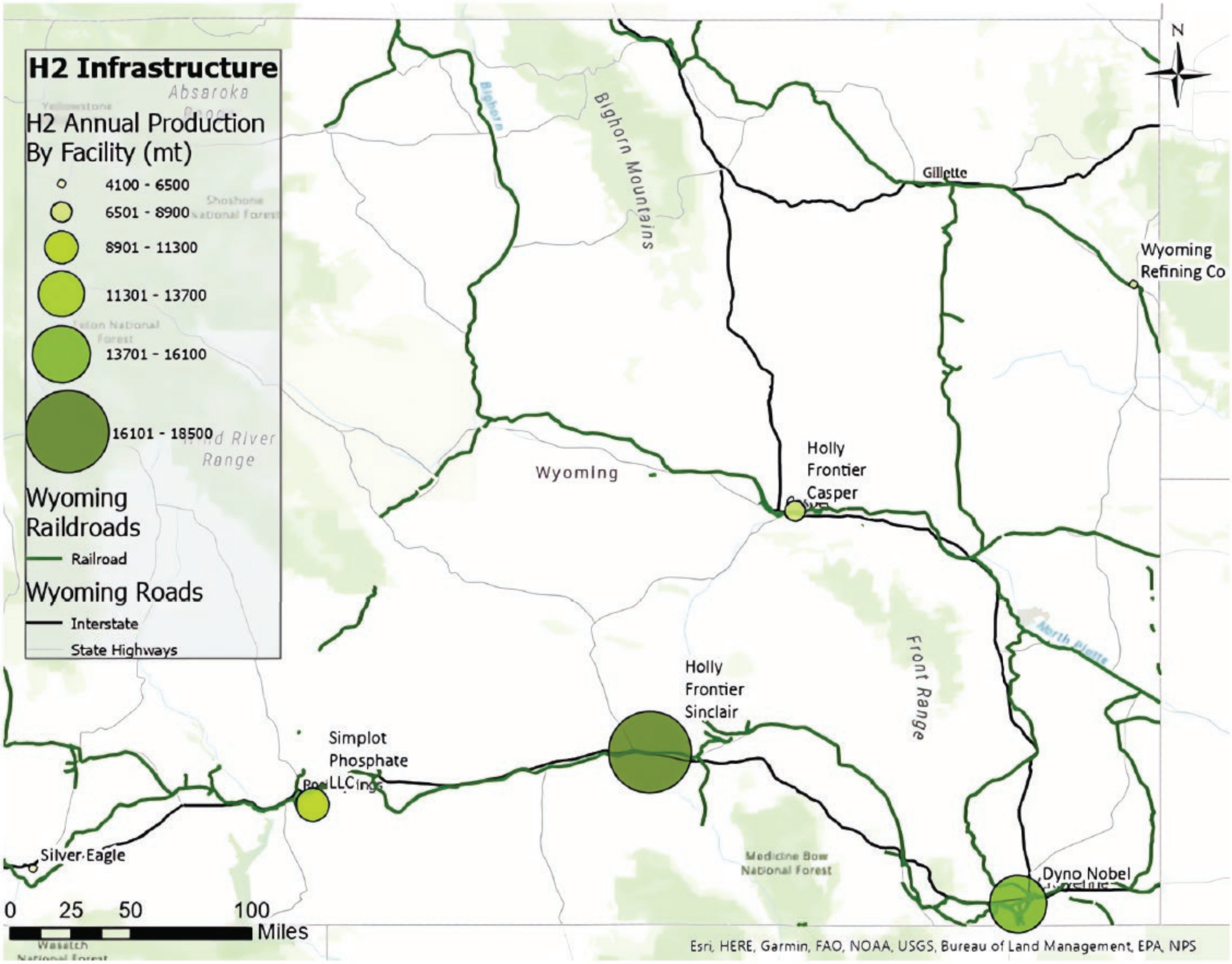


FIGURE 17. GIS map of Wyoming's current hydrogen production facilities and the major roads and railways used to transport a limited quantity of hydrogen at present.[205]

[205] Holubnyak, E., et al., *A Mid-Century Net-Zero Scenario for the State of Wyoming and its Economic Impacts,* U.S. Department of Energy (July 15, 2024). https://www.osti.gov/biblio/2426416

1. **Holly Frontier (HF) Sinclair Corporation – Petroleum Refining and Synthetic Fuels Production**

Hydrogen is used at several HF Sinclair Corporation refineries across the state, including in Casper, Cheyenne and Sinclair, Wyoming. Hydrogen is also used in the petroleum refining process and the production of synthetic fuels such as renewable diesel, which the Cheyenne and Sinclair refineries both produce.[206] Producing renewable diesel is a growing opportunity for petrochemical companies, with the consumption of the fuel increasing as shown in Figure 18.[207] As of 2023, these two refineries accounted for 207 million gallons per year (mmgy) of the 2,856 mmgy (approximately 7.3%) of renewable diesel production capacity in the U.S.[208]

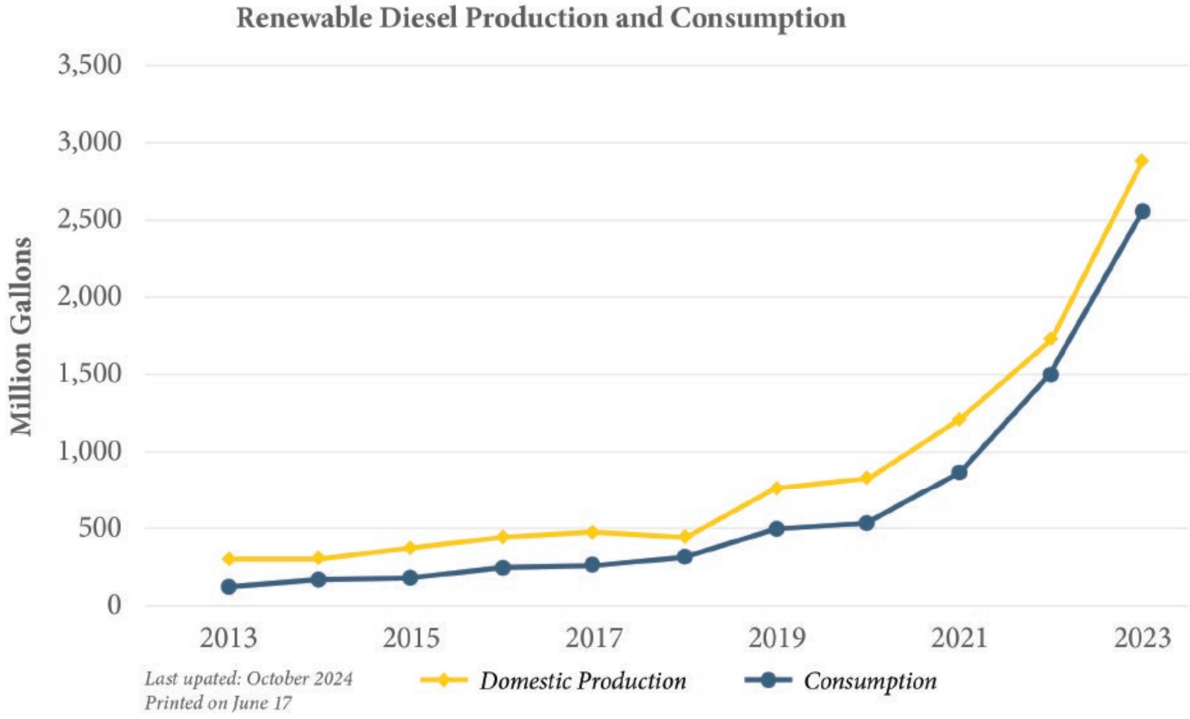


FIGURE 18. U.S. Renewable Diesel Fuel Production and Consumption.[209]

2. **Wyoming Refining Company - Petroleum Refining**

A subsidiary of Par Pacific, Wyoming Refining Company operates a refinery located in Newcastle, Wyoming with a capacity of 20,000 barrels per day.[210] As discussed with HF Sinclair Corporation operations, the refining process utilizes hydrogen, making Wyoming Refining Company a consumer of hydrogen in the State. Beyond this, Par Pacific has also announced its intention to produce sustainable aviation fuels (SAF) at other locations outside the State, making this a possibility for future investment in Wyoming.[211]

[206] *Facilities,* HF Sinclair (2022). https://www.hfsinclair.com/operations/facilities/us/cheyenne-wy/default.aspx

[207] Alternative Fuels Data Center, *Renewable Diesel,* U.S. Department of Energy (2024). https://afdc.energy.gov/fuels/renewable-diesel

[208] *Ibid.*

[209] *Ibid.*

[210] *Wyoming Refining Company,* Par Pacific (2025). https://www.parpacific.com/operations/refining-logistics/wyoming

[211] 2023 Par Pacific Sustainability Report, Par Pacific (2024). https://www.parpacific.com/sites/par-pacific-holdings/files/sustainability-reports/2023-Par-Pacific-Sustainability-Report.pdf

3. **Simplot Phosphate LLC – Fertilizer and Ammonia Production**

   Simplot is an international agribusiness company with operations in Rock Springs, Wyoming primarily using phosphates to produce fertilizer products.[212] Through this production process, hydrogen is produced which is used as both a feedstock for producing ammonia, a primary ingredient in several of Simplot's products, and is a component of the fuel used to produce electricity at this facility.[213] Beyond this, by deploying several technologies, including a technology developed at its Moses Lake Plant using a blend of biogas, hydrogen, and natural gas to generate electricity, Simplot has plans to further reduce energy use at their production facilities by 15% per ton of product by 2030.[214, 215]

4. **Dyno Nobel - Explosives Manufacturing**

   Dyno Nobel is an explosives manufacturing company located in Cheyenne, Wyoming that primarily provides its products to the mining industry.[216] Hydrogen is used extensively in the manufacturing process as a feedstock to produce ammonia, a primary ingredient in ammonium nitrate, which is used to produce several of their products.[217] Dyno Nobel is among the largest producers and consumers of hydrogen in the State as shown in Figure 17.

Proposed

Hydrogen will likely be a key variable for many sectors of the U.S. economy at large going forward, playing an increasing role in transportation, industrial processes and energy production. Wyoming is well positioned to capitalize on this emerging industry, providing the opportunity to further build the State's industrial base and diversify and grow the State's economy. This could open Wyoming to markets both in and outside the State. Beyond what already exists for the Wyoming hydrogen industry, there is investment interest that could grow the ability for producing and consuming hydrogen in the State. The following are proposed hydrogen projects in Wyoming. Like the previous section, there could be additional investments to the ones listed below that are either yet to be announced or are proprietary in nature.

212 *The J.R. Simplot Company,* Simplot (2025). https://www.simplot.com/company

213 Simplot Phosphates LLC, Rock Springs Chamber of Commerce (2025). https://business.rockspringschamber.com/list/member/simplot-phosphates-llc-971

214 *4Sight 2030 Goals*, Simplot (2025). https://www.simplot.com/sustainability/planet/4sight2030

215 *2013 Moses Lake Plant Honored for Environmental Excellence,* Simplot (2025). https://www.simplot.com/company/news/2013-moses-lake-plant-honored-for-environmental-excellence

216 *About Dyno Nobel*, Dyno Nobel (2025). https://www.dynonobel.com/about-us/

217 *Technical Data Sheet – Ammonium Nitrate,* Dyno Nobel (2025). https://www.dynonobel.com/siteassets/product-hub/tech-info/1ammonium_nitrate_industrial.pdf

1. **Pronghorn Clean Hydrogen Center**

The Pronghorn Clean Energy Center is a proposed hydrogen production project in eastern Wyoming, spearheaded by Focus Clean Energy. With ambitions to use a collocated large-scale wind project to produce hydrogen via electrolysis, the project will invest billions of dollars into the Wyoming hydrogen industry.[218] Ultimately, the hydrogen generated through this project will be used either directly as hydrogen fuel or combined with other gases to make ammonia or SAF.[219] The project will encompass over 46,000 acres of private and State land in Converse County with over 302.5 MW of wind energy capacity currently slated for construction.

Projected Economic Impacts
According to Focus Clean Energy the Pronghorn Clean Hydrogen Center project represents $1.7 billion in private investments and will create 107 total jobs in Converse County, generating an estimated $10 million per year in total labor income. Beyond this, it anticipates that this project will contribute a combined $477 million in state and local tax revenue throughout its estimated 35-year life.[220]

2. **Sidewinder Clean Hydrogen Center**

Also spearheaded by Focus Clean Energy, the Sidewinder Clean Hydrogen Center project proposes to generate hydrogen via electrolysis using collocated large-scale wind power.[221] This project is similar in scale, location and application to the Pronghorn Clean Hydrogen Center. There is less information available for the Sidewinder Clean Hydrogen Center as it has received relatively less public attention than the Pronghorn Clean Hydrogen Center.

Projected Economic Impacts
Focus Clean Energy stated that, "Sidewinder will create 200 new, well-paying long-term jobs for the community and will generate up to $20 million per year in new tax revenue for Niobrara County during its anticipated 35-year lifespan."[222]

[218] *About the Project,* Pronghorn Clean Energy Center (2024). https://www.pronghornh2.com/about

[219] Madison, David, *Ranch Family Files Lawsuit to Block Wyoming Wind Lease, Citing Generational Legacy,* Cowboy State Daily (June 2, 2025). https://cowboystatedaily.com/2025/06/02/ranch-family-files-lawsuit-to-block-wyoming-wind-lease-citing-generational-legacy/

[220] *Ibid.*

[221] *About the Project,* Sidewinder Clean Energy Center (2024). https://www.sidewinderh2.com/about

[222] *Ibid.*

3. **Prometheus Hyperscale**

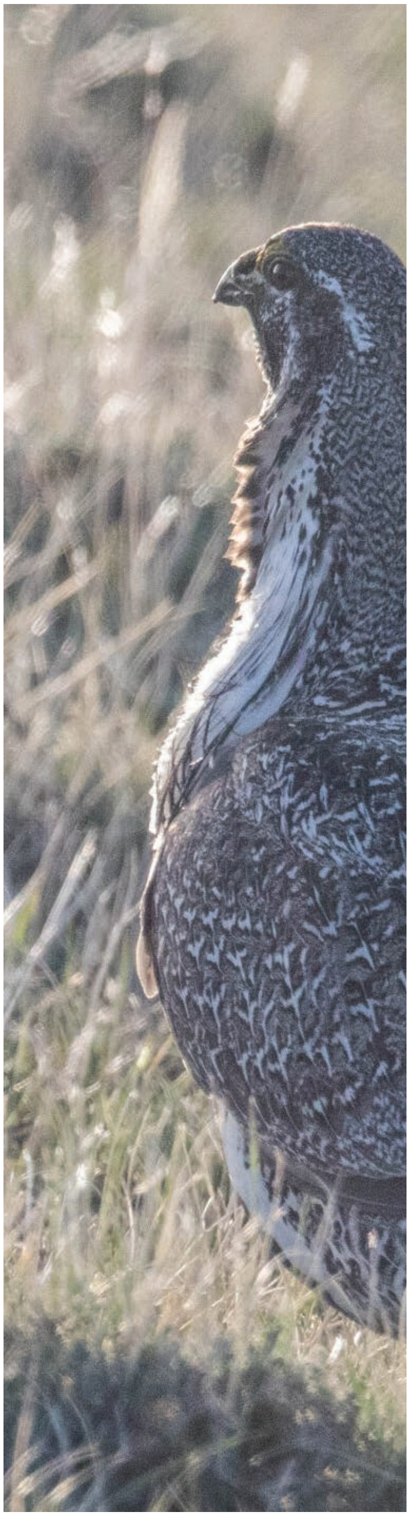
Prometheus Hyperscale is a data center company planning to construct its flagship 1 GW data center in Evanston, Wyoming. The project includes a zero-carbon data center operating with minimal emissions using natural gas as fuel alongside carbon capture and storage (CCS). The project has future plans to establish nuclear energy capabilities.[223] In May 2025, Frontier Infrastructure, an energy infrastructure company, purchased 16 Baker Hughes NovaLT gas turbines, each with an individual capacity of 17.5 MW, to power data centers in Texas and Wyoming, including the Prometheus Hyperscale data center.[224] Though natural gas is the current fuel of choice for this project, the NovaLT gas turbines are also compatible with hydrogen blends and 100% hydrogen as fuel.[225] Unfortunately, the current lack of hydrogen infrastructure in Wyoming has made it impossible to use hydrogen as fuel right now, but it does create opportunities to develop in-state hydrogen demand. Fostering the potential to source fuel for these turbines is a promising sign for the demand side of hydrogen in Wyoming.

4. **BrightLoop**

In partnership with Babcock and Wilcox (B&W), Black Hills Energy is proposing to use Powder River Basin coal from their WyoDak mine to produce low carbon intensity hydrogen using B&W's BrightLoop technology. The project proposes to build a demonstration plant and use the process to produce 15 mt of hydrogen per day. Upon successful demonstration of the first plant, a second plant will be built to produce upwards of 200 mt of hydrogen per day while storing or utilizing the captured CO_2 generated in the production process.[226]

Projected Economic Impacts

Black Hills Energy and B&W have estimated the economic impacts for both the demonstration plant and the second plant of the BrightLoop project. For the demonstration plant, the estimated impacts include $150 million in capital expenditures, 75-100 construction jobs and 263 direct, indirect and induced jobs with a projected annual payroll of $2.4 million. The second plant, being significantly larger, would include $650 million in capital expenditures, 300-500 construction jobs and 422 direct, indirect and induced jobs with a projected annual payroll of $3.8 million.[227]



[223] *Pioneering Projects Across the American West,* Prometheus Hyperscale (2024). https://www.prometheushyperscale.com/

[224] Skidmore, Zachary, *Frontier Infrastructure Buys 16 Baker Hughes Natural Gas Turbines for US Data Centers*, Data Center Dynamics (May 30, 2025). Frontier Infrastructure buys 16 Baker Hughes natural gas turbines for US data centers - DCD

[225] NovaLT16, Baker Hughes (2025). https://www.bakerhughes.com/gas-turbines/novalt-technology/novalt16

[226] *PRB Coal to Hydrogen with BrightLoop Final Report*, Black Hills Energy (2025). https://wyoenergy.org/wp-content/uploads/2024/06/BW-BHE_PRB_Coal_to_Hydrogen_with_BrightLoop-Final_Report-Public.pdf

[227] *Ibid.*

RECOMMENDATIONS - POTENTIAL IMPROVEMENTS TO INCENTIVIZE HYDROGEN MARKETS IN WYOMING

Legal, Regulatory and Policy

Considering the potential legal, regulatory, or policy roadblocks that could hinder the buildout of a Wyoming hydrogen industry is an important part of incentivizing investment for commercial hydrogen projects in the State. The following are recommendations to address existing challenges.

1. **Increase Awareness of the Benefits of Producing Hydrogen in Wyoming**
   Wyoming is one of the few states in the region that has a history of hydrogen production, making the State well positioned to attract new investments and expand the existing industry to meet future hydrogen demand in the U.S. Increasing awareness of the benefits of producing hydrogen in Wyoming, including the ease of permitting hydrogen production facilities makes Wyoming an attractive option for siting a project. Beyond this, Wyoming is a safe location with a small population that has a clear understanding of the energy industry relative to the rest of the country. Wyoming also hosts large-scale geological storage options, easing the constraints for hydrogen storage. The State also has an excellent track record of investing in the necessary infrastructure to support its energy industries.

2. **State Investment in Emerging Technologies**
   Providing investment opportunities for pilot projects with the greatest potential to advance commercial, technical and readiness levels of hydrogen production could help stimulate growth in the industry. With this, attracting investment for these technologies, and doing so in a time effective manner, will decrease time to market which ultimately decreases financial risk and operational cost burdens. Holistically developing a strategy to attract investment for this industry will catalyze growth, allowing for a greater chance of economies-of-scale being achieved.

3. **Enact State Support for the 45V Tax Credit**
   The current amount allocated by the 45V tax credit is tiered based on the carbon intensity of the technology being utilized to produce hydrogen. In most cases, it excludes natural gas and coal-derived hydrogen projects from qualifying for 45V, even when utilizing carbon capture technologies, rendering these technologies significantly less cost competitive when compared to alternative technologies of producing hydrogen. Enacting State support to levelize the 45V tax credit for all production technologies, to provide natural gas and coal-derived hydrogen production with even footing in project finance considerations, would allow the industry to leverage the abundant natural gas and coal resources found in the State, and benefit multiple Wyoming industries simultaneously.

4. **Address Gaps in Federal and State Hydrogen Policy**
   There are known and likely unknown gaps in Federal and State policy that may inhibit growth of a Wyoming hydrogen industry. In order to continually advance deployment of hydrogen in the State, it will be important to maintain ongoing research in this realm and provide recommendations for ways to address these gaps to Federal and State agencies involved in the policy creation and regulatory oversight of hydrogen.

Infrastructure

With the buildout of a Wyoming hydrogen industry will come the need to invest in the necessary infrastructure to carry out hydrogen production, transportation, storage, and consumption. It is important to consider the primary aspects of making these investment decisions and which investments could provide the greatest opportunity for the growth of the industry in Wyoming.

1. **Investing in Transportation and Storage Infrastructure**

   Investment in cost-effective methods of hydrogen transportation and storage should be highly prioritized as it underpins the rest of the buildout of the industry. The most cost-effective methods of both, as analyzed in this paper, are:

   A. *Transportation* - Wyoming will not see the volumes necessary to invest in hydrogen pipeline infrastructure in the foreseeable future; therefore, liquid hydrogen rail transportation coupled with liquid hydrogen truck transportation for shorter distances will likely be the most economical options for hydrogen transportation in Wyoming and the surrounding regions.

   B. *Storage* – with an estimated cost per kilogram of hydrogen being $1.50 ($1.00 less than the next closest storage option), depleted natural gas reservoirs are the most economical option for hydrogen storage in Wyoming, all else held equal. Considerations should be made for geological constraints and other costs associated with site selection, still making both saline aquifers and salt caverns potentially viable options for hydrogen storage in specific scenarios.

   Please note more research specific to Wyoming should be conducted regarding the technoeconomic feasibility of these methods of hydrogen transportation and storage.

2. **Leveraging All Sources of Investment**

   Transportation infrastructure is among the most expensive aspects of building out a hydrogen industry in the State and is a crucial aspect of connecting hydrogen production with demand centers. It is apparent that Federal, State, and private sector investment will be necessary to effectively build out this infrastructure. Leveraging all investment avenues should be explored when considering investment in hydrogen transportation infrastructure. More specifically, efforts should be made to enhance Wyoming's extensive intrastate and interstate rail, highways, and pipeline infrastructure to accommodate hydrogen transportation and connect Wyoming to neighboring states and extended markets. This will benefit the buildout of a Wyoming hydrogen industry while supporting the existing industry.

3. **Utilizing Hydrogen as a Feedstock**

   With some aspects of a Wyoming hydrogen industry potentially proving difficult to overcome, it could be beneficial to focus on using hydrogen as a feedstock for ammonia production. Ammonia, a larger molecule and therefore less technically difficult to transport and store, could prove to be a better value-added product in terms of the necessary infrastructure to accommodate its transportation and storage. Considering these constraints, ammonia would also be a more viable option when looking at accessing ports to reach outside markets. Domestically, ammonia already has well-established markets in the State and greater region. More research should be conducted to better understand the dynamics of focusing on this pathway for Wyoming hydrogen.

Emerging Hydrogen Opportunities

The hydrogen industry at large is in its early stages, so naturally there are many opportunities being explored for how to best expand it. The following are the opportunities for which Wyoming is best positioned to catalyze the industry's growth in the State.

1. **Using Hydrogen to Harness Stranded Assets in Wyoming**

There are several opportunities surrounding Wyoming's stranded assets (i.e. natural gas or oil resources that cannot be recovered economically using traditional methods) that could be utilized by a Wyoming hydrogen industry.

A When fossil fuels such as natural gas or coal are used to produce hydrogen, CO_2 is generated as a byproduct. Although CO_2 is often seen as a waste byproduct, incorporating carbon capture technologies into fossil fuel derived hydrogen production enables the CO_2 to be utilized in EOR, making once uneconomical oil and natural gas resources available for extraction. This, coupled with the value of the hydrogen production itself, would further add value to the hydrogen production process and unlock valuable extractable resources in the State.

B Oil and natural gas resources are sometimes stranded due to location and transportation constraints making it uneconomical to produce. One solution is to collocate consumption onsite, negating the need for transportation. Although a hydrogen transportation buildout would still be necessary, the possibility of collocating hydrogen production provides ample opportunity to the State. A likely candidate to limit the constraints of the requirements for transportation would be to use the produced hydrogen as a feedstock for ammonia production which is much easier to transport, as discussed above.

2. **Leveraging Data Center Electricity Fluctuations to Produce Hydrogen**

New data center projects are continuously being announced throughout the U.S., and Wyoming is no exception to this trend. With these data centers comes the need for reliable and dispatchable electricity, often leading to data center companies investing and collocating their own electricity generation. In several projects, including some that are being constructed in the State, this means generating electricity using natural gas. Though some natural gas turbines can meet the highly fluctuating electricity demand of these data centers, it may make more sense to maintain a steady level of electricity generation and employing the unused electricity to produce hydrogen onsite. This creates further value for the data center while also stabilizing its electricity demand.

3. **Sustainable Aviation Fuel Production**

With the increasing adoption of SAF and the State's proximity to Denver International Airport (DIA), producing SAF in Wyoming could prove to be a considerable opportunity. Regional airports around Wyoming could also be potential consumers of SAF if the industry continues the current rate of adoption of the fuel as shown in Figure 19.

The extension of the 45Z tax credit, a clean fuel production tax credit that includes the production of SAF, to the end of 2029 in the passing of the OBBBA is also a significant development for the future growth of the SAF industry.[228] Compared to the rollbacks of other tax credits in the bill, the extension of 45Z insures the security, at least in the short term, of government subsidization for the SAF industry.

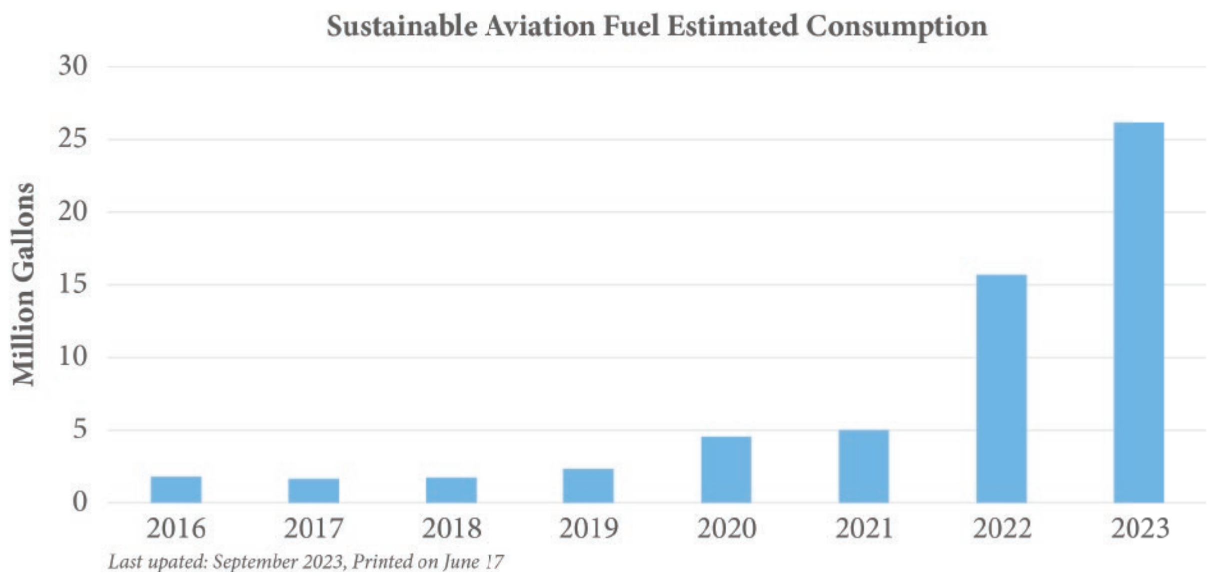


FIGURE 19. This graph shows the estimated quantity of sustainable aviation fuel (SAF) consumed in the United States, based on the Renewable Identification Numbers (RINs) volume generated as reported to the Environmental Protection Agency (EPA) for the Renewable Fuel Standard.[229]

CONCLUSION

As energy markets continue to evolve, it will be important for Wyoming to stay engaged and continue innovating to maintain a competitive advantage as an energy leader. Current investments in emerging technologies such as nuclear energy and CCS will help the State retain its role as the third-biggest energy supplier in the United States. Hydrogen production could be a prosperous part of maintaining this position, particularly as hydrogen demand is expected to more than double by 2050.

There are several reasons why a hydrogen industry would be a natural fit for Wyoming's energy portfolio. For instance, hydrogen production typically relies on existing energy resources, such as natural gas and coal, which the State has in abundance. Additionally, although Federal regulations governing hydrogen production, transportation and storage are complex and fragmented, Wyoming is well-positioned from a regulatory and permitting standpoint to move forward with a hydrogen industry.

The IMPLAN economic impact analysis developed for this paper examined three potential scenarios for a Wyoming hydrogen industry, with each scenario for Wyoming capturing 1%, 3%, and 5% of forecasted U.S. hydrogen production between 2025 and 2055 given in the NPC's Harnessing Hydrogen Report. The results showed significant direct, indirect and induced economic impacts between 2025 and 2055 summarized in Table 12. Though this analysis should be seen as theoretical rather than a forecasted outlook of a Wyoming hydrogen industry, it showcases the potential economic impacts that could come from a build out of this industry.

[228] Kempe, Ysabelle, *A Cheat Sheet to Clean-Energy Tax Credit Changes under Trump's New Law,* Canary Media (July 14, 2025). https://www.canarymedia.com/articles/clean-energy/tax-credit-changes-trump-law

[229] Alternative Fuels Data Center, *Sustainable Aviation Fuel Estimated Consumption,* U.S. Department of Energy (January 2023). https://afdc.energy.gov/data

Impact	1% U.S. Production	3% U.S. Production	5% U.S. Production
Output	$637,515,403	$1,912,546,209	$3,187,577,014
Value Added	$241,289,919	$723,869,758	$1,206,449,597
Employment	970	2,910	4,851
Total Tax Revenue	**$43,535,405**	**$130,606,216**	**$217,677,027**
County	*$1,677,848*	*$5,033,543*	*$8,389,238*
State	*$12,870,549*	*$38,611,647*	*$64,352,745*
Federal	*$28,987,009*	*$86,961,026*	*$144,935,044*

TABLE 12. Summary of Average Annual Direct, Indirect and Induced Impacts from the IMPLAN Economic Impact Analysis (2025-2055)

The existing markets for hydrogen in Wyoming and the emerging markets that show the greatest future potential provide a baseline understanding for how this industry may grow in coming years and beyond. For existing markets, the use of hydrogen in oil refineries, the production of synthetic fuels such as renewable diesel, and ammonia production for creating value added products have given Wyoming a strong foundation for the use of hydrogen in the State. Emerging markets demanding hydrogen such as electricity production at data centers, energy storage, and production of SAF provide opportunities to further create in-state demand for hydrogen. With increased demand will come the opportunity to leverage other assets in Wyoming to produce hydrogen. This could include harnessing stranded assets in Wyoming to produce hydrogen, developing technologies to produce low carbon intensity hydrogen using coal, and capturing the fluctuating electricity use of the ever-growing data center industry in the State to produce hydrogen.

With these existing and emerging markets for hydrogen in Wyoming, there is ample opportunity for policymakers to foster growth in an already established sector and further diversify Wyoming's energy industry and economy at large. This includes increasing awareness of the benefits of producing hydrogen in Wyoming to attract new investments, including the ease of hydrogen permitting, benefits of a safe location with a small population, and availability of large-scale geological storage options. Additional incentives would be to support legislation to levelize the 45V tax credit to include credit for hydrogen produced from natural gas and coal, providing investment opportunities for commercial-scale pilot projects, and investing in necessary hydrogen transportation and storage infrastructure.

APPENDIX A
WYOMING HYDROGEN PERMITTING FLOW CHART

Preconstruction	
Permit	**Agency**
Industrial Siting Permit (ISC Permit) (for facilities with an estimated construction cost of more than $290,000,000 – construction cost estimates do not include pipelines)	WDEQ Industrial Siting Division
Drinking Water/Wastewater Permits to Construct/Engineering	WDEQ Water Quality Division
SDWA Public Water System Permit (for facilities not connected to a municipal water source that serve water to more than 25 people for the better part of a year)	EPA Region 8
404/401 Dredge & Fill permits	U.S. Army Corp of Engineers WDEQ Water Quality Division
Water Rights/Engineering/Water storage/Dam safety	State Engineer Wyoming Water Development Commission
Pipeline Operating ID	Wyoming Public Service Commission (WPSC)
Environmental (endangered species)	Wyoming Game and Fish Department (WGFD) U.S. Fish & Wildlife (as applicable)

Construction	
Permit	**Agency**
Demonstrate ISC Permit compliance (if applicable)	Industrial Siting Council
Air Quality	WDEQ Air Quality Division
Stormwater Construction (Wyoming Pollutant Discharge Elimination System (WYPDES))	WDEQ Water Quality Division
Underground Injection Control (UIC) Class I, Class V (also for operation)	WDEQ Water Quality Division
UIC Class VI (applicable for carbon capture storage) (also for operation)	WDEQ Water Quality Division (in coordination with Wyoming Oil and Gas Conservation Commission for pore space unitization orders)

Operations	
Permit	**Agency**
Demonstrate ISC permit compliance (if applicable)	Industrial Siting Council
Air Quality Operating Permit	WDEQ Air Quality Division
Air Quality GHG Part 98	EPA
Accidental Release Prevention/Risk Management Plan (for pipeline facilities)	EPA Region 8 per Section 112r of CAA and 40 CFR part 68
WYPDES (wastewater discharge)	WDEQ Water Quality Division
Industrial stormwater permit (WYPDES)	WDEQ Water Quality Division
Solid waste processing facility permits	WDEQ Solid and Hazardous Waste Division
Hazardous waste generator requirements	WDEQ Solid and Hazardous Waste Division

Hydrogen Storage	
Permit	**Agency**
Demonstrate ISC Permit compliance (if applicable)	Industrial Siting Council
Geologic storage	WDEQ Water Quality Division (UIC Class V or Class I) or in conjunction with Wyoming Oil and Gas Conservation Commission for pore space unitization orders (UIC Class II and Class VI)
Above-Ground Storage (hydrogen)	EPA
Above-Ground Storage (blended hydrogen/natural gas)	WDEQ Solid and Hazardous Waste Division WDEQ Air Quality Division
Underground Storage Tanks (hydrogen)	EPA
Underground Storage Tanks (blended hydrogen/natural gas)	WDEQ Solid and Hazardous Waste Division
Structural components and operations safety of gaseous and liquid hydrogen storage	OSHA

Transmission/Transportation	
Permit	**Agency**
Compression prior to transmission	WDEQ Air Quality Division (permit) EPA Region 8 per Section 112r of CAA and 40CFR68
Pipeline (dedicated/blending)	WPSC PHMSA
Trucks	PHMSA
Pipeline leaks	WPSC PHMSA

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