Texas as powerhouse of the clean hydrogen economy

Opportunities for Dutch businesses

Netherlands Enterprise Agency

May, 2025

Colofon

This publication is commissioned by:

Netherlands Business Support Office Texas
4201 Main Street | Suite 205
Houston, Texas 77002
United States of America
E office@nbso-texas.com
W www.nbso-texas.com

International Clean Energy Partnership,
Netherlands Enterprise Agency (RVO)
Graadt van Roggenweg 200
P.O. Box 8242
3531 AH Utrecht
The Netherlands
E redesk@rvo.nl
W www.rvo.nl

Kingdom of the Netherlands

Netherlands Enterprise Agency

Netherlands

NBSO Texas | Netherlands Business Support Office

ACRETIO PROJECT DEVELOPMENT CONSULTING

This publication
Lead author:
- Serge Ribot – Acretio, Houston

Co-authors:
- Baukje ‘Bee’ Kothuis - Netherlands Business Support Office Texas, Houston
- Marcella Kneppers – Embassy of the Netherlands, Washington DC

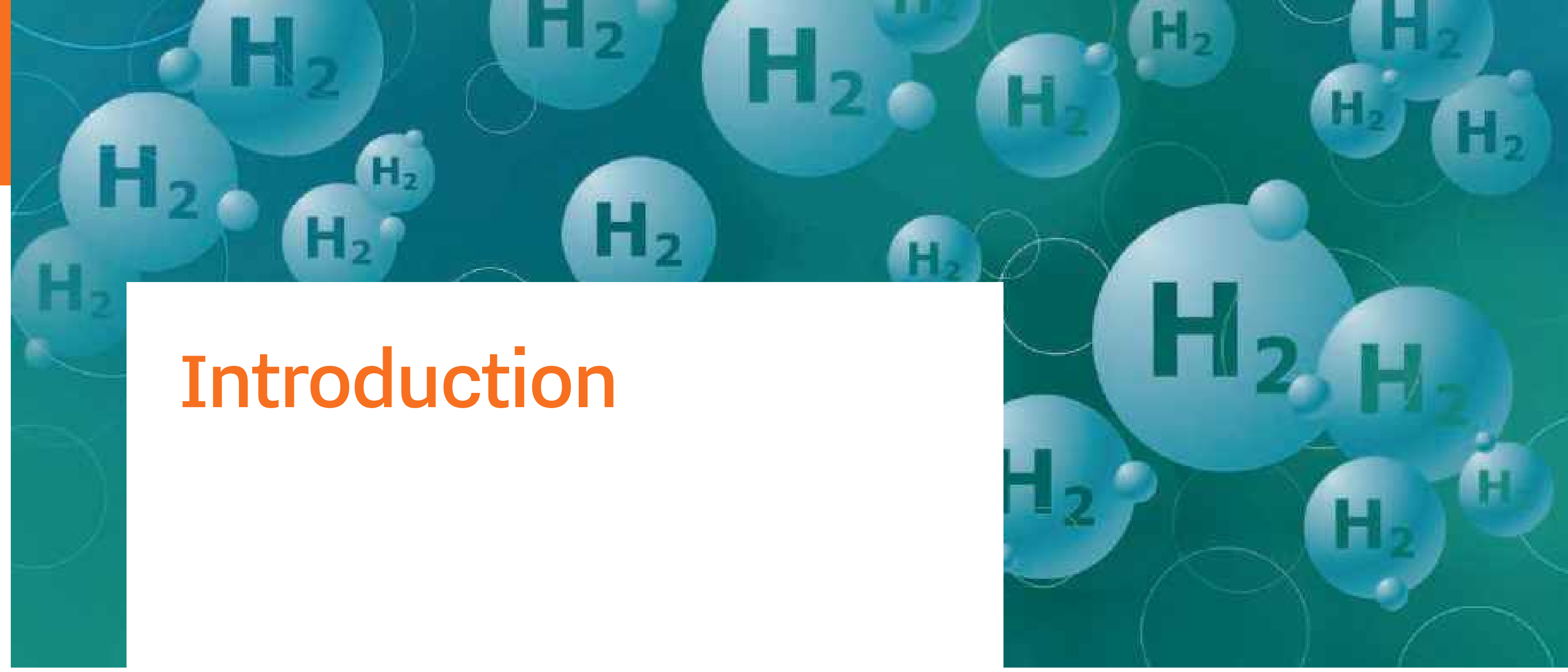
Reviewers
- Claire Hooft Graafland - RVO, The Hague
- Ralf van der Ven - Acretio, Houston
- Thomas Gieskes - Acretio, Houston
- Fleur Verbiest - Embassy of the Netherlands, Washington DC
- Lisette den Breems – Consulate of the Netherlands, Miami
- Carla Robledo – Ministry of Climate Policy and Green Growth, The Hague
- Randolf Weterings - Port of Rotterdam, Rotterdam

Graphic and visual design
Brigitte Wijnbergen - Pica2, Sayalonga

Photo credits
Pixabay, Pexels, Unsplash

Version May 2025

Content



Introduction

This market scan has been commissioned by the Netherlands Business Support Office (NBSO) Texas and the International Clean Energy Partnership (ICEP), both part of the Netherlands Enterprise Agency (RVO). It aims to provide insight into the emerging opportunities within the clean hydrogen economy in Texas, with a focus on Dutch-Texan collaboration.

We are mindful that current policy developments in the U.S. may introduce some short-term uncertainty, with potential implications for the longer-term policy landscape. Nonetheless, there is strong momentum for continued investment in energy transition initiatives—including hydrogen. In Texas, this transition is often framed not as a shift away from traditional energy sources, but as energy addition or energy abundance: the pursuit of clean energy sources alongside an ongoing commitment to conventional energy production.

Texas is uniquely positioned as a global leader in cost-effective energy production. It generates more wind and solar power than any other U.S. state and is actively advancing Carbon Capture and Storage (CCS) and Carbon Capture, Utilization and Storage (CCUS) technologies. This makes Texas a key player in both green and blue hydrogen developments.

The joint effort between the Netherlands and Texas was sparked by the visit of Her Majesty Queen Máxima to Texas in late 2022. During this visit, both sides agreed to explore the development of a Transatlantic Hydrogen Corridor between the Netherlands and the Texas Gulf Coast. This report intends to serve as a further catalyst for the many initiatives that have since taken root in support of this vision.

The close and highly valued partnerships with Texan stakeholders—ranging from government to industry and academia—have been instrumental in driving this effort forward. We warmly encourage Dutch entrepreneurs, researchers, and policymakers and their Texan counterparts to explore the opportunities described in this report and to reach out to RVO, ICEP, NBSO Texas, and the wider Dutch diplomatic network in the U.S. for further information, guidance, and matchmaking support in developing the Dutch-Texas hydrogen ecosystem.

To conclude, we would like to express our sincere appreciation to Serge Ribot, the lead author of this report, for his sharp analysis and tireless efforts in bringing this market scan to completion. Special thanks go to Marcella Kneppers, for her key role in co-conducting and reporting on the interviews, and contributions to the innovation-focused chapters and editorial reviews, and to Brigitte Wijnbergen for her outstanding work in transforming the content into a clear and visually engaging report. We are likewise grateful to RVO and the broader Dutch international network for their support throughout the process. Finally, we acknowledge the vital contributions of Bee Kothuis in Texas as co-author of this report, and of Claire Hooft Graafland for her unwavering support from the Netherlands. Together, they proudly sign this introduction.

Baukje 'Bee' Kothuis, Chief Representative,
on behalf of Netherlands Business Support Office (NBSO) located in Texas, part of the Kingdom of the Netherlands Economic and Diplomatic Network in the United States of America.

Claire Hooft Graafland, Senior Advisor Hydrogen,
on behalf of the International Clean Energy Partnership (ICEP), Ministry of Foreign Affairs, and the Netherlands Enterprise Agency (RVO) part of the Ministry of Economic Affairs of the Netherlands in The Hague.

POST EDITORAL DISCLAIMER!

This report, drafted prior to the recent US administration change, projects a robust growth trajectory for clean hydrogen, predicated on the stability of existing tax incentives, notably the 45V Clean Hydrogen Production Tax Credit. However, in this post-editorial review, we recognize that the evolving political landscape introduces considerable uncertainty. Potential changes to these critical policies may impact our initial projections and warrant close attention moving forward. Furthermore, the global context has also shifted. The current economic and political uncertainty might affect demand for clean hydrogen and impact potential export markets. That said, this post-editorial analysis does not alter the 'bones' of the Texas hydrogen ecosystem—such as its infrastructure, expertise, and skilled workforce—which remain strong and well-positioned for future development. At the same time, it underscores the need to reassess the original outlook for clean hydrogen demand growth, given the shifting domestic and international context.

Executive summary

The rising demand for clean hydrogen presents a unique opportunity for collaboration between Texas and the Netherlands. Texas is rapidly positioning itself as a leading hub for hydrogen production, storage, and export—thanks to its abundant wind and solar resources, vast natural gas network, mature carbon capture and storage (CCS) infrastructure, and major deepwater ports along the Gulf Coast.

With over 190 hydrogen-related projects underway, Texas is building a robust hydrogenvalue chain. At the same time, the Netherlands brings world-class expertise in hydrogen technologies, system integration, and smart port infrastructure, as well as strong capabilities in public-private collaboration across the energy value chain.

This market scan provides a comprehensive overview of the hydrogen landscape in Texas, including regulatory frameworks, federal incentives under the Inflation Reduction Act (IRA), and regional initiatives such as the HyVelocity Hydrogen Hub. It explores technological trends and emerging business models, as well as the viability of hydrogen carriers like ammonia and LOHCs for long-distance export. The report also highlights the complementary nature of Dutch and Texan strengths—such as Texas' production scale and infrastructure, and the Netherlands' track record in collaborative innovation, international logistics, and hydrogen project development. The report further explores the dual momentum behind renewable and low-carbon hydrogen (green, blue, etc.), and how Texas' narrative of "energy addition" is shaping its transition strategy.

For Dutch companies, technology providers, and research institutions, the Texan hydrogen market presents significant commercial and collaborative opportunities across the full value chain—from electrolysis and system integration to storage, infrastructure, and industrial applications. Dutch entrepreneurs and institutions can contribute niche expertise in areas such as offshore hydrogen, port logistics, smart grid management, and circular chemistry.

The report highlights the importance of long-term partnerships, local presence, and tailored market strategies. It includes case studies and practical recommendations to support Dutch market entry and ecosystem engagement. With growing public-sector, academic, and private-sector support on both sides of the Atlantic, the Dutch-Texan hydrogen connection is not only feasible—it is already underway!

Texas as leading clean hydrogen hub

Texas is poised to become a leading clean hydrogen hub due to a combination of factors:

Existing infrastructure
Texas has a robust energy infrastructure, including pipelines, ports, and a skilled workforce, which can be leveraged for clean hydrogen production, transportation, and export.

Abundant resources
Texas has vast wind and solar potential for green hydrogen production, as well as abundant natural gas and depleted oil fields suitable for blue hydrogen production and carbon sequestration.

Favorable geology
The state's unique salt caverns offer significant underground hydrogen storage capacity.

Cost competitiveness
Federal and regional incentives, combined with low production costs, make Texas a highly competitive location for clean hydrogen production.

Supportive policies
Government initiatives like the H_2Hubs program and the National Clean Hydrogen Strategy and Roadmap are supporting the development of the clean hydrogen industry in Texas.

Moreover, the success factors that underpinned its century-long success in the traditional oil & gas will ensure its prominence in the Energy transition:

Success Factor	Traditional Oil & Gas	Renewables & Low Carbon Energy	Opportunities/Threats
Land Ownership	Shale growth independent of government	Texas produces large amounts of renewable power on private land	Large-scale solar, wind, and hydrogen projects offer potential due to abundant land availability, but face challenges like land-use conflicts and environmental impact assessments.
Innovation	Fracking and Oil Recovery	Carbon Sequestration and Blue Energy	Hydrogen exports, particularly via ammonia, present a significant opportunity. However, transportation and storage infrastructure needs development.
Regulatory & Incentives	MLPs drove large midstream infrastructure investments	IRA bipartisan legislation & Hydrogen Hubs	Combined US, EU, and Japanese incentives, including tax credits and subsidies, can accelerate clean energy adoption. However, policy changes and regulatory uncertainty pose risks.
Economies of Scale	LNG exports, Henry Hub, Mont Belvieu	Hydrogen pipelines, CCS and salt dome storage	Expanding renewable energy infrastructure to meet growing demand in key areas presents a major opportunity. This requires strategic planning and overcoming logistical challenges.
Access to Capital Markets	Private equity teams, MLP, E&P structure	Private and governmental capital strength combined	While access to capital is readily available, long project timelines in clean energy may exceed typical investment horizons, potentially hindering project development.
Geographical Advantages	From Spindletop to Shale revolution. Salt formations. Access to seaports	Wind and solar patterns, density, and overlap	Underground hydrogen storage offers a promising solution for managing seasonal variations in clean energy production. However, geological suitability and potential environmental impacts need careful consideration.

Unique window of opportunity

While many aspects of the hydrogen value chain are already well-established, with both Texas and the Netherlands enjoying decades of experience in areas such as natural gas production and transportation, the burgeoning field of clean hydrogen presents a unique set of opportunities. In this nascent market, technologies and processes are still emerging, creating a dynamic landscape ripe for innovation and competition. This presents a significant opportunity for new entrants, particularly those with specialized expertise and a drive to shape the future of the hydrogen economy.

Technology	TX experience	NL experience
Windpower	Established	Established
Sun power	Established	Established
Batteries	Emerging	Emerging
Electrolysis	Established	Established
Desalination	Emerging	Emerging
H_2 pipeline	Established	Established
Pipeline conversion to H_2	Emerging	Emerging
CCS	EOR* only	Emerging
Cavern H_2 storage	Emerging	Emerging
H_2 liquefaction	Emerging	Emerging
H_2 retail	Emerging	Established
NH_3 storage	Established	Established
NH_3 transport	Established	Established
NH_3 shipping	Established	Established
NH_3 cracking	Emerging	Emerging
Other H_2 carriers	Emerging	Emerging
H_2 turbine	Emerging	Emerging
Conversion of gas turbine for H_2 blend	Emerging	Emerging
Green resource certification	Emerging	Established

Recommendations for Dutch SMEs

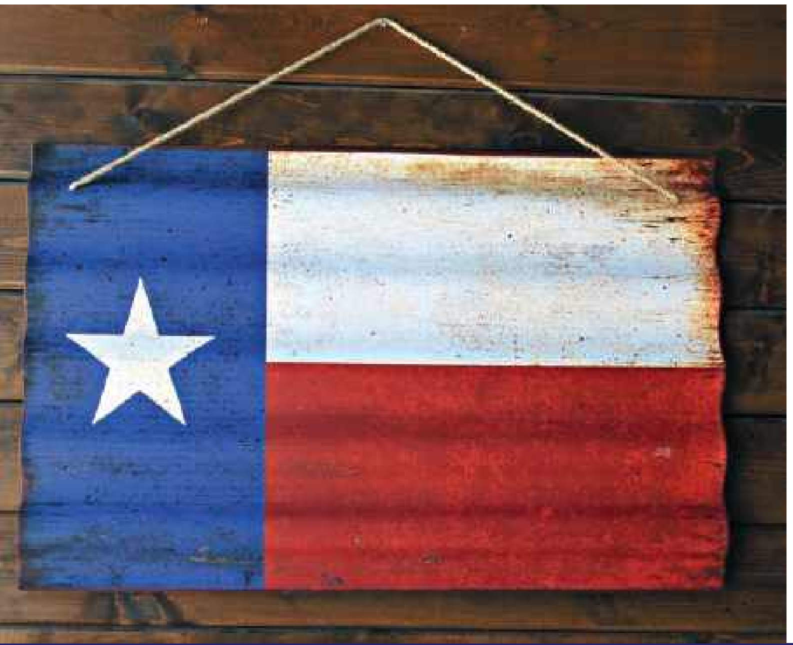
1. **Local Presence and Networking:**
Establish a physical presence or partner with local entities to foster trust and navigate the relationship-centric Texan market. Actively participate in industry events and conferences to connect with potential clients and partners.

2. **Strategic Partnerships:**
Forge alliances with established players in the Texan hydrogen ecosystem, including companies, research institutions, think thanks, and government agencies, to leverage their expertise and networks.

3. **Tailored Solutions:**
Adapt products and services to meet the specific needs and expectations of the Texan market, emphasizing niche expertise and value-added solutions. Highlight the economic benefits and job creation potential of your technologies.

4. **Market Knowledge:**
Stay informed about the latest developments, policy changes, and funding opportunities in the Texan hydrogen sector. Engage with industry associations and utilize online resources to gather market intelligence.

5. **Flexibility and Adaptability:**
Be prepared to adjust your business strategies and offerings as the Texan hydrogen market matures and new technologies emerge. Embrace the state's openness to transitional solutions while maintaining a focus on long-term sustainability goals.



By understanding the Texan context and embracing a proactive approach, Dutch SMEs can successfully capitalize on the opportunities presented by the nascent clean hydrogen market and contribute to the global transition towards a sustainable energy future.

1. The nascent clean hydrogen economy

The global pursuit of a clean energy future has intensified significantly in recent years, fueled by a growing awareness of the urgent need to combat climate change. The landmark Paris Agreement, adopted at COP21 in 2015, solidified international commitment to limit global warming to well below 2 degrees Celsius above pre-industrial levels, with efforts to limit the increase to 1.5 degrees. This ambitious goal has spurred nations and regions to develop concrete strategies for decarbonizing their economies.

The European Union, with its ambitious Green Deal, has emerged as a leader in this transition. Central to this plan is the target of achieving climate neutrality by 2050, effectively reducing greenhouse gas emissions to net-zero. However, recognizing the urgency of the climate crisis, the EU has also set ambitious interim goals, including the "Fit for 55" package, which aims to reduce emissions by at least 55% by 2030 compared to 1990 levels. These targets have far-reaching implications, requiring a fundamental shift in how we produce and consume energy. The EU's regulatory framework will require private companies to comply with these targets, ensuring a collective effort towards decarbonization.

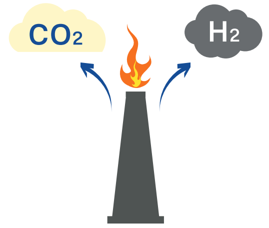
Hydrogen, the most abundant element in the universe.

Clean hydrogen, produced from low carbon energy sources, has emerged as a key enabler of this transition. Its versatility allows it to decarbonize sectors that are difficult to electrify, such as heavy industry, long-haul transportation, and seasonal energy storage. The EU's hydrogen strategy, with its focus on scaling up production and infrastructure, highlights the crucial role this technology will play in achieving the 2030 and 2050 climate targets.

Hydrogen, the most abundant element in the universe, holds immense promise as a clean energy carrier. When used as a fuel, hydrogen produces only water vapor as a byproduct, making it a compelling alternative to fossil fuels in the fight against climate change. However, not all hydrogen is created equal. It is often categorized by "color" based on its production method, which has implications for its environmental impact.

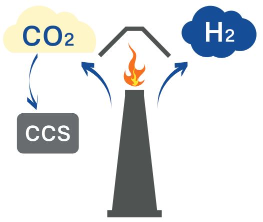
The “colors” of hydrogen

While carbon intensity is gaining traction as a way to classify hydrogen production, the color terminology remains widespread in many business settings. See IEA.org for more information.



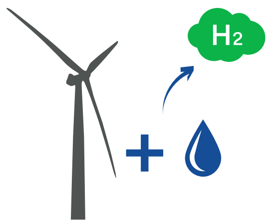
from natural gas

Gray hydrogen
the most common type today, is produced from natural gas mostly through steam methane reforming (SMR), a process that releases significant carbon dioxide.



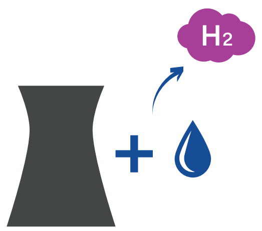
from natural gas with carbon capture and storage

Blue hydrogen
also uses natural gas but incorporates carbon capture and storage (CCS) technology to reduce emissions, with little to no emission of CO_2.



from water using zero-carbon electricity

Green hydrogen
the holy grail of the hydrogen economy, is produced through electrolysis using renewable energy sources like wind and solar power, resulting in virtually no greenhouse gas emissions in the production process.

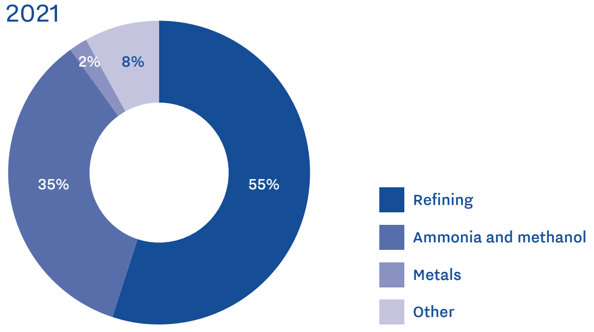


from water using electricity by nuclear power

Pink hydrogen
is produced via electrolysis using electricity generated from nuclear power plants. This process involves using nuclear reactors to generate electricity, which then powers the electrolyzers to split water into hydrogen and oxygen. While nuclear energy is a low-carbon source of electricity, it is not renewable due to the finite nature of uranium resources and the challenges associated with nuclear waste disposal. However, pink hydrogen offers a potential pathway to decarbonize hydrogen production using an established and reliable baseload power source.

Current use and future demand

Hydrogen consumption in the U.S. by end use
2021



Source: US National Clean Hydrogen Strategy and Roadmap

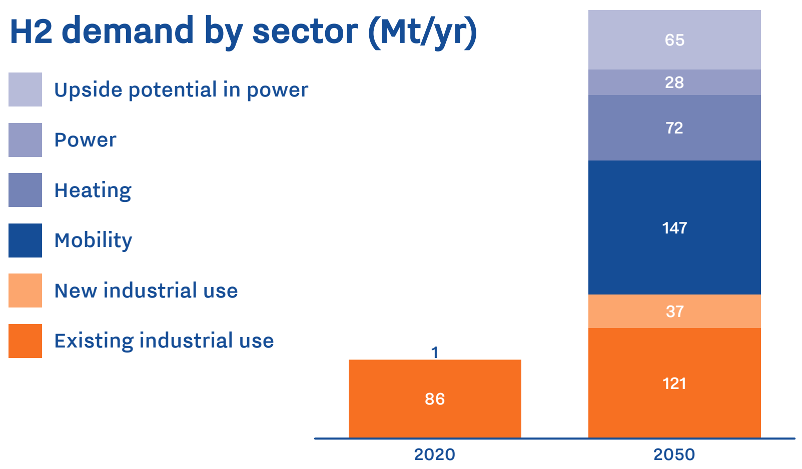
Currently, hydrogen is primarily used in industrial processes, such as refining petroleum and producing ammonia for fertilizers.[1] However, its potential applications are vast and expanding rapidly.

In the future, hydrogen could fuel cars, trucks, and trains, power homes and businesses, and even provide energy storage for the electricity grid. It could decarbonize heavy industries like steel and cement production, and even play a role in aviation and shipping.

As per McKinsey’s *2023 Global Energy Perspective: Hydrogen Outlook*, nearly all of the 90 million tons of hydrogen consumed per year today is grey hydrogen. But the reputable institution expects grey hydrogen demand to drop constantly over the next 25 years, while clean hydrogen is projected to reach about 270 million tons per annum in their “Current Trajectory” scenario. McKinsey’s worst-case scenario “Fading Momentum” still projects an increase of clean hydrogen demand to 130 million tons per annum, with their most ambitious scenario (“Net Zero”) seeing demand near 600 million tons.

A more realistic scenario (“Further Acceleration”, which McKinsey describes as “further acceleration of transition driven by country-specific commitments, though financial and technological restraints remain”) projects clean hydrogen demand to reach 404 million tons with an upside to 469 million tons if power generation switch to hydrogen for 1-3% of the gross generation depending on the region.[2]

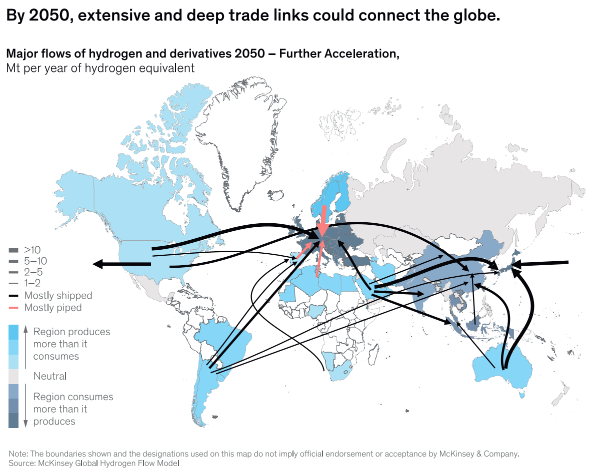
H2 demand by sector (Mt/yr)



Source: Data from McKinsey’s Global Energy Perspective 2023 - Hydrogen Outlook

[1] US National Clean Hydrogen Strategy and Roadmap, page 16
[2] McKinsey & Company: Global Energy Perspective 2023: Hydrogen outlook

Infrastructure needs



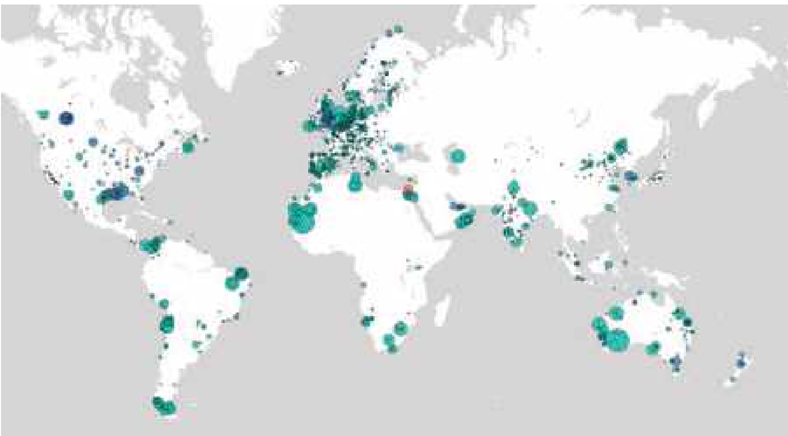
Source: McKinsey Global Energy Perspective 2023: Hydrogen Outlook

To support this immense growth, massive investment in infrastructure will be needed. And just as the world currently relies on intricate networks of pipelines and tanker routes to transport oil from oil-rich regions to energy-hungry industrial centers, clean hydrogen often cannot be produced where it is needed the most. Regions blessed with abundant sunshine or consistent winds will become the "Saudi Arabias of clean energy," generating vast quantities of green hydrogen through electrolysis powered by renewable sources. Similarly, regions blessed with abundant natural gas and options for carbon storage will generate vast quantities of blue hydrogen. This clean hydrogen can then be transported via pipelines, tankers, or even converted into ammonia or other carriers for shipping, to fuel industrial hubs with high energy demands but limited low carbon resources.

Production hubs

There are currently almost 1,300 projects (from concept phase all the way to Final Investment Decision (FID) and under construction) aiming at producing 115 million tons of clean hydrogen by 2030 as per the International Energy Agency (IEA) database. The map of these projects clearly highlights these future production hubs which are not necessarily the same as the current, energy-hungry industrial hubs, e.g. the wind-rich Canadian northeast, the North Sea, Patagonia, the sun-basked Iberic and Arabic peninsulae, Western Australia, South Africa,etc.. Texas stands out as it possesses both huge solar and wind potential for green hydrogen production, and ample natural gas production coupled with numerous abandoned oil wells for carbon sequestration for blue hydrogen production. As we will see later, it also has salt formations which lend themselves very well for large volumes of underground hydrogen storage.

Almost 1300 projects are aiming at producing 115 million tons of clean hydrogen by 2030.



Source: IEA database

Transport challenges

Transporting hydrogen presents unique challenges due to its low energy density by volume and its propensity to potentially leak. However, those issues are well understood and have been addressed by the industry in various processes such as that for ammonia, methanol and refinery hydrogenation that require hydrogen supplies under high pressure. Pipelines are suitable for shorter and longer cross-continental distances, i.e. in the range of 500 to 2,000 km. Since hydrogen, even at high pressures, has very low density and viscosity, the pressure drop in hydrogen pipelines is low, and they can be effectively designed as buffer storage to even out intermittent supply from renewable energy resources and continuous demand.

Liquid hydrogen and hydrogen carriers

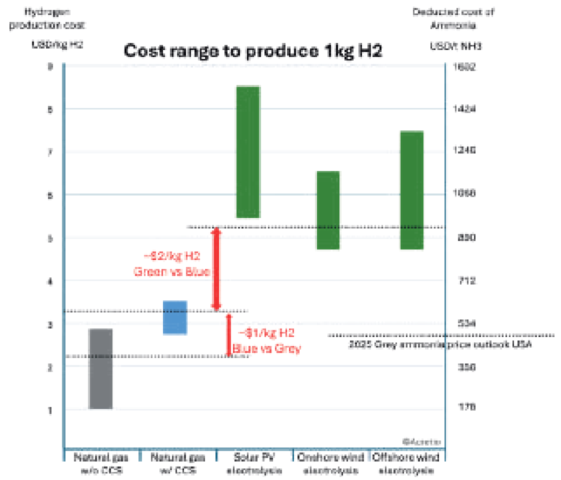
Although there have been pilot projects using liquid hydrogen for long-distance transport, significant challenges remain. As a result, it is primarily used for immediate consumption, storage, and short-distance distribution. Ongoing research is focusing on converting hydrogen into denser, more transportable form: a hydrogen carrier. While additional options are likely to emerge over time, ammonia (NH_3) currently stands out as a leading hydrogen carrier, offering several advantages. It can be liquefied at much higher temperatures than hydrogen, simplifying storage and transport. There is already an abundant existing infrastructure for ammonia, widely used in the fertilizer industry, but converting hydrogen to and from ammonia is energy-intensive and can generate emissions if not powered by renewable sources. This has spurred interest in other hydrogen carriers, particularly Liquid Organic Hydrogen Carriers (LOHCs). These organic compounds can absorb and release hydrogen under specific temperature and pressure conditions. LOHCs offer higher energy density than ammonia, potentially reducing transport costs, and can be handled using existing infrastructure for liquid fuels. However, unlike Ammonia, LOHC technology is still in its early stages of development, with research focusing on improving efficiency and reducing costs.

Shipping ammonia has its challenges due to its toxicity and corrosiveness, requiring specialized handling, storage, and transport to ensure safety. Maintaining temperature and pressure during transport is crucial to prevent leaks and spills, which can release harmful ammonia gas. Additionally, the need to "crack" ammonia upon arrival to extract hydrogen adds complexity. While the Dutch energy storage provider VTTI is developing ammonia cracking facilities in the Port of Rotterdam, the Japanese utility company JERA is currently experimenting with using ammonia as a fuel in power plants, specifically by "co-firing" it with coal in existing coal-fired power plants.

The choice of hydrogen carrier will depend on various factors, including distance, existing infrastructure, cost, and environmental impact. As the hydrogen economy matures, a diversified approach with multiple carriers may be necessary to meet the needs of a global energy system. We expect ammonia to remain vital for the hydrogen economy, especially for long-distance transport and international trade.

Costs challenges

One of the biggest hurdles facing the clean hydrogen economy is the challenge of cost competitiveness. Currently, there's a signficant mismatch between the price of widely-available grey hydrogen, produced from fossil fuels, and the cost of producing clean hydrogen. Grey hydrogen, benefiting from mature technology and existing infrastructure, typically costs around $1 to $2+ per kilogram. In contrast, green hydrogen production costs are currently much higher, ranging from $4 to $8+, or even up to $12+, per kilogram depending on factors like electricity prices and electrolyzer efficiency. Blue hydrogen lies in the middle. This price gap presents a major obstacle to the widespread adoption of clean hydrogen. To compete with established fossil fuels and grey hydrogen, the cost of clean hydrogen production must decrease significantly. This requires advancements in electrolyzer technology, increased economies of scale, and access to low-cost renewable electricity. Bridging this cost gap is crucial for unlocking the full potential of clean hydrogen and accelerating the transition to a sustainable energy future.



Source: Acretio internal analysis

To compete with grey hydrogen, the cost of clean hydrogen must decrease.

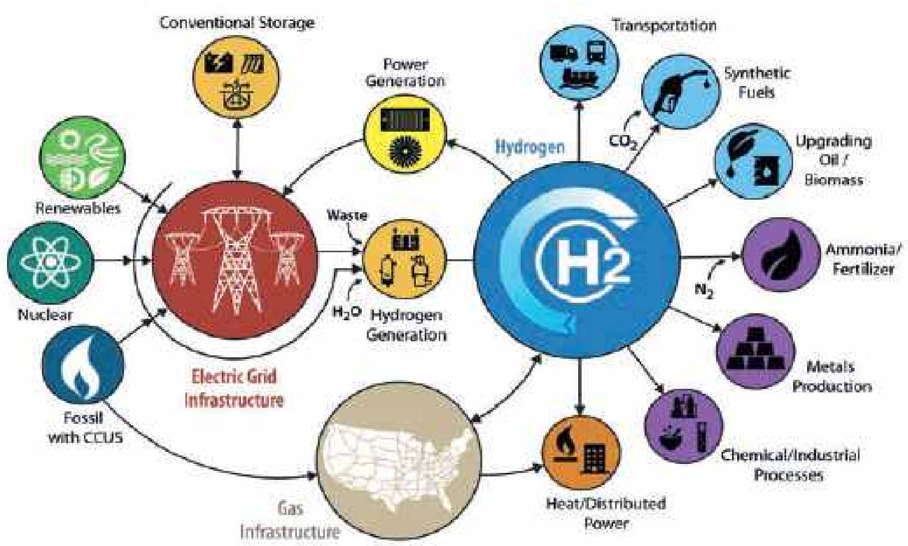
Governments are starting to put in place incentives (see paragraph 2.1 below for more US incentives), loan guarantees, funding mechanisms, etc., but without commitments (offtake agreements), projects struggle to get to Final Investment Decision (FID). Also, the significant amount of energy loss along the end-to-end value chain, with estimates ranging from around 30% to as high as 70% of the original energy input, depending on the production, liquefaction, transportation and reconversion processes involved, will remain controversial.

2. USA as emerging clean hydrogen power

2.1 Governmental strategy and IRA

The US has shown interest in hydrogen as an energy carrier for decades, with initial research and development efforts focused on its potential for transportation and energy storage. Already under the Bush Administration the Hydrogen Fuel Initiative was launched in 2003 aiming at accelerating the development and deployment of hydrogen technologies.

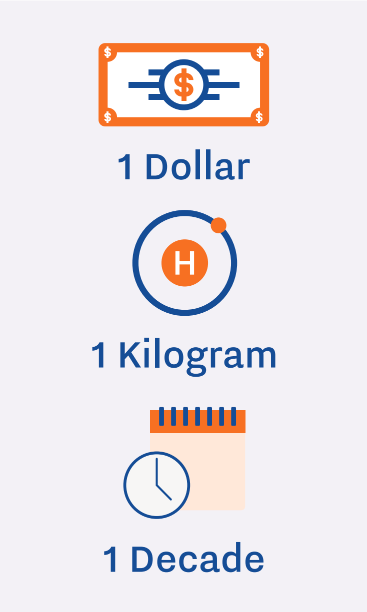
The focus shifted towards clean hydrogen production under the Obama Administration with investments in research and development of renewable hydrogen production methods like electrolysis. During the first Trump administration the Department of Energy (DoE) continued to fund research and development efforts and created in 2017 the H2@Scale initiative "bringing together stakeholders to advance affordable hydrogen production, transport, storage, and utilization to enable decarbonization and revenue opportunities across multiple sectors".[3] A multi-industry, end-to-end supply chain vision started to take shape:



Source: The H2@Scale concept

[3] H2@Scale

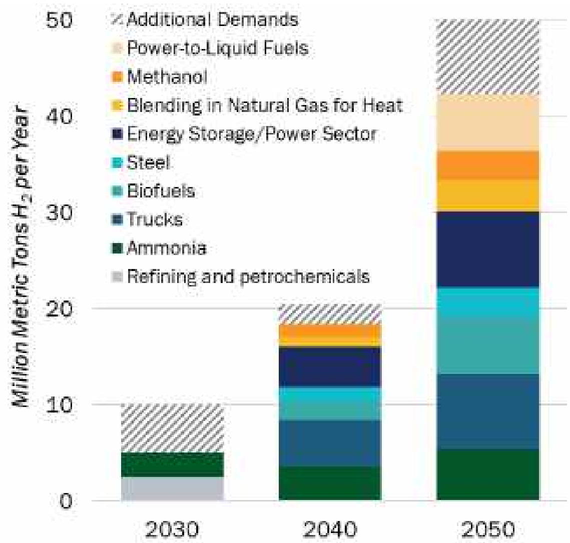
Hydrogen strategies



But it is under the Biden Administration that a strong focus on **clean** hydrogen emerged, with significant policy support and funding allocated through the 2021 Bipartisan Infrastructure Law (BIL) and the 2022 Inflation Reduction Act (IRA).

In 2021, the DoE launched an initiative dubbed "the Hydrogen Shot" (emulating the ambitions of the 1962 Moon Shot) that set the ambitious goal of reducing the cost of clean hydrogen to $1 per kilogram within one decade (the so-called "1-1-1" goal). This cost target aims to make clean hydrogen competitive with fossil fuels and drive widespread adoption, as the current cost of grey hydrogen is about $1/kg.

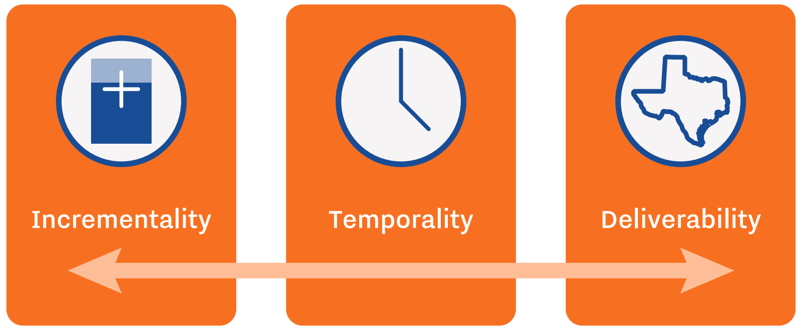
Then, in 2023, the "National Clean Hydrogen Strategy and Roadmap" was released by the DoE. It outlines a comprehensive approach to accelerate the development and deployment of clean hydrogen across various sectors of the economy. This roadmap sets a strategic goal of 10 million tons clean hydrogen production by 2030, 20 million tons by 2040 and 50 million tons by 2050. Focusing on reducing production costs, it includes the development of regional hydrogen hubs (see below section 2.3) and tries to address infrastructure needs. Its main supporting policy are the tax credits stemming from the IRA, especially 45Q (credit for CO_2 sequestration), 45 and 45Y (clean electricity production credit), 45V (clean hydrogen production credit) and 45Z (Clean fuel production credit).[4] See below for more details on 45Q and 45V. Leading the hydrogen program is the Hydrogen and Fuel Cell Technologies Office (HFTO) within the DoE Office of Energy Efficiency and Renewable Energy (EERE).



Source: *National Clean Hydrogen Strategy and Roadmap*

[4] U.S. Department of Treasury: Fact Sheet: How the Inflation Reduction Act's Tax incentives are ensuring all Americans benefit from the growth of the clean energy economy

45V: Clean hydrogen



45V specifically focuses on clean hydrogen production, offering a tiered tax credit based on the lifecycle greenhouse gas emissions intensity of the process. The cleaner the hydrogen production, the higher the credit, reaching a maximum of $3 per kilogram for hydrogen produced with near-zero emissions. To qualify for the highest credit tier, producers need to meet stringent criteria based on three key pillars:

1. Additionality

This pillar ensures that the clean electricity used for hydrogen production is truly new and wouldn't have been generated otherwise. This prevents producers from simply using existing renewable energy sources and claiming the credit, which wouldn't result in any additional decarbonization. Essentially, it incentivizes investment in additional clean energy capacity specifically for clean hydrogen production. This could involve building new solar or wind farms, or expanding existing ones to meet the demand from electrolyzers. It also includes nuclear power under some circumstances or power from gas- or coal-fired plants where the facility has added carbon capture and sequestration (CCS).

2. Hourly matching

This pillar requires producers to match their hydrogen production with the actual hourly generation profile of the renewable energy source. This ensures that the clean electricity used to produce hydrogen is consumed when it is generated, maximizing the use of renewable resources and minimizing reliance on grid electricity with higher emissions. This encourages the use of electrolyzers that can operate flexibly (i.e. load following), responding to the variability of renewable energy generation.

3. Geographic matching

This pillar mandates that the clean electricity used to produce hydrogen must come from the same geographic region as the production facility. This ensures that the benefits of clean energy development, such as job creation and grid improvements, are realized in the same region where the hydrogen is produced. It also reduces transmission losses and promotes regional energy independence.

	Carbon Capture (CCS)	H_2 Production
Incentive	45Q	45V
Value	$85/ton CO2 captured	$3/kg green H_2
Value translated for H_2	$0.88/kg H_2	$3/kg H_2
Value translated for NH_3	$156/ton	$534/ton
Most applicable to	Blue Hydrogen	Green Hydrogen
	45Q and 45V cannot be combined but they can be transfered	

45Q: carbon capture

45Q, on the other hand, centers on carbon capture and sequestration (CCS). It provides a tax credit for capturing carbon dioxide from industrial sources and storing it securely, either underground or through utilization in certain products. The credit amount varies based on the type of facility and the storage method, with higher incentives for dedicated geological storage.

A key distinction is that facilities producing hydrogen with CCS must choose between 45V and 45Q – they cannot claim both. This encourages careful evaluation of the project's emissions profile and the economics of each credit.

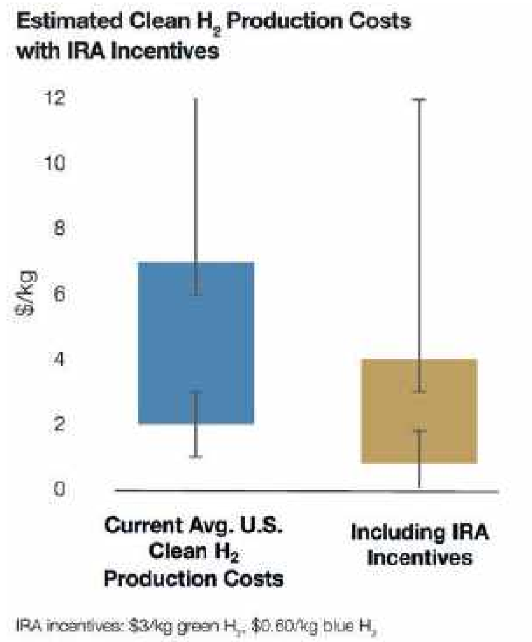
A choice must be made between 45V and 45Q - both cannot be claimed.

Essentially, 45V rewards the production of green hydrogen, while 45Q rewards the production of blue hydrogen through the incentivization of the capture and storage of carbon emissions. But we expect some producers of blue hydrogen to claim under 45V if they can successfully measure, and prove, a much higher lifecycle Greenhouse Gas (GHG) emission capture (from gas production wells to the methane steam reformer process) than generally modelled until now.

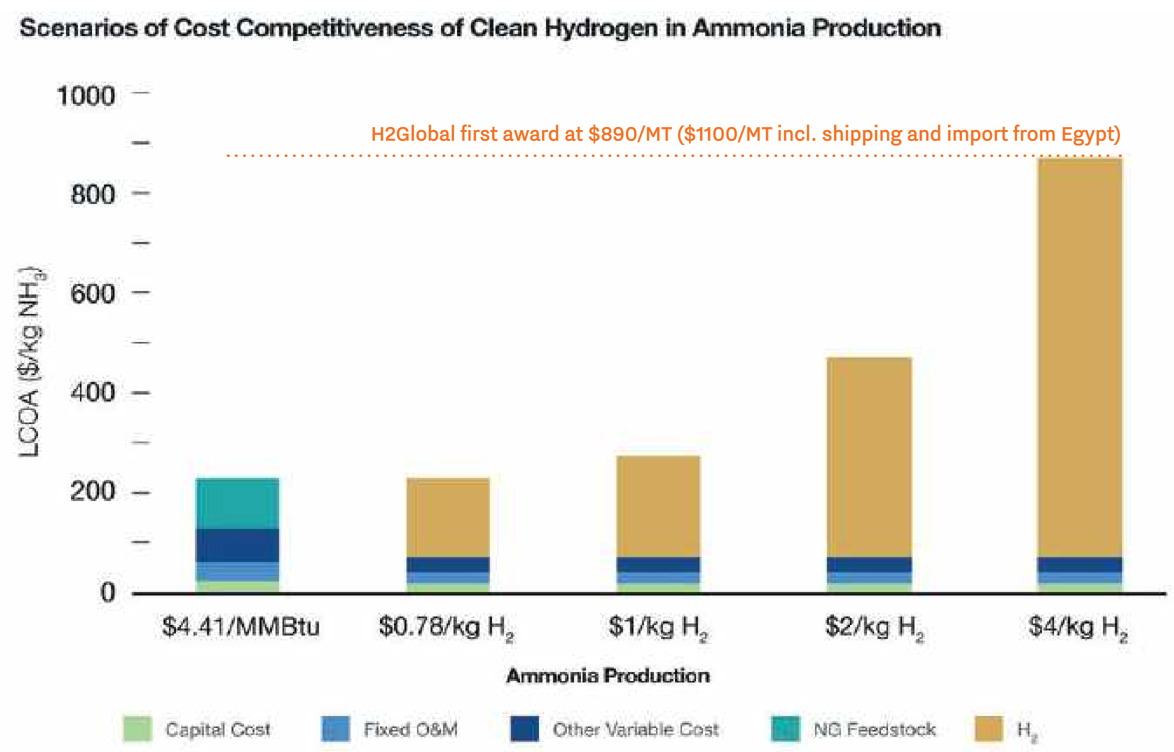
Tax credit impact

These tax credits play a huge role in decreasing the cost of producing clean hydrogen in the short-term. They are designed to act as catalyst to jumpstart the clean hydrogen and carbon capture industries, driving down costs in the long run after the credits expire through economies of scale, technology advancement, market growth and infrastructure.

With these IRA tax incentives, the production cost of clean hydrogen goes from a current estimated range of $2-$7/kg H_2 down to $1-$4/kg H_2. This translates to a LCOA (levelized cost of Ammonia) of $500-$900/ton NH_3, which puts US production cost near the $350-$550/ton range within which grey ammonia has fluctuated in the last 2 years if we exclude the spike of the 2021-2022 period. It is to be noted that due to the very early stage of green hydrogen production, there is a wide range of production cost estimates depending on the source.



Source: Energy Futures Initiative. "U.S. Hydrogen Demand Action Plan," February 2023



This figure shows the levelized cost of ammonia for conventional and low-carbon hydrogen-supplied options. Parity with the conventional option is achieved at $0.78/kg hydrogen price.

LCOA: Levelized cost of Ammonia

Source: Energy Futures Initiative. "U.S. Hydrogen Demand Action Plan," February 2023

2.2 The hydrogen hubs

The 2021 Bipartisan Infrastructure Law (BIL) allocated $8 bln for the creation of Regional Clean Hydrogen Hubs. In 2022, the DoE launched the H2Hubs program, soliciting proposals from across the country. In 2023, the DoE announced the selection of seven H2Hubs, awarding a total of $7bln in funding. These hubs are now in the initial stages of development, working to finalize their plans and secure additional funding from public and private sources. The goal is to have these hubs operational within the next few years, demonstrating the feasibility of clean hydrogen production, storage, transport, and utilization across various sectors. More on the Gulf Coast Hydrogen Hub (HyVelocity) in section 3.5.

2.3 Projected clean H_2 production

The IEA lists about 151 clean H_2 projects in the United States (as of the Oct 2024 update), with the vast majority of large projects situated on the Gulf Coast. Should all these projects reach FID and become operational, they would add 17 million tons production of clean H_2 by 2030 (vs. the 10 million target set by the DoE).

Source: IEA Hydrogen Project Database, interactive map

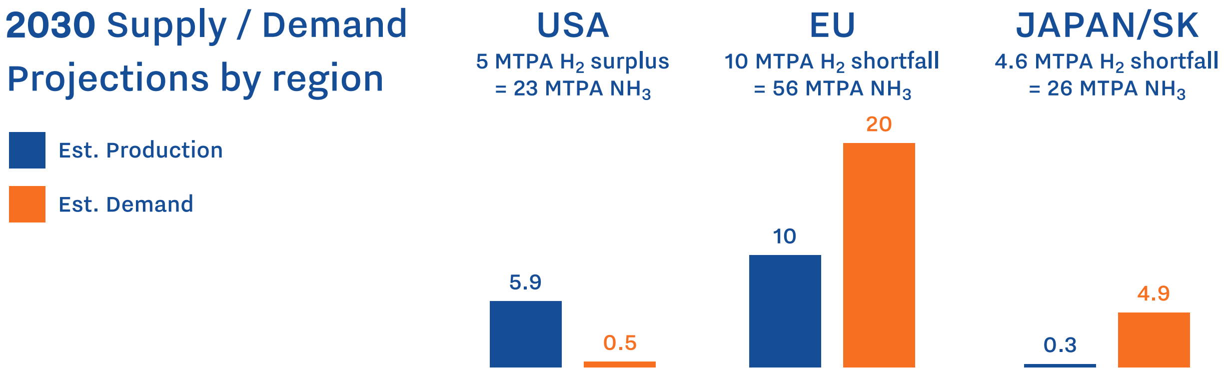
The top projects above 200k tons/year accounting for more than 70% of the potential additional capacity are almost all in early stage, only 3 have reached FID by end 2024.

Status	Project name	Location	Date online	Technology	Product	Announced size	Capacity kt H_2/y
FID / Construction	Eastern Louisiana Clean Hydrogen Complex (LA)	Louisiana	2027	NG w CCUS	Various	5Mt CO_2/y - 750 millin scfd	690
	CF Industries blue ammonia Blue Point (LA)	Louisiana	2026	NG w CCUS	Ammonia	1.4Mt NH_3/y - 2Mt CO_2	252
	Linde hydrogen plant for OCI fertilizer blue ammonia Beaumont (TX)	Texas	2025	NG w CCUS	H_2	1.7Mt CO_2/y - 1.1Mt NH_3/y	198
Feasibility study	ExxonMobil Baytown petrochemical site	Houston, TX	2029	NG w CCUS	H_2	1 BCF H_2/d - 7Mt CO_2/y	919
	HyStor	Mississippi	2025	Other Electrolysis	H_2	2.2GW	381
	Hydrogen City, phase 1	South Texas	2030	Other Electrolysis	H_2	2GW	347
	North Dakota Hydrogen Hub (former Great Plains Synfuel Plant)	North Dakota	2028	NG w CCUS	H_2	310000t H_2/y	310
	HIF USA	Texas	2026	PEM	Synfuels	1.8GW	270
	Sustainable Fuels Group - CIP Carbon reduced Ammonia plant St Roze (LA)	Louisiana	2027	NG w CCUS	Ammonia	4kt NH_3/d (production)	263
	CF Industries and Mitsui Blue ammonia complex (LA)	Louisiana	2028	NG w CCUS	Ammonia	1-1.4Mt NH_3/y	252
	Enbridge Ingleside Energy Center low carbon ammonia (TX)	Texas	2029	NG w CCUS	Ammonia	1.2-1.4Mt NH_3/y	234
	Yara-BASF Gulf Coast	Gulf Coast	2029	NG w CCUS	Ammonia	1.2-1.4Mt NH_3/y	234
	Horizons Clean Hydrogen Hub	Texas	2030	Other Electrolysis	Various	1200MW	208
Concept	Hydrogen City, phase 2	South Texas		Other Electrolysis	H_2	3Mt H_2/y	2,654
	Angeles Link	California		Other Electrolysis	H_2	10-20GW	2,599
	Ascension Clean Energy (ACE) complex (LA)	Louisiana	2028	NG w CCUS	Ammonia	12Mt CO_2/y - 7.2Mt NH_3/y	1,297
	Port of South Louisiana	Louisiana		Other Electrolysis	Ammonia	4kt NH_3/d production	526
	Adams Fork Energy (WV)	West Viriginia	2028	NG w CCUS	Ammonia	6kt NH_3/d - 3.6Mt CO_2/y	394
	Acme-Port of Victoria	South Texas	2027	Other Electrolysis	Ammonia	1.2Mt NH_3/y (production)	379
	Ammonia project on the Gulf Coast	Gulf Coast	2030	NG w CCUS	Ammonia	2Mt NH_3/y production	360
	Eneos project	Louisiana	2030	NG w CCUS	H_2	220kt H_2/y production	244

Source: IEA Hydrogen Project Database

2.4 USA likely emergence as clean H_2 supplier to EU and other countries

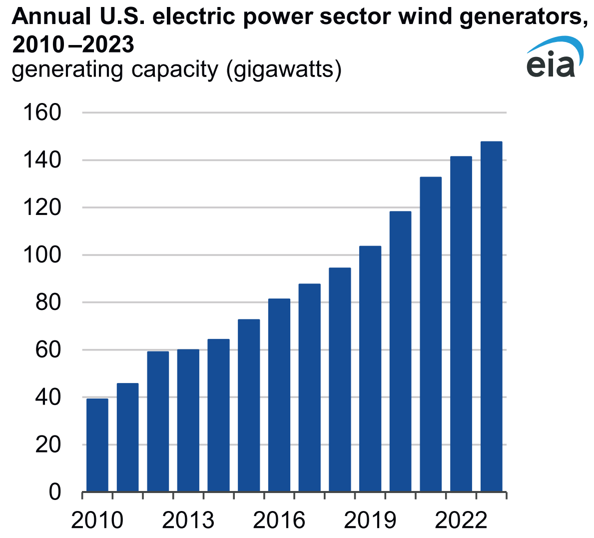
With its abundant natural gas resources, vast solar and wind energy potential, significant carbon sequestration opportunities, and salt cavern potential, the US is poised to become a top clean hydrogen exporter thanks to strong government support as seen above and growing mismatch between demand and production in key top demand hubs: Europe, Japan and South Korea. Indeed, in 2022 the EU expressed an ambition to reach 20 million tons of clean H_2 by 2030 to cover their "Fit-for-55" ambitions. They also quickly realized that the domestic production capacity will at best cover 10 million tons, leaving a necessity to import 10 million tons per annum by 2030 already. Similarly, Japan and South Korea, faced with even greater lack of potential for domestic clean H_2 production, bank on significant import to match their planned clean H_2 demand. This creates a lucrative export opportunity for the US, allowing it to capitalize on the growing global hydrogen economy, especially since local demand for clean hydrogen is not seen to take off anytime soon due to the lack of constraining regulations like in Europe.



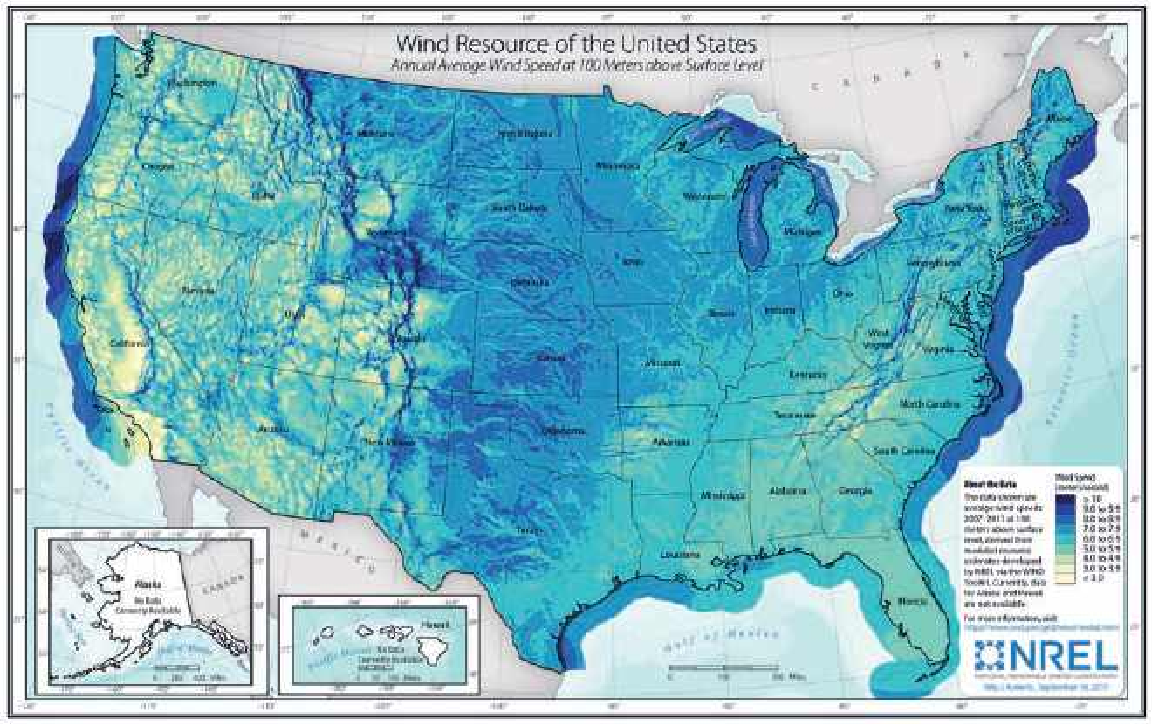
Source: Acretio internal analysis

2.5 US as current producer of renewable power

The United States has emerged as a major producer of renewable energy, largely driven by significant growth in solar and wind power generation. Vast open spaces, particularly in the Southwest, offer ideal conditions for large-scale solar installations, while consistently strong winds across the Great Plains and coastal regions make the US a prime location for wind farms. Technological advancements and falling costs have further accelerated the adoption of these renewable sources, contributing to a substantial increase in their share of the US energy mix. US wind capacity more than tripled between 2010 and 2023, from 47 GW to 147.5 GW.



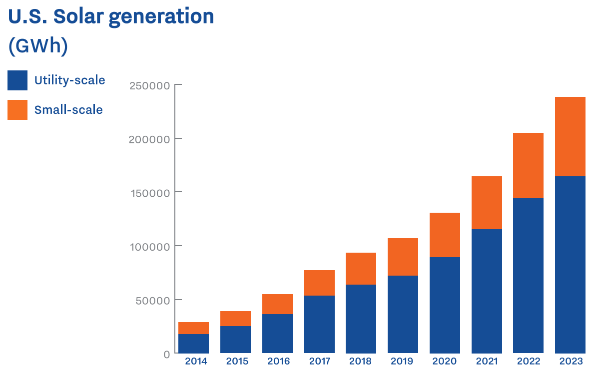
Source: IEA, Today in Energy



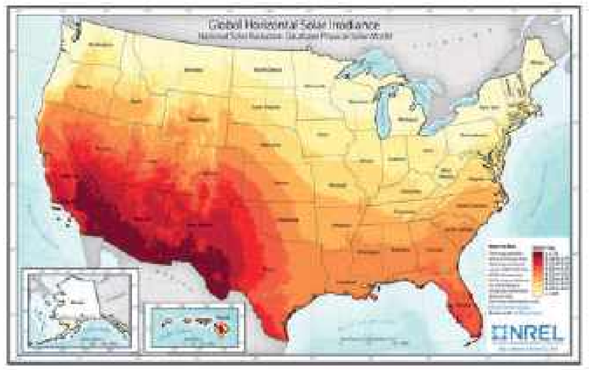
Source: National Renewable Energy Laboratory, maps

As for solar, the US generated more than a quarter million GWh of electricity from solar in 2023, eight times the amount generated in 2014, a decade earlier. In just one year, solar generation grew 25% in Texas (to 32 TWh) and 28% in Florida (to 17 TWh) from 2022 to 2023, utility- and small-scale combined, slowly catching up with California which added almost 28 GW of its current 36 GW capacity in the 2014-2023 period. For comparison: California's 36 GW system capacity generated 68.8 TWh (more than twice Texas'), enough to power 7.8 million households in that state.[5]

Government incentives have played a pivotal role in the widespread adoption of small-scale solar systems in the US over the past decade. Key programs like the federal solar tax credit, which allows homeowners to deduct a percentage of the installation cost from their taxes (up to 30%), have significantly reduced the financial burden of going solar. Furthermore, many states have implemented their own incentive programs, such as rebates, performance-based incentives, and net metering policies, further encouraging solar adoption.

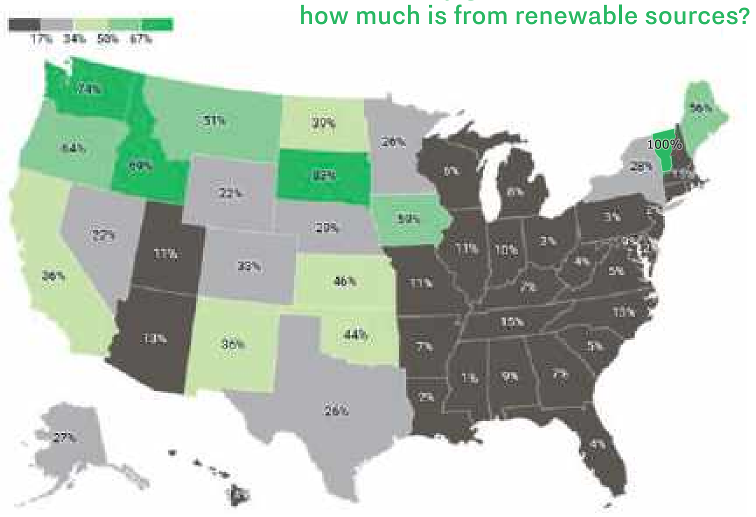


Source: *Climate Central*



Source: *National Renewable Energy Laboratory, maps*

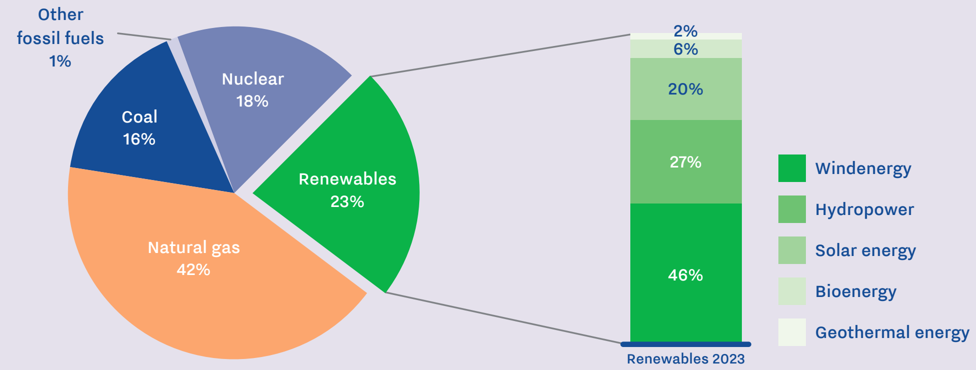
Of the electricity generated in each state, how much is from renewable sources?



Source: *Energy Information Administration*

Within the US, wind energy is the leading renewable source of power, followed by hydro and solar. While Texas is the biggest producer of renewable energy, followed by California in absolute numbers, Vermont, South Dakota, Idaho and Washington state lead the nation with the highest percentage of electricity coming from renewable power.

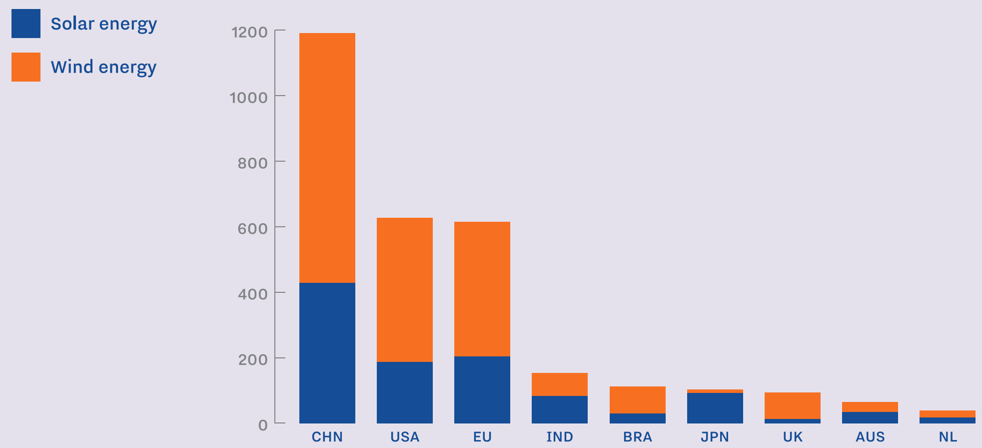
2023 US Electricity generation



Source: *International Renewable Energy Agency and Energy Information Administration*

Worldwide, the US is only second to China in renewables energy production from solar and wind, and the EU a very close third, with about half of the Chinese production far ahead of any other country.

Sum of Electricity Generation (x 1.000 GWh)



Source: *International Renewable Energy Agency, Country Rankings, 2022*
EU incl NL, NL shown separately only for comparison purposes

[5] Average monthly electricity usage per CA household 729 kWh, NRG Clean Power

3. Texas emerging as the real hydrogen powerhouse within the US

3.1 Texas overview

With 52 Fortune 500 companies[6] headquartered in the state, Texas together with California and New York lead the country in hosting more than 50 headquarters of these companies. They represent all major branches of the economy, from IT to Energy, Biotechnology and Life Sciences, Banking, Insurances amongst other. And with the recent move of Tesla from California to Texas, Electrical vehicles are now part of this mix too.

The Oil & Gas industry in Texas accounts for 9% of Texas' GDP, which makes it the No. 1 state for energy production in the USA.

Some of the Global Fortune 500 Companies headquarters in Texas:

ExxonMobil, AT&T, McKESSON, DELL Technologies, PLAINS GP HOLDINGS, PHILLIPS 66, ENERGY TRANSFER, Enterprise Product Partners L.P., ORACLE, ConocoPhillips, Tesla, Valero, USAA, Sysco

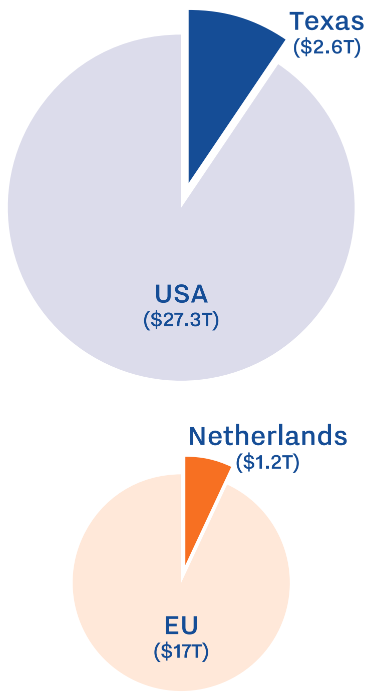
NL/TX at scale

Economically, the center of gravity is in what is known as "the Texas Triangle", the region delimited by the four metropolitan areas of Houston, Dallas/Fort Worth, Austin and San Antonio interconnected by the three interstate freeways I10, I45 and I35. Nearly 75% of the Texas population lives in the Texas Triangle. Projections from the Texas Demographic Center indicate ongoing growth due to the pull of Texas (relocation) on companies and people. The Dallas/Fort Worth and Houston metroplexes are respectively 4th and 5th in the nation.

6. As of January 2025

Population and GDP

With a land size of 677 km² Texas is about 16 times the size of the Netherlands; population-wise Texas just reached about 30 million inhabitants vs. almost 18 million in the Netherlands. At $2.6 trillion the Texas GDP in 2023 is more than double the Netherlands' $1.2 trillion.



Population of major Metroplexes		
1	Greater New York	19.3 mln
2	Greater Los Angeles	12.8 mln
3	Greater Chicago	9.3 mln
4	Dallas/Forth Worth metroplex	8.1 mln
5	Greater Houston	7.5 mln
	Netherlands' Randstad	8.4 mln

History

The modern history of Texas energy begins in 1901 with the famous Spindletop gusher near Beaumont in Southeast Texas. This boom period, fueled by further discoveries like the East Texas Oil Field in the 1930s, saw Texas become a national leader in oil production, driving economic growth and technological advancements in drilling and extraction.

However, the oil price shocks of the 1970s marked a turning point, forcing Texas to diversify. This era saw the rise of natural gas production, further accelerated by fracking technology. Simultaneously, Texas began harnessing its vast wind resources, becoming a pioneer in renewable energy so much that Texas is now leading the USA in wind energy production and is second to California in solar energy production.

NL and Texas

Texas and the Netherlands have a long-tangled history. Well before Royal Dutch Shell decided to move its US headquarters from New York to Houston in 1971, the most influential Dutch in Texas was Phillip Hendrick Nering Bögel, the self-proclaimed Baron de Bastrop, who arrived in Texas around 1795 and convinced the Mexican government to admit the first colony of Anglos in the then-Mexican state. Another Dutch, David Levi Kokernot, settled in 1832 at Anahuac and fought in the Texas Revolution. But it is in 1895 that Dutch investors created the Port Arthur Land Company (and built the Orange Hotel) which became the first successful Dutch colony in Texas; about 50 families came and started the town of Nederland, east of Houston.

Dutch settlers in Nederland photographed after the harvest , source: Texan Cultures

Shared industries between the Netherlands and Texas include aerospace and aviation, chemicals, energy, financial services, food & beverage, industrial products, infrastructure, materials, oil & gas, petroleum, medical technology, delta technology and professional services. As per the Texas Economic Development Corporation (TxEDC), the cumulative Dutch direct investment between 2011 and 2023 included 73 projects, with $6,328 million in capital investment and 5,698 jobs created by 58 companies.

The Netherlands' economic ties with the United States are significant and continue to strengthen. Dutch exports to the U.S. are steadily growing, with 2024 projections indicating they will reach nearly $60 billion (+10.6% vs 2023). This robust trade relationship is underscored by substantial investments between the two countries. In 2023, Dutch investments in the U.S. reached an impressive $717.5 billion (+2.4% vs 2022), while U.S. investments in the Netherlands grew by 3.8%, reaching $980.4 billion. Not only economically significant but also a driver of employment opportunities, NL-US trade relationships support an estimated half a million jobs in the Netherlands and over a million jobs in the U.S.

On the export side, the Netherlands are the 3rd top export destination for Texas in 2024 with more than $32.5 bln of goods and services exported, crude oil and oil products taking the lion share in recent years. On the import side, Texas imported for more than $2 bln of goods and services from the Netherlands.

Texas' top export destinations in 2024	
1	Mexico
2	Canada
3	Netherlands
4	South Korea
5	China

Source: Office of the United States Trade Representative, Executive Office of the President

Mapping the top economic sectors of the Netherlands and Texas results in significant overlaps and therefore a vast open space of opportunities.

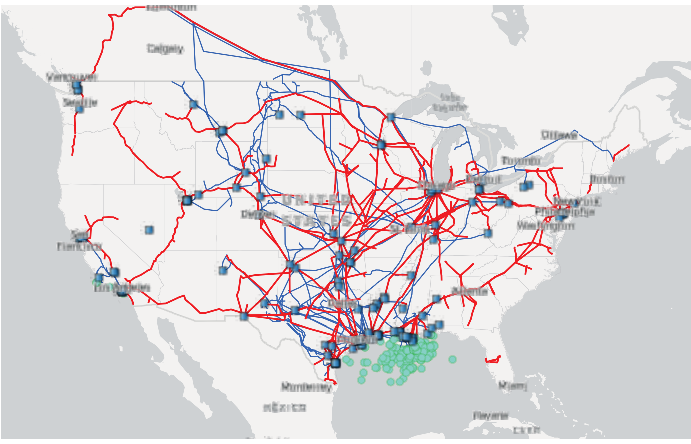
NL Top sectors / Texas key clusters	Advanced manufacturing	Aerospace, Aviation & Defense	Biotechnology & Life sciences	Energy & Energy transition	Petrochemicals	Information technology	Corporate Services	Creative industry	Transportation & Logistics
Agri, Food, Horticulture									
Creative industry								Austin	
Energy transition				Houston Dallas/ FtW	Houston Corpus Christi				
Life Sciences & Health			Houston Dallas/ FtW						
Logistics (Maritime)									Houston Dallas/ FtW
Water management & Maritime technology									Houston West Texas
High tech systems & Materials	Austin Dallas/ FtW	Houston Dallas/ FtW				Austin San Antonio			
Human capital							Dallas/ FtW		

3.2 Current Texas energy infrastructure

A quick look at the petroleum map of the US shows that Texas plays a central role. One of a producer of crude oil and natural gas, refiner of crude oil and originator of multiple petroleum product pipelines.

Petrochemicals

With 34 refineries within the state limits and a crude oil refining capacity of 6.3 million barrels per day (about a third of the total US capacity or the equivalent of Germany, NL, Italy and France capacity combined), Texas dwarfs all the other states. The two largest refineries in the country are located in the state: the 631 kbpd Marathon Petroleum refinery in Texas City and the 626 kbpd Motiva refinery in Port Arthur. With almost 490,000 miles of pipelines (more than twice the distance earth-moon), crude is moved from wells to refineries and exporting ports (blue lines on the map); refined products are moved within the states to terminal and ports, and -via large interstate pipelines- to states in the North, Northeast and East all the way to the East coast (red lines on the map).



Source: National Energy and Petrochemical Map by The FracTracker Alliance on FracTracker.org

Sea ports

With 19 commercial seaports, including 11 deepwater ports, along 624 miles (1,004 km) of coastline, Texas is home to the #1 port in the US for waterborne foreign-trade (the port of Houston).

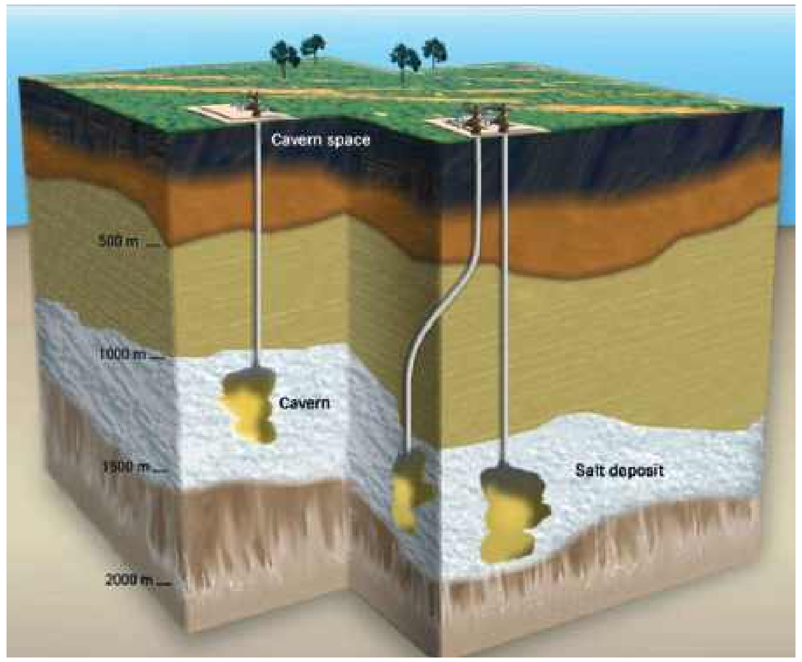
While the port of Corpus Christi is the 3rd in the US in terms of tonnage, it is the largest crude oil export gateway in the nation and 3rd worldwide after Ras Tanura in Saudi Arabia and Basrah in Iraq.

The port of Galveston is not only Texas' Number 1 cruise port, it also ranked as the 4th busiest cruise port in North America and with almost a million cruise passengers in 2017 is in the top ten cruise home-ports worldwide.

Source: TxEDC, Business in Texas, map

Salt caverns

While Canada was a pioneer in using salt caverns for hydrocarbon storage in the early 1940s, energy companies in the US have been using rock salt formations ever since to create underground storage for hydrocarbons. One of the most famous uses of these salt caverns is the US Strategic Petroleum Reserve which stores more than 700 million barrels of crude oil for emergency use in 60 caverns at 4 locations along the Gulf Coast. Projects have been expanding in recent years because of increased demand from liquefied natural gas (LNG) terminals and alternative energy industries.



How companies store natural gas in underground salt caverns
Source: Oil & Gas Watch, news item May 30, 2024

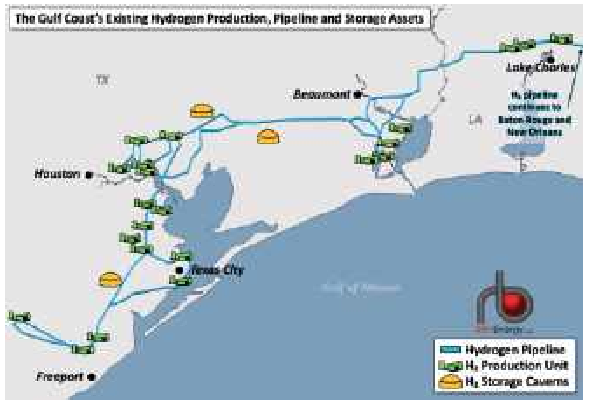
Salt caverns are created by drilling a hole into a naturally occurring underground rock salt formation, called a "salt dome", between layers of sedimentary rock. Companies then inject water to dissolve the salt and pump out the saltwater solution. This leaves behind an empty space that can be filled with natural gas or other petroleum products. Companies withdraw fuel from the cavern by pumping in water, forcing the petroleum product upwards. The Strategic Petroleum Reserve caverns range in size from 6 to 37 million barrels (meaning each cavern can sustain 10 to 60 days of running capacity at the largest refinery in the US) with the typical one holding 10 million barrels in a vertical cylinder 200 feet wide (61m), 2,500 feet high (232m).

Salt caverns start to be used for hydrogen storage.

It is thanks to the presence of these salt caverns used for LPG storage (and the extensive access to pipelines, gas processing plants and waterborne terminals) that Mt Belvieu near Houston, has gained worldwide name recognition by becoming the nucleus for propane gas trading and has its own dedicated price marker. Similarly, Spindletop, famed for its 1901 oil gusher, is experiencing a resurgence, leveraging its existing salt caverns—previously used for natural gas storage since the 90s—for pioneering hydrogen storage.

Hydrogen

Texas produces yearly about 3.6 million tons of Hydrogen, nearly entirely used in industrial processes, particularly in petroleum refining to remove sulfur, for treating metals, producing chemicals, and in the production of ammonia for fertilizer. It is produced almost entirely via steam methane reformers (SMR) in oil refineries or dedicated large facilities. The major industrial gas players in this space are Air Liquide, Air Products and Linde/Matheson. If not used on site, hydrogen is piped to end-users via an extensive network of dedicated pipelines. Texas has more than 900 miles of hydrogen pipelines, connected to almost 500 miles in Louisiana, all in private ownership, with close to 90% owned by the 3 companies mentioned.



Source: RBN Energy, hydrogen-hub

CO_2/CCS

Texas offers ample opportunities for long term CO_2 sequestration due to its vast amount of depleted oil and gas reservoirs and saline aquifers. CO_2 is currently used as one the various Enhanced Oil Recovery (EOR) techniques. EOR involves injecting materials or energy into the reservoir to extract oil that cannot be extracted using traditional methods, in this case CO_2 injected increase pressure and push the oil towards the well but also dissolve in the oil, reducing its viscosity.

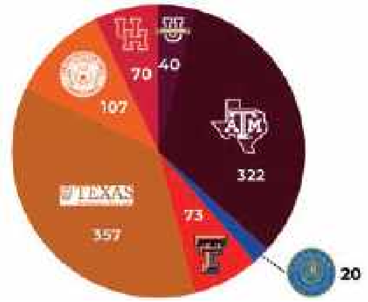
Source: The Exxon/Denbury CO_2 pipeline network

There is an existing network of CO_2 pipelines in the Permian basin for EOR purpose as well as an 81-mile pipeline owned by TCV from southwest Houston to West Ranch near Lavaca Bay. There is another network of CO_2 pipelines on the Gulf Coast, the Exxon/Denbury pipeline used currently for EOR purposes but with carbon sequestration planned in so-called Class VI wells.

The Baker Institute for Public Policy at the Rice University in Houston provides a very detailed map of all CCUS infrastructure in Texas. CCUS Map is another resource ($).

Skilled workforce

While Texas boasts a robust energy infrastructure, it is important to recognize the skilled workforce that underpins this industry. Decades of experience and expertise have been cultivated within the state's energy sector, ensuring the safe and efficient operation of these critical facilities. From engineers and technicians to skilled tradespeople, these individuals possess the knowledge and capabilities to maintain and innovate within the energy landscape. Their contributions are essential to the ongoing success of Texas' energy industry. According to the Texas Higher Education Coordinating Board data, 989 students were enrolled in petroleum engineering programs in 2023 at Texas' 4-year public institutions. We also see a rising interest in energy beyond oil and gas with colleges adding courses and curriculum in the Energy Transition space (see Addendum 10 for resources on Academia).

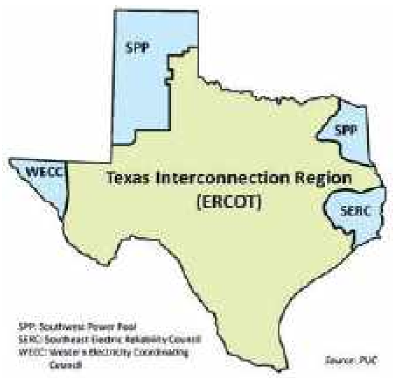


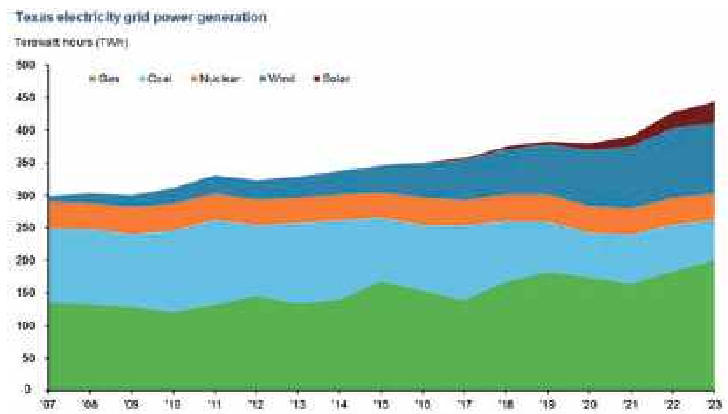
Total enrollment of Petroleum Engineering Programs in Texas in 2023
Source: THECB DataBridge

Electricity

Texas is the only state to have its own independent electric grid. It is managed by ERCOT, an independent, membership-based nonprofit corporation governed by a board of directors under governmental supervision. With almost 500 TWh electricity generated in 2023, almost twice the production of Florida, the distant second largest producer, Texas produces 12.53% of the total US energy generation through its 764 utility-scale power generating assets (power plants, wind turbines, solar farms, etc.).

While Natural gas is still the dominant energy source at 43%, wind already represents 26% and solar 6% of the 2023 electricity generation by utility-scale producers.[7]





Source: Electric Reliability Council of Texas, Research data

[7] Source: EIA-923 Power Plant Operations Report (released: 10/4/2024)

3.3 Current renewable power in Texas

As mentioned earlier, Texas is the largest producer of wind energy in the US and the second largest solar producer after California. Favorable wind conditions and favorable solar irradiance as seen in chapter 2.5 are obvious large contributing factors. Land availability is another critical factor. Repsol's Frye Solar in Northwest Texas competes with Tokyo Gas' Aktina plant near Houston as the largest operational solar plants in Texas each with a capacity of 500 MW. NextEra's Great Prairie Wind farm in Northwest Texas is the largest operational wind farm in Texas with more than 1 GW of installed capacity, second only in the US to California's Alta Wind farm.

Not only is utility-scale renewable power generation growing significantly year over year, but small-scale solar generation is also increasing at 20-40% annual growth rate in the state to reach more than 4 TWh in 2023, enough to power more than 400,000 homes.

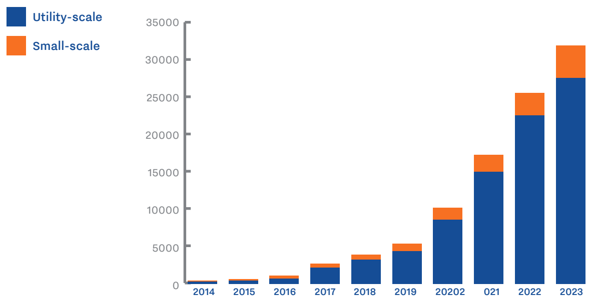
Contrary to popular belief, Texas energy consumption per capita ranks only 6th in the US and 12th in terms of electric consumption per capita.

	Wind generation Jun 2024 (TWh)	# in US
Texas	11.1	1
Oklahoma	3.5	2
Iowa	3.4	3
Kansas	2.8	4
Colorado	1.5	5
California	1.5	6

	Solar generation Jun 2024 (TWh)	# in US
California	8.7	1
Texas	4.5	2
Florida	2.2	3
Nevada	1.7	4
Arizona	1.7	5
North Carolina	1.4	6

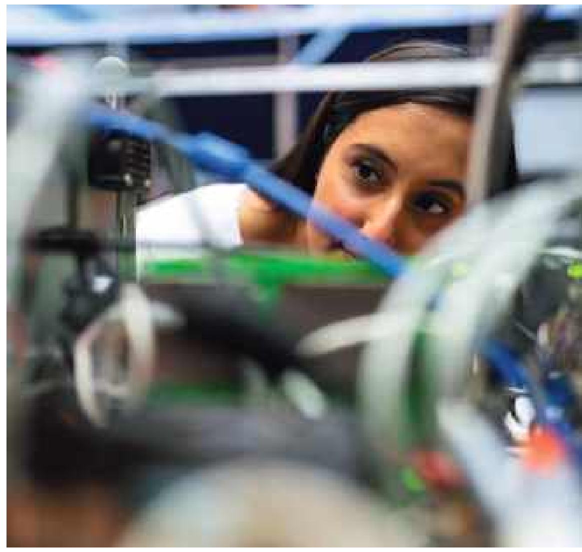
Source: Choose Energy | solar | wind

Texas annual solar generation (GWh)



Source: Data from EIA through Climate Central

3.4 Emerging clean H_2 production



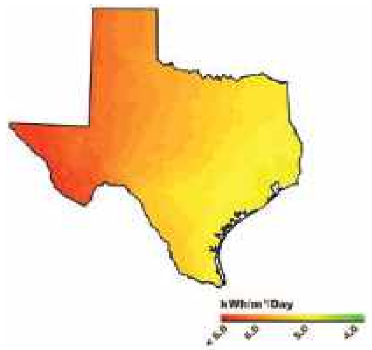
Texas, with its vast geographic expanse and strong wind and solar potential, offers a compelling opportunity for developing a robust green hydrogen industry. With abundant natural gas resources and nearby depleted oil fields for carbon sequestration, Texas also presents a compelling opportunity for blue hydrogen development. The state's existing energy infrastructure, including pipelines, ports, and a skilled workforce, combined with current tax advantages and favorable cost differentials, positions Texas well to capitalize on the growing global demand for green and blue hydrogen. Finally, Texas' unique access to undeveloped salt domes provides ideal storage solutions, further solidifying its position as a leading hub for clean hydrogen.

3.4.1 Suitability of TX for clean H_2 production

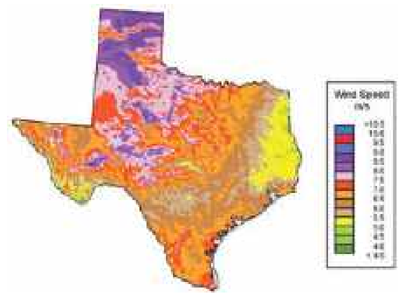
Land potential

Texas boasts an abundance of land suitable for both solar and wind energy generation. The state's vast, flat landscapes, particularly in the western and northwest regions, with miles of unbuilt land, offer ideal conditions for large-scale solar and wind farms. So called wind leases are a welcome source of additional revenues for landowners and perceived as helping reverse the economic decline affecting many rural communities (a survey found 70% of the rural population in these areas perceived wind power as improving employment and the overall economy).[8] Land use is around 50 acres/MW of capacity, but generally, the wind turbines do not interfere with other land uses. Selecting an optimum wind power source area will involve a trade-off between transmission cost and number of wind generators needed. Though almost the entirety of wind capacity sits on private lands, the Texas General Land Office (Texas GLO) actively leases land for renewable energy projects, further contributing to the state's potential.

Solar Resources in Texas



Wind Resources in Texas



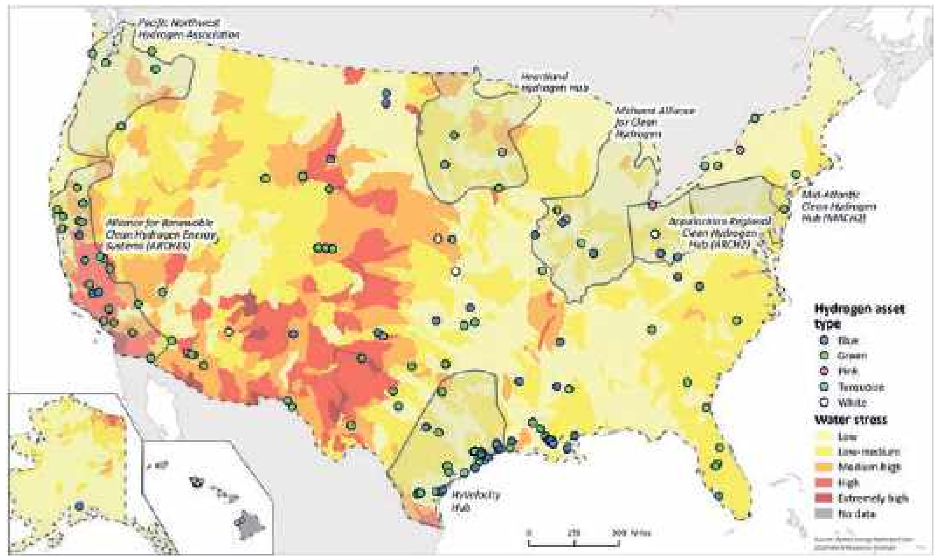
Source: Office of the Texas Governor | Report Renewable energy

[8] Spatial Distribution of Estimated Wind-Power Royalties in West Texas

Green hydrogen: Unique solar and wind opportunities but water constraints

Source: Acretio LLC

West Texas is most particularly prone for solar and wind farms with a combination of exceptional solar irradiance and high wind speeds at 80-100m altitude. And one of the unique features of the West Texas wind resource region is that on average, wind speeds are higher during the night than during the day, so that wind and solar power production complement each other. While this offers significant potential for green power, hydrogen production through electrolysis process requires a substantial amount of water (9 to 10 liters per kg of hydrogen produced). This raises concerns about potential water scarcity and competition with other water-intensive industries, such as agriculture and oil and gas production. The electric infrastructure to bring power from West Texas to the Gulf Coast is already at capacity and even on the Gulf Coast, with abundant water nearby in the Gulf, green hydrogen projects have faced significant backlash if they intend to tap fresh water supply. However, Texas contains several large saline aquifers[9] and is home to the largest inland desalination plants in the world. The challenges are not insurmountable, but it will most likely require a combination of desalination, green power generation and new transmission lines before we can see a number of new green hydrogen projects reaching FID.



Locations of proposed hydrogen production projects are overlaid over the World Resources Institute's Aqueduct Water Risk Atlas map of water stress in the United States. The gray circles indicate areas included in the regional hydrogen hubs selected for funding by the U.S. Department of Energy. (Map courtesy of Rystad Energy)

Source: Floodlight News

[9] Saline Water Resources of Texas, A.G. Winslow and L. R. Kister, 1956 | Report

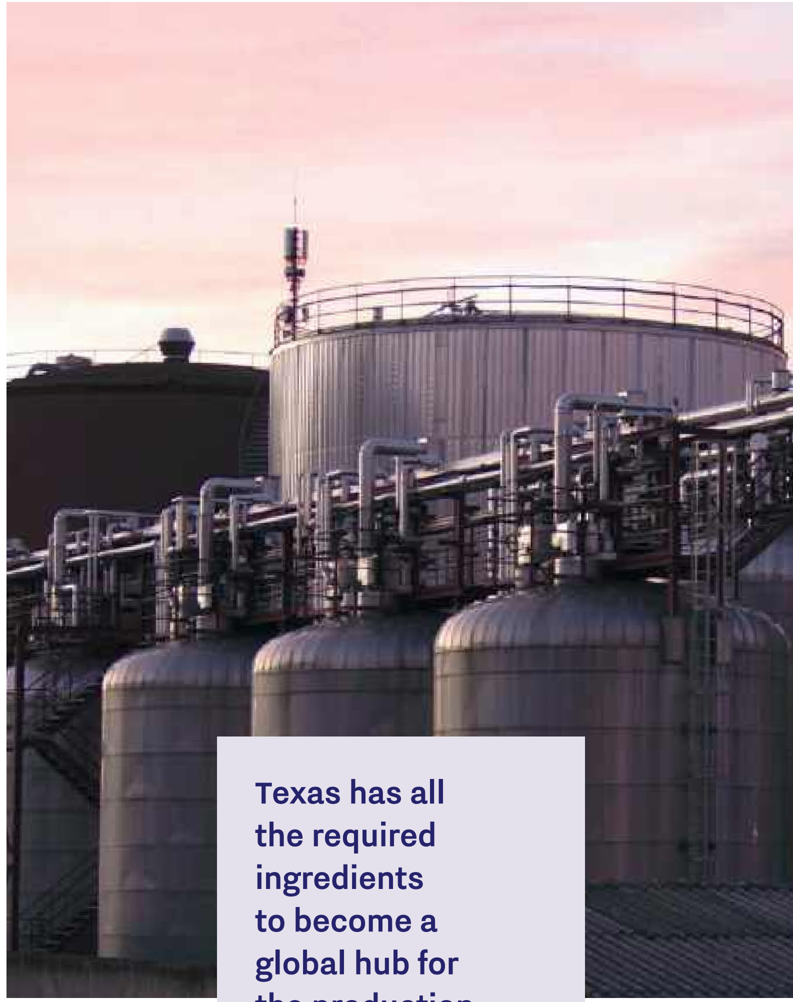
Blue hydrogen viability

Blue hydrogen production faces similar challenges in transmitting green power from West Texas to the existing production sites on the Gulf Coast but it requires only a third of water consumption in the process (see Appendix 8.5 for details and requirement for both technologies). This advantage over green hydrogen production, coupled with its ability to leverage the existing natural gas infrastructure, to bring natural gas from the extraction sites to the Steam-Methane reformers along the Gulf Coast, and the existing infrastructure of CO_2 pipelines to send the captured CO_2 into the sinks (mostly depleted oil fields), makes blue hydrogen a more practical candidate for clean hydrogen at this stage in Texas.

Storage and export strengths

Whether the pathway to clean hydrogen production is through green or blue processes, and regardless of the export method (ammonia or other liquid hydrogen carriers), Texas possesses a unique advantage: its extensive network of salt domes. These geological formations offer significant storage capacity for hydrogen (see below paragraph 3.4.2).

Furthermore, Texas' established ammonia infrastructure provides a solid foundation for the export of clean hydrogen. The state is a major producer of ammonia, with 60% of the entire US production capacity concentrated in Louisiana, Oklahoma, and Texas. The ports of Corpus Christi, Beaumont, Houston, and Victoria, all of which are already involved in ammonia storage and production (or have advanced projects underway) are well-positioned to facilitate the export of clean hydrogen to global markets. By leveraging its existing infrastructure and geological assets, trained skills and decades of experience, Texas has all the required ingredients to become a global hub for the production, storage, and export of clean hydrogen.



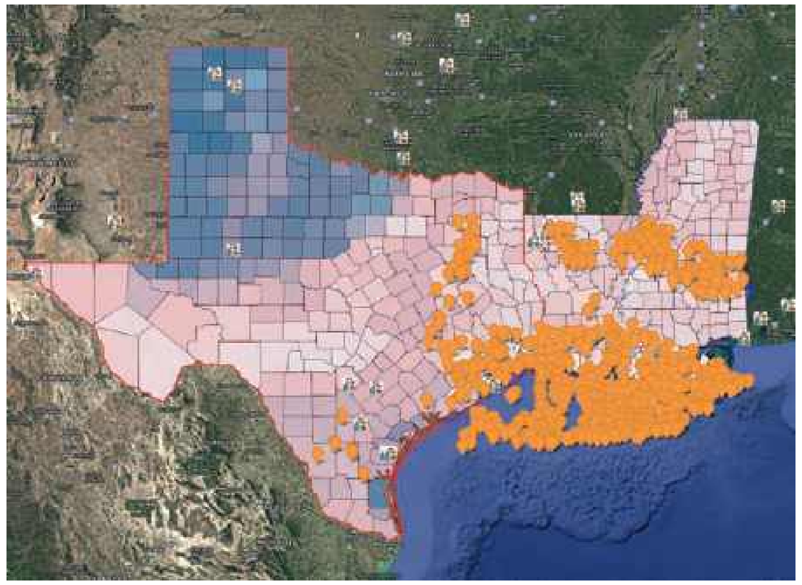
Texas has all the required ingredients to become a global hub for the production, storage, and export of clean hydrogen.

3.4.2 Salt caverns for hydrogen storage

Hydrogen is a challenging gas to transport and store due to its low energy density and tendency to leak. By converting hydrogen into ammonia, a liquid at cold temperature (-33.1 °C) and atmospheric pressure, it can be more efficiently transported and stored, reducing logistical challenges. Green ammonia, a likely carrier of green hydrogen across oceans, is produced by combining green hydrogen (generated from solar and wind power) and nitrogen. This process requires a continuous supply of both elements. However, solar and wind power being intermittent by nature, salt caverns represent an ideal form of storage for green hydrogen, allowing a consistent supply for ammonia production.

Besides storage needs for green ammonia production, salt caverns are excellent cost-effective options for storing hydrogen on a large scale because they have a large storage capacity and flexible operation with large injection and withdrawal rates. Underground hydrogen storage will enable the development of the clean hydrogen sector by ensuring security of clean hydrogen supply for end customers.For example, Linde has been operating one of the handful commercial hydrogen high-purity cavern in the world since 2007 (gray H_2 in this case) and supply some of their pipeline hydrogen customers out of this hydrogen storage facility in Texas. The underground storage cavern is an integral part of their pipeline network and designed to provide hydrogen during periods of planned and unplanned peak demand.

With more than 500 onshore and offshore salt domes mapped along the Gulf Coast, the potential for hydrogen storage is huge as each of these domes is unique and can have between 60 and 70 caverns. A study from the STARR at the University of Texas calculated in their base scenario, that 368 TWh of energy could be stored in 2,550 caverns of the 98 domes under study, that's 82% of the state entire year power generation.

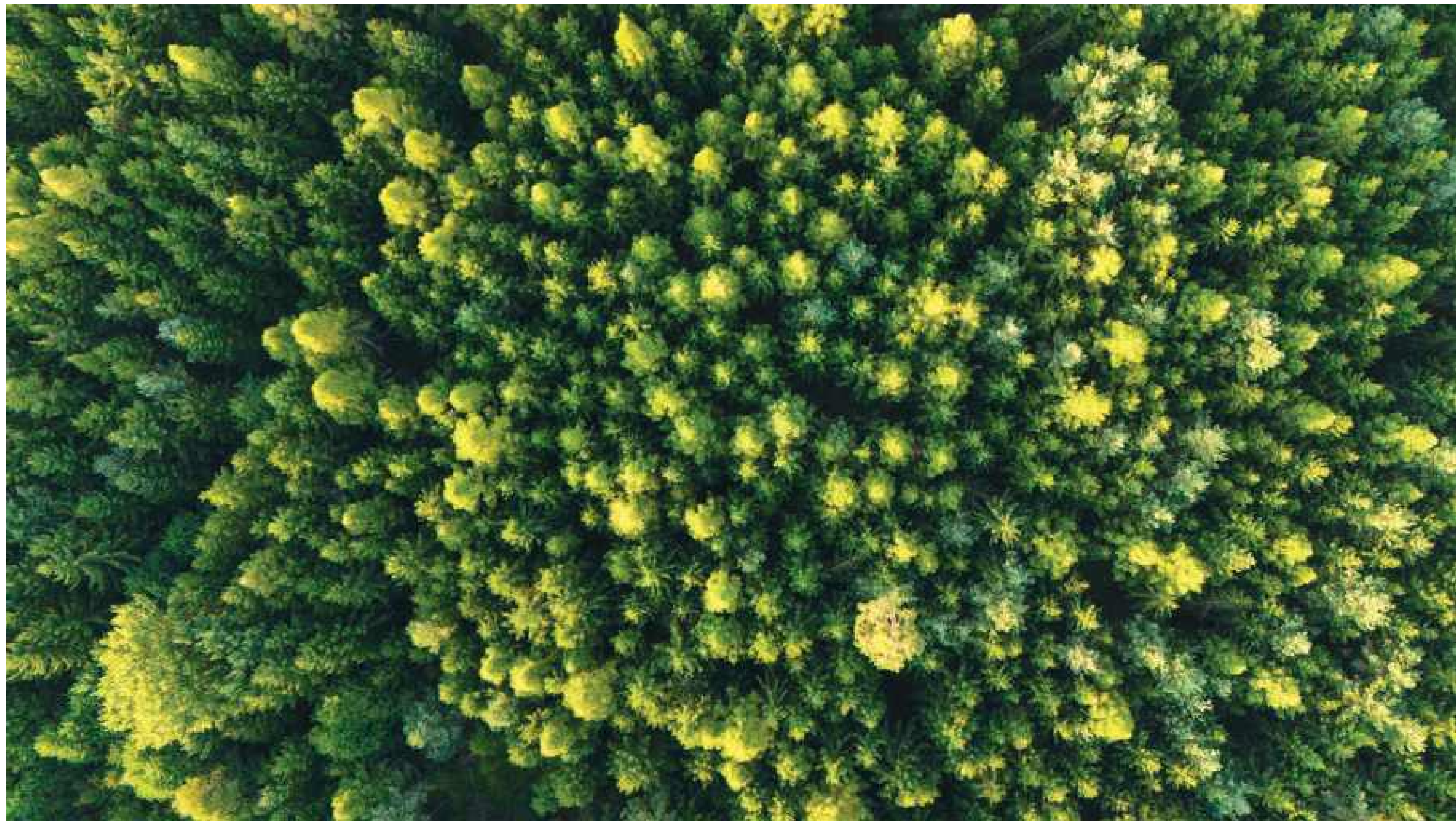


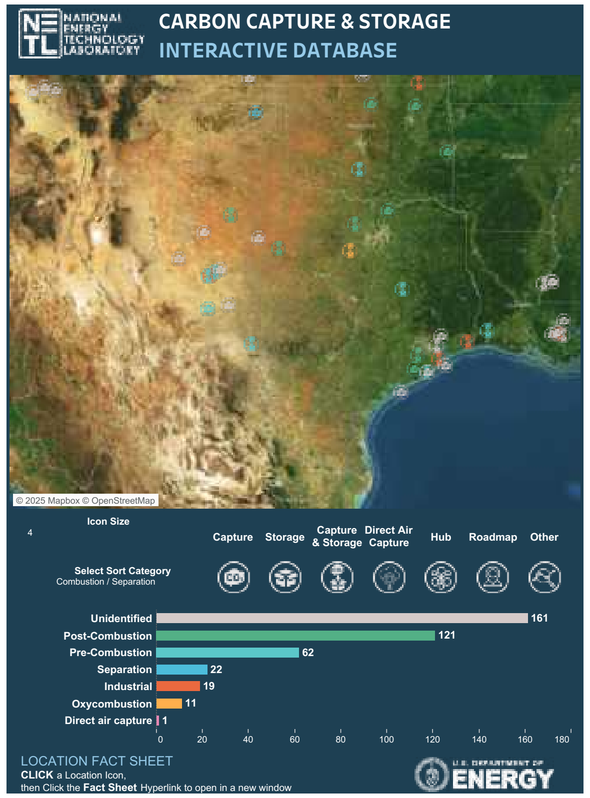
Each orange dot represents one of the 589 salt domes along the Gulf Coast. Source: State of Texas Advanced Resource Recovery (STARR)

3.4.3 New hydrogen pipelines

The distance from the wind and solar resource areas in West Texas to the nearest deepwater export facilities in Corpus Christi is in the order of 800 km (500 miles). To transport the renewable energy in the form of high voltage electrical power is far more costly and more difficult to permit than building a hydrogen pipeline. Several existing rights-of-way and pipeline corridors already connect the prolific oil and gas production in West Texas with the US Gulf Coast and landowners are familiar with the permitting process and the royalty system.

We estimated that a single 36" pipeline system operating at similar pressures as used for underground storage would be able to transport 6,000 ton/day of hydrogen, enough to feed 10 world-scale ammonia plants and would carry the equivalent of 8.3 GW of electrical power. Moreover, the line fill of such an 800 km pipeline system would be in the order of 5,200 tons, enough to buffer out the daily cycle of solar power generation. One of the oddities of hydrogen is that its very low density and viscosity makes it difficult to compress, but also results in very low friction losses during pipeline transport.





Source: The global CCS [interactive database]

3.4.4 CO_2 sequestration

As mentioned earlier, CO_2 sequestration is an essential part of the blue hydrogen production and Texas has a long history of using CO_2 for EOR (Enhanced Oil Recovery, see paragraph 3.2). In September 2024, the EPA (US Environmental Protection Agency) announced the first draft permits for carbon sequestration wells in Texas (so-called [Class VI wells]).

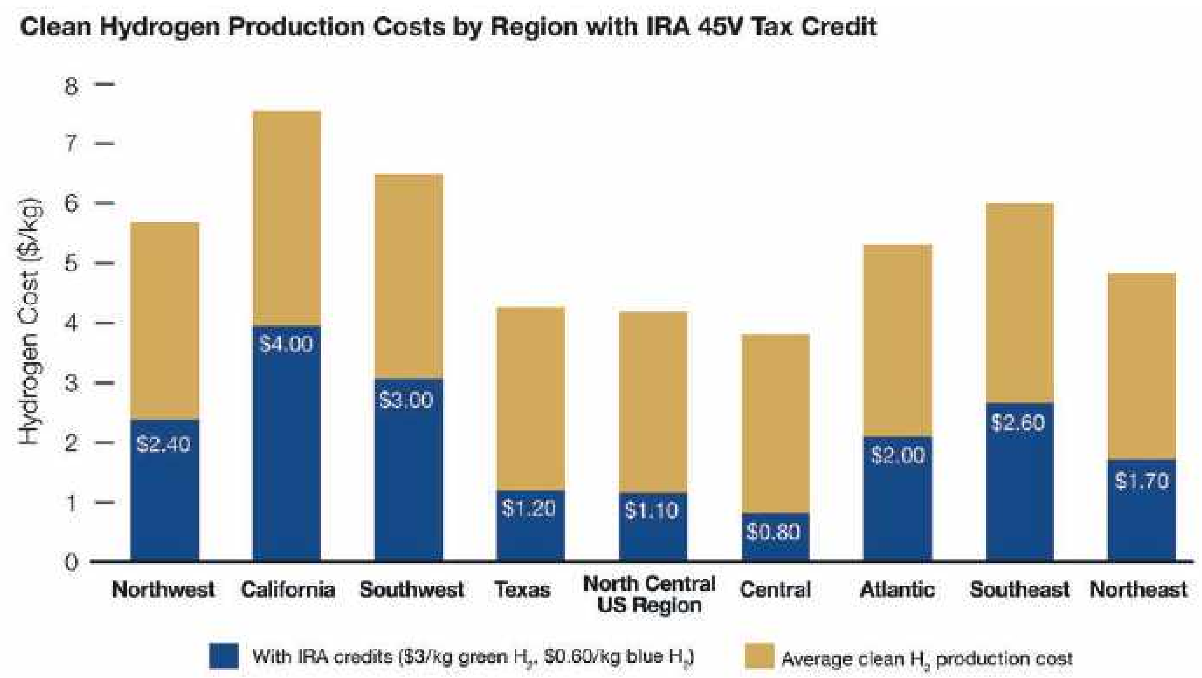
The state, rich with on- and offshore saline and depleted hydrocarbon reservoirs, is an ideal candidate for these carbon sequestration wells and projects are popping up everywhere. The DoE's National Energy Technology Laboratory which maintains an interactive database of worldwide CCUS projects lists about 20 projects in the state at the end of 2024. Some of the key known active projects are listed below (not all lists in the DoE interactive database yet as they might still be in feasibility study stage):

Project name	Area	Type	Acreage	CO_2
Repsol/Carbonvert	Corpus Cristi	Offshore	140,000	600 Mtons
Exxon GOM CCS Hubs I, II, III	Baytown	Offshore	271,000	
Bayou Bend (TTE, CVX, EQNR)	Port Arthur	On/Offshore	100,000 on/40,000 off	225-275 Mtons
Coastal Bend CSS (TTE)	Corpus Cristi	Onshore	13,000	50-100 Mtons
South Texas DAC Hub	Corpus Cristi	Onshore	106,000	3,000 Mtons
FRESSH	Freeport	Onshore		400 Mtons
Oxy 1PointFive	TX / LA	Onshore	300,000	6,000 Mtons

With the increased focus on Blue Hydrogen in the state, we can expect the list of these CCS projects to increase and materialize in coming years.

3.4.5 Clean H_2 cost differential within US

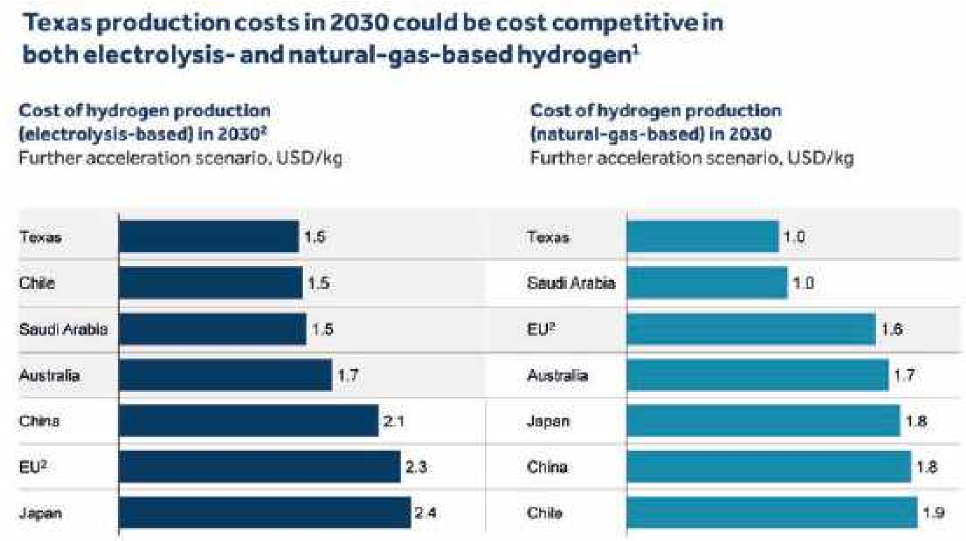
As mentioned earlier, the US cost to produce clean hydrogen is very competitive compared to other places in the world, especially with IRA incentives (see chapter 1). The vast availability of wind and solar in Texas, combined with the proximity of carbon underground sequestration options and cavern storage as well as the existing port and logistics infrastructure amongst other factors, result in Texas being amongst the most competitive state within the country itself. The Energy Future Initiative estimates the cost to produce clean hydrogen in Texas to about \$4/kg H_2, potentially down to \$1.20 after taking into account the full tax credit from IRA's 45V.



This figure compares regional hydrogen production prices based on energy input costs, CO_2 storage, and clean energy resource availability and how those impact eligibility for the 45V hydrogen PTC. Regions with abundant CO_2 infrastructure and renewable resources overall have the lowest clean hydrogen production costs as a result of the PTC.

Source: The US Hydrogen Demand [Action Plan] (Energy Future Initiative)

With the US itself being already very competitive, being amongst the lowest cost in the US means for Texas that the state is amongst the lowest clean hydrogen cost producers in the world. The Hydrogen Council and McKinsey project that by 2030, green hydrogen production cost in the US, will even be lower than any blue hydrogen production around the world, except Saudi Arabia.[10]



1. Further Acceleration Scenario refers to a scenario where global hydrogen demand reaches 540 MTPA in 2050.

2. Electricity costs based on solar in Australia, Chile, KSA, wind in Texas, China, Japan, and EU; 2. Germany example Source: McKinsey Hydrogen Insights

Source: Houston Hydrogen Hub

Beyond tax incentives at federal levels, other incentives are available at regional and local level. In Texas, for example:

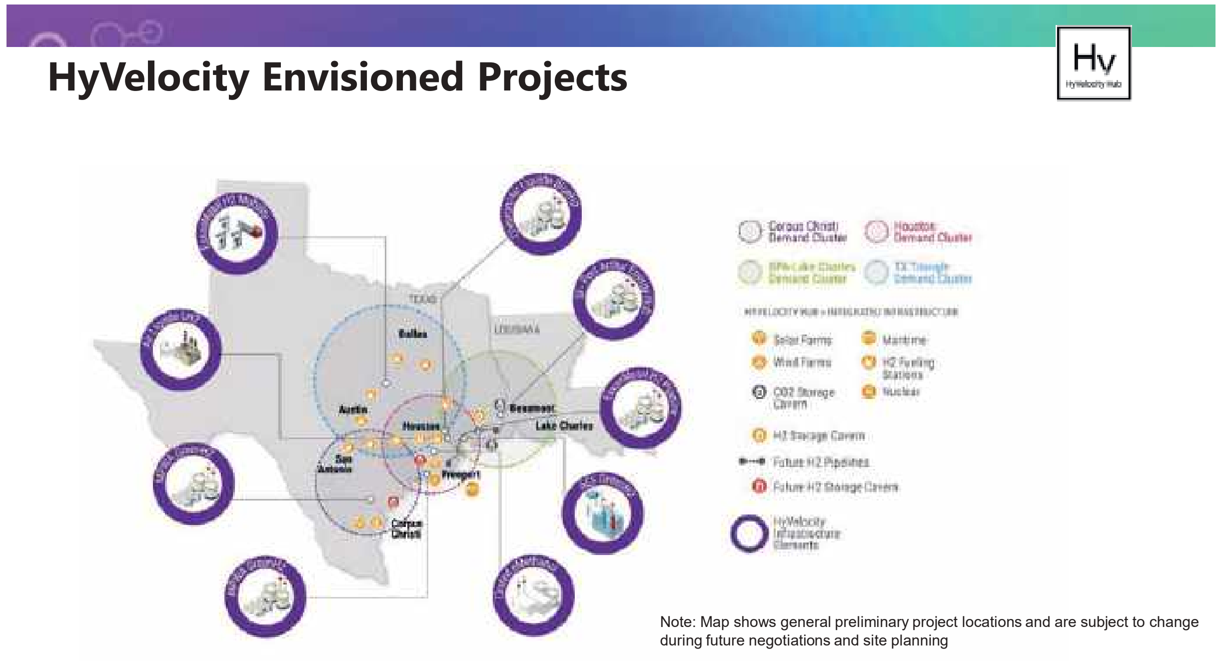
- The Texas Enterprise Zone Program
- The property tax exemption for Solar and Wind-powered energy devices
- Local agreements under the Chapter 312 Property Tax Abatement Act

3.4.6 Houston H_2 hub and Corpus Christi hub alternate

The DoE selected the Gulf Coast as one of the 7 clean hydrogen hubs. The so-called HyVelocity Hydrogen Hub, centered in Houston, and led by seven core industry partners was slated to receive up to $1.2 billion in funding. At the time of this report, it is unclear whether the new administration will honor this funding commitment.

[10] Hydrogen Council & McKinsey's Global Hydrogen Flows - 2023 Update, Exhibit 1

Envisioned projects are centered around four defined demand clusters, Corpus Christi, Houston, Beaumont/Port Arthur/Lake Charles and the Texas Triangle and comprise solar and wind farms, maritime infrastructure, hydrogen fueling stations, nuclear power as well as CO_2 storage caverns, hydrogen storage caverns and pipelines. Nine HyVelocity infrastructure elements seem to have been already identified, ranging from H_2 pipelines to eMethanol production and mobility-focused assets.



Source: HyVelocity - Gulf Coast Regional H2Hub

Also a candidate for one of the seven hydrogen hubs, the Port of Corpus Christi's own Horizons Clean Hydrogen Hub (HCH2) was selected by the DoE as Hub Alternate. HCH2's scope comprises infrastructure projects and clean H_2 production projects with a nameplate capacity of more than 5,000 ton per day of clean hydrogen.

HORIZONS CLEAN HYDROGEN HUB PORT CORPUS CHRISTI

3.4.7 Summary

Texas is poised to become a leading clean hydrogen hub due to a combination of factors:

Existing infrastructure
Texas has a robust energy infrastructure, including pipelines, ports, and a skilled workforce, which can be leveraged for clean hydrogen production, transportation, and export.

Abundant resources
Texas has vast wind and solar potential for green hydrogen production, as well as abundant natural gas and depleted oil fields suitable for blue hydrogen production and carbon sequestration.

Favorable geology
The state's unique salt caverns offer significant underground hydrogen storage capacity.

Cost competitiveness
Federal and regional incentives, combined with low production costs, make Texas a highly competitive location for clean hydrogen production.

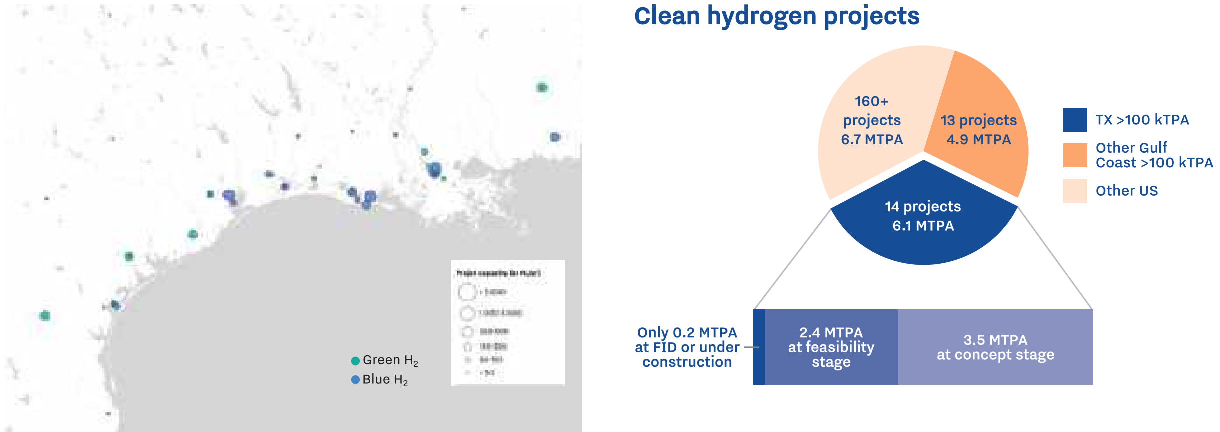
Supportive policies
Government initiatives like the H_2Hubs program and the National Clean Hydrogen Strategy and Roadmap are supporting the development of the clean hydrogen industry in Texas.

Moreover, the success factors that underpinned its century-long success in the traditional oil & gas will ensure its prominence in the Energy transition:

Success Factor	Traditional Oil & Gas	Renewables & Low Carbon Energy	Opportunities/Threats
Land Ownership	Shale growth independent of government	Texas produces large amounts of renewable power on private land	Large-scale solar, wind, and hydrogen projects offer potential due to abundant land availability, but face challenges like land-use conflicts and environmental impact assessments.
Innovation	Fracking and Oil Recovery	Carbon Sequestration and Blue Energy	Hydrogen exports, particularly via ammonia, present a significant opportunity. However, transportation and storage infrastructure needs development.
Regulatory & Incentives	MLPs drove large midstream infrastructure investments	IRA bipartisan legislation & Hydrogen Hubs	Combined US, EU, and Japanese incentives, including tax credits and subsidies, can accelerate clean energy adoption. However, policy changes and regulatory uncertainty pose risks.
Economies of Scale	LNG exports, Henry Hub, Mont Belvieu	Hydrogen pipelines, CCS and salt dome storage	Expanding renewable energy infrastructure to meet growing demand in key areas presents a major opportunity. This requires strategic planning and overcoming logistical challenges.
Access to Capital Markets	Private equity teams, MLP, E&P structure	Private and governmental capital strength combined	While access to capital is readily available, long project timelines in clean energy may exceed typical investment horizons, potentially hindering project development.
Geographical Advantages	From Spindletop to Shale revolution. Salt formations. Access to seaports	Wind and solar patterns, density, and overlap	Underground hydrogen storage offers a promising solution for managing seasonal variations in clean energy production. However, geological suitability and potential environmental impacts need careful consideration.

3.5 Emerging clean H_2 projects & commercial announcements

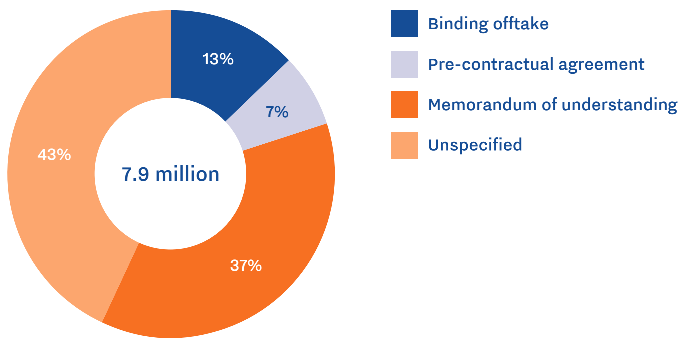
The IEA currently lists 190 projects linked to clean hydrogen in the USA, whether blue or green, totaling a potential H_2 capacity of 17 MTPA. 27 of these projects are large (>100 kTPA) and located in the Gulf Coast, of which 14 in Texas, see table in appendix (8.10) for details.



Source: IEA 2024 map & database

While the list grew significantly over the last two years, the second part of 2024 saw a slowdown of many projects if not outright postponements. Many factors continue to impede the full realization of the state's hydrogen potential. These include uncertainties surrounding federal incentives under the new administration, technological challenges, and the development of robust infrastructure. The lack of firm offtake agreements compounds the issues. This is not specific to Texas, Bloomberg lists, as of September 2023, only about 7.9 million tons per year of hydrogen offtake agreements, of which only 13% are firm.

Low-carbon hydrogen offtake by agreement type
Metric tons/year



Source: BloombergNEF

Note: Data as of Sep 29, 2023. The database only includes projects of over 20MW or 2,800 metric tons/ year of capacity. Pre-contractual agreement includes term sheets, letters of intent, and heads of agreement.

3.6 Future development

Significant on- and offshore CCS projects have already been announced and we can expect this trend to continue, especially as economics for Blue Hydrogen are currently more favorable than Green. CO_2 pipelines and H_2 storage caverns should follow the same trend. Similar to Europe, local usage of H_2 in fleet transportation can also be expected to slowly emerge.

3.7 Conclusion

Texas, with its vast expanse and abundant natural resources, has a long and rich history in the energy sector, from the Spindletop gusher of 1901 to the shale revolution of the 21st century. The state's energy landscape is both diverse and dynamic, encompassing not only traditional oil and gas production but also a growing renewable energy sector, with wind and solar power generation leading the way.

Texas' extensive energy infrastructure, including pipelines, ports, and a skilled workforce, provides a solid foundation for the state's ambition to become a leading clean hydrogen hub. The state's unique geological advantages, such as its numerous salt domes, offer significant storage capacity for hydrogen, further enhancing its appeal.

While challenges remain, such as the need for additional infrastructure and the uncertainty surrounding federal incentives, Texas' potential in the clean hydrogen economy is undeniable. The state's commitment to innovation and its business-friendly environment are expected to drive further growth and development in this emerging sector.

4. Dutch expertise and innovations in hydrogen

4.1 The Dutch hydrogen program and strategy

The national hydrogen program and strategy of the Netherlands ("Nationaal Waterstof Programma" NWP; National Hydrogen Program) aims to accelerate the development of a sustainable hydrogen economy. The program involves collaboration between public and private parties and seeks to give hydrogen a central role in the energy transition. Key elements of the NWP include:

Holistic approach
The program connects all aspects of the hydrogen value chain, including production, transport, distribution, storage, and applications.

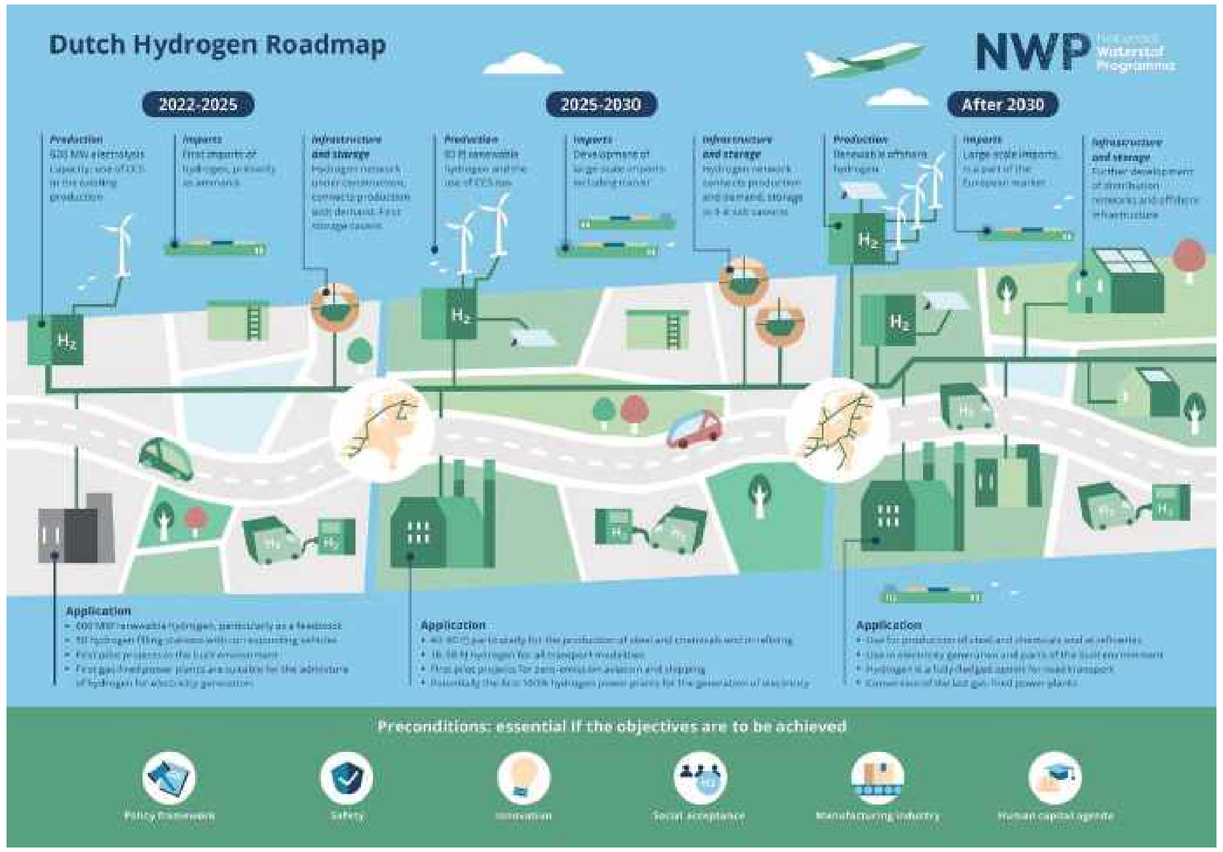
Innovation and research
Promoting research and development of hydrogen technologies to reduce costs and improve efficiency.

Infrastructure
Promoting investment in infrastructure to ensure a reliable and safe hydrogen supply.

International cooperation
Encouraging collaboration with other countries to exchange knowledge and experience and strengthen the global hydrogen market.

Roadmaps

The National Hydrogen Roadmap (Routekaart Waterstof) outlines the Dutch national strategy and how a broad group of stakeholders aims to make progress in the coming years to achieve the Netherlands' hydrogen ambitions and climate goals. It involves both public and private parties that have committed to the National Hydrogen Program (NWP).



Source: National Hydrogen Roadmap (Routekaart Waterstof)

Another valuable resource is the Dutch Hydrogen Map (Waterstof Kaart). It is developed by Mission H2 NL and TKI New Energy. Mission H2 NL is a coalition of Dutch companies and government entities. Their goal is to position the Netherlands as a leading hydrogen nation by 2030. TKI New Energy is a Top Consortium for Knowledge and Innovation (TKI) within the 'Topsector Energy' framework. Topsector Energy focuses on driving the energy transition. It facilitates collaboration between public and private stakeholders to achieve rapid and effective results.

This comprehensive and up-to-date Hydrogen map highlights the various hydrogen initiatives and projects currently underway in the Dutch hydrogen sector. Moreover, the interactive map offers a unique opportunity to travel through time to see the development of the Netherlands as the Hydrogen Country 2030. Check out the hydrogen map here.

Dutch Hydrogen Map (Waterstof Kaart)

4.2 Incentives and participation in product auctions

The government of the Netherlands has implemented several initiatives to support its hydrogen market. Through these measures, the Netherlands actively fosters its hydrogen market, aligning with European efforts to promote renewable hydrogen production and utilization.

Subsidy schemes for hydrogen production

The Dutch government offers subsidies to bridge the cost gap between renewable hydrogen production and fossil-based alternatives. For instance, a €998 million scheme supports large-scale renewable hydrogen production, covering both investment and operational costs (source: RVO), for example the Shell HH1 project that is currently under construction.

Collaborative auctions with Germany

In partnership with Germany, the Netherlands will host a joint auction to import RFNBO compliant hydrogen, utilizing the H2Global Mechanism (see appendix 8.8 for details). Both countries have committed €300 million each to procure RFNBO hydrogen from international suppliers, aiming to stimulate the hydrogen market and ensure competitive pricing (source: Hydrogen Insight).

Infrastructure support
The Dutch government supports the development of a national hydrogen infrastructure through the Hydrogen Backbone, led by Gasunie. This network repurposes existing gas pipelines to transport hydrogen between industrial clusters and across borders. Backed by €750 million in public funding, the first phase is expected to be operational by 2026 and the full network by 2033 (source: Gasunie).

Subsidies for hydrogen equipment manufacturing
The Dutch government offers subsidies covering up to 15% of eligible costs for companies establishing facilities to produce electrolyzers and other green hydrogen components. In designated EU regional aid areas, this subsidy can increase to 20% (source: Hydrogen Europe).

Hydrogen mobility subsidy scheme
Between 2024 and 2028, the Netherlands has allocated €125 million to promote hydrogen-powered vehicles and infrastructure. This program subsidizes up to 80% of the price difference between hydrogen and diesel vehicles and covers 40% of the construction costs for new hydrogen refueling stations (source: RVO). Consult also the most recent RVO report on RFNBO-certification process.

4.3 Dutch ports: relations to US ports and the hydrogen ecosystem

Port of Rotterdam

The Port of Rotterdam has been actively collaborating with counterparts in Texas to establish a Clean Hydrogen Atlantic Corridor, aiming to commence the transportation of clean hydrogen molecules by 2026. This initiative is part of the broader Transatlantic Clean Hydrogen Trade Coalition (H2TC), which aspires to facilitate the trade of over three million metric tons of clean hydrogen annually, in forms such as ammonia and methanol, between the U.S. Gulf Coast and Northwestern Europe by 2030.

In February 2021, the Port of Rotterdam and the Port of Corpus Christi signed a Memorandum of Understanding (MoU) to collaborate on reducing carbon footprints and enhancing environmental protection. Their joint efforts include deploying carbon capture and storage technologies, utilizing hybrid, electric, or hydrogen-powered vehicles for port operations, and offering incentives for vessels that exceed environmental standards.

The ports are also working together to advance hydrogen initiatives, fostering partnerships with clients across the Atlantic.

Fourteen terminals have now announced plans to import hydrogen through the Port of Rotterdam, using carriers such as ammonia, LOHCs, LH_2, and (e-)SAF. In Europe, Rotterdam port closely collaborates with Duisport in Germany and the Port of Antwerp in Belgium on hydrogen initiatives.

In 2020, the cities of Rotterdam and Houston signed an MoU to strengthen economic collaboration between their energy hubs and ports. This partnership led to a digital trade forum in October 2020, focusing on energy transition topics such as hydrogen application, CO_2 capture, and digital technologies in the energy sector. The MoU between Rotterdam Partners and the Greater Houston Partnership aimed to support companies in starting up, expanding, and investing in both cities. Ongoing discussions have been taking place since as there is strong interest in continuing the economic ties with collaboration in the energy sector.

Port of Amsterdam

In 2022, the Port of Amsterdam signed an MoU with Evos and Hydrogenious to develop a green hydrogen import facility. The project plans to include a Liquid Organic Hydrogen Carrier (LOHC) dehydrogenation plant with a release capacity of up to 100-500 tons of hydrogen per day, along with related storage and handling facilities, targeting volumes up to 1 million tons per year. Deliveries to off-takers are scheduled to begin in 2028. Additionally, the Port of Amsterdam is collaborating with Duisburger Hafen (Duisport in Duisburg, Germany) to facilitate the distribution of hydrogen to the German and European hinterland.

Port of Eemshaven (Northern Netherlands)

Europe's first official Hydrogen Valley, known as HEAVENN (Hydrogen Energy Applications for Valley Environments in Northern Netherlands), is situated in the northern Netherlands. This initiative plays a crucial role in the European energy transition, aiming to establish an integrated green hydrogen value chain encompassing production, distribution, storage, and utilization across six locations: Eemshaven, Delfzijl, Zuidwending, Emmen, Hoogeveen, and Groningen. Supported by European subsidies and a consortium of 31 public and private entities from six European countries, the northern Netherlands is well-positioned to play a leading role in the sustainable energy supply of the near future.

4.4 The hydrogen pipeline corridors towards Belgium and the German hinterland

Dutch National Hydrogen network: HyNetwork

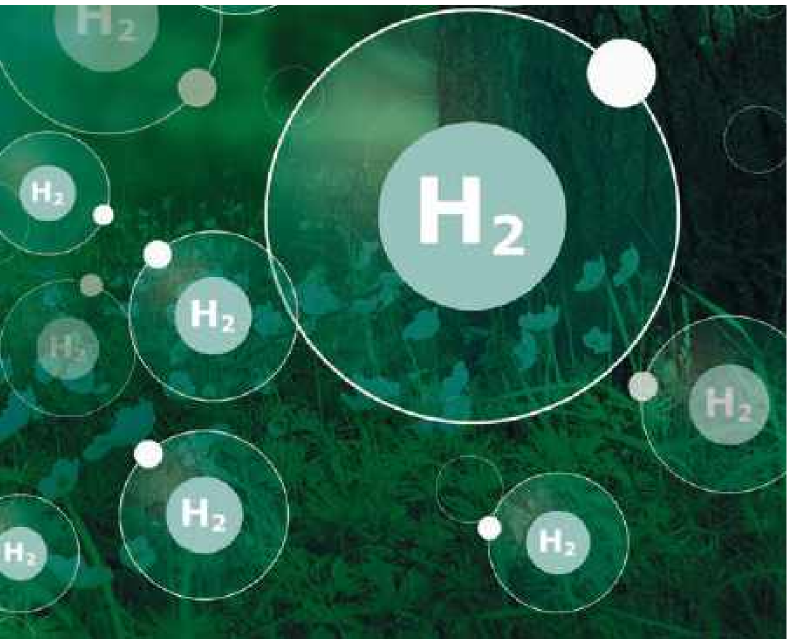
HyNetwork, a 100% subsidiary of Gasunie (the Dutch Transmission System Operator), is responsible for creating the national hydrogen network in the Netherlands. This network will connect five key industrial clusters—located at the ports of Rotterdam, Amsterdam, Northern Netherlands, Zeeland, and Geleen/Chemelot. Ultimately, the EU Hydrogen Backbone will connect with the Port of Antwerp, and beyond that with key locations in Germany, and other countries. It will also link to hydrogen storage facilities and import locations.

The hydrogen network is being developed partly through the retrofitting of existing natural gas pipelines. In locations where existing pipelines are insufficient or unavailable, new construction will occur.

The HyNetwork is crucial for the connection between industrial clusters in the Netherlands and the locations where hydrogen will be stored. Also in the Northern Netherlands, at Zuidwending, 4 to 6 large empty salt caverns are projected to be used as seasonal storage for hydrogen.

Connections to Germany and Belgium

The Delta Rhine Corridor (DRC) is a critical East-West link connecting the Rotterdam industrial cluster to the Eastern part of the Netherlands and to Germany. The DRC is expected to be operational in 2032. The ambitious infrastructure project is designed to establish a network of underground pipelines for transporting hydrogen and CO_2 between Rotterdam, Moerdijk, Geleen, and into Germany. The project's complexity arises from its integrated approach, aiming to install multiple pipelines and cables within a single corridor.



In June 2024, the Dutch Ministry of Economic Affairs and Climate Policy announced a delay in the DRC's timeline, shifting the expected completion from 2028 to 2032. This postponement is attributed to the intricate coordination required for the simultaneous installation of diverse infrastructures and the alignment of procedures between the Netherlands and Germany.

Flanders and the Netherlands collaborate in WaterstofNet, a knowledge and collaboration platform promoting hydrogen technology. It supports and implements hydrogen projects through partnerships with industry, research institutions, and governments. The organization focuses on four key areas: fostering a hydrogen network, serving as a knowledge center, developing projects, and advising governments on hydrogen policies. WaterstofNet advocates for hydrogen's role in transportation, industry, and energy storage with projects and coordinates initiatives like RH2INE, a European network that aims to establish a zero-emission transport corridor along the Rhine.

4.5 The strengths of Dutch industry sectors

Kickstarting the hydrogen economy necessitates significant investments in supply and infrastructure, alongside establishing a stable demand for hydrogen applications. Dutch researchers and companies are exploring various uses of hydrogen, focusing on those that can substantially reduce carbon emissions.

Mobility

In mobility, Dutch innovations are targeting transportation modes where electrification is less feasible, such as shipping and long-distance trucking. Plans include introducing 150 hydrogen-powered barges over the next 10 years, establishing hydrogen bunkering stations along key European shipping routes, hydrogen-fueled buses and trucks, range extenders for electric vehicles, and the technology needed for hydrogen refueling stations.

Residential heating

For residential heating, traditional gas-fired systems are being phased out in favor of sustainable alternatives. While newer homes utilize solar energy and heat pumps, older homes may benefit from hydrogen, utilizing adapted existing gas infrastructure. The Netherlands has a strong ecosystem of condensing boiler manufacturers who are investing heavily in transitioning from natural gas to hydrogen. Several have marketed models suitable for gas mixtures with up to 30% hydrogen and have showcased 100%-hydrogen boilers. Others are working on technology that would allow existing gas-fueled condensing boilers to be retrofitted for use with hydrogen. However, if it does become viable, it would likely be after 2040. For now, options like district heating, heat pumps, and geothermal energy are deemed more practical.

Power infrastructure

As reliance on renewable energy grows, developing flexible power infrastructure is crucial. This includes converting gas power plants to operate on hydrogen and creating storage solutions to manage fluctuations in renewable energy supply. Other innovations include flexible electrolyzers that can be used for grid balancing, frequency containment or - combined with fuel cells for example - as emergency power systems.

High temperature applications

In industrial processes, hydrogen is poised to play a vital role in high-temperature applications traditionally reliant on fossil fuels. The Netherlands goal is to adapt industrial burner systems and ensure they can deal with hydrogen's somewhat different combustion characteristics to achieve significant reductions in CO_2 emissions. Additionally, hydrogen, when combined with CO or CO_2, provides opportunity to produce synthetic fuels and sustainable bulk chemicals, such as methanol, alkenes and aromatics.

4.6 Dutch R&D efforts with innovations in the hydrogen ecosystem

The Netherlands plays a significant role in the hydrogen economy with innovative projects and collaborations advancing the energy transition. Through initiatives like GroenvermogenNL, the Netherlands has set a clear ambition to act as a hydrogen hub. Supported by the National Growth Fund, GroenvermogenNL is investing €838 million to scale up technology and innovation in hydrogen and green chemistry. This approach focuses on developing national and international hydrogen supply chains, positioning the Netherlands as a central hub. Key priorities include expanding electrolyzer capacity, improving hydrogen infrastructure, and accelerating technological innovation through pilot projects.

The Netherlands is a frontrunner in hydrogen R&D, which can be determined from the number of patents registered in the country. In Europe, the Netherlands is the second largest applicant for green hydrogen patents, according to research by the European Patent Office and the International Energy Agency. Large multinationals as well as small start-ups are responsible for this great power of innovation in the Netherlands.

Dutch R&D efforts applicable to the hydrogen supply chain

Hydrogen at sea:
TNO and its partners are developing the PosHYdon project, a large-scale offshore hydrogen production platform. The initiative aims to produce hydrogen directly from offshore wind energy in the North Sea, which is becoming increasingly populated with wind turbines. This pilot project is the first of its kind globally and serves as a crucial foundation for future large-scale hydrogen production. It consists of a drilling platform located 13 kilometers (8 miles) off the coast of Scheveningen. The existing oil and gas installations are being expanded with an electrolyzer that converts seawater into green hydrogen using electricity from an adjacent wind farm. The hydrogen is then mixed with natural gas and transported to land via existing gas pipelines. This combination of offshore wind energy, offshore hydrogen production, and existing natural gas infrastructure is unique. Mixing the hydrogen with natural gas allows for easier integration into the existing energy grid. While still in testing phase, the first hydrogen is expected to flow through the gas pipelines this year.

The Netherlands plans to launch the first tender for a larger pilot project (Demo 1) in 2025, aiming for a 20-50 MW electrolyzer offshore. In 2027, the plan is to tender for Demo 2, which should realize 500 MW offshore electrolysis capacity. Commercial scale hydrogen production in offshore conditions is expected for 2030-2035.

Hydrogen in the city:
The small city of Stad aan 't Haringvliet, with approximately 600 houses, aims to connect to a green hydrogen network. A few enthusiastic residents initiated this project and are achieving concrete results. In 2022, the first house was taken off natural gas and connected to hydrogen for heating via the existing gas infrastructure. This initiative has garnered support from various stakeholders, including grid operator Stedin, housing corporations, and the municipality. The Dutch government has also provided 5.6 million euros in subsidies. The city aims to transition to 100% hydrogen by 2025 to reduce its carbon footprint and contribute to national sustainability goals. To achieve this, a village council was formed to ensure community involvement. The village council established a 70% approval threshold for residents and business owners, a requirement for Stad aan 't Haringvliet to become the first city heated entirely with hydrogen. This high threshold ensures strong community support (in the summer of 2024, more than three quarters of residentst voted in favour of the project) and commitment to the project's success.

Hydrogen manufacturing:
In the Port of Rotterdam (Tweede Maasvlakte), Shell is constructing Europe's largest green hydrogen plant. The plant, Holland Hydrogen I, will utilize power from the offshore wind turbine park Hollandse Kust Noord, which is partly owned by Shell. A 200-megawatt electrolyzer will produce 60,000 kilograms of green hydrogen daily. The plant incorporates several innovative features, including a futuristic design and a visitor's center housed in a distinctive building. The hydrogen will be used for various applications at nearby chemical plants and oil refineries. It is expected to be operational in 2025-2026. The green hydrogen will supply the Shell Energy and Chemicals Park Rotterdam via the HyTransPort pipeline.

The hydrogen will partially decarbonize the production of energy products such as gasoline, diesel, and kerosene by replacing some of the gray hydrogen currently used at the refinery. As the market expands to include more hydrogen trucks and a growing network of hydrogen refueling points for heavy transport, the supply of green hydrogen can contribute to the decarbonization of road transport.

Hydrogen in mobility:
Dutch ports are pioneering the use of hydrogen-powered vessels for sustainable transportation. In Rotterdam, a hydrogen-powered water taxi has been operating since the beginning of 2023. This twelve-person boat was developed by a consortium of Dutch companies, including innovation developer Enviu, Watertaxi Rotterdam, and the start-ups Flying Fish and ZEPP.solutions. This collaboration enabled the companies to design and launch the first hydrogen-powered water taxi. While initially the port lacked the infrastructure to refuel the boat with hydrogen regularly, it is now fully operational with regular passengers.

The Port of Amsterdam is also at the forefront of hydrogen-powered shipping with the Neo Orbis, the world's first hydrogen-powered ship using sodium borohydride ($NaBH_4$) as a solid hydrogen carrier. This innovative ferry operates by reacting $NaBH_4$ with ultrapure water onboard to produce hydrogen on demand. The released hydrogen is converted into electricity via a fuel cell, enabling completely emission-free propulsion. Sodium borohydride offers significant safety and storage advantages over gaseous hydrogen due to its stability and compactness. This technology could revolutionize maritime transport by providing a safe and efficient way to power vessels with zero emissions.

4.7 Specific competencies and innovations of Dutch SMEs

Not only the large companies, but especially also small and medium-sized enterprises (SMEs) in the Netherlands are driving advances in hydrogen technology. They contribute niche expertise in electrolysis efficiency, storage solutions, and flexible hydrogen applications. Supported by GroenvermogenNL, many of these SMEs are accelerating the scaling of electrolysis capacity and refining processes to reduce the use of critical materials. A recent example is the H_2 Experience Center, opened in December 2024 by the Dutch Minister of Climate and Green growth in Kootwijkerbroek. This unique Dutch electrolyzer design developed by XINTC is the first all-plastic gas module (stack) without critical materials, membranes and seals. This design will enable mass production at lower costs (unlike normal electrolyzers) thanks to cheaper parts and be nearly maintenance-free.

Dutch SMEs play a critical role in strengthening the hydrogen value chain. The Netherlands is known for its integrated approach across diverse sectors, and this is also true in the hydrogen domain. Large-scale projects often combine specialized knowledge and technological innovations from SMEs, enabling them to act as crucial players in advancing hydrogen solutions on a global scale. These companies contribute to the development and implementation of innovative technologies, ensuring that the Netherlands remains at the forefront of the hydrogen transition.

Innovative solutions

Dutch SMEs excel in creating innovative solutions for hydrogen production and storage. Companies like Battolyser B.V., Connectr Energy Innovation, Desu Systems B.V. and HyET Hydrogen B.V. in the storage space are integral to the development of efficient electrolyzer technologies and advanced storage systems, ensuring scalability and reliability in the various hydrogen supply chains. SMEs also contribute to retrofitting existing infrastructures, such as pipelines, to accommodate hydrogen, enhancing the transition to renewable energy sources. Companies like Groningen Seaports, Fluor, gAvilar B.V., Demaco Holland B.V and Antonius are some examples of Dutch players focusing on infrastructure.

SMEs are also instrumental in integrating hydrogen into mobility solutions, such as emission-free transport systems and infrastructure like fueling stations. In industrial sectors, they contribute specialized components and technologies that enable hydrogen use in processes such as energy generation and manufacturing, helping reduce emissions. Example of companies like Ekinetix B.V., Nedstack Fuel Cell Technology, NXT Mobility and HYZON Motors Europe B.V. are active in this mobility solution space.

Through participation in public-private initiatives and innovation programs, Dutch SMEs are closely aligned with government policies promoting the hydrogen economy. These collaborations support the development of technologies that are adaptable to diverse markets and ensure SMEs remain competitive and innovative.

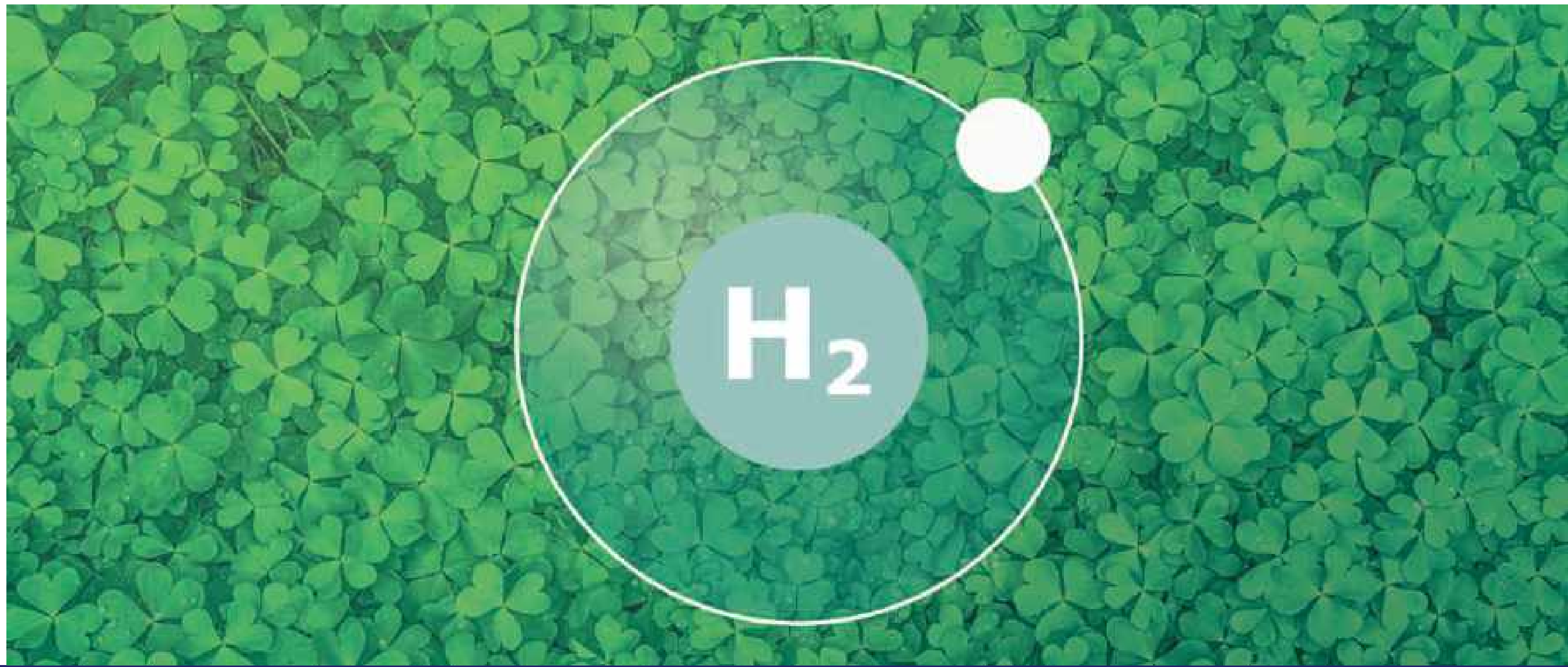
4.8 Key Dutch sectors and innovations with potential to succeed in the Texan market

The Netherlands is well-positioned to contribute to the hydrogen sector in Texas with unique capabilities and innovations that align with Texas' hydrogen growth ambitions. According to the Netherlands Enterprise Agency (RVO, part of the Ministry of Climate and Green Growth) report 'Excelling in Hydrogen – Dutch Technology for a Climate Neutral World', the Netherlands' hydrogen sector is strategically integrated, enabling collaboration across multiple areas, including offshore hydrogen production, electrolysis, and infrastructure development.

The Dutch focus on green hydrogen production technologies and their expertise in regulatory frameworks further enable them to address specific challenges in the Texan market, such as reducing carbon emissions and meeting environmental standards. With Texas' ambition to lead in hydrogen, these Dutch capabilities could strengthen Texas' hydrogen infrastructure, from production and storage to distribution and regulatory compliance, thus facilitating the state's goal of becoming a leader in the hydrogen economy.

Key Dutch innovation sectors and companies:

- Large-scale hydrogen production and infrastructure, and (offshore) hydrogen generation using wind power are led by large (non-SME) organizations like Shell, TSO Gasunie, and TNO. This is a model highly relevant to Texas' offshore capabilities along the Gulf Coast. This innovation aligns with Texas' goals for diverse energy sources and robust infrastructure integration.
- Dutch SMEs bring specialized solutions in areas like electrolysis efficiency, flexible hydrogen storage, and transport, making them well-suited to support Texas' hydrogen projects with tailored, scalable solutions – (For a complete overview of Dutch companies in the Hydrogen space, consult Appendix 8.10).



4.9 Specific focus: liquid hydrogen

In the domain of liquid hydrogen (LH_2), Dutch companies and research institutions are advancing key technologies in transport and storage, which hold strong potential for the Texan market. An overview of Dutch companies related to LH_2 (liquid hydrogen) in the storage and transportation realm:

Royal Vopak
Leading in storage solutions, especially in cryogenic storage systems that keep hydrogen in a liquid state which is essential for long-distance transport and large-scale energy applications. Their vision is to support international hydrogen hubs with their solutions.

Cryoworld
Specializes in cryogenic systems and has extensive experience in creating solutions for liquid hydrogen storage and transportation. Their work includes systems that maintain the extreme low temperatures required to keep hydrogen in liquid form, essential to transport or store liquid hydrogen across distances. References include CERN, ITER and GSI.

Nouryon
Specializes in chemical solutions and is a leader in developing safe storage and handling methods for hydrogen. Their innovations in sustainable chemicals and hydrogen storage contribute to enabling the storage of hydrogen in various forms, including liquid hydrogen, in an environmentally safe manner.

VDL Group
Brings expertise in manufacturing high-tech components and systems, including equipment for cryogenic applications. VDL's engineering capacity supports both liquid hydrogen storage and safe transport, making them a valuable partner in developing scalable and resilient hydrogen infrastructure.

TNO
Active in mostly research & development of storage materials., liquid hydrogen safety and efficiency. They are working with various partners to develop new technologies and methods for safely and economically storing hydrogen in liquid form, tailored to meet international standards and ensure compatibility with diverse infrastructure.

Fluidwell
Known for its high-precision instrumentation and monitoring solutions that play a crucial role in hydrogen storage and transport applications. Their advanced flow meters and control systems ensure accuracy and reliability, especially essential in cryogenic environments where liquid hydrogen must be carefully monitored.

Adsensys
Provides advanced sensor technology designed to enhance safety and monitoring in hydrogen applications. Their sensors can operate in extreme conditions, which makes them ideal for cryogenic liquid hydrogen systems. This capability supports in operational safety and efficiency, especially in transport and storage solutions.

5. Market access and collaboration opportunities in Texas

5.1 Identification of key challenges and opportunities for entering the Texan market

While Texas, and the US in general, is an open, business-friendly market, there are a few things to keep in mind. A local presence is advisable, whether through partnership with a local company or a direct presence. The set up of an Limited Liability Company (LLC) in the state of Texas takes less than an hour via the Secretary of State's self-service website and the confirmation comes by within 24h generally. While there is no personal nor business income tax in Texas (only taxes at Federal level apply) businesses are subject to local and state sales taxes. The state also levies a "franchise" tax on all LLC above a certain threshold.

If a company intends on selling to public entities, some public requests for proposal will require the bidders to ensure a certain percentage of subcontracting will be awarded to MWBE (Minority- and/or Women-owned Business Enterprises). Some public entities are more stringent than others in these requirements (see for example Harris County's Supplier Diversity policy).

In the emerging clean H_2 space, many projects are still in early phase and as of late 2024, MOUs are regularly announced between technology providers and project owners, creating a wide space of opportunities. Examples like Hydrogen City, Port of Corpus Christi H_2 projects, abound. As this is an area in constant development, consult the IEA database or other sources.

5.2 Networking opportunities, associations, gatherings

Besides attending yearly scheduled conferences (see chapter 10 for a selected list) or joining/following existing associations (also in chapter 10), networking opportunities are numerous and are important in the Texas business environment, where face-to-face interactions are often preferred to virtual introductions, as mentioned by several of our interviewees in chapter 6. The different ports generally have monthly meetings and public events; for example the Port of Houston hosts monthly luncheon on various topics, another example is the Port of Corpus Christi whose Commissioner meetings can be attended and watched online. The Greater Houston Partnership organizes regularly conferences and events where Energy is often the main focus or a significant part of it.

In the last decade, a series of startup incubators have popped up in the different large cities of the state. Most have social and networking events (e.g. the Cup of Joey at Houston's ION District, events organized by the Greentown Labs at ION, those by the Energy Tech Nexus). Other incubators offer education or connect with academia (e.g. Port San Antonio).

5.3 Potential synergies between the hydrogen value chain and Dutch expertise

While many aspects of the hydrogen value chain are already well-established, with both Texas and the Netherlands enjoying decades of experience in areas such as natural gas production and transportation, the burgeoning field of clean hydrogen presents a unique set of opportunities. In this nascent market, some technologies and processes are still emerging, creating a dynamic landscape ripe for innovation and competition. This presents a significant opportunity for new entrants, particularly those with specialized expertise and a drive to shape the future of the hydrogen economy.

One area of particular promise lies in the adaptation of existing infrastructure for hydrogen utilization. The conversion of existing natural gas pipelines to accommodate hydrogen transport represents a cost-effective and efficient pathway to leverage existing assets. Similarly, the development of efficient and scalable ammonia cracking technologies for hydrogen end-use is crucial. Furthermore, the exploration of non-NH_3 hydrogen carriers offers another avenue for innovation. These advancements could revolutionize hydrogen storage and transport, unlocking new possibilities for the global hydrogen economy.

In Texas, and the US in general, hydrogen liquefaction and retailing are still in their early stages, presenting a unique window of opportunity for companies with established expertise in these areas. Dutch players, with their longer history of utilizing these technologies in Europe, could leverage their experience to gain a competitive advantage in these emerging markets. By capitalizing on their technological edge and adapting their offerings to the specific needs of the Texan and US markets, Dutch companies can position themselves as key players in the burgeoning clean hydrogen sector.

Technology	TX experience	NL experience
Windpower	Established	Established
Sun power	Established	Established
Batteries	Emerging	Emerging
Electrolysis	Established	Established
Desalination	Emerging	Emerging
H_2 pipeline	Established	Established
Pipeline conversion to H_2	Emerging	Emerging
CCS	EOR* only	Emerging
Cavern H_2 storage	Emerging	Emerging
H_2 liquefaction	Emerging	Emerging
H_2 retail	Emerging	Established
NH_3 storage	Established	Established
NH_3 transport	Established	Established
NH_3 shipping	Established	Established
NH_3 cracking	Emerging	Emerging
Other H_2 carriers	Emerging	Emerging
H_2 turbine	Emerging	Emerging
Conversion of gas turbine for H_2 blend	Emerging	Emerging
Green resource certification	Emerging	Established

** See chapter 3.2*

6. Case studies of hydrogen market players

Overview of insights shared by experienced representatives from the following interviewed companies: OCI, Sterling Cryogenics, Exolum, Fugro, Air Liquide, HyCC, and Power2X.

Commonalities

Texas, particularly its Gulf Coast, is recognized for its robust hydrogen infrastructure, including pipelines and storage terminals, making it attractive for companies entering the hydrogen economy. Its status as an energy hub offers access to existing resources and expertise further enhances its appeal.

Texas offers a business-friendly climate with no corporate taxes and relatively flexible regulations, especially compared to EU and e.g. California in the US. This environment is conducive to innovation and investment in hydrogen technologies.

Texas' more relaxed regulatory environment contrasts with stricter EU standards. U.S. flexibility on "color" of hydrogen (blue, green) makes for a less stringent market but poses adaptation challenges for EU companies accustomed to higher certification standards.

Unlike Europe, the U.S. market is more open to transitional technologies, such as blue hydrogen, as long as they reduce emissions. This flexibility offers Dutch SMEs opportunities to test and scale innovative transitional technologies that are not (yet) fully green.

There is still quite some infrastructure challenges for export of liquid hydrogen. This may be an opportunity for innovative products and solutions. However, at this moment, there is a preference for ammonia, SAF, and methanol as hydrogen derivatives for export, as they still offer better scalability and energy efficiency.

The funding landscape requires strategic navigation, as securing direct support is challenging without larger projects or established networks. While federal tax credits and incentives (e.g. IRA) are there, companies we interviewed are not the ones filing for it (but their clients would) or had not taken benefit of it (yet), which some firms, like Fugro, aim to improve upon.

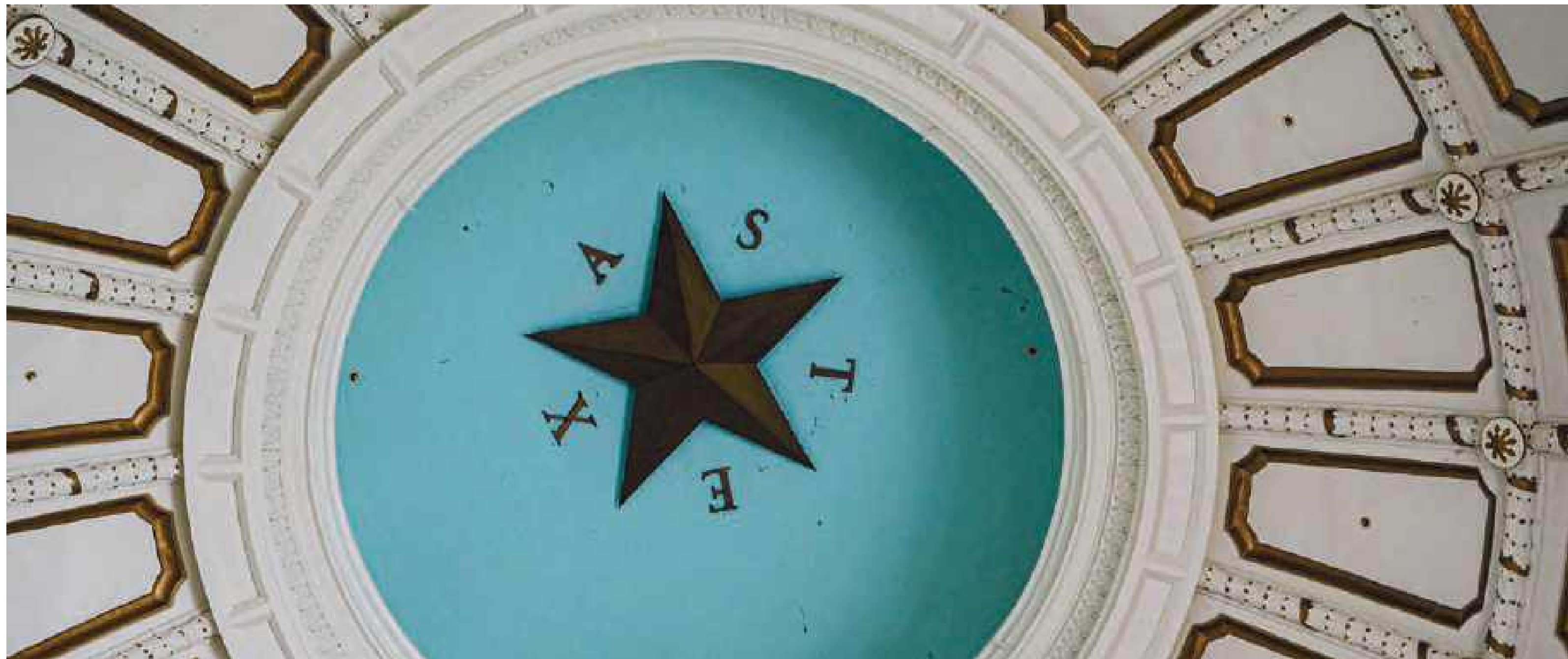
Most of the interviewees mentioned the importance of local relationships, in different ways:

Texas business culture highly values relationship-building and face-to-face interactions. Establishing local partnerships or finding reliable local contacts is crucial for integration but can be challenging without a prior presence or strong connections locally. Advice is to be present locally or via a local trusted partner who understands the market and has an established network.

Building connections within Texas' hydrogen hubs (e.g., HyVelocity, MACH2) is difficult for newcomers, as these networks can feel difficult to penetrate for those who are not regularly on the ground to engage face to face.

Know your playing-field: understanding the mindset of the state is important to focus on the right activities and next steps. Texas regulators and businesses are pragmatic, focusing on economic growth (job creation, local investments) rather than rigid environmental standards. Dutch SMEs should highlight the economic benefits of their solutions when entering this market.

SMEs need to ensure a product-market fit tailored to local expectations and gradually build a reputation within the U.S. ecosystem. Networking, attending industry events (like CERAWeek), and maintaining a visible presence are effective for building credibility and trust.



Unique remarks that can benefit SME

The U.S. regulatory structures have always prioritized emission reduction over specific hydrogen “colors”. Now that the US regulator is working towards synchronisation with the EU framework, in terms of additionality, European SMEs and regulators need to realize the impact this has on the projects. To gain early traction, blue Hydrogen is going to be taking a big role in both the EU and the US now, rather than exclusively green hydrogen.

An advice to SMEs in the Netherlands that want to explore the US/Texas hydrogen market, is to get in contact with NWBA fuel cell association for support and advice.

The hydrogen projects we work with in Texas often operate on accelerated timelines, driven by client urgency (most likely due to federal support program timeframe deadlines). SMEs must be cautious and adaptable during proposal phases to address funding uncertainties and (the impact of) rapid engineering needs.

As a legacy company with a strong local presence, Fugro highlights the importance of lobbying European decision-makers at multinationals like Linde and Shell to align project priorities before entering the U.S. market.

With a still-developing hydrogen market, SMEs offering solutions for system integration, technical advice, or consultancy on hydrogen storage and safety could be valuable, especially as the market infrastructure grows.

Recommendations

by big, small and medium enterprise for Dutch SMEs

- Establish Local Networks: Partner with reputable local entities to gain insights into the hydrogen market and build trust in a relationship-driven ecosystem.
- Utilize Existing Relationships: Leverage connections with European offices of global firms (e.g., Linde, Air Liquide) to bridge cultural and strategic gaps.
- Focus on Value-Add Expertise: SMEs should emphasize niche expertise to differentiate themselves.
- Participate in Industry Events: Engage in conferences and forums to expand visibility, learn about funding opportunities, and align with U.S. market trends.

Note:
A slowdown in hydrogen projects worldwide is happening and with the new administration taking office in the US, this slowdown will maintain or worsen.

Views expressed here are personal.

7. Conclusions and recommendations

Conclusion

Texas is poised to become a leading hub for clean hydrogen production, storage, and export, benefiting from abundant renewable resources, geological advantages, and existing infrastructure. The Dutch expertise in hydrogen technology, particularly in areas like electrolysis, aligns well with Texas' growth ambitions in this sector. However, market entry for Dutch SMEs requires strategic planning, including establishing local networks and understanding the nuances of the Texan business landscape. Networking opportunities, industry events, and participation in conferences are crucial for building relationships and gaining market insights. SMEs should emphasize their niche expertise and adaptability to align with the evolving demands of the Texan hydrogen market.

Considering logistical costs and the limitations imposed by the Panama Canal on hazardous cargo transport, it is likely that the majority of clean ammonia (or other hydrogen carriers) exported from Texas will target the European market rather than those in the Far East. Successful Texas export projects will necessitate fully contracted offtake agreements and a secure logistics chain, encompassing import terminals and pipeline capacity to inland markets. The Netherlands can play a pivotal role in this process by collaborating with producers and offtakers to establish viable logistics chains. The nascent clean hydrogen market is expected to follow a similar trajectory to the early LNG industry, where projects relied on fully contracted, dedicated logistics chains, including ships, regasification terminals, and pipelines. The financing of these projects, encompassing both production and logistics, was often underwritten by long-term offtake agreements with creditworthy buyers. This model underscores the importance of securing reliable partnerships and long-term commitments for the successful development of a clean hydrogen market.

Recommendations for Dutch SMEs

1 **Local Presence and Networking:**
Establish a physical presence or partner with local entities to foster trust and navigate the relationship-centric Texan market. Actively participate in industry events and conferences to connect with potential clients and partners.

2 **Strategic Partnerships:**
Forge alliances with established players in the Texan hydrogen ecosystem, including companies, research institutions, think thanks, and government agencies, to leverage their expertise and networks.

3 **Tailored Solutions:**
Adapt products and services to meet the specific needs and expectations of the Texan market, emphasizing niche expertise and value-added solutions. Highlight the economic benefits and job creation potential of your technologies.

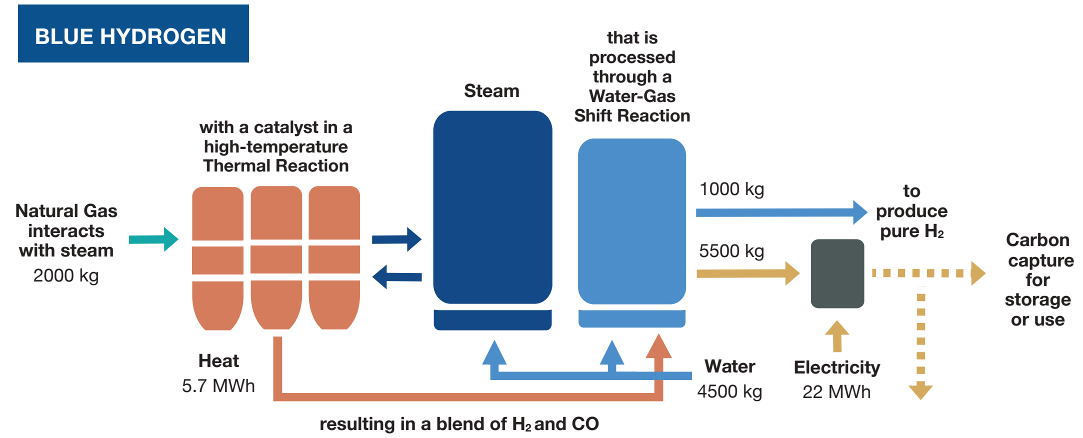
4 **Market Knowledge:**
Stay informed about the latest developments, policy changes, and funding opportunities in the Texan hydrogen sector. Engage with industry associations and utilize online resources to gather market intelligence.

5 **Flexibility and Adaptability:**
Be prepared to adjust your business strategies and offerings as the Texan hydrogen market matures and new technologies emerge. Embrace the state's openness to transitional solutions while maintaining a focus on long-term sustainability goals.

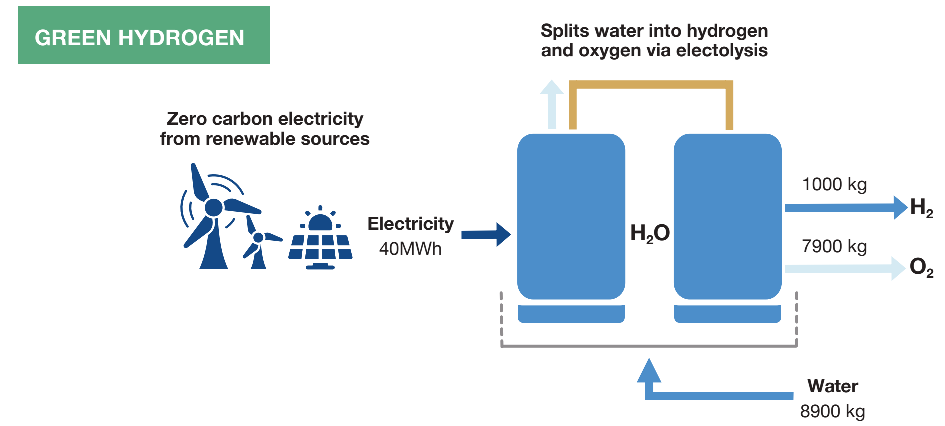
By understanding the Texan context and embracing a proactive approach, Dutch SMEs can successfully capitalize on the opportunities presented by the nascent clean hydrogen market and contribute to the global transition towards a sustainable energy future.

8. Appendix

8.1 Select clean hydrogen production pathways and resource balance

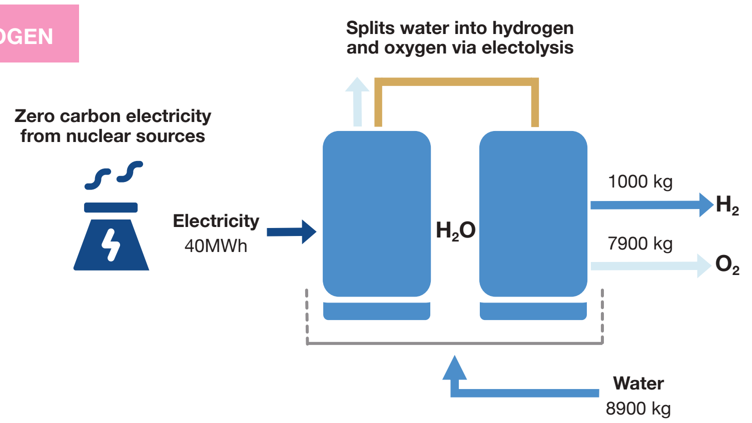


Blue hydrogen production follows the same process as gray hydrogen (i.e., SMR) to the production of pure hydrogen and CO_2. However, blue hydrogen adds a carbon capture unit to the process which requires electricity to facilitate the capture of the CO_2 for storage or utilization.



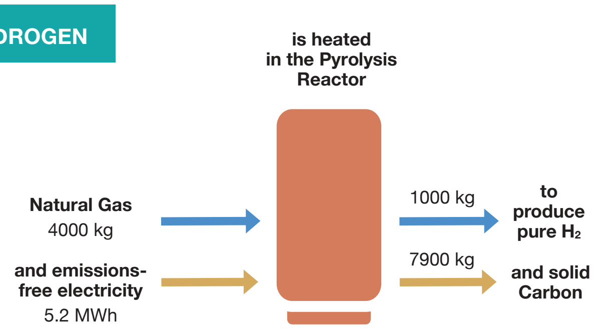
Green hydrogen is produced through the process of electrolysis, where zero-carbon electricity from renewable energy sources is used to split the component atoms of water molecules in an electrolyzer into pure hydrogen and oxygen gas. This process yields no greenhouse gas emissions.

PINK HYDROGEN



Pink hydrogen is produced through the process of electrolysis, where zero-carbon electricity from a nuclear power plant is used to split the component atoms of water molecules in an electrolyzer into pure hydrogen and oxygen gas. This process yields no greenhouse gas emissions.

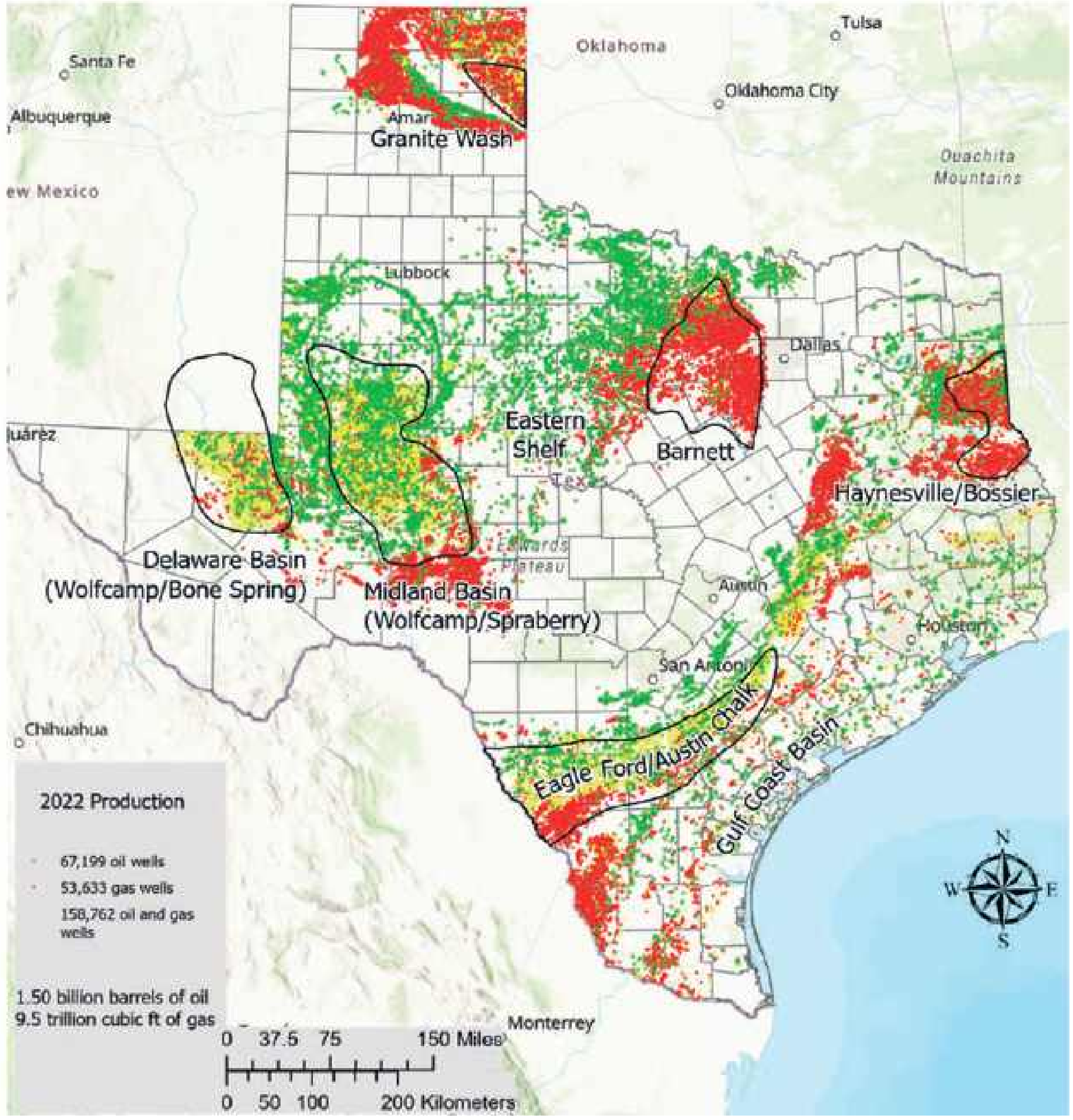
TURQUOISE HYDROGEN



Turquoise hydrogen is produced through methane pyrolysis, which requires inputs of natural gas and low- to zero-emissions electricity. Pyrolysis uses these inputs to produce pure hydrogen gas and a solid carbon byproduct known as carbon black, as opposed to carbon emissions.

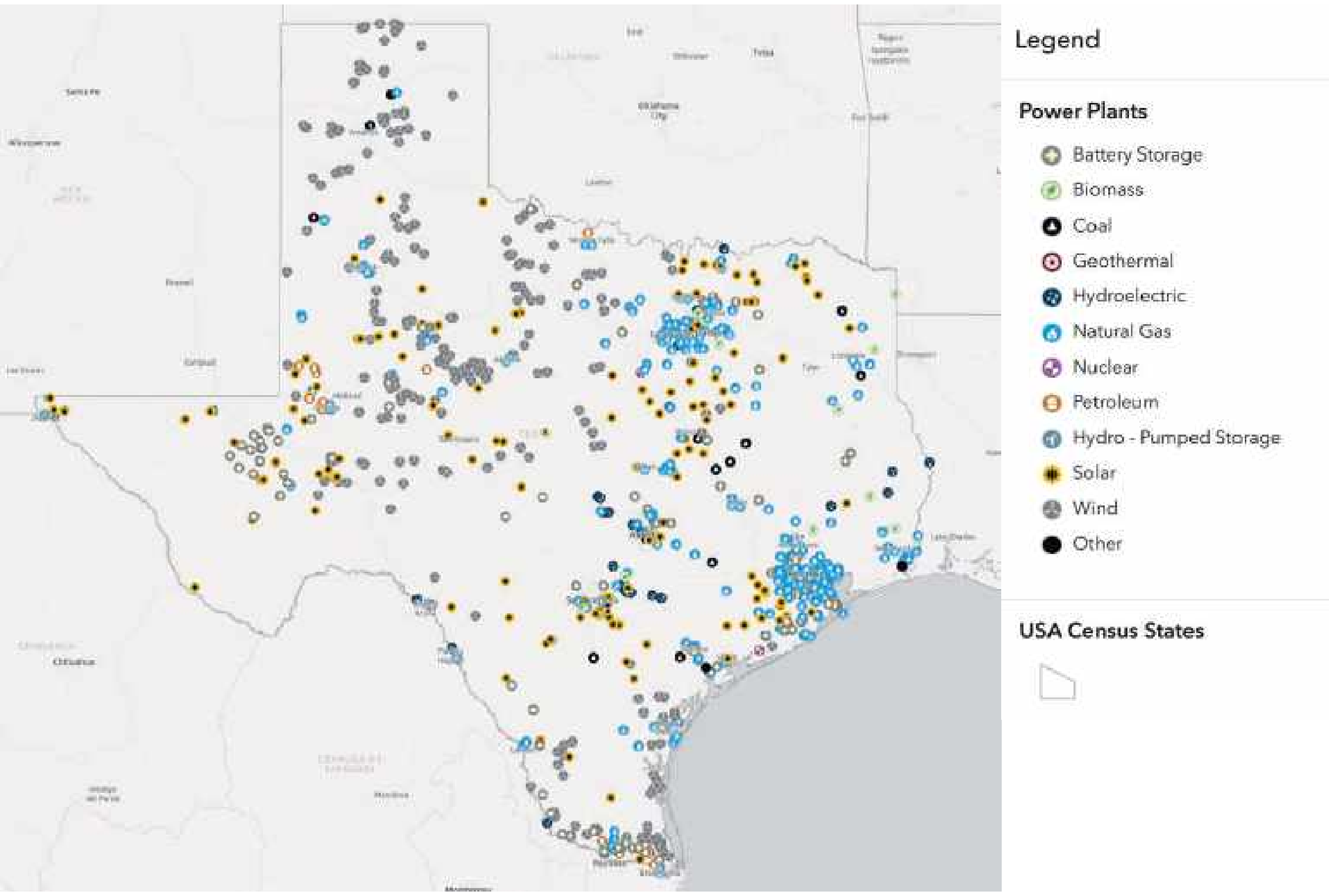
Source: The US Hydrogen Demand – [Action Plan by Energy Futures Initiatives]

8.2 Oil and gas map of Texas – 2022 production



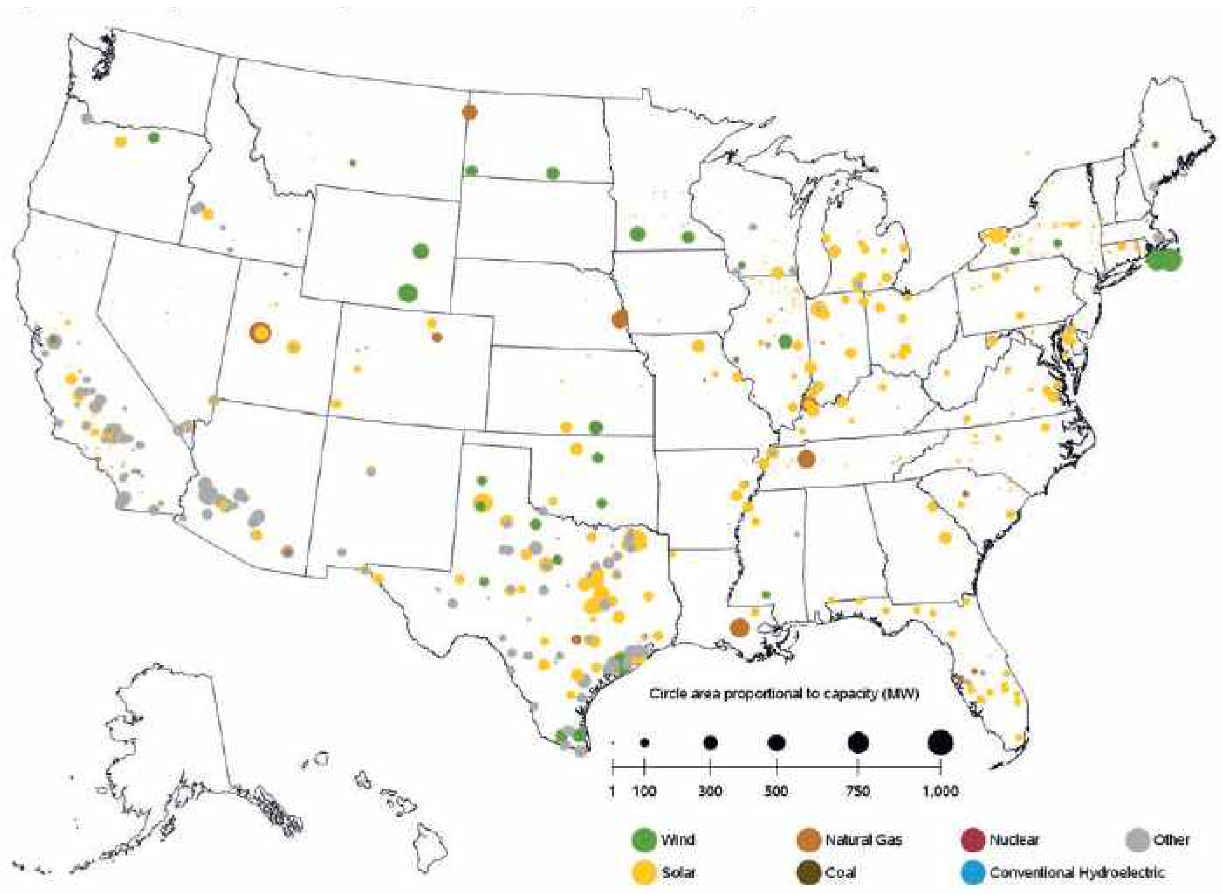
Source: State of Texas Advanced Resource Recovery Program ([STARR])

8.3 Power generation



Source: [EIA Maps]

8.4 Utility scale generating units planned to come online Sep 2024-Aug 2025



Sources: U.S. Energy Information Administration, Form EIA-860, 'Annual Electric Generator Report' and Form EIA-860M, 'Monthly Update to the Annual Electric Generator Report'

Source: EIA, [Dashboard Production Capacity Generation]

8.5 Water consumption by technology

Technology	Water consumption (kg H_2O/t NH_3)	(kg of CO_2 emitted /t NH_3)	Energy - electricity and heat consumption (kWh/Tonne NH_3)	Efficiency %	Capital cost per ton/day NH_3 capacity
Steam methane reforming coupled with Haber-Bosch	Ca.0.656	Ca.1.8	Ca. 9,500	Ca. 61-66%	500,000
Water electrolysis coupled with Haber-Bosch powered by solar/ wind	Ca. 1.588	negligible	Ca. 12,000	Ca. 54%	700,000

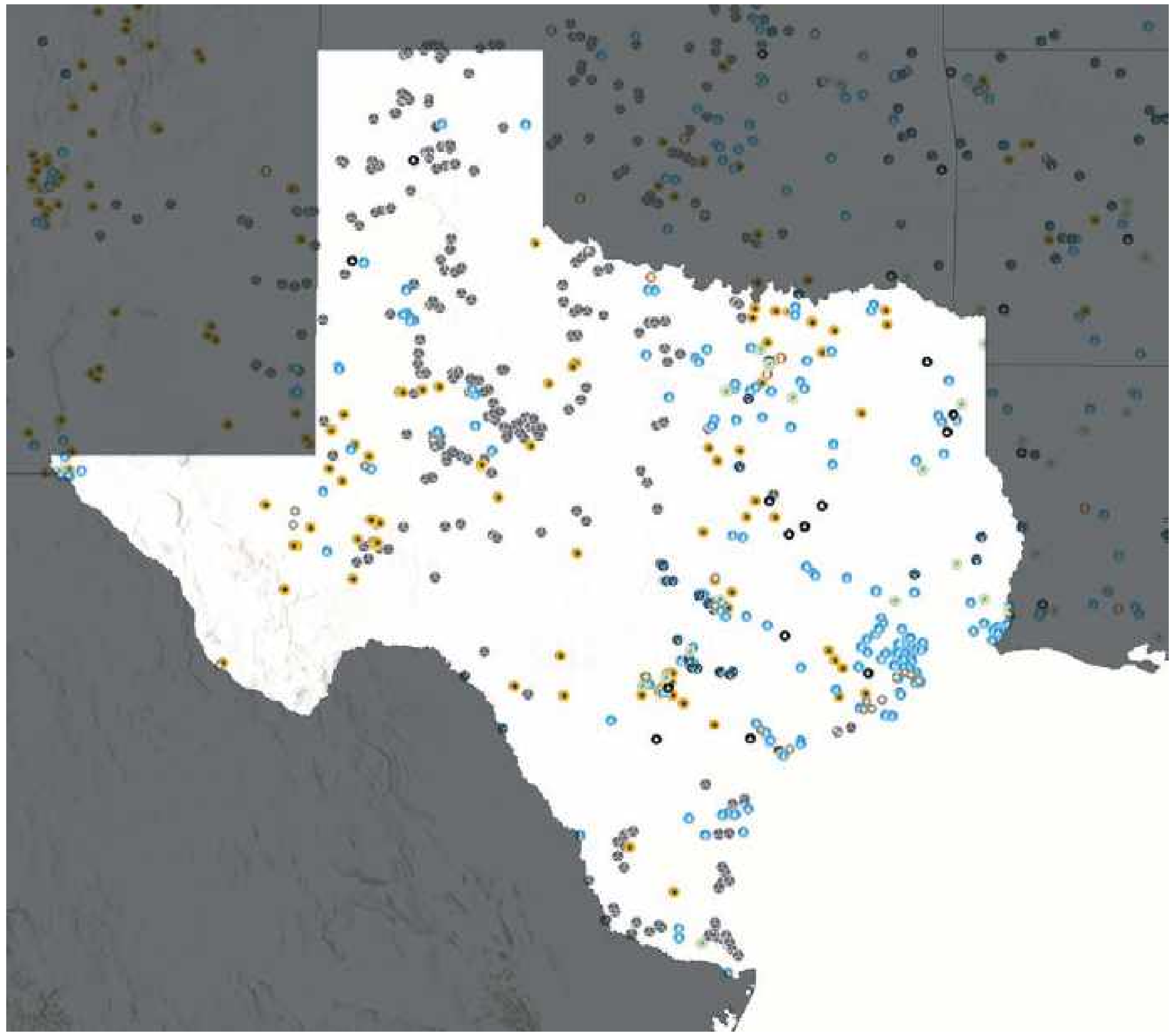
Source: Ghavam S, Vahdati M, Wilson IAG and Styring P (2021): "Sustainable Ammonia Production Processes." Front. Energy Res. 9:580808. doi: 10.3389/fenrg.2021.580808

A recent analysis evaluated traditional ammonia production against its renewable counterpart by examining key factors such as water usage, carbon emissions, energy demands, process efficiency, and capital investment. While it comes as no surprise that renewable ammonia production results in minimal CO_2 emissions, it is noteworthy that this method requires significantly more water than the conventional process. Additionally, both the energy requirements and capital cost are greater for renewable ammonia.

Even though coal or biomass gasification with carbon capture uses more water than ammonia production via conventional natural gas reforming, fossil-based methods still generally maintain a water-use advantage over renewable ammonia pathways.

Source: National Energy Technology Laboratory (NETL)

8.6 Texas electric generation map



Source: EIA Maps

8.7 Details on IRA

Tax Credits for Clean Hydrogen in the Inflation Reduction Act
(in units per kilogram of hydrogen)

Project Lifecycle Emissions	45V Credit Value	45Q Credit Value
4 kg CO2e	$0.60/kg	Up to $0.80/kg*
2.5 kg CO2e	$0.75/kg	Up to $0.80/kg*
1.5 kg CO2e	$1.00/kg	Up to $0.80/kg*
0.45 kg CO2e	$3.00/kg	Up to $0.80/kg*

*Commensurate with carbon capture rates.
Source: U.S. Code 45V (2024) and Resources for the Future.

CSIS | ENERGY SECURITY AND CLIMATE CHANGE PROGRAM

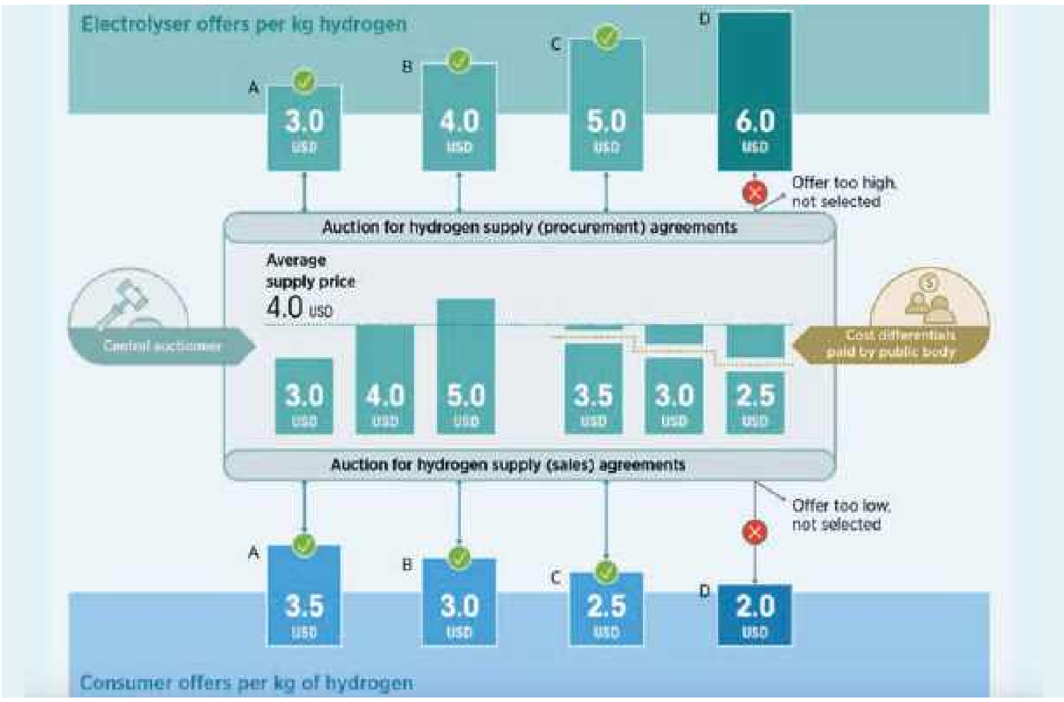
Source: Center for Strategic & International Studies

8.8 Price support auctions: Germany's H2Global foundation example

Federal Ministry for Economic Affairs and Climate Action | H2Global | Hintco

- Double-sided auction mechanism implemented by H2Global foundation to kick-start Green Hydrogen production outside EU funded by German Government
- Hintco (subs of H2Global) buys green hydrogen products at a low price on the global market through one bidding round and will sell them to the highest bidder via another bidding mechanism in Germany or the EU. Negative delta financed by foundation
- Seller-side: 10 year offtake committed by Hintco. Buyer-side: 1 year (not yet set up)
- €5 bln promised by German government upon creation
- €900 mln approved by 1st funding window for 3 initial tenders
- €600 mln approved by NL/DE in 2nd funding window with NL (subject to EU approval)
- Canada and Germany signed MOU to add another funding window (Canada approved C$300 mln/$219 mln, Germany expected to approve €200 mln/$221 mln)
- First tender (seller-side) awarded to Fertiglobe (Egypt) for €397 mln ($1,004/T CFR vs grey ammonia market at $490/T) for a total cumulative 387kT Ammonia over 2027-2033

Source: Acretio



Source: IRENA

8.9 The different Texas regions

There are 6 regions in the state with each their distinctive geography and economy:

Central Texas:
With Austin, the State Capital, at its center, Central Texas has a diverse economy driven by technology, government, education, tourism, and agriculture. Austin is a major tech hub, while surrounding areas rely on agriculture, ranching, and tourism (especially in the Texas Hill Country with its rolling hills, limestone cliffs, and spring-fed rivers). The Austin metro area was for 12 years from 2010 onwards the fastest growing large metro area in the country reaching 2.4 millions inhabitants in 2023.

West Texas:
Sparsely populated, this arid and mountainous part of the state offers vast open spaces and dramatic landscapes, encompassing the Chihuahuan Desert and mountain ranges like the Guadalupe Mountains and Davis Mountains. Historically reliant on ranching and agriculture, but now dominated by the oil and gas industry, particularly in the Permian Basin with Midland and Odessa as major cities, the region is also the epicenter of the new wind and solar boom. Tourism is also important, with attractions like Big Bend National Park and the Guadalupe Mountains National Park. At the western extremity, El Paso (a long journey of 1,345 km from Port Arthur at the southeast extremity near the Louisiana border!) with almost a million residents, predominantly Hispanic with a strong binational, bicultural identity, has an economy driven by the military, government, healthcare, and trade with Mexico. In the northwest, the so-called Texas Panhandle, flat plains in high elevation with Amarillo and Lubbock as major cities, each with about 300,000 residents, agriculture (wheat, cotton, cattle) is still a strong economic sector.

North Texas:
With rolling prairies and plains, with some wooded areas, the region is dominated by the Dallas-Fort Worth metroplex, one of the largest urban areas in the US with a population of more than 8 million. Densely populated and diverse, with a large influx of people from other states and countries, Dallas and Fort Worth are major urban centers; Dallas is a financial and distribution center, while Fort Worth has a strong presence in aviation and defense.

Northeast Texas is characterized by piney woods, rolling hills, and fertile river valleys. It is predominantly rural, with a significant African American population in the eastern parts. Tyler and Longview are major cities, each metro with a population over 200,000 inhabitants. Historically reliant on agriculture (timber, cotton) and oil production, the economy now also includes manufacturing, healthcare, and tourism.

Southeast Texas is made of flat coastal plains along the Gulf of Mexico but also includes the Big Thicket National Preserve, a unique ecosystem with diverse plant and animal life. While also the 4th largest city in the US, Houston is the center of an incredibly spread out metroplex of 7.6 million people covering a vast area with a mix of urban and suburban developments. Greater Houston is also the most ethnically diverse metropolitan area in the US with at least 145 languages spoken by residents and 90 nations have consular representation in the city. Historically dominated by the oil and petrochemical industry, centered around Houston (nicknamed the Energy capital of the world), Texas City, Beaumont and Port Arthur, shipping is also very important with major ports along the Gulf Coast, healthcare and life sciences (Houston's Texas Medical Center is the largest medical complex in the world, employing thousands and attracting patients globally), as well as aerospace (NASA's Johnson Space Center and the two international airports are the main drivers of a 23,000-strong professionals ecosystem).

South Texas:
From the flat coastal plains along the Gulf of Mexico, with barrier islands, lagoons and estuaries to the drier regions of West Texas, this region is overwhelmingly Hispanic, with a strong Mexican cultural influence. San Antonio is the major urban center with a metro area of 2.7 million people. The Corpus Christi metro area, though only with a population slightly above the 400,000 mark, is a major port on the Gulf: the third-largest port in the USA in total tonnage and largest crude oil export port. Bordering Mexico, the Rio Grande Valley, with McAllen and Brownsville as the biggest cities on the US side, is the second-largest border conurbation with Mexico (after San Diego-Tijuana on the Pacific Coast) with an estimated 2.67 million people (1.29 million in USA and 1.38 million in Mexico). Historically based on agriculture and ranching (cattle ranching, sheep, goats in the north and citrus fruits, vegetables in the south), the economy of the region now also includes tourism (the Alamo and River Walk in San Antonio attracting 9.3 million tourists annually), military bases (mostly in San Antonio) international trade (due to its proximity to Mexico), and healthcare.

8.10 List of Dutch companies active in the hydrogen space

Company	Electricity	H_2 Production	Engineering / Installation	Infrastructure	Flow Solutions	Storage	Mobility	Maritime	Industry	Built Environment	Infrastructure and Storage	Research / Advisory	Association
&Flux												●	
20K Hydrogen B.V.				●	●		●	●	●		●		
ABB	●	●	●	●	●	●	●	●	●	●	●		
ABC-Techniek B.V.			●		●		●	●	●		●		
Adsensys H2 Solutions		●	●				●	●	●	●	●	●	
AECOM	●	●	●	●		●	●	●	●	●	●	●	
AEG Power Solutions B.V.	●	●	●						●	●			
Air Liquide		●	●	●	●	●	●	●	●	●	●	●	●
Air Products Netherlands B.V.		●	●	●		●	●	●	●	●	●		
Alkalium B.V.		●	●			●							
AMF Bakery Systems – AMF Den Boer									●				
Ansaldo Thomassen B.V.									●				
Antonius				●		●		●	●		●		
AquaBattery B.V.		●				●		●	●	●	●	●	
Arcadis			●	●			●		●	●	●	●	
AVK Nederland BV			●		●				●	●	●		
Avoxt B.V.		●	●				●	●	●				
AWL Techniek B.V.			●						●			●	
BA2C													
Battolyser B.V.	●	●	●			●	●		●	●	●		
Berenschot												●	
Bilfinger Engineering	●	●	●	●		●			●		●		
Bosal	●	●					●	●	●	●	●		
Bosch Rexroth B.V.				●	●	●	●	●	●	●	●		
Bosch Thin Metal Technologies			●			●	●		●		●	●	
Bredenoord	●						●		●	●	●		
BrigH2		●					●		●			●	
Bronkhorst Nederland B.V.		●	●	●	●		●	●	●	●	●	●	●
Brunel													
Bureau Veritas		●	●	●		●	●		●	●	●	●	
Bürkert Fluid control systems		●			●		●	●	●	●	●		
Stichting Cenex Nederland (Cenex NL)							●					●	
Circonica Circular Energy BV	●	●	●			●	●	●	●	●			
CLEAR												●	
CoheSys												●	
Connectr - Energy innovation	●	●	●	●	●	●	●	●	●	●	●	●	●
ConPackSys B.V.			●	●	●	●			●		●		
Corre Energy Storage						●							
Cryoworld				●	●	●	●	●	●		●	●	
Danfoss B.V.	●	●		●	●	●		●	●	●	●		
De Boer SPS		●	●	●		●			●		●		
Deelrijk | hydrogen & experts		●	●	●		●	●	●	●			●	
Deerns		●	●	●	●	●			●	●	●	●	
Deltalinqs													●
Demaco Holland B.V.			●		●		●	●	●		●	●	
Demcon		●	●				●		●			●	
Desu Systems B.V.		●				●	●	●	●		●	●	
DLS – Drive Line Systems			●				●	●	●				
Doeko B.V.		●	●	●		●		●	●	●	●		
Douna Machinery B.V.		●	●		●	●			●	●		●	
Duiker Combustion Engineers			●			●			●	●		●	
Dumaco Woerden B.V.			●										
Dutch Boosting Group							●		●	●	●	●	
Dutch Marine Energy Centre (DMEC)	●	●						●	●			●	
DWG	●	●	●		●	●	●	●	●	●	●	●	●
E&E advies												●	
Eekels Technology B.V.	●					●		●	●		●	●	
Ekinetix B.V.	●	●	●	●	●	●	●	●	●	●	●	●	
Ekwadraat Advies BV												●	
ElecHydro BV		●											
Elestor BV		●				●			●	●			
Eltacon Engineering BV	●	●							●		●		
Emmett Green	●	●	●	●		●	●	●	●	●		●	
Enablemi												●	
Endress+Hauser					●								
ENERCY B.V.			●	●								●	
Energy Storage NL													●
ENGIE Services Nederland N.V.	●	●			●		●	●	●	●		●	
ENTRANCE | Centre of Expertise Energy		●	●	●	●		●	●	●	●	●	●	
EoxTractors B.V.							●		●	●			
Erez Energy		●					●		●				
ERIKS Nederland	●	●		●	●	●	●	●	●	●	●		
E-Trucks Europe B.V.							●						
EY | Ernst & Young												●	
Feenstra			●							●			
Technology Centre Europe Van der Klok Beheer BV / FINN BV		●					●	●				●	
Fluidwell B.V.		●	●	●	●				●	●	●		
Fluor		●	●	●	●	●			●		●	●	

Source: *Dutch solutions for a hydrogen economy, pages 32-34*

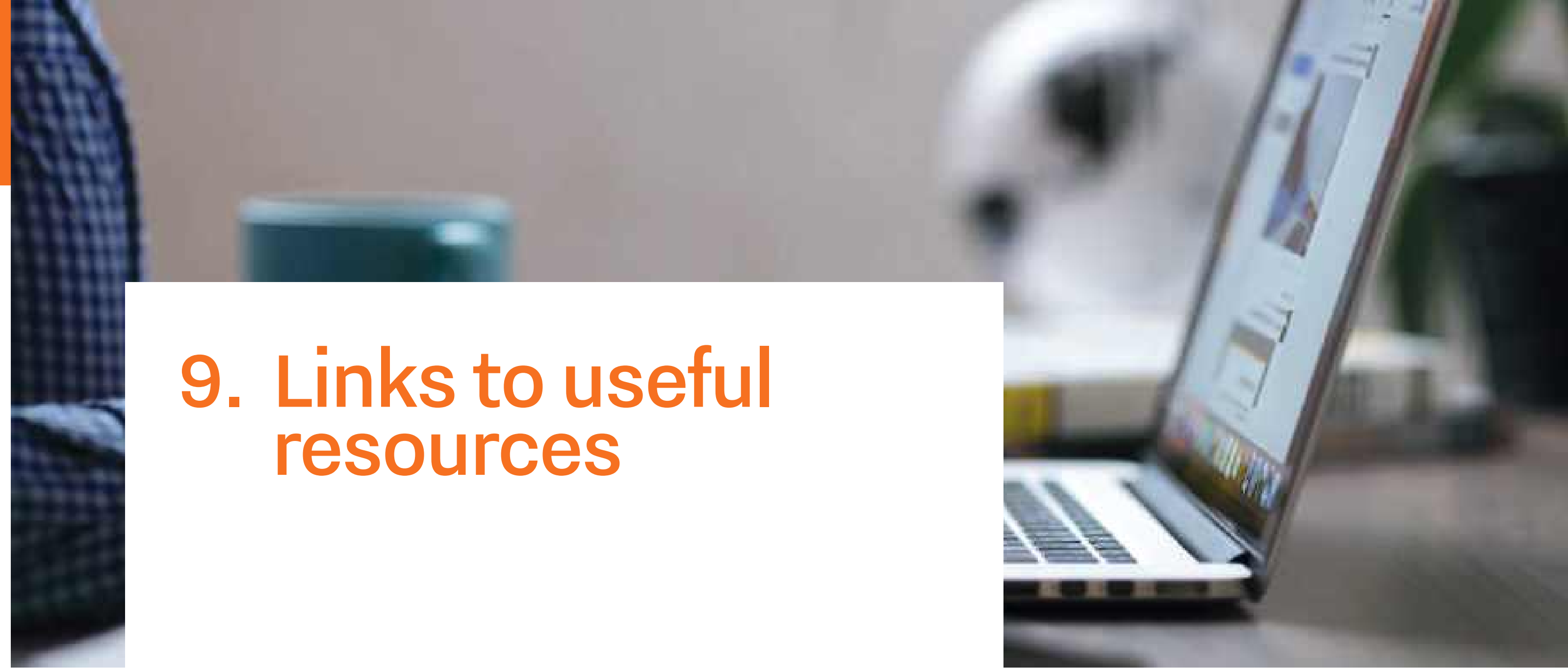
Company	Electricity	H_2 Production	Engineering / Installation	Infrastructure	Flow Solutions	Storage	Mobility	Maritime	Industry	Built Environment	Infrastructure and Storage	Research / Advisory	Association
FME												●	●
Fountain Fuel				●			●						
Frames Renewables		●					●	●	●	●	●		
Fujifilm		●										●	
Future Proof Shipping							●	●	●	●		●	
N.V. Nederlandse Gasunie				●		●							
gAvilar B.V.			●	●					●	●		●	
GF Piping Systems		●		●	●			●	●		●		
Green Energy Park Global B.V		●		●		●			●		●		
Platform Groene Hart Werkt!													●
Groningen Airport Eelde NV	●	●		●			●					●	
Groningen Seaports	●	●	●	●	●	●	●	●	●		●	●	
H2ARVESTER	●		●				●	●	●			●	
H2 Circular Fuel B.V.		●				●	●	●	●	●	●		
H2Dock BV		●											
H2Hub Twente	●	●		●			●		●	●	●	●	
H2Makers												●	●
H2O Systems Holland BV		●		●						●	●	●	
H2Storage B.V.			●	●		●	●	●	●	●	●		
HAN University of Applied Sciences				●			●	●	●	●	●	●	
Heattec Heat Technology B.V.		●	●						●	●			
Hinicio												●	
Hint Global B.V.													
Hobre Instruments B.V.	●	●							●				
HOWDEN		●		●	●	●	●	●	●		●		
HSM Offshore Energy BV		●	●						●				
Hy-Cell Co. Ltd.	●						●	●	●			●	
HyCC		●							●				
HyDevCo B.V.		●	●				●	●	●	●			
Hydrasun BV		●	●	●	●		●		●		●		
Hydrogen Architects		●	●	●		●	●	●	●		●	●	
Hydrogen Powered Solutions BV		●	●			●			●	●	●	●	
TU Delft Hydro Motion Team			●		●	●	●	●					
Hydron Energy		●					●	●	●	●	●		
Hydronex B.V.	●	●		●			●	●	●			●	
HyEnergy Consultancy (Europe) BV		●	●	●		●	●	●	●			●	
HyET Hydrogen B.V.				●	●	●	●	●	●	●	●	●	
HyGear		●	●	●		●	●	●	●	●		●	
HyMatters Operations B.V. / HyMatters Research & Consultancy B.V.	●	●	●	●	●	●	●	●	●	●	●	●	
HyMove B.V.							●	●	●				
HyNorth												●	●
HyPlanet BV		●		●		●	●	●	●				
Hysolar		●		●			●	●				●	
Hystream B.V.	●	●		●		●	●	●	●	●	●	●	
Institute for Sustainable Process Technology (ISPT)									●			●	
Iv-Groep b.v.	●	●	●			●							
Invest International	●	●	●	●	●	●	●	●	●		●		
JP Energy Systems		●	●			●	●		●	●			
Kapp Nederland B.V.		●	●		●		●	●	●	●			
Kelvion B.V. - Kelvion Thermal Solutions		●	●			●	●		●		●		
Kenter B.V.				●									
Kiemt												●	●
Kiwa	●	●	●	●	●	●	●	●	●	●	●	●	
KLINGER The Netherlands		●	●		●				●		●		
Koedood Marine Group	●		●			●	●	●	●			●	●
Koninklijke Van Twist	●								●				
Krock H2 Boats								●					
MAGNETO special anodes B.V.		●			●		●	●	●	●	●	●	
Magnus Energy B.V.				●					●		●	●	
Marsh Netherlands						●			●		●	●	
Mechatest Sampling Solutions									●				
Metalot Future Energy Lab												●	
Mokveld Valves BV					●				●		●		
Mott MacDonald BV		●	●	●	●	●	●	●	●		●	●	
MTSA Technopower B.V.		●				●	●	●	●	●	●		
Micro Turbine Technology B.V. (MTT)	●		●						●	●		●	●
MV Energietechniek	●	●	●	●	●	●	●		●	●	●	●	
Neptune Energy Netherlands B.V.		●		●		●					●		
Netherlands Enterprise Agency (RVO)												●	
Nettenergy B.V.	●	●	●									●	
New Cosmos - BIE	●	●		●		●	●	●	●	●	●	●	
New Energy Business School							●	●	●	●	●	●	●
New Energy Coalition		●		●		●	●	●	●	●	●	●	●
Nexus Energy B.V.			●	●				●	●	●	●		
NGT BV		●		●	●	●			●		●		
Development Agency North Holland North (NHN)							●	●	●	●		●	●
NLHydrogen													●

	ELECTRICITY	H_2 PRODUCTION	ENGINEERING / INSTALLATION	INFRASTRUCTURE	FLOW SOLUTIONS	STORAGE	MOBILITY	MARITIME	INDUSTRY	BUILT ENVIRONMENT	INFRASTRUCTURE AND STORAGE	RESEARCH / ADVISORY	ASSOCIATION
NOGAT B.V.	●	●		●		●					●		
North Sea Port				●				●					
Nuvera Fuel Cells Europe	●						●	●	●				
Netherlands Hydrogen & Fuel Cell Association NWBA													●
NXT Mobility				●			●						
OCI Global		●		●			●	●	●				
ON2Quest		●	●				●	●	●	●		●	
Pondera (Consult B.V.)	●	●	●			●	●		●	●	●	●	●
Port of Amsterdam	●	●		●			●	●	●		●		
Port of Rotterdam	●	●		●			●	●	●		●		
Power2X		●		●		●		●	●		●	●	
Pro Control Process Automation BV					●		●	●	●				
Prodrive Technologies B.V.	●	●		●					●		●		
Proton Ventures BV			●			●		●	●			●	
Pure Water Group	●	●	●						●				
PwC												●	
RAI Automotive Industry NL							●	●	●			●	●
RAP Clean Vehicle Technology							●		●		●	●	
REDstack B.V.	●	●			●				●				
Remeha			●							●		●	
Resato International			●	●			●						
RN Solutions B.V.									●				
Royal HaskoningDHV												●	
RWE	●	●				●	●	●	●				
SALD bv			●				●	●	●	●		●	
Samotics									●				
Saxion University of Applied Sciences							●		●	●	●	●	
Schaeffler Nederland B.V		●					●	●	●	●	●		
Schwank BV		●	●	●	●				●	●	●	●	●
SHV Energy N.V.				●		●	●		●	●	●		
Sia Partners	●	●		●	●							●	
Siemens Energy B.V.	●	●	●	●		●	●	●	●		●		
Solstice Management B.V.												●	
SoluForce B.V.				●	●						●		
Sorama B.V.	●	●	●	●	●	●	●	●	●	●	●	●	
SparkNano			●						●			●	
R. Stahl Electromach				●			●	●	●		●	●	
Stork			●	●	●			●	●	●	●	●	
Strohm BV					●	●		●			●		
Summit Engineering B.V.		●	●	●		●	●	●	●	●	●	●	
SuWoTec B.V.		●					●	●	●	●	●	●	
Swagelok Nederland					●		●	●	●	●	●	●	
Tebulo Engineering	●	●	●	●	●	●	●	●	●		●	●	
Teesing B.V.			●		●		●		●				
T.EN Netherlands B.V.		●	●						●			●	
TKI New Gas (Topsector Energy)												●	
TNO Process Safety Solutions												●	
To70 aviation												●	
Torrgas bv		●	●						●			●	
Toyota Material Handling							●		●			●	
Tradinco Instruments					●		●	●	●	●	●	●	
TSG Group			●						●			●	
TSG Netherlands BV		●				●	●	●	●		●		
TU Delft	●	●		●	●	●	●	●	●	●	●	●	
TwynstraGudde	●	●	●	●			●	●	●	●	●	●	●
Van Campen Ecotechniek B.V.							●						
VARO Energy Netherlands B.V.		●							●				
VDL Energy Systems B.V.			●			●	●		●	●	●		
Veco B.V.		●					●		●				
Vecom Group B.V.		●		●	●	●	●	●	●		●		
VEGA level and pressure	●	●		●	●	●		●	●	●	●		
VoltH2		●					●	●	●				
VONK	●	●							●	●			
Royal Vopak				●	●	●	●	●	●		●		
Voyex B.V.						●	●	●			●		
VTTI		●		●		●	●	●	●		●		
Water Alliance													●
WE | doubleyouenergy B.V.		●	●			●	●	●	●	●	●		
Wigersma & Sikkema B.V.					●						●		
Witteveen+Bos	●	●	●	●					●	●	●	●	
WSP	●	●	●	●	●	●	●	●	●	●	●	●	●
XINTC		●					●	●	●	●	●		
zepp.solutions	●						●	●	●		●	●	
Zeton BV		●							●			●	

8.11 List of current clean hydrogen projects in Texas and nearby Gulf Coast

Project name	Location	Date online	Status	Capacity (kt H_2/yr)
Hydrogen City	South Texas		Concept	347 (phase 1) 2,654 (phase 2)
Ascension Clean Energy (ACE) complex (LA)	Louisiana	2028	Concept	1,297
ExxonMobil Baytown petrochemical site	Houston, TX	2029	Feasibility study	919
Eastern Louisiana Clean Hydrogen Complex (LA)	Louisiana	2027	FID/Construction	690
Port of South Louisiana	Louisiana		Concept	526
Hy Stor	Mississippi	2025	Feasibility study	381
Acme - Port of Victoria	South Texas	2027		379
HIF USA	Texas	2026	Feasibility study	270
Sustainable Fuels Group - CIP Carbon reduced Ammonia plant St Rose (LA)	Louisiana	2027	Feasibility study	263
CF Industries blue ammonia Blue Point (LA)	Louisiana	2026	FID/Construction	252
CF Industries and Mitsui Blue ammonia complex (LA)	Louisiana	2028	Feasibility study	252
Eneos project	Louisiana	2030	Concept	244
Enbridge Ingleside Energy Center Low carbon ammonia (TX)	Texas	2029	Feasibility study	234
Yara-BASF Gulf Coast	Gulf Coast	2029	Feasibility study	234
Horizons Clean Hydrogen Hub	Texas	2030	Feasibility study	208
Linde hydrogen plant for ex-OCI/ Woodside fertilizer blue ammonia Beaumont (Texas)	Texas	2025	FID/Construction	198
LSB Ammonia project - Houston Ship Channel	Houston, TX	2027	Feasibility study	180
Ammonia project Baytown complex	Houston, TX	2028	Concept	180

Project name	Location	Date online	Status	Capacity (kt H_2/yr)
Gron Fuel Renewable Energy Complex	Louisiana	2030	Feasibility study	173
Tallgras-Kowepo MoU	Texas		Concept	173
Cormorant Clean Energy Project	Texas	2027	Feasibility study	158
Air Products H2 plant Wilbarger County	Texas	2027	Concept (On hold)	146
DG Fuels	Louisiana	2028	Feasibility study	142
Maersk - Ørsted methanol Gulf plant	Texas	2025	Feasibility study	117
Mississippi Clean Hydrogen Hub	Mississippi	2025	Feasibility study	110



9. Links to useful resources

Policy and governmental sources

Hydrogen Program of the DoE (Department of Energy)

Hydrogen shot (DoE)

U.S. National Clean Hydrogen Strategy and Roadmap

Regional Clean Hydrogen Hubs initiative

Solar Energy Research Database (at the Office of Energy Efficiency & Renewable Energy)

Wind Energy Technologies Office Projects Map ((at the Office of Energy Efficiency & Renewable Energy)

Texas General Land Office

The Center for Houston’s Future

The HyVelocity Hub

Texas Hydrogen Alliance

Maps and data sources

IEA Hydrogen production projects interactive map

EIA US Energy Atlas interactive map

Texas CCUS Map at Baker Institute for Public Policy at Rice University

National Pipeline Mapping System Public Viewer

US Hydrogen resource (wind/solar, etc.) maps at the National Renewable Energy Laboratory (NREL)

National Energy and Petrochemical map (at Fractracker Alliance)

Texas population projection map by Texas county (Texas Demographic Center)

Texas General Land Office Maps & Data

SEIA (Solar Energy Industries Association) Project Location map

EIA State overview (Beta version)

10. Emerging hydrogen triple helix

Academia

The University of Houston offers a few “micro-credentialing programs” in the Hydrogen space:

- The Hydrogen Economy Program
- The Hydrogen Pipelines: Facts, Opportunities and Solutions
- CCUS Executive Education Program

The University of Texas hosted a Hydrogen Day and maintains a webpage dedicated to Hydrogen resources and news.

The other large Texas universities have all either hydrogen-dedicated centers or strong Energy institutes.

University of Texas (UT)
Program: H2@UT

Texas A&M University
Program: Energy institute

Rice University
Program: Baker Institute for Public Policy

University of Houston
Program: Division of Energy and Innovation

Non-governmental organizations

Houston Energy Transition initiative
Part of Greater Houston Partnership dedicated to Energy transition
Read more

Center for Houston's Future
Non-profit affiliated with Greater Houston Partnership bringing business, government, community and academia together
Read more

Greater Houston Partnership
Public-Private Partnership
Read more

Dallas-Fort Worth Clean Cities Coalition
Program of the North Central Texas Council of Governments (NCTCOG) and one of DoE's Clean Cities Coalition Network (focusing on clean transportation)
Read more

Central Texas Clean Cities Coalition
See DFW Clean Cities above
Read more

Texas Hydrogen Association
Small association supporting the growth of the H_2 sector in Texas
Read more

Texas Hydrogen Alliance
Key industry stakeholders for advocacy, policy and education
Read more

Clean Hydrogen Future Coalition
Diverse group of energy companies, utilities, NGOs, equipment suppliers, project developers etc. promoting clean H_2 in the US
Read more

Hydrogen Council
International companies involved in the entire hydrogen value chain
Read more

Selected deep draft ports in Texas

Recurring conferences

Hydrogen Technology Expo. North America
Houston, organized by Trans-global Events
Read more

CERA week
Houston, organized by S&P Global
Read more

Hydrogen North America
Houston, organized by Reuters
Read more

World Hydrogen North America
Houston, organized by S&P Global
Read more

Hydrogen Americas Summit & Exhibition
Washington DC, organized by Sustainable Energy Council
Read more

GasTech / Hydrogen
Houston and rotating locations, organized by dmg events
Read more

Contact details of relevant agencies/other organizations in Texas and USA

Office of Clean Energy Demonstrations
U.S. Department of Energy
1000 Independence Ave SW
Washington, D.C. 20585
Email: OCED@hq.doe.gov
Media Inquiries: OCEDNewsroom@hq.doe.gov

Embassy of the Kingdom of the Netherlands in the United States
4200 Linnean Ave NW
Washington, DC 20008
www.netherlandsandyou.nl/web/united-states

Consulate General of the Kingdom of the Netherlands in Miami
701 Brickell Ave #500
Miami, FL 33131
Email: MIA-EA@minbuza.nl
www.netherlandsworldwide.nl/contact/embassies-consulates-general/united-states/consulate-general-miami

Netherlands Business Support Office Texas
4201 Main Street, Suite 205
Houston, TX 77002
Email: office@nbso-texas.com
www.nbso-texas.com

Acretio LLC
1000 N Post Oak, Suite 220
Houston, TX 77055
Email: info@acretio.com
www.acretio.com

Texas is rapidly becoming a global hub for clean hydrogen, with large-scale infrastructure, strong renewables, and growing investment in cleaner hydrogen. At the same time, the Netherlands offers world-class expertise in hydrogen innovation, logistics, and integrated system design.

This market scan explores how Dutch and Texan strengths align and complement each other, and provides insight into key developments such as the Inflation Reduction Act, the HyVelocity Hydrogen Hub, and the broader Texan energy strategy framed as “energy addition.”

For Dutch SMEs and technology providers, Texas presents clear opportunities—but market entry requires local engagement, a nuanced understanding of the business landscape, and a proactive approach. The report outlines strategic recommendations, case studies, and partnership pathways.

With increasing public, academic, and private-sector momentum on both sides of the Atlantic, the Dutch-Texan hydrogen corridor is moving from ambition to reality.