Renewable Hydrogen in Iowa

EXECUTIVE SUMMARY

Assessing the prospects of a renewable hydrogen economy in Iowa with economic and employment projections, techno-economic modeling, and resource mapping.

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21 March 2022

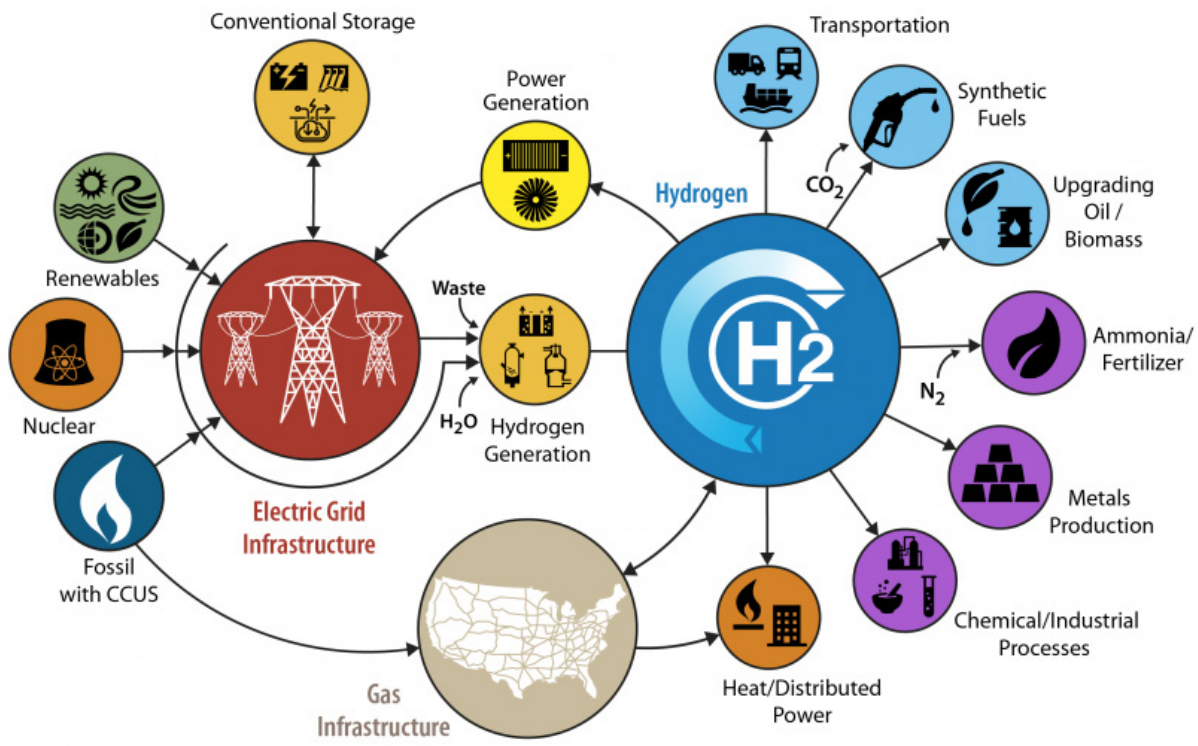
This report was produced by Ideal Energy, LLC with support from the Iowa Economic Development Authority.

The information, data or work presented herein was funded in part by the Office of Energy Efficiency and Renewable Energy (EERE) and the U.S. Department of Energy, under award number DE-EE0007471.

WHY HYDROGEN?

The energy transition – the global changeover from fossil fuels to a renewable, carbon-free energy economy – will involve trillions of dollars of wealth creation. Iowa is in a unique position to lead the way and benefit from this transition.

To decarbonize energy the world needs both clean electricity and a carbon-neutral chemical energy carrier. A chemical energy carrier is necessary where electricity and batteries are not suitable, including applications like long-distance heavy transport, the chemical industry, heavy manufacturing, and long-term energy storage.



Renewable Hydrogen and Green Ammonia are Ideal Chemical Energy Carriers

Hydrogen (H2) is a flammable, lighter-than-air gas with strong existing demand and a wide array of potential future uses. Ammonia (NH3), which is made from hydrogen, is more stable and more energy-dense, ideally suited for long-term storage, and among the world's most in-demand chemicals due to its use as the principle ingredient in most fertilizers.

Renewable Hydrogen is Clean

Renewable hydrogen production requires only water, an electrolyzer, and a renewable power source such as a wind farm or solar array. The electrolyzer uses electricity to split water molecules into hydrogen and oxygen. **No pollution or greenhouse gases are emitted in this process.** Green ammonia, which is made from renewable hydrogen, is also carbon-free. In contrast, traditional brown ammonia production accounts for 1.8% of all CO2 emissions worldwide.

Hydrogen is Versatile and In Demand

There is an existing market for hydrogen as the principle feedstock for ammonia production. Hydrogen can also be injected into the natural gas network, burned in power plants or industrial furnaces, used to power hydrogen fuel cells vehicles, and used to produce carbon-free fuels.

Hydrogen is used to make ammonia. Hydrogen is the primary feedstock for ammonia production. There is a vast, existing market for ammonia, especially among agrichemical manufacturers producing nitrogen fertilizers such as anhydrous ammonia. The ammonia market is valued at $74.61 billion and is expected to grow at a compound annual rate of 5.59% over the next five years.

Hydrogen in the natural gas grid. Hydrogen can be mixed with natural gas at up to 10% with no safety hazard, no impact to gas infrastructure, and no requirement to modify or replace end-use appliances like furnaces, boilers, stoves and ranges. European projects have already demonstrated the viability of this approach.

Hydrogen can be turned back into electricity. Hydrogen can be burned in modified peaking power plants. It can also be used in large, stationary fuel cells to provide peak demand reduction or grid stabilization services. Ammonia can be burned in modified coal power plants. Projects using each of these approaches are operational or under construction in the U.S., Europe, and Japan.

Renewable hydrogen is ideal for heavy transport and aviation. Hydrogen is a necessary ingredient in carbon-free fuels like renewable diesel, sustainable aviation fuel (SAF), and hydrotreated vegetable oil (HVO). Hydrogen can also power fuel cell electric vehicles (FCEVs), fuel cell locomotives, and fuel cell powered oceanic transport ships.

Hydrogen can Expand the Reach of Renewables

Electricity generation represents only 25–30% of global carbon emissions. The remaining 70–75% of emissions stem from difficult to decarbonize sectors, including heavy transport, steelmaking, and agrichemical processes. Emissions from these sectors cannot be easily addressed with solar power, wind power, or batteries, but they can be addressed with renewable hydrogen.

Iowa: the Persian Gulf of Renewable Hydrogen

Iowa is extremely well-positioned to become a center of renewable hydrogen production and consumption. Iowa has abundant renewable energy resources, an existing agrichemical industry, and a huge demand for hydrogen products.

Iowa has Excellent Renewable Energy Resources

- **Iowa generates 57.51% of its electricity with wind – the highest percentage in the nation.** Iowa has 11,660 megawatts (MW) of installed wind capacity – second only to Texas.

- **The technical solar potential of Iowa ranks 16th in the nation, ahead of Florida and the Carolinas.** Iowa has 158.7 MW of installed solar capacity with another 1,349 MW approved or proposed.

Iowa has a Robust Agrichemical Industry

- Iowa is home to several agrichemical companies that produce nitrogen fertilizers from ammonia, including CF Industries and Iowa Fertilizer Company.

- The NuStar ammonia pipeline carries upwards of 30,000 barrels of ammonia per day to facilities in Iowa and neighboring states.

Iowa has Significant Local Demand for Hydrogen Products

- Iowa is a major agricultural state with the highest corn production in the nation and the second highest soybean production.
- With approximately 23,619,000 acres planted – more than any other state – demand for ammonia-based nitrogen fertilizers in Iowa exceeds 1.5 million tons per year.

Iowa has Potential Markets for Hydrogen in Transport, Manufacturing, and Natural Gas

- Iowa is a crossroads state for truck freight and a key refueling stop for trucks coming from and going to Chicago, St. Louis, Kansas City, Minneapolis, and Milwaukee.
- The busiest freight railway in the nation passes through Iowa.
- Iowa's manufacturing sector – which is the state's second largest industry and accounts for 18.4% its economy – could use hydrogen extensively with little modification to existing infrastructure.
- Replacing even 5% of Iowa's natural gas with hydrogen would create over 2.75 TW of hydrogen demand.

HOW IOWA CAN BENEFIT

Renewable hydrogen can provide Iowa with billions of dollars in economic growth and thousands of jobs.

- With a renewable hydrogen industry in the state, Iowa could see a **$1.19 billion increase to its gross state product (GSP) by 2030 and a $6.375 billion GSP increase by 2050.**
- Research suggests Iowa's hydrogen industry could contribute **more than 7,000 new jobs by 2030, and up to 35,000 new jobs by 2050.**
- Employment factor is a measure of both direct and indirect jobs per terawatt-hour (TWh) that includes initial construction as well as ongoing operations. **The employment factor of renewable hydrogen surpasses wind energy and compares favorably with solar energy.**

ENERGY INDUSTRY	EMPLOYMENT FACTOR
Solar	1,000 jobs/TWh
Renewable Hydrogen	575-775 jobs/TWh
Wind	200-300 jobs/TWh

Is Renewable Hydrogen Competitive?

Renewable hydrogen is more expensive than hydrogen made from natural gas using steam methane reforming (SMR) in most situations. However, if electricity costs are low enough renewable hydrogen can be cheaper. Iowa has some of the lowest cost wind energy in the nation:

- Wholesale wind price . . . $15 / MWh (average)
- Power purchasing agreement (PPA) wind prices . . . $11 / MWh (average)

Ideal Energy's modeling shows that a renewable hydrogen production plant may be able to produce cost-competitive hydrogen in Iowa today.

- Renewable hydrogen price parity target . . . $2 / kg or less
- Modeled renewable hydrogen cost with $15 / MWh electricity . . . $1.69-1.99 / kg

In addition, Iowa has among the highest curtailment rates in the nation. Curtailed power is power that could have been generated, but was not due to insufficient demand, grid congestion, or other factors. Curtailed power can be used for renewable hydrogen production, which would drive prices even lower.

- Wind curtailment rate in Iowa . . . 4.1% (MISO average)
- Wind curtailment rates elsewhere . . . 0.5-2.7% (range of other ISOs)

The H2Hub Program is a Once-in-a-Generation Opportunity for Iowa

The Infrastructure Investment and Jobs Act contains several provisions providing funding for renewable hydrogen projects. Some of the key provisions of the Infrastructure Act are as follows:

- Authorizes $9.5 billion in spending for clean hydrogen, including
    - $8 billion for development of large-scale Regional Clean Hydrogen Hubs,
    - $1 billion for Clean Hydrogen Electrolysis Research and Development,
    - $500 million for Clean Hydrogen Manufacturing and Recycling.
- Directs federal government to develop national hydrogen roadmap and strategy.
- Defines "clean hydrogen."

The Regional Clean Hydrogen Hub program, also known as H2Hub, calls for the creation of four hydrogen hubs. The Department of Energy defines a hydrogen hub as "a network of clean hydrogen producers, potential clean hydrogen consumers, and connective infrastructure located in close proximity." Hydrogen hubs are expected to have geographic diversity, feedstock diversity, and end-use diversity. At least one of the hydrogen hubs must focus on renewable hydrogen. ***Iowa is perfectly positioned to be the renewable hydrogen hub.***

Recommendations

Iowa needs a comprehensive approach to building a renewable hydrogen industry. Ideal Energy has identified five key recommendations to do so:

1. **Assemble a task force to apply to the federal H2Hub program.** The Department of Energy's H2Hub program represents a unique opportunity to leverage federal funding to kickstart the renewable hydrogen industry within Iowa. Iowa has the resources necessary to support a strong application. To that end, an H2Hub Task Force should be created to coordinate efforts by the state government, economic development organizations, private industry, and other stakeholders.

2. **Identify key resources, stakeholders, and potential partners within the state.** The H2Hub Task Force should identify key resources and existing infrastructure in three categories: production, transportation & storage, and demand. In addition, the Task Force should identify potential project developers and partners, as well as other stakeholders.

3. **Address regulatory barriers.** A key challenge to the development of a renewable hydrogen industry in Iowa is the lack of a utility tariff specific to hydrogen production. Under current tariffs, wind energy – even if it is currently curtailed – has to be sold at rates that may be too expensive to be financially viable in a renewable hydrogen plant. The Iowa Utility Board could create a new tariff to set lower prices for wind energy used to power renewable hydrogen production.

4. **Leverage existing infrastructure to build momentum.** These key opportunities will help build momentum for renewable hydrogen's growth in Iowa.

    a. Develop partnerships between wind farm owners and agrichemical companies. Iowa has the second largest portfolio of wind energy assets in the nation. In addition, Iowa is home to several large-scale nitrogen fertilizer plants that require large feedstocks of ammonia. These two industries are a natural fit for renewable hydrogen project development.

    b. Use existing natural gas infrastructure to grow hydrogen demand and offset greenhouse gas emissions. This will generate enough demand to absorb a considerable amount of renewable hydrogen production.

    c. Leverage storage and transportation infrastructure, including existing pipelines, to transport hydrogen and hydrogen products out of state. National Renewable Energy Laboratory data indicates that even with its significant existing demand for ammonia and fertilizer, Iowa has the potential to be a net-exporter of renewable hydrogen products.

5. **Deploy state-level incentives to scale up the hydrogen industry.** Iowa successfully used wind energy production tax credits, renewable energy tax credits, and solar energy system tax credits to grow the wind and solar industries in their critical early years. The Iowa government should once again implement state-level incentives, this time to stimulate hydrogen production. Possibilities include investment tax credits, production tax credits, and direct grants. Iowa can follow the Department of Energy's lead with regard to selection criteria and funding mechanism.

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