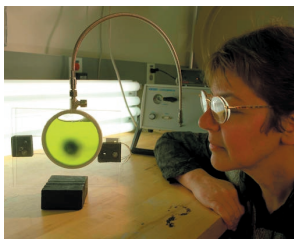


# Minnesota Renewable Hydrogen Initiative

A roadmap to achieving the state's goal of moving to hydrogen as an increasing source of fuel for Minnesota's energy needs



Minnesota is rich in wind and biomass resources which can be harnessed to create hydrogen.



Developing hydrogen sources from Minnesota's renewable resources offers potential for economic growth and job creation. Above, a researcher works with algae as a source of hydrogen.

## Vision

By 2010, the State of Minnesota will be a national leader in the production and use of hydrogen from renewable bio-based and wind energy sources, thereby achieving statewide economic development, reduced risk to the environment and public health, and enhanced national energy security.

**T**he Minnesota Renewable Hydrogen Initiative (MRHI), a partnership of industry, university, government, and non-government organizations, leads the state's effort to grow and promote Minnesota's renewable hydrogen industry.

To guide this effort, MRHI has outlined a roadmap to identify and implement the most strategic opportunities that will best leverage resources to move the state to hydrogen as an increasing source of energy for its electrical power, heating, and transportation needs. In addition, this roadmap will structure and pursue the partnerships needed between industry, government, and institutions to functionally achieve the technological, policy, and product development steps necessary to achieve the initiative's goal and vision. The Minnesota Renewable Hydrogen Initiative will create jobs, encourage economic development, and foster new industries in Minnesota, while decreasing the risk to our health, environment, and energy security.

## Goal

“It is a goal of this state that Minnesota move to hydrogen as an increasing source of energy for its electrical power, heating and transportation needs.”

*(Minnesota Session Laws 2003 1st Special Session, Chapter 11)*



## Policies

Minnesota has established a number of policies in the statute to support this goal, including the following:

- ▶ The Department of Employment and Economic Development is required to establish a program to attract hydrogen-related businesses, and establish energy enterprise zones for a hydrogen infrastructure.
- ▶ Hydrogen production from renewables may count toward a utility’s renewable energy objective after 2010<sup>1</sup>.
- ▶ The Department of Commerce will issue a Request for Proposals to build a wind-powered, electrolysis-to-hydrogen project that includes pipeline, storage, and fuel cell components.
- ▶ In 2003, The University of Minnesota Initiative for Renewable Energy and the Environment (IREE) will support basic and applied research and demonstration activities related to renewable energy, including hydrogen. To this end, IREE received \$10 million from the Xcel Energy Renewable Development Fund in 2003 and will receive approximately \$10 million in additional funding over the next five years from the Xcel Energy Conservation Improvement Program.

## Benefits to the state

Minnesota will benefit in a number of ways from growing and promoting Minnesota’s renewable hydrogen industry, including:

- ▶ More diverse sources of energy to provide additional sources of commercially viable electricity.
- ▶ A significant decrease in the pollution associated with the use of fossil fuels.
- ▶ Improved environment, public health, and safety through an increased percentage of electricity produced from technologies that do not create hazardous waste or harmful emissions.
- ▶ Increased economic development and job growth.
- ▶ Decreased energy dependence on fuels imported from outside the state and nation.
- ▶ Increased energy security through a more diverse Minnesota-based and distributed energy system.

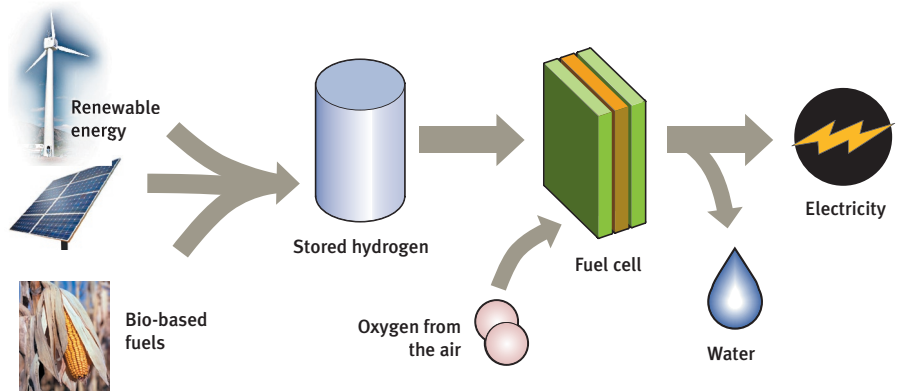


Ethanol plant in Luverne, MN

## Hydrogen complements Minnesota’s resources

Fuel cells offer an excellent complement to Minnesota’s abundance of clean, renewable wind energy and agricultural resources.

By combining stored hydrogen and oxygen from the air, fuel cells generate electricity and release only pure water as a by-product.



## Elements of MRHI's Roadmap

The following outline for Minnesota Renewable Hydrogen Initiative (MRHI) Roadmap describes the action plan needed to support the State of Minnesota's hydrogen energy goal established by Minnesota law in 2003.

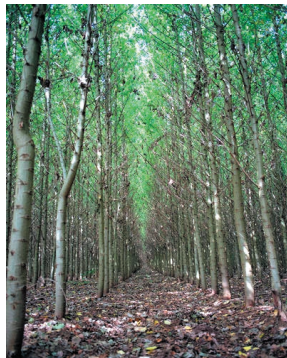
### Partners will identify and evaluate opportunities.

**1 Strengths and opportunities.** Perform a niche analysis to determine the areas of greatest strength and opportunity for Minnesota to pursue its goal. Areas to be examined include:

- ▶ methods of renewable hydrogen production.
- ▶ methods of purification, storage, infrastructure, and delivery that may be unique to renewable hydrogen production.
- ▶ end-use applications and distribution options for hydrogen fuel, as blended fuel and as feedstock for products.
- ▶ codes, standards, insurance, financing, and risk assessment for the production, storage, transport, and use of hydrogen and fuel-blended hydrogen, and for the renewable energies used to produce renewable hydrogen.
- ▶ opportunities for funding and support.
- ▶ methods to measure progress toward meeting the goal.

**2 Production.** Identify opportunities to include and leverage Minnesota's experience and expertise regarding production of renewable energy and materials, of which continued development is needed to sustain the renewable hydrogen effort. Areas to be examined include development, production, and use of:

- ▶ wind power
- ▶ ethanol fuel
- ▶ biodiesel fuel
- ▶ biological and biomass-derived fuels from forest products, agricultural hybrid poplar, crops, crop residue, and animal and food processing wastes.
- ▶ renewable methanol
- ▶ solar and micro hydro industries
- ▶ biomaterials, products, and refineries



Agricultural hybrid poplar can be an effective source of biomass for hydrogen and other fuels.

**3 Use of alternatives.** Identify opportunities to leverage Minnesota's experience and expertise regarding increasing use of alternative fuels and hybrid electric vehicles. Areas to be examined include:

- ▶ strategies used, lessons learned, and benefits of increased use of E85, natural gas, and biodiesel fueled vehicles.
- ▶ strategies used, lessons learned, and benefits of increased use of hybrid gasoline-electric vehicles, which, due to their direct relationship with development of hybrid fuel cell-electric vehicles, are a critical step in development of cost-effective hydrogen fuel vehicles.



Honda's fuel-cell car

**4 Other efforts.** Identify opportunities and current research, projects, and product development underway in the region that is applicable to this initiative. Sectors to be examined include:

- ▶ universities
- ▶ utilities
- ▶ hydrogen storage and transport industry
- ▶ alternative fuels industry
- ▶ renewable energy equipment manufacturers and component suppliers
- ▶ fuel cell component suppliers
- ▶ state and regional units of government and other organizations

**5 Education.** Identify and leverage use of available expertise and information needed to develop and promote a public education campaign on the long-term, economic, public health, environmental, and energy security benefits of producing and exporting hydrogen made from Minnesota's renewable energy resources. Identify teaching and curriculum opportunities for educating and providing the expertise needed to meet research and technical employment needs in this area.



**Partners will pursue opportunities..**

MRHI will focus on and support those partnerships and projects that bring highest value to achieve the vision and goal. Categories include:

**6 Research and development.** The principal focus for research and development efforts will take advantage of the state’s most significant renewable resources: biological and biomass-based hydrogen production and wind electrolysis. Added focus will include opportunities for increasing use of solar and micro hydro.

**7 Regional partnerships.** Other states and Canadian provinces in the region have strengths in other sources of energy that may be used to produce hydrogen. Partnerships will be developed such that regional cooperation is in place to assure coordinated progress toward a common and viable hydrogen economy future.

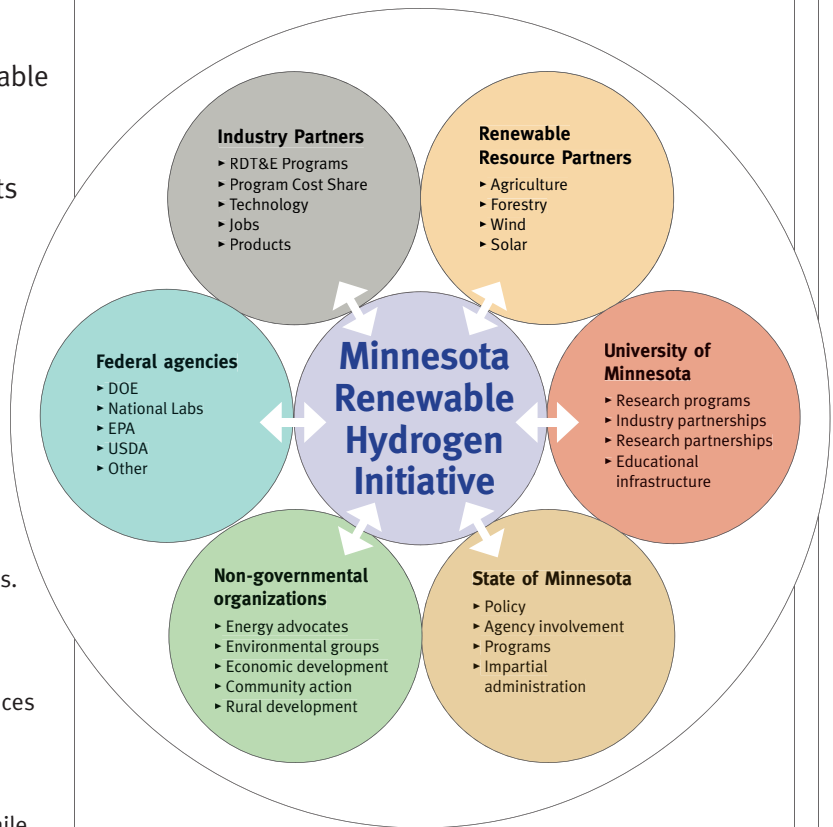
**8 Demonstration projects.** Demonstration projects will support and enhance contributions to the approaching hydrogen economy, and will support regional efforts to develop a hydrogen infrastructure. These projects should:

- ▶ stimulate market demand for hydrogen and related technologies.
- ▶ be replicable elsewhere in the state and region.
- ▶ identify and leverage use of applied research.
- ▶ demonstrate complementary aspects of hydrogen production, storage, distribution, and use opportunities.
- ▶ be accessible to the public, with an explicit public education and awareness component.
- ▶ be scalable to enable response to changing circumstances and market demands.
- ▶ result in functional infrastructure development.
- ▶ maximize use of Minnesota business and expertise, while

fostering and coordinating with partners in surrounding states and Canada for the mutual benefit of the region.

- ▶ increase production of energy from Minnesota-based renewable sources to achieve more energy independence while hydrogen energy conversion technologies are developed.
- ▶ foster economic development and job creation, and maximize use of market forces to achieve the vision and goal.
- ▶ result in measurable outcomes.

**9 Education and promotion.** A public education campaign will promote awareness of the long-term, economic, public health, environmental, and energy security benefits of producing and exporting hydrogen made from Minnesota’s renewable energy resources.



To learn more, or to find out how to become a partner in this initiative, contact Linda Limback, Energy Office, Minnesota Department of Commerce, at 651-296-1883 or [linda.limback@state.mn.us](mailto:linda.limback@state.mn.us)

**(Footnotes)**

<sup>1</sup> The 2003 legislation provides that natural gas is considered a renewable feedstock for hydrogen generation until 2010; however, the MRHI Vision is based on use of “renewable energy” defined as: “Energy sources which are never exhausted because they are renewed by nature within a short time span, i.e., replenished by nature such that they are still available in the same capacity for following generations.”

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