

# TRANSPORT

## New Hydrogen Pipeline

Pipelines can be used to transport hydrogen gas similar to natural gas today. Approximately 1,600 miles of hydrogen pipelines operate in the United States, which mainly serve large hydrogen users such as petroleum refineries and chemical plants. Pipeline are costly to install and lengthy permitting processes are costly, once installed they are the cheapest transportation method.

### CONSIDERATIONS

Pipelines historically have been disproportionately routed through communities of color and indigenous land, disrupting their communities and livelihoods. Building a new pipeline has environmental impacts. As with all technologies that use flammable fuels, there are risk of leaks and explosions. Hydrogen gas is lighter than air and disperses rapidly, a built-in safety advantage in an outside environment.



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Alaskan oil pipeline, image by Gillfoto, CC-BY-SA-4.0.

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## TRANSPORT



Alaskan oil pipeline, image by Gillfoto, CC-BY-SA-4.0.

# PRODUCTION

## Electrolyzer

Electrolyzers use electricity, sourced from renewables or the grid, to split water into hydrogen and oxygen. The electricity source determines the greenhouse gas footprint. Current electrolyzer costs comprise about half from the system and half from installation. For the electrolyzers 40-60% of the total system capital cost comes from the electrolyzer itself and the remainder from the balance of plant components.

### CONSIDERATIONS

Like other consumer products, electrolyzers currently require the use of “forever” PFAS chemicals which creates environmental and health risks if they are not properly disposed of or manufactured. As with all technologies that use flammable fuels, there are risk of leaks and explosions.



Must be  
partnered with...

Electricity Source

Water

# Electrolyzer



  
NEEDS  
PARTNER

## PRODUCTION



Electrolyzer Denmark, Image: Rh2network, Creative Commons Attribution-Share Alike 3.0 Unported license.

Must be  
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# PRODUCTION

## Grid Electricity **100% RENEWABLE SOURCES**

An electrical grid is an interconnected network for electricity delivery from producers to consumers. Electrical grids vary in size and can cover whole countries or continents. Renewable electricity is produced from solar-, wind-, geothermal, and hydro- powerplant. Presently no grid electricity is 100% renewable. Updating the whole grid to renewables is difficult and costly due to intermittency and the need to greatly increase amount of renewable energy generation systems to meet demand.

### CONSIDERATIONS

Renewable electricity sources do not release emissions during use which is good for human health and our environment. However, they use critical minerals, like Colbolt, that require mining which causes environmental health harms. Critical minerals mining internationally can be poorly regulated leading to harmful labor practices.



Must be  
partnered with...

Electrolyzer

Water

# Grid Electricity 100% RENEWABLE SOURCES

NEEDS  
PARTNER



## PRODUCTION



Image credit: USEPA, public domain.

Must be  
partnered with...

Electricity Source

Water



# PRODUCTION PARTNER CARD

## Water

All processes to make hydrogen require the use of water. However, less water is used to make hydrogen by electrolysis than is used in coal and nuclear electricity generation. Natural gas powered electricity generation requires a similar amount of water to electrolysis. Water costs include drawing from municipal sources and purification where needed.

### CONSIDERATIONS

Water use is a particular concern in drought regions or where water rights are contested.



Can be  
partnered with...

**Biomass  
Gasification**

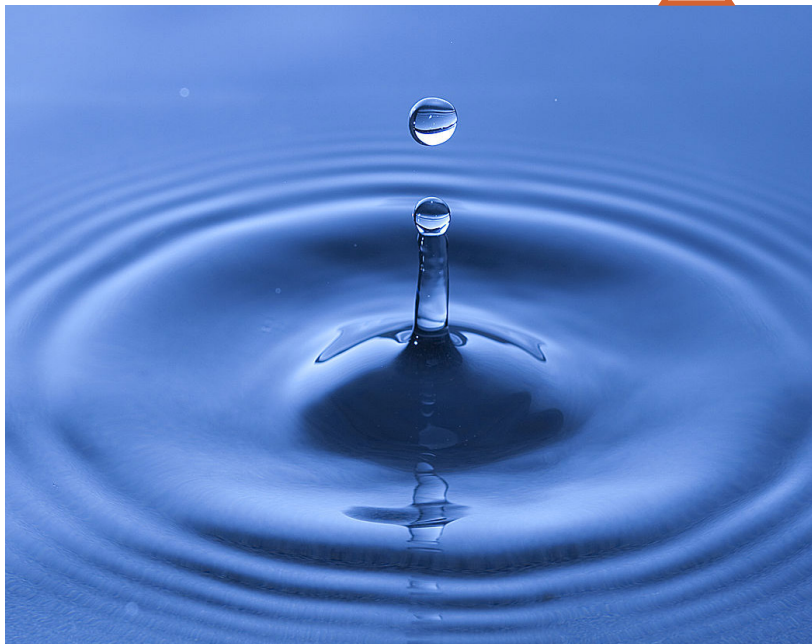
**Electrolyzer**

**Steam Methane  
Reforming**

# Water



PARTNER  
CARD



Davide Restivo, Creative Commons Attribution-Share Alike 2.0 Generic license.

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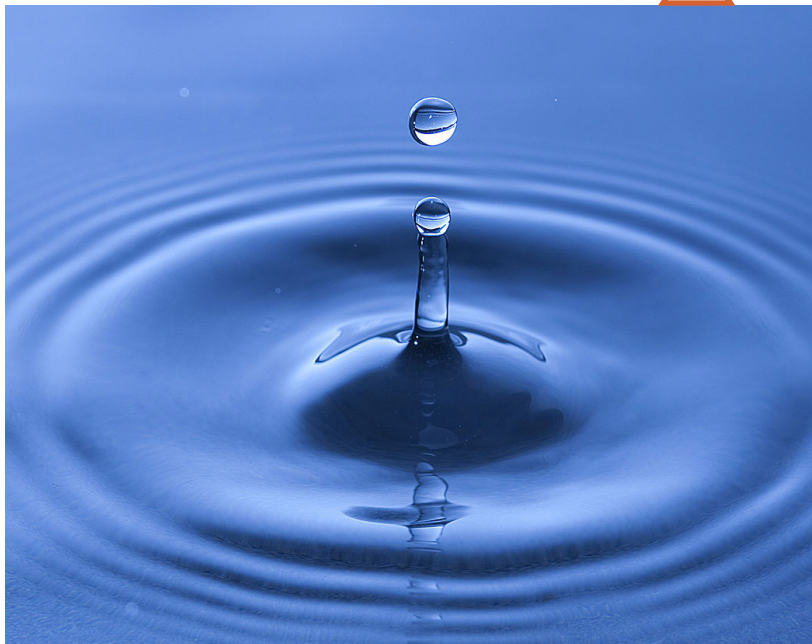
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# PERMITTING AND SAFETY

## Permitting and Safety

Permitting and safety are critical components of all hydrogen projects. Delay time in permitting can add significant costs to hydrogen projects.

### CONSIDERATIONS

Each part of a Hydrogen supply chain requires multiple permits from multiple federal and state agencies. For instance, interstate pipelines are regulated and permitted by the Pipeline and Hazardous Materials Safety Administration (PHMSA) and the Federal Energy Regulatory Commission (FERC).



# Permitting and Safety



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Permit by nicolas from Noun Project (CC BY 3.0).



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# Permitting and Safety



## PERMITTING AND SAFETY



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# END USE

## Forklifts

Forklifts are used at ports, warehouses, and distribution centers to move goods. Fuel cell forklifts operate using hydrogen instead of another fuel like gasoline. The fuel cell uses oxygen and hydrogen to produce water and electricity. The electricity powers the engine. Hydrogen forklifts can have a lower overall cost than comparable battery-powered equipment when averaged over the equipment lifetime.

### CONSIDERATIONS

Using hydrogen fuel cells in forklifts eliminates green house gas and other air pollutants produced by gasoline or diesel. This is better for the environment and for communities that live near industrial facilities. Their short refueling time and lack of emissions improve operations for workers. As with all technologies that use flammable fuels, there are risks of leaks and explosions.



Must be  
partnered with...

Fueling Station

# Forklifts



## END USE



Fuel Cell Forklift, Image Credit: Comyu, Creative Commons Attribution-Share Alike 4.0 International. Modified to remove logos.

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# PRODUCTION

## Wind Farm

Wind turbines generate electricity when wind turns the propeller-like blades, which spins a generator to create electricity. Wind turbine costs have fallen greatly over the last decade, down more than 40% since the peak in 2010.

### CONSIDERATIONS

Wind turbines do not release greenhouse gases or other air pollutants during use. This lack of emissions is good for human health and our environment. But wind turbines can cause noise pollution and disrupt habitats.



Must be  
partnered with...

Electrolyzer

Water

# Wind Farm



NEEDS  
PARTNER

## PRODUCTION



Wind turbine Lubbock, Texas, Image Credit: Matthew T Rader, MatthewTRader.com, License CC-BY-SA.

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## Ferries

Ferries are a necessary form of public transportation. Fuel cell ferries use hydrogen instead of diesel or gasoline. The fuel cell uses oxygen and hydrogen to produce water and electricity. The electricity powers the engine. Ferries can be retrofit with fuel cells for power which requires a relatively low cost for the greenhouse gas emissions saved.

### CONSIDERATIONS

Using hydrogen fuel cells in ferries eliminates the greenhouse gas emissions and air pollution caused by gas and diesel. This is better for the environment and for the disproportionately impacted communities of color that live near ports. As with all technologies that use flammable fuels, there are risk of leaks and explosions.



Must be  
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# Ferries



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A ferry boat in Puget Sound. Image credit: Regan Fernbrook, Creative Commons Attribution-Share Alike 4.0 International.

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## Passenger vehicles

Passenger vehicles are the main means of transportation by the majority of the population. Fuel cell passenger vehicles operate using hydrogen instead of gasoline. The fuel cell uses oxygen and hydrogen to produce water and electricity. The electricity powers the engine. Hydrogen passenger vehicles have comparable costs to electric vehicles.

### CONSIDERATIONS

Using hydrogen fuel cells in passenger vehicles eliminates air pollution caused by gas and diesel and they use fewer critical minerals compared to Electrical Vehicles. This is better for the environment and for the disproportionately impacted communities of color that live near highways. As with all technologies that use flammable fuels, there are risk of leaks and explosions.



Must be  
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Fueling Station

# Passenger vehicles



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Hydrogen fuel cell car. Image credit: Dr. Artur Braun (Arturbraun), CC BY-SA 4.0 DEED.

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Must be  
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## Steel production

Steel-making is a necessary part of the US infrastructure. Steel-making requires high heat and chemical processes that are currently met using natural gas which produces greenhouse gases. There is an increased cost with using hydrogen from the electricity required to generate the hydrogen but significant greenhouse gas reductions.

### CONSIDERATIONS

Decarbonizing steel production with hydrogen is important as steel is needed to make clean energy technologies. Using hydrogen to replace fossil fuels in steel production reduces greenhouse gas emissions and other harmful air pollutants. However, Nitrogen Oxides (NOx) may still be released. NOx can lead to respiratory illnesses. As with all technologies that use flammable fuels, there are risk of leaks and explosions.



# Steel production



## END USE



Tata Steel IJmuiden, the Netherlands. Image Credit: Joost J. Bakker, CC BY 2.0.



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# STORAGE

## Geologic Hydrogen Storage

Geologic hydrogen storage is used to store large volumes of hydrogen similar to natural gas long-term storage underground. While very location dependent, geologic hydrogen is the most economical given the large volume capacity.

### CONSIDERATIONS

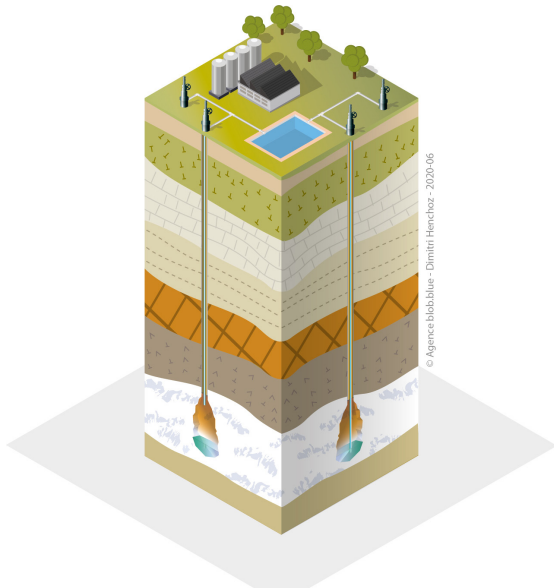
Like natural gas which is stored in geological formations, hydrogen is flammable creating the risk of leakage and explosions. Like natural gas, effective monitoring and release detection is vital to ensuring safe longer storage.



# Geologic Hydrogen Storage



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Graphic of a salt storage cavern. Image: PageGK, CC-BY 4.0.

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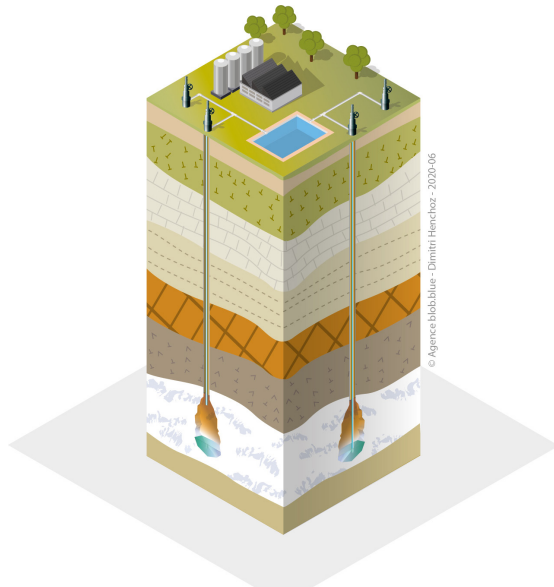
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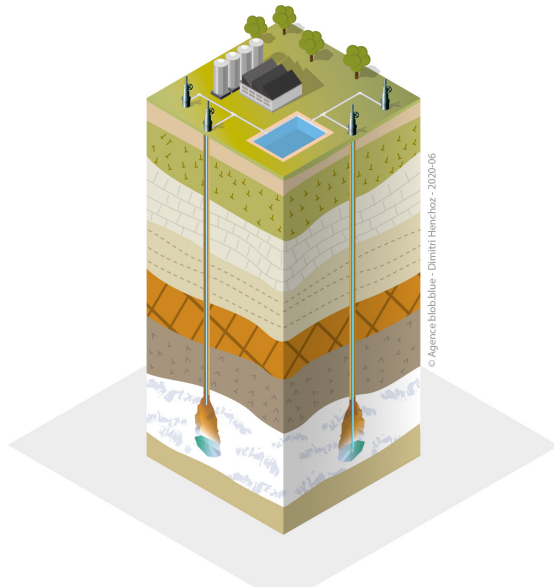
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## STORAGE

### Hydrogen Storage Tanks

Hydrogen can be stored in tanks of various sizes above ground. These tanks can be made of multiple materials often including carbon fiber as an overwrap which provides strength but contributes about 70% of the cost.

#### CONSIDERATIONS

As with all technologies that use flammable fuels, there are risk of leaks and explosions.



# Hydrogen Storage Tanks

2

0

1

## STORAGE



Liquid Hydrogen Tank at NASA's Kennedy Space Center. Image: Public Domain.

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# TRANSPORT

## Hydrogen Tube Trailers

Compressed gas tube trailers are used widely today to transport gases such as methane and oxygen. Tube trailers are used when a relatively small amount of hydrogen is needed, such as at a fueling station. Tube trailers add significant cost to hydrogen projects due to the cost supporting equipment such as compressors.

### CONSIDERATIONS

Tube trailers currently burn diesel which creates noise and air pollution such as particulate matter which contributes to asthma. As with all technologies that transport flammable fuels, there are risk of leaks and explosions.



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Type IV Hydrogen trailer. Image credit: Privateconfidential1970, CC BY-SA 4.0.



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# PRODUCTION

## Steam Methane Reforming

Steam methane reforming separates hydrogen from carbon in natural gas through a high temperature process. Steam methane reforming is currently the cheapest way to make hydrogen and accounts for 95% of commercially produced hydrogen in the United States.

### CONSIDERATIONS

Significant greenhouse gases are emitted from steam methane reforming along with harmful air pollutants, carbon monoxide and nitrogen oxides. If used with carbon capture and storage, greenhouse gas emissions are decreased.



Must be  
partnered with...

**Methane**

**Water**

Can be  
partnered with...

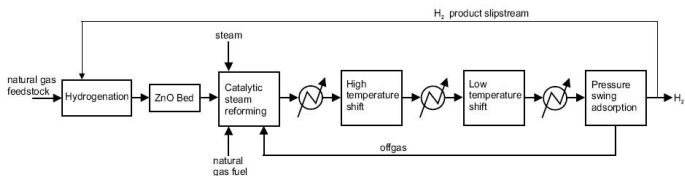
**Carbon  
Capture**

# Steam Methane Reforming

NEEDS  
PARTNER



## PRODUCTION



Steam Methane Reforming (SMR) process, flue gas includes carbon dioxide. Image Credit: Margaret K. Mann, Public Domain.

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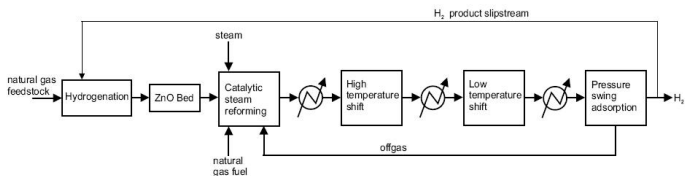
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# PRODUCTION

## Natural Gas

Required for the production of hydrogen through steam methane reforming. Natural Gas (methane) is a greenhouse gas. Leaking and flaring of natural gas contributes to climate change. Natural gas is relatively cheap due to hydraulic fracturing.

### CONSIDERATIONS

The majority of US natural gas is produced through hydraulic fracturing (fracking) which requires large quantities of chemicals and water. Living in close proximity to fracked wells increase risks of asthma, low birth weight and preterm babies as well as increased risks of childhood cancers. As with all technologies that transport flammable fuels, there are risk of leaks and explosions.



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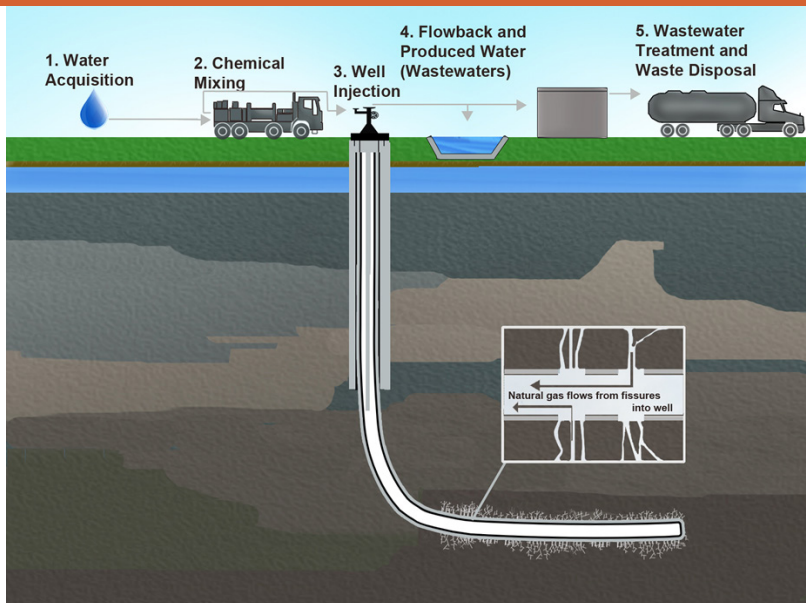


Illustration of hydraulic fracturing and related activities. Image credit: USEPA, Public Domain.

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NEEDS PARTNER

## PRODUCTION

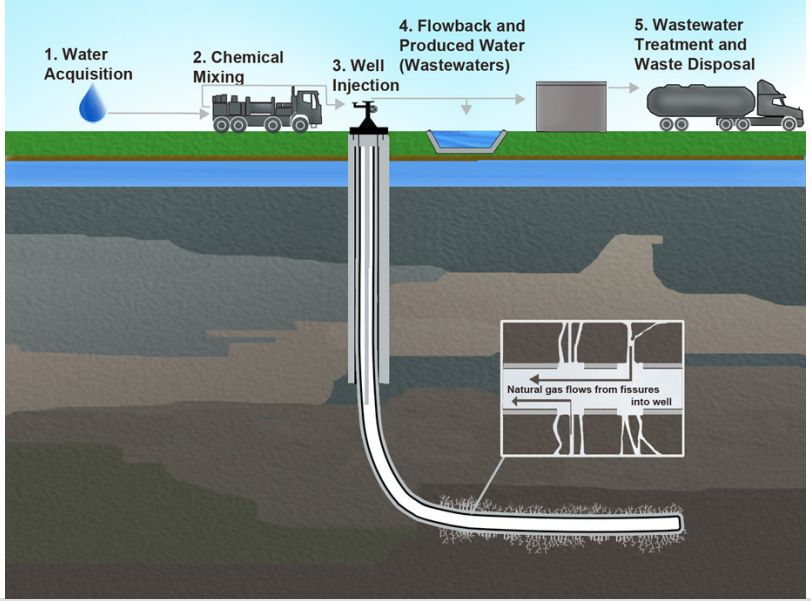


Illustration of hydraulic fracturing and related activities. Image credit: USEPA, Public Domain.

Must be partnered with...

**Steam Methane Reforming**

# PRODUCTION

## Natural Gas

Required for the production of hydrogen through steam methane reforming. Natural Gas (methane) is a greenhouse gas. Leaking and flaring of natural gas contributes to climate change. Natural gas is relatively cheap due to hydraulic fracturing.

### CONSIDERATIONS

The majority of US natural gas is produced through hydraulic fracturing (fracking) which requires large quantities of chemicals and water. Living in close proximity to fracked wells increase risks of asthma, low birth weight and preterm babies as well as increased risks of childhood cancers. As with all technologies that transport flammable fuels, there are risk of leaks and explosions.



Must be  
partnered with...

**Steam Methane Reforming**

# Natural Gas



NEEDS  
PARTNER

## PRODUCTION

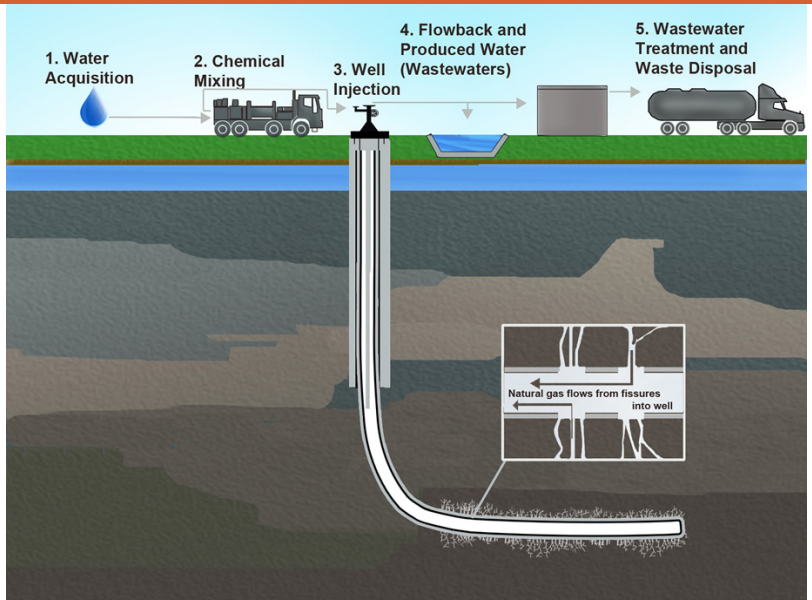


Illustration of hydraulic fracturing and related activities. Image credit: USEPA, Public Domain.

Must be  
partnered with...

**Steam Methane Reforming**

# PRODUCTION

## Solar Farm

Solar technologies convert sunlight into electrical energy either through photovoltaic (PV) panels or through mirrors that concentrate solar radiation. This energy can be used to generate electricity or be stored to be used later. Solar installation cost has fallen greatly as solar panel manufacturing has scaled up.

### CONSIDERATIONS

Solar panels do not release greenhouse gases and other air pollutants during use which is good for human health and our environment. However, they rely on critical minerals that require mining which cause environmental health harms. Critical mineral mining internationally can be poorly regulated leading to harmful labor practices. Solar farms need a significant amount of land.



Must be  
partnered with...

Electrolyzer

Water

# Solar Farm



NEEDS  
PARTNER

## PRODUCTION



Solar power station, Hawaii. Image credit: Reagan Moen. US DOE.

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NEEDS  
PARTNER

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Solar power station, Hawaii. Image credit: Reagan Moen. US DOE.

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partnered with...

Electrolyzer

Water

## END USE

### Fuel Cell Truck

Fuel cell trucks operate using hydrogen instead of another fuel source, such as diesel. The fuel cell uses hydrogen and oxygen to produce water and electricity. The electricity then powers the engine. Hydrogen requires similar fueling times as compared to diesel which is important for the trucking industry and shipping costs. The main costs of fuel cell trucks are operating at high power density and their precious metal content.

#### CONSIDERATIONS

Unlike gas or diesel, using hydrogen fuel cells in trucking does not release green house gases and air pollution. This is better for the environment and for the disproportionately impacted communities of color that live near highways. As with all technologies that transport flammable fuels, there are risk of leaks and explosions.



Must be  
partnered with...

Fueling Station

# Fuel Cell Truck



NEEDS  
PARTNER

## END USE



Hydrogen fuel cell truck. Image credit: JoachimKohler-HB, CC BY 4.0 DEED.

Must be  
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Fueling Station

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PARTNER

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Hydrogen fuel cell truck. Image credit: JoachimKohler-HB, CC BY 4.0 DEED.

Must be  
partnered with...

Fueling Station

## Carbon Capture and Storage

Carbon capture and storage (CCS) is a process that captures carbon dioxide emissions from sources like power plants or steam methane reformers and stores it so it will not enter the atmosphere and contribute to climate change. Carbon dioxide is stored by injecting it below the earth's surface. The main cost associated with CCS is electricity used to capture and compress carbon dioxide.

### CONSIDERATIONS

While carbon capture & storage can help reduce greenhouse gas pollution, it comes with risks including concentrated carbon dioxide pipelines and subsurface storage. If carbon dioxide leaks in high concentrations it can displace oxygen in the air creating risk to human and animal life.



Can be  
partnered with...

Steam Methane  
Reforming

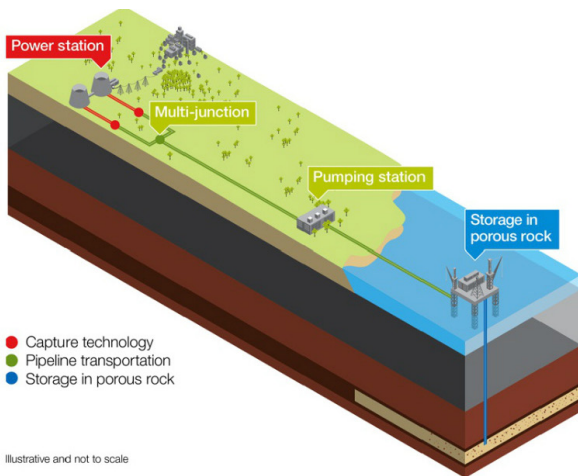
Biomass  
Gassification

Cement

# Carbon Capture and Storage



PARTNER  
CARD



Graphic from UK Department of Energy and Climate Change, CC BY-ND 2.0 DEED.

Can be  
partnered with...

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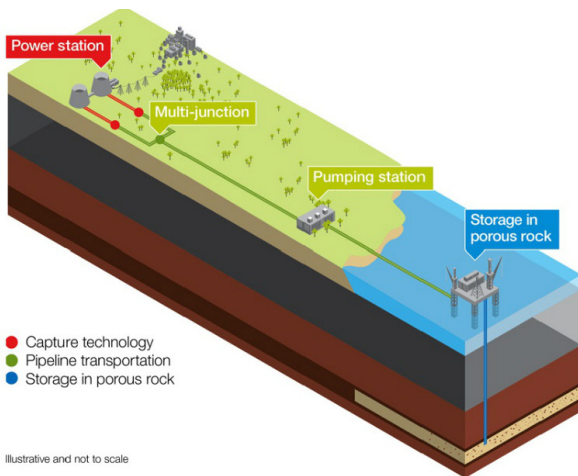
Biomass  
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PARTNER  
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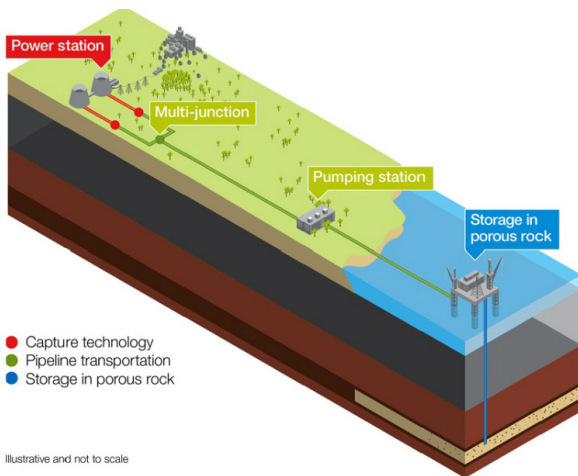
Biomass  
Gassification

Cement

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PARTNER  
CARD



Graphic from UK Department of Energy and Climate Change, CC BY-ND 2.0 DEED.

Can be  
partnered with...

Steam Methane  
Reforming

Biomass  
Gassification

Cement

# PRODUCTION

## Biomass Gasification

Process of converting waste materials such as biomass or food waste into hydrogen and other gases at high temperatures. This method is versatile and distributed and can be modified to match the waste materials present. This process can become carbon negative if carbon capture is used. The high costs of biomass gasification is largely due to the cost of biomass feedstocks.

### CONSIDERATIONS

Large waste burning facilities can increase local air pollution. As with all technologies that produce flammable fuels, there are risk of leaks and explosions.



Can be partnered with...

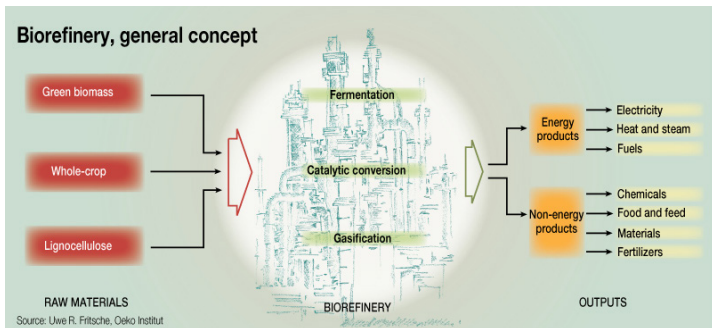
Carbon capture and storage

# Biomass Gasification



**CAN HAVE  
PARTNER**

## PRODUCTION



Graphic from [www.grida.no/resources/6193](http://www.grida.no/resources/6193), CC BY-NC-SA 2.0 DEED.

Can be  
partnered with...

**Carbon capture and storage**

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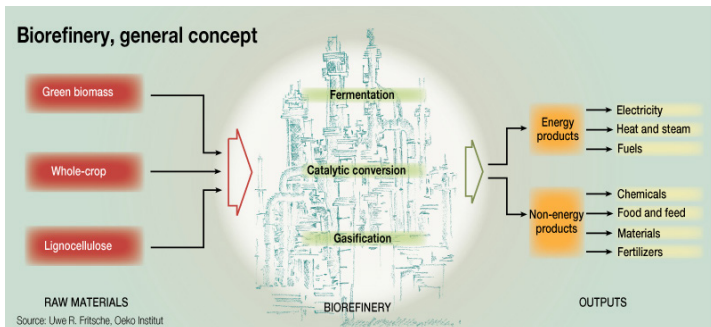
Carbon capture and storage

# Biomass Gasification



**CAN HAVE  
PARTNER**

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Graphic from [www.grida.no/resources/6193](http://www.grida.no/resources/6193), CC BY-NC-SA 2.0 DEED.

Can be  
partnered with...

**Carbon capture and storage**



## END USE

### Cement

Cement manufacturing requires high heats from fuels. Hydrogen can replace fossil fuels for heating. However, current chemical reactions for making cement emit greenhouse gases so to fully decarbonize cement production, greenhouse gases from those chemical reactions must also be captured. Making cement is fairly inexpensive as the process is well established.

#### CONSIDERATIONS

As cement is needed to deploy clean energy technologies, it is an important industry to decarbonize. Burning Hydrogen can reduce some air pollutants associated with fossil fuels. However, Nitrogen Oxides (NOx), air pollutants that can lead to respiratory illnesses, are still produced. As with all technologies that produce flammable fuels, there are risk of leaks and explosions.



Must be  
partnered with...

Carbon capture and storage

# Cement



## END USE



Cement manufacturing plant. Photo credit: Kobie Mercury-Clarke, CC BY 2.0 DEED.

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Carbon capture and storage

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## END USE



Cement manufacturing plant. Photo credit: Kobie Mercury-Clarke, CC BY 2.0 DEED.

Must be  
partnered with...

**Carbon capture and storage**

## Chemicals

Chemicals are one of the largest industrial greenhouse gas emitting sectors and are required to manufacture clean energy technologies including solar panels. Making chemicals requires high temperatures that can only be generated with fossil fuels or hydrogen. Making some chemicals such as ammonia also requires hydrogen. Many existing hydrogen pipelines are in chemical refineries. Making chemicals is fairly inexpensive due to the large scale of these well established processes.

### CONSIDERATIONS

Ammonia is a critical chemical used to make fertilizer that is used worldwide to grow food. Using Hydrogen instead of fossil fuels can reduce some air pollutants however Nitrogen Oxides, that can lead to respiratory illnesses, could still be emitted because of the high heats used to make chemicals. As with all uses of flammable fuels, there are risks of leaks and explosions.



# Chemicals



## END USE



Ethylene cracking facility, PA. Image Credit: Mark Dixon, public domain.

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# Chemicals



## END USE



Ethylene cracking facility, PA. Image Credit: Mark Dixon, public domain.



## Oil Refining

Refining operations to make gasoline and other products are the largest source of industrial greenhouse gases. Other chemical products made from refined fossil fuels are needed for clean energy technologies. This market is difficult to remove entirely and therefore requires abating greenhouse gas emissions with clean hydrogen. Refining is fairly inexpensive due to the large scale of this well established process.

### CONSIDERATIONS

The high heat needed in refining could be provided by hydrogen, reducing the Greenhouse Gas emissions from fossil fuels. Using Hydrogen can reduce some air pollutants however Nitrogen Oxides, that can lead to respiratory illnesses, could still be emitted. As with all technologies that produce flammable fuels, there are risk of leaks and explosions.



# Oil Refining



## END USE



Oil refinery, TX. Image Credit: Carol M Highsmith, CC0 1.0 DEED.

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# Oil Refining



## END USE



Oil refinery, TX. Image Credit: Carol M Highsmith, CC0 1.0 DEED.

# PRODUCTION

## Grid Electricity

### 100% FOSSIL ENERGY SOURCES

An electrical grid is an interconnected network for electricity delivery from producers to consumers. Electricity is produced at powerplants and then transmitted along power lines to homes, businesses, and industries. Electricity costs are well documented by the Energy Information Administration.

### CONSIDERATIONS

This grid electricity is sourced from coal, oil or natural gas. It releases significant greenhouse gases, and releases Nitrogen Oxide and other hazardous air pollutants during production. This process has a large human health impact.



Must be  
partnered with...

Electrolyzer

Water

# Grid Electricity 100% FOSSIL ENERGY SOURCES



## PRODUCTION



Image credit: USEPA, public domain.

Must be  
partnered with...

Electrolyzer

Water

# PRODUCTION

## Grid Electricity

**80% FOSSIL | 20% NUCLEAR SOURCES**

An electrical grid is an interconnected network for electricity delivery from producers to consumers. Electricity is produced at powerplants and then transmitted along power lines to homes, businesses, and industries. Electricity costs are well documented by the Energy Information Administration.

### CONSIDERATIONS

This grid electricity is sourced from coal, oil or natural gas and nuclear energy. It releases less greenhouse gases than a fully fossil fueled grid but is associated with additional environmental risks from nuclear energy production.



Must be  
partnered with...

Electrolyzer

Water

# Grid Electricity 80% FOSSIL | 20% NUCLEAR



NEEDS  
PARTNER

## PRODUCTION



Image credit: USEPA, public domain.

Must be  
partnered with...

Electrolyzer

Water



# PRODUCTION

## Grid Electricity

50% FOSSIL | 50% RENEWABLE

An electrical grid is an interconnected network for electricity delivery from producers to consumers. Electricity is produced at powerplants and then transmitted along power lines to homes, businesses, and industries. Electricity costs are well documented by the Energy Information Administration.

### CONSIDERATIONS

This grid electricity is sourced from fossil fuels and renewable resources, it produces less greenhouse gases and other harmful air pollutants than a fully fossil fuel grid. Renewables do rely on critical minerals that require mining which causes environmental health harms. Critical mineral mining internationally can be poorly regulated leading to harmful labor practices.



Must be  
partnered with...

Electrolyzer

Water

# Grid Electricity 50% FOSSIL | 50% RENEWABLE

NEEDS  
PARTNER



## PRODUCTION



Image credit: USEPA, public domain.

Must be  
partnered with...

Electrolyzer

Water

# PRODUCTION

## Nuclear Power

Nuclear plants are a method of producing energy that releases no greenhouse gases, and can produce energy at a predictable level continuously. The cost of nuclear power is well documented by the Energy Information Administration.

### CONSIDERATIONS

While reducing climate change risks, Nuclear plants create environmental and social risk for those living in proximity to nuclear plants from accidental releases or disasters. Water use is extremely intensive. Mining of minerals creates environmental and social risks and nuclear waste currently has no long term safe storage or remediation strategies.



Must be  
partnered with...

Electrolyzer

Water

# Nuclear Power



NEEDS  
PARTNER

## PRODUCTION



Nuclear power plant. Image credit: Hansueli Krapf, CC BY-SA 3.0.

Must be  
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Electrolyzer

Water

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PARTNER

## PRODUCTION



Nuclear power plant. Image credit: Hansueli Krapf, CC BY-SA 3.0.

Must be  
partnered with...

Electrolyzer

Water

# PRODUCTION

## Impure Water

All processes to make hydrogen require the use of water. Waste, brackish and salt water, can be used instead of fresh water but purifying water is difficult and costly with today's technologies, since most electrolysis technologies use ultra-purified water to avoid any contaminants within the system.

### CONSIDERATIONS

Water use is a particular concern in drought and agricultural regions or where water rights are contested. Using waste water would not compete with drinking water and reduce environmental and justice concerns.



Must be  
partnered with...

Electrolyzer

Steam Methane Reforming

## Impure Water



### PRODUCTION



Waste water discharge. Image credit: US Dept. of Agriculture, public domain.

Must be  
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**Steam Methane Reforming**



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Waste water discharge. Image credit: US Dept. of Agriculture, public domain.

Must be  
partnered with...

**Electrolyzer**

**Steam Methane Reforming**

# Fueling Station

Fueling stations are required to fuel vehicles of all types that use hydrogen, just like gasoline and diesel fueling stations. The main costs of hydrogen fueling stations are the purchase and operation of compression, cooling, and dispensing equipment.

### CONSIDERATIONS

Fueling stations are required to store hydrogen, which like gasoline and diesel are combustible. As with all technologies that handle flammable fuels, there are risk of leaks and explosions.



Can be  
partnered with...

Passenger  
Vehicle

Fuel Cell  
Truck

Ferries

Forklifts

# Fueling Station



PARTNER  
CARD



Hydrogen fueling station. Image credit: US Department of Energy, public domain.

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Can be  
partnered with...

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Vehicle

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Forklifts

## END USE

# Stationary Fuel Cell

Stationary fuel cells operate using hydrogen and oxygen to produce water and electricity. The electricity can then provide backup power to increase resiliency including on microgrids and at hospitals. Stationary fuel cells can replace diesel generators which burn diesel for power resulting in emissions, poorer air quality, and significant noise.

### CONSIDERATIONS

Stationary fuel cells require hydrogen, which like gasoline and diesel are combustible. As with all technologies that handle flammable fuels, there are risk of leaks and explosions. Replacing an existing diesel generator with a fuel cell increases resilience during storms or grid power outages and improves air quality.



# Stationary Fuel Cell



## END USE

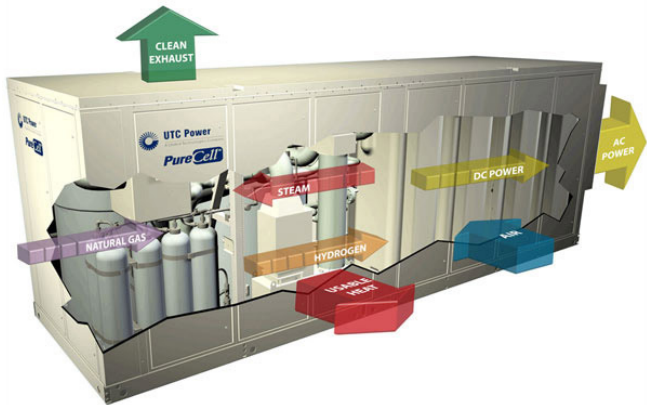


Image by: WillidaUTC, Creative Commons Attribution-ShareAlike 3.0 Unported.

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# Stationary Fuel Cell



## END USE



Image by: WillidaUTC, Creative Commons Attribution-ShareAlike 3.0 Unported.

# TRANSPORT

## Existing Pipeline Retrofit

Pipelines can be used to transport hydrogen similar to natural gas today. Existing oil and natural gas pipelines can be retrofitted to carry hydrogen. This is the cheapest way to transport hydrogen however not all pipelines can be retrofitted because hydrogen has different properties than fossil fuels and can damage pipelines leading to increased risks of leaks.

### CONSIDERATIONS

As pipelines are disproportionately in Disadvantaged Communities, while more cost effective retrofitting continues to burden existing communities. As with all technologies that use flammable fuels, there are risk of leaks and explosions. Hydrogen gas is lighter than air and disperses rapidly, a built-in safety advantage in an outside environment.



# Existing Pipeline Retrofit



## TRANSPORT



Alaskan oil pipeline, image by Gillfoto, CC-BY-SA-4.0.



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Alaskan oil pipeline, image by Gillfoto, CC-BY-SA-4.0.

## ABOUT THESE CARDS

# Harnessing Hydrogen Technology Cards

These Harnessing Hydrogen cards are for discussion purposes only. The scores and technical descriptions reflect current estimates of economics and technologies, which will change as the hydrogen economy evolves and we get closer to reaching the Department Of Energy Hydrogen Shot targets. The cards do not reflect Department Of Energy technical guidance.

For further information on Hydrogen Technologies from Department of Energy see: the Hydrogen Fuel Cell Technologies Office website: <https://www.energy.gov/eere/fuelcells/hydrogen-and-fuel-cell-technologies-office>

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