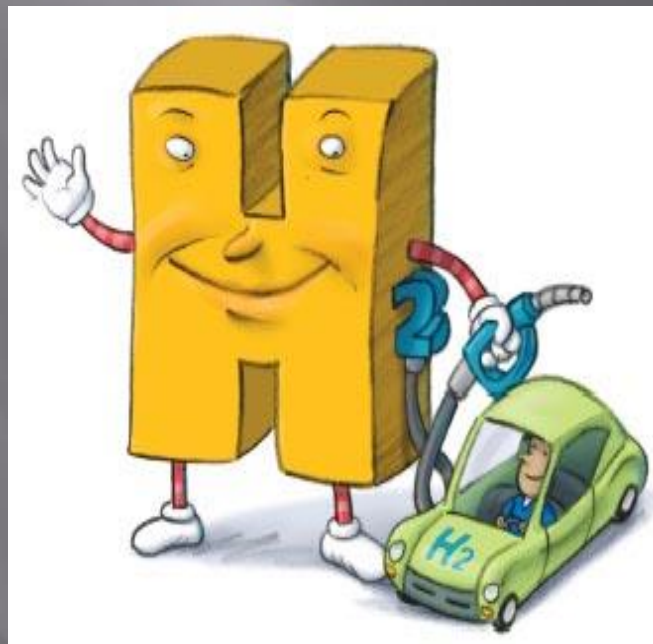


# Unit 3 Hydrogen Manufacture and Safety



# Aims

The aim of this unit is to:

- identify and understand hydrogen production processes
- identify and understand the natural gas reforming and electrolysis hydrogen production processes
- understand the emergency response requirements within the processes of hydrogen production
- be able to confirm relevant emergency response resources are in place prior to the start of hydrogen production

# How can you produce Hydrogen?

Currently the most dominant hydrogen production methods focus around **STEAM REFORMING** from hydrocarbons and **ELECTROLYSIS**.

In addition hydrogen can be produced from domestic feed stocks using a variety of process technologies.

Also Hydrogen containing compounds such as fossil fuels, biomass or even water can be a source of hydrogen.

# How can you produce Hydrogen?

## Natural Gas

Through a process called the steam reformation of natural gas you can produce hydrogen fuel.

Steam reformation is a process which involves using methane or other types of natural gases that react with

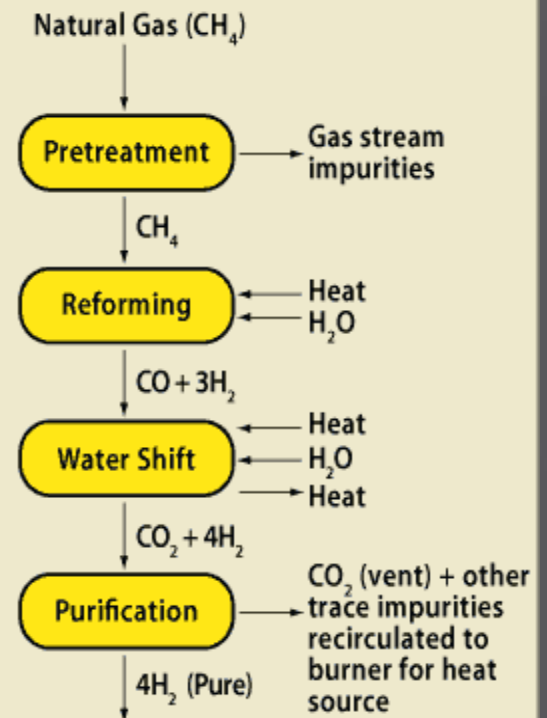
steam at temperatures between 700°C to 1100°C.

With this process, hydrogen can be derived from natural gases with about an 80% rate of efficiency.

Using other types of hydrocarbon matter will naturally result in varying degrees of efficiency.

The end result of this process is syngas.

### Steam Methane Reforming Block Flow Process



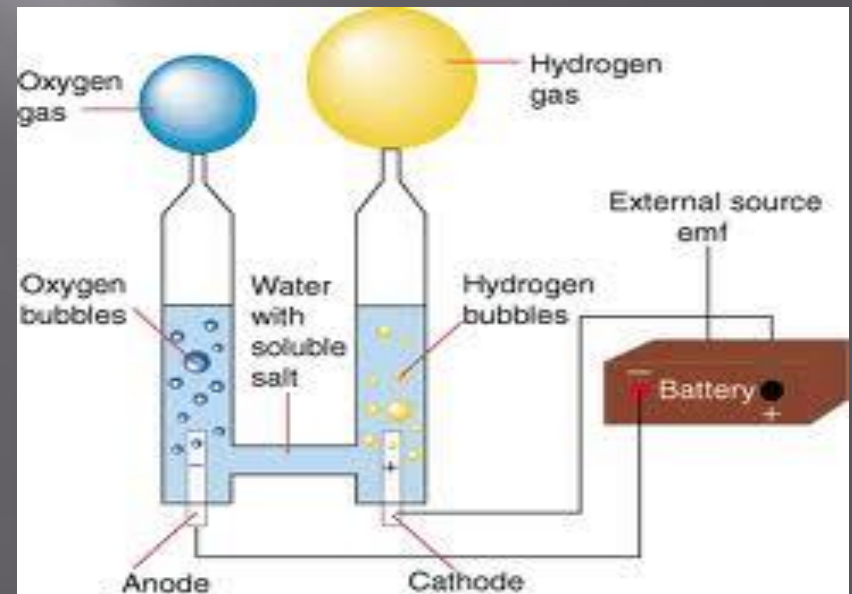
Source: Gas Technology Institute.

# How can you produce Hydrogen?

## Nuclear

Nuclear energy has also been widely used in the production of hydrogen fuel by way of water electrolysis. This process requires as much as 240,000 tons of raw uranium, which is enough to provide power for up to 2,000 power plants running at 600 megawatts. This is quite a costly production process.

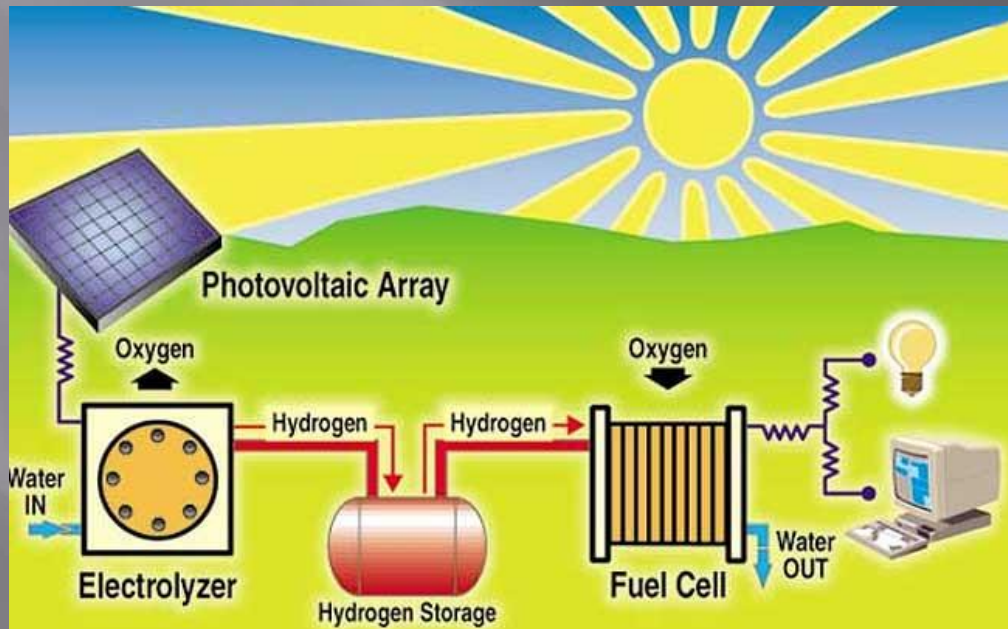
Water is used for the production of both Hydrogen and Oxygen via electrolysis, when an electric current is passed through it, making it decompose into its constituent components. Hydrogen appears at the cathode (-) and oxygen at the anode (+).



# How can you produce Hydrogen?

## Solar

Solar energy is another way to produce hydrogen fuel. The process used to produce this hydrogen fuel is through the electrolysis of water.

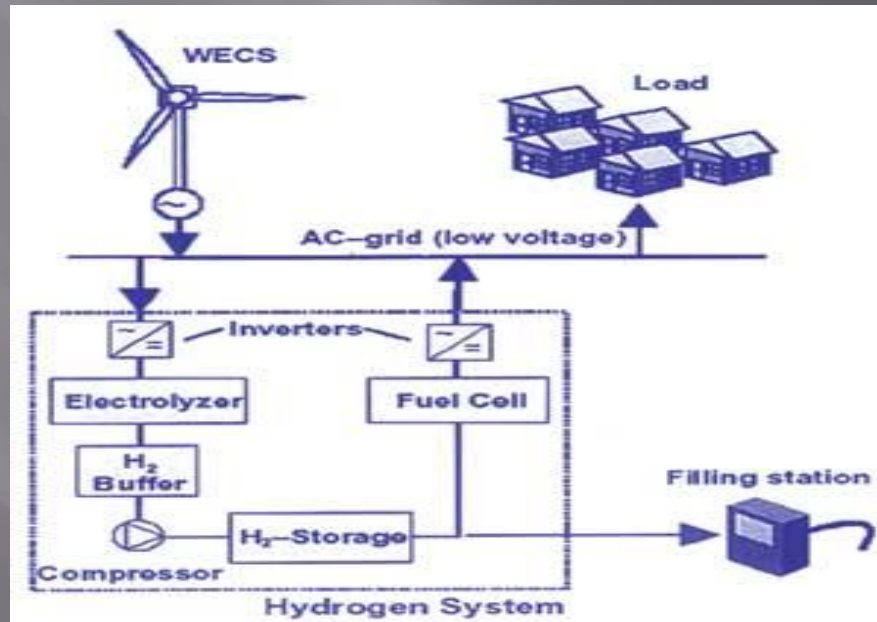




# How can you produce Hydrogen?

## Wind

Wind energy has come into increased prominence as a viable energy source over the past several years, and it too involves the electrolysis of water to produce the fuel.



# How can you produce Hydrogen?

## Biomass

Another process that can be used in the production of hydrogen fuel is to utilise biomass material. Again this process involves steam reformation to produce the energy source, hydrogen.

## Coal

Finally, coal is another viable substance that can be used to produce hydrogen fuel. The process involves the gasification of coal, which then produces hydrogen fuel via a steam reformation process.



Q&A

# Hydrogen Safety



With the increase in the manufacture of hydrogen and the subsequent demands of continuous environmental legislation there must be a matched increase in hydrogen safety awareness and training.

# Hydrogen Safety

Due to its chemical properties, hydrogen poses unique challenges.

Hydrogen gas is colourless, odourless, and not detectable by human senses. It is lighter than air and hence difficult to detect where accumulations cannot occur. Note is it detectable by infrared gas sensing technology.

Where a new hydrogen manufacturing facility is being embedded there is a need for the deployment of adequate safeguards and controls to counteract the possible effects of potential hydrogen leaks, fire and explosions.

# Hydrogen Storage



# Storage

Hydrogen and oxygen can be stored as a pressurised gas or cryogenically as a cooled liquefied gas. Hydrogen can also be stored in a chemical compound as a hydride.

The difficulty is that the hydrogen atom is so small that it can permeate almost anything which is trying to contain it.

It has good energy density by weight but poor energy density by volume, especially compared to hydrocarbons such as petrol.

# Causes of Mishaps

Statistics show that only 16% of accidents involving hydrogen happen when used or stored as a gas.

Most of those are due to equipment failure or incompatibility leading to leakage only, rarely fire or explosion.

The greatest number of accidents occur during manufacture, transportation and accidental production of hydrogen during other reactions or processes.



# Hydrogen Incident (FIRE)



On arriving at a hydrogen incident which involves a hydrogen trailer it is imperative that there is an immediate exclusion zone established.

For the first responder it is imperative that the trailer and containers are cooled with large quantities of water.

# Hydrogen Incident (LEAK)



On arriving at a hydrogen incident which involves a suspected or potential leak of hydrogen it is imperative that the hydrogen source is turned off and the building ventilated.

# Hydrogen Incident (BURN)



On immediate contact with cold or liquid hydrogen the casualty should place his hand under tepid water and leave it there until medical assistance arrives on the scene.

# Emergency response plans

People handling hydrogen systems should be familiar with the basic chemical, physical and hazardous properties of hydrogen.

They should be also aware of human capabilities and limitations.

They must recognise the ignition sources, ignition prevention, materials to be used in a hydrogen system.

The hydrogen system designers should be trained in the accepted standards and codes.

# That's it! Well done.

Once you have successfully completed the Unit 3 test you are ready to move onto Unit 4 Hydrogen Distribution and Safety.

If you would like to learn more about Unit 3 Hydrogen Manufacture and Safety, please ask.

In the mean time, thank you for your attention.

# Next step

Well done with the test everyone.

Your next unit of study is Unit 4 Hydrogen Distribution and Safety .

Thank you for your attention.