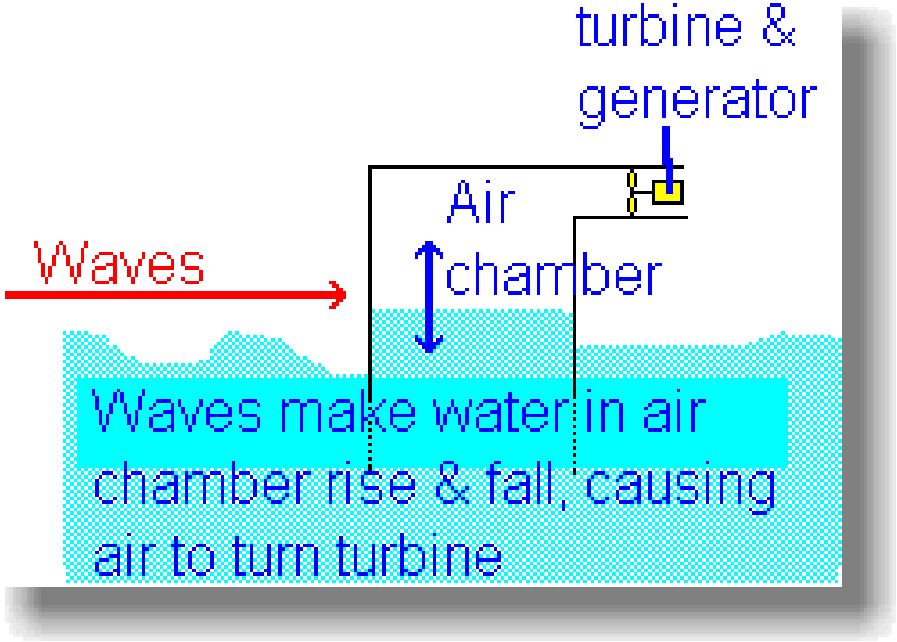
Wave Power Stations

At a wave power station, the waves arriving cause the water in the chamber to rise and fall, which means that air is forced in and out of the hole in the top of the chamber.



Floating tube **Pelamis**

This long, hinged tube (about the size of 5 railway carriages) bobs up and down in the waves, as the hinges bend they pump hydraulic fluid which drives generators.

http://www.youtube.com/watch?v=slawyq4PXxE

Ocean Energy - Wave Power Station

https://www.youtube.com/watch?v=gcStpg3i5V8

Pelamis Prototype (Off Scottish Orkney Islands – 2004)

- Pelamis is a kind of “sea snake” made of movable, coupled segments.
- Normal sea conditions, with moderate vertical oscillation, cause segments of Pelamis to perform a horizontal evasive motion, like a sea snake swimming.
- Hydraulic assemblies convert this motion into usable energy.

Power: 750 kW

Length: 120 m with 3 segments of 3.5 m dia

Onshore OWP Systems

- Built along shorelines, onshore wave power systems extract the energy in breaking waves.
- Onshore system technologies include the following:

Oscillating water column

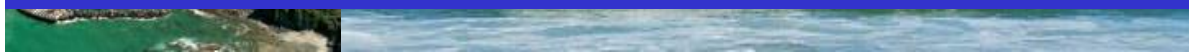
Tapchan

Pendulor device

Oscillating Water Column Onshore OWP Systems

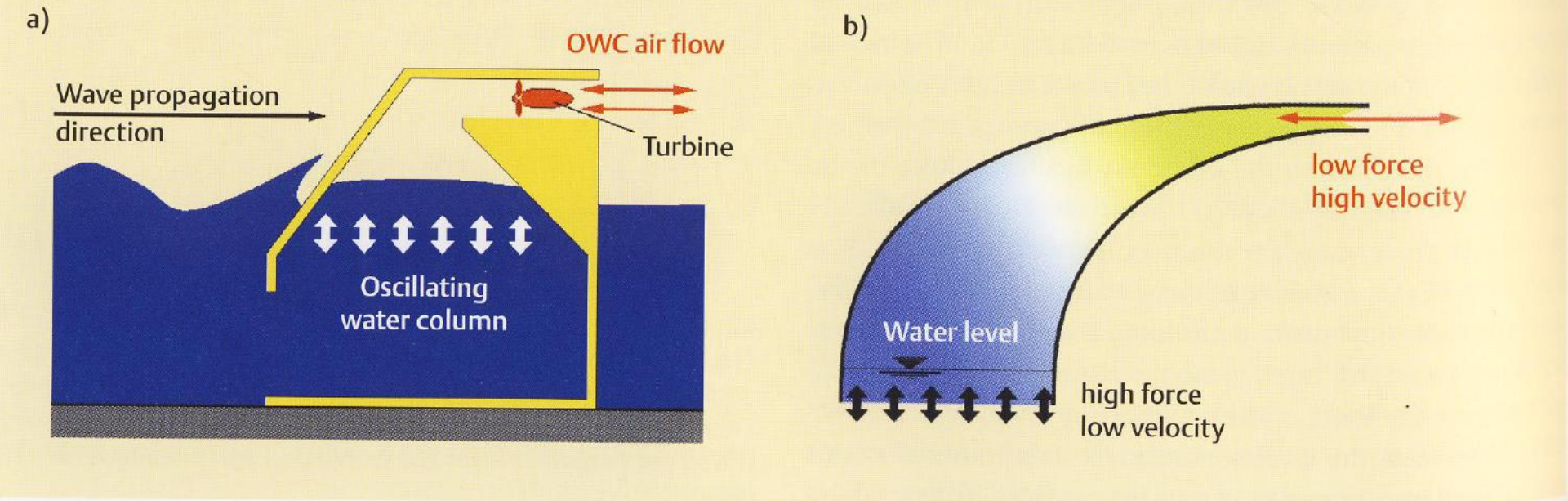
- The oscillating water column consists of a partially submerged concrete or steel structure that has an opening to the sea below the waterline.
- It encloses a column of air above a column of water. As waves enter the air column, they cause the water column to rise and fall.
- This alternately compresses and depressurizes the air column.
- As the wave retreats, the air is drawn back through the turbine as a result of the reduced air pressure on the ocean side of the turbine.

http://www.youtube.com/watch?v=3y89ikQQiHY



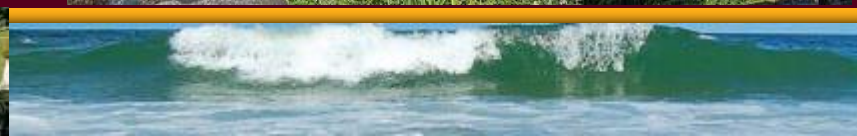
OWC Principle

- The power plant converts the oscillating motion of water column into electrical energy.
- It acts like a step-up gear unit. It is a motion conversion device. The essential aspect is that the low specific mass of the air permits a high acceleration



Ocean Energy from OWC

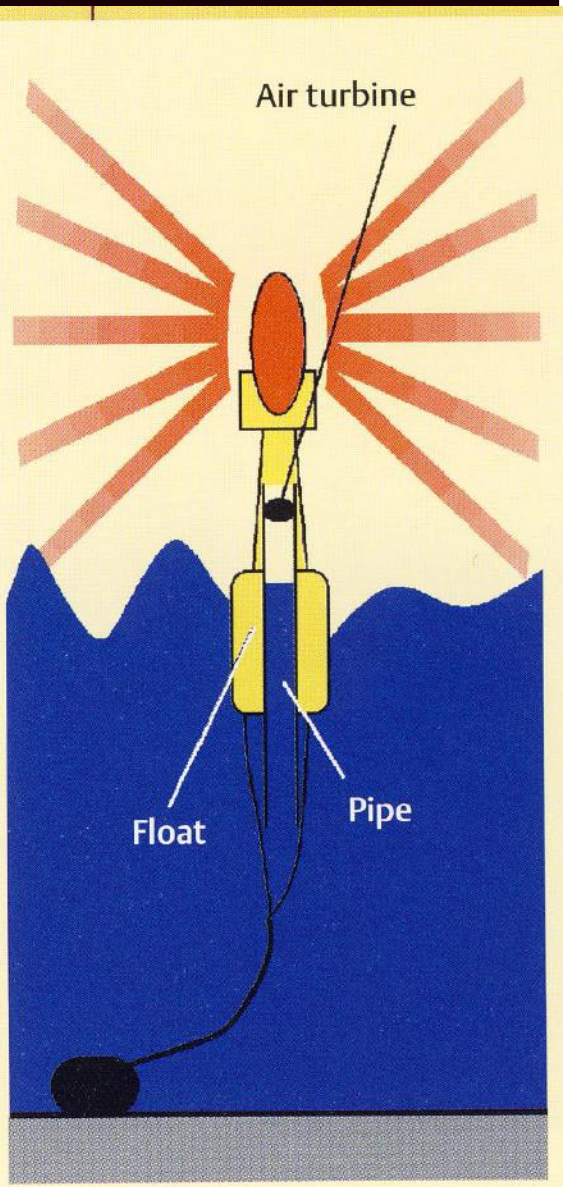
- This plant is based on the oscillating water column (OWC) principle.
- The wave energy plant at Vizhinjam has shown that a random and diffused form of energy can be converted into electrical energy that can be used to power up a Reverse Osmosis based desalination plant of capacity 10000 liters/day



500 kW Wave Power Plant (Scottish Island of Islay, 2001)

An OWC Buoy

- OWC buoys are for the most part designed as beacon buoys, with their own autonomous energy supplies.
- In an OWC buoy, a vertical pipe assumes the function of the chamber.
- It reaches down into the calmer water layers below the buoy.
- Therefore, the water column in the pipe is at rest relative to the waves outside – but it moves relative to the buoy, since the latter is raised and lowered by the wave motion.
- Like standard OWC, the buoys employ an air turbine.



Tapchan Onshore OWP Systems

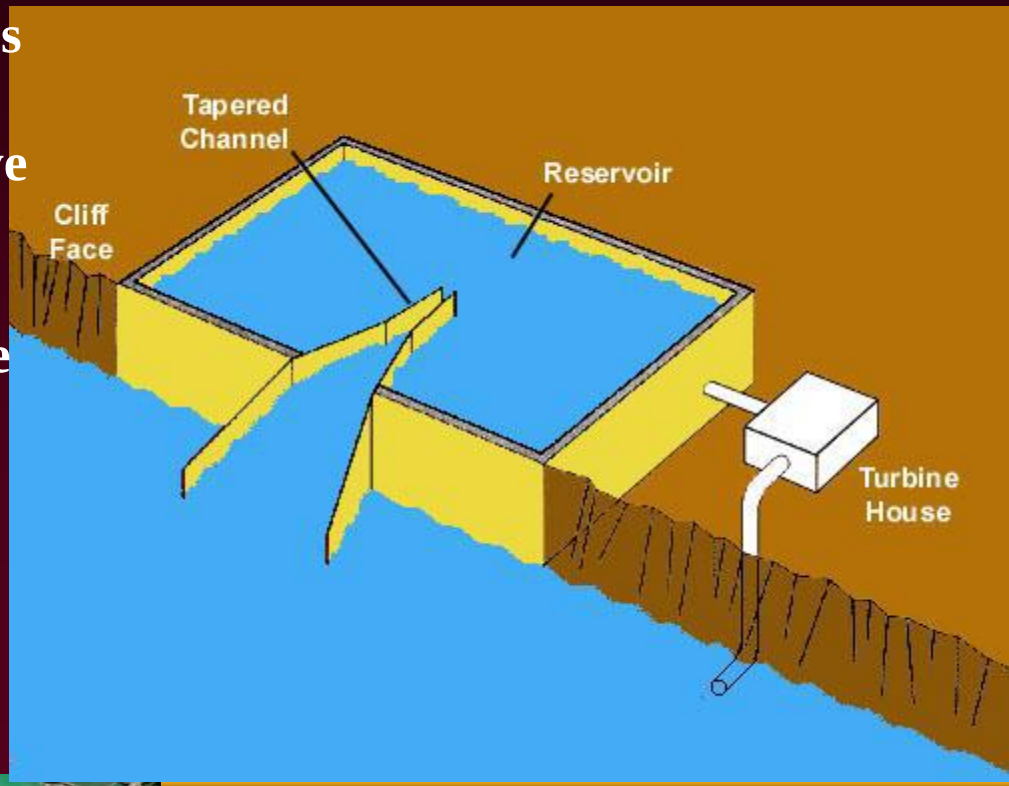
- The Tapchan, or tapered channel system, consists of a tapered channel, which feeds into a reservoir constructed on cliffs above sea level.
- The narrowing of the channel causes the waves to increase in height as they move toward the cliff face.
- The waves spill over the walls of the channel into the reservoir and the stored water is then fed through a turbine.

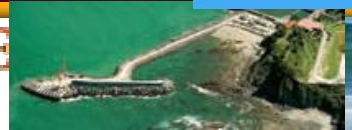
TAPCHAN

- The narrowing of the channel causes the waves to increase their amplitude (wave height) as they move towards the cliff face.

Eventually the waves spill over the walls of the channel and into the reservoir, which is positioned several meters above mean sea level.

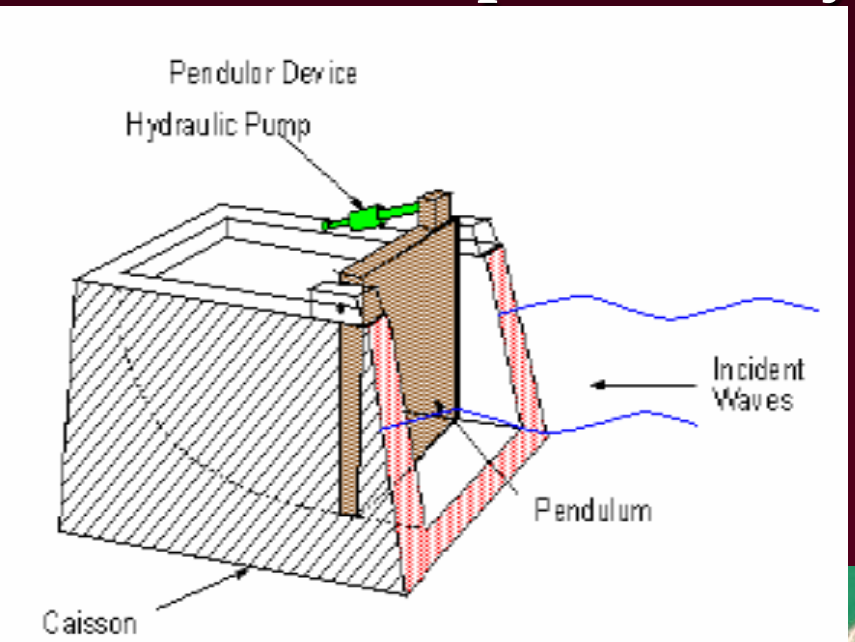
The kinetic energy of the moving wave is converted into potential energy as the water is stored in the reservoir. The generation of electricity is then similar to a hydroelectric power plant. The stored water is then fed through a Kaplan turbine.





Pendulor Device
Onshore OWP Systems

- The pendulor wave-power device consists of a rectangular box, which is open to the sea at one end.
- A flap is hinged over the opening and the action of the waves causes the flap to swing back and forth.
- The motion powers a hydraulic pump and a generator.



Environmental and Economic Challenges of OWP

- In general, careful site selection is the key to keeping the environmental impacts of wave power systems to a minimum or to preserve scenic shorefronts.
- Economically, wave power systems have a hard time competing with traditional power sources.
- However, the costs to produce wave energy are coming down.
- Some European experts predict that wave power devices will find lucrative niche markets.
- Once built, they have low operation and maintenance costs because the fuel they use - seawater - is free.

Archimedes Waveswing (1.5 MW, off Portugal coast, 2004)

- The Archimedes waveswing consists of submerged cylinders which float in the water.
- The outer cylinder (green) moves up and down relative to the central one.
- To generate power, linear generators (grey) utilize this motion – reversing the principle from that of a magnetic levitation railway.

ASU ARIZONA STATE UNIVERSITY

Fuel Cell

- Considered a curiosity in the 1800’s.
- The first fuel cell was built in 1839 by Sir William Grove, a lawyer and gentleman scientist.
- Serious interest in the fuel cell as a practical generator did not begin until the 1960's, when the U.S. space program chose fuel cells over riskier nuclear power and more expensive solar energy.
- Fuel cells furnished power for the Gemini and Apollo spacecraft, and still provide electricity and water for the space shuttle.

Hydrogen

The Only Truly Clean Chemical Fuel

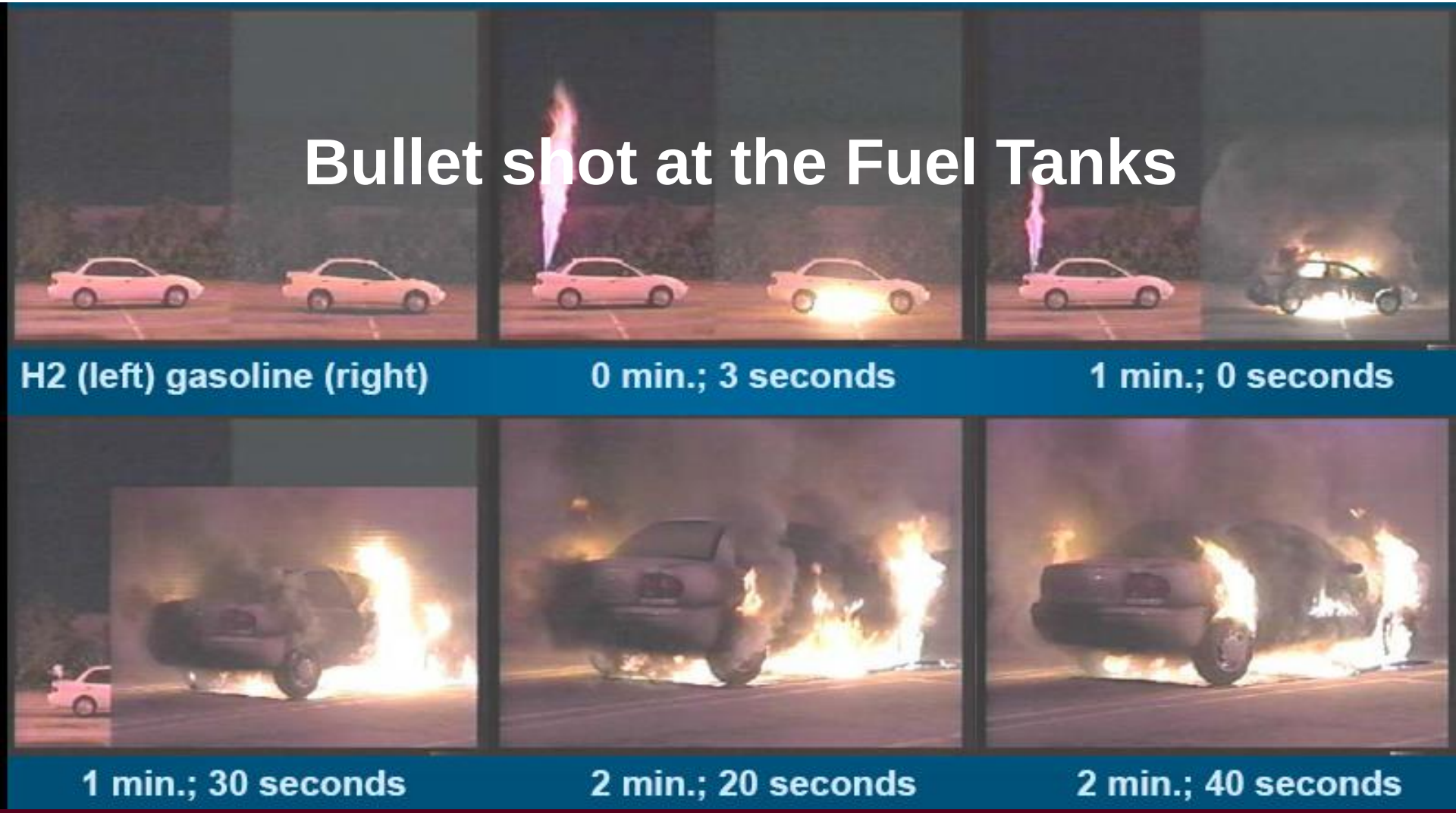
Hydrogen

- Hydrogen (Greek: water former) is an odorless, tasteless, colorless and very reactive element in group 1 of the periodic table.
- It is the most abundant element of the universe but is hardly found alone

Hydrogen: Advantages

- Hydrogen has a high energetic value, it is more fuel efficient than fossil fuels.
- It produces water during combustion.
- It is not toxic and does not contribute to the Greenhouse Effect, ozone depletion or acid rain.
- It can be used as an energy storage (instead of batteries or flywheels for example).
- It produces great heat.
- It is more expensive to move electrical energy across the continent than an equal amount of hydrogen as a compressed gas by pipeline.
- H2, When combined with Oxygen, produces 9 times the amount in clean, potable water.

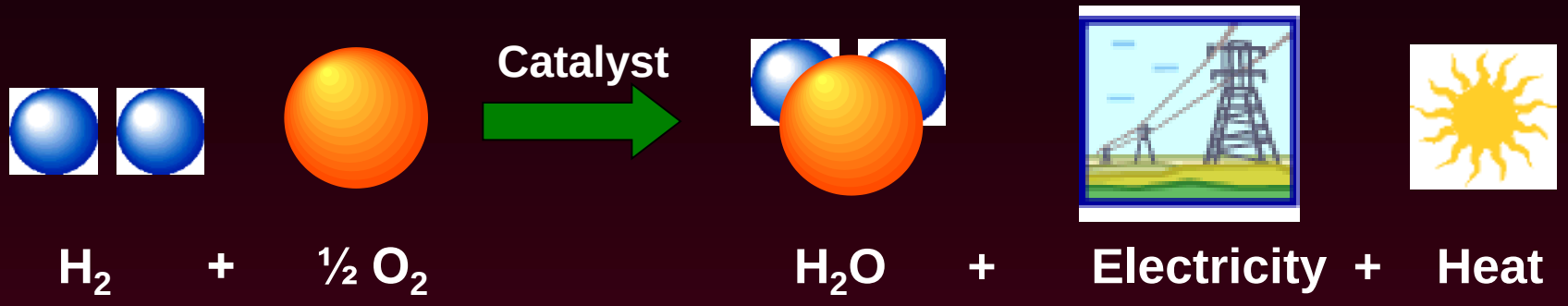
Safety of H_2 in vehicles



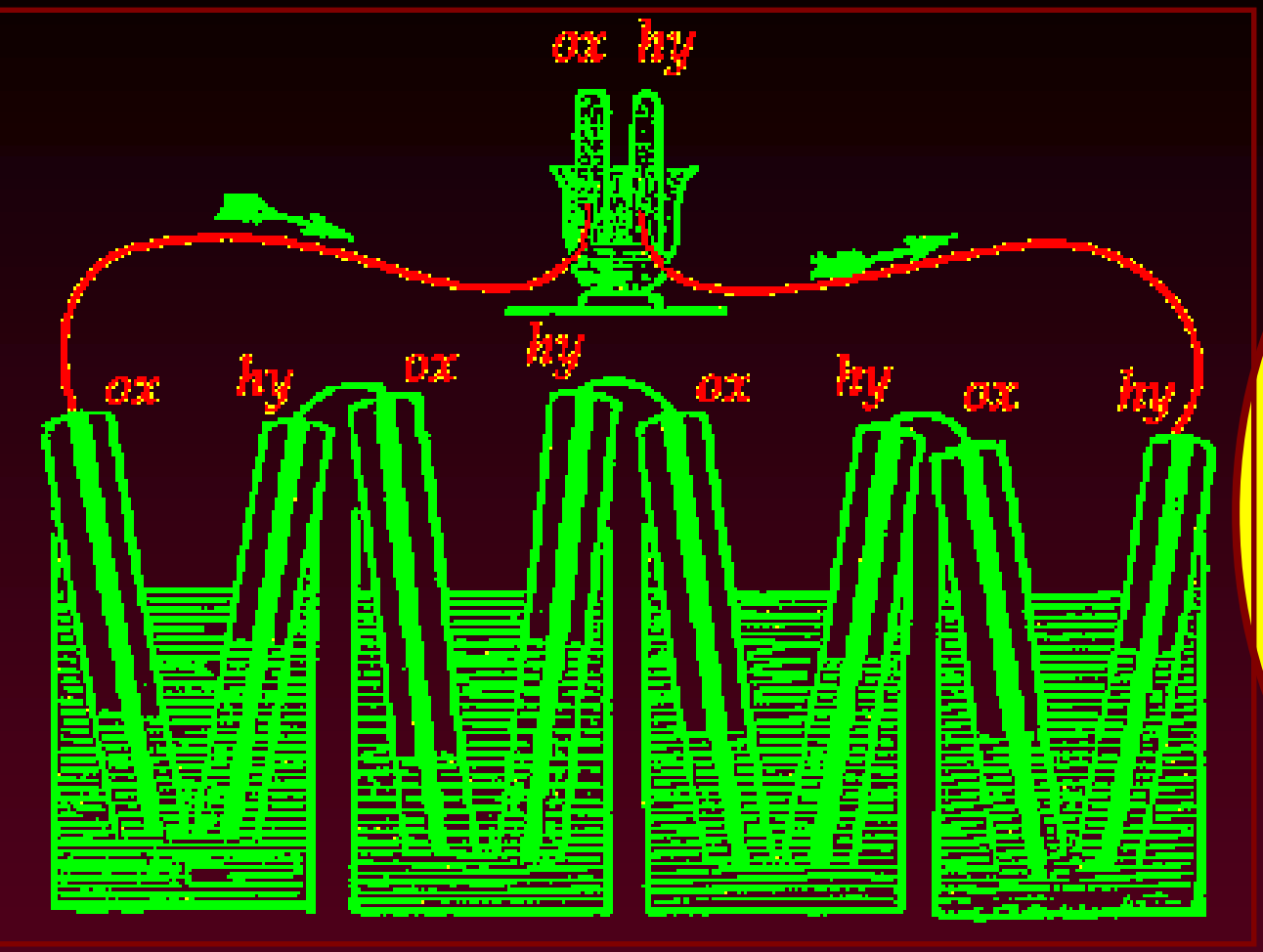
Hydrogen: Disadvantages

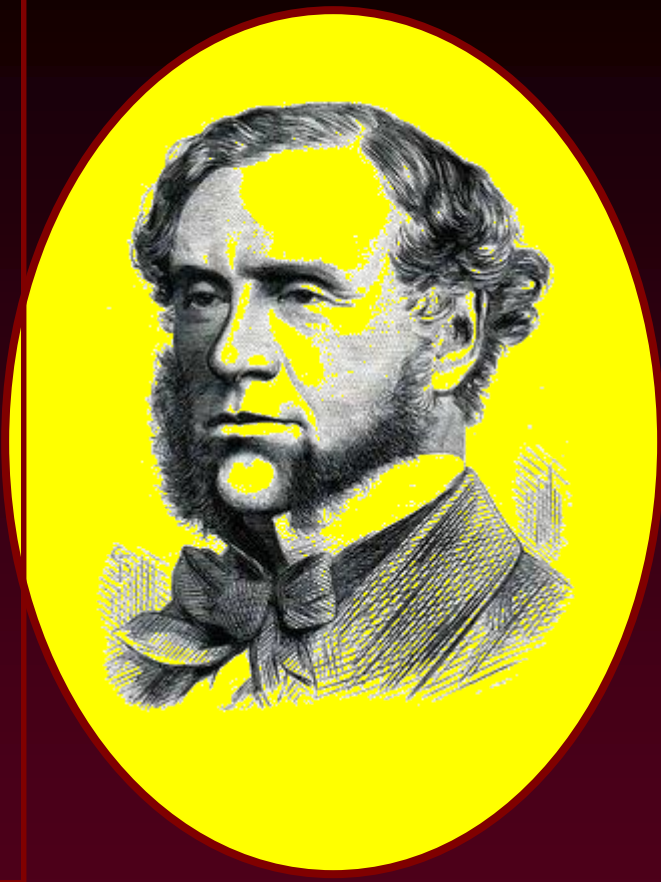
- It seldom comes alone.
- It can't be used as a primary energy source.
- More energy is used to produce Hydrogen than what is get from combustion or fuel cells.
- It is very flammable and volatile

What is a Fuel Cell?



- Fuel cells combine hydrogen and oxygen electrochemically to produce electricity
- The only by-products are water and useful heat





- In 1839, Sir William Grove (Father of FCs), a British Scientist first discovered the principle of fuel cells
- Only after about 100 years, Francis Bacon fabricated a 5 kW Fuel cell stack