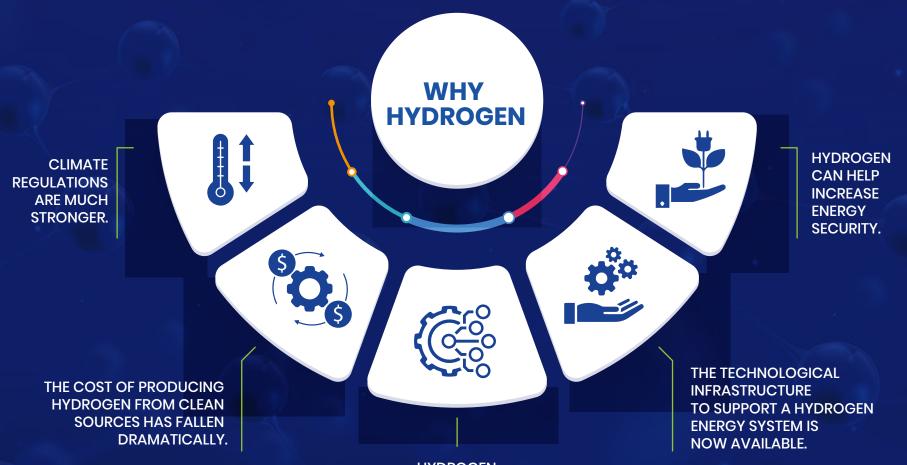




EES VENTURES (P) LTD AHMEDABAD GUJARAT







HYDROGEN
TECHNOLOGIES
HAVE IMPROVED IN
COST AND PERFORMANCE.

HYDROGEN SPECIFIC ENERGY AND ENERGY DENSITY COMPARISON OF COMMONLY USED FUELS



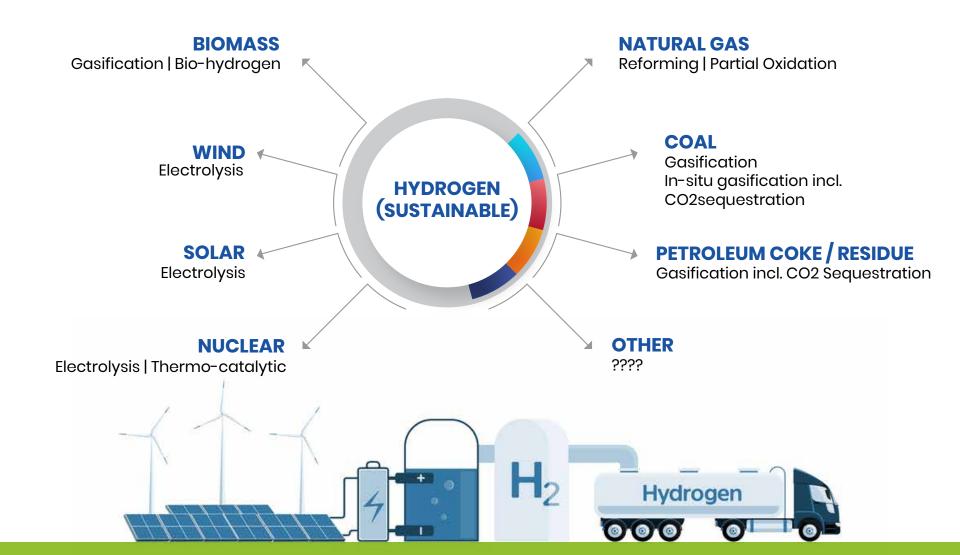
FUEL	SPECIFIC ENERGY (MJ/KG) (1KWH = 3.6 MJ)	ENERGY DENSITY (MJ/L)
HYDROGEN	142.0	0.01 (1 ATM); 7.10 (1,000 BAR); 10.00 (LIQUID)
METHANOL	20.0	15.90
AMMONIA	22.5	15.60
GASOLINE	47.1	35.00
DIESEL	42.8	40.40
HEAVY FUEL OIL	42.4	40.70
BIODIESEL	42.2	33.00
NATURAL GAS	50.0	0.04
LNG	50.0	22.20

Source: World Bank compilation of higher heating values obtained from multiple sources.

Note: atm = atmospheres; kg = Kilogram; kWh = kilowatt-hour; L = liter; LNG = Liquefied natural gas; MJ = Megajoule.

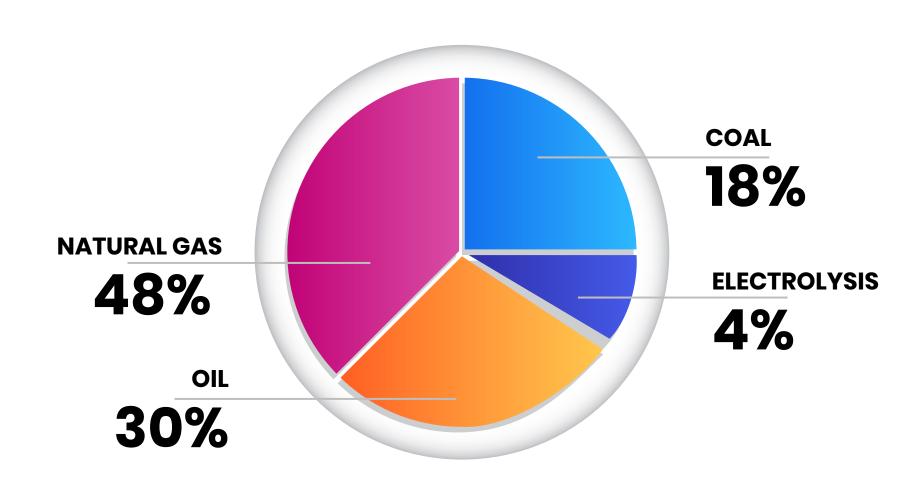
HYDROGEN PRODUCTION





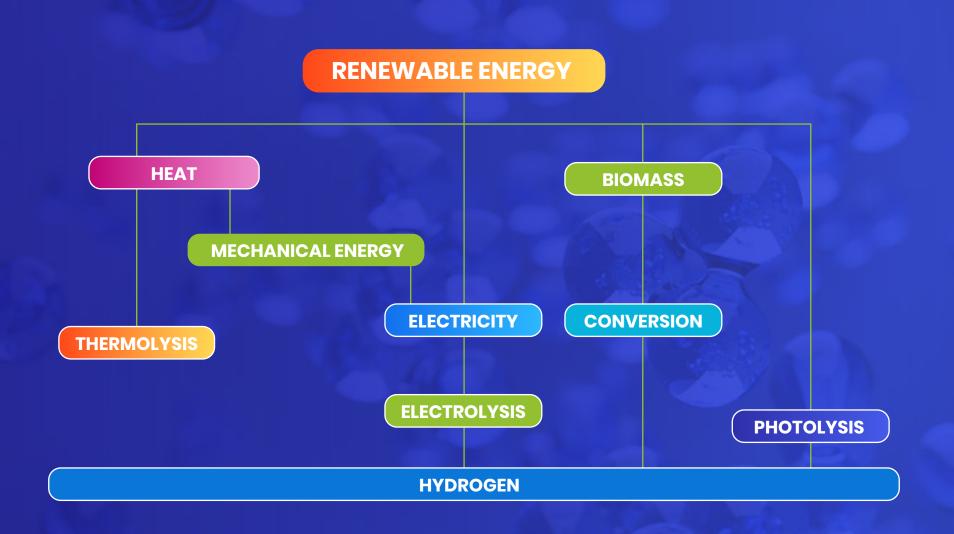
FEEDSTOCKS USAGE IN HYDROGEN PRODUCTION





SUSTAINABLE PATHS TO HYDROGEN







HYDROGEN PRODUCTION METHODS

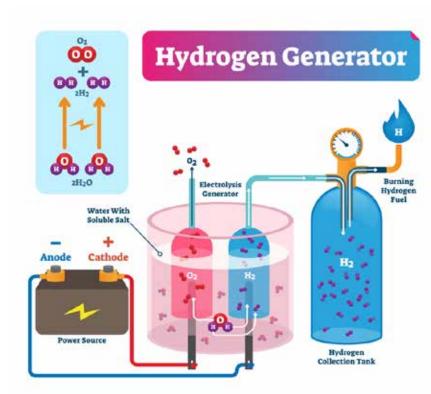
Most methods of producing hydrogen involve splitting water (H2O) into its component parts of hydrogen (H2) and oxygen (O).

The most common method involves steam reforming of methane (from natural gas), although there are several other methods.

PROCESS TO GENERATION HYDROGEN



- Steam reforming converts methane (and other hydrocarbons in natural gas) into hydrogen and carbon monoxide by reaction with steam over a nickel catalyst
- Electrolysis uses electrical current to split water into hydrogen at the cathode (+) and oxygen at the anode (-)
- Steam electrolysis (a variation on conventional electrolysis) uses heat, instead of electricity, to provide some of the energy needed to split water, making the process more energy efficient
- Thermochemical water splitting uses chemicals and heat in multiple steps to split water into its component parts
- Photoelectrochemical systems use semi-conducting materials (like photovoltaics) to split water using only sunlight
- Photobiological systems use microorganisms to split water using sunlight Biological systems use
- microbes to break down a variety of biomass feed stocks into hydrogen
- Thermal water splitting uses a very high temperature (approximately 1000°C) to split water
- Gasification uses heat to break down biomass or coal into a gas from which pure hydrogen can be generated.

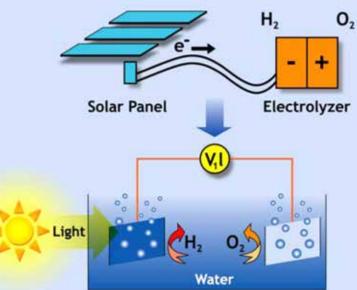


H, PRODUCTION: PHOTO ELECTRO CHEMICAL



- Combines a photovoltaic system (light harvesting)
 and an electrolyzer (water splitting) into a single
 monolithic device.
- Electrolysis area approximates that of the solar cell the current density is reduced.
- Balance of system costs reduced.
- Capital cost of electrolyzer eliminated
- Semiconductor processing reduced.
- Efficiency 30% higher than separated system.

Goal of the Research



A Monolithic Photoelectrochemical Cell





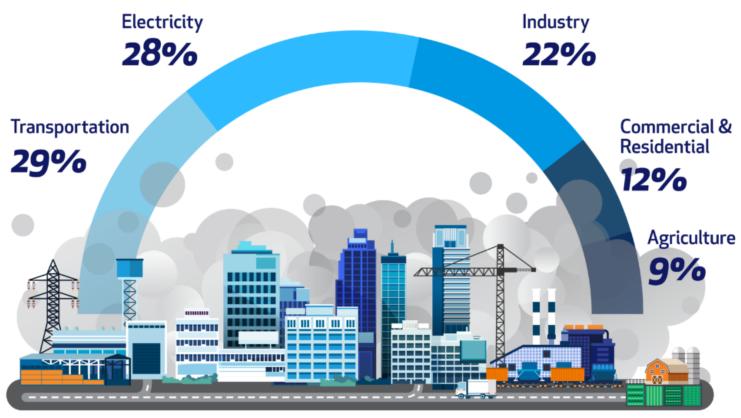
ORGANIC / BIO WASTE

APPLICATION IN INDUSTRY



The United States's greenhouse gas output by sector breaks down as so:

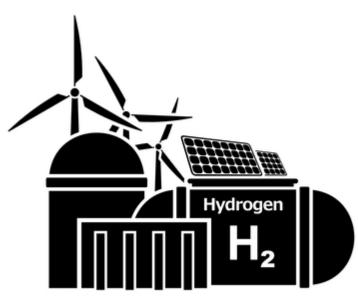
Share of emissions by economic sector for 2017 (%)



SOURCE: United States Environment Protection Agency

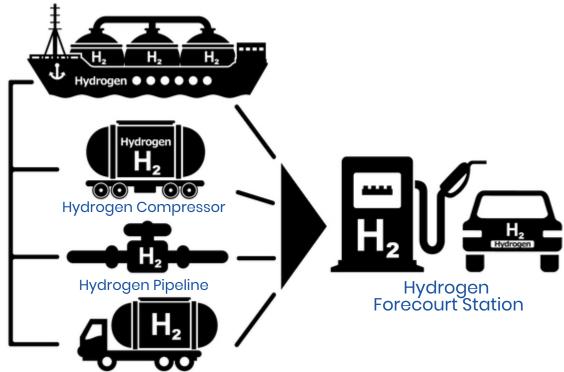
HYDROGEN DELIVERY SECTION





Central Wind Electrolysis Hydrogen

Hydrogen through Shipment



Truck Delivery of Compressed Hydrogen

ELECTROLYZERS HYDROGEN ELECTOLYSIS





AIR COMPRESSOR AND BOS SYSTEM





Thank You





