

BIODIESEL VS CNG VS FUEL CELL

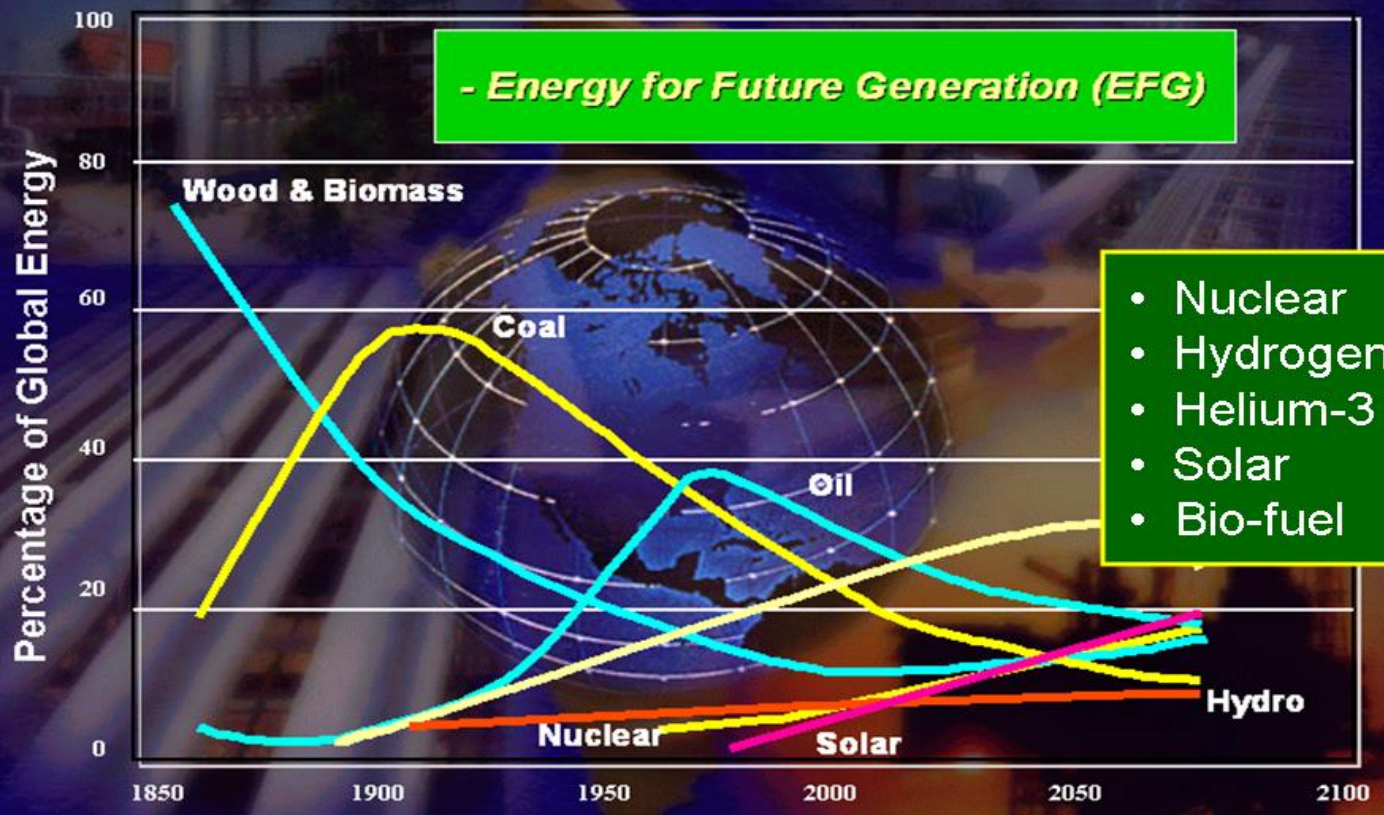
Organisation of Presentation

1. Introduction.
2. Bio Diesel.
3. Manufacturing Method.
4. CNG & Use.
5. Fuel Cell & Use.
6. Comparision Between Alternative Fuels.
7. Conclusion.

INTRODUCTION

- Energy comes in a variety of renewable forms; wood, biomass, wind, sunlight. It also comes in the non-renewable form of fossil fuels - oil and coal and their use is a major source of pollution of land, sea and above all the air we breathe. Two centuries of unprecedented industrialization, driven mainly by the fossil fuels, have changed the face of this planet. The present civilization cannot survive without motor cars and electricity. The increasing rate at which changes in human lives are occurring has important consequences for the environment and carrying capacity of the earth. The industrial revolution has brought greatly increased wealth to one quarter of the population and also severe inequality. Pollution and accelerating energy consumption have already affected equilibrium of the earth's landmasses, oceans and atmosphere. Particularly, important is the loss of bio diversity. Fortunately, the last 25 years has seen growing awareness of some of these consequences.
- Since the dawn of the Oil Age, man has burnt about 800 million barrels of petroleum. About 71 million barrels are burnt every day throughout the world and this consumption figure goes up by 2% every year. The 2% increase doubles the quantity every 34 years. Somewhere between 1000 billion and 1600 billion barrels of fuel are estimated to remain in formations where economic recovery is feasible. By 2010 the world would have consumed one-half the total amount that is technically and economically feasible to extract. And, at the current rate of consumption, 1600 billion barrels would be depleted in 60 years. It is the time to think about the alternative fuels.

PATTERN OF GLOBAL ENERGY DEPENDENCE



Source: World Energy Council

We think of Bio Diesel , CNG & Fuel Cell

They offer the world many benefits, including:

- Sustainability.
- Reduction of green house gas emissions.
- Regional development.
- Social structure and agriculture.
- Security of supply

As compare to our available energy resource

BIODIESEL

- Biodiesel is the name of a clean burning alternative fuel, produced from domestic, renewable resources. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend. It can be used in compression-ignition (diesel) engines with little or no modifications. Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatics.
- Biodiesel is made through a chemical process called trans-esterification whereby the glycerin is separated from the fat or vegetable oil. The process leaves behind two products -- methyl esters (the chemical name for biodiesel) and glycerin (a valuable byproduct usually sold to be used in soaps and other products).
- Biodiesel can help cut the emissions of CO₂ the primary green house gas contributing to global warming. Biodiesel does not contain any sulfur so it does not create any sulfur dioxide. Biodiesel has the best fuel balance of any liquid fuel.

REASONS FOR USING BIODIESEL:

- Biodiesel is an environmentally friendly fuel.
- Sulfur (Causes respiratory disease and contributes to acid rain) = 100% reduction
- Particulate matter (Black soot and smoke exhaust) = 47% reduction
- Carbon Dioxide (CO₂) (primary greenhouse gas contributing to global warming) = 78% reduction
- Hydrocarbon emissions (volatile organic compounds, or VOCs, which form harmful ozone) = 85% reduction
- Carbon Monoxide (CO) = 48% reduction
- Biodiesel easily decomposes biologically and in the case of an accident no harm is done to the soil or ground water.
- Biodiesel is not considered a hazardous material (flashpoint above 110°C).
- Biodiesel has superior lubrication capabilities and increases engine life.
- Biodiesel, If anything, becoming cheaper due to problems in disposing of waste Vegetable Oil since the implementation of the Animal By-products Directive.
- Biodiesel provides your business with a Green Image.

MANUFACTURING METHOD:

- Biodiesel By Conventional Catalysis
- Push-Pull method
- Biodiesel By Enzymatic Catalysts

RAW MATERIALS:

There are mainly three raw materials for the manufacture of **Biodiesel**. They are

Vegetable Oils

Alcohol

Lye

VEGETABLE OIL: Vegetable oils good alternatives to depleting fossil fuels for use in diesel engines.

Neem

Kusam

Koku

Salvador

Thumb

Karanja

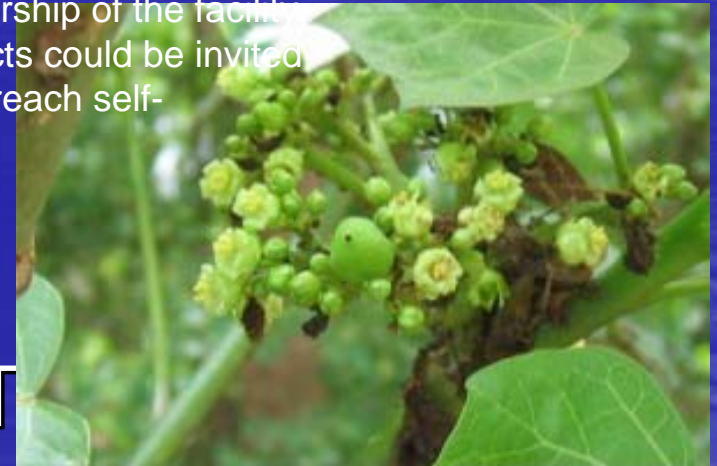
Jatropha

Mahua

JATROPHA THE ANSWER:

India with just 2.4% of the global area supports more than 16% of the world's human population and 17% of the cattle population. According to the economic survey (1995-96), of the cultivable land area about 176 million hectares are classified as waste and degraded and marginal land. If the non-forest waste lands can be used to cultivate plants which can survive on such soil and which can produce oilseeds, these could be effectively used to combat fuel shortage in the country and at the same time bring such degraded lands back to its productive capacity. Jatropha (*Jatropha curcas*, ratanjyot) is a suitable candidate for this purpose.

Considerable political support would be needed for execution of such a grand project. To start with it could adopt the community level concept with the farmers cooperative retaining ownership of the facility depending on the success of the project other projects could be invited in all the jatropha growing parts of the country. And reach self-sufficiency level some day.



JATROPHA PLANT

SPECIAL FEATURES OF JATROPHA CURCAS:

- . It is quick growing; none browsed by animals and has a remarkable adaptability to a variety of climate and soils.
- In India it is to be introduced by Portuguese navigators in the 16th century..
- Jatropha curcas: Oil plant, multipurpose, drought resistance etc. suitable for low rainfall areas. (But not less than 200 mm rain fall).
- Easy to grow and establish can be grown as live hedge and block plantation to supplement the farmer's income. It has the minimum gestation period amongst all the tree borne oil seeds.
- Seeds of Jatropha curcas contain 30% oil by weight of air – dried seeds and once the production and use, as bio-diesel starts shall find ready market.
- Jatropha oil can be used as bio-diesel after simple processing or esterification.
- It has vast potential to meet rural energy needs in a decentralized manner.
- Animals don't browse Jatropha, however, initial protection from damage due to trampling by livestock is required. Low cost energy plantations are feasible.

Table 2: Estimated cost of Bio-diesel Production

	Rate (Rs/ kg)	Quantity (kg)	Cost (Rs)
Seed (after collection)	8.00	3.28	26.24
Cost of decortication and oil extraction	3	1.05 kg oil from 3.28 Kg seed	3.15
Less cake produced	3.0	2.23 kg cake from 3.28 Kg seed	- 6.69
Transesterification cost	8.0	1.0	8.0
Cost of glycerol produced	35	0.08	- 2.8
Cost of Biodiesel			27.90

Biodiesel – Jatropha



33 million hectares of wasteland have been allotted to tree plantation in India.



Multipurpose trees such as Jatropha can grow well on wastelands with little inputs, and reclaim it.



Yields of up to 5 t/ha oilseeds possible under optimum conditions



Use of biodiesel is completely CO₂ emission free; the CO₂ fixed by the plantation could be used in emissions trading.



If the potential is fully realised India's current annual diesel requirement (40 million tonnes this year) could be fully met!



Produces 2 tonnes of biodiesel that could be used in automobiles, other agro-industrial useful by-products.



Biodiesel CO₂ Cycle

No fossil CO₂ Released

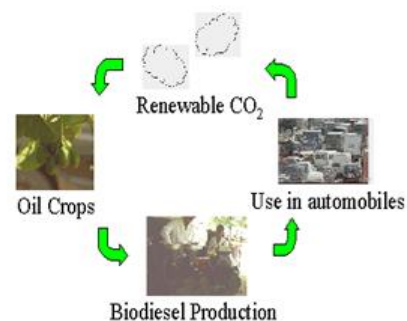


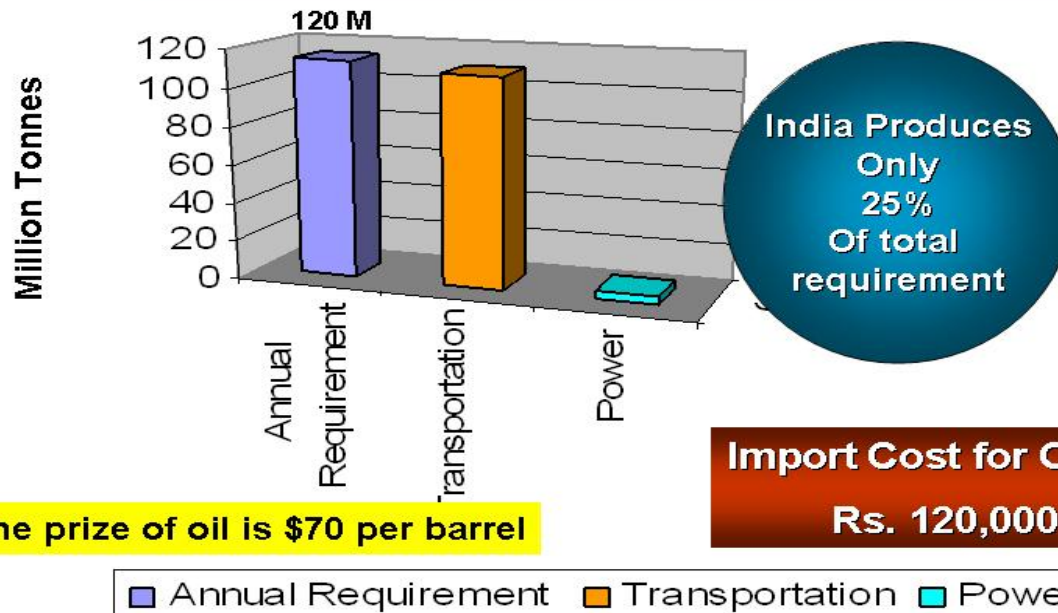
Table 1: Production and import of crude oil in India

Year	Production (MMt)	Import (MMt)	Total requirement (MMt)
1971	6.8	11.7	18.5
1981	10.5	16.2	26.7
1991	33	20.7	53.7
2000	32	57.9	89.9
2003-04	33.4	90.4	123.8
2004-05	33.4	100	133.4

Source: Ministry of Petroleum and Natural Gas

Energy Security to Energy Independence

Annual Requirement of OIL in India



The prize of oil is \$70 per barrel

How to Achieve Energy Independence by 2030?



BIODIESEL PLANT

State-wise area undertaken by NOVOD for Jatropha Plantation

State	Area (ha)
Andhra Pradesh	44
Bihar	10
Chhatisgarh	190
Gujarat	240
Haryana	140
Karnataka	80
Madhya Pradesh	260
Maharashtra	150
Mizoram	20
Rajasthan	275
Tamil Nadu	60
Uttaranchal	50
Uttar Pradesh	200

Employment potential

As per Planning Commission report on bio-fuels, 2003

- Likely demand of petro diesel by 2006-07 will be 52 MMT and by 2011-12 it will increase to 67 MMT.
- 5% blend of Bio-diesel with petro diesel will require 2.6 MMT of Bio-diesel in 2006-07
- By 2011-12, for 20% blend with Petro-diesel, the likely demand will be 13.4 MMT.
- To meet the requirement of 2.6 MMT of bio-diesel, plantation of Jatropha should be done on 2.2 - 2.6 million ha area.
- 11.2 - 13.4 million ha of land should be covered by 2011 - 12 for 20% bio-diesel blending

Year	No. of jobs in plantation	In maintenance	Operation of BD units
2006-07	2.5 million	0.75 million	0.10 million
2011-12	13.0 million	3.9 million	0.30 million

Energy Vehicles – Bio-Fuel Train – Indian Railways

Two passenger locomotives (Thanjavur to Nagore section)



Tiruchirapalli to Lalgudi, Dindigul and Karur sections



Energy Vehicles – Bio-Fuel /Electric Vehicles



Electric CAR



entofindi

CNG

What is Natural Gas?

- Natural gas is a mixture of hydrocarbons—mainly methane (CH₄)—and is produced either from gas wells or in conjunction with crude oil production. Natural gas is consumed in the residential, commercial, industrial, and utility markets.
- The interest for natural gas as an alternative fuel stems mainly from its clean burning qualities, its domestic resource base, and its commercial availability to end-users. Because of the gaseous nature of this fuel, it must be stored onboard a vehicle in either a compressed gaseous state (CNG) or in a liquefied state (LNG).
- Chemical Properties: The main constituent of natural gas is methane, which is a relatively uncreative hydrocarbon. Natural gas as delivered through the pipeline system also contains hydrocarbons such as ethane and propane; and other gases such as nitrogen, helium, carbon dioxide, hydrogen sulfide, and water vapor.

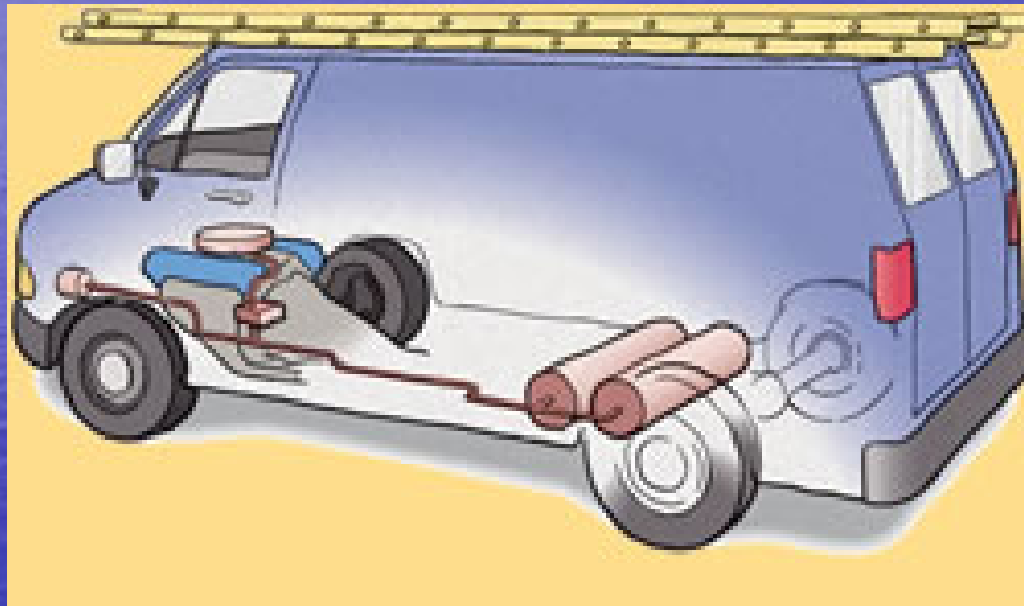
How is Natural Gas Made?

- Most natural gas consumed in the United States is domestically produced. Gas streams produced from reservoirs contain natural gas liquids and other materials. Processing is required to separate the gas from petroleum liquids and to remove contaminants. First, the gas is separated from free liquids such as crude oil, hydrocarbon condensate, water, and entrained solids. The separated gas is further processed to meet specified requirements. For example, natural gas for transmission companies must generally meet certain pipeline quality specifications with respect to water content, hydrocarbon dew point, heating value, and hydrogen-sulfide content. A dehydration plant controls water content; a gas processing plant removes certain hydrocarbon components to hydrocarbon dew point specifications; and a gas sweetening plant removes hydrogen sulfide and other sulfur compounds

Natural Gas Vehicles

- Vehicles that run on natural gas instead of gasoline are called natural gas vehicles (NGVs). Natural gas that has been compressed into special high-pressure cylinders to get more volume into a smaller amount of space is called compressed natural gas, or CNG. Some NGVs run on CNG only, and others can run on either CNG or gasoline. Some long-haul trucks and transit buses run on liquefied natural gas, or LNG, which is made by refrigerating natural gas to condense it into a liquid.
- When the engine of an NGV is started, natural gas flows into a fuel line, then enters a regulator where the gas pressure is reduced. A fuel injection system mixes the gas with air and feeds the mixture into the engine. The fuel/air mixture is adjusted to burn efficiently and with the least possible emissions. Natural gas burns in the engine just like gasoline.
- NGVs produce fewer pollutants than gasoline or diesel vehicles and cost less to maintain. The tanks used to store natural gas can withstand crashes and heat far better than most gasoline tanks can. In the event of a crash, natural gas disperses into the air, whereas gasoline pools on the ground, creating a fire hazard.

Natural Gas Vehicle



Advantage & Disadvantage Of Natural Gas

Advantages

- Easy on the engine, giving longer service life & lower maintenance costs.
- Reduces the demand for finite petroleum supply
- Reduces exhaust emission pollution.
- Improves fuel consumption and engine efficiency. When CNG and air in the right proportions are brought together, they mix thoroughly and rapidly, thereby improving the combustion efficiency, while the engine stays clean internally.
- Dry gaseous fuel does not dilute the lubricating oil, thus saving on oil filters and oil changers

Disadvantages

- Driving complaints due to loss of power with CNG. Dynamometer tests indicate that CNG- fuelled vehicles have 10-15% lower power output than petrol engines.
- Increased exhaust-valve wear in CNG-operated vehicles are anticipated due to the drying effect of the gaseous fuel
- Limited service availability
- High cost of conversion
- The additional weight of CNG cylinders does pose a problem
- Inability to make an impression on the common man

FUEL CELL

What is fuel cell?

A fuel cell is an electrochemical energy device that produces electricity and heat. To do this it uses hydrogen as a fuel to combine with the oxygen in the air, converting it into water while producing the heat and electricity. It is much like a battery, except that a fuel cell does not run down or require recharging like a battery. It recharges itself while you are drawing power.

Hydrogen is commonly available in fuels like propane and natural gas. Fuel cells also use other fuels containing hydrogen, the most abundant element on the Earth. Fuels that contain hydrogen include:

- Methanol
- Ethanol
- Natural gas
- Gasoline
- Diesel fuel

Today, energy can also be supplied by wind, solar power, biomass and even gas from landfills and wastewater treatment plants; these are known as renewable fuels. Hydrogen made from these renewable fuels is a clean and abundant energy source. When used in a fuel cell, the only emission created is water - no burning or combustion therefore no pollutants! The water can be electrolyzed to make more hydrogen which supplies more fuel

_How Fuel Cells Work?

There are several different types of fuel cells that work with different electrochemical reactions. The types of fuel cells have very technical names (abbreviated as shown) and are:

- Proton Exchange Membrane (PEM)

- Phosphoric Acid (PAFC)

- Solid Oxide (SOFC)

- Alkaline (AFC)

- Direct Methanol (DMFC)

- Molten Carbonate (MCFC)

The Proton Exchange Membrane is one of the most commonly used types of fuel cell and is very promising for widespread use in homes and automobiles. The Alkaline fuel cell is the oldest design .it is quite expensive and probably least likely to be used in homes.

The chemical elements used in a fuel cell are:

- Hydrocarbons (natural gas) (CH_2)

- Oxygen (O_2)

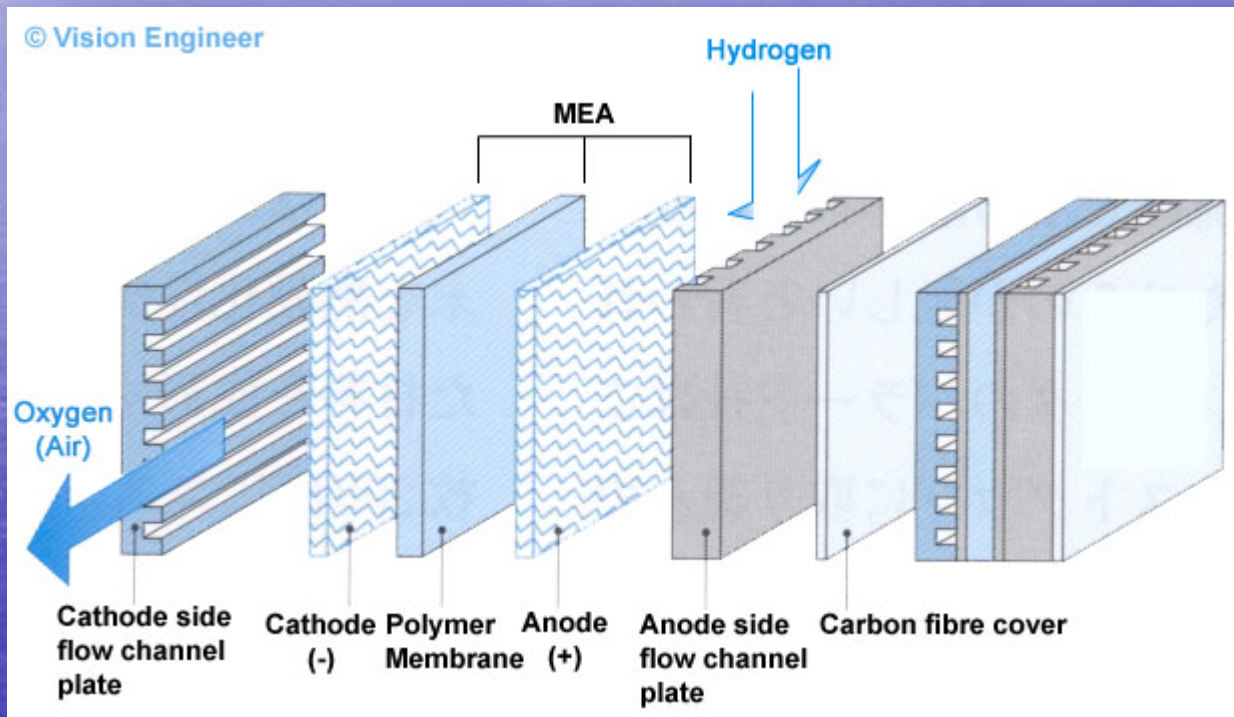
- Water (H_2O)

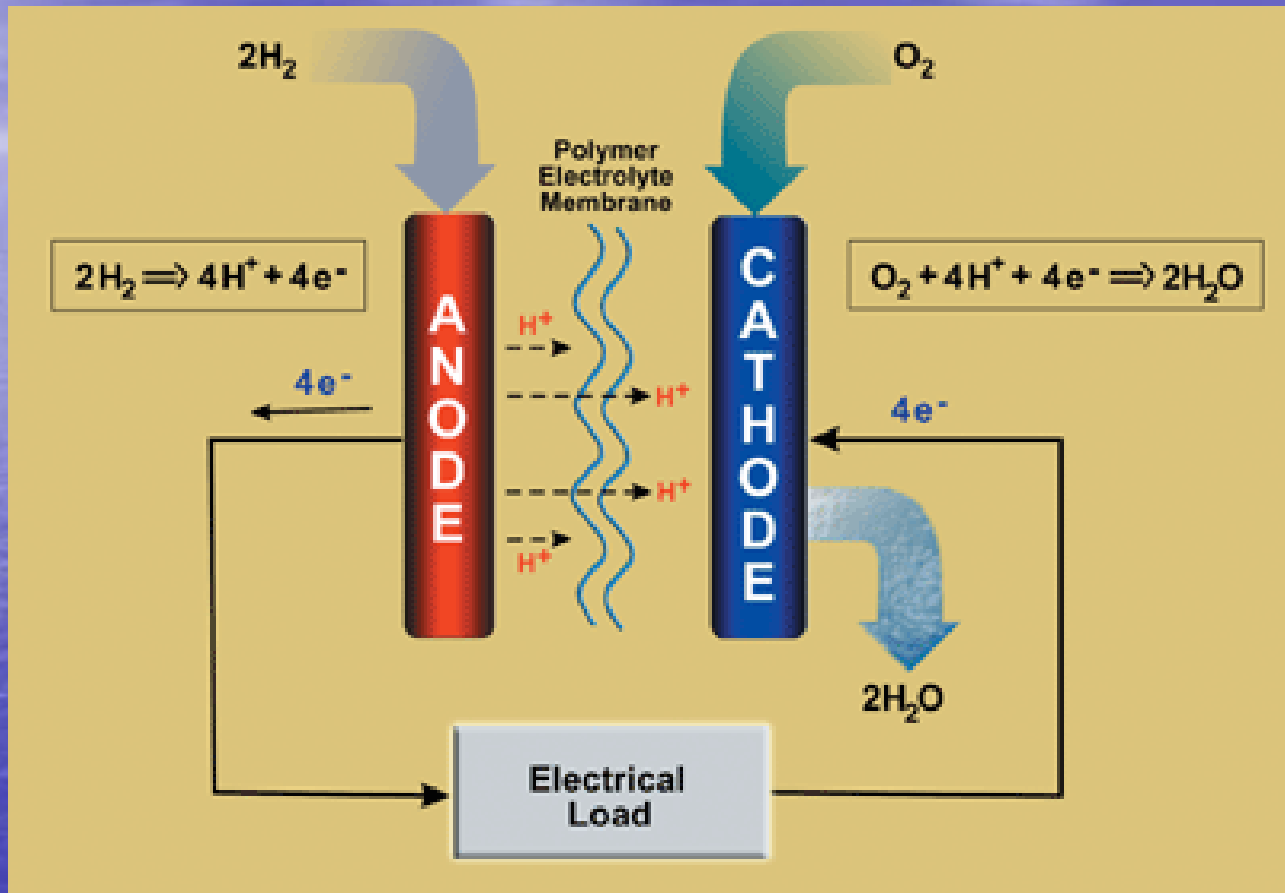
- Hydrogen (H_2)

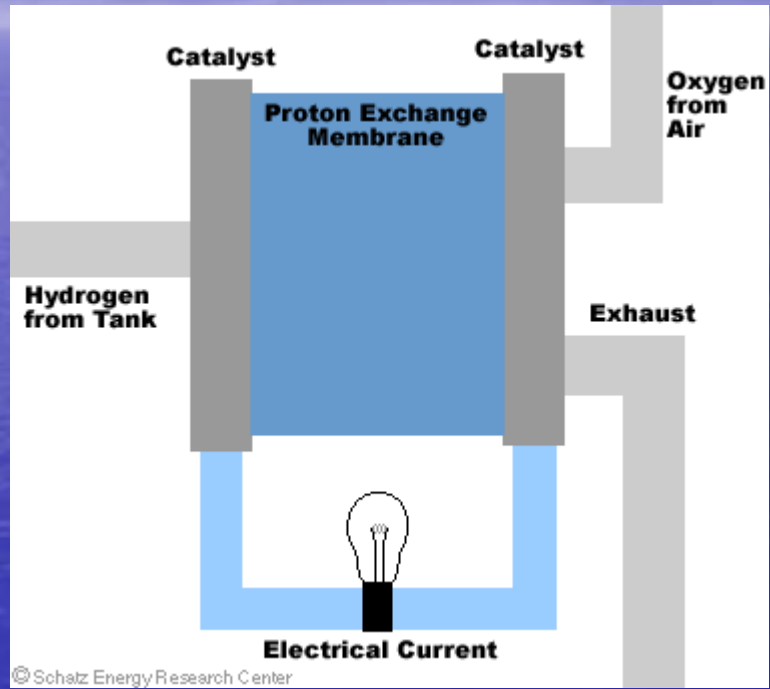
- Carbon Dioxide (CO_2)

- Carbon Monoxide (CO)

Systematic Illustration of Fuel cell







Potential Applications of Fuel Cells:

- Can be used in CHP mode
- Industrial applications
- Surface transportation
- Residential applications
- Power supplies for personal computers, hospitals, health clinics, etc.
- Electrification of remote locations/villages

Cheaper to operate

Pollution-free

Competitively priced

Free from imported oil



BHEL (Hyderabad) is working on developing PAFC and MCFC for distributed power generation and also focuses on preparing catalyst and fuel reformer to be used in fuel cell power plants. They have demonstrated some distributed power systems.

TERI is working on MCFC stack development for power generation and procedure for making electrodes, electrolyte tapes and electrolyte carriers.

SPIC Science Foundation (Chennai) is engaged in PEMFC technology for applications such as stationary, portable and transportation purposes. It is also involved in designing PEM electrolyser and hydrogen sensors.

GAIL is actively involved in establishing fuel infrastructure for fuel cell vehicles in India.

Basic research on anode, cathode, electrolyte and interconnect materials for SOFC technology is carried out by BARC (Mumbai) and MIT (Chennai).

IISc (Bangalore) and CGCRI (Kolkata) are involved in developing SOFC systems. A methanol reformer was developed and integrated with a fuel cell system by IISc, Bangalore.

	GASOLINE	#2 DIESEL	BIODIESEL	COMPRESSED NATURAL GAS
MAIN FUEL SOURCE	Crude oil	Crude oil	Soybean oil, waste cooking oils, yellow grease, any vegetable oil	Underground reserves
ENERGY CONTENT PER GALLON	109,000- 125,000 Btu (does not factor in the energy to get it from source)	128,000- 130,000 Btu (does not factor in the energy to get it from source)	117,000-120,000 BTU	33,000-38,000 Btu @ 3000 psi 38,000-44,000 Btu @ 3600 psi
ENVIRONMENTAL IMPACTS OF BURNING FUEL	Produces harmful emissions	Produces harmful emissions; however, diesel vehicles are improving and emissions are being reduced with after-treatment devices	Reduces pollutant categories* by 50-100%, especially particulate matter and global warming gas emissions (78%+) compared to conventional diesel (*NOx emissions are unclear-- see Fact Sheets)	CNG vehicles can demonstrate a reduction in ozone-forming emissions compared to some conventional fuels; however, HC emissions may be increased
ENERGY SECURITY IMPACTS	Manufactured using imported oil, which is not an energy secure option	Manufactured using imported oil, which is not an energy secure option	Biodiesel is domestically produced and recycles urban and agricultural waste	CNG is domestically produced. The United States has vast natural gas reserves
COSTS	<u>Current Fuel Prices</u>	<u>Current Fuel Prices</u>	Depending prices of soybean oil, waste cooking oils, animal fats, plus refining overhead	Underground reserves plus costs of conversion (\$40,000 to \$90,000) and fueling infrastructure <u>Current Alternative Fuel Prices</u>

Emission Reductions	CO	HC	NOx	PM
Bio Diesel B20	12.6%	11%	+1.2%	15%
Bio Diesel B100	43.2%	56.3%	+5.8%	70%
CNG	90-97%	50-75%	35-60%	90%-97%

Conclusion

- We have discussed the benefits of some alternative sources like CNG, Fuel Cells and Biodiesel over conventional sources like petrol, diesel, etc.
- Fuel cell related technologies are still very young and yet to reach the market. However, Prototypes have been developed in laboratories, which is efficient, environment-friendly and economical.
- Compressed natural gas (CNG) has been implemented in many parts of India which had positive effects on environment. However, CNG is temperature sensitive which makes it hazardous in the high temp of summer in cities like New Delhi, Chennai, etc. because CNG cylinder may explode causing life and material loss.
- Pilot projects for production of biodiesel have been implemented in Uttaranchal to assess the viability of its large scale usage which had positive results. Barren lands available in large amount in India can be used for cultivation of Biodiesel plants like Jatropha. It will generate employments for millions in rural areas and also boost the agriculture sector of India. On top of it, byproduct of biodiesel production like glycerine, etc. can be used as raw material for other industries. Biodiesel production at large scale will reduce the dependence on fossil fuels like Petrol, diesel, etc. which in turn save the foreign reserve of India needed for import of petroleum products.

- If India can grow the biomass which are suitable for biodiesel in marginal agricultural lands, it would be wonderful. Of course, India also needs clean-burning modern diesel engines as well. This can be one of those technologies that create a partnership between the agricultural and manufacturing sectors: the former grows the stuff and provides the latter the induced demand for its output.

The background is a vertical gradient of blue, transitioning from a lighter, hazy blue at the top to a deeper, more saturated blue at the bottom. A bright, white sun is positioned on the left side, just above the horizon line, creating a shimmering reflection on the water's surface that extends across the middle of the image. The overall effect is serene and calm.

THANK YOU