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Fuel Cell – A Viable Nonconventional Technology of Future

Mr. Sachin. M. Dandage, Prof. K.R. Sontakke

PLITMS, Buldana, Maharastra , India

Abstract : Energy has been a key information to drive and enhance the life cycle. Basically, it is a blessing given to humanity from nature. The utilization of vitality is specifically relative to the advancement of humankind. It has turned out to be a help to humankind and its branches. In any case, with the continually expanding populace and even quickly developing industrialization, it is gathered that the coming eras might miss the mark concerning this unmatched and impossible endowment of nature. The essential wellspring of vitality is fossil fuel (ordinary vitality), however the limit of fossil powers stores and expansive scale ecological corruption created by their across the board utilize the worldwide marvels like Global warming, Acid downpour, Air contamination are expanding. This paper portrays to sum things up the significance of utilization of non-customary vitality or renewable vitality sources. Renewable vitality sources likewise called non-customary vitality are sources that are constantly recharged by normal procedures. For example,solar vitality, wind vitality, bio-vitality - bio-energizes developed manage capably), hydropower and so forth., are a portion of the cases of renewable vitality sourcesA renewable vitality framework changes over the vitality found in daylight, wind, falling-water, ocean waves, geothermal warmth, or biomass into a structure, we can utilize, for example, warmth or power. The vast majority of the renewable vitality comes either specifically or in a roundabout way from sun and wind and can never be depleted, and in this manner they are called renewable. In any case, the greater part of the world's vitality sources are gotten from ordinary sources-fossil energizes such ascoal, oil, and characteristic gasses. These fills are frequently termed non-renewable vitality sources. In spite of the fact that, the accessible amount of these energizes are to a great degree vast, they are by the by limited thus will on a basic level 'run out' sooner or later Renewable vitality sources are basically streams of vitality, while the fossil and atomic fills are, inessence, supplies of vitality.
India positions 6th on the planet vitality utilization and requirements to quicken the improvement of the division to meet its development desires. The nation, however rich in coal and plentifully invested with renewable vitality as sunlight based, wind, hydro and bio-vitality has little hydrocarbon holds (0.4% of the world's store). India, in the same way as other creating nations, is a net shipper of vitality, more than 25 percent of essential vitality needs being met through imports for the most part as raw petroleum and characteristic gas. The rising oil import bill has been the center of genuine worries because of the weight it has set on rare outside trade assets and is additionally to a great extent in charge of vitality supply deficiencies. The imperfect utilization of business vitality unfavorably influences the profitable areas, which thusly hampers financial development. On the off chance that we take a gander at the example of vitality generation, coal and oil represent 54 percent and 34 percent separately with normal gas, hydro and atomic adding to the equalization. In the force era front, almost 62 percent of force era is from coal let go warm power plants and 70 percent of the coal delivered each year in India has been utilized for warm era support. India is blessed with extensive measure of maintainable asset base and non-customary vitality innovations which are appropriate for matrix joined force era, vitality supplies in remote territories which are not/couldn't be associated with the lattice and for hostage utilization. Nonconventional vitality sources like wind vitality, sun oriented vitality through warm and also photovoltaic framework, biomass and crossover sources will help, all things considered, in upgrading power era limit. Henceforth fitting strategies and software engineers that improve the utilization of accessible vitality assets with new advances must be spread, advanced and received, if essential, by budgetary.

***Watchwords**: Conventional Energey,non routine Energy.*

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I. INTRODUCTION

1. What is Energy?

Energy can be defined as “Ability to do work”. Energy can neither be created nor be destroyed; it can just be converted from one form to another. We require energy to do any kind of work. Energy is mainly classified into two types:-

Conventional Energy
Non-conventional Energy

1. *Conventional Energy*:-

I. The energy which have been in use for a long time e.g., Energy we get form coal, petroleum, natural gas and water power.
II. The sources of these are exhaustible except water
III. These types of energy cause pollution when used, as it emits smoke and ash.
IV. They are very expensive to maintain

2. *Non-conventional Energy:-*

I. The energy which is yet in the process of development over the past few years. It includes solar energy, wind energy, tidal energy, biogas and biomass, geothermal energy.
II. These types of energies are inexhaustible.
III. They are generally pollution free.
IV. Less expensive due to local use and easy to maintain.

II. NEED OF NON-CONVENTIONAL ENERGY

As we know with ever growing population, improvement of the living standard of humanity, Industrialization of the developing countries, the global demand for energy is expected to increase rather significantly in the near future. In present near about all our energy comes from the conventional energy sources includes mostly fossil fuels like petrol, diesel, coal etc. They all exhaustible sources of energy and in near future they are about to extinct. Presently oil 40%, natural gas 22.5%, coal 23.3%, hydroelectric 7.0% provide almost all worlds energy, Also over usage of these fuels cause

degradation of environment by means of Global warming, Acid rains, Air pollution etc. So, to fulfill our energy need we have to use non- conventional energy sources in future. They not only provide energy but they are also more efficient than conventional energy sources. Non-conventional energy is clean form of energy. Using it will help to control global phenomena like Global warming, Air pollution etc. Nonconventional energy is easily available on earth and can be stored easily, also it is less expensive and the maintenance of this is very less than conventional energy. These all things make Non-conventional energy the future source of energy.

III. WHAT IS NON-CONVENTIONAL ENERGY?

According to the definition of Non-conventional energy it is the renewable energy which is clean as well as efficient energy than traditional energy also called as conventional energy. Non-conventional energy sources capture their energy from on-going natural process such as geothermal heat flow, wind, flowing water and biological process. Most renewable forms of energy come from sun. Some forms of renewable such as wind energy is considered as short term energy storage while energy like Biomass considered as long term energy as they can be stored for long period of time. Basic types of non-conventional energy are:-

Solar Energy (Photosynthesis)
Geothermal Energy
Energy
Hydro Energy
Energy
Wind Energy
Biomass
Nuclear Energy
Tidal

IV. HYDROGEN FUEL CELL

Introduction:-A fuel cell is device that converts chemical energy from fuel to electrical energy thorough chemical reactions with oxygen or other oxidizing agents. Hydrogen is the most common fuel but hydrocarbons like natural gas and Alcohols are sometimes used. Hydrogen fuel cells are different than batteries in that they require constant source of Hydrogen and Oxygen to run but they can produce electricity continually for as long as these fuels are supplied. Hydrogen Fuel cells are used for primary and backup power for commercial, Industrial and Residential buildings and in remote or inaccessible areas. They are used to power Hydrogen Fuel cell vehicles including Automobiles, Two-wheelers, Airplanes, Buses, Forklift and submarines.

Keeping energy security and environment protection in mind the applications of hydrogen as an energy carrier can be Broadly categorized into

1. Vehicular Applications (hydrogen alone in either fuel cell vehicles or in IC engine based vehicles or as a blended fuel with CNG in IC engine based vehicles)
2. Stationary Applications [Spark ignition engines using hydrogen and Compression ignition dual fuel (diesel andhydrogen) engines]
3. Use in portable devices like laptops, camcorders

Various Methods to Produce Hydrogen

Method	Process	Implementation
Steam reforming of methane gas	In presence of nickel catalyst & at 700 – 1100 °C: $CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$ Next reaction at lower temperature: $CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$	Current major source of hydrogen
Hydrogen from coal (Gasification)	At high temperature and pressure: $Coal + H_2O(g) + O_2(g) \rightarrow$ syngas Syngas = $H_2 + CO + CO_2 + CH_4$	Current method of mass hydrogen production
Electrolysis of water	Electric current passed through water: $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$	Not in widespread use due to cost of electricity
Solar – Hydrogen system	Electric current passed through water: $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$	Not in widespread use due to cost of renewable energy sources

There are many types of fuel cells but all consists of Anode (negative side), cathode (positive side) and Electrolyte that allows charges to move in between two sides of fuel cell. Electrons are drawn from anode to cathode through an external circuit, producing direct current electricity. As the main difference in fuel cells are electrolytes, they are classified by the electrolytes they use. Hydrogen fuel cells come in various sizes. In addition to electricity Hydrogen fuel cells produce water, heat and depending on the fuel source very less amount of nitrogen oxide and other emissions. The efficiency of Hydrogen fuel cell is 40-60 % or sometimes 80% also if the waste heat is captured and used. Fuel cells have the capacity to replace the internal combustion engines in vehicles and to provide power in stationary and portable power applications because they are energy efficient, fuel flexible and clean.

Working:-The first step towards the manufacturing of HFC's is the production of hydrogen. Hydrogen can be produced using diverse, domestic resources such as fossil fuels, natural gas and coal. Above all, ethanol is the main constituent in the production of hydrogen. Ethanol is a renewable resource as it can be produced from biomass without contributing to the greenhouse gas emissions. Reforming of ethanol to produce hydrogen is a potentially attractive process. The reactions involved include steam reforming followed by water-gas shift and selective oxidation of CO. The development of suitable catalysts for these reactions is crucial for the viability of the process.

The reactions involved for producing hydrogen from ethanol include (i) steam reforming (ii) high temperature water-gas shift reaction (iii) low temperature water gas shift reaction and (iv) selective carbon monoxide oxidation.

The overall reactions are as follows

Steam reforming $C2H5OH+3H2 \longrightarrow 2CO2+6H$
Water –gas shift $CO+H2O \longrightarrow CO2+H2$

In the steam reforming reaction, in addition to H2 and CO2, significant amounts of CO and CH4 are also formed due to side reactions. For use in fuel cells, the CO content has to be reduced to less than 10 ppm. Water-gas shift reactors are therefore used to reduce the CO concentration and produce additional H2. Even after the low temperature shift reactor, the CO concentration is around 1% and is further reduced by selective oxidation. The major challenge is to develop highly active, selective and durable catalysts for the reactions involved. The device used for the production of Hydrogen for fuel cell is called as MICROREACTOR. The one of the most common method for production of Hydrogen is called as Ethanol steam reforming process. Micro reactors are used to carry out this process.

(5) Output: industrial Ethernet.

(6) Ex forms: Explosion-proof and safe.

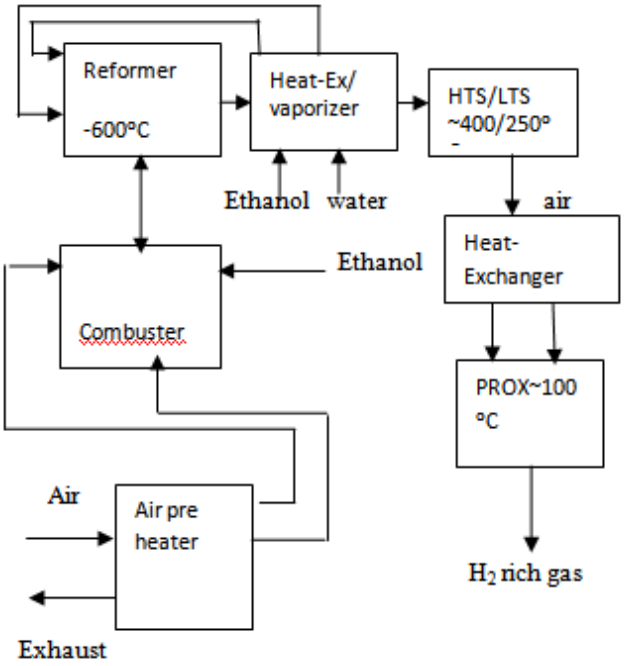


Fig1:- Diagram for integrated reactor for steam reforming of Ethanol

Conventional packed bed reactors have too high a reactor volume to be applied to small fuel cells. Moreover, these reactors show limitations in heat and mass transfer and are not able to fulfill the dynamic demands of fuel cell systems. Micro reactors, with their low reactor volumes and high heat and mass transfer rates, are ideally suited for such applications. To have high thermal efficiency, micro-reactors need to be designed such that the heat from the exothermic reactions is utilized for heating and evaporation of the fuel as well as for providing heat to the endothermic reactions. Moreover, the catalysts for steam reforming, water-gas shift reaction, and selective oxidation need to be active, selective and stable. Another problem is that the optimum temperature for each of the above reactions is different, thus heat exchangers need to be incorporated in the micro fuel processor.

After the production of Hydrogen it is used as a fuel in the Hydrogen fuel cell along with the Oxygen. Assembly diagram of the Hydrogen fuel cell is shown below

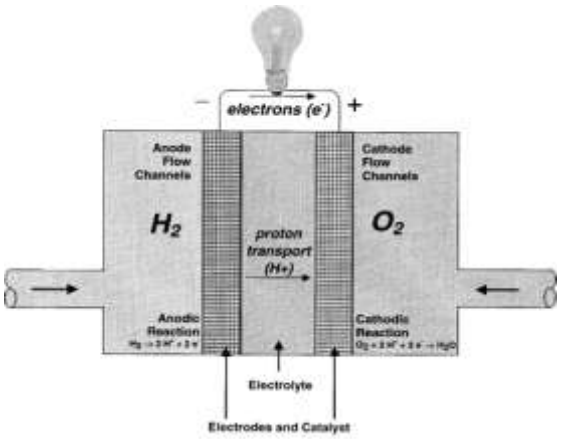


Fig2:- Hydrogen fuel cell assembly

As shown in assembly diagram of Hydrogen fuel cell, Hydrogen (H2) is passed through anode flow channels where the following reaction takes place

$$H2 \longrightarrow 2H^+ + 2e^-$$

The Hydrogen atom is split into proton(H^+), then the proton transport across anode and cathode takes place through electrolyte and the protons combined with oxygen supplied at cathode flow channels and forms water. The reaction at cathode is given below

$$O_2+2H^++2e^- \longrightarrow H_2O$$

After this reaction the protons are converted into water now as the flow of charges occur in between the anode and cathode connecting both electrodes with conducting wire current flows from it and electric energy is produced.

Efficiency- A hydrogen fuel cell is an extremely efficient producer of energy. An estimated 60 percent or more of the energy produced in a hydrogen fuel cell goes to powering a vehicle. This is a vast improvement over the 20 percent or so produced by most internal-combustion engines. However, hydrogen fuel costs more energy to make than the fuel itself will create in the hydrogen fuel cell. So there is a trade-off in efficiency. *Stacks*-A single hydrogen fuel cell will produce only about 1 volt of power by itself. That is why hydrogen fuel cells must be stacked to produce enough energy to drive a vehicle's engine. One of the biggest challenges is creating fuel-cell stacks small enough to fit into a vehicle and power it without taking up too much room and weighing too much.

Batteries-A hydrogen fuel cell can be thought of like a battery. It runs on a chemical-electric reaction, breaking up hydrogen and using its electrons to create an electric current. However, unlike a battery, a hydrogen fuel cell will continue to function as long as it is provided with fuel. This is where a lot of its efficiency comes from, since the reaction is constant and relatively simple.

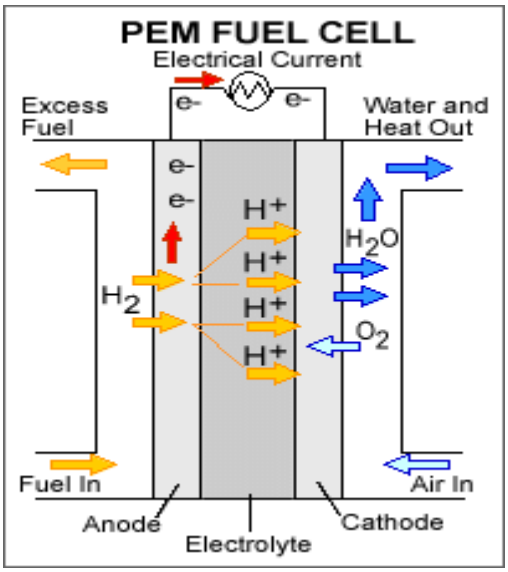
Exhaust-Unlike internal-combustion engines, a hydrogen fuel cell puts out only two products while it runs, first one is Water and another is electrical energy itself both are harmless to humans hence it is a clean energy source.

V. PROTON EXCHANGE MEMBRANE FUEL CELL (PEMFC)

Proton exchange membrane (PEM) fuel cells work with a polymer electrolyte in the form of a thin, permeable sheet. This membrane is small and light, and it works at low temperatures (about 80 degrees C, or about 175 degrees F). Other electrolytes require temperatures as high as 1,000 degrees C.

To speed the reaction a platinum catalyst is used on both sides of the membrane. Hydrogen atoms are stripped of their electrons, or "ionized," at the anode, and the positively charged protons diffuse through one side of the porous membrane and migrate toward the cathode. The electrons pass from the anode to the cathode through an exterior circuit and provide electric power along the way. At the cathode, the electrons, hydrogen protons and oxygen from the air combine to form water. For this fuel cell to work, the proton exchange membrane electrolyte must allow hydrogen protons to pass through but prohibit the passage of electrons and heavier gases.

Efficiency for a PEM cell reaches about 40 to 50 percent. An external reformer is required to convert fuels such as methanol or gasoline to hydrogen. Currently, demonstration units of 50 kilowatt (kw) capacity are operating and units producing up to 250 kw are under development.



VI. ARTIFICIAL PHOTOSYNTHESIS

Introduction:- Artificial photosynthesis is a chemical process that replicates the natural process of photosynthesis, a process that converts sunlight, water, and carbon dioxide into carbohydrates and oxygen. The term is commonly used to refer to any scheme for capturing and storing the energy from sunlight in the chemical bonds of a fuel (a solar fuel). Photo catalytic water splitting converts water into protons and eventually hydrogen and oxygen, and is a main research area in artificial photosynthesis. Light-driven carbon dioxide reduction is another studied process, replicating natural carbon fixation. Research developed in this field encompasses design and assembly of devices (and their components) for the direct production of solar fuels, photo electrochemistry and its application in fuel cells, and engineering
of enzymes and photoautotrophic microorganisms for
microbial bio fuel and bio hydrogen production from sunlight.

One process for the creation of a clean and affordable energy supply is the development of photo catalytic water splitting under solar light. This method of sustainable hydrogen production is a key objective in the development of alternative energy systems of the future.[6] It is also predicted to be one of the more, if not the most, efficient ways of obtaining hydrogen from water. The conversion of solar energy into hydrogen via a water-splitting process assisted by photo semiconductor catalysts is one of the most promising technologies in development. This process has the potential for large quantities of hydrogen to be generated in an ecologically sound method. The conversion of solar energy into a clean fuel (H_2) under ambient conditions is one of the greatest challenges facing scientists in the twenty-first century.

Two approaches are generally recognized in the construction of solar fuel cells for hydrogen production:

A homogeneous system is one where catalysts are not compartmentalized, that is, components are present in the same compartment. This means that hydrogen and oxygen are produced in the same location. This can be a drawback, since they compose an explosive mixture, demanding further gas purification. Also, all components must be active in approximately the same conditions (e.g., pH).

A heterogeneous system has two separate electrodes, an anode and a cathode, making possible the separation of oxygen and hydrogen production. Furthermore, different components do not necessarily need to work in the same conditions. However, the increased complexity of these systems makes them harder to function and they are more costly.

Working:- Using biomimetic approaches, artificial photosynthesis tries to construct systems doing the same type of processes. Ideally, a triad assembly could oxidize water with one catalyst, reduce protons with another and have a photosensitize molecule to power the whole system. One of the simplest designs is where the photosensitize is linked in tandem between a water oxidation catalyst and a hydrogen evolving catalyst:

The photosensitize transfers electrons to the hydrogen catalyst when hit by light, becoming oxidized in the process.

This drives the water splitting catalyst to donate electrons to the photosensitizer. In a triad assembly, such a catalyst is often referred to as a donor. The oxidized donor is able to perform water oxidation.

The state of the triad with one catalyst oxidized on one end and the second one reduced on the other end of the triad is

referred to as a charge separation, and is a driving force for further electron transfer, and consequently catalysis, to occur. The different components may be assembled in diverse ways, such as supramolecular complexes, compartmentalized cells, or linearly, covalently linked molecules

Research into finding catalysts that can convert water, carbon dioxide, and sunlight to carbohydrates or hydrogen is a current, active field. By studying the natural oxygen-evolving complex, researchers have developed catalysts such as the "blue dimer" to mimic its function. A triad assembly, with a photosensitizer (P) linked in tandem to a water oxidation catalyst (D) and a hydrogen evolving catalyst (A). Electrons flow from D to A when catalysis occurs. The simple diagram of the Triad assembly is shown below:

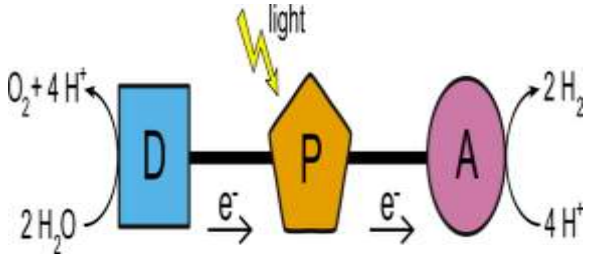


Fig4:- Triad assembly that produce Hydrogen using photosynthesizer

Advantages of solar fuel production through artificial Photosynthesis are as follows:-
The solar energy can be immediately converted and stored. In photovoltaic cells, sunlight is converted into electricity and then converted again into chemical energy for storage, with some necessary loss of energy associated with the second conversion.
The byproducts of these reactions are environmentally friendly. Artificially photosynthesized fuel would be a carbon-neutral source of energy, which could be used for transportation.
The disadvantages are as follows:-
Materials used for artificial photosynthesis often corrode in water, so they may be less stable than photovoltaics over long periods of time. Most hydrogen catalysts are very sensitive to oxygen, being inactivated or degraded in its presence; also, photodamage may occur over time. The overall cost is not yet advantageous enough to compete with fossil fuels as a commercially viable source of energy.

7. Statistics India is very rich in biomass. It has a potential of 19,500 MW (3,500 MW from bagasse-based cogeneration and 16,000 MW from surplus biomass). Currently, India has 537 MW commissioned and 536 MW under construction. The facts reinforce the idea of a commitment by India to develop these resources of power production. Following is a list of some States with most potential for biomass production:

Andhra Pradesh (200 MW) Bihar (200 MW)
Gujarat (200 MW) Karnataka (300 MW)
Maharashtra (1,000 MW) Punjab (150 MW)
Tamil Nadu (350 MW) the following table demonstrates the current capacity utilization of alternative sources of energy and their potential

Sr. no.	Alternative energy	Current capacity (MW)	Potential (MW)
1	Wind power	10242.5	45195
2	Bio power	703.3	16881
3	Solar photovoltaic	2.12	
4	Biomass cogenerations	170.78	
5	Biomass gasifiers	105.46	
6	Energy from waste	92.97	2700

Source: MNRE, Figures at the end of March, 2009

VII. CONCLUSION

Keeping in view the reserves of fossil fuels and economy concerns, these fuels are likely to dominate the world primary energy supply for another decade but the environmental scientists warned that if this trend is not checked by 2100, the average temperature around the globe will rise from 1.4 to 5.8 degree Celsius, which will cause upsurge in the sea water level drowning all the low lands and costal lines. So the world has already begun to bring about the infrastructural changes in the energy sector so as to be able to choose the renewable energy development trajectory. In developing countries like India where a lot of new energy production capacity is to be added, rapid increase in the use of renewable sources is easier as compared to the industrial countries where existing energy capacity needs to be converted if a rapid change is to take place. That is, the developing countries have an upper hand in driving the world market. However the participation of developed countries is equally necessary as the initial progress of the use and research of non conventional energy has taken place in those countries. India, nevertheless, should provide thrust to the research and development and the use of non conventional energy sources not only to minimize the threat of greenhouse effect but also to lessen the dependence on oil/gas which consumes major chunk of foreign exchange reserves. It is hence clear that any energy system that contains two or more non renewable energy sources has the advantage of stability, reliability and economical viability. Last but not the least, we, the common citizens of our world should also

understand the importance of non conventional energy also called as renewable energy.

REFERENCES

[1] http://www.wikipedia.com/non-conventionalenergysources/hydrogenfuelcell.pdf
[2] http://www.mnre.gov.in – Ministry of new and renewable energy
[3] K.S Sindhu "Non conventional energy" Director/Researcher Punjab Electricity board, PCE campus, Chandigarh
[4] D. Kunzaru "Hydrogen production from ethanol for fuel cell" Department of chemical engineering I.I.T Kanpur. dkunzaru@iitk.ac.in
[5] Chemistry for tomorrow's world: A roadmap for chemical sciences, Royal society of chemistry, www.rsc.org/Roadmap,2009
[6] "Deriving energy from sunlight and water" The Swedish Energy Agency P.O box 310, S.E-631, Eskilstuna
[7] http://www.preservearticals.com/non-conventional-energy
[8] Overview of power sector in India in 2005- Indiacore.com
[9] National hydrogen Energy Roadmap, abridged Version, Ministry of New and Renewable Energy, Government of India, 2007.
[10] Case study by Rachel Chamousis, Hydrogen : fuel of the future