Solar Hydrogen hybrid system: “Akshay Urja”
The Green Energy solution.

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Executive summary

Solar-hydrogen is a Completely Green system which avails all the Energy requirements using a Hybrid System for our home, that employs photovoltaic (PV) panels to convert sunlight into electricity which is used for home appliance in the day time and remaining Electricity that is harnessed to extract hydrogen from harvested rain water or tap water. The stored hydrogen will be used for car fuel, cooking gas and also through the fuel cell stacks to power our entire house during night and winter season, leaving behind the water, which can be pumped right back into the system.

Keywords: Fuel cell, Solar PV, Inverter, water, Output Voltage Regulation, equivalent circuit

Introduction:

The personalized home with hybrid energy system consists of array of solar panels on the roof, fuel cells system for night time power supply and a small electrolyzer (a device, about the size smaller than a washing machine that uses electricity to break down water into its component hydrogen and oxygen). It requires a few tanks to store hydrogen, Plug Power fuel cell stack (an electrochemical device that mixes hydrogen and oxygen to produce electricity and water) and a hydrogen refueling kit for the car. Hydrogen that is extracted from water using solar energy is sustainable and renewable energy. Make hay (or hydrogen) when the sun shines and then use the stored hydrogen to produce heat for cooking and electricity for home appliances!

On a typical sunny day, the solar panels convert sunlight to electricity; a part of electricity will be consumed to run the home appliances, including television and other modern conveniences. The remaining electricity used for the electrolyzer, which splits the molecules of purified water into hydrogen and oxygen. The oxygen is vented and the hydrogen goes into the tanks where it is stored for use in the fuel cell to provide electricity for the house during night and also the stored hydrogen will be used to full fill energy requirement in the cold and dark winter months from November to March when there are few
days sunshine per months. This system produce only water as a waste product, which can be pumped right back into the system.

A key strategy to setup this system in our home equipped with hybrid solar hydrogen system and rain water harvesting system is to create a new lifestyle which is convenient, clean, energy-efficient and sustainable. It is very true that the combination of a fuel cell electric vehicle and the hybrid solar hydrogen system will lead to the establishment of a hydrogen society based on renewable energy, resulting in a major reduction of CO2 emissions and greater saving of energy and environmental sustainability.
**FUEL CELL**

A fuel cell by definition is an electrical cell, which unlike storage cells can be continuously fed with a fuel so that the electrical power output is sustained indefinitely (Connihan, 1981).

They convert hydrogen, or hydrogen-containing fuels, directly into electrical energy plus heat through the electrochemical reaction of hydrogen and oxygen into water. The process is that of electrolysis in reverse.

**Overall reaction:**

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2 \text{H}_2(\text{gas}) + \text{O}_2(\text{gas}) \rightarrow 2 \text{H}_2\text{O} + \text{Energy}
\]

Because hydrogen and oxygen gases are electrochemically converted into water, fuel cells have many advantages over heat engines. These include: high efficiency, virtually silent operation and, if hydrogen is the fuel, there are no pollutant emissions. If the hydrogen is produced from renewable energy sources, then the electrical power produced can be truly sustainable.
The two principle reactions in the burning of any hydrocarbon fuel are the formation of water and carbon dioxide. As the hydrogen content in a fuel increases, fuel becomes proportionally dioxide (Fig. 1). As fuel use has developed through hydrogen content in the fuels has sed. It seems a natural progression that the fuel of the future will be 100% hydrogen.

How system Works:

Hydrogen and oxygen will be produced from water using electricity with an electrolyzer. With the installation and operation of a 12 cell Hydrogen, 1000 Watt electrolyzer. This electrolyzer can produce 170 liters/hour (6 cubic feet/hour) of hydrogen and 85 liters/hour (3 cubic feet/hour) of oxygen (at standard temperature and pressure). In addition, we describe a homebrew purification and storage system for the hydrogen and oxygen produced by the electrolyzer. With proper after-treatment, the gases produced can be stored safely. The purified hydrogen and oxygen can be used in fuel cells (to produce direct current electricity) and catalytic burners (for heating and cooking) without poisoning or damaging the noble metal catalyst materials. The gases can also be used for welding and cutting, as well as for motor vehicle fuel.

How Much Hydrogen is needed?

This varies tremendously from household to household, depending on how well the Demand Side Management job has been done. We can run our 1kW system for about three hours on a cubic meter of hydrogen. The amount of gas needed can be estimated from the energy consumption of any appliance.

How Much Power Does It Take?
A cubic meter (35.3 cubic feet) of hydrogen gas takes about 5.9 hours to produce in this electrolyzer, and then operated at its rated input power of 1 KW. This means the energy required producing a cubic meter of hydrogen and 0.5 cubic meter of oxygen is about 5.9 kW-hr. This translates to an efficiency of 51%, where 3 kW-hr/m3 equals 100% efficiency at 20°C. Typical industrial scale plants operate at about 4.5 kW-hr/m3 or 67% efficiency at high current density.

The efficiency is better at lower current density. How much Power required for the Electrolysis: Our solar electric power is produced by 10 photovoltaic solar panels. On a good summer day we get up to 75 Amperes at 24 Volts Direct Current. This can be supplied for home appliance by concerting and stepping up by Inverter Or when the two house battery banks are fully charged, our two 50 Amp SCI charge controllers disconnect the PV power, and the PV voltage rises. An automatic controller senses the voltage rise and transfers the PV power to the electrolyzers to make hydrogen and oxygen during the remainder of the day. A utility grid electrolyzer power supply is used to make hydrogen and oxygen when there is insufficient solar power available.

The hydrogen gas and the oxygen gas are purified by two different systems. The hydrogen will be stored in two 0.47 cubic meter (125 gallon) propane tanks, and the oxygen will be stored in another propane tank.

Our system includes the following components and sub-systems: Solar PV module/or utility grid power

- Power Controller
- Electrolyzer and PEM Fuel Cell
- Hydrogen Purifier
- Hydrogen and Oxygen Storage Tanks
- Electrolyte Storage Tank and Transfer Pump
- Makeup-water Purifier
What Is Needed to Produce Hydrogen at Home?

Summary of Advantages:

- Applicability for distributed power generation: power is generated at the site where it is used rather than central generation and distribution through a grid. On site generation avoids transmission line losses of 98% to 100%.

- Low maintenance and reduced down time: This systems require low or negligible maintenance and can achieve 99% availability.

- Off-grid independence: Brownouts and blackouts associated with distribution grids are eliminated by onsite generation. This system provides a useful online backup where uninterruptible power is needed.

- Quality of electricity: Constant flow of current with few fluctuations—important for many scientific and technological applications.
- Environmentally benign: Hydrogen fuel cells have only water as an emission.

- Energy independence: This System provides grid-independent electric power and reduces dependence on oil imports for India.

- Lack of noise: Fuel cells are quiet.

- Efficiency: Fuel cells are more efficient than most fossil fuel power plants and internal combustion engines as well as battery.

- Lighter and longer life: For portable applications, fuel cells are lighter and have a longer run time than batteries, and when they do run out of fuel they don’t require a long, inefficient recharging process, only refueling.

**Social Impact Analysis:**

In the general social and economic contexts, energy systems form an integral part of the society. Seen from that perspective, their planning and implementation should be performed accordingly. The availability of energy is a basic requirement for most tasks in a modern society, both in the domestic life and for the business, commerce and the service sectors.

Our system produced and consumed in a clean and sustainable manner, thus offering important environmental benefits (CO2 and other pollutants reduction, which helps to fulfill the international agreements on limits for emissions). Electricity generation from our system offers socio-economic benefits from untapped solar energy and rain harvesting water.

The use of our project supports the decentralization of energy production that does not rely upon constrained transmission and distribution grids and offers a steady and secure supply of day to day required energy. Our system is strongly supportive of country policy in areas such as, meeting energy requirement, major reduction of CO2 emissions and greater energy savings and environmental sustainability. The use of our system gives value to the society in betterment of lifestyle of citizen.
The way in which the social value depends on the economic environmental relation is depicted. It is easy to understand that the higher the environmental and economic values are, the higher the social value will be. When the economic and environmental values rise together, then the social welfare value rises as well, as a result of the high appreciation given to both the other factors. The social value moves through three different zones—of low, medium and high social values.

**CONCLUSION**

As our demand for electrical power grows, it becomes increasingly urgent to find new ways of meeting it both responsibly and safely. In the past, the limiting factors of renewable energy have been the storage and transport of that energy. With the use of fuel cells and hydrogen technology, electrical power from renewable energy sources can be delivered where and when required, cleanly, efficiently and sustainably.

**References:**