Solar Driven Hydrogen Generation for a Telecommunications Fuel Cell Power Plant

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Abstract- Fossil fuels (especially coal) seem to be the major fuel source worldwide. However, the use of fossil fuels for energy supply has negative environmental impacts (such as greenhouse effects, air pollution, ozone layer depletion) which must be severely countered and reduced, if not completely resolved. For these reasons, the current research and design is being focused on the generation of hydrogen for energy supply in fuel cells, from renewables such as solar and wind. This paper presents work in progress for research on the solar-photovoltaic generation of hydrogen.

Keywords- Alternative Energy, Solar Driven Hydrogen Generation, Renewables, Solar-photovoltaic.

1. INTRODUCTION

Alternative energy refers to any form of energy which is an alternative to the traditional fossil fuels of oil, natural gas and coal. Renewable energy on the other hand are the forms of alternative energy that are renewed by the natural processes of the Earth, such as sunlight from the sun or wind from the air, and so are environmentally friendly [5].

Alternative energy encompasses a variety of power generation sources. It refers to electrical power derived from "renewable" resources such as solar or wind energy [5].

Solar power is destined to make a significant contribution to the world energy supply because of finite amounts of fossil fuels and environmental damage consciousness. It is emphasized that the global environmental damage caused thermodynamically is more alarming to life on earth than the risk of exhausting the finite amount of fossil fuels being consumed at the present rate [1].

Solar technology can be categorized into three major systems, namely: (a) solar heating and cooling of space, (b) solar thermal conversion, and (c) photovoltaic cells. Among the renewable energy systems, the photovoltaic cells, which generate direct current electric energy when exposed to solar radiant energy, can be considered the most important source of energy. It generates electricity with a little impact on the environment, have no moving parts to wear out, is modular, which means that they can be matched to a need for power at any scale, can be used as independent power source or in combination with others, and they are reliable with long life expectancies [1].

Hydrogen can play an important role as an alternative to conventional fuels. One of the most attractive features of hydrogen as an energy carrier is that it can be produced from water. Also, hydrogen has the highest energy content per unit mass as compared to chemical fuel and can be substituted in place of hydrocarbons in a broad range of applications. Its burning process is non –polluting and it can be used in fuel cells to produce both electricity and useful heat [1]. Hydrogen is widely regarded as the fuel of the future, and in order to benefit from its unique properties, it must be produced by the use of a renewable source so that there will be no limitation or environmental pollution in the long run [4].

Almost all the renewable energy sources originate from the sun. The interest in solar energy utilization has taken place since 1970, principally due to the then rising cost of energy from fossil fuels. Solar radiation is the worlds' most abundant and permanent energy source. The amount of solar energy received by the surface of the earth per minute is greater than the energy utilization by the entire population in one year. Solar energy will be available as long as the sun continues to shine [4].

Hydrogen production using direct solar energy and electrolyzer systems can be achieved in various ways [1]. The following methods can be mentioned: (i) solar thermal electrical power generation and water electrolysis, and (ii) photovoltaic electrical power and water electrolysis. The last method has an additional advantage, as the direct current electrical power produced by a photovoltaic generator can be supplied directly to an electrolyzer [1].

A number of solar hydrogen projects have been undertaken to produce hydrogen gas for various applications by using electricity from photovoltaic panels and commercially available electrolyzers. In the past, these projects have proven unsatisfactory due to the low efficiency and high cost of the technology which converted 2-6% of the solar energy to hydrogen [2]. A suitable and effective solar hydrogen production method is therefore imperative. This is what this research aims to address.

2. RELATED WORK

A wide variety of literature is available on the production of hydrogen by an electrolyzer using PV energy. The integration between solar photovoltaic arrays and a water electrolysis unit for hydrogen production has been investigated [1]. Furthermore, the optimization of solar

powered hydrogen production using photovoltaic electrolysis devices has been carried out [2]. Lehman et al. [3] reported the performance, safety, and maintenance issues of a photovoltaic power plant which used hydrogen energy storage and fuel cell regenerative technology. Figure 1 shows an example of such a system.

The above provides us with useful information necessary for this current research.

3. RESEARCH AIMS

The aim of this research is to develop a suitable and effective photovoltaic-electrolyzer hydrogen generation and storage system that can be adopted by appropriate industries. In telecommunications it will be of value as a secondary or standby power supply for existing telecommunication sites.

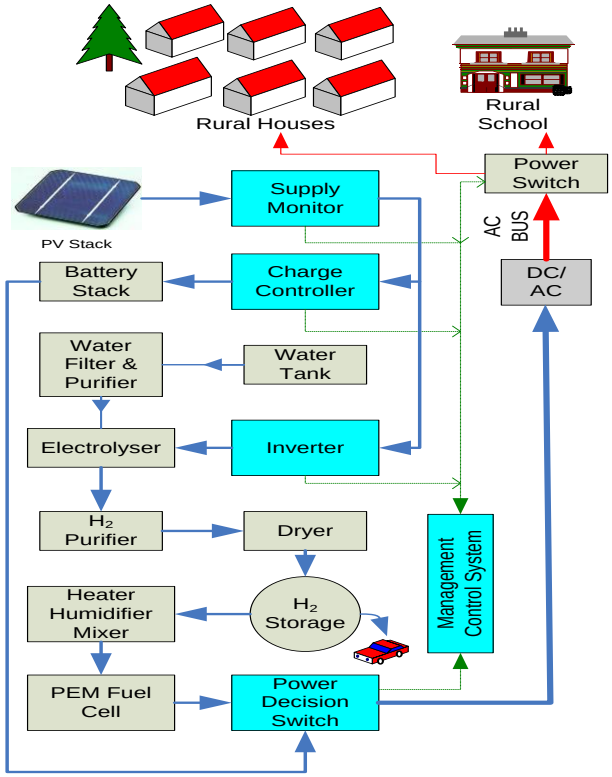

Figure 1 A solar-hydrogen control and management system.

(a) (b)

Figure 2 (a) Installed solar-photovoltaic panels for the current research; (b) laboratory hydrogen storage setup.

This project will serve as a springboard for further research in this field, and it is envisioned that its completion will evoke interests and concerns and thus encourage present and future researchers to collaborate. Finally, it is expected that the research will serve as a means of education in renewable energy to the general public.

4. WORK DONE AND FUTURE WORK

The equipment (photovoltaic panels, electrolyzer, batteries, charge controller, flowmetre, and inverter) needed for the research have been acquired. The solar-photovoltaic hydrogen generation and storage system has been designed and installed as shown in figures 2a and b. A hydrogen purity sensor has been ordered and as soon as it arrives, the laboratory test and measurement will begin.

Various essential parameters like current, voltage, hydrogen flow rate, effect of temperature on the hydrogen production, and the solar-hydrogen efficiency will be determined from all the tested solar panels. The development of a suitable and effective hydrogen generation system will complete the project.

5. CONCLUSION

The production of hydrogen using solar photovoltaic technology is highly promising and of immense advantage to the world at large. It will address and procure solutions to existing problems caused by the use of fossil fuels thereby making our immediate environment a better and safer place to live in. It will also solve part of the problem of electricity shortage in Africa.

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