A Review Paper on Green Power Generation Using Renewable Energy Sources without Pollution

Nirma Kumari Sharma

Assistant Professor Electrical Engineering Department, Mewar University, India

Abstract: ***Green power is electricity that is generated from resources such as solar, wind, geothermal, biomass, and low-impact hydro facilities. Conventional electricity generation, based on the combustion of fossil fuels, is the nation's single largest industrial source of air pollution. The increasing availability of green power enables electricity customers to accelerate installation of renewable energy technologies. As more green power sources are developed - displacing conventional generation - the overall environmental impacts associated with electricity generation will be significantly reduced. There are many ways to generate electricity, including photovoltaics, turbines and fuel cells.Zero emission green power is generated from renewable energy sources without creating air pollution. Green power energy is also called clean power energy.It's electricity without pollution. Electricity from renewable resources—like the wind, the sun, small dams and Maine's trees. Clean energy has environmental and health benefits. It also has economic and security benefits. Clean, homegrown energy from renewable resources reduces demand for expensive and often-imported fuels like oil and natural gas.***

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1. Introduction

Green energy or clean energy is electricity without pollution. Electricity from renewable resources—like the wind, the sun, small dams and Maine's trees. Clean energy has environmental and health benefits. It also has economic and security benefits. Clean, homegrown energy from renewable resources reduces demand for expensive and often-imported fuels like oil and natural gas.Fuel cells create electricity, usable heat, and water by combining hydrogen and oxygen. The hydrogen does not need to be available because commercial offerings run on natural gas, coal gas, propane and bio fuels, including methane. The cells internally extract the necessary hydrogen. They produce Direct Current (DC) electricity without the conventional combustion reaction, which is then converted into Alternating Current (AC) for use. Current fuel cells are generally stationary and used for large fixed locations like resorts, prisons, wastewater facilities, and manufacturing plants, although there are units currently available for smaller uses.

Smartly designed microCHP (combined heat and power) fuel cells maximize energy efficiency by creating electricity as well as usable heat from one clean source. Specifically developed to take advantage of the current fuel infrastructure, these fuel cells plumb to readily available natural gas and offer available power 24/7, day or night. Easily configurable, these units integrate seamlessly into existing or newly designed electrical and mechanical systems providing locally generated energy where and when it is needed. Unlike conventional grid-power sources that burn coal or gas and create an increased environmental burden, clean energy fuel cells create power with efficiency rates of 90% while offering a reduction in energy bills and a 40% reduction in carbon emissions.

2. Green Power: Generation Technology

There are many ways to generate electricity. Most electric power plants generate electricity by creating steam to turn a turbine.

Photovoltaic's

Solar cells (also called photovoltaic or PV systems) convert light energy directly to electric current. When light strikes the cell, energy is absorbed within a semiconductor material, freeing electrons. Impurities within the semiconductor material force these electrons to flow in a certain direction. This creates an electric current.The photovoltaic (PV) Solar HomeSystems (SHS) under discussion aresold mostly to rural and semi urbanhouseholds in India. Many of the re-gions in rural India are completely off-grid (around 46%); others are connected to the grid but have intermittentor no supply, so there is a real needfor these consumers to find alternativepower solutions. The SHS providesreliable power for lighting and otherlow-power appliances, such as radio and television. Customers today understand the benefits of installing SHSand see the value of investing in one.Though initial applications of theseSHS were restricted to domestic lighting, today there are many instances ofinstallations in schools, small hospitals, community centers, and a multitude of micro-enterprises, where SHScan extend viable working hours intothe night and provide power for op-erations. The SHS have great intangible benefits too – smoky and carbonintensive kerosene lights are avoidedand people have new leisure and educational opportunities.

3. Photovoltaic Cells: Converting Photons to Electrons

The solar cells that you see on calculators and satellites are also called photovoltaic (PV) cells, which as the name implies (photo meaning "light" and voltaic meaning "electricity"), convert sunlight directly into electricity. A module is a group of cells connected electrically and packaged into a frame (more commonly known as a solar panel), which can then be grouped into larger solar arrays, like the one operating at Nellie Air Force Base in Nevada.Photovoltaic cells are made of special materials called semiconductors such as silicon, which is currently used most commonly. Basically, when light strikes the cell, a certain portion of it is absorbed within the semiconductor material. This means that the energy of the absorbed light is transferred to the semiconductor. The energy knocks electrons loose, allowing them to flow freely.PV cells also all have one or more electric field that acts to force electrons freed by light absorption to flow in a certain direction. This flow of electrons is a current, and by placing metal contacts on the top and bottom of the PV cell, we can draw that current off for external use, say, to power a calculator. This current, together with the cell's voltage (which is a result of its built-in electric field or fields), defines the power (or wattage) that the solar cell can produce.

3.1 Fuel Cells

A fuel cell converts hydrogen and oxygen into water, producing electricity and heat through a chemical process. Electric current is produced as electrons are separated from hydrogen gas on the anode side of the cell, while recombining with hydrogen and oxygen to form water on the cathode side. The fuels that power fuel cells can come from either renewable sources (such as hydrogen produced by wind-generated electricity) or non-renewable sources (such as natural gas). If you want to be technical about it, a fuel cell is an electrochemical energy conversion device**.** A fuel cell converts the chemicals hydrogen and oxygen into water, and in the process it produces electricity.

The other electrochemical device that we are all familiar with is the battery. Abattery has all of its chemicals stored inside, and it converts those chemicals into electricity too. This means that a battery eventually "goes dead"and you eitherthrow it away or recharge it.With a fuel cell, chemicals constantly flow into the cell so it never goes dead -- as long as there is a flow of chemicals into the cell, the electricity flows out of the cell.

A fuel cell is an electrochemical energyconversion device. It is two to threetimes more efficient than an internal combustion engine in converting fuel to power. A fuel cell produces electricity, water, and heat using fuel and oxygen in the air. Water is the only emission when hydrogen is the fuel. As hydrogen flows into the fuel cell on the anode side, a platinum catalyst facilitates the separation of the hydrogen gasinto electrons and protons (hydrogen ions). The hydrogen ions passthrough the membrane (the center of the fuel cell) and, again with thehelp of a platinum catalyst, combine with oxygen and electrons on thecathode side, producing water. The electrons, which cannot passthrough the membrane, flow from the anode to the cathode through anexternal circuit containing a motor or other electric load, which con-sums the power generated by the cell.The voltage from one single cell is about 0.7 volts – just about enoughfor a light bulb – much less a car. When the cells are stacked in series, the operating voltage increases to 0.7 volts multiplied by the numberof cells stacked.

3.3 Electrolyte Membrane Fuel Cell

An ordinary electrolyte is a substance that dissociatesinto positively charged and negatively charged ions inthe presence of water, thereby making the water solution electrically conducting. The electrolyte in apolymer electrolyte membrane fuel cell is a type ofplastic, a polymer, and is usually referred to as a membrane. The appearance of the electrolyte variesdepending upon the manufacturer, but the most prevalent membrane, Nafion TM produced by DuPont, resembles the plastic wrap used for sealing foods. Typically, the membrane material is more substantial than common plastic wrap, varying in thickness from 50 to175 microns. To put this in perspective, consider that apiece of normal writing paper has a thickness of about 25microns. Thus polymer electrolyte membranes haven thicknesses comparable to that of 2 to 7 pieces of paper.In an operating fuel cell, the membrane is well humidified so that the electrolyte looks like a moist piece of thick plastic wrap. Polymer electrolyte membranes are somewhat unusual electrolytes in that, in the presence of water, which the membrane readily absorbs, the negative ions are rigidly held within their structure. Only the positive ionscontained within the membrane are mobile and are freeto carry positive charge through the membrane. Inpolymer electrolyte membrane fuel cells these positiveions are hydrogen ions, or protons, hence the term –proton exchange membrane. Movement of the hydro-gen ions through the membrane, in one direction only, from anode to cathode, is essential to fuel cell operation.Without this movement of ionic charge within the fuelcell, the circuit defined by cell, wires, and load remainsopen, and no current would flow.Because their structure is based on a Teflon TM backbone,polymer electrolyte membranes are relatively strong,stable substances. Although thin, a polymer electrolytemembrane is an effective gas separator. It can keep thehydrogen fuel separate from the oxidant air, a featureessential to the efficient operation of a fuel cell. Al-though ionic conductors, polymer electrolytemembranes do not conduct electrons.

The organic nature of the polymer electrolyte membrane structuremakes them electronic insulators, another featureessential to fuel cell operation. As electrons cannot move through the membrane, the electrons produced atone side of the cell must travel, through an externalwire, to the other side of the cell to complete the circuit.It is in their route through the circuitry external to thefuel cell that the electrons provide electrical power torun a car or a power plant.

3.4 Regenerative Fuel Cell

A regenerative fuel cell, currently being developed for utility applications, uses hydrogen and oxygen or air to produce electricity, water, and waste heat as a conventional fuel cell does.However, the regenerative fuel cell also performs the reverse of the fuel cell reaction, usingelectricity and water to form hydrogen and oxygen. In the reverse mode of the regenerativefuel cell, known as electrolysis, electricity is applied to the electrodes of the cell to force thedissociation of water into its components.

The “closed” system of a regenerative fuel cell could have a significant advantage because itcould enable the operation of a fuel cell power system without requiring a new hydrogen infrastructure. There are two concerns to be addressed in the development of regenerativefuel cells. The first is the extra cost that would be incurred in making the fuel cell reversible. The second drawback to the operation of the regenerative fuel cell is the use of gridelectricity to produce thehydrogen. In the United States, most electricity comes from burning fossil fuels. The fossil fuel electricity hydrogen energy route generates significantly more green house gases than simply burning gasoline in an internal combustion engine.

Although the concept of aregenerative fuel cell is attractive, until renewable electricity, e.g. electricity from solar or wind sources, is readily available, this technology will not reduce green house gas emissions.

3.4 Potential Applications for Fuel Cells

Fuel cells were developed for and have long been used in the space programto provide electricity and drinking water for the astronauts. Terrestrialapplications can be classified into categories of transportation, stationary or portable power uses. Polymer electrolyte membrane fuel cells are well suited to transportation applications because they provide a continuous electrical energy supply fromfuel at high levels of efficiency and power density. They also offer the advantage of minimal maintenance because there are no moving parts in thepower generating stacks of the fuel cell system.

Distributed power" is a new approach utility companies are beginning toimplement locating small, energy-saving power generators closer to wherethe need is. Because fuel cells are modular in design and highly efficient, these small units can be placed on-site. Installation is less of a financial risk for utility planners and modules can be added as demand increases. Utilitysystems are currently being designed to use regenerative fuel cell technologyand renewable sources of electricity.

4. Future Opportunities

Sustainable development is one of those often used, but seldom defined, phrases. According to theUnited Nations, it is "meeting the needs of the presentwithout compromising the ability of future generationsto meet their own needs." Attaining sustainable development doesn't mean that growth must stop; it doesmean that environmental limits do exist because of thelimited ability of the biosphere to deal with the wastesfrom human activities. This is one of the greatestchallenges we face today — a challenge that can only bemet by responsibly developing and using technologiesthat will protect our environment for everyone.
Polymer electrolyte membrane fuel cells arelimited by the temperature range over whichwater is a liquid. The membrane must containwater so that the hydrogen ions can carry thecharge within the membrane. Operating polymer electrolyte membrane fuel cells attemperatures exceeding 100˚C is possibleunder pressurized conditions, required to keepthe water in a liquid state, but shortens thelife of the cell. Currently, polymer electrolytemembranes cost about $100/square foot.Costs are expected to decrease significantlyas the consumer demand for polymer electro-lyte membrane fuel cells increases.Innovativesolutions can be an important competitiveplus. Over half of the threat to our climate disappears ifwe use energy inways thatsave money. In general, it'sfar cheaper to be efficient and save fuel than burn fuel.Fuel cells offer an opportunity for innovation. Helpingto make fuel cells be a part of the solution might be achallenge that's too exciting to ignore.

"Developing countries face a fundamental choice. They can mimic the industrialcountries, and go through a development phase that is dirty and wasteful and creates anenormous legacy of pollution. Or they can leapfrog over some of the steps followed byindustrial countries and incorporate modern efficient technologies."

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