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Green Energy: A Primer

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Abstract Concerns about climate change and global warming are driving increasing renewable energy legislation. Green or renewable energy is a form of energy that does not contribute to climate change or global warming. It uses energy sources that are continually replenished by nature. It can fulfill the need for energy while saving the planet. This paper briefly reviews major types of renewable energy and their usage.

Keywords green energy, renewable energy, sustainable energy, clean energy

Introduction

Energy is crucially important in the economic and social development of any society. The use of energy is evident in our everyday lives. We need energy in lighting, heating, cooling, transport, communication, systems, domestic appliances, and battery-powered devices to mention but a few. Conventional sources of energy are from non-renewable fossil fuels (coal, oil, natural gas, petroleum, etc.) and nuclear power [1]. Energy that comes from these conventional means is called "brown energy." Another type of energy is "green energy" which is clean source of energy with a lower environmental impact compared to conventional sources.

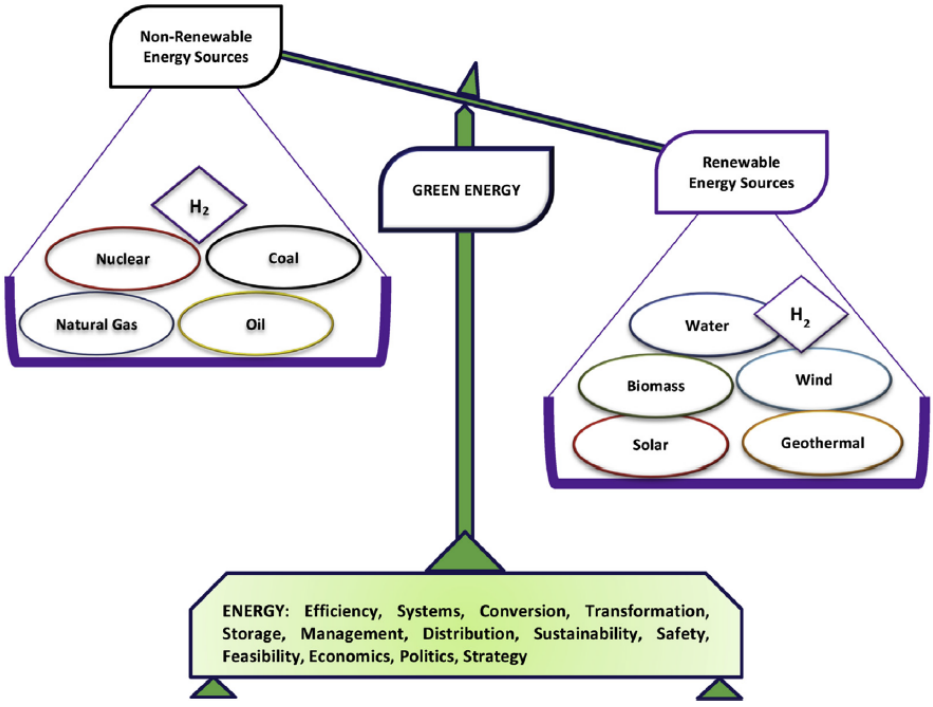

Figure 1: Green energy [2]

Green energy, which is sometimes called *renewable* or *sustainable* energy, comes from natural sources like wind, water, and sunlight. It is often called "clean" because it produces no pollutants. It is an attractive option because it provides a clean and earth-friendly alternative to traditional energy. It is illustrated in Figure 1 [2].
Renewable energy is derived from natural phenomena such as sunlight, wind, tides, and geothermal heat which are replenished constantly. It would reduce environmental pollution and lead to energy independence and an electrical grid that is much more reliable, secure, efficient, and greener. As Sherrod Brown (the US senator) rightly said, "Green energy is an environmental strategy, a national security strategy, an economic strategy. Investing in its development and production is both right and smart. Failing to invest in it is a risk to the future of our nation and our planet" [3].

Types of Green Energy

Green energy is generated from sources such as solar, wind, geothermal, and biomass. There are different forms of green energy depending on the sources [4,5]. The sun plays a crucial role in most types of renewable energy since they depend on it one way or the other.

- *Solar*: This involves capturing the sun's energy with photovoltaic cells and converting it into electricity. This energy can be collected and converted in different ways. It can be harnessed through a range of technologies like solar heating and photovoltaic. Solar energy is produced by capturing the sun's energy directly. Solar energy is the fastest growing renewable, while **solar photovoltaics** is the largest renewable employer**.** For example, a building can be constructed to incorporate a solar hot water, cooling or ventilation system.
- *Wind*: Wind energy is produced by wind turbines with rotating blades capturing the wind flow and harnessing the wind's kinetic energy to generate electricity. It requires extensive area coverage to produce significant amounts of energy. For example, wind turbines may be used to generate electricity as a supplement to an company's existing power supply.
- *Hydroelectric:* This involves using water flow to power a turbine. The turbines are connected to generators which harness the mechanical energy from the water currents and convert it into hydroelectricity. This is often regarded as the largest source of renewable energy. Strictly speaking, hydropower is not renewable because it has the largest environmental impacts partly due to the need to construct dams which block animal migration and disrupt river flows. For example, small towns can harness the energy of local rivers by building hydroelectric power systems.
- *Geothermal energy:* As the name implies, geothermal energy is heat energy from the earth itself. The temperature of the earth steadily increases with depth. Geothermal power plants harness the heat sources to produce electricity, which is cost effective, reliable, sustainable, and eco-friendly. A major challenge with this energy source is that plants are expensive to build. For example, geothermal energy may be used for heating/cooling office buildings or manufacturing plants.
- *Biomass*: This is produced when organic wastes decay. This waste can be converted to fuel through combustion for the generation of electricity. Biomass is mankind's original source of energy. The most popular form is burning trees for cooking and warmth. Geothermal and biomass power plants may require water for cooling. For example, farm operations can convert waste from livestock into electricity.

Other types of green energy include energy from tides, hydrogen, and fuel cells.
All these are produced with the same goal in mind, which is to save the planet.

Applications

Rapid advances in green energy technologies are improving the efficiency of generating electricity using renewable sources, and also driving down the cost of deploying a green power system. Here we present some usages or applications of green energy.

- *Smart Home:* A smart home provides optimum living conditions required naturally. Green renewable energy source (such as solar panel) has been utilized in generating power for all the smart appliances used to sustain the smart home. Solar heat energy has been used to generate hot water and do the

cooking. Using the green energy source in smart home can reduce energy cost and minimize wastage of energy [6].

- *Businesses*: Reducing energy usage is not limited to household. For businesses, it is important to effectively reduce electricity consumption and environmental pollution. Switching to green energy can actually bring many different benefits to a business. The benefits include lower energy bills, boosting public relations, creating jobs, and great return on investment [7].
- *Data centers*: Data centers are known for consuming an enormous amount of electricity. Mega data centers (such as those of Apple and Google) have emerged due to the soaring demand for IT services. Data center operators are constantly under pressure to minimize the carbon footprint. To achieve this requires powering data centers by on-site generation of renewable energy. Renewable energy integration lowers the cost of designing fault tolerant distributed data centers with reduced carbon footprint [8].
- *Mobile networks*: These are among the major energy guzzlers. The growing energy consumption leads to a significant rise of carbon footprints. Therefore, greening mobile networks is becoming a necessity for economic and environmental sustainability. Green energy is a promising energy alternative for future mobile networks [9].

Other applications include cellular networks, cognitive radio networks, and for battlefield.

Benefits

Green energy offers a number of benefits to businesses and institutions. In a sense, green energy is unlimited since supplies are continually replenished through natural processes. Choosing green power is a prudent step towards more sustainable operations and practices and a demonstration of environmental stewardship. Green energies tend to have much lower emissions than other sources, such as natural gas or coal. The renewable energy industry is more labor intensive and supports thousands of jobs. It is providing stable and affordable electricity [10]. Many homeowners can sell excess solar or wind energy to their utility companies. This way, they can pay off their energy investments quickly.

Challenges

The most significant challenges to the widespread implementation of renewable energy and low carbon energy strategies are seen to be mainly social and political, not technological or economic. The key barriers include climate change denial, the fossil fuels lobby, political inaction, unsustainable energy consumption, and outdated energy infrastructure. Renewable energy technology has sometimes been regarded as expensive by critics, and affordable only in the affluent developed world. But renewable energy can be suitable for developing countries as well. It can contribute to poverty reduction by providing the energy needed for creating businesses and jobs [11].

Renewable energy from sources such as wind power and solar power is sometimes criticized for being variable and not available 24/7. Hydroelectric power generators can disrupt river ecosystems both upstream and downstream from the dam.

Investment in green energy depends on the availability of finance. Developed economies dominated the financing of renewable energy. In developing economies, investing in green energy technology is difficult because of the high cost of financing and also because obtaining financing at affordable rates is a major challenge.

Conclusion

To be green is becoming fashionable today. Green energy has attracted much attention across the globe due to the fact that it is non-polluting and more environmental-friendly. Renewable energy systems are rapidly becoming more efficient and cheaper. The market for renewable energy will keep growing.

Each country should have green energy as an important component of their energy planning. Government policies are important in ensuring that the energy sector produces sustainable energy. Policy instruments such as taxes, regulations, and subsidies can stimulate the adoption of green energy technologies [12].

More education about green energy is necessary for the general public, students, and engineers to be aware of the new field. More information about green renewable energy can be found in *International Journal of Green Energy* and *Green Energy & Environment*, two journals devoted exclusively to green energy.

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