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Green Energy: Options and Viability to Meet Energy Demand

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Abstract

Green energy is viable in long term to meet the energy demand and for air quality improvement. Solar, biomass, wind, anaerobic digestion, combined heat & power (CHP) and hydro-electricity constitute green energy. Renewable energy sources also have a much smaller impact on the environment than fossil fuels, which produce pollutants such as greenhouse gases as a by-product, contributing to climate change. Gaining access to fossil fuels typically requires either mining or drilling deep into the earth, often in ecologically sensitive locations. Green energy can replace fossil fuels in all major areas of use including electricity, water and space heating and fuel for motor vehicles. There is lot of scope and potentiality to generate green energy to achieve sustainable development.

Keywords: Green energy; climate; mitigation; air quality; energy demand.

1. Introduction

Green energy includes natural energetic processes that can be harnessed with little pollution. Anaerobic digestion, geothermal power, wind power, small-scale hydropower, solar energy, biomass power, tidal power, wave power, and some forms of nuclear power (ones which are able to "burn" nuclear waste through a process known as nuclear transmutation, e.g. an Integral Fast Reactor), and therefore belong in the "Green Energy" category). Some people, including Greenpeace founder and first member Patrick Moore [1-3], George Monbiot [4], Bill Gates [5] and James Lovelock [6] have specifically classified nuclear power as green energy. Others, including

Greenpeace [7-8] disagree, claiming that the problems associated with radioactive waste and the risk of nuclear accidents (such as the Chernobyl disaster) pose an unacceptable risk to the environment and to humanity. However, newer nuclear reactor designs are capable of utilizing what is now deemed "nuclear waste" until it is no longer (or dramatically less) dangerous, and have design features that greatly minimize the possibility of a nuclear accident. Some have argued that although green energy is a commendable effort in solving the world's increasing energy consumption, it must be accompanied by a cultural change that encourages the decrease of the world's appetite for energy [9].

In several countries with common carrier arrangements, electricity retailing arrangements make it possible for consumers to purchase green electricity (renewable electricity) from either their utility or a green power provider. When energy is purchased from the electricity network, the power reaching the consumer will not necessarily be generated from green energy sources. The local utility company, electric company, or state power pool buys their electricity from electricity producers who may be generating from fossil fuel, nuclear or renewable energy sources. In many countries green energy currently provides a very small amount of electricity, generally contributing less than 2 to 5% to the overall pool. In some U.S. states, local governments have formed regional power purchasing pools using Community Choice Aggregation and Solar Bonds to achieve a 51% renewable mix or higher, such as in the City of San Francisco [10]. One of the main problems with purchasing green energy through the electrical grid is the current centralized infrastructure that supplies the consumer's electricity. This infrastructure has led to increasingly frequent brown outs and black outs, high CO_2 emissions, higher energy costs, and power quality issues [11]. An additional $450 billion will be invested to expand this fledgling system over the next 20 years to meet increasing demand [12]. To have a more sustainable energy profile, the developed countries like United States must move towards implementing changes to the electrical grid that will accommodate a mixed-fuel economy [13]. Merging heat and power in system would create added benefits and help to increase its efficiency by up to 80-90%. This is a significant increase from the current fossil fuel plants which only have an efficiency of 34% [14].

NASA said in 2000 that the technology was worth pursuing but it is still too soon to say if the technology will be cost-effective [15]. The World Wide Fund for Nature and several green electricity labeling organizations have created the Eugene Green Energy Standard under which the national green electricity certification schemes can be accredited to ensure that the purchase of green energy leads to the provision of additional new green energy resources [16]. A carbon neutral fuel is a synthetic fuel such as methane, gasoline, diesel fuel or jet fuel produced from renewable or nuclear energy used to hydrogenate waste carbon dioxide recycled from power plant flue-gas emissions, recovered from automotive exhaust gas, or derived from carbonic acid in seawater [17-21]. Such fuels are carbon neutral because they do not result in a net increase in atmospheric greenhouse gases [22-23]. To the extent that carbon neutral fuels displace fossil fuels, or if they are produced from waste carbon or seawater

carbonic acid, and their combustion is subject to carbon capture at the flue or exhaust pipe, they result in negative carbon dioxide emission and net carbon dioxide removal from the atmosphere, and thus constitute a form of greenhouse gas remediation [24-26]. Such fuels are produced by the electrolysis of water to make hydrogen used in turn in the Sabatier reaction to produce methane which may then be stored to be burned later in power plants as synthetic natural gas, transported by pipeline, truck, or tanker ship, or be used in gas to liquids processes such as the Fischer–Tropsch process to make traditional transportation or heating fuels [27-28].

2. Types of Green Energy

Research into renewable, non-polluting energy sources is advancing at such a fast pace, it's hard to keep track of the many types of green energy that are now in development. Here are 6 of the most common types of green energy: (a) solar power: most prevalent type of renewable energy, solar power is typically produced using photovoltaic cells, which capture sunlight and turn it into electricity. Solar energy is also used to heat buildings and water, provide natural lighting and cook food. Solar technologies have become inexpensive enough to power everything from small hand-held gadgets to entire neighborhoods; (b) wind power: air flow on the earth's surface can be used to push turbines, with stronger winds producing more energy. High-altitude sites and areas just offshore tend to provide the best conditions for capturing the strongest winds. According to a 2009 study, a network of land-based, 2.5-megawatt wind turbines in rural areas operating at just 20% of their rated capacity could supply 40 times the current worldwide consumption of energy; (c) hydropower: also called hydroelectric power, hydropower is generated by the Earth's water cycle, including evaporation, rainfall, tides and the force of water running through a dam. Hydropower depends on high precipitation levels to produce significant amounts of energy (d) geothermal energy: just under the earth's crust are massive amounts of thermal energy, which originates from both the original formation of the planet and the radioactive decay of minerals. Geothermal energy in the form of hot springs has been used by humans for millennia for bathing, and now it's being used to generate electricity. In North America alone, there's enough energy stored underground to produce 10 times as much electricity as coal currently does; (e) biomass: recently-living natural materials like wood waste, sawdust and combustible agricultural wastes can be converted into energy with far fewer greenhouse gas emissions than petroleum-based fuel sources. That's because these materials, known as biomass, contain stored energy from the sun; (f) bio-fuels - Rather than burning biomass to produce energy, sometimes these renewable organic materials are transformed into fuel. Notable examples include ethanol and biodiesel. Bio-fuels provided 2.7% of the world's fuels for road transport in 2010, and have the potential to meet more than 25% of world demand for transportation fuels by 2050.

3. Climate Change Mitigation

Climate change mitigation plan includes generation of green energy. Climate change and global warming concerns, coupled with high oil prices, peak oil, and increasing government support, are driving increasing renewable energy legislation, incentives and commercialization. New government spending, regulation and policies helped the industry weather the global financial crisis better than many other sectors. According to a 2011 projection by the International Energy Agency, solar power generators may produce most of the world's electricity within 50 years, dramatically reducing the emissions of greenhouse gases that harm the environment. Renewable energy sources, that derive their energy from the sun, either directly or indirectly, such as Hydro and wind, are expected to be capable of supplying humanity energy for almost another 1 billion years, at which point the predicted increase in heat from the sun is expected to make the surface of the Earth too hot for liquid water to exist.

4. Benefits of Green Energy

Green energy has a long list of benefits from air quality improvement to economic development accepted by society at large to achieve sustainable development. Benefits of green energy includes supporting and expanding economic investment, thus building a stronger, greener economy with an estimated 50,000+ direct and indirect jobs over the next three years; expanding Ontario's use of clean and renewable sources of energy such as wind, solar, biomass and biogas; and better protecting the environment, combating climate change and creating a healthier future for generations to come.

5. Local Green Energy Systems

Those not satisfied with the third-party grid approach to green energy via the power grid can install their own locally based renewable energy system. Renewable energy electrical systems from solar to wind to even local hydro-power in some cases are some of the many types of renewable energy systems available locally. Additionally, for those interested in heating and cooling their dwelling via renewable energy, geothermal heat pump systems that tap the constant temperature of the earth, which is around 7 to 15 degrees Celsius a few feet underground and increases dramatically at greater depths, are an option over conventional natural gas and petroleum-fueled heat approaches. Also, in geographic locations where the Earth's Crust is especially thin, or near volcanoes (as is the case in Iceland) there exists the potential to generate even more electricity than would be possible at other sites, thanks to a more significant temperature gradient at these locales. The advantage of this approach in the United States is that many states offer incentives to offset the cost of installation of a renewable energy system. In California, Massachusetts and several other U.S. states, a new approach to community energy supply called Community Choice Aggregation has provided communities with the means to solicit a competitive electricity supplier and

use municipal revenue bonds to finance development of local green energy resources. Individuals are usually assured that the electricity they are using is actually produced from a green energy source that they control. Once the system is paid for, the owner of a renewable energy system will be producing their own renewable electricity for essentially no cost and can sell the excess to the local utility at a profit.

Using green energy Renewable energy, after its generation, needs to be stored in a medium for use with autonomous devices as well as vehicles. Also, to provide household electricity in remote areas (that is areas which are not connected to the mains electricity grid), energy storage is required for use with renewable energy. Energy generation and consumption systems used in the latter case are usually stand-alone power systems. Some examples are: (i) energy carriers as hydrogen, liquid nitrogen, compressed air, oxyhydrogen, batteries, to power vehicles; (ii) flywheel energy storage, pumped-storage hydroelectricity is more usable in stationary applications (e.g. to power homes and offices). In household power systems, conversion of energy can also be done to reduce smell. For example organic matter such as cow dung and spoilable organic matter can be converted to biochar. To eliminate emissions, carbon capture and storage is then used. Usually however, renewable energy is derived from the mains electricity grid. This means that energy storage is mostly not used, as the mains electricity grid is organized to produce the exact amount of energy being consumed at that particular moment. Energy production on the mains electricity grid is always set up as a combination of (large-scale) renewable energy plants, as well as other power plants as fossil-fuel power plants and nuclear power. This combination however, which is essential for this type of energy supply (as e.g. wind turbines, solar power plants etc.) can only produce when the wind blows and the sun shines. This is also one of the main drawbacks of the system as fossil fuel power plants are polluting and are a main cause of global warming (nuclear power being an exception). Although fossil fuel power plants too can made emission less (through carbon capture and storage), as well as renewable (if the plants are converted to e.g. biomass) the best solution is still to phase out the latter power plants over time.

Nuclear power plants too can be more or less eliminated from their problem of nuclear waste through the use of reprocessing and newer plants as fast breeder and nuclear fusion plants. Renewable energy power plants do provide a steady flow of energy. For example hydropower plants, ocean thermal plants, osmotic power plants all provide power at a regulated pace, and are thus available power sources at any given moment (even at night, wind still moments etc.). At present however, the number of steady-flow renewable energy plants alone is still too small to meet energy demands at the times of the day when the irregular producing renewable energy plants cannot produce power. Besides the greening of fossil fuel and nuclear power plants, another option is the distribution and immediate use of power from solely renewable sources. In this set-up energy storage is again not necessary. For example, TREC has proposed to distribute solar power from the Sahara to Europe. Europe can distribute wind and ocean power to the Sahara and other countries. In this way, power is

produced at any given time as at any point of the planet as the sun or the wind is up or ocean waves and currents are stirring. This option however is probably not possible in the short-term, as fossil fuel and nuclear power are still the main sources of energy on the mains electricity net and replacing them will not be possible overnight. Several large-scale energy storage suggestions for the grid have been done. This improves efficiency and decreases energy losses but a conversion to an energy storing mains electricity grid is a very costly solution. Some costs could potentially be reduced by making use of energy storage equipment the consumer buys and not the state. An example is car batteries in personal vehicles that would double as an energy buffer for the electricity grid. However besides the cost, setting-up such a system would still be a very complicated and difficult procedure. Also, energy storage apparatus' as car batteries are also built with materials that pose a threat to the environment (e.g. sulphuric acid). The combined production of batteries for such a large part of the population would thus still not quite environmental. Besides car batteries however, other large-scale energy storage suggestions for the grid have been done which make use of less polluting energy carriers (e.g. compressed air tanks and flywheel energy storage).

6. Conclusion

Green energy comes from natural sources such as sunlight, wind, rain, tides, plants, algae and geothermal heat. These energy resources are renewable, meaning they're naturally replenished. In contrast, fossil fuels are a finite resource that take millions of years to develop and will continue to diminish with use. Green Energy Technologies uses the latest wind measurement instrumentation and software to accurately assess average wind speed and direction and Green Energy conducts a wind speed study to determine an optimal, cost-effective location for anemometer equipment. Green energy is an essential component for purification and air quality improvement that leads to climate change mitigation approach to achieve sustainable development. Green energy, however, utilizes energy sources that are readily available all over the world, including in rural and remote areas that don't otherwise have access to electricity. Advances in renewable energy technologies have lowered the cost of solar panels, wind turbines and other sources of green energy, placing the ability to produce electricity in the hands of the people rather than those of oil, gas, coal and utility companies. There is need for further research.

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