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A Review of Nano -Technology and Renewable Energy: Challenges and scope

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Abstract

The objective of this research is to cover both old and the latest and emerging technologies in the field of renewable energy sources. The topic describes the various forms of renewable sources of energy and their applications. The term Nano technology and its applications have captured the worldwide market. The nanomaterials which are developing using this technology can be incorporated into the devices so that renewable energy can be converted or generated more efficiently. Nanomaterials have the potential to change the way we generate, deliver and use energy.

Introduction:

The technology is shrinking day-by-day in toady's world and the prefix "nano" implies one of the dimension sizes in this cutting-edge era. Nano is of the order of 10(-9). The demand for energy is increasing at a high rate these days. Each and every thing requires energy to carry out its functions. So conservation of energy becomes an important issue. First of all, let me define what is Energy? The rate of doing work is termed as energy. Energy can be in various forms (light, heat, work, etc). There are two major sources of energy being used in today's world, Renewable and Non-renewable sources. Let me define the non-renewable source first. These are the sources which can not be renewed after a period of time and becomes exhausted e.g., coal, fossil fuels, natural gas, etc. Such sources release harmful gases to the environment thereby polluting the atmosphere. The alternative to such sources is the renewable source of energy. These sources are clean or say, non-polluting or it reduces the effect of harmful gases to a considerable amount. Such sources can never be exhausted and hence called non-conventional sources of energy. Renewable sources include solar energy, bio-mass, wind, etc.

Energy Challenges:

In today's economy, reliable, efficient, pollution free, abundant energy requirement is the major challenge. Our major economy needs, in terms of energy comprises of transportation sector, residential and commercial sectors. We are heavily dependent on the non-renewable sources for our energy needs. Not only these resources will deplete over time, they are also the major source of pollution, which is another key issue in front of the economy. To face these challenges there's needed to come up with the new technology that helps in reducing the problems and also improves our economy.

History of renewable sources of energy

Several developments have been made and are in progress to harness the renewable source of energy. The increasing popularity of the use of solar energy, wind energy and bio-mass fuels provide the evidence that the work has been in progress to accomplish the task and improves the economy.

The Energy Efficiency and Renewable Energy branch of the US Department of Energy Office [1] heads the research, development, and deployment efforts in renewable sources of energy. It develops energy efficiency technologies to provide reliable and affordable supply of energy using the solar, biomass and wind. Due to their efforts, tremendous progress has been made in bringing renewable energy technologies to the marketplace. While the efforts of DOE have started giving results but a lot more has to be done to meet current energy challenges.

Solar Energy

Solar Energy is the energy obtained from the sun. It's the most efficient and clean source of energy to drive the latest trends in the market. Solar energy in the form of photovoltaic cells has been extensively used in electricity and the related areas. It is the permanent and reliable source of non-conventional form of energy.

Solar energy is a non-exhaustible, non-pollutant, readily available source of energy. The sun is being used for many purposes in our daily life routine. It is used for several household activities like cooking, drying clothes, generating electricity and so on and so forth.

The solar energy can be used through photovoltaic cells to generate the electricity that can either be stored in the form of battery or used for many applications such as [2]:

Desalination of salty water, Railway signals, Electrification, Telecommunication, etc.

The modern technology is full of electronic gadgets that utilize solar energy like solar cookers, solar cells, solar heating and cooling systems, solar timber kilns, and power towers.

Figure: Solar Towers

Biomass

It is defined as the conversion of biodegradable waste obtained from the organic and inorganic substances into fuel or power. It is an important source of energy used in domestic as well in industrial applications. All such kind of energy sources are used to produce the pollution free atmosphere and healthy and clean surroundings. Several researches show the new trends in the use of biomass productions [7].

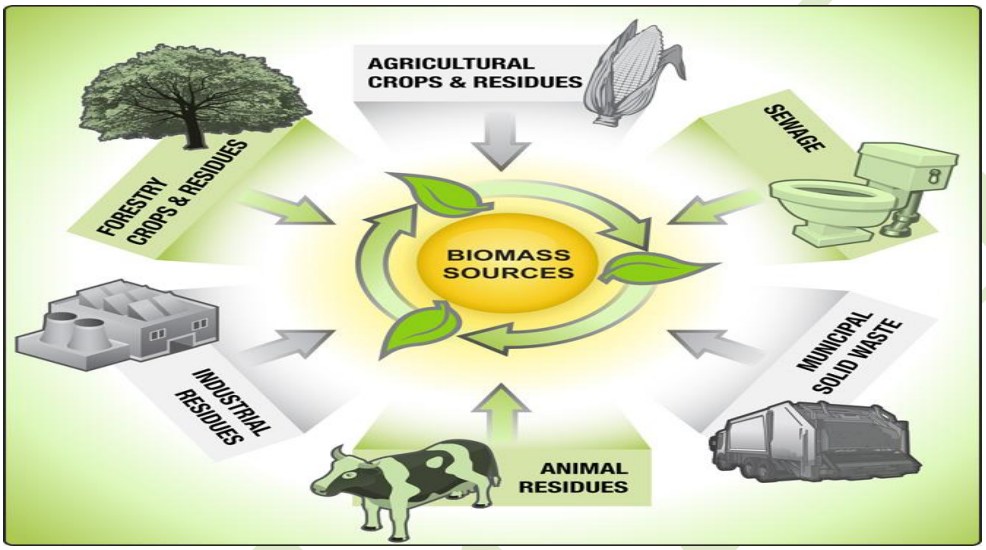

Figure: Biomass Energy

Wind energy

The air in our environment moves in many directions. The movement is caused by the temperature difference. Hot air rises while cool air comes down. The air from hot tropical region moves towards the cold polar region. The wind energy can be converted into electricity by using a windmill. The wind rotates the fan on the mill which is connected to a dynamo that generates electricity. This wind electricity can also be utilized to produce hydrogen which is the most important element in Hydrogen economy [8].

Emerging Technology

To conserve and establish the new renewable sources, many countries are trying hard to develop new projects and harness the new renewable forms of energy. These countries are trying to tap the energy from relatively unexplored sectors. Nanomaterials and Hydrogen fuel cell have the advantage of being smaller and portable. Therefore they have many more applications.

Nano materials

DOE is also active in research and development of nanotechnology [1]. Nanomaterials, which are of the size of a 10-9 of a meter, offer different chemical and physical properties from the same materials in normal form. They can be adopted in new technologies.

Nanomaterials have the potential use in making more efficient solar cells and catalysts that can be used in hydrogen-powered fuel cells.

Due to small size and excellent conductivity, CNTs (carbon nanotubes), can possibly be used as foundation of future electronic devices. CNT cables could be used to make electricity transmission lines . CNT cables could be used to make electricity transmission lines, which will give us large performance improvement over present day power lines.

Hydrogen fuel cell

Hydrogen can be used in a fuel cell which basically operates like a battery. The fuel cell consists of two electrodes and an electrolyte. Hydrogen and Oxygen are passed over the electrodes to generate electricity and Water. Hydrogen cells are used in Auto industry. Compressed hydrogen tanks are used to supply the Hydrogen and Oxygen is used from the air directly. There is no pollution caused by hydrogen fuel cell autos and the only emission is water. If the hydrogen fuel cell autos become main stream instead of exception, we can eliminate autos from the global pollution problem.

Hydrogen economy

The hydrogen economy is an energy system of the coming generations in the near future.

The hydrogen can be generated using the renewable energy sources which are readily available. One of such sources is the wind energy that is playing the major role in the generation of hydrogen. The hydrogen economy is capable of fulfilling the human needs of the coming generations [3].

The hydrogen being in the most demand needs the technologies for their production, storage, distribution, and utilization.

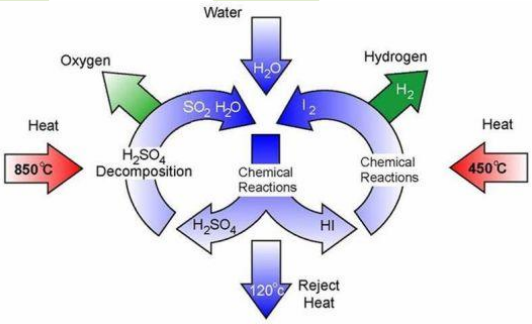

Figure 1: Generation of Hydrogen-clean, cyclic process

There's always the need for clean, efficient, convenient forms of energy which the user can easily access. Hydrogen is one of the many other convenient forms of energy which forms an energy system and satisfies the human energy needs [3].
(Bockris, 1975; Bockris and Veziroglu, 1985; Bockris et al., 1991).
Characteristics of Hydrogen: (Veziroglu and Babir, 1992)
Hydrogen in chemistry has the following properties:

- Available in huge quantity.
- Can be stored in solid, liquid or gas form.
- Can be converted into other forms of energy efficiently.
- Renewable source as made from the product of water or water vapor.
- Easily transportable.
- Hydrogen as an energy carrier is environmentally compatible.

Hydrogen Production:

Several technologies have been developed to produce hydrogen. Some of the ways have been attempted to describe regarding the hydrogen production. Hydrogen is mainly being produced from fossil fuels in refineries or in industries. The fossil fuels which are used for hydrogen production are in the form of coal, crude oil or natural gas. These fuels produce carbon-dioxide gas during their production process. The processes involved are hydro-treating and hydro- cracking. To avoid the emission of carbon-dioxide gas many other technologies are coming up to produce cost effective hydrogen. Water electrolysis is one of the efficient methods to produce hydrogen but it needs electricity which is expensive [3].

If the method of water electrolysis is being used with photovoltaic (PVs) then that would be more suitable as well an effective method. But photovoltaic cells are costly to produce and install so even though highly efficient but not a good alternative.
Wind energy is the other way to produce hydrogen at a low cost but this energy can be utilized in the areas where the wind energy is easily available. The energy required to produce hydrogen is more than what it releases during its utilization [3].

Hydrogen Storage

After production storage becomes and important issue which needs to be taken care of. Hydrogen can be stored as solid, liquid or gas in the form of glass micro-spheres, chemical hydrides, metal hydrides or cryo-adsorbers.
Hydrogen storage in caverns, aquifers are costly and cause loss of gas and pressurized gas storage systems are similar as conventional gas storage systems. Liquid hydrogen storage is being used only in the condition of high need of hydrogen. Metal hydride storage system has an advantage of storing hydrogen in terms of safety aspect. This process requires system set up and the release of heat during the process is another important factor to make this storage system more popular [3].

Hydrogen Transport and Distribution

Hydrogen transportation by pipeline is up to 200 km from production to utilization sites but for effective transportation high capacity reciprocating compressors are used. The pipelines used for hydrogen transportation requires large diameter and more compression power. Due to low volume of hydrogen and lower pressure losses, less recompression stations are required and that too placed far apart. It has been estimated that transportation of hydrogen is cheaper comparative to electricity transport [3].

Hydrogen Utilization

The use of hydrogen as a fuel in the internal combustion engines has been found to a great extent. The hydrogen is more efficiently use by 20% in the internal combustion engines. The greater advantage is its more clean that is the use of hydrogen causes less amount of pollution compare to other gasoline engines. Hydrogen use in jet engines and turbines produces the only pollutant nitrogen oxides. Use of hydrogen in biomedical technology is becoming popular in the form of micro steam generator. Catalytic burners in household appliances are coming up with the use of combustion of hydrogen only.

Hydrogen Safety:

Every process has its own risks and benefits. Similarly hydrogen can be a risk-full factor if the proper care is not done starting from the process of production until the process of utilization. Hydrogen has the smallest molecule so high tendency to leak through the smaller openings. Also due to low ignition energy of hydrogen the flame becomes nearly invisible and that could be a dangerous issue as it becomes hard to detect if there is a fire. Liquid hydrogen also causes the risk of cold burns.
In spite of all the safety hazards hydrogen is still has a very good safety record and is actually a safer fuel than any other gas.

Conclusion

The conclusion obtained from the above topic is that we should increase the use of renewable sources of energy and decrease the use of non renewable resources. Existing renewable resources are well established and proven. It has been seen through the various articles that available renewable energy resources are helping in the production of the other forms of energy which makes our energy system more strong and economical. Likewise the production of hydrogen, from the available wind energy, and its usage is more clean, safe and efficient. They are commercially available and are being utilized. The new upcoming technologies in renewable resources are very promising but a lot more research and infrastructure is required before it can be adapted.

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