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TOWARDS GREEN ENERGY – EXPLORING RENEWABLE SOURCES WITH FOCUS ON BIOFUEL

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Abstract **-** This is a review paper on energy sector and it reviews the research studies in this sector. The findings indicate that there is a need to develop renewable sources of energy, which can enable faster development of mankind. Governments should come forward to promote development of renewable energy sources.

Keywords - Biofuel energy, renewable energy, solar, Biofuels, SDG

Fundamental Terms -

Biofuels and waste **-** It comprises of solid Biofuels, liquid Biofuels, industrial waste, urban waste and other waste. These are converted into electricity or fuel or heat.

Wind **-** Electricity generated by wind is called wind electricity

Hydro - Energy produced in hydro power plant is called hydro electricity. It has highest share in renewable sources of energy.

Coal transformation losses – It includes losses involved when coal is transformed from primary to secondary fuel (coal to coke) and from secondary fuel to tertiary fuel. Coal is a major source of energy for the world now, however, it is depleting and it is non-renewable source of energy.

Electrochemistry - Electrochemistry is the branch of physical chemistry that studies the relationship between electricity, as a measurable and quantitative phenomenon, and identifiable chemical change, with either electricity considered an outcome of a particular chemical change or vice versa.

Fossil fuels **-** Fossil fuel is the sources of energy, which on burning produces thermal energy, which is used by various mechanisms for electricity generation. It provides 67% of the total world energy requirements. It consists of coal (41%), oil (5.5%), gas (21%), and other such sources, which are based on fossil based materials.

Greenhouse gas emission - The emission of pollutants due to fossil fuel based electricity generation is the main reason for greenhouse gases, which is causing environmental threats. In US, 40% of emissions are due to electricity generation, from which 70% of electricity is generated through the fossil fuel based sources. However, some countries are trying to go for renewable sources of energy to prevent losses to the environment. For example France is now generating only 10% of its electricity from the fossil fuel based sources and thus minimizing environmental loss.

Photovoltaic **-** Photovoltaic is a conversion of the electricity from general term light. It uses semiconductor and converts high speed photon which is in desired energy belt to release electron and thus converts into electrical energy. The solar panels are made by the same thing.

Renewable energy - Those sources which help in produces energy, which can be renewed or are present in a very huge abundant are called renewable sources of energy. It contributes about 18% of total world energy. It is considered an important source because fossil fuels or the non renewable sources are short termed and will vanish shoon. It includes Hydro energy (16%), geothermal (.3%), solar PV (.06%), solar thermal 9.0004%) a wind energy and tidal energy sources. Michael Faraday is considered the father of modern electricity from the early nineteenth century. Earlier mankind was using biomass including wood and other sources.

TPES - It refers to total primary energy supply - it includes indigenous production, imports – exports, international marine bunkers etc.

Transparent Conductors - Granqvist, C. G. (2007) has definedTransparent conductors as solar energy materials. Transparent conductors (TCs) have a multitude of applications for solar energy utilization and for energy savings, especially in buildings. The largest of these applications, in terms of area, make use of the fact that the TCs have low infrared emittance and hence can be used to improve the thermal properties of modern fenestration. Depending on whether the TCs have been reflecting or not in the near infrared pertinent to solar irradiation, the TCs can serve in "solar control" or "low-emittance" windows. Other applications rely on the electrical conductivity of the TCs, which make them useful as current collectors in solar cells and for inserting and extracting electrical charge in electrochromic "smart windows" capable of combining energy efficiency and indoor comfort in buildings. They have radiative properties. They are of three types - *spectral selectivity*, *angular selectivity*, and *temporal variability*. The spectrally selective materials have been thin films based on metals (normally gold or titanium nitride) or wide band gap semiconductors with heavy doping (normally based on indium, tin, or zinc). Their applications to energy-efficient windows have been covered in detail, experimentally as well as theoretically, and briefer discussions have been given applications to solar cells and solar collectors. Photocatalytic properties and superhydrophilicity have been touched upon. Angular selective TCs, for which the angular properties have been caused by inclined columnar nanostructures, have been then covered.

Turbines **-** Turbines are the mechanical device used in the process of energy conversion. In simple terms, it is a device which converts the rectilinear motion into a rotating one. Almost maximum technology this is used. Electricity is generated with turbine, which is generated by wind or water, or steam, or other such methods. A turbine drives a generator transforming mechanical energy into electrical energy through electromagnetic induction

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I. Introduction

Energy is the most essential source of input for any work. Human development is directly related to development of energy sector. As human development takes place, so does the

development of energy sector. A review of human development will reveal that there is a direct positive correlation between human development and energy development. New sources and methods of energy enable faster development for human being. Thus the key to development is the development of energy sector.

Energy

Energy is required for every human activity. We cannot think of any office or any business without energy. The demand of energy increases with development of mankind. Increasing income of people enables them to buy latest products, which require modern sources of energy. While earlier, animals and forest resources were the main energy sources. Today electricity and other modern methods are the main sources of energy. These sources of energy are developing and the future will witness newer sources of energy.

Electricity

Commercial production of electricity started in 1870. Electricity generation has been through transforming kinetic energy into electricity. Boyle, G. (2004) is optimistic about generating substantial power from renewable sources of energy. Stimulated by recent technological developments and increasing concern over the sustainability and environmental impact of conventional fuel usage, he visualizes the prospect of producing clean; sustainable power in substantial quantities from renewable energy sources arouses interest around the world. He provides a comprehensive overview of the principal types of renewable energy--including solar, thermal, photovoltaic's, bioenergy, hydro, tidal, wind, wave, and geothermal. In addition, it explains the underlying physical and technological principles of renewable energy and examines the environmental impact and prospects of different energy sources.

Why Renewable Energy

The world is today dependent on energy, which comes mostly from fossil fuel based resources. Fossil fuel resources are limited and they will exhaust. Their supplies are shrinking. They are also causing negative impact on environment. There is a need to find such resources

which are perennial. There is a need to develop a policy framework to guide the development of new sources of energy. Sustainable Development Goals have given us broad guidelines. The SDG number seven is important for every country to prepare a strategy for development of renewable energy sector.

Energy Crisis

We will take a look at the energy crisis, which is due to huge gap between energy demand and energy supply. There is a need to develop environmentally useful energy sources. We will also look at current researchers on the issues with regard to energy. The world substantially relies on fossil fuel based energy sources. Fossil fuel based resources are shrinking and will eventually get exhausted. There is a need to develop renewable sources so that the reliance on fossil fuel based sources may reduce. As per IEA (2018, p.4) oil had 31.9% share and coal had 27.1% share and natural gas had 22.1% share in world energy in 2016. All these are fossil fuel based resources and they are non-renewable. These resources will extinguish in the future. Nuclear energy had 4.9% share, Hydro had 2.5% share and Biofuels and waste had 9.8% share in the world energy during 2016. Thus the share of renewable sources is less. The development of renewable sources depends on initiatives by governments and participation by private sector. Participation of private sector depends on incentives by governments. Thus there is a need to develop a voice to promote government actions in this direction.

Emerging economies

The underdeveloped and developing regions have seen tremendous growth in energy demand. As per IEA (2018) the share of China in total world energy increased from 7% in 1973 to 21.6% in 2016, the share of Middle East increased from 0.8% in 1973 to 5.3% in 2016 and share of non-OECD Asian countries increased from 5.5% in 1973 to 13.2% in 2016. At the same time, the share of OECD countries in world energy has reduced from 61.3% in 1973 to 38.4% in 2016. The share of Africa in total world energy is also rising. It has risen from 3.4% in 1973 to 5.9% in 2016. In terms of share in world electricity generation, the share of China has increased from 2.9% in 1973 to 24.9% in 2016. China has increased hydro-electricity and solar electricity

substantially. The share of non-OECD Countries in total world electricity has increased from 2.7% in 1973 to 11.7% in 2016. The share of Africa, Middle East and non-OECD America has also increased but that of OECD countries has reduced from 72.8% in 1973 to 43.9% in 2016.

Once, the OECD countries were dominating as the major source of energy and major suppliers of energy resources. However, the developing countries are now rising. In terms of source of primary energy in the world, the share of Asia has increased. It was just 29.2% in 1990 and it has increased to 47.7% in 2016. The share of Europe has reduced from 33.2% in 1990 to 18.5% in 2016 and that of America has also reduced from 29.5% in 1990 to 23.9% in 2016. Hubbert, M. K. (1956) reviews the world situation with respect to the requirements and supply of fossil fuels, and of whether nuclear energy from uranium and thorium will be able to replace that from the fossil fuels as the latter approach their inevitable exhaustion The initial supply of fossil fuels, reduced to a common unit of energy, consisted of about 70 percent coal, 14 percent petroleum and natural gas, and about 16 percent oil shale and tar sands. Should tile world continue to be dependent upon its fossil fuels for its energy requirements, the peak of coal production would probably be reached with the next 200 years, and that of oil in about 50 years.

Of these initial fuel reserves, the United States had about a third of the world's coal, and about half of its oil shale, but only about an eighth of the initial supply of oil. Of it last, one third has already been consumed The reserves of coal and oil shale in the United States have been found to be sufficient for a few centuries, but the production peaks for both oil and gas will probably occur in near future. With regard to uranium and thorium, the heat obtainable from 1 gram of either of these elements, by means of the breeder reaction, has been found to be equal to the heat of combustion of 3 tons of coal, or 13 bbl of petroleum. The uranium equivalent of all the fossil fuels in the United States has been only about a third of a million tons. The so-called high-grade ores of the Colorado Plateau will yield possibly 100,000 tons of uranium, but the large reserves have been contained in the low-grade deposits of phosphate rocks and black shale’s which contain several hundred million tons of uranium The energy content of these low-grade deposits, occurring at a concentration equivalent to 250 tons of coal, or 1,000 bbl of oil per ton of rock, amounts to several hundred times that of all the fossil fuels combined.

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Options for development of renewable energy sector:

There is a need to develop new sectors of energy. There is a need to study and explore possible options like Tidal, Wind, Solar and Biofuel. These new sources of energy can help us in meeting the challenges of tomorrow. There is a need to invest in research, development and commercialization of these technologies. Private sector participation will help in meeting the energy demand. Energy crisis seems to be certain and there is a need to develop new options of energy so that this crisis can be averted. There is a need to invest in research and innovations in this sector. Education and training programs should incorporate training in energy conservation. There is also a need to develop research centers in alternative sources of energy. There is a need of dedicated institutions to focus on development of newer sources of energy. Countries like Venezuela are already facing energy crisis. Even developed countries like Australia are now facing energy crisis. There are two challenges: -

a. To meet the energy demand

b. To develop environment friendly technologies so that there is no negative impact on environment.

These twin objectives can be achieved only through development of better technologies through dedicated efforts. There is a need to invest in mass scale adoption of new technologies. All the technologies have certain cost structure and these technologies are not profitable at a small scale and therefore they require mass scale production and adoption. Countries should come together and form consortium to develop and produce new energy resources on mass scale. The challenge is to scale up energy generation in renewable sector so that it becomes profitable for private sector to invest in this sector. Fyfe et al. (1993) asserts that the present technologies are not very useful from environment perspective. We need to invest in development of new technologies so that we are able to meet the challenges of environment. There is a need to invest in renewable energy sector. The energy crisis can be overcome through the following: -

a. Development of better technology

b. Scaling up to increase the production from these sources so that the advantages of economies of scale are available and due to this the cost per unit comes down

c. Creating support system to support transition to renewable sources of energy so that this transition may result into increased efficiency and operational improvement in the renewable sources of energy

Renewable energy sources have to be popularized and these sources need greater investment in technology and innovation. A number of research studies are being carried out in this sector.

Kamat, P. V. (2007) suggests use of new technologies in order to meet the growing energy demand. There is a need to develop new technologies in the domain of solar energy so that this sector can meet the growing demand of energy. There is a need to develop better technologies including nano-technologies in this sector. A few alternatives are suggested: -

1. Mimicking photosynthesis with donor−acceptor molecular assemblies or clusters,
2. semiconductor assisted photocatalysis to produce fuels such as hydrogen, and
3. nanostructure semiconductor based solar cells.

Pena, R., Clare, J. C., & Asher, G. M. (1996) described the engineering and design of a doubly fed induction generator (DFIG), using back-to-back PWM voltage-source converters in the rotor circuit. While ensuring sinusoidal supply currents, a vector-control scheme for the supply-side PWM converter results in independent control of active and reactive power drawn from the supply. Vector control of the rotor-connected converter provides for wide speed-range operation. The vector scheme has been embedded in control loops which enable optimal speed tracking for maximum energy capture from the wind. An experimental rig, with assumption of a 7.5 kW variable speed wind-energy generation system has been studies and the experimental results have been given that illustrate the excellent performance characteristics of the system. It considers a grid-connected system; a further paper will describe a stand-alone system.

Herbert et al. (2007) observes that energy has been an essential ingredient of socio-economic development and economic growth. Renewable energy sources like wind energy has been

indigenous and can help in reducing the dependency on fossil fuels. Wind has been the indirect form of solar energy and has been always being replenished by the sun. Wind has been caused by differential heating of the earth's surface by the sun. It has been estimated that roughly 10 million MW of energy have been continuously available in the earth's wind. Wind energy provides a variable and environmental friendly option and national energy security at a time when decreasing global reserves of fossil fuels threatens the long-term sustainability of global economy. This paper reviews the wind resources assessment models, site selection models and aerodynamic models including wake effect. The different existing performance and reliability evaluation models, various problems related to wind turbine components (blade, gearbox, generator and transformer) and grid for wind energy system have been discussed. This paper also reviews different techniques and loads for design, control systems and economics of wind energy conversion systems

Wind Energy

A large number of scholars see wind energy as having huge potential. Teleke et al. (2009) focuses on development of a control strategy for optimal use of the BESS for it purpose. The paper considers a conventional feedback-based control scheme with revisions to incorporate the operating constraints of the BESS, such as state of charge limits, charge/discharge rate, and lifetime. The goal of the control has been to have the BESS provide as much smoothing as possible so that the wind farm can be dispatched on an hourly basis based on the forecasted wind conditions. The effectiveness of it control strategy has been tested by using an actual wind farm data. Finally, it has been shown that the control strategy has been very important in determining the proper BESS size needed for it application. Blanco (2009) undertook detailed experimental studies on wind energy and found it to be very useful source of energy. Billinton & Bai (2004) recommend development of new technologies to assess wind energy potential and development of wind energy as per proper assessment. Wind energy conversion systems (WECS) can be used in development of this sector. Wind energy independence also has a significant positive impact on the reliability contribution of multiple WECS. Markvart, T. (1996) has described a research which determines the sizes of the PV array and wind turbine in a PV/wind energy hybrid system. Using the measured values of solar and wind energy at a given location, the method employs a

simple graphical construction to determine the optimum configuration of the two generators that satisfies the energy demand of the user throughout the year. Costanza, R. (1980) has used Input-output analysis to calculate the total (direct plus indirect) energy required to produce goods and services in the U.S. economy.

McKendry, P. (2002) finds that the use of renewable energy sources has become necessary, if we want to achieve the changes required to address the impacts of global warming. Biomass has become the most common form of renewable energy, widely used in the third world but until recently, less so in the Western world. Latterly much attention is focused on identifying suitable biomass species, which can provide high-energy outputs, to replace conventional fossil fuel energy sources.

Devine-Wright, P. (2011) studied tidal energy sources and suggested that tidal energy development should be an important priority for coastal countries. Blunden and Bahaj (2007) reviewed tidal energy resources in the context of the emerging technology of tidal stream power generation.

Energy efficiency

Energy efficiency would lead to better productivity and better energy generation through improved efficiency. Research has to be carried out in this sector. Energy storage and trading opportunities have to be created and improved. Energy storage and trading improvement will open opportunities for greater access and availability of energy. Sharma et al. (2009) find latent heat storage system using phase change materials (PCMs) as an effective way of storing thermal energy and has the advantages of high-energy storage density and the isothermal nature of the storage process. PCMs have been widely used in latent heat thermal-storage systems for heat pumps, solar engineering, and spacecraft thermal control applications. The uses of PCMs for heating and cooling applications for buildings have been investigated within the past decade. There are large numbers of PCMs that melt and solidify at a wide range of temperatures, making them attractive in a number of applications. They undertake detailed investigation and analysis of

the available thermal energy storage systems incorporating PCMs for use in different applications

Nuclear energy

Nuclear energy needs improvement – both in safety systems and also in operational efficiencies. New technologies need to be developed to develop nuclear power plants that may use other nuclear materials also which are abundantly available. Bowman et al. (1992) describe a new approach for commercial nuclear energy production without a long-term high-level waste stream and for transmutation of both fission product and higher actinide commercial nuclear waste using a thermal flux of accelerator-produced neutrons in the 10^{16} n/cm^{2}s range. Continuous neutron fluxes at it intensity, which has been approximately 100 times larger than has been typically available in a large scale thermal reactor, appear practical, owing to recent advances in proton linear accelerator technology and to the spallation target-moderator design presented here. This large flux of thermal neutrons makes possible a waste inventory in the transmutation system which has been smaller by about a factor of 100 than competing concepts. The accelerator allows the system to operate well below criticality so that the possibility for a criticality accident has been eliminated. No control rods have been required. The successful implementation of it new method for energy generation and waste transmutation would eliminate the need for nuclear waste storage on a geologic time scale. The production of nuclear energy from

Energy Storage and Distribution

Energy storage and distribution are very important sectors in Indian context. There is a need to invite private sector partnership in this sector. The government has recently opened these sectors. There is a need of private sector partnership in electricity distribution so that electricity theft is minimized. Alanne, K., &Saari, A. (2006) find that a new trend has been developing toward distributed energy generation to minimize distribution and transmission losses through smaller units of electricity production in different locations. A distributed energy system has been an efficient, reliable and environmentally friendly alternative to the traditional energy system. Allanne and Saari (2006) discuss the definitions of a distributed energy system and

evaluate political, economic, social, and technological dimensions associated with regional energy systems on the basis of the degree of decentralization. They also detail the characteristics of a distributed energy system in the context of sustainability. They conclude that a distributed energy system will become a better option with respect to sustainable development

Rabaey, K., &Verstraete, W. (2005) find that Microbial fuel cells (MFCs) are useful in development of alternative energy resources.

Buhre et al. (2005) asserts that coal and other fossil fuel based energy resources are no longer useful due to their negative impact on environment. There is a need to develop alternative sources of energy and there is a need to focus on investing in development of environment friendly energy resources.

Bio-fuel

Biofuel refers to development of fuel from non-edible oil. There are a large number of resources, which can provide biofuel. These are economical sources of energy. There is a need to undertake extensive research in this sector so that this sector can be developed further. This can be developed to prepare replacement of diesel. There is a need to develop better alternatives to fossil fuel so that the challenges can be overcome. There is a need to introduce the use of Jatropha, Thumba, and other sources of biofuel, which can easily be used for production of biodiesel. This can help the mankind in overcoming the current challenges. Likhanov et al. (2020) undertook experimental studies on rapeseed oil and developed biodiesel, which was found to be useful in diesel engines. The study showed that biofuel so extracted can easily replace diesel. This study proved that there is a need to invest in development of technologies for production of biofuel. Mathimani & Pugazhendhi (2019) undertook experimental studies and found algae very useful in production of biofuel. The studies confirmed that algae can be viably be converted into biofuel. The biofuel was found to be useful in internal combustion engines. Abdullah et al. (2019) suggest use of fourth generation biofuel derived from genetically modified algae and suggest its wider use.

Alalwan et al. (2019) recommend that biofuel should be promoted because there is already excessive pressure on fossil fuel resources and it is not possible to stretch those resources further. There is a need to develop alternative sources of energy and biofuel can be the best option. There is a need to invest in this sector so that the negative impact on green house gases can be achieved. Correa et al. (2019) finds that there is a need to develop biofuel sector. There is a need to have government support and market interventions so that this sector can develop. If market develops, there will be increased business innovations in this sector, which will lead to scale of economies. There is a need to introduce mechanisms to promote this sector.

II. Conclusion and future directions

We have observed that the developing countries are experiencing tremendous increase in energy consumption. These countries generally have excellent opportunities for solar energy generation and wind power. Therefore these countries must invest in these sectors. Renewable sources of energy need greater investment and greater attention so that these sectors can become viable sources as well as economical sources. Research and development initiatives have to be encouraged in these sectors. Distributed sources of electricity generation need encouragement. Research on nuclear energy needs to be stepped up.

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