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Review Article

Energy Generation: A Review

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A B S T R A C T

The society is facing the problem relating to energy. The researchers look at the present crisis and identify different sources of energy. This is a review of important research papers on the subject of energy generation.

Energy includes electricity and other forms of energy which enables mankind in its activities. Energy generation refers to generation of electricity from primary sources of power.

Energy sources include renewable and non-renewable sources. Renewable sources include those sources, which are non-perishable and therefore these sources of energy should be promoted. These sources include the following:

- **Hydro-electric** – energy generated from dams and reservoirs
- **Solar energy** – energy generated through Rays of the Sun
- **Wind power energy** - energy generated through wind
- **Tidal energy** – electricity generated through tides
- **Bio-fuel** – electricity generated from lifeless biological material
- **Geothermal energy** – it is the energy derived from internal structure of the Earth
- **Non**-renewable sources of energy include all those sources of energy, which will exhaust and therefore they have a limited supply. These include nuclear energy, fossil fuel, SDG7 refers to sustainable development goal of providing an access to clean, sustainable and economical source of energy to everyone.

Electrification refers to the use of electricity in using some equipment or for other uses or applications.

Introduction

Energy is an essential source in human activity from day to day life. From daily basic need to the inter government workings is based on the energy generation. The source of energy generation is the prime issue. The availability of major sources are declining from day to day and affecting to the climate change. Energy is required to fulfil the sustainability of the economic growth, elevating poverty and achieving sustainable development goals. The SDG 7 aims to ensure access to clean energy sources for everyone. These goals require investments in infrastructure, energy efficiency research and in overall improvement in electricity transmission. The goal is to ensure that energy efficiency should double by 2030. The goal is to increase the share of renewable energy sources in total energy mix.

Evolution of fuels

Originally unto 2000, bio-fuel was the main source of energy generation in developing countries. About 52% of total population relied on the major biomass sources like fuel wood, dung, agricultural waste, crop residues, charcoal, etc for basic necessity from cooking to heating. But the biomass combustion resulted in adverse effect; the major impact was estimated 1.6 million death per year by WHO, 2006, as the biomass combustion was responsible in causing indoor air pollution which triggered various health effects. On the other hand, for the availability of the source of biofuel, such as fuel wood, major impacts like deforestation took place (Arnold et al., 2006).

Focusing on the fuel wood data, official data on fuel wood includes only production but are considered to be equal to the consumption (FAO, 2005). However, this fact cannot be reliable, as the fuel wood gathered from woodlands are not accounted in the data. The other forms of the biomass (dung, agricultural waste, crop residues etc.), are surveyed but not accounted for the statistics databases. (FAO, 2005; Xiaohua and Zhenmin, 2005).

As per the inventions and fuel switching, the usage of the traditional biomass is decreasing per capita from the share of total energy use. An analysis done by victor and victor (2002) stated several factors for the declining fuel wood usage: income change, availability, urbanisation and industrialisation. Other minor factors responsible for the decline in the usage are: cost of the energy stocks (feedstock, conversion or alternative fuels), climate, geography, land available, difference in culture and traditions. The minor factor cultural and tradition is usually neglected, as to quantify it is a hard task. The factor about the income of the family explains that the low income family more often used the fuel wood as their source.

Electrification

There is a difference between the usages of energy use, in the urban areas; the electricity is the predominant type of energy, whereas in the rural, the traditional biomass dominates the usage. Central electricity grid is still not able to reach many remote villages especially the mountainous areas (Goldemberg, 2000; Reddy, 2000). From the World Energy Outlook (2002), the data analysed suggests that the electrification rates increases as the income does. The rate of electrification slows down as only the remote areas are left to be electrified.While the increase in income, increases the electrification so does increase the investments in the electricity sector. So the access of electricity helps in improving income generation, as working and manufacturing are the power source needs. Efficient electric machinery and equipment can be leading the productivity and income.

For the economic development, market development, financial service access, and quality products for satisfying the client's willingness to pay any small manufacturing enterprises, electricity is the one of the major barrier solution (Kooijman, 2005).

IPCC/SRES model assumes that the increase in the electrification demands more electricity generation. Electrification influence the primary energy use as per the grid or non grid means of generated electricity. Small scale renewable energy or oil generators stated the non grid electricity. Grid-delivered electricity consist the large scale sources like coal, gas, nuclear reaction, etc and costs a large capital access and economic viability.

Economic Development and Energy use

During the development of economies, the nature of economic value added and employment changes. Developing countries are generally categorized as the countries where large share of the population works in the agricultural field. Earlier the developing countries which grew up to industrialize economy, increased the production of the labour intensive products examples Taiwan, Singapore, South Korea, Hong Kong, etc, and the countries like china, and India are also following the same path.

The historic economist criticized the concept over the service sector. In Sweden, the share of the service sector is constant whereas the agricultural sector in increasing at the expense (Kander, 2005). In India, service sector is comparatively increasing (Vries et al., 2007). The decline in the industrial sector in developed countries by the replacement of (heavy) industry from high to low income countries is concluding the difference in the development of developing countries.

Dematerializations can be related to economic structural change. It can be summarised in two elements:

- The intensity of use (in kg/$) of a given material follows a similar pattern for all economies, increasing with per capita GDP, reaching a maximum and then declining.
- The maximum intensity of use declines the later in time it is attained by a given economy (Bernardini and Galli, 1993).

This structural change explains the decrease in material inputs, substituting new materials with better characteristics. (Cleveland and Ruth, 1998).

Current State of Energy in The World

At present the world is dependent on fossil fuel for its energy requirements. These resources are exhausting and they will not be available to the future generations. Therefore there is a need to change the sources of energy.

There is a need to switch over to other sources of energy including solar and wind energy. At present four-fifth of our energy requirements are met by three important fossil fuel based sources namely coal, natural gas and oil. 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 require investment in research and development and development of better technologies so that the per unit cost may reduce. The costs may also reduce with increased use of these sources of energy. As the renewable sources are used more, their cost per unit will come down and this will open opportunities for greater use of these resources in the future.

Regional Distribution in Energy Sector

There is major inequality in energy sector and this inequality is due to differences in standards of living. The per capita electricity consumption is very high in developed countries in comparison to under-developed countries. However, the electricity consumption is rising at a very high rate in underdeveloped countries. This would put a huge demand of electricity in the third world in the years to come. The underdeveloped and developing regions are having very high growth in energy generation and consumption. These regions are now experiencing tremendous growth due to rising middle class and due to rising purchasing power of the people. These economies are now experiencing tremendous growth and this growth is reflected in increased energy requirements. 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.

Electricity generation

There is a need to develop new technologies and new means of energy generation, storage, transmission and consumption. More and more research and development initiatives have to be supported in the sectors related to energy efficiency, energy generation and energy storage. Distributed energy generation is the latest trend, which would help in development of this sector further. Alanne, K., &Saari, A. (2006) assert that a new trend has been developing toward distributed energy generation, which means that energy conversion units have been situated close to energy consumers, and large units have been substituted by smaller ones.

Renewable 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 these sectors.

Kamat P. V. (2007) has mentioned that the increasing energy demand in the near future will force us to seek environmentally clean alternative energy resources. The emergence of nano-materials as the new materials to construct light energy harvesting assemblies has created new possibilities in the field of solar energy. The author highlights some of the recent developments in these areas and points out the factors that limit the efficiency optimization.

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 7.5kW 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.

Energy is an important tool in development process. It plays an important role in socio-economic development of people. Renewable energy sources can help our societies in developing towards a climate friendly development process, which is the goal of SDG7. Solar and wind energy can help our world in reducing dependence on fossil fuel based energy. Fossil fuel energy is dependent on exhaustible source of energy. It is also causing lot of pollution. Solar and wind energy are environment friendly sources of energy (Herbert et al. ;2007)

Wind Energy

There is a huge potential in the sector of wind energy. This sector is yet under-exploited in developing countries. There is a need of research in this sector to generate lower cost wind energy plants, which can be widely used in under-developed countries. Wind energy plants can also have

solar energy plans, so research and innovation can help in development of cost effective plants. 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.

Wind Electricity Generation costs have increased in the last few years substantially due to a rise of the price of certain strategic raw materials and also due to rising demand. However, the overall financial viability of wind energy investments vis-à-vis other electricity plants has not been altered. In the long-term, one would expect the electricity plant investment requirements to go down. Research, innovation and application of new technologies may enable underdeveloped countries to invest in wind energy plants. Billinton, R., &Bai, G. (2004) mention that wind has been a highly variable energy source and behaves far differently than conventional energy sources.

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.

Place-related symbolic meanings also emerged as significant, with contrasting sets of meanings proving significant in each context. Implications of the findings for research on place attachment and responses to land-use changes, as well as for developers seeking to engage with residents affected by energy projects have been discussed.

Blunden and Bahaj (2007) review of the current understanding of tidal energy resources in the context of the emerging technology of tidal stream power generation.

Research in Energy Efficiency

SDG 7 gives stress on research in energy efficiency, which can enable wider dissemination of clean energy for everyone. This research should develop new materials, new technologies and new transmission and storage equipments so that clean energy is economically distributed. Research and innovation in energy efficiency can contribute substantially towards SDG 7. Energy efficiency would lead to better productivity and better energy generation through improved efficiency. Research should be carried out in these sectors. Energy storage and trading opportunities must be created and improved.

The uses of PCMs for heating and cooling applications for buildings have been investigated within the past decade.

They undertake detailed investigation and analysis of the available thermal energy storage systems incorporating PCMs for use in different applications

Improvement in 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.

Challenges for the Future

The challenge is to scale up energy generation in renewable sector. Fyfe et al. (1993) assert that the present technologies are un-sustainable. The researches have been relying on capital investments. Given that one hour of sunlight could provide our annual needs for one year, the future must be with solar energy. Geothermal energy sources, using the normal thermal gradient of Earth have been found to be viable and economical. There has been growing curiosity whether this challenge can be achieved through the following:

- Development of better technology
- 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
- 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

Buhre et al. (2005) proposes that the awareness of the increase in greenhouse gas emissions has resulted in the development of new technologies with lower emissions and technologies that can accommodate capture and sequestration of carbon dioxide. For existing coal-fired combustion plants there are two main options for CO_2 capture: removal of nitrogen from flue gases or removal of nitrogen from air before combustion to obtain a gas stream ready for geo-sequestration. In oxy-fuel combustion, fuel has been combusted in pure oxygen rather than air. This technology recycles flue gas back into the furnace to control temperature and makeup the volume of the missing N_2 to ensure there has been sufficient gas to maintain the temperature and heat flux profiles in the boiler. A further advantage of the technology revealed in pilot-scale

tests reduced emissions. For coal-fired combustion, the technology has been suggested since the eighties; however, recent developments have led to a renewed interest in the technology.

Conclusion and future directions

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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