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Electricity Generation and Environmental Issues

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Abstract – Development of society increases the demand of energy. Energy consumption is considered to be a good indicator of economic progress. We consume energy in many forms. Electricity is an important component of national development all over the world. Although electricity is a clean and relatively safe form of energy when it is used. But generation and distribution of electricity affects our environment. Electricity is generated at power plants by electromechanical generators. There are various types of power plants as nuclear power plants, hydroelectric power plants, coal - fired power plants, diesel - fired power plants, geothermal power plants, gas - fired power plants, solar -power plants, wind power plants, tidal power plants. We can classify the power plants in two types as renewable and non – renewable resources. Non – renewable resources of electricity generation have negative climate change effects and global warming. Emission of greenhouse gases from power plants is a matter of concern. The aim of the paper is the investigation and assessment of the negative effects of electricity generation on our environment. This paper reviews various types of power generation plants for their cost, efficiency, availability and long term and short term impacts on environment. Problems and issues in the application of the new technologies are also discussed. Advantages and disadvantages of using the renewable and non – renewable energy resources in India are also discussed. It is concluded that the application of new technologies in power plants and appropriate use of the renewable energy resources can change the scenario drastically. In this paper I have also discussed about the future prospects and challenges in this regard.

Keywords – Power Plants, Renewable and Non – Renewable Resources, Greenhouse Gases, Climate Change, Global Warming.

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INTRODUCTION

Growing energy demands and environmental concerns are driving forces for use of alternative, sustainable and clean energy sources. Development of society increases the demand of energy. Energy consumption is considered to be a good indicator of economic progress. We consume energy in many forms. At present electricity is the backbone of national development all over the world.

The renewable energy sources are natural sources that are constantly replenished over a relatively short time scale. These are available free of cost for everyone. Air, sun, water, biomass and geothermal heat are the main examples of such types of sources. In nonrenewable energy resources, we use such sources which are in limited quantity and can be finished after use. These sources are not replenished regularly in natural way. Fossil fuels are the main example of such type sources.

Advantages and Disadvantages of Renewable Energy Resources:- Renewable energies resources are safe to use. Problem of pollution is not associated with them. These are not risky. These are present everywhere and available to all. Renewable energy is becoming cost efficient with the advancement of the technology. After the establishment, maintenance costs are generally low. Because trained technicians are needed to maintain the equipment, some renewable energy plants have the potential to generate more jobs than highly mechanized fossil fuel plants. Renewable energy resources do not contribute to greenhouse gas emissions as there are little or no greenhouse gas emissions associated with them. There are some disadvantages also. Initial costs for setting up renewable energy plants are often quite high. Maintenance cost is also high. Construction and maintenance of dams and establishments of hydro power plants is very costly. Amount of energy produced is lesser than fossil fuel – fired power plants. Renewable energies like solar and wind require large area of land to produce energy quantities competitive with fossil fuel – fired power plants. Renewable energy is weather dependent. For example, there should be enough speed of wind to

produce wind energy. Solar panels are not suitable for the region where sunlight is not enough. Solar panels do not operate at night.

Advantages and Disadvantages of Nonrenewable Energy Resources:- At present time we are very much dependent on fossil fuels. Fossil fuel is used in thermal power plants, vehicles and various industrial plants. Some nonrenewable energy sources are more reliable than renewable energy sources. They provide continuous, not intermittent, weather independent energy. New technologies are emerging for using fossil fuel with less harmful effects to the environment. There are some disadvantages of nonrenewable energy resources. Fossil fuels are not unlimited. Process of extraction as well as transportation is not safe for environment. CO2 and other harmful gases are released from burning of fossil fuels. Use of new technologies into existing fossil fuel plants to prevent CO2 emissions is extremely costly. Nuclear power plants do not release CO2, but pose other risks such as potential radiation leaks and waste storage problems. The cost for building nuclear reactors is very much. So these are less economical than other types of power plants.

The rapid economic growth of developing countries is expected to result in considerable expansion in demand of electricity. Developing countries are increasing power generation capacity to fulfill the demand. The investments required for this purpose are also substantial. According to Bloomberg NEF, global electricity demand will grow from 25,000 terawatt-hours (TWh) in 2017 to about 38,700 TWh by 2050, which will drive new investment in power generating capacity in the coming years. According to the International Renewable Energy Agency (IRENA), global solar power capacity will increase by 9% each year between 2018 and 2050, in which time it will grow from 480 GW to more than 8,000 GW. When planning the energy profile for various countries and communities, comparison of the advantages and disadvantages of renewable and nonrenewable energies is important. Environmental impacts of the different types of power plants are given below.

Nuclear power plants

Using a nuclear fission reaction and uranium as fuel, Nuclear power plants generate a high amount of electricity. A nuclear power plant is a thermal power station in which a nuclear reactor provides heat. Nuclear power plants are considered to be a low emission and more environment - friendly option. The power generation from nuclear power plants is also considered to be more reliable than renewable sources of energy such as solar and wind. Although the investment required to establish a nuclear power plant is significant, the running costs are relatively low. Nuclear energy sources also have a higher efficiency than fossil fuels and release large amounts of energy. Nuclear power plants require low quantities of fuel but produce a vast amount of power. However nuclear energy has been proposed as an answer to the need for a clean energy source. But it is not necessarily a clean energy source. Before the construction of nuclear reactors the environmental issues should be considered. Nuclear reactors do not release CO2 and other harmful gases during operation but the construction and other activities necessary for operation of these plants are responsible for the emission of harmful gases. Radioactive elements like Uranium are used in nuclear reactors. Mining of uranium and dumping of radioactive waste pose serious environmental concern. Nuclear power plants constantly emit low levels of radiation into the environment. Various scientific studies have shown an increased rate of cancer among people who live near nuclear power plants. Long-term exposure to low level radiation has been shown to damage DNA. Research is going on to determine the effects caused by low levels of radiation on wildlife, plants, ozone layer and environment. Waste from nuclear power plants can remain active for hundreds of thousands of years. There are also several issues with burying the radioactive waste. Transportation of radioactive waste is very risky. In the event of an accident or terror attack the radioactive waste could possibly leak. At present there is no environment friendly solution to deal with the issue of radioactive waste. Cooling systems are used to keep nuclear power plants from overheating. Environmental problems are associated with nuclear power plant cooling systems. The cooling system intake water from an ocean or river. After the water is used to cool the power plant, it is returned to the ocean or river. The water that is returned is approximately 25 degrees warmer than the water was originally. This warmer water disturb the eco system and also kills some species of water animals and plants. To date all operating nuclear power stations were developed by state-owned or regulated utilities where many of the risks associated with construction costs, operating performance, fuel price, and other factors were borne by consumers rather than suppliers.[1] Accidents and terrorism threats need to be addressed. Even if all safety precautions are followed, it is no guarantee that a nuclear power plant accident will not occur. If a nuclear power plant accident occurs, the environment and surrounding people could be exposed to high levels of radiation. The 2011 accident at the nuclear power plant in Fukushima, Japan is one of the worst nuclear disasters in history. The reactors were destroyed by a tsunami following a major earthquake.

Hydroelectric power plants

Hydropower plants converts potential energy of river water into mechanical energy. Water turbines are rotated with this mechanical energy and generate electricity. Hydro power is comparatively cheap. International institutions such as the World Bank view hydropower as a means for economic development without adding substantial amounts of carbon to the atmosphere.[2]

We block and harness rivers for hydropower plants. Dams are responsible for the considerable harm to the environment. Dams can have significant negative social and environmental impacts.[3] There are a number of disadvantages of hydroelectric power. Some of them are:

Impact on animals living in rivers and riverside habitats:- Fish migration is prevented by dams. This prevents fish from reaching their breeding ground. Animal that relies on those fish for food are also affected. Riverside habitats begin to disappear after the construction of a dam. Dams slow rivers. Some organisms depend on steady flow of rivers. Timing of flows is also altered. Natural seasonal flow variations trigger natural growth and reproduction cycles in many species. But due to dams this natural phenomenon is destroyed. Dams divert water from the stream of river. Dams impact quantity as well as quality of water. So this impact on quantity and quality of water is also responsible for destruction of healthy ecosystem of the river.

Impact on plants:- Hydropower plants are also responsible for shrinkage of forests. Seasonal floods of rivers play an important role in the growth of plants. Construction of dam changes the way of function of a river.

Increase in the emission of greenhouse gasses such as Carbon dioxide and Methane:- While the actual electricity generation in the plant does not produce emissions, there are emissions from the reservoirs they create. Plants that are at the bottom of a reservoir begin to decompose. And when plants die, they release large quantities of carbon and methane.

Susceptible to Droughts:- Hydro power is susceptible to droughts. It is dependent on the amount of water flow which depends on rain fall and snow fall. So, the performance of a hydro plant could be significantly affected by a drought.

Flood Risk:- Dams pose a serious risk to any town nearby that is below it.

Higher initial Costs:- Cost of construction of hydro power plants is higher than similarly sized fossil fuel plants.

Fossil fuel - fired power plants

Coal-fired power plants:- According to the World Coal Association, coal-fired power plants accounted for about 37% of global electricity in 2018, with China possessing the world's largest fleet. Coal-fired power stations emit over 10 Gt of carbon dioxide each year,[4] . To reduce greenhouse gas emissions, many developed nations have already announced to stop the operation of coal-fired power plants. Canada plans to phase out its coal plants by 2030, while the UK has set a deadline of 2025 and Germany is aiming to remove the technology from its electricity grid by 2038. A number of other European countries are expected to following suit soon. Coal generation in India (the third-largest emitting country) was down 8% in 2020 compared to 2018. In 2020 think tank Carbon Tracker estimated that 39% of coal-fired plants were already more expensive than new renewables and storage and that 73% would be by 2025.[5]

Diesel-fired power plants:- These plants use diesel as the fuel. Diesel plants require only a small area to be installed and offer higher thermal efficiency compared to coal-fired power plants. Due to high maintenance costs and diesel prices, the power plants have not gained popularity at the same rate as other types of power generation plants such as steam and hydro.

Gas-fired power plants :- Natural gas power stations generates almost a quarter of world electricity and a significant part of global greenhouse gas emissions and thus global warming.[6] A gas-fired power plants burns natural gas (a rapidly growing energy source across the world) to generate electricity. Data from the International Energy Agency (IEA) shows that gas-fired power generation expanded by 3% in 2019, taking its power generation in the global mix to 23%. Another type of plant that uses gas is a combined-cycle power plant. They capture heat from the gas turbine to increase power production and are also found to release low amounts of harmful gases into the atmosphere.

Geothermal power plants

There are three types of geothermal power plants. These are, dry steam power stations, flash steam power stations and binary cycle power stations, all of which use steam turbines to produce electricity. The installed capacity of geothermal energy has gradually increased worldwide over the past decade, up from just short of 10 GW in 2010 to almost 14 GW in 2019.

Geothermal electricity generation is currently used in 26 countries.[7] Geothermal power plants are considered to be environmentally friendly and emit lower levels of harmful gases compared with fossil fuel-fired power plants. But there are some environmental concerns also. Local climate cooling is possible as a result of the work of the geothermal circulation systems. Fluids drawn from the deep earth carry a mixture of gases, notably carbon dioxide (CO_2), hydrogen sulfide (H_2S), methane (CH_4), ammonia (NH_3), and radon (Rn). If released, these pollutants contribute to global warming, acid rain and radiation. In addition to dissolved gases, hot water from geothermal sources may hold in solution trace amounts of toxic chemicals, such as mercury, arsenic, boron, antimony, and salt.[8]

Solar - power plants

Solar energy plants convert solar energy into electricity. Life of solar power plants is about 20 years. According to the International Renewable Energy Agency (IRENA), global solar power capacity will increase by 9% each year between 2018 and 2050, in which time it will grow from 480 GW to more than 8,000 GW. But the initial costs involved in financing solar power plants are high. Another similar technology is solar thermal. It is a system of giant mirrors placed accordingly to concentrate the sun's rays on a very small area to create heat, which then produces steam to power a turbine that creates electricity.

Wind power plants

In recent years, there has been a rapid growth in the number of wind farms across the world, underpinned by technological advancements. Global installed wind-generation capacity onshore and offshore has increased by a factor of almost 75 in the past two decades, jumping from 7.5 GW in 1997 to 564 GW by 2018, according to the IRENA. After the wind turbines are built, operational costs involved in maintaining wind power plants are low and they are generally considered to be relatively cost-effective. The maintenance of wind turbines may vary, as some need to be frequently checked and wind power projects typically require huge capital expenditure.

Environmental concerns of wind and power:- Solar and wind powers are also not free of adverse environmental consequences. Bird mortality, biodiversity, habitat loss, noise, visual impact, and hazardous chemicals used in solar panels are the main concerns.

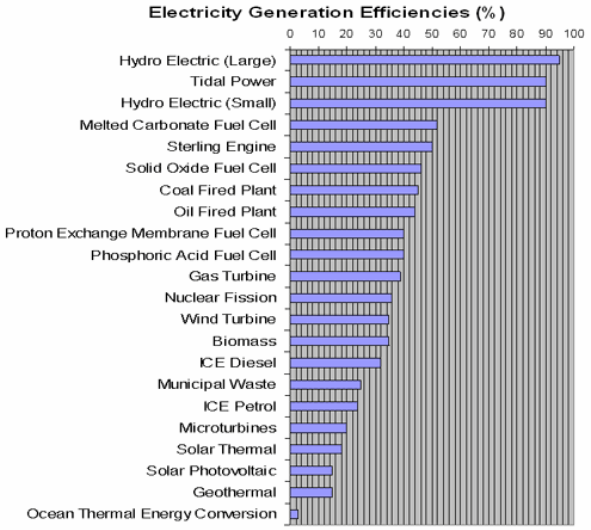
Tidal power plants

Tidal energy is harnessed by converting energy from tides into useful forms of power, mainly electricity using various techniques. Production of tidal energy is considered more predictable compared to wind energy and solar power. But tidal power is still not widely used. The world's first large-scale plant of its type became operational in 1966. Tidal power has the potential to grow significantly in the coming years.

Environmental concerns of tidal power:- Tidal power affects water animals. Marine life is an important factor when installing tidal power energy generators in the water. In terms of Global Warming Potential (i.e. carbon footprint), the impact of tidal power generation technologies ranges between 15 and 37 gCO2-eq/kWhe, with a median value of 23.8 gCO2-eq/kWhe.[9] The main environmental concerns with tidal energy are: blade strike, electromagnetic fields, noise, degrading water quality and disrupting sediment processes affecting near shore ecosystems. Initial cost of tidal energy is high and cannot be used everywhere.

Efficiency Comparisons

The table below shows the theoretical efficiency of converting various energy sources by a variety of methods into useful electrical energy [10].



Source - Eurelectric

CONCLUSIONS

We all know that clean sources of energy are vital to the environment. Many countries are replacing high-polluting fossil fuel fired power plants with low-carbon alternatives. There are a number of views what form that clean energy should be in. Hydropower plants have higher initial costs but there is no need to purchase fuel later on. Thermal power plants have higher running cost due to the regular requirement of fossil fuels. According to some experts nuclear energy is an efficient source of energy that is easy to implement. People against nuclear energy propose using combined methods of solar, wind and geothermal energy. Solar, wind and geothermal energy still have environmental issues, but ones that are not as great as nuclear plants or fossil fuel-burning power plants. Solar and wind are among the most promising sources and have been developing steadily in recent years. We should use less harmful techniques and methods of electricity generation. Governments worldwide are recognizing that burning fossil fuels is not good for Earth's environment. Considering these concerns, renewable energy comes out to be the solution of our environmental concerns. Many countries, including the United States, have programs for limiting CO_2 emissions. Research and development in the field of renewable energy is helping to reduce costs and increase efficiency. In the future, there will not be a single solution to a country's or community's energy needs but a combination of a number of technologies. Communities will need to identity the energy resources in their area and develop sustainable energy plans. Environmental issues are always present with energy issues. Use of energy affects the environment. In order to guarantee the

future generations the wellbeing that has been obtained up to now, sustainable development is necessary. A number of conferences have been held and numerous international agreements have been signed to protect the environment. Introducing new technologies we can improve the performance and efficiency of power plants. They can also replace sources of energy that are highly polluting with others that are less polluting or not polluting at all. In this way without compromising their needs they can contribute in conservation of environment. The developing countries should be helped with better technologies that have low environmental impact and high performance.

In this age of globalization a collective effort of scientists and policymakers is the demand of present time to face the challenges of environmental issues. We should focus on green technology and eco friendly development. Threat of present and upcoming technology should be studied very well. We have to decide what kind of world we want to live. Critical thinking and humanitarian approach is required to make our environment clean and green. A collective effort of all the countries of world is the demand of present time to face the threats to environment. It will take the positive application of all of our scientific knowledge. Governments should promote the research in the areas related to cleaner resources of energy. To ensure the conservation of our environment through scientific knowledge should be one of the aims of scientists. Development of new technologies also poses some new threats to society. Science can be a blessing as well as a curse depending upon its usage. So scientific discovery and technological development cannot be necessarily equated with progress for the mankind. It is important than ever before to understand the implications of scientific discovery and technological development.

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