



Energy Sources for Electricity Generation: An Overview

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ABSTRACT

The high requirements for the utilization of energy (electric power) for our day – to – day need across the entire globe are very significant and of paramount consideration. In order to meet with the energy use of our domestic, educational, health, industrial, commercial, social activities/endeavors, etc., there is the need for adequate and reliable supply of energy (electricity) from the conversion of numerous primary energy sources to electricity. This research/study considered the available conventional and non-conventional energy sources, as a potential to ameliorating the inadequacies in the supply of electrical power, and the lack of harnessing same in many parts of the rural and even the urban population among the developing world. The paper also looked at the merits and disadvantages of some energy sources and highlighted on socio-economic and policy implications associated with some energy sources. It also made some recommendations on how to easily access electricity through communal efforts, non-governmental supports and government aid via grid extension etc.

Keywords: Energy, Utilization, Electricity, Conventional, Non-Conventional, Globe, Population.

INTRODUCTION

Electric power is a very dare necessity for the betterment of man's life for both the rural and urban population across the globe (Aliyu A. Baba et al., 2021). Study conducted by (Breyer & Gerlach, 2013) indicated that an estimation of 1.2 billion of the population in the world have no good access to electricity supply even with the surplus renewable energy sources that have not yet been tapped. Reliable supply of energy is significance for commercial ventures, heating, industries, transport, lighting and other facets of human endeavors, renewable energy supply has significantly decrease the emissions of greenhouse gases when fossil fuels are used alongside (Neha & Rambeer Joon, 2023). Most electrification connectivity to rural and other settlements are achieved either through the design of off-grid

electrification system (decentralized method) or grid extension method (Adamu A. Baba et al., 2020; Mosberg, 2013; Yadoo & Cruickshank, 2012). Power plants or power industries are faced with a prosperous future of obtaining electric power supply and mitigating the emission and exposure of greenhouse gases (climate change). However, about 85% of the population were reported to be leaving in the rural settlements with shortage of electricity supply and by the year 2030, they are projected to rise from 2.7 to 2.8 billion with dependence on traditional means of providing light etc. (Neha & Rambeer Joon, 2023).

Extension of electricity to the consumers for whatever applications is paramount but, that for the rural dwellers is largely faced with a lot of obstacles among which are low energy demand, bad terrain, high investment costs, cost of operation and cost of maintenance (Aliyu Adamu Baba et al., 2020; Rahman et al., 2013). The table below (table 1) shows the statistical data in 2011 from the united states (US) department of energy information, primary energy consumption by sources and sectors (Javid Mohtasham, 2015; U.S. Energy information administration., 2011).

Table 1. Energy Sources for different Sectors of the society in the United States (US)

| S/No. | Sources of Energy | Percentage use (%) | Consumption by sectors | Percentage use (%) |
|-------|------------------------|--------------------|------------------------|--------------------|
| 1 | Petroleum | 36 | Commercial | 40 |
| 2 | Natural gas | 26 | Transportation | 28 |
| 3 | Coal | 20 | Industrial | 21 |
| 4 | Renewable Energy | 09 | Residential | 11 |
| 5 | Nuclear Electric Power | 08 | | |

Source: (Javid Mohtasham, 2015; U.S. Energy information administration, 2011).

Table 1 above indicated that about 90% of the energy sources used in the united states (US) come from the non-renewable energy, it is worth noting that the use adoption of renewable energy sources like

the solar, tidal, biomass, geothermal, wind etc. will be highly advantageous due to their abundance and cleanliness (Javid Mohtasham, 2015). Renewable energies are obtained from conversion of different primary energy sources that are non-exhaustible, they are derived straight from the wind, sun, geothermal, etc. In the year 2008, 19% of the world's energy consumption was from renewable energy sources, with about 13% realised through traditional biomass while the remaining (about 3.2%) was from hydro-electricity. Renewable energy resource is gradually replacing conventional fuels (fossil fuels) in many areas ranging from electric power generation to hot water heating, transport fuels and off-grid (decentralised) energy system (Javid Mohtasham, 2015; Khalil E., 2012). Energy sources mostly consumed around the world are the traditional energy sources comprising the various forms of fossil fuels i.e., solid (coal), liquid (liquid oil), and gas (natural gas) (Guanting Huang & Haoran Wang, 2021).

Renewable energy sources (RES) is one of the energy sources that provides employment in the field of energy as data obtained from International Renewable Energy agency (IRENA) provided that nearly 10 million of the population in Europe are into the field of renewable energy (Dragoljub Lj. MIRJANIĆ et al., 2019). Electricity is the most commonly used energy sources in every home electricity retail accounted for about 43% energy consumption in 2020 of the aggregate residential sector (Guanting Huang & Haoran Wang, 2021; U.S. Energy Information & Administration (EIA), 2020).

In Nigeria, a part of the sub-Saharan Africa with a land area of about 924000km², there are ample energy sources such as petroleum, solar, large hydropower, small hydropower, natural gas and biomass but the economy of the country depends largely on monies gotten from crude oil, and relies mostly on fossil fuel for her energy need. About 61.9% of Nigeria's electricity generation is from fossil fuels while the remaining 38.1% is gotten from hydropower (Aliyu A. B., 2017). This study/research looked into the available energy sources (conventional, non-conventional) that could either be renewable or non-renewable

in order to create awareness and reduce the shortage of electricity supply in some areas (rural areas) thereby increasing the use of electricity for the betterment of the population, by proffering some recommendations on how they can be accessed with some features put in place.

GENERATION OF ELECTRICAL ENERGY

Electrical energy is generated by the conversion of different forms of energy available from a lot of sources such as electrical energy from the chemical energy of fuel combustion (which could either be in the solid, liquid or gaseous), energy from the pressure head of water, energy from moving winds, and energy from radioactive substances (nuclear energy). The generation of electrical energy could be through the conventional or non-conventional methods.

Conventional Methods of Power Generation

These are the power generation sources that use the prime movers which includes; the diesel engines, steam turbines, petrol engines, steam engines, hydraulic turbines or gas turbines as the device that turns the shaft of the alternators or generators coupled to them, and thus converts the mechanical energy of the prime movers into electrical energy. If DC is supplied, then 'generators are used and if AC is supplied, 'alternators are employed. The commonest approaches of power generation using this method are in the thermal, hydro, and nuclear systems.

Non-Conventional Methods of Power Generation

These are the other ways in which electrical power can be generated without employing prime movers, these include the use of fuel cells, solar cells, thermionic converters, thermoelectric generation, solar power generation, geothermal energy generation, wind power generation, tidal power generation etc., though these methods are still of little use in the industrial or commercial set-up.

Energy Sources

The main energy sources available across the world are; energy from falling water, sun, moving wind, ocean tides, terrestrial heat, waves, radioactive substances and fuels, out of all these sources, the ones from fuels, radioactive substances and water are in common use and more reliable.

Water (Hydro Power)

This makes the primary source of water based energy (F. Schrader et al., 2019; Neha & Rambeer Joon, 2023). Water at high a high pressure or running with a high velocity can be utilised to run turbines or water wheels coupled to generators to provide electric power (J.B. Gupta, 2015). This source is becoming more popular because of its reliability and low maintenance/care but has high initial cost i.e. during erection or construction.

Ocean Tides and Waves

There is a great energy in ocean tides and waves although very difficult to tap (J.B. Gupta, 2015) for the generation of electrical power. It is obtained at a point where the orientation of an inlet permits the construction of a large hydro electrical plant.

Wind

The wind obtained from the kinetic energy of running air can be used to run a wind mill to drive generators in order to generate electric power, wind is found in almost everywhere around the world with varying speeds in different locations, and that determines the energy strength. Mostly the generators connected to the wind mills are small and as such the energy generated are used for charging batteries for continuous use. Its supply is in abundance, inexhaustible and does not pollute the environment. The wind turbines are mainly employed to transform the wind power (kinetic energy of air) into electrical power.

The Fuels

Fuels, be it in the solid (Coal), liquid (liquid oil), or gaseous (natural gas) form are the main source of energy. Solid fuel (Coal) is found in large amount in almost all industrialised nations. The coal is ignited and burnt in the furnace of the boiler thereby transferring the heat from the burnt fuel to the water in the boiler and its transformation to steam. The steam then produced is used at the steam turbine side to turn the blades or buckets of the turbine and thereby giving mechanical energy of rotation, the steam turbine coupled to the generator aids in starting the generator and the mechanical energy is changed or converted to electrical energy/power. Some of the limitations of this energy source are its need to consume large area for storing the fuel (coal) and incurrance of high cost of transporting the fuel where coal mines are far from the generating stations. Liquid fuels are mostly used for generating power where small power is needed mostly as standby because of its high cost. Natural gas is mostly used where the use of boiler plant is highly expensive or where the involved process does not need steam and preferably used near a gas work or oil field.

The Sun (Solar Energy)

The sun is the primary source of energy, the energy radiated from the sun is in the form of electromagnetic waves (J.B. Gupta, 2015). The radiant heat energy from the sun can be used to generate electric power DC. Solar energy can be tapped directly using photovoltaic (PV) or indirectly using concentrated solar power to generate electricity for human applications. Solar panels can be mounted on rooftops or ground-mounted to directly harness solar energy from the sun to produce electricity. Solar energy is almost found in most places with different intensities. It is pollutant free, clean, maintenance free as it requires no fuel. It has the issue of high initial costs at the point of installation.

Geothermal Energy/Terrestrial Heat

Geothermal energy (J. L. Renner & M. J. Reed, 2017) is produced naturally from the earth's innermost part, the temperature root is linked to the inner system of the earth. During volcanic action, the material that comes out of the bowls of the earth to form volcanic explosions also produces steam vents (J.B. Gupta, 2015). The earth crust contains large amount of thermal heat, fluids with various temperatures can be used for power generation and other applications when brought to the surface.

Radioactive Substances

Large quantities of heat energy are released by the fission of nuclear disintegration of Uranium, Thorium and other similar fissionable materials. It is estimated that about 2500 tonnes of coal equates to 1 kg of nuclear fuel (Uranium, Thorium etc.) (J.B. Gupta, 2015). However, the heat energy released by the fission of the nuclear fuel in the nuclear reactor is absorbed by the cooler i.e. molten metal like liquid sodium or gas and then moved to the heat exchanger where it is exchanged by circulation in the heat exchanger with the water to generate steam which is used to propel the gas turbine or steam turbine coupled to the generator or alternator in order to produce electricity. This energy source is available in large quantity and inexhaustible in many years to come but its high capital or initial cost of setting up the power plant, coupled with the shortage of getting trained manpower/staff to manage the plant and difficulty in getting a good place to dispose the waste product of the radioactive substances slows the developments of nuclear power plants.

SOCIO-ECONOMIC AND POLICY IMPLICATION

A lot of factors impede the development and utilization of some energy sources (Conventional, non-conventional, renewable etc.). Some of these factors among others are; government policies, legislation, innovations, technology, fiscal incentives, politics, programs, strategies and even the initial capital costs (Emodi & Ebele, 2016). These factors to energy developments and utilizations could be

minimized or eliminated by using appropriate methods/steps used by other countries that produced weighty outcomes. These steps include, subsidies & grants, feed in tariffs, renewable energy portfolio standards, competitive bidding, fiscal support, and loans (Emodi & Ebele, 2016).

Subsidies and Grants

There should be grants and good subsidies for the development of technology in the energy industries and coupled with proper monitoring and a good mechanism for cost recovery policy so as to have smooth energy operations and efficiency.

Feed-in-Tariffs

Government should encourage the supply of energy resources to provide electricity, discourage the use of generators and possibly eliminate monopoly in sales and supply. There should be flexibility in the feed in tariff base on technology, market and locations. Sustenance in the feed in tariff should be there with consistency and proper return for investors after some years.

Renewable Energy Portfolio Standards

This system is used by governments to reimburse investors/generators in renewable energy through subsidies of any additional cost sustained during construction and operations. This measure if employed in developing nations can boost renewable energy market and make it relevant.

Competitive Bidding

Reduced cost of electricity may discourage the use of generators and this should be considered if the policy makers will adopt and bring the cost of electricity down for the end users.

Fiscal Support

Energy investors can be inspired or motivated by giving a production tax credit, this will make them generate, operate and maintain the energy plants proficiently. When this is provided, adequate utilization

should be ensured through proper monitoring in order to avoid tax payment disputes.

Loans

Provision of loans (soft and long-time) to energy investors can be made by the government of developing nations through banks (commercial or micro-finance banks) to generate capitals for energy programs so as to eliminate the issue of initial take-off.

CONCLUSION

This study/research investigated on the available sources of energy around the world with a view to knowing their viability and possibility of harnessing them. It further showed that large number of the population across the world, especially those living in rural settlements are without power supply (electricity). Merits and disadvantages of some energy sources were highlighted and there are indications that renewable energy sources are promising. Socio-economic and policy implications were discussed with factors working against the developments of energy resources mentioned.

RECOMMENDATIONS

Based on the study/review made, many populations around the world especially the rural dwellers should be encouraged to acquire or obtain electricity through communal efforts by making adequate contributions to provide energy in their community. Electrical power can be gotten by approaching the non-governmental organisations (NGO's) for support in that regard, and government can also provide electricity through grid extension, and by making/providing policies that can encourage energy investors and also encouraging communities with funding to possess an off-grid (decentralised) power system.

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