

Renewable Energy as a Cost Effective and Sustainable Power Source for Industry 4.0

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ABSTRACT

The demand for energy is rapidly increasing due to the high rate human population growth and industrial development. Due to the high demand for improved processes for enhanced quality and quantity of products and services, the global target has been to adopt the fourth industrial revolution also known as industry 4.0 as a new industrial standard. Industry 4.0 comprises of cyber-physical systems (CPS), Internet of Things (IoT), Internet of Service (IoS), robotics, big data, cloud manufacturing, blockchain, rapid prototyping etc., to automate and optimize manufacturing processes. Its major limitation especially in the developing economies such as Nigeria is that it requires reliable and regular power supply to drives units. However, the existing power supply which is majorly powered with fossil fuel products has become expensive to operate and unreliable. The use of fossil fuel has numerous environmental consequences due to the emission of carbon dioxide and other dangerous substances into the environment. To address these, the renewable energy technologies especially solar energy and biofuel must be considered because they are very much available, cheap and sustainable to ensure a reliable and steady power supply. Solar energy based plants have high initial cost and zero running cost because they use sunlight. Biofuel which is sourced from biomass is available and cheap. Thus, the renewable energy technologies will guarantee cheaper and more reliable power supply with no

environmental consequence. Hybridizing the two renewable energy technologies will achieve power supply requirement for the new industrial standard.

Keywords: Renewable Energy, Sustainable Energy, Industry 4.0, Solar Energy, Biofuel

1. INTRODUCTION

Electrical power supply is a basic requirement to power most activities in the recent industrial setup. Thus, the need for steady, reliable and cheaper power supply is increasing by the day because, the rate and quality of industrial production and services are directly related to the rate and cost of power supply. Secondly, the level of requirement globally is rapidly increasing as the population of the world increases. It has been estimated that the Earth's energy requirements are estimated at 14 TW/ y (Biernat et al, 2021). On the other hand, considering the economic development, and thus high consumption due to increasing industrial activities and constantly increasing population of the world, it is estimated that energy demand in the year 2050 will amount to about 28 - 30 TW/ y (Biernat et al, 2021). The world's energy supply from the beginning of the 21st century was mostly derived from fossil fuels such as coal, crude oil, and natural gas. It has been also estimated that fuels from crude oil accounts for about 96% of the worldwide energy demand for most domestic and industrial activities especially transportation. However, crude oil is not easily replenished hence it can get exhausted within some period of time and the known petroleum reserves are limited and will eventually run out someday. It has been preliminarily calculated that fossil fuels will be exhausted within 150-200 years (Biernat et al, 2021). Generally, fossil fuel sources are finite resources. The use of fossil fuel has numerous negative environmental consequences. Fossil fuel based plants emit air pollutants such as sulfur dioxide, particulate matter, nitrogen oxides, and toxic chemicals in the form of heavy metals for

example mercury, chromium, and arsenic. The mobile sources, such as fossil fuel based vehicles, emit nitrogen oxides, carbon monoxide, and particulate matter. Exposure to these pollutants has caused a lot of health issues such as heart disease, asthma, and other human health problems. In addition, emissions from fossil fuel combustion are responsible for acid rain, which has led to the acidification of many lakes and consequent damage to aquatic life, leaf damage in many forests, and the production of smog in or near many urban areas. Furthermore, the burning of fossil fuels releases carbon dioxide (CO₂), one of the main greenhouse gases that cause global warming. Therefore, there is need for alternative source of energy.

In the same vein, due to the high cost and the inconsistencies in the fossil fuel based power supply and its high level of environmental pollution, there has been high consideration for alternative source of power supply. Renewable energy, also referred as alternative energy, is a usable energy derived from a sources which is capable of replenishing itself such as the Sun (solar energy), wind (wind power), rivers (hydroelectric power), hot springs (geothermal energy), tides (tidal power), and biomass (biofuels) (Selin, 2021). Unlike other renewable energy sources, biomass can be converted directly into liquid fuels, called "biofuels," to help meet transportation fuel needs. The two most common types of biofuels in use today are ethanol and biodiesel, both of which represent the first generation of biofuel technology. The electricity generation capacity in different electricity generation stations in Nigeria as studied by Bello-Imam (2009), is very poor and from his findings, it is obvious that the demand is still not met and the situation remaining the same over the years. Hence, there is need to improve the energy production through renewable energy sources.

The industrial processes have evolved through revolutions to the recent revolution referred to as fourth industrial revolution also called industry 4.0 where the processes are automated and linked

through the internet for better and improved quality and quantity production. Industry 4.0 also known as the umbrella concept for new industrial paradigm which consists of a number of future industry characteristics, comprises of cyber-physical systems (CPS), Internet of Things (IoT), Internet of Services (IoS), robotics, big data, cloud manufacturing and augmented reality. By adopting these technologies globally as the key development in more intelligent manufacturing processes which involve devices, machines, modules, and products, the process of information exchange, action and control will stimulate each other, subsequently to an intelligent manufacturing environment (Ing et al, 2019). A major problem limiting the performance and adoption of industry 4.0 is cost and availability of steady power supply. Industry 4.0 requires steady power supply to the automated and intelligent systems for proper functioning and optimal production. To solve this problem, the renewable energy technology must be fully considered and exploited in order to meet the energy demand for future development.

2. METHODOLOGY

2.1 Trend of Industrial Development

The industrial process development has passed through different stages depending on the methods involved and the results achieved. The industrial development has gone through these revolutions (Jadhav and Mahadeokar, 2019):

1st Industrial Revolution (mid- 1780s) Mechanization: Mechanization driven by steam engines and water. The first mechanical loom was invented in 1784.

2nd Industrial Revolution (mid 1870s) Electrification: Assembly line led mass production with the use of electrical energy. The first conveyor belt was set-up by Cincinnati slaughterhouse in 1870.

3rd Industrial Revolution (mid 1960s) Automation: Information technology led automation as computers were developed to simplify various tasks. The first programmable logic controller was invented in 1969.

4th Industrial Revolution (2011) Cyber Physical Systems: While Industry 3.0 focused on the automation of single machines and processes, Industry 4.0 focuses on the end-to-end digitisation of all physical assets and integration into digital ecosystems with value chain partners. Generating, analysing and communicating data seamlessly underpins the gains promised by Industry 4.0, which networks a wide range of new technologies to create value.

2.2 Industry 4.0

Integration of virtual and physical systems forms the integrated technologies in manufacturing sector is known as the Fourth Industrial Revolution. The goal of the integrated technologies is to create an integrated, optimized and automated production flow. Energy is naturally at the center of every mechanism involved in most industrial production. Industry 4.0 has been adopted in most nations especially the developed and industrialized nations and it has proven very effective in achieving its target of improving production and profits. Thus, it has become the target of most developing economies in order to join in the global industrial and economic development. However, industry 4.0 technology relies fully on regular and steady supply of power to drive the modern technological features that are critically involved in the integrated technologies as shown in figure 1. The present power supply situation in most developing nations such as Nigeria cannot support the energy demand for the adoption of industry 4.0. Therefore, to adopt the fast moving technologies, the power sector must be hybridized with the consideration of renewable energy as the major gradual replacement for the fossil fuel powered generator sets currently running the present manufacturing industries.

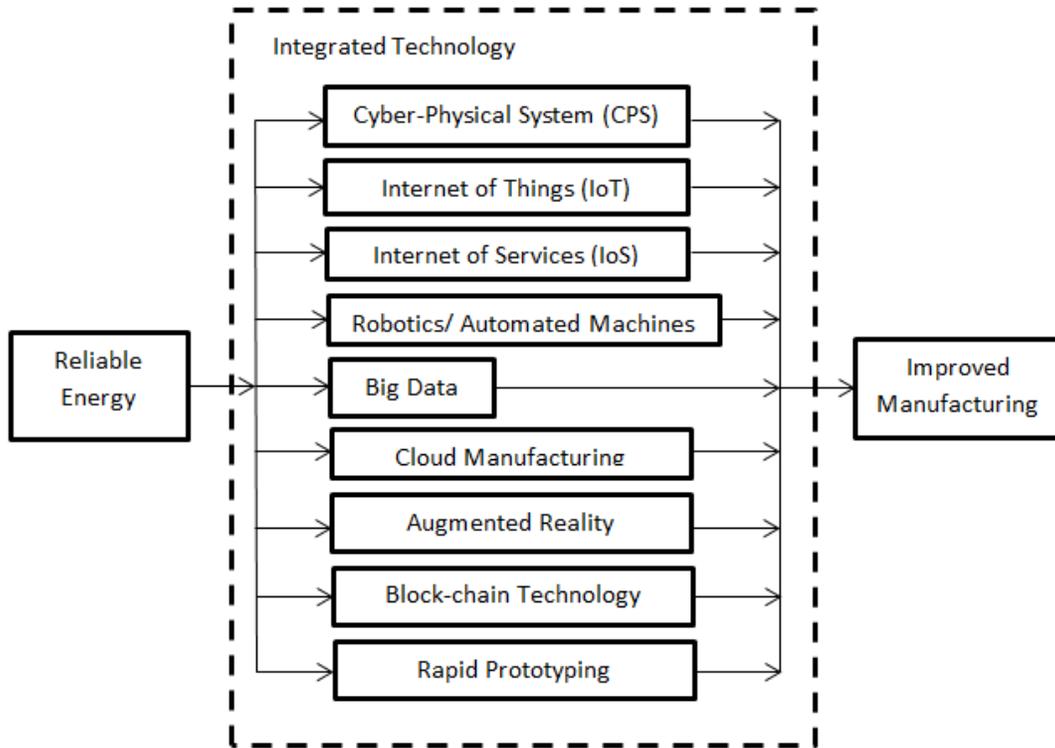


Figure 1: Industry 4.0 based manufacturing technology

A reliable energy setup can only be ensured if hybridization of renewable energy sources is fully integrated into the power sector as shown in figure 2.

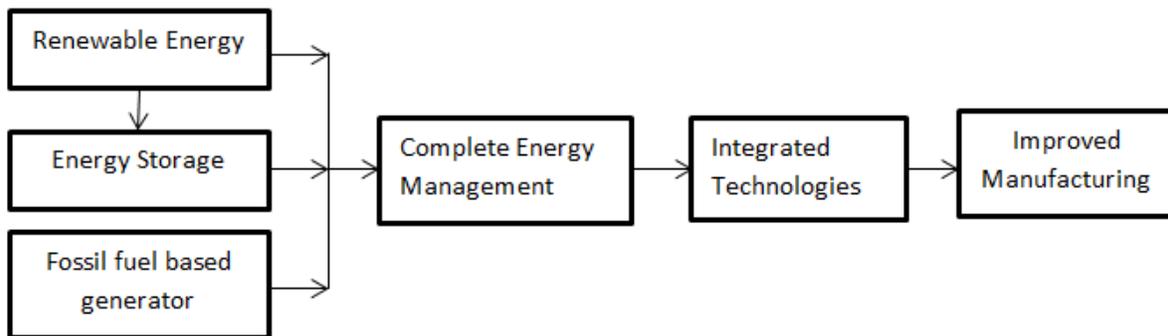


Figure 2: Hybridized power for the industry 4.0

3. CHALLENGES OF RENEWABLE ENERGY

Renewable energy technologies are facing some challenges which are limiting their full implementation. The following are the likely challenges.

Education: The level of education in most developing nations such as Nigeria and other African countries is fast depreciating with increasing number of graduates without jobs. Hence, the necessary scientific, technological and innovative skills and also knowledge are extremely lacking.

Cost: The cost of production of most renewable energy sources is very high which has also affected the cost of the products, making it difficult for people to purchase or utilize them.

Government Policies: The governments of most developing nations are not considering the full implementation of the renewable energy technologies. The government should create the enabling environment for foreign and local renewable energy products manufacturers so that the products will become cheap for the people to purchase.

4. CONCLUSION

The global target is to adopt the fourth industrial revolution as a new industrial standard for national development which the developing nations must adopt in order to achieve the development goal. Industry 4.0 comprises of cyber-physical systems (CPS), Internet of Things (IoT), Internet of Service (IoS), robotics, big data, cloud manufacturing, rapid prototyping etc., to automate and optimize manufacturing processes. To achieve the full implementation of industry 4.0, the hybridization of renewable energy must be considered because, the new industrial standard requires a reliable energy source.

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