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Leveraging Renewable Energy as a Cost-Efficient and Sustainable Power Source in Industry 4.0

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ABSTRACT

As the world's population and industrial output continue to soar, so does the need for more reliable sources of energy. The worldwide goal has been to embrace the fourth industrial revolution, also known as industry 4.0, as a new industrial standard in order to meet the rising need for better processes leading to higher quality and more plentiful goods and services. Automation and improvement in production are the goals of Industry 4.0, which uses cyber-physical systems (CPS), the Internet of Things (IoT), the Internet of Services (IoS), robots, big data, cloud manufacturing, block chain, rapid prototyping, etc. Its inability to function without a consistent and steady power source is a serious drawback, particularly in emerging economies like Nigeria's. However, running the current electricity grid, which relies heavily on fossil fuel products, is now prohibitively costly and fraught with reliability issues. In addition to releasing harmful gases like carbon dioxide, burning fossil fuels also has a number of additional negative effects on the environment. The widespread availability, low cost, and long-term sustainability of renewable energy technologies like solar power and biofuel make them a viable option for meeting these demands. The setup costs for solar power plants are substantial, yet they have no operating expenses at all. Biofuel made from biomass is readily accessible and inexpensive.

1. INTRODUCTION

As the world's population and industrial output continue to soar, so does the need for more reliable sources of energy. The worldwide goal has been to embrace the fourth industrial revolution, also known as industry 4.0, as a new industrial standard in order to meet the rising need for better processes leading to higher quality and more plentiful goods and services. Automation and improvement in production are the goals of Industry 4.0, which uses cyber-physical systems (CPS), the Internet of Things (IoT), the

Internet of Services (IoS), robots, big data, cloud manufacturing, block chain, rapid prototyping, etc. Its inability to function without a consistent and steady power source is a serious drawback, particularly in emerging economies like Nigeria's. However, running the current electricity grid, which relies heavily on fossil fuel products, is now prohibitively costly and fraught with reliability issues. In addition to releasing harmful gases like carbon dioxide, burning fossil fuels also has a number of additional negative effects on the environment. The widespread availability, low cost, and long-term sustainability of renewable energy technologies like solar power and biofuel make them a viable option for meeting these demands. The setup costs for solar power plants are substantial, yet they have no operating expenses at all. Biofuel made from biomass is readily accessible and inexpensive.²

METHODOLOGY

2.1 Trend of Industrial Development

Different phases of industrial process development have occurred based on the approaches used and the outcomes obtained. These revolutions have shaped the history of industrialization (Jadhav and Mahadeokar, 2019):

First Great Mechanical Era, Around the Year 1780
Mechanization: Mechanization fueled by water and steam engines. In 1784, an inventor created the first mechanized loom. Midway through the 1870s is when the Second Industrial Revolution began. The use of electricity to power the assembly line enabled mass manufacturing for the first time. In 1870, a butcher in Cincinnati installed the world's first conveyor belt.

Third Wave of Manufacturing, Around the Year 1960
Computers and the information technologies that enabled them were the driving force behind the rise of automation. It wasn't until 1969 that the first

programmable logic controller was developed. Revolution in Manufacturing, Fourth (2011) In the realm of cyber-physical systems: Industry 4.0 aims to fully digitize all physical assets and integrate them into digital ecosystems with value chain partners, as opposed to Industry 3.0's concentration on the automation of individual equipment and processes. The benefits of Industry 4.0, which integrates several cutting-edge technologies to produce value, are predicated on the efficient generation, analysis, and dissemination of data.

Integrated technologies in the industrial sector are the focus of the Fourth Industrial Revolution, or Industry 4.0. The purpose of these combined technologies is to provide a streamlined and efficient manufacturing process. In most manufacturing processes, energy is an integral cog in the machine. Most countries, particularly the more advanced and industrialized ones, have implemented Industry 4.0, and the results have been positive: more output and greater profitability. As a result, most emerging countries now want to achieve this in order to take part in the world's growing industrial and economic might. However, as illustrated in Figure 1, the current technical elements that are crucial to industry 4.0's integrated technologies cannot function without a reliable and constant supply of electricity. Unfortunately, most developing countries, including Nigeria, do not yet have reliable enough power infrastructure to meet the energy requirements of industry 4.0. Since the power industry must keep up with rapidly evolving technology, a hybrid approach is required, with renewable energy gradually replacing the fossil fuel-powered generator sets now used to power today's industrial enterprises.

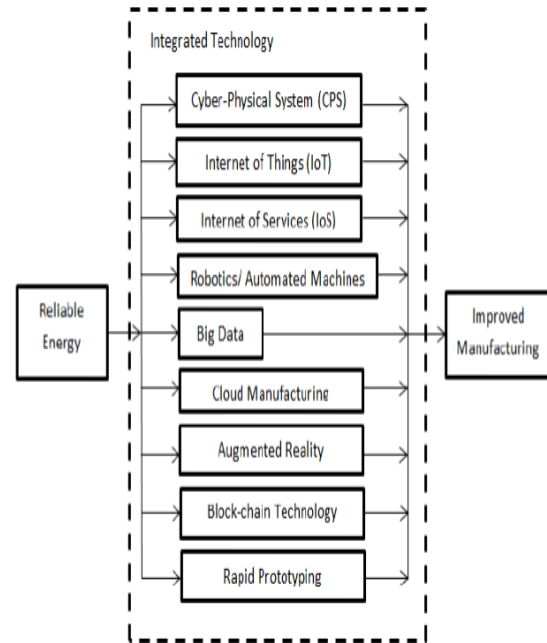


Figure 1: A production system built on Industry 4.0 principles.

Only via complete hybridization of renewable energy sources into the power sector, as seen in figure 2, can a stable energy setup be guaranteed.

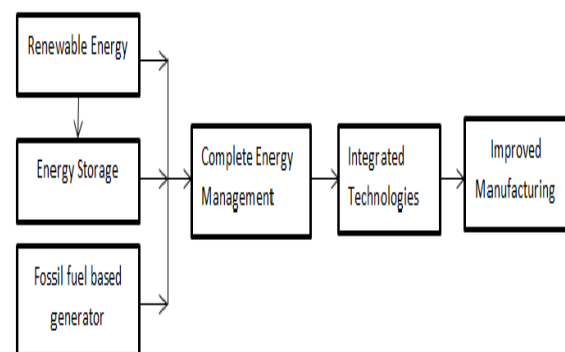


Figure 2: Hybridized power for the industry 4.0

3. CHALLENGES OF RENEWABLE ENERGY

There are obstacles to the widespread use of renewable energy technology. Here are some of the obstacles that may arise.

In most countries that are still in the process of developing, the educational system is rapidly deteriorating. This is especially true in Nigeria and other African countries. Therefore, there is a severe dearth of the requisite scientific, technical, and

inventive abilities and knowledge. The high price of renewable energy products is mostly attributable to their high manufacturing cost, which in turn makes it difficult for the general public to afford them. Most third-world countries are not really exploring full-scale deployment of renewable energy technology. To make renewable energy products more affordable for the general public, governments worldwide should facilitate the growth of the industries that produce them.

4. CONCLUSION

Developing countries are expected to follow the global trend of adopting the Fourth Industrial Revolution as a new industrial benchmark for national growth. Automation and improvement in production are the goals of Industry 4.0, which uses cyber-physical systems (CPS), the Internet of Things (IoT), the Internet of Services (IoS), robots, big data, cloud manufacturing, fast prototyping, etc. Hybridizing renewable energy sources is an important step toward complete industry 4.0 deployment since the new industrial standard need a stable energy supply.

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