AI and IoT for Energy Optimization

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Abstract:- The Energy sector all over the world is faced with the challenges on how to control wastages to its minimal bearing point with a view to optimize its consumption. The generation is capital intensive and the demand by the consumers is very high and the global world cannot wait to have a carbon free zone. Hence, the need for a greener and clean energy without leakages or wastages by the consumers

The research work is focusing on the role of Artificial Intelligence (AI) and Internet of Things (IOT) for energy optimization in Nigeria, a country where the demand for energy is far higher than its supply in both government buildings, residential buildings as well as market and business places.

The emergence of Internet of Things (IOT), smart technologies and AI (artificial intelligence) has made it possible to integrate renewable energy solutions together with a view to meet up consumer's demand and to create a carbon free environments to improve Energy generation without causing major harm to the environment as well as reducing energy wastages by both the generating company and the consumers in the Building Construction Industry (BCI)

With our current nature of power supply, Artificial Intelligence and Internet of Things are needed to synchronize the conventional power source and other backups sources like the fuel (diesel and PMS) generators and solar for steady power supply and by extension, steady work flow in the offices, residential buildings, business shops and market places.

The Building Construction Industry in Nigeria has a market size of about USD$105.8 billion in 2023 with an annual expectancy growth projection of >3% for a population of about 225.604 million people hence, the urgent need for more energy generation and proper optimization.

Finally, this paper will also look at some of the challenges with AI and IOT technologies in building structures as well as possible recommendations for a better greener carbon free environment

I. INTRODUCTION

This paper present the concept of Smart home building automation using AI and IOT technologies for Optimal Energy efficiency. The energy we are talking about in context include both man power energy and other conventional power generators like the Nuclear energy, Hydro power energy, Wind turbine, Biomass energy, Solar energy, etc.

Artificial Intelligence (AI): This refers to a technology or group of technologies that enable computers or machine(s) to carried out a function or varieties of functions including but not limited to ability to see, understand and translate spoken and written language(s), gather and collect data, analyze the data and proffer solutions or make recommendations where necessary, etc. AI is also commonly defined as computer systems that simulate human thinking and capacities such as learning with a result or output base on human input.

➤ *Internet of Things (IOT):*
This refers to the collective network of connected devices and the technology that facilitates communication between the said devices and the cloud. The core functionality of IOT devices is to reliably collect and share the perceived data with the physical world.

The hardware element of the IOT device consists of a battery-powered sensor, an actuator and a communication system. The function of a sensor is to collect the data from its designated environment. The data can be flow rates, temperatures, pressures, physical movements, distance, mass, voltage, current, etc. The collected data is then processed on the device so that it can be sent to remote servers through the communication network. – (Prof. Aparna Aravelli, Jaya Dofe and Hardik Gohel 2016).

➤ *Energy Optimization:*
This refers to the process of using energy more efficiently by reducing or eliminating wastages. It involves identifying areas where energy may be wasted or go lost during generation and implementing control measures to prevent such lost or wastages for maximum efficiency. This can include upgrading t-efficient appliances, improving building insulation, and using renewable sources of energy such as solar power and wind turbine.

II. BRIEF LITERATURE SURVEY

In Nigeria, coal, oil, and natural gas have been the principal sources of energy right from time immemorial. Coal was discovered in 1909 in Enugu, eastern Nigeria, with early production dating back to 1916. About 24,500 tons of coal was produced and used for mass (railway) transportation, which increased electricity generation, and industrial activities.

Today, 80% of power generation comes from gas; most of the remainder comes from oil, with Nigeria being the largest user of oil-fired backup generators in the continent. Natural gas remains the main source of power in the alternating current generation in Nigeria as almost all our turbines are either hydro or gas, although there is a shift towards solar PV as the country starts to exploit its large solar potential (IEA, 2019).

According to the rural electrification agency (REA) of Nigeria, developing off-grid alternatives to complement the national grid creates a **$9.2B/year (₦3.2T/year) market opportunity for mini-grids and solar home systems** that will save **$4.4B/year (₦1.5T/year)** for Nigerian homes and businesses. The agency estimates that there is a large potential for scaling considering the large swath of unserved customer population in the country.

Currently, Solar Home Systems, Solar C&I systems, Solar Mini grids, and other off-grid gas-fired solutions dominate the off-grid space in Nigeria. As of 2019, Nigeria's total off-grid electricity generation capacity approved by the NERC was about 500MW (Rural Electrification Agency, 2019). Of this number, solar mini-grids accounted for roughly 3MW.

The policy direction and strategies of the government towards the diversification of Nigeria's energy mix and building a vibrant off-grid sector have been largely progressive. Some of these policies include the National Electric Power Policy (2001), Renewable Energy Master Plan (2005), Renewable Energy Policy Guidelines (2006), Renewable Electricity Action Programme (2006), National Renewable Energy and Energy Efficiency Policy (2015), Renewable Energy Feed-in Tariff regulations (2015 - under review), NERC Mini grid regulation of 2017, and the Eligible Customer Regulations 2017.

Other more recent legislative actions include the federal government-issued VAT (Modification Order) 2020 in which renewable energy equipment such as wind-powered generators, solar-powered generators, and solar cells, were listed as items exempted from the application of VAT.

III. OBJECTIVE AND SCOPE OF STUDY

The primary objective of this project is to improve power generation in Nigeria through the use of Artificial Intelligence and Internet of Things as well as to reduce wastages by the consumer's i.e. Government buildings, residential and business buildings through the use of Artificial Intelligence and Internet of Things

➢ *Main Body*

With AI and IOT technologies, Energy efficiency is improved through a better production and consumption control system by reducing wastages and avoidable losses, improved surveillance for a better energy management system as well as to reduce system failure by ensuring that fault tracing become much easier for optimum clean energy generation. In addition, it improve the comfortability of the building to the end – user and make designs faster and beautiful to the Building Services Engineers (BSE) as well as attractive to the client.

Automation of Buildings for optimal Energy Management and power consumption Audit to save cost and proper accountability is possible and affordable within the shortest time frame through Re-Engineering and integration of both new and existing Structures into Smart homes for Energy Optimization. All these are achievable through proper monitoring, data collection, analysis, and implementation using advance technology such as AI, smart technologies and IOT

For many years, the energy sector have suffered a lot of setback from one technical and non - technical issue to the other that will lead to total black out. Is either the generating plant is down today or the National grid is down somewhere putting a major part of the country in total darkness.

➢ *Some of These Challenges Facing the Energy Sector Includes:*

- Poor surveillance system on energy infrastructures
- Outdated technology/equipment
- Poor metering system
- Corruption
- High technical losses
- Man power, etc.

All these and many more contribute to poor Energy generation and causes a lot of wastages in the energy sector.

➢ *With the use of Artificial Intelligence (AI), Internet of Things and Smart Technologies Equipment, the Following Progress can be Achieved:*

- Security on energy infrastructures: This can be achieve through the use of AI and IOT tools like drones and stationary Close circuit television (CCTV) cameras. The drones keep flying over the infrastructures to monitor the activities of bandits and other Harding criminals through data gathering, analyzing and documentations for preventive purposes
- Outdated equipment/technologies like the turbines, circuit breakers, switch gears, etc. should be replaced with the latest updated ones that uses sensors to detect overheating, high pressure, vibrations at the bearings or the rotors,

wear and tear of the equipment for quick replacement before breakdown
- Proper Smart metering system should be enforced for accountability
- Proper data collection and analysis using the appropriate technology should be implemented to reduce corruption and wastages
- The use of Alexa and other smart switches technology should be encourage in residential buildings, businesses and government buildings to reduce Energy lost and wastages
- The effect of Corona and High Voltage Differential pressure (HVDP) should always be checked to avert equipment/cable unexpected breakdown that can cause high technical losses.

➢ *Advantages of AI and IoT in Energy Optimization*

- They reduces energy waste and save cost: With the use of Smart phones, one can turn off the entire power in his house wherever you are through the use of Alexa app
- In the industries, it enable one to predict how long a machine will last before it breakdown through the use of AI like the HVDP sensors
- It enable the synchronization of different sources of Energy into one output possible
- They help in energy consumption forecasting. This is sure in determining the weather conditions and the best location to install solar panels, determine the consumption requirement of the end users to avert any story of blackout
- It also help in determining the energy storage capacity needed as well as tracking the battery performance
- With the high cost of tariff, lighting and HVAC (heating, ventilation and air conditioning) systems in buildings are optimized to save cost
- AI can also predict the breakdown of portable appliances early enough for maintenance purposes or even replacement
- AI and IOT reduces human errors.

➢ *Disadvantages of AI and IoT*

- Depending on what one intend to do but on general note, AI and IOT are capital intensive to implement
- It lack ability to create new ideas no has feelings like humans

IV. CONCLUSION

The need for the application of Artificial Intelligence and Internet of Things in the Energy sector for maximum optimization cannot be over emphasize. Government at all levels should venture into it to be able to meet up with the Energy demand of the people.

RECCOMMENDATION

Government at all levels should subsidize the cost of smart equipment to make it affordable to people, both individuals and organizations to encourage the use of renewable energy for a carbon free environment

Government should ensure prompt implementations and enforcement of all regulations gearing towards the expansions of renewable energy with zero tolerance to corruption

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