Acceptability of Smart Grid Technologies for Sustainable Energy Distribution in Developing Nations

[1]Onawola, H.J., [2]Longe, O.B, [3]Adebayo, S & [4]Olasina, J.R.
[1&2]School of IT & Engineering, Information Systems Programme, American University of Nigeria, Yola, Nigeria
[1,3&4]School of Engineering, Department of Computer Engineering, The Federal Polytechnic, Offa, Nigeria
E-mails: [1]Hassan.onawola@aun.edu.ng, [2]Olumide.longe@aun.edu.ng, [3]adebayo@yahoo.com, [4]jamiu.olasina@federalpolyilaro.edu.ng

ABSTRACT

Many developing Nations have been indisposed to key into the technology of smart grid system due to some of the flaws associated with the technology, interestingly the potentials in smart grid technologies cannot be overemphasized, in that its operation is automated and requires minimal human intervention. More so its mode of communications is done bi-directionally, and eco-system friendly with self-healing system. The Smart grid is the process of integration of information communication technologies with the existing power system infrastructure to enhance good service delivery[1].The technology is different from the traditional grid and it requires new ways of thinking and good planning strategies. This paper foot on acceptability of smart grid technology for sustainable energy distribution in developing nation, and the authors therefore modifies a conceptual frame work plans on its adoption by major stake holders in the distribution chain of the sector. The authors also viewed that a smart grid intelligent technology be adopted by developing Nation for electricity distribution system; so that it will curtail the problem of electricity distribution by the Distribution Company with enhanced system of energy sustainability and its distribution to all stakeholders and gives confidence to all investors concerned. However, the process must be carefully planned and well understood by all stakeholders (government, regulatory body, policy makers, operators, utility users and other concern stake holders) in order to achieving a sustainable electricity distribution.

Keywords: Smart Grid, Flaws, Bi-directional, Eco-System, Self-healing, Acceptability

iSTEAMS Proceedings Reference Format
Onawola, H.J., Longe, O.B, Adebayo, S & Olasina, J.R. (2019): Acceptability of Smart Grid Technologies for Sustainable Energy Distribution in Developing Nations. Proceedings of the 19th iSTEAMS Multidisciplinary Conference, The Federal Polytechnic, Offa, Kwara State, Nigeria.
7th – 9th August, 2019. Pp 125-132. www.isteams.net/offa2019 - DOI Affix - https://doi.org/ 10.22624/AIMS/iSTEAMS-2019/V19N1P16

1. INTRODUCTION

The grid system is systematically running up against its limitation, in Nigeria, for instance, electricity supplies may be on for a few hours and a times, a few minutes and sometimes resulted in total black-out, a reliable system is expected to be available at all time. In other words, the uptime of a system should be more than its downtime. The risk associated with dependent on the national grid system can be best imagined by people who depend only on grid power for their sustainability [2]. There are quite some problems facing grid system, and each of which varies from one country to another. Also, some of these challenges are: security, vandalization of grid equipment, theft, in-efficiency of workers, climatic change, non-availability of requisite tools for fault detections and diagnosis, brown-out, black-out and other challenges alike.

Power system engineering has three subdivisions and these include: generation, transmission, and distribution. Electricity is generated through power plant (generator) in the form of high voltage; electrical energy is then conveyed on high voltage lines and further stepped up to reduce energy loss along the transmission lines. The high voltage electrical energy after being transmitted over transmission lines was then stepped down to low-voltage electrical energy as it would be required for industrial and domestic use (that is, final consumers), this is then distributed through the distribution network system to the end[3]. Power can be generated through various sources and some of these are: water, wind, thermal, solar, and so on. This is transmitted via transmission system before distribution. Usually, some countries transmit at 33KVA and some do so at 11kVA and if the transmission resulted in heavy current and power losses [4], the efficiency of overall power system would drastically decline and as such, the competitive market situation in the power sector which is expected to be geared towards provision of reliable, affordable, and efficient power supply may not be achievable and available and even the real-time system would become impossible. The conventional methods of generating, transmitting and distribution of electricity supply is therefore gradually becoming obsolete because the methods are considered to have wasted a lot of power, and besides, it lacked the required efficiency, not too customer-friendly, high cost of sustainability, and in fact, it is completely unreliable due to the problem posed by brownout and at times, blackouts [5].

With new trends in electric power transformation in eliminating carbon emission, replacing aging assets and controls with Information and Communication Technologies (ICT) infrastructure has become the order of the day [6]. The deployment of smart grid internet of things (IoT) involves the use of sensors, actuators, and smart meters in the generation, transmission and distribution for monitoring, analyzing and controlling electricity consumption [5]. Smart grids provide a grid that hinges on cyber infrastructure due to the usage of big data to yield a reliable and improved grid system. The fact that SGs is considered to have more advantages over the traditional grid, the interest of the end-users' needs to be adequately protected from menace of cyber-attack by provision of effective controls of possible vulnerabilities in the smart metering system and other infrastructural elements built in the smart grid system[7];[8].Smart grid system uses digital technology to give reliable energy, it is a self-healing system with greater efficiency to provide electric system right from point of generation, transmission, and distribution to end-users.

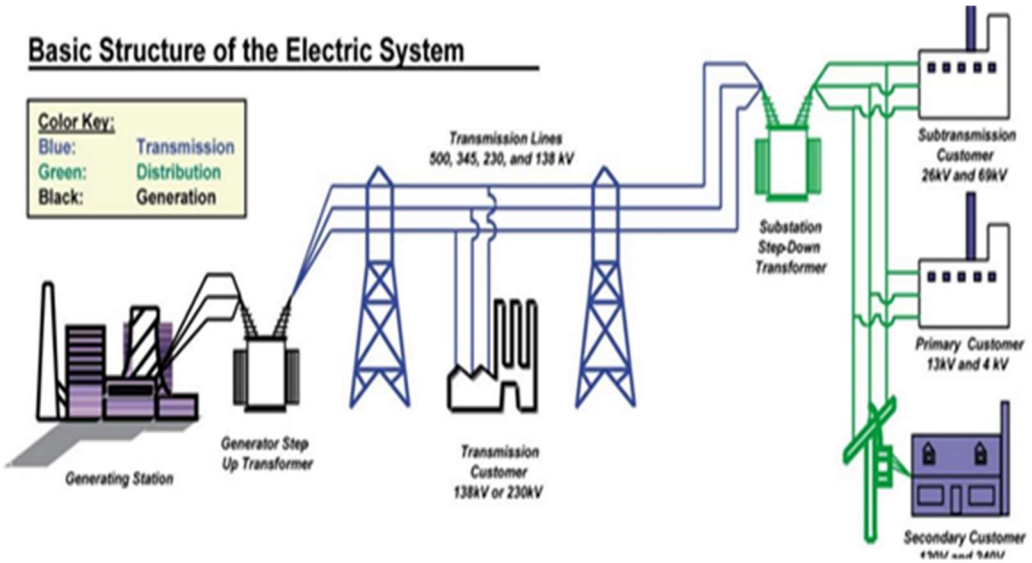

Fig I: Conventional Power Supply Grid System
Source: Mohamed Eid Aljahani. (2014).https://scholarworks.wmich.edu/masters_theses/496

However, with exponential growth rate in the economy, the future of the sector might be in jeopardy if urgent attention is not taken by appropriate authorities to meet the country's power generation and distribution needs. Recently, the Federal Government of Nigeria signed an agreement with Siemen Company to increase energy capacity to 7MW by 2021, 11MW by 2023 and then 25MW thereafter [9]. The country relies more on one source of power generation (hydropower). To continue in this way may not be a very good idea and besides, it may not be sustainable. Although, the cost of implementing and deploying smart grid is extremely high, for instance, it cost the USA to deployed smart grid between $338-$476B for a period of 2010-2030 (www.greencarcongress.com), though it may be one of the critical challenges, but the benefits, and its sustainability at long will justify SGS is an investment that gives stakeholders values of their investment[10]and it will in fact returns credits to the nation of its deployment. A tenable solution to problem of epileptic power supply is to harness and connect to the power of Information and Communication Technology (ICT) to increase efficiency, reliability, availability, and then modernize the electricity supply system by plugging into the interface provided by the Internet of thing (IoT) to power supply infrastructures if we must meet up the future needed power generations for the teeming populace.

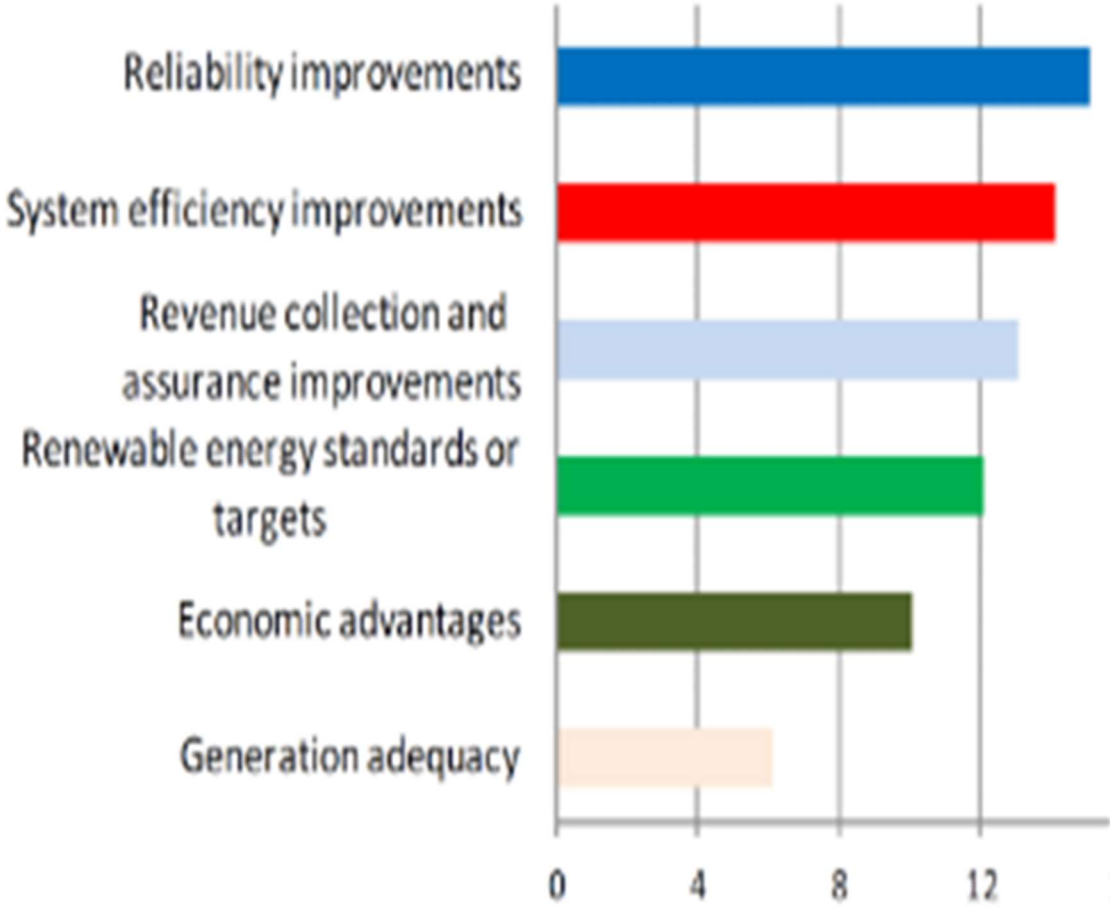

Fig 2: SG Technology motivating drivers based on country surveys for developing
Source: Smart grids overview of activities & players in smart grids, 2014-2015

2. RELATED WORKS

In the management of energy consumption, smart grids(SGs) has a greater prospect but in the transformation from the conventional grid system to SGS, there exist some challenges [7]. Smart grids (SGs) can efficiently co-ordinate grid operators, the customers and other stakeholders to operate all parts of the system with the reduction in cost and environmental emission thereby maximizing stability, reliability, resilience in the entire system [10]. Adoption of smart grids can revolutionize the energy environment with less human intervention and improvement in service delivery to utility users [11];[12]. Findings show that sustainable SG system is good with greater potential because the expected growth in the energy sector in the coming decades will raise from 9,385-16,442 TWh i.e. between the year 2005-2030 in Asia-Pacific Economic Cooperation (APEC) economies and expected investment will also increase from $6.2-8.4 trillion [13].

Developing nations are still investigating the potentials in SG and much attention weren't giving to the adoption of the technology and only very few countries like Brazil, China and India have had suitable plan and development for this technology. SG adoption takes more than deploying new technologies and application of new equipment. It actually requires new thinking, changing from analogue to a digital system and also to system integration [14].In view of all review works, the authors are of the opinion that the SG intelligent technology be adopted to electricity distribution system to minimize the problem of electricity distribution by the Distribution Company to enhance sustainable energy distribution for the benefits of its users and to also give confidence to investors. However, the process of its acceptability must be carefully planned and well understood by all stakeholders (that is, government, regulatory body, end-users, and all policymakers) if such nation must achieve a sustainable electricity distribution. According to the United Nations on economic and social council, it established and fully explained that policy mixes are very crucial for grid infrastructural deployment [15].

2.1 Problem Statement

Electric power system across the globe is becoming more attractive and competitive and is at the verge of transformation which will involve using ICT in monitoring and controlling the distribution, transmission, and generation of electricity to allow for specific information of the real state of the system at any particular point in time. Many people across the globe do not have access to electricity and findings show that 20 out of 100 do not have access to modern energy, and this is what has motivated the united Nation to unveil the sustainable energy for all initiative in 2014, to ensure more efficiency in energy distribution [16]. To realize this noble objective, a modernized system of electricity is required to enable more people to have access to electricity. Reports from US department of energy indicated that the US is out to address the challenges and opportunities in the deployment of SG technologies to improve the nations electric power system to meet the 21st-century challenges [17].In the light of this, it is imperative for all developing countries to key into the adoption of SG technologies and particularly at the distribution unit of the sector to minimize the problem of electricity distribution by the Distribution Company, enhancing sustainable energy distribution to final users and gives confidence to all investors. However, the process must be carefully planned and well understood by all stakeholders in achieving the best result.

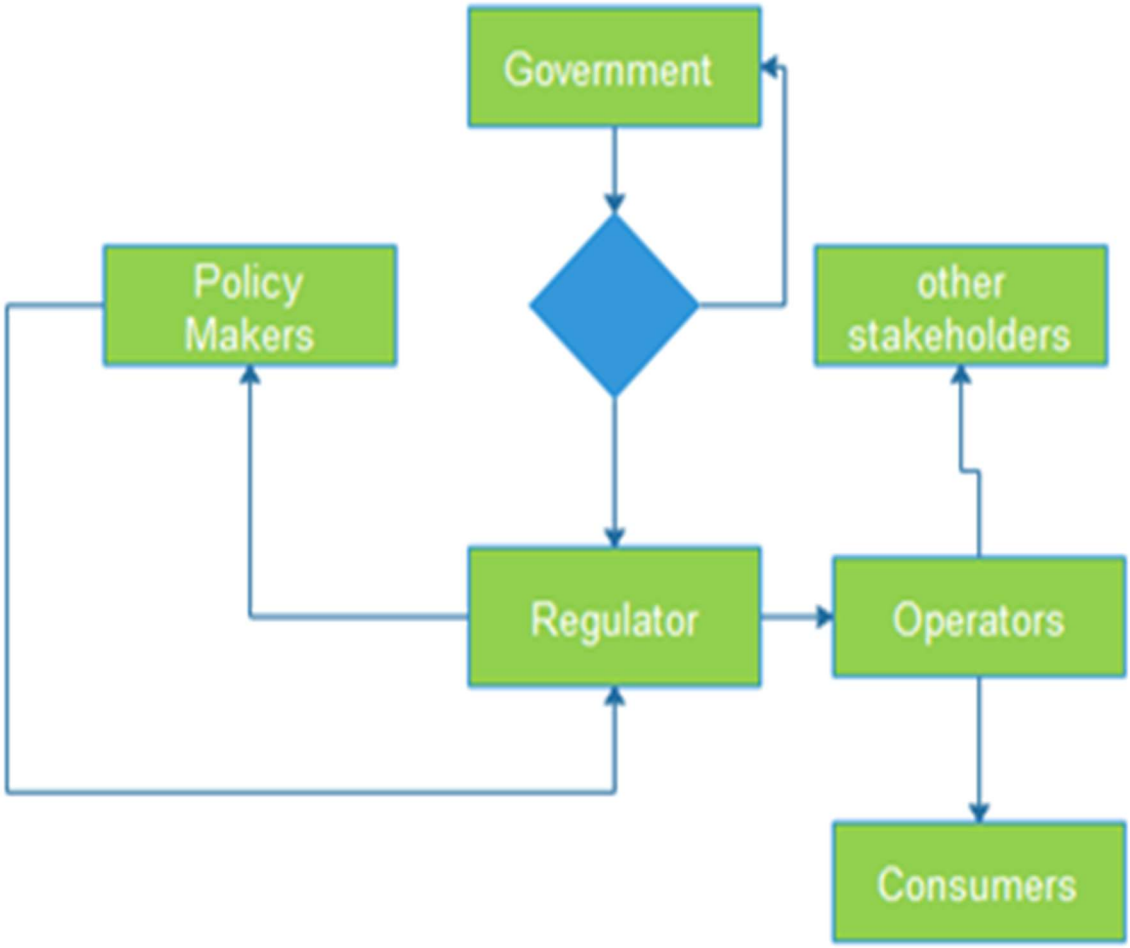

Fig. 3: Conceptual framework for Plan Sustainable Energy Distribution with SG

3. DISCUSSION OF CONCEPTUAL PLANNING

In the framework, discussions were on the adoption of smart grid technologies for electricity distribution to all utility users, on having a proper planning system for electricity distribution to provide better service delivery to utility users. Looking at the empirical situation of the power sector, the way forward is to create an enabling environment suitable for the adoption of the SG system by the developing nations. The adoption of the technology will enhance the operations of distribution company with greater efficiency and wide coverage area with greater service delivery to the satisfaction of final consumers, and also improve the quality of electricity distribution, pave way for competitiveness among service providers of distribution of electricity, automated metering system adoption, electricity network expansion and also gives confidence to investors, and finally strengthening the distribution network. Below are some of the focal points in the planning process for the adoption of SG by developing nations.

3.1 Government

Government of the day should show concerns and interest in the new modern technology, thereby creating enabling environment for private participation and other investors to strives. Investors will not put in their investment where the return on investment (ROI) is not guaranteed, and more so many investors like to minimize risk and maximize profit and opportunity. Additionally, the value of SG technologies can be difficult to quantify due to multi-tiered benefits and opportunities they provide to utility users and as such, financial metric system may also be difficult to calculate because each infrastructure incorporated to SG technologies has a unique level of investment which may be of high level of interest to all investors.

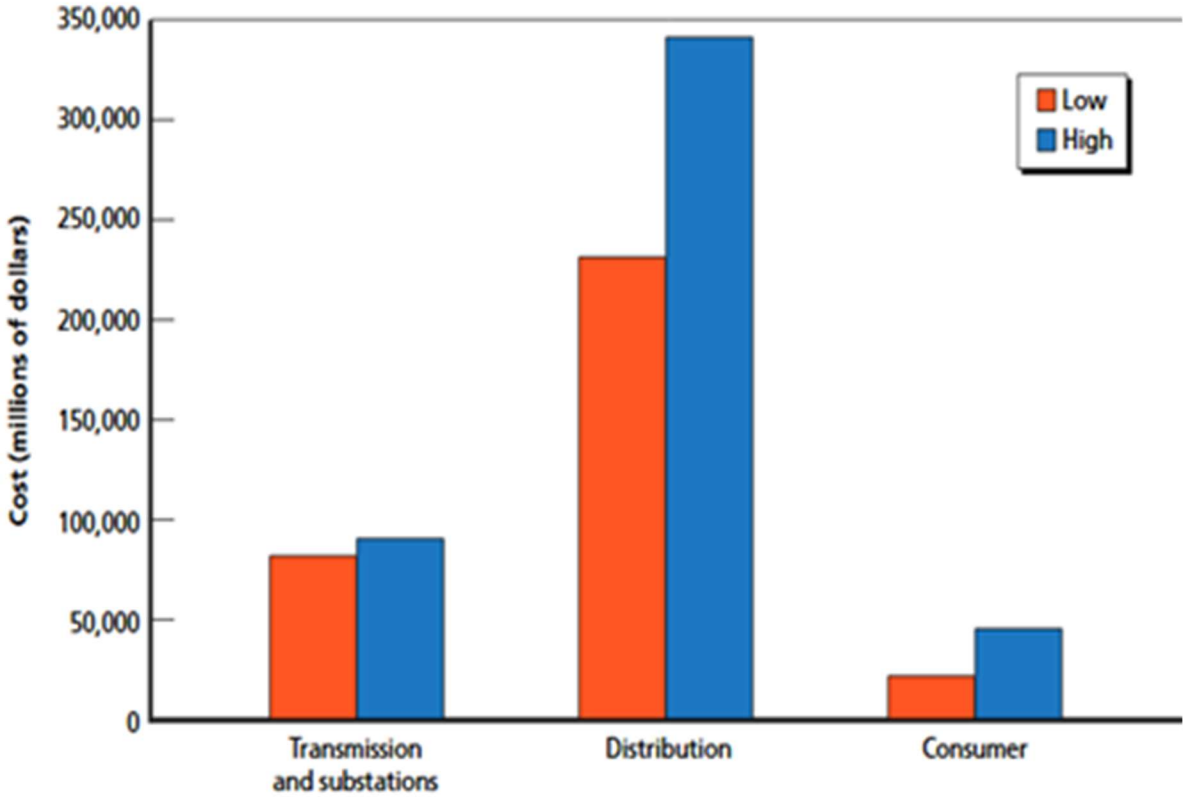

Fig. 4: Estimated investment cost of a fully functioning SG
Source: C. Guo,2015 [15]

3.2 Regulator

It is a fact that SG technologies employ the digital device in its operation to improve efficiency. Regulator is therefore required to set a standard, and imagine a situation where the standard is not regulated, there is no doubt that such a system would not perform optimally [18]. The regulator should develop measures to protect the critical SG infrastructure and address issues that may jeopardize the adoption of the technology. Regulators are to have enforceable standards for all stakeholders as lacking appropriate standard may be a source barrier for SG adoption [19]. The inability to disallow private individual to participate in a regulated utility's increases the risk associated with that investment and making that investment less attractive.

3.3 Policy makers

Policy formulation should be such that it is proactive. Invention of new technology cannot materialize without adoption by the concern stakeholders. Therefore, formulation of good policies can be used as an instrument to prepare people's mind to key into SG technologies adoption, and however, they are expected to make decision that will not hamper the acceptability of the technology by the concern stakeholders, and make decision that will encourage and guarantee investors' confidence to allow for more competitiveness in the business.

3.4 Consumers and other Stakeholders

SG technologies requires proper planning, adequate coordination, understanding among all the concerns utility users and proper education, because it is a digital technology with new ways of thinking which uses real-time system in monitoring all controls and other things in the distribution unit of the power system, and as such will require significant planning and synergy among all stakeholders for its implementation.

3.5 Operators

To have a good and safer landing in the adoption of SG technologies, it is obligatory for the operators of the technology to provides its customers with proper education and training on how to operate the SG system, the knowledge provided by the operators to consumers are very key for the adoption of the technology.

4. CONCLUSION

The paper presents the acceptance of SG technology by developing nations with emphasis on potential benefits on the adoption of the technology. It further explained the framework for the conceptual plan that can be used to sensitize the customers and other stakeholders in the business chain to the adoption of SG technologies by developing countries. In conclusion, SG intelligent technology should be adopted as a modern way of electricity distribution system to minimize the problem of electricity distribution by the Distribution Company. Also, it will enhance sustainable energy distribution for the benefits of utility users and give confidence to all investors; and however, the process of its acceptability must be carefully planned and well understood by all stakeholders.

REFERENCES

[1] J. R. Young, "Smart grid technology in the developing world," p. 82.
[2] "The Smart Grid: An Introduction," p. 48.
[3] M. E. Aljahani, "An Enhanced Self-Healing Protection System in Smart Grid: Using Advanced and Intelligent Devices and Applying Hierarchical Routing in Sensor Network Technique," p. 50.
[4] A. Janjić, L. Velimirović, J. Ranitović, and Ž. Džunić, "Internet of Things in Power Distribution Networks – State of the Art," p. 5.
[5] A. O. Otuoze, M. W. Mustafa, and R. M. Larik, "Smart grids security challenges: Classification by sources of threats," Journal of Electrical Systems and Information Technology, vol. 5, no. 3, pp. 468–483, Dec. 2018.
[6] Y. Yan, Y. Qian, H. Sharif, and D. Tipper, "A Survey on Smart Grid Communication Infrastructures: Motivations, Requirements and Challenges," IEEE Commun. Surv. Tutorials, vol. 15, no. 1, pp. 5–20, 2013.
[7] R. Yesudas and R. Clarke, "A Framework for Risk Analysis in Smart Grid," in Critical Information Infrastructures Security, vol. 8328, E. Luiijf and P. Hartel, Eds. Cham: Springer International Publishing, 2013, pp. 84–95.
[8] A. Ashok, A. Hahn, and M. Govindarasu, "Cyber-physical security of Wide-Area Monitoring, Protection and Control in a smart grid environment," Journal of Advanced Research, vol. 5, no. 4, pp. 481–489, Jul. 2014.
[9] J. Nda-Isaiah, "Nigeria: Govt Signs Electricity Deal With Siemens," allAfrica.com, 23-Jul-2019. [Online]. Available: https://allafrica.com/stories/201907230043.html. [Accessed: 03-Aug-2019].
[10] "Smart.Grids.Overview.pdf." .
[11] Ó. Álvarez, A. Ghanbari, and J. Markendahl, "A COMPARATIVE STUDY OF SMART GRID DEVELOPMENT IN DEVELOPED AND DEVELOPING COUNTRIES," p. 14.
[12] A. Elizabeth, W. Samuel, A. Felix, and M. Simeon, "Smart Grid Technology Potentials in Nigeria: an Overview," vol. 13, no. 2, p. 10, 2018.
[13] S. E. Widergren, M. L. Paget, T. J. Secrest, P. J. Balducci, A. C. Orrell, and C. N. Bloyd, "Using Smart Grids to Enhance Use of Energy-Efficiency and Renewable-Energy Technologies," PNNL-20389, 1013938, May 2011.
[14] J. Dedrick and Y. Zheng, "Adoption of Smart Grid Technologies: Results of a Survey of U.S. Electric Utilities," p. 6, 2016.
[15] "The role of science, technology and innovation in increasing substantially the share of renewable energy by 2030," p. 17.
[16] "IEEE Smart Grid Newsletter.pdf." .
[17] "Smart Grid:Enabler of the New Energy Economy," p. 38.
[18] "Smart Grids and Renewables: A Guide for Effective Deployment," p. 47.
[19] C. Guo, C. Bond, and A. Narayanan, The Adoption of New Smart-Grid Technologies: Incentives, Outcomes, and Opportunities. RAND Corporation, 2015.
[20] M.A.Ponce-Jara,E.Ruiz,R.Gil,E.Sacristobal,C.Perez-Molina and M.Castro "Smart grid:Assessment of the Past & Present /in developed & developing Countries.