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Power Quality Improvement Strategy, Renewable Energy, A Solution to Long Power Outage in Nigeria

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***Abstract*— Electrical power, in the short span of two centuries, has become an indispensable part of modern day life. Our work, leisure, healthcare, economy, and livelihood depend on a constant supply of electrical power. Even a temporary stoppage of power can lead to relative chaos, monetary setbacks, and possible loss of life. Power outages can be especially disastrous when it comes to life-support systems in places like hospitals and nursing homes, or in co-ordination facilities such as in airports, Automatic Teller Machine (ATM), and traffic control. While the majority of power failures from national grids last only a few hours, some blackouts can last days or even weeks, completely shutting down production at companies and critical infrastructures such as telecommunication networks, financial services, water supplies and hospitals. Controlling that risk should not just be limited to having emergency back-up generators or being able to relocate their operations and workforce – it also needs to take into account the effect that a power outage could have on their supply chains as well. Renewable energy resource is as resource that can be re-generated through natural process within a relatively short time which can be used to bridge the gap in times of long power outage. This paper therefore examined the renewable energy as a solution to long power outage in Nigeria.**

Keywords: Biomass, Power outage, quality, power quality, renewable energy, and solar .

I INTRODUCTION

Some countries (developed and developing) have lagged behind other countries in the transition to a low-carbon energy system fuelled by renewable energy. Some scholars suggest that this low level of progress is due to the abundance of fossil fuels and the advancement of policy to support the generation of energy from traditionally reliable sources in fossil-fuel-resource-rich countries.

Countries that have abundant resources such as crude oil and coal depend heavily on these resources, and their energy systems are built on energy generation from the locally abundant resources, therefore, the transition to green energy has proceeded slowly. Ultimately, a continued policy focus on developing power plants fuelled by the locally abundant resources to meet the needs of the local population impacts negatively on the agendas aimed at transitioning to renewable energy and economy recovery [1].

The power issues in Nigeria are no longer new. From generation to distribution, the reliability and quality of the system is far below expectation [2]. Energy crisis in Nigeria has become a norm for several decades and is bane of her economic development. There is an extreme electricity deficiency in Nigeria and the causes of this deficiency are related to financial, sociopolitical, structural, improper planning, no competition, obsolete power equipment and lack of good service delivery.

Light bulbs dim like a bulb powered by a weak battery, fans slow to sluggish limp. Air conditioners bleat and make sounds they were not manufactured to make; the compressor of an air-conditioner suffers. The new energy saving bulb blinks till it finally give up and burnt. Sometimes, the light bulb goes off and on and off and on, and suddenly brightened as if jerked awake, before dimming again. Power equipment sparks, snaps and burnt.

The power technician is invited to come and diagnose the problem, the troubleshooting report is always, the current is either too high or too low, a wire has melted, the laptop charger is burnt if the laptop escaped the fluctuation, the compressor is burnt and has to be replaced.

Both electric utilities and end users of electric power are becoming increasingly concerned about the quality of electric power.

A. Power Outage

A power outage (also called a power cut, a power blackout, power failure or a blackout) is a short-term or a long-term loss of the electric power to a particular area. There are many causes of power failures in an electricity network.

There are five major reasons for the increased concerned:

Newer generation load equipment, with microprocessor-based controls and power electronic devices, is more sensitive to power quality variations than was with analogue/manually operated equipment used in the past.

The awareness on the use of energy saving bulbs is on the increase which contributes more to power quality issue as non linear load. The increased emphasis on overall power system efficiency has resulted in continued growth in the application of devices such as high efficiency, adjustable speed motor drives and shunt capacitors for power factor correction to reduce losses.

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The end users are becoming better informed about issues as interruptions, flickers, long power outage, load shedding, sag, spike, harmonics, etc and are challenging the utilities to improve the quality of power delivered.
Equipment is now being interconnected in a network. Integrated processes mean that failure of any component has much more important consequences.

B. Renewable Energy

Energy exist freely in nature, some of them exist infinitely (never run out, called renewable), the rest have finite amounts and will run out one day, called non renewable.
Renewable energy is energy generated from natural resources such as sunlight, wind, rain, tides and geometric heat which are renewable (naturally replenished). Renewable energy technologies range from solar power, wind power, hydroelectricity, biomass and biofuels for transportation.
With this in mind, it is a lot easier to lay any type of energy source in its right place. Let's look at these types of energy in figure 1.

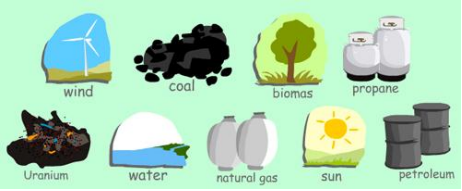

Figure 1

It can be noticed that water, wind, sun and biomass (vegetation) are all available naturally and were not formed. The others do not exist by themselves, they were formed. Renewable energy resources are always available to be tapped, and will not run out. This is why some people call it Green Energy.

C. Power Quality

Despite important papers, articles, and books published in the area of electric power quality, its definition is yet to be agreed to universally. There is no doubt that, everyone accepts that power quality has direct impact on efficiency, security, Gross domestic product of any country and reliability of an electrical system.

According to [3], Power quality problems are associated with an extensive number of electromagnetic phenomena in power systems with broad ranges of time frames such as long duration variations, short duration variations and other disturbances. Short duration variations are mainly caused by either fault conditions or energization of large loads that require high starting currents. Depending on the electrical distance related to impedance, type of grounding and connection of transformers between the faulted/load location and the node, there can be a temporary loss of voltage or temporary voltage reduction (sag) or voltage rise (swell) at different nodes of the system.

Power quality is defined in the IEEE 100 Authoritative Dictionary of IEEE Standard Terms as The concept of powering and grounding electronic equipment in a manner that is suitable to the operation of that equipment and compatible with the premise wiring system and other connected equipment Utilities may want to define power quality as reliability (IEEE, 2000).

Generally, power quality can be expressed as the quality of the voltage and/or the quality of current and can be defined as the measure, analysis, and improvement of the bus voltage to maintain a sinusoidal waveform at rated voltage and frequency. This definition includes all momentary and steady state phenomena.

The key aspects of power quality are: Disturbances: any kind of fluctuation in power, including voltage sags, swells, spikes transients, and outages.

Harmonics: Electric voltages and currents that add frequency distortions and can cause power quality disturbances. The following are examples of electronics that add to harmonics; local area network, electronic ballasts, personal computers, laser printers, fax machine, fluorescents lightings, Uninterruptible power supply (UPS), variable frequency drives, switching mode power supplies and medical test equipment.

Power Factor: the ratio of true power to apparent power in a circuit. It is a way to measure a circuit's level of power efficiency.

II. CAUSES OF INEFFICIENT POWER QUALITY

The causes can be divided into two, internal and external sources.
The internal sources are: Powering on and off large equipment, Wiring errors and aging infrastructure, Increases in number of electronics and Large loads sharing the same circuit
The external sources are: Severe weather, Utility faulty clearing, Power line accidents, Grid switching, Lightening, Vandalism.

III. CAUSES OF POWER OUTAGES

A. Weather-related causes of power outages

Lightning - Lightning is a common cause of outages. Lightning strikes can hit our electrical equipment, causing you to lose power. Lightning can also strike trees, which may fall onto power lines and cause outages.

Wind - High winds may cause objects, such as fallen trees, to come in contact with power lines. If that happens, circuit breakers or other protective equipment will shut off the flow of power. Wind may also blow tree limbs or entire trees onto the power lines, causing the lines to fall to the ground, or breaking the lines and poles.

Rain and flooding - Heavy rains can cause flooding in certain areas. Floods can cause damage to electrical equipment. To prevent major damage, The Utility may need to shut the equipment down, affecting service to some customers.

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B. Others Causes of Power Outages

Car accidents - Car accidents can cause power outages, as they sometimes result in damaged poles and power lines.

Animals - Animals can also cause power outages when they climb on equipment, such as transformers and fuses, causing the equipment to shut down. By shutting down, the equipment protects the rest of the system.

Planned outages - It is sometimes necessary to interrupt power to homes and businesses, to perform maintenance on our system. The Utility is not making any effort to alert affected customers and communities in advance of these planned outages.

Vandalism: this has been a major concern as one of the causes of poor power supply, vandalism of gas pipe line has been the biggest challenge the power sector is facing. This has caused massive blackouts across major cities and town in the country

Short Circuits: A short circuit occurs when an electric current travels along a path that is different from the intended one in an electrical circuit. When this happens, there is an excessive electric current which can lead to circuit damage, fire, and explosion. In fact, short circuits are one of the primary causes of electrical fires throughout the world.

Power Surges

Power surges are the bane of any electrical system. A power surge can lead to rapid overheating and loss of critical and expensive equipment. Fortunately, protection from such surges is available in the form of surge protectors and circuits breakers.

C. Effect of power outages

There are various painful effects of long term power outage that can be felt for a long time, even after the power comes back on. When in or around cities, there are special consequences during power outages. Most urban and suburban locations are very highly dependent on uninterrupted electricity. Transportation systems can go into mayhem, Water supply systems shut down, Communication stations go off; therefore you can't call the police, an ambulance, police, etc and Surveillance and security resources can be temporarily knocked down which could prompt rising crime rates.

IV. BENEFITS OF RENEWABLE ENERGY

Renewable energy has the potential to reduce pollution, slow global warming, create new industries and jobs, and move Nigeria toward a cleaner, healthier energy future, though renewable energy is not without its challenges and impacts.

Renewable energy provides substantial benefits for our climate, health and economy. The benefits are

It produces little or no waste products such as carbon dioxide or chemical pollutant. It therefore has minimal impact on the environment.

Renewable energy facilities generally require less maintenance than traditional generators.

The cost of operation is reduced because the fuel being used is derived from natural and available resources.

It is sustainable and will not run out

It also brings economic benefits to many areas.

It should also be noted that, renewable energy has some short falls

One disadvantage with renewable energy is that it is difficult to generate the quantities of electricity that are as large as those produced by traditional fossil fuel generators. This may mean that we need to reduce the amount of energy we use or simply build more energy facilities. Another disadvantage of renewable energy sources is the reliability of supply. Renewable energy often relies on the weather for its source of power. Hydro generators need rain to fill dams to supply flowing water. Wind turbines need wind to turn the blades, and solar collectors need clear skies and sunshine to collect heat and make electricity. When these resources are unavailable so is the capacity to make energy from them. This can be unpredictable and inconsistent. The current cost of renewable energy technology is also far in excess of traditional fossil fuel generation. This is because it is a new technology and as such has extremely large capital cost. Figure 2 shows renewable energy implementation in Sokoto and Katsina wind farm in Nigeria.

Figure 2a. Pilot Water Heater at UDUTH by SERC, Sokoto

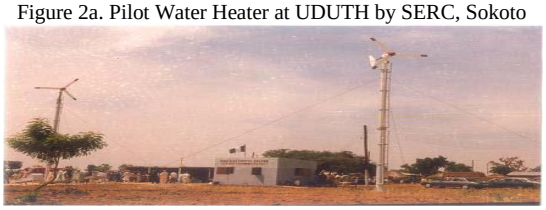

Figure 2b. 5kW aero generator in Sayya Gidan Gada, Sokoto State

Table 1. Renewable Energy projection in Nigeria (Mega Watts)

S/N	Renewable Energy (MW)		Timeline (Year)/Quantity To Be Generated		
		Now	Short Time (2012-2015)	Medium Term (2016-2020)	Long Term (2020-2030)
1	Biomass Electricity	0.00	5.00	30.00	100.00
2	Solar PV Home Systems	15.00	600.00	6,136.00	48,132.00
3	Hydro Power	1,998.18	4,100.00	9,760.00	14,750.00
4	Wind	10.00	23.00	40.00	50.00
	Total	2,023.18	4,728.00	15,966.00	63,032.00

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Table 2. Electricity Demand Projection (Mega Watts)

Scenario/ Year	2010	2015	2020	2025	2030	2035	2040
Reference (7%)	7,440	24,380	45,490	79,798	115,674	161,651	213,122
High Growth (10%)	8,420	30,236	63,363	103,859	196,875	333,444	487,510
Optimistic Scenario I (11.5%)	9,400	36,124	76,124	145,113	251,224	468,183	710,271
Optimistic Scenario II (13%)	10,230	41,133	88,282	170,901	315,113	573,289	979,326

Table 3. Projected electricity supply by Fossil fuel (Mega Watts)

Type/ Year	2010	2015	2020	2025	2030
Coal	3352.98	3352.982	12121.79	14,011.27	20298.63
Gas	13109.8	26426.06	49996.47	120512.45	164306.85
Total	16462.8	29779.04	62118.26	134,523.72	184605.48

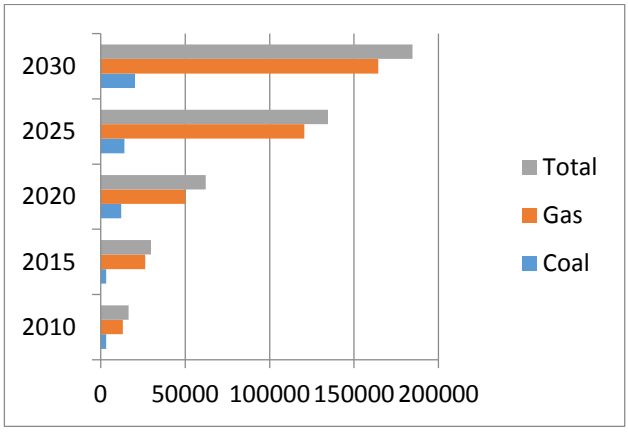

Figure 3: Electricity supply projection by fossil fuel only

Table 4. projected electricity supply by mix (Mega Watts)

Type/ Year	2010	2015	2020	2025	2030
Coal	3352.98	3352.982	12121.79	14,011.27	20298.634
Gas	13109.8	26426.06	49996.47	120512.45	164306.85
Hydro	1930	4157	11207	12132	12132
Solar	490.35	2543.303	6417.268	15969.94	39737.5
Wind	23	36	41	47	54
Biomass	0	5	30	65	100
Total	18906.1	36520.34	79813.53	162,737.66	236628.984

Table 5. Energy Projection (Mega Watts)

Year	Demand Projection	Supply From Fossil fuel only	Supply from Renewable energy	Supply From Fossil fuel and renewable energy
2010	10,230	16,462	2,443	18,901
2015	41,133	29,779	6,741	36,520
2020	88,282	62,118	17,695	79,813
2025	170,901	134,523	28,213	162,737
2030	573,289	184,605	52,023	236,628

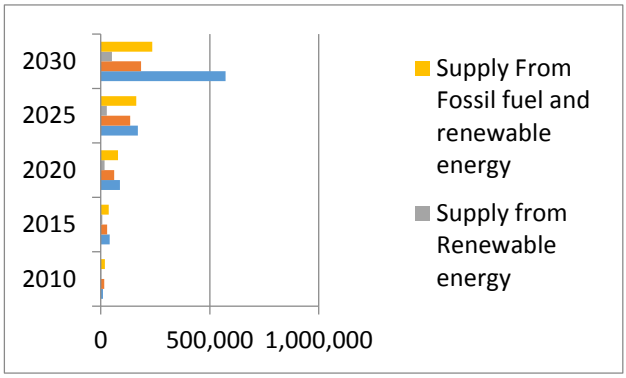

Figure 3. Energy projection that can solve long power outage

V. CONCLUSION AND RECOMMENDATION

Energy is a critical resource for development. When linked to economic activity, energy spurs economic development within countries. In the quest to fulfill the objectives of sustainable development, countries establish renewable energy programs to advance the transition to low-carbon economies, while also aiming to diversify the national energy mix.

Policy alternatives for renewable energy development are selected by governments (Federal, state and Local) based on the potential to accelerate renewable energy development and provide financial incentives in terms of profitable returns to investors, while minimizing the overall cost to governments and citizens during the lifespan of the renewable energy policy.

To handle these enormous technical challenges, grids need to become much smarter. Governments should develop new grids with metering, control and communication functions to handle the future growth of renew able energies. They should also promote storage facilities for excess energy such as pumped storage hydropower plants or underground vaults for compressed air.

If the energy projection is strictly followed, it will boost the quality and the quantity of energy to be generated, transmitted and distributed.

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Overhauling national grids comes at a considerable cost should be championed by the government.

This also indicates that the best solution to our energy problems may be to have a balance of many different power sources.

REFERENCES

[1] B. A Hamilton "Green Jobs Study". U.S. Green Building Council. Retrieved 2013-06-11.2012
[2] J. J. Popoola. , Akinlolu Adediran Ponnle and Thomas O. Ale (2011) "Reliability Worth Assessment of Electric Power Utility in Nigeria: Residential Customer Survey Results" AUJ.T. 14(3): 217-224, 2011
[3] M. E. Karthik). "The 27 Level Multilevel Inverter For Solar PV Applications" IEEE Vo/Nol 978-4673-0934-9/12, 2012

IEEE Standard 1100-1999, "Recommended Practice for Powering and Grounding Sensitive Electronic Equipment, 2000.

Energy Commission of Nigeria "Energy Commission of Nigeria (ECN) Renewable Energy Master Plan". Energy Commission of Nigeria, Government of Nigeria, Abuja. 2006

Eergy Commission of Nigeria (ECN) "Renewable Energy Master Plan". 2009