Renewable Energy: Comparison of Nuclear Energy and Solar Energy Utilization Feasibility in Northern Nigeria

Ismaila Yusuf Pindiga[*], Olusola Olorunfemi, Bamisile[*]
[*] *Department of Energy Systems Engineering, Cyprus International University, Haspolat-Lefkosa, Via Mersin 10, Turkey*

***Abstract*— The use of fossil fuel to generate energy poses great danger to the environment due to pollution and carbon emissions. Nigeria greatly depends on fossil fuel source to generate energy for electric power and transportation. The major fuel crisis of 1973 followed by other minor ones in subsequent years, triggered several nations to seek for alternative energy source. That has given birth to Renewable Energy Technology. In Nigeria, electricity is produced primarily through the combustion of coal, natural gas and oil. Economically, fossil fuel of such caloric value should be replaced by low value fuels which have no other application. The production of electricity from nuclear was thought to be an alternative solution. But, it has a key environmental, economic and social role to play in meeting the growing demand for electricity throughout the world. With abundant sunshine particularly in Northern part of Nigeria all year round, the country can utilize solar energy to her best advantage. The paper assesses the challenges of nuclear energy, explores the opportunities of solar energy utilization and concludes that appropriate investment in solar infrastructure and utilization can provide large amount of electricity to fill the Nigeria's projected energy demand gap by 2030.**

***Index Terms*— Fossil Fuel, Electric Energy, Renewable Energy, Alternative Source, Nuclear Energy, Solar Energy, Energy Demand.**

I. Introduction

ENERGY is the mainstay of Nigeria's economic growth and development. It plays a significant role in the nation's international diplomacy, serves as a tradable commodity for earning the national income, serves as an input into the production of goods and services in the nation's industry, transport, agriculture, health, and education sectors, as well as an instrument for politics, and security (Sambo. A.S., 2009).

True renewable energy sources are energy supplies that are refilled by natural processes. All renewable energy are produced (directly or indirectly) from the sun, since solar energy drives wind and rain, grow trees, and grow crops to nourish our animals and ourselves. Renewable energy is an energy source that can replenish itself. Solar energy over the years is one of the strongest renewable energy that has proven itself in the renewable world. Its rapid growth in the last decade has made it a technology that has been embraced by most developed countries with good solar energy potential. Nuclear energy is still been debated as being a renewable energy or not because of it low carbon emission. One of the major criteria of renewable energy sources is the little or no emission of carbon during operation and nuclear energy satisfies this criterion. According to Bernard L Cohen (former professor at University of Pittsburg), "Nuclear energy satisfies time span required for an energy source to be sustainable enough to be called renewable energy". He further explains that Uranium which is the major element in nuclear energy production can be proved to last as long as the earth and sun is supposed to last. On the other hand a serious argument against nuclear energy being a renewable energy source is the finiteness of uranium deposit unlike that of wind and solar. The harmful waste released by nuclear reactors during its production process has been said not to satisfy a criteria of renewable energy (K. Johnson, 2009).

The solar potential in Nigeria is rated as one of the best among the third world countries (Olusola. O. B., 2014). Therefore, the use of solar energy (renewable energy) as an alternative energy sources particularly in northern part of Nigeria is a solution that is economical, assure that our grandchildren and great grandchildren will have enough energy, and free us from the uncertainties of depending on energy supplies from fossil fuels. This paper makes a comparison between the use of solar energy and nuclear energy for power production in northern Nigeria

II. Survey of Available Energy Resources in Nigeria

The Energy Commission of Nigeria was established by Act No. 62 of 1979, as amended by Act No. 32 of 1988 and Act No. 19 of 1989 with the statutory mandate for the strategic planning and coordination of National Policies in the field of Energy in all its ramifications. In one of its studies, the Commission found that the country has the potential of generating 15,000MW of power through hydro. The studies also revealed that the availability of untapped renewable energy resources; biomass crop residue of 83 million tones/annum; biomass animal waste of 61 million tones/annum; biomass fuel wood of forest land of 13.071 million hectors of land; solar radiation of 3.5 to 7.0 kWh/Sqm/day and annual average wind speed of 7.0 to 14.0 km/h at height of 10.0m (ECN, 2013). Furthermore, in 2005, the Federal Ministry of Science and Technology confirmed that some areas in Sokoto, Jos, Pankshin, Gembu, Maiduguri,

Kano, Lagos and Enugu have relatively all season strong wind speed suitable for energy generation using wind turbines(Isah M., 2012).

III. A BRIEF OVERVIEW OF NUCLEAR POWER

The use of nuclear reactors to release nuclear energy is basically known as nuclear power. This includes nuclear fission, nuclear fusion and nuclear decay. Nuclear power history can be traced back to the early 20th century when nuclear elements such as radium released a large amount of energy due to the principle of mass-energy equivalence. The technology needed for nuclear power plants is available and can be made in almost any environment, nuclear power plant has low operating costs, and has the ability to generate a vast amount of electricity which met the industrial and residential needs. Nuclear energy provides a constant source of energy which run 24 hours a day, 7 days a week without destructions, nuclear reactors work in a similar as many engines such as heat water to steam and use the steam pressure to drive the machine. Radioactive fuel rods heat pressurized water tubes, while the superheated water is piped into a turbine hall, then it may vaporize into steam. The steam drives the turbines that is turn to big electric generators.

3.1 The Challenges of Nuclear Power Station

Nuclear power claims to be safe, cost-effective and able meet the world's energy needs, but nothing could be further from the truth than this. When atoms are split, a lot of energy is released. It produces not only energy but also highly dangerous radioactive waste, such as platinum that can be very harmful for people and the environment. One of the scariest things about nuclear power is when something goes wrong, an accident occurs. Three of the most famous nuclear power station accident occurred at the Three Mile Island in 1979 in USA which was considered to be the worst nuclear disaster in the history of the United States; Chernobyl, Ukraine in 1986 in the former Soviet Union which release radiation 200 times that of the Hiroshima and Nagasaki nuclear bombs combined and at a time raised radiation levels in Scotland 10,000 times the norm; and Fukushima, Japan in 2011 (Isah M., 2012). Chernobyl is marked in history as the world's worst civilian nuclear disaster. The precise death toll from Chernobyl will never be known but it may exceed 90,000 people (IEIA, 2006). As former UN Secretary General Kofi Annan was reported as saying on the twentieth anniversary of the accident, "seven million people are still suffering, everyday". "Three million children require treatment and many will die prematurely" (Associate Press, 2000).

3.2 Nuclear Power: A Dangerous Waste of Time

In the transformation of uranium fuel in a nuclear power plant operation/process, a rich, highly-toxic and dangerous cocktail of radioactive elements, such as plutonium is produced. Plutonium is the manmade element used in nuclear bombs, lethal in minute quantities and dangerous for about 240,000 years (DU Report, 2012). In contrast to nuclear power, solar energy is clean and safe. Technically-accessible renewable energy sources are capable of producing six times more energy than current global demand (Greenpeace, 2013).

3.3 Nuclear Waste: Hazardous for Hundreds of Thousands of years

Nuclear waste is categorized according to both its level of radioactivity and how long it remains hazardous. The International Atomic Energy Agency (IAEA, 2013) estimates that, every year, the nuclear energy industry produces the equivalent of about 1 million barrels (200,000m3) of what it considers 'Low and Intermediate-Level Waste' (LILW) and about 50,000 barrels (10,000m3) of the even more dangerous 'High-Level Waste' (HLW). High-level waste can be radioactive for hundreds of thousands of years and emits large amounts of hazardous radiation. Nuclear reprocessing plants discharge large volumes of radioactive waste on a daily basis with serious environmental impacts. A study published in 2001 showed an increased incidence of leukaemia among under-25 year olds living within 10 kilometers of La Hague nuclear reprocessing plant, in northwest France (A.V Guizard et al, 2001). According to a 1997 study in the UK, there was twice as much plutonium in the teeth of young people living close to the Sella field nuclear reprocessing plant than in the teeth of those living further away (O'Donnell, etal 1997). Reprocessing of nuclear waste endangers our health and does not decrease the radioactive waste problem. It has been estimated that, over the next 40 years, the radioactive discharges of the Rokkasho reprocessing plant, to be started in Japan, will be very large relative to other nuclear operations and will lead to exposure of members of the public to radiation equivalent to half of that released during the Chernobyl catastrophe (I. Fairlie, 2006).

The nuclear industry wants to bury the problem of radioactive waste by storing it in deep geological repositories. However, not a single one has yet been built. It appears to be impossible to find suitable locations where safety can be guaranteed for the timescales necessary. Construction of the Yucca Mountain waste site in Nevada, in the United States, began in 1982, but the date for start of operation has been postponed from 1992 to beyond 2020 (Edwin L., 2004). The US Geological Survey has found a fault line under the planned site and there are serious doubts about the long-term future movements of underground water that can transport deadly contamination into the environment. Proposals for an underground dump in Finland suffer from similar concerns. Given the immense difficulties and risks associated with the storage of dangerous nuclear waste, it's not surprising that the nuclear industry tries to dump it out of sight. One such example is Russia, during the Soviet era, nuclear facilities were built in closed cities such as Urals and Siberia, resulting in a history of nuclear disasters, environmental contamination and public health scandals, all of which were kept secret by the Soviet government. One of these cities, Mayak, may now be the most radioactively contaminated place on Earth. Despite its appalling record of managing nuclear waste, Russia wants to import foreign nuclear waste for storage and/or reprocessing at Mayak, as well as other sites.

3.4 Nuclear Power: A threat to Global Security

Nuclear power evolved from the atomic bomb, and the two have remained connected ever since. One of the most fundamental and insoluble problems of nuclear power is that the enriched uranium it burns, and the plutonium it produces, can be used to construct nuclear weapons. Other radioactive products formed in nuclear reactors can be used to produce dirty bombs. A typical nuclear power plant produces sufficient plutonium every year for 10-15 crude nuclear bombs(Greenpeace, 2012). Former UN Secretary-General Kofi Annan warned, in 2005, that using such nuclear bombs "would not only cause widespread death and destruction, but would stagger the world economy and thrust tens of millions of people into dire poverty". China, India, Iraq, Israel, North Korea, Pakistan and South Africa have all used their nuclear power industry to covertly develop nuclear weapons programs. Nuclear facilities, as well as the radioactive waste transports that regularly cross countries, are also potential targets for terrorists. A study, written by nuclear expert John Large, evaluated scenarios involving terrorist attacks on, or the crash of, a plutonium shipment from France's La Hague reprocessing plant to the Marcoule reactor .The report estimates that 11,000 people would die from the effects of radiation exposure (Large & Associates, 2004). A similar study by Edwin Lyman of the Union of Concerned Scientists finds that a potential terrorist attack on the Indian Point nuclear plant in the US could lead to 518,000long-term deaths from cancer and as many as 44,000 near-term deaths from acute radiation poisoning (Edwin L., 2004).

3.5 Nuclear Power is Expensive

Nuclear power is often described as "the most expensive way to boil water." Despite its proponents now claiming it to be cost-effective, cost estimates for proposed projects have consistently proved inaccurate. A look at current and past experiences of the anticipated and real costs of nuclear projects reveals an industry in which overspends are prevalent and which is propped up by subsidies (Stephen T. et al, 2007). The ratings agency, Moody's, in 2007 has made it abundantly clear that, even with massive government subsidy, nuclear power is not a sound investment .The cost of building a nuclear reactor is consistently two to three times higher than the nuclear industry estimates. In India, the country with the most recent experience of nuclear reactor construction, completion costs for the last 10 reactors have, on average, been300% over budget. In Finland, the construction of a new reactor is already €1.5 billion over budget (Associate Press, 2000).Over the years, billions of dollars worth of taxpayers' money has been poured into nuclear energy, compared to trifling sums that have gone towards promoting clean, renewable energy technologies. In the case of the US, where not one new reactor has been ordered in30 years, the government tries to tempt private investors with tax credits, federal loan guarantees and contributions to risk insurance. Nuclear reactors present too large a liability for insurance companies to accept. One major accident, costing hundreds of billions of Euros (the total Chernobyl cost is estimated at €358 billion) would bankrupt them. Governments, and ultimately their taxpayers, are forced to shoulder this financial liability. The cost of clean-up after a nuclear power plant closes and the safe management of nuclear waste for many generations is also largely carried by the states instead of the companies themselves.

3.6 Nuclear Power: A risk for Climate Change and Energy Security

Renewable energy technologies and energy efficiency measures are available now and forever. Construction time for installing a large wind turbine has fallen to only two weeks, with an associated planning period of between one and two years(Greenpeace, 2013). Harnessing domestic natural resources, a decentralized mix renewable energy and energy efficiency could really provide for more CO2 reduction and energy security without the hazards of nuclear power.

3.7 Migration from National Integrated Power Project (NIPP) to Nuclear Power Program (NPP)

Without fully completing the National Integrated Power Project (NIPP), initiated during the 1st and 2ndrepublic, the Federal Government has now triggered off a Nuclear Power Program (NPP) by approving the road map for its implementation (Isah M., 2012). The aim is to attain 4000MW from nuclear power plants by 2030. This is also part of the power sector transformation. In my opinion, the Government should be both caution and mindful in buying cheap Mox reactor fuels or receiving free donations as international technical aid from any country. Doing so will certainly pave ways ignorantly or unknowingly, which through clandestine intelligence operations will allow the donor country to sneak radioactive waste of every kind into the country, ridding their mess at no cost and infected our virgin land with lethal radiations that the Government never bargained for. It's absolutely truth that no nuclear reactors were ever designed to explode like atomic bomb in event of an accident. But, the Government shouldn't be oblivious of the fact that accidents occur in nature and it is gospel truth that they cannot be stopped. The Government should try to understand that all countries in the world are going for 'Green' energy of renewable leaving the Dark' energy of nuclear. For example Germany plans to switch to 100% renewable by 2050 (Greenpeace 2006).

IV. APPLICATION OF SOLAR ENERGY

This section is to disabuse the mind of many Nigerians having myopic thinking about utilization of solar energy to produce electricity on large scale. Further, to stimulate debate about Government recent decision to build Nuclear Power Station in the country while at the same time privatizing PHCN. Electricity generation using solar is the least form of generation utilized in Nigeria. This is perhaps due to lack of public awareness and serious Government participation. According to M.C. Ezeudenna (2012), Nigeria is the only country in the world that has coal but no single coal fired station, while China has over 2,000 different coal fired stations and is still building more. He added that, Nigeria has total

number of 18 power plants of oil, gas and hydro for on-grid generation. By September 2012, generation of about 4019MW, 2865MW (61%) came from thermal station while 1164 (29%) came from hydro (M.C. Ezeudenna 2012). What percentage of on-grid generations comes from renewable energy? 0%. Advances in solar energy technology have made it possible to have solar powered wrist watches, torchlight's, table fans, deep freezers, refrigerators, calculators, cell phones, radios, TV sets, laptop computers, water heaters, cookers, bicycles, cars and many more. Below are some major solar power projects around the world to show its practicability.

4.1 Plan to Power the Entire Europe from Solar Electricity Generated in Sahara Desert

The EU renewable energy giants are prepping up the installation of the world's largest solar power plant that collectively will generate a whopping 100GW of concentrating solar power. The power output will be transported across the Mediterranean Sea to Europe on high-voltage DC lines. Scientists calculated that only 0.3% of the solar energy falling on desert in the Middle East and Sahara would be required to achieve this (Greenpeace, 2012).

4.2 Solar Park

The Serbian Government has signed a memorandum to construct what is billed to be the planet's biggest solar park. It's estimated that the park will require more than $2.5 billion to establish. The solar park will be spread over a huge 3,000 ha of land and will have an estimated peak capacity of 1,000MW (Greenpeace, 2013).

4.3 Electrification Stadium with Solar Energy

Japan-based Toyo Architects are using solar energy beyond all conventional to power the main stadia build for world games. The $150 million stadium can accommodate 55,000 spectators and can power 80% of the surrounding neighborhood if its solar array is connected to the grid during days when the stadium is not being used. The stadium roof is covered with 8,844 solar panels that could potentially generate a whopping 1.14GWh of electricity annually (Greenpeace, 2012).

4.4 Grid Connected Solar Power Station

Spain is constructing a 300MW solar power project. The first phase of the project, consisting of 11MW solar tower was completed and put into operation on 27th April 2009. Located in the Andalusian country side in the municipality Sanlucar la Mayor, the 115m high concrete tower collects sunlight reflected by a field of 624 huge mirrors each with surface area of 120m2. The power plant generates 24.3GWhr per annum of clean energy. The entire project will be completed by December 2013, when it will produce around 300MW with expected life span of 25 years. The platform will create more than 1,000 jobs in the manufacturing and constructing phase, and 300 service and maintenance jobs (Greenpeace, 2013).

4.5 Solar Kitchen for Hotels, Institutions and Camp Areas

The world's largest solar kitchen has been set up at Taleti, near Mount Abu in India, with six-module solar steam cooking system and a total of 84 parabolic dish concentrators and receivers. Steam is collected in the header pipes, which is then directed via insulated pipes to cooking vessels in the kitchen. The system generates temperatures of up to about 650 0C degrees, and 3500-4000 kg of steam per day. The food is cooked in 400 liters capacity cooking pots, producing an average of 20,000 meals a day and up to 38,500 meal per day during periods of peak solar radiation maximum (Greenpeace, 2006).

4.6 Solar Energy Projects in United States

According to Solar Energy Industries Association of the United States (SEIA) as at November 1st 2013, there is total number of 126 operating, 64 under-construction, and 38 under-development solar energy projects in the United States (SEIA, 2013).

V. Conclusion

Nigeria has everything to grow as a nation greater than the United States, not only in terms of power but in every aspect of life. But, that didn't happen and would never happen in the very near future. Nigeria is blessed with abundance fertile land and rivers, natural and human resources, raw and crude materials, oriental and western education, independence and sovereignty, sunshine and rainfall; then what else? Nigerian Government should note that, Nuclear power gambles with our lives, health and environment, while a sustainable energy future without these risks is at hand. Technically-accessible renewable energy sources are capable of producing six times more energy than current global demand. Nuclear power increases the risk of nuclear weapons capabilities spreading to other countries, of terrorists gaining material to make nuclear bombs and of potential terrorist attacks on nuclear facilities or transports. Renewable energy carries none of these safety or proliferation concerns. It does not require complex safeguards, international bodies, or treaties to police its trade and use. Renewable energy technologies and skills can be easily and safely exported around the world. Research indices confirmed that nuclear power is 50% more expensive than renewable to build, plus additional costs related to fuel and waste disposal would be avoided. Therefore, appropriate investment in solar infrastructure and utilization with a fairer legal and political framework, **green electricity** can keep the lights on with cleaner, safer and cheaper electricity that can fill the Nigeria's projected energy demand by 2030.

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