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RISKS AND CHALLENGES OF FOSSIL FUELS AND INCENTIVES FOR INVESTMENTS IN RENEWABLE ENERGY

JOSEPH CHIKE AJADIKE (Ph.D)
Dept. of Geography and Meteorology
Faculty of Environmental Sciences
Enugu State University of Science and Technology, Enugu.
joajadike@yahoo.com
+2348075478842

Abstract
Global energy systems since the Industrial Revolution of the 1750 has been dominated by fossil fuels especially coal, petroleum and natural gas as well as nuclear power and large dams of more than 50 mega watts capacity. But this paper shows that coal, petroleum and natural gas, nuclear power and large dams have serious environmental risks and challenges. Fossil fuels pollute waters of the earth and fouls the air that envelopes the earth and hence create very serious environmental and health issues to the inhabits. One of the clear risks of massive use of fossil fuels on earth is the increasing trapping of heat by some gases such as carbon dioxide, nitrous oxide and methane collectively called greenhouse gases. Greenhouse gases lead to global warming and anthropogenic stimulated climate change. Climate change is now posing serious environmental and developmental challenges and this paper is recommending that the only way to avoid catastrophic climate change from happening across the world is to transit from global economy based on fossil fuels to the one that is based on renewable energy systems.

***Keywords**: Risks, Challenges, Fossil fuels, Incentives, Investment and Renewable Energy*

Introduction

Since 20th century, fossil fuels such as coal, petroleum and natural gas have dominated global energy consumption. Sulphey (2013) rightly observed that over 76 percent of global energy consumption comes from fossil fuels. Many earth scientists are concerned that if the world does not shift the way it uses energy, it may be very difficult to achieve the 2^{O}C warming which is the target to be achieved by 2100 to avoid climate change getting out of hand and spinning to the tipping point, a level of irreversible climate change. This level will result to catastrophic consequences for the planet earth and associated ecosystems including sustainable livelihoods for humans.

There is obvious pessimism that the earth may not achieve the 2^{O}C benchmark by 2100 as agreed in Conference of Parties (COP 21) in December in Paris because the global economy is still dependent on burning fossil fuels in power plants for electricity generation, factories and in ever increasing automobiles operated by the peoples of the world.

In order to achieve The Future We Want as agreed in Rio plus 20 Conference in Rio de Janeiro, Brazil in 2012 and the 2015 Paris Climate Change Agreement on limiting greenhouse gases to avoid tipping point in 2100, the world must shift from current dependence on energy from fossil fuels to ones generated from renewable energy such as solar, wind, geothermal, small hydropower plants, waves and tidal currents, hydrogen and fuel cells.

This paper highlights the short comings and challenges of current energy systems based on fossil fuels, especially biomass, coal, petroleum and natural gas. For example, biomass based fuel destroys and degrades the forests, and it is a major air and indoor polluter that kills millions of people especially in the developing world where wood and charcoal are still the dominant fuels for cooking and house heating: Coal is a major air polluter across the world. It is associated with aerosols, smog and acid rain. Coal is the highest generator of carbon dioxide per unit of energy hence it is a serious emitter of greenhouse gases. Mining of coal creates other serious hazards such as trapping of miners underground leading to injuries and sometimes mass death of the miners. Petroleum as a dominant fuel in the 20th and 21st centuries has a lot of problems. It is a major polluter of the environment Air, water and soil are not spared. For example, in 1978, the world recorded the largest single marine spill as a result of a ship wreck of Amoco Cadiz near Portsall, France, About 1.6 million barrels were spilled and, more than $ 50 million was used for cleanup operations (Montgomery, 2003). This super tanker oil spill of 1978 killed about 20,000 marine birds (Pipkin, 1994). Another major oil spill, that drew global attention happened on the evening of 23rd May, 1989 when a super oil tanker (Exxon Valdez) left Valdez Fjord in Alaska but an accident occurred when the ship drove in a reef that tore its hull releasing about 10.1 million gallons of oil into the bay teaming with marine mammals, fish, waterfowls and eagles Biologists estimated that the Exxon Valdez oil spill killed 100,000-350,000 marine birds (Pepkin, 1994).

In Nigeria, oil spills are daily occurrences as result of accidents and from vandal activities especially in the Niger Delta. Apart from oil spills petroleum is a major producer of carbon which is greenhouse gas. Moreover, petroleum is depleting resource which means that it is exhaustible.

Natural gas is strongly related to petroleum but it is the cleanest fossil fuel but natural gas is very restricted to the Middle East, Russian and Canada. Remote gas fields make piping to industrial city centres very expensive and building liquid natural gas systems to transport gas to distant places is even more expensive than piping. These two factors place restrictions to the wholesome use of gas.

Nuclear power and large hydropower dams present some serious environmental risks and challenges prompting the global community to be shifting thinking and emphasis to non-fossil and non-nuclear energy fuels as the global energy of the future. This paper highlights the risks and challenges of fossil fuels, large dams and nuclear energy and makes a case for alternative energy systems that are based on renewables.

Risks and Challenges of Fossil Fuels, Biomass and Nuclear Energy and Large Dams.
Biomass

The break through that really launched the Industrial Revolution was the development of the steam engine in the late 1700s. The steam engine became the power source for steamships, steam shovels, steam tractors, steam locomotives and stationary

engines to run sawmills, textile mills and virtually all the other industrial plants and the first major fuel for steam engines was firewood (Nebel, 1990).
The massive use of fuel wood as the primary energy source in the wake of the Industrial Revolution led to serious deforestation in Europe and United States of America. Fuel wood dominated domestic and industrial uses from the 1700s to the end of 1800s before Coal which by 1920 provided about 80 parent of all energy used in the United States (Nebel, 1990). The use of wood as the primary energy source has ebbed drastically in the developed economies of the world but the same is not true for developing economies of the world. For example, Nigeria is still dominated by low efficient traditional biomass such as wood, straw, dung, animal waste and agricultural residues (Sambo (2009); Ajadike (2014).

Coal
Coal is the most abundant stored energy of the earth (Pepkin, 1994).
Coal is found in all continents of the world including the Antarctica, the uninhabited continent of the world. Coal was the main source of energy that powered the Industrial Revolution of the 1750s first in Western Europe, then the other parts of Europe and North America. Coal in the past was used to power locomotive engines and in the iron and steel industries across Europe, United States, Japan and China. Since the discovery of petroleum and internal combustion engines, coal has been relegated to second position as the prime energy of transportation. Presently, coal is used mainly in heating and in electricity generation. For example, Wright (2007) stated that 91 percent of coal produced in United States is used in the generation of electricity.
According to The Economist (2007), Poland generates 95.1 percent of her electricity from coal; South Africa 93.5 and China, 79.4 percent. But coal as a global energy source has a lot of health and environmental issues. It emits carbon dioxide, nitrous oxide and sulphur dioxide major greenhouse gases that cause global warming. The heavy emissions from burning of coal contribute to formation of smog in many cities of the world of which Beijing, the capital of China is particularly notorious. The great London smog of 1952 caused more than 4000 deaths and led directly to the enactment of the Clean Air Acts of 1956 and 1968 in Great Britain (Lodha, 2007). Coal produces a great deal of solid waste in the form of ash. Indeed, the ash residue left after coal is burned typically ranges from 5 to 20 percent of the original volume (Mongtmery, 2003). Mining accidents have also increased. In 2012, more than one hundred Chilean miners were trapped underground for more than 100 days and their rescue cost million of US Dollars to be executed. Many other mining accidents have led to many deaths especially in China and South Africa.

Petroleum
Oil was first struck in commercial quantity in Titusville, Pennsylvania, USA on the 29th August, 1859 by Seneca Oil Company, New Haven. The first commercial Oil Refinery was built in Cleveland, Ohio by John D. Rockefeller in 1863. Seven years later, John D. Rockefeller who became one of the first billionaires of the United States established the Standard Oil Company (Pipkin, 1994). Petroleum or crude oil is the most versatile of the energy currently known to man. It is used every where on air, water and land transport and it has many industrial uses including production of artificial fibres, petro- chemicals

and pharmaceuticals. Geologists project that known and projected global reserves of crude oil will be 80 percent depleted sometime between 2050 and 2100, depending on consumption rates (Miller and Spoolman, 2010). Petroleum has many advantages over coal; its extraction causes less environmental damage; it has more concentrated energy than coal, it burns with less pollution and can be moved easily through pipes. It is most widely used in automobiles (Enger and Smith 2004). But in spite of petroleum's known good qualities as a global energy of choice, it has many shortcomings. It is expensive to produce. It has also serious environmental impacts such as water pollution whenever there are oil spills. Associated gas when flared is a serious air pollutant in countries such as Nigeria, Russia and Iran. Oil prices fluctuates a lot in global oil market and this affects economic and development activities of mono-economies such as Nigeria, Venezuela, Angola, Russia and Indonesia where crude oil is the major revenue and foreign exchange earner. Moreover, petroleum burning in vehicles, industries and in electricity generation produce three important greenhouse gases – carbon dioxide, methane and nitrous oxides.

Natural Gas

Apart from coal and petroleum, natural gas is another energy source that has global usage. According to Enger and Smith (2004), natural gas supplies about 27 percent of world's energy needs. Natural gas is exploited by drilling of wells as in crude oil. A drilled well can yield both crude oil and natural gas. Natural gas can occur alone or in association with crude oil. It is a mixture of gases of which 50-90 percent is methane. It also contains smaller amounts of heavier gaseous hydrocarbons such as propane and butane. It is a versatile fuel which can be burned to heat space and water, to produce electricity and to propel vehicles (Miller and Spoolman, 2010). The world has more proven reserves of natural gas than petroleum. But most of the gas fields are located on remote land areas and deep-seas and require expensive piping to bring the fuel to industrial zones and urban centres of the world. Apart from moving natural gas in pipelines, the fuel can be subjected to cooling of about minus 160^{o}C and when this happens, the gas becomes liquid – liquefied natural gas (LNG). LNG is the modern method of transporting natural gas from remote gas fields of Nigeria, Iran, Qatar and Venezuda. Iran, Qatar and Russia are the three countries that have the largest natural gas fields in the world (Bruges, 2007). Natural gas is the cleanest of all fossil fuels. It yields more energy than coal or crude oil. But still it yields carbon dioxide and methane gases – two strong greenhouse gases. It is very difficult and expensive to transport across countries. Two of the three largest suppliers of natural gas (Russia and Iran) are two difficult ideological countries who have been playing a lot of economic politics with their natural gas endowment especially for the European buyers.

Nuclear Power

Nuclear power comes from two principal processes fission and fusion. Fission is the splitting apart of atomic nuclei into smaller ones with the release of energy. Fusion on the other hand, is the combining of smaller nuclei into larger ones, also releasing energy (Montgomery, 2003).

Fission process dominates nuclear technology and involves a lot of release of highly radioactive materials in the form of spent fuels According to Miller and Spoolman, (2010), these high-level radioactive wastes consist mainly of spent fuel rods and

assemblies from commercial nuclear power plants and assorted wastes from the production of nuclear weapons must be store safely for at least 10,000 years and by some estimates, up to 240,000 years if long-lived plutonium – 235 is not removed from the wastes. Apart from dangerous radioactive wastes emanating from nuclear plants, nuclear accidents do occur and two remarkable ones have occurred recently. First in Chernobyl, Ukraine in the then USSR in 1986 and in Fukushima following an earthquake that triggered a tsunami that reaped open the Daiichi Nuclear Plant in March, 2011.

Chernobyl nuclear plant disaster was largely caused by human error. Miscalculation by the operators of the Nuclear Plant at Chernobyl allowed neutron buildup in part of the core and the resulting chain-reaction went out of control leading to two explosions in Reactor Number 4 on the 26th April, 1986. The explosions led to the igniting of graphite which burnt furiously and spew radioactive materials directly into the atmosphere (Pipkin, 1994). Chernobyl was recorded as the worst nuclear accident in history (Edwards, 2002). According to Edwards (2002), the explosion threw out 100 million curies of dangerous radionuclides, such as cesium 137 twice as much as previously estimated. The World Health Organisation recorded that 49 million people in Ukraine, Belarus and Russia were affected. The Japanese earthquake of March 11, 2011 precipitated a tsunami that knocked out electricity supply from the Fukushima Dai-ichi Plant, cutting off the cooling system and setting in motion a series of nuclear meltdowns (The Economist, 2013). More than 88,000 people were evacuated from homes within 20km radius of the nuclear power plant. Tepco, the owner of the Dai-ichi nuclear plant has been sued and the people affected demanded compensation to the tune of $31 billion or 3 trillion Japanese Yen by those who were driven from their homes because of radiation or lost land and income (The Economist, 2013). Some countries including Germany and France have declared dates in which to terminate all nuclear plants in their respective countries.

In fact, the then Japanese Prime Minister, Naoto Kan after the Fukushima accident rightly observed that we must develop a society that can manage without nuclear power and Klaus Topfer after the Chernobyl disaster in 1986 wanted a future without nuclear energy (Magazin Deutschland, 2011).

Large Hydroelectric Dams

The energy of falling or flowing water has been used for centuries. Currently, hydropower supplies about 7 percent of world energy needs and about 10 percent of United States electricity (Montgomery, 2003). Hydroelectricity is the cheapest source of generating electricity. It is also renewable source of energy. But dams have a lot of environmental challenges especially the large dams of 50 megawatts capacity and higher. For example, large dams can fail and this can create serious flooding. The 2012 Super floods in Nigeria was attributed largely to the release of water from the Lagdo Dam in the Republic of Cameroon. Large dams can greatly alter the architecture of drainage basins. Large dams hold a lot of water and the reservoir increases the load on rocks. For example, in December 1967, an earthquake of magnitude 6.4 resulted in 177 deaths and considerable damage. The earthquake was caused by the reservoir behind the Konya Dam in Indiana U.S.A (Montgomery, 2003).

Global Warming and Climate Change

The science of climate change is very straightforward and it now very clear to scientists and non scientists alike. The greenhouse effect and enhanced greenhouse effects are now well understood in the science of climate change.

The science of climate change is more than 180 year old. In 1827, Joseph Fourier, a French Mathematician was the first to identify the influence of various gases on the atmosphere but John Tyndall, an Irish scientist later took on the idea. Then in 1898, Svante Arrhenius, a Swedish scientist coined the phrase "greenhouse effect" and predicted that if concentrations of carbon dioxide in the atmosphere doubled, the global climate would warm by 4ºC to 6ºC (Bruges, 2007).

Arrhenius 1898 predictions have come true in many respects. The greenhouse effect is very true. Carbon dioxide is an important greenhouse gas and the emission of carbon dioxide has increased in the atmosphere because of the increasing global use of fossil fuels and unbridled deforestation. These two activities pump carbon dioxide into the atmosphere and these help to drive global warming and climate change.

Apart from carbon dioxide, other important greenhouse gases are methane, nitrous oxide, water vapour and chlorofluoro carbons (CFCs).

We have strong empirical evidence that most greenhouse gases have dramatically increased from pre-industrial levels. The rate of increase of the three principal greenhouse gases- carbon dioxide, methane and nitrous oxide from pre-industrial time and the latest measurement in 2011 is shown in Table 1.

Table 1: Rate of increase of three principal greenhouse gases from pre-industrial and 2011 when measurement was last made by IPCC (IPCC, 2013).

Gas	**Pre-industrial level**	**2011 level**
Carbon dioxide	280 ppmv	391ppmv
Methane	848 ppbv	1803ppbv
Nitrous oxide	285ppbv	324ppbv

Ppmv = parts per million by volume
Ppbv = parts per billion by volume

Source IPCC (2013).

Table 1. shows that carbon dioxide has increased by as high as 39.6 percent between pre-industrial period and 2011; methane 112.6 percent and nitrous oxide 13.68 percent.

All the increases recorded in greenhouse gases are strongly related to increasing use of fossil fuels as the primary sources of energy that drive global economic activities that include electricity generation, transportation, house heating etc and unless alternatives are found and utilized, mitigation of climate change will be almost impossible. This explains why energy was the main issue of controversy in the various climate change conferences but especially the Conference of Parties (COP-3) in Kyoto, Japan in 1997, the Copenhagen Accord (COP-15) in Copenhagen, Denmark in 2009 and (COP-21) in Paris, France (Paris Agreement on Climate Change).

The objective of 1997, Kyoto protocol include reducing greenhouse emissions and to look for alternative sources of energy that will lead to lesser carbon dioxide emissions (Sulphey, 2013). According to Light (2012) the main virtue of Copenhagen Accord was

commitment to limiting human caused temperature increases to no more than 2 degrees Celsius with promises to investigate the feasibility of holding temperature increases to 1.5^{o}C and the pledge of $30 billion in financing from developed countries by 2012 to assist developing countries with adaptation to a warmer world and transition to low carbon economy.

The 2015 Paris Climate Change Agreement on the other hand focused on limiting global temperature by 2100 by 2^{o}C and to strive to even achieve 1.5^{o}C if feasible. The basis of achieving 2.0^{o}C temperature increase was strongly hinged on Intended Nationally Determined Contributions (INDCs) which 146 countries of the world pledged to contribute in order to reduce emission. All the INDCs cover limiting CO_2 and other gases such as CH4 and other greenhouse gases.

Incentives and Opportunities in Investing in Renewable Energy

Renewable Energy is Inexhaustible

Renewable energy such as solar, winds, waves are always available because their sources result from natural processes on the earth surface. The sun is always shinning during the day at different times on parts of the earth though on varying durations Winds are always blowing, waves and currents are always prevailing in various parts of the world.

Renewable Energy and Green Economy

Investing in renewable energy will be one sure way of transiting to green economy. United Nations Environment Programme (UNEP,2011), defines a green economy as one that results in improved human wellbeing and social equity, while significantly reducing environmental risks and ecological societies. In its simplest expression, a green economy can be thought as one in which there is low carbon, resource efficient and socially inclusive (UNEP, 2011) Transiting from fossil fuel (brown economy) to green economy will help in reducing environmental and other risks associated with fossil fuel dependent economy as currently witnessed globally.

Green Jobs

Green economy creates a lot of green jobs that include but not limited to production, distribution, installation of solar panels inverters, batteries, connectors; production, distribution, installation and maintenance of wind turbines; cultivation, processing and distribution of bio-fuel crops such as jatropha, sugar cane, corn, sunflower, sesame and palm oil.

According to Green Jobs: Towards a Decent Work in a Sustainable, Low-Carbon World (2008) globally, some 300,000 workers are employed in wind power and about 170,000 in solar photovoltaic (PV); more than 600,000 in solar thermal and about 1.2 million are employed in generating biomass-derived energy (mostly bio-fuels in just four leading countries) of Brazil, the USA, Germany and China. Details on generated green jobs across some selected countries are show in Table 2.

Table 2: Estimated Employment in the Renewable Energy Sector in Selected Countries and World in 2006

Renewable Energy Sourc	World*	Selected Countries	
Wind	300,000	Germany United States Spain China Denmark India	82,100 36,800 35,000 22,200 21,000 10,000
Solar PV	170,000**	China Germany Spain United States	55,000 35,000 26,449 15,700
Solar Thermal	624,000-Plus	China Germany Spain United States	600,000 13,300 9,142 1,900
Biomass	1,174,000	Brazil United States China Germany Spain	500,000 312,200 266,000 95,400 10,349
Hydropower	39,000-plus	Europe United States	20,000 19,000
Geothermal	25,000	United States Germany	21,000 4,200
Renewables, Combined	2,332,000-plus		

Source: Green Jobs: Towards a Decent Work in a Sustainable Low-Carbon World (2008)

Provision of off-Grid Electricity to People of the World

Billions of people especially in the rural communities of Africa, Asia and Latin America still have no access to electricity.

In-fact, Ochs (2010) estimated that 1.5 billion people worldwide are currently without access to electricity from existing central griding system, Providing electricity via off-grid small photovoltaic (PV) (solar panels) will be far cheaper and simpler than connecting by grids given that the homes of some rural inhabitants are very dispersed and may present other challenges such as being very mountainous.

Renewables and Mitigation of Climate Change

The world will never address the issue of climate change without addressing the way energy is produced and consumed globally. This work and many others including (IPCC Reports) have high lighted the fact that activities of humans especially the ways they depend on fossil fuels such as coal, petroleum and natural gas are the main drivers of greenhouse gases that generate global warming and climate change. The only sure way to

avoid catastrophic climate change is to gradually transit to renewable energy system from the current fossil fuel system.

Conclusion

This paper has argued very strongly against the massive use of fossil fuels such as coal, petroleum and natural gas as well as nuclear as sources of energy to power global development because of identified risks to the environment and humanity.

Fossil fuels especially coal, petroleum and natural gas are major polluters of our air, water and soil. For example, air pollution results from massive use of energy from coal, petroleum and natural gas and this use precipitate greenhouse gases – the gases that trap out going radiation and hence contribute to global warming and anthropogenic –induced climate change. Climate change is now established as a major environmental and developmental challenge to the entire human race-developed and developing.

Apart from climate change issue, nuclear power another major source of energy for the global community is also froth with a lot of risks and challenges as clearly demonstrated in the two major nuclear accidents the world has witnessed; first was Chernobyl 1986 nuclear disaster in Ukraine and second, the 2011 Fukushima nuclear melt down as a result of an earthquake and associated tsunami.

To address the risks and challenges of current use of fossil fuels and nuclear power in the world, this paper is proposing a gradual transition to renewable energy sources such as solar, wind, geothermal and bio-fuels. To this end, there should be huge investment in the research, development and deployment of renewable energy in all the regions of the world. It is hoped that in the long run, renewable energy will be able to satisfy all the energy needs of the world.

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