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Nuclear Power: Alternative Energy Source for Uganda

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Abstract

Uganda will be able to use its uranium deposits to generate electricity using nuclear power. With the ever increasing demand, it is envisaged that nuclear power will play an increasing role in the future energy supply. This study identify the advantages and disadvantages of nuclear energy and recommended that Nuclear energy will be a future option for generating low carbon electricity for not only Uganda but the entire African region.

Keywords: Africa; Energy; Nuclear power; Uganda.

1. Introduction

Nuclear power started beneath the football stands at the University of Chicago. That's where, in late 1942, a group of scientists under Enrico Fermi created the first nuclear reactor [1]. Like all reactors that followed, this one split fuel atoms into lighter elements – a process called fission that releases large amounts of energy, more than a million times as large as an ordinary chemical reaction. Reactor concepts have evolved since then over the period of nuclear power reactor development. Nuclear energy has the potential to supply electricity to countries, to contribute to climate stabilization by producing electricity without CO2 emissions, and to displace fuels that lead to air pollution. Nuclear power plants do not burn any fuel. Instead, they use uranium fuel, consisting of solid ceramic pellets, to produce electricity through a process called fission. At the moment 31 different nations operate nuclear power plants with a total of 388 reactors, with more than 60 reactors under construction in 13 countries. They say that eight countries are either planning to build for the first time (Belarus and United Arab Emirates), have signed contracts (Lithuania and Turkey), or have some plans to build (Bangladesh, Jordan, Poland, and Vietnam). In terms of new build, 67 reactors are under construction world wild with a total capacity of 64 GW [2]. The energy needs of the world are large and growing. The 1.2 billion people who don't even have access to electricity cannot be denied the ability to improve their quality of life.

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Nuclear energy provides a scalable, clean source of safe, reliable power, which with other clean energy sources can meet the world's needs in a sustainable manner.

2. Literature

In 2004 the Department of Geological Survey and Mines (DGSM) under the Ministry of Energy and Mineral Development (MEMD) embarked on the Sustainable Management of Mineral Resources Project (SMMRP) with financial support from the World Bank, African Development Bank and Nordic Development Fund, in addition to the Government of Uganda. One of the main objectives was to promote Uganda as a destination for mineral exploration by domestic and international companies. As part of this work, a High Resolution Airborne Geophysical Survey, including gamma ray spectrometer surveys, was conducted covering around 80% of the country [3]. This culminated in the production of high resolution radiometric (i.e. uranium) data. These surveys show that Uganda has about 52,000 square kilometres of uranium prospects. This includes 18,000 km2 in the Buganda-Toro region; 12,000 km2 in the Karagwe-Ankole region; 5,000 km2 between Lake Albert and Lake Kyoga; 5,000 km2 around Lake Edward; 900 km2 on the Buhweju plateau and 12,000 km2 in Lake Albert [4]. Apart from South Africa, the other African countries that are producing uranium are exporting it. Namibia is the largest African producer, shipping out around 4,000 tonnes of Uranium annually, while Niger and Malawi each produce and export around 1,000 tonnes of uranium per year [3]. For the case of Uganda, however, President Museveni has repeatedly spoken out against exporting Uranium in its raw form, insisting on exploiting it to make up for the country's energy deficit. "As long as I am in the chair, nobody will touch the Uranium in Uganda," he told Summit of East African leaders in Kampala in 2013 [5]. In the meantime, the Government of Uganda has made some steps towards establishing the necessary legal and institutional framework for nuclear power generation. There are provisions in the Uganda Vision 2040, National Development Plan (2010/11 – 2014/15) and Energy Policy for Uganda 2002. Additionally there is the Atomic Energy Act 2008 and Nuclear Power Development Strategy 2013/14-2015/16 [3].

The Atomic Energy Act 2008 established the Atomic Energy Council (AEC) as an independent regulatory authority and the Nuclear Energy Unit (NEU) to promote and develop the use of nuclear energy for electricity generation and other peaceful purposes [6]. The function of the NEU is to prepare a strategy and implementation plan for the acquisition of nuclear power plants for power generation; prepare a long-term sustainable programme for the supply of nuclear fuel; and coordinate the technical cooperation programme between International Atomic Energy Agency (IAEA) and Uganda. Under the NEU are various working groups including Technology Deployment, Policy and Legal, Regulatory Infrastructure and Human Resources Development. The NEU have sent at least seven people abroad to undertake specialised training in fields including nuclear science and technology, quantum engineering, international nuclear law and policy and nuclear engineering [7]. However, it is clear many more will require training to effectively deliver the mandate of the NEU.

3. Statement of Problem

Biomass is the predominant type of energy used in Uganda, accounting for 94% of the total energy consumption

in the country [8]. The wood biomass demand and supply scenario projects that in the next ten years, the country will move from a surplus to a deficit and later to an acute deficit.

The electricity supply system in Uganda total installed capacity is 822 MW, generated primarily from Owen Falls Hydropower Station at Jinja in the South-Eastern part of Uganda [9]. However, during droughts (like in 2009), only around half of the installed capacity could be used as a result of the low water level of Lake Victoria. Contributing to electricity supply problems is the fact that growth in demand for electricity has not been matched with new generation capacity. Access to electricity in 2013 at national level in Uganda is very low with 15% (1991: 5.6%; 2006: 9%; 2010: 10%) but only 7% in rural areas [9]. A total of 93% of rural households without access to electricity are currently using traditional lighting technologies such as candles or kerosene lamps that give poor quality lighting, emit noxious fumes and present hazards in terms of fires or burns (in particular for small children). Furthermore, the majority of social institutions (e.g. schools and health centres) in rural areas do not have access to electricity, which leads to inferior health and education services in comparison to electrified institutions. Lack of access to electricity also severely constrains the economic development of rural areas of Uganda, preventing the establishment of businesses that require electric power or forcing companies to buy diesel or petrol generators that are costly to operate and negatively impact the environment. Furthermore, job creation is being seriously constrained by the lack of adequate investment in the provision of rural infrastructure services, of which electricity is a key component. Lack of electricity also prevents access to information and communication technologies (e.g. mobile phones, computers, and internet). This contributes to further isolation of rural areas from the rest of the country. Further, the quality of rural life is hampered by lack of electricity, particularly as rural public institutions such as health, educational and water facilities would be able to provide better services if they had access to electricity.

The Energy sector badly needs largescale investment and prudent utility practices. Sustainable development in Uganda is difficult to achieve, as it is incompatible with the poverty prevalent in the country. The government has the challenge of expanding access to affordable, reliable and adequate energy supplies as a way to address poverty issues.

4. Methodology

The design of this study is descriptive and qualitative in nature, gathering data from ministry of energy and mineral development, documents, text books, journals and other textual materials on Nuclear Energy.

5. Advantage of Nuclear Power

5.1. Generate a high amount of electrical energy

It is possible to generate a high amount of electrical energy in one single plant. Uganda currently has one of the lowest electricity consumption rates in the world with 215 kWh per capita per year. Sub-Saharan Africa's average is 552 kWh per capita and the world average is 2,975 kWh per capita – more than ten times that of Uganda [10]. One 1,000 MW (1 GW) nuclear power station would produce four times as much power as the 250 MW Bujagali Hydroelectric Power Station (currently Uganda's biggest) and more than the entire of Uganda's

current 822 MW capacity. This amount of power would sharply reduce the country's power deficit bringing much needed energy to Ugandan homes and businesses.

5.2. No Greenhouse Gases

Nuclear power stations do not contribute to carbon emissions – no CO2 is given out – it therefore does not contribute to global warming. It is in most cases more beneficial, in terms of the climate crisis, to replace other energy harnessing methods we use today with nuclear power. The generation of electricity through nuclear energy reduces the amount of energy generated from fossil fuels (coal and oil). Less use of fossil fuels means lowering greenhouse gas emissions (CO2 and others).Currently, fossil fuels are consumed faster than they are produced, so in the next future these resources may be reduced or the price may increase becoming inaccessible for most of the population. It's an alternative to fossil fuels, so the consumption of fuels such as coal or oil is reduced. By reducing the consumption of fossil fuels we also improve the quality of the air affecting disease and quality of life.

5.3. Reliability

Nuclear energy is undeniably reliable, providing on-demand baseload energy 24-hours a day. The average nuclear facility is on line 90 percent of the time. When a nuclear power plant is functioning properly, it can run uninterrupted for up to 540 days. This results in fewer brownouts or other power interruptions. The running of the plant is also not contingent of weather or foreign suppliers, which makes it more stable than other forms of energy. Nuclear plants also provide stability to the electrical grid, as their output is constant and reliable. Nuclear power does not depend on natural aspects. It's a solution for the main disadvantage of renewable energy, like solar energy or eolic energy, because the hours of sun or wind does not always coincide with the hours with more energy demand.

5.4. Relatively Low Cost

The initial construction costs of nuclear power plants are large. On top of this, when the power plants first have been built, we are left with the costs to enrich and process the nuclear fuel (e.g. uranium), control and get rid of nuclear waste, as well as the maintenance of the plant. The reason this is under advantages is that nuclear energy is cost-competitive. Generating electricity in nuclear reactors is cheaper than electricity generating from oil, gas and coal, not to speak of the renewable energy sources!

5.5. High Energy Density

It is estimated the amount of energy released in a nuclear fission reaction is ten million times greater than the amount released in burning a fossil fuel atom (e.g. oil and gas). Therefore, the amount of fuel required in a nuclear power plant is much smaller compared to those of other types of power plants.

5.6. Safety

It is important to note the safety record of the nuclear industry. Despite a bad reputation, there is evidence over six decades that shows nuclear power is actually extremely safe. The risk of accidents in nuclear power plants is low and declining. In fact, in terms of the number of people killed by one kind of energy or another per kWh, nuclear energy is actually the lowest (together with wind); coal is unsurprisingly the highest. Modern advanced reactor designs (unlike those built at Chernobyl and Fukushima) are generally considered inherently safe.

6. Disadvantage of Nuclear Power

6.1. Accidents Happen

The radioactive waste can possess a threat to the environment and is dangerous for humans. We all remember the Chernobyl accident, where the harmful effects of nuclear radiation on humans can even be witnessed today. In 2011, on March 18, a major nuclear crisis happened again in Japan. While the casualties were not as high as with the Chernobyl accident, the environmental effects were disastrous. History shows that we can never really protect 100% against these disasters. Accidents do happen. A small probability of failure will always last. If there is an accident, large amounts of radioactive material could be released into the environment. The consequences of an accident would be absolutely devastating both for human being and environment.

6.2. Radioactive Waste

Nuclear waste remains radioactive and is hazardous to health for thousands of years. Used fuel will need to be stored in ponds or storage container for up to 100 years before the heat and radioactivity is low enough for indefinite storage or permanent disposal.

6.3. Cost

Another practical disadvantage of using nuclear energy is that it needs a lot of investment to set up a nuclear power station. Nuclear power plants are expensive and will require a huge amount of capital investment.

7. Conclusion and Recommendation

Nuclear power plants have provided reliable, affordable and clean energy for decades. Though, they also carry risk - to the public, to the environment and to the financial solvency of utilities. Risk is the product of the probability of an occurrence and its consequence. The probability of dying in a car accident is actually quite high compared to other daily events, but such accidents usually claim few individuals at a time, and so the risk is low. The reason nuclear energy attracts so much attention is that while the probability of a catastrophic event is extremely low, the consequence is often perceived to be extremely high. In the US, commercial nuclear plants have been operating since the late 1960s. There have been no fatalities to any member of the public due to the operation of a commercial nuclear power plant in the US. Our risk in human terms is vanishingly low. While the probability of a nuclear catastrophe is extremely low, it is only part of the risk calculation. The other part of risk is consequence. The world has been host to three major nuclear power generation accidents: Three Mile Island in 1979, Chernobyl in 1986 and Fukushima in 2011. These accidents had serious, lasting consequences that

aren't to be trivialized, but the consequences are nothing like what has been feared. I think most people would be surprised to know that in 2012, seven million people globally died from health complications due to air pollution and that an estimated 13,000 US deaths were directly attributable to fossil-fired plants [11]. US deaths from coal represent an annual catastrophe that exceeds that of all nuclear accidents over all time. In fact, nuclear power has prevented an estimated 1.84 million air-pollution related deaths worldwide. Through the Nuclear Regulatory Commission (NRC)'s oversight and the work of researchers all over the world, we have applied lessons from every global nuclear event to every nuclear plant. The risk inherent in nuclear plant operation will always be present, but it is one of the world's most rigorously monitored activities, and its proven performance in delivering zero-carbon electricity is one that shouldn't be dismissed out of fear.

Four internationally recognized climate scientists issued this plea to fellow environmentalists in November 2013, arguing that nuclear energy needs to be a part of the global climate change solution [1]. We need to reduce carbon dioxide (CO2) emissions from fossil fuels. Nuclear power is the best option today; it can deliver electric power in a sufficiently safe, economical, continuous and secure manner synergistic with supply from other carbon-free sources such as solar and wind.

The current electricity generation potential from Hydro, biomass, geothermal and peat, if fully developed, will not be able to meet Uganda Vision 2040 targets. Nuclear energy will be a future option for generating low carbon electricity for not only Uganda but the entire African region. Failure to act could foreclose the nuclear power option in this country and make the road to clean air and energy independence in the future that much harder.

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