Infrastructure and Other Considerations to Launch Nuclear Power Programme: The Case of Sub-Sahara African Developing Countries like Ethiopia

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Abstract. Trends in the world's population and energy use during the past decades show dramatic increases; and the demand for electricity, mainly from developing countries, is expected to increase more rapidly than the demand for other forms of energy. Besides, concern of climate change led to the need for production of significant amount of 'safe and clean' energy which in turn favours to nuclear option. Other alternative renewable sources like solar and wind can assist but currently they are short of supplying the required high energy demand either economically or/and in substantial amount. Nuclear option therefore remains a possible (developed) technology to fill this energy gap; and many countries including developing one show interest to make use of this energy source. In this paper the economic situations and energy production of six East Africa Sub-Saharan developing countries, with total population of 240 million were assessed, and 6.8% and 2.9% avergae GDP and population growth respectively registred in the last four years; however, their energy production in 2008 (est.) was 17.662 billion kWh, which is the least in the world. The contribution of inadequate energy and its poor coverage in hampering development, increase poverty and unstability were also analayzed. To come out of this cyclic challenge; it is recommended that countries based on regional economic cooperation should interconnect their electricity grid like EAPP and cooperate to invest commonly or unilaterally to launch Nuclaer Power Programmes in relatively stable countries. Candid support of the international community is crucial, and IAEA should support and encourage such arrangements. It is also noted that the best candidate to start NP programme in these countries would be the worldwide dominat water cooled reactors. However, for countries with low grid capacity and to carry out projects in remote areas which are far-away from national grid systems or to disalinate water, considerations for smaller reactor designs with affordable capital cost is also required.

1. INTRODUCTION

Trends in the world's population and energy use during the past century show dramatic and relatively parallel increases in both [1]. The demand for electricity is expected to increase more rapidly than the demand for other forms of energy and nearly double by 2020 [1]. I. Kimura [2] also remarked that: *"For welfare and prosperity of mankind and even for world peace in and after the next century, vast amount of energy is required."* This worldwide growing energy demand and the rising concern of climate change led to the need for production of significant amount of '*safe and clean*' energy which in turn favours to nuclear option. Other alternative renewable sources like solar and wind can assist but currently they are short of supplying the required high energy demand either economically or/and in substantial amount [3]. Nuclear option therefore remains a possible (developed) technology to fill this energy gap in better conditions of safety and sustainability without large greenhouse gas emissions [4].

Vast amount of potential energy resources including hydro, oil, gas and coal reserves exist in the Sub-Sahara African region; yet it is very deprived of energy provision and is one of the least developed part of the world. One reason to the region's under development can therefore be attributed to lack of adequate energy. As Dr. ElBaradei also once remarked: lack of energy in developing countries is one of the highest impediments for development and the fight against poverty [5].

It is also noted that considerable amount of uranium reserves in sub-Saharan countries, exploration and mine development is proceeding in countries which have not hitherto supplied uranium. These include Central African Republic, Congo, Guinea, Malawi, Zambia along with previous world suppliers like Namibia, Niger, Gabon and South Africa [6].

2. THE ECONOMIC SITUATION AND ELECTRIC PRODUCTION OF SOME SUB-SAHARA COUNTRIES

The socio-economic situations of most Sub-Saharan countries are similar; and mainly based on subsistence farming. The electric power generated in the region is mostly from hydropower stations; with few oil generators and coal plants. Currently, in most of these countries there is very high shortage of electricity and continuous power outage due to repeated draught and shortage of water reserves in dams resulting in shift supply system; which in return lead to drop of GDPs and reduction in income of small businesses and families that worsen the existing poverty.

For instance, Ethiopia is one of the Sub-Saharan country in the Horn of Africa; with a population of about 77 million. The country's most important, developed and high potential source of energy is hydroelectric power. The Ethiopian Electric and Power Corporation (EEPCO), a government corporation, operated most of the country's power systems. EEPCO incorporated all electric power stations and currently generate about 875 MW per day, which is short of 150 MW at peak times [7]. Ongoing efforts to increase its production by 3270 MW are expected from operational hydropower projects. The energy demand of the country in recent years also increased annually up to 17% [8]; and according to its strategy, the Universal Electricity Access Projects, EEPCO plans to increase its coverage to 50% of the population within five years (2006-2010) from current 21% [8].

The table below shows that the current economical situations of six sub-sharan East African countries and their electric production. Econmocal indactors show that GDP of these countries are growing more or less continously for the past few years. However, comparing the steady growth of population and their economy, including manufacturing industry, the production of electricity is too slow; even in some cases countries like Uganada and Kenya electric generation were severly cut due to closure of ageing dams. These low production of electrcity highly discourage investments and debt many companies operating in these countries due to continous production loss as a result of power disruptions; or costting them extra money to get their own energy sources, mainly from disel generators which also incur importation of more oil from meager hard currencies of nations.

Country Population (July 2009 est.)		**GDP (official exchange rate)***	**GDP per capita (PPP)***	**GDP real growth rate***	**Electricity–production** kWh (2006 est.)
Djibouti	516,055	$982 million	$3,700	5.8%	250 million
Ethiopia	85,237,338	$25.66 billion	$800	11.6%	3.268 billion
Kenya	39,002,772	$30.24 billion	$1,600	1.7%	6.264 billion
Sudan	41,087,825	$57.91 billion	$2,200	6.5%	4.037 billion
Tanzania	41,048,532	$20.72 billion	$1,300	7.1%	2.682 billion
Uganda	32,369,558	$14.53 billion	$1,300	6.9%	1.161 billion

Note: *data are in 2008 US dollars and 2008 est. [9]

Analysis of data found from the above source to the six developing countries also show that the population growth rate in this part of the region averaged between 2006-09 is 2.9%; and the total population is 240 million. They registered 6.8% avergae GDP growth in the last four years, with 10.55% highest growth performed by Ethiopia and the least 4.5% by Djibouti followed by Kenya 5.05%. However, their energy production in 2008 (est.) was 17.662 billion kWh, which is the least in the world. This energy growth with world poor basic coverage of less than 20% of the population is

very minimal to meet and support the required continuous average growth of 7% to fulfill the millinium developmental goals.

There are many different energy options in the region; the choice of which may depend on the available national resources, funding and other technological factors. Considering the current level of economies in sub-sharan countries handling the existing energy situations with available, tested and less complicated sources of energy like hydropower and coal might be justified. However, with ever increasing envirnmental degradations and influences of climate change which badly affects most water sources in the region; considering other sustainable form of energy sources is mandatory to sustain developmnent and ensure stability.

The relative costs of generating electricity from coal, gas and nuclear plants vary considerably depending on location. Coal is, and will probably remain, economically attractive in countries such as China, the USA and Australia with abundant and accessible domestic coal resources as long as carbon emissions are cost-free. Gas is also competitive for base-load power in many places, particularly using combined-cycle plants, though rising gas prices have removed much of the advantage [10].

Nuclear energy is, in many places, competitive with fossil fuel for electricity generation, despite relatively high capital costs and the need to internalize all waste disposal and decommissioning costs. If the social, health and environmental costs of fossil fuels are also taken into account, nuclear is outstanding [10]. Emphsis also should be given on the long time from decisions making to launch the first NPP (Nuclear Power Plant) in these countries. This could be more than 15 years and proper direction by political leaders and adeqaute preparation by different stakeholders should start as soon as possible.

3. ROLE OF REGIONAL COOPERATION IN NUCLEAR POWER PROGRAMME

According to news from IAEA and the World Nuclear Association more than thirty countries are actively considering embarking upon nuclear power programs [11]. These ranges from advanced economies to developing ‘new’ nations. Almost all North African countries; Nigeria and Ghana from West to Namibia down to the South are included in the region. Some reasons for this shift to nuclear options are: to overcome with natural disasters (for instance effect of cyclic draughts); decline of national fossil fuel reserves; and strategic utilization of national resources. Though numerous the reasons may be, it seems that there is growing interest of nations (mainly developing countries) to nuclear power, which may raise concerns of the proliferation of nuclear weapons and safety issues. It is not only electricity and heat nuclear technology provides to the world, but many diverse social and economic rewards; and various spin-off benefits. Therefore, it is sensible and reasonable that nations show great interest towards this technology. Yet, it should be related with all responsibilities that the technology entails and with full commitment of states for its peaceful applications as well as developing all other prudence capabilities that the technology requires.

Although there is only one nuclear power reactor in operation in South Africa, there are ten research reactors in eight countries in the region. The increasing demand for electricity and fresh water in the region has opened up the prospect for AFRA - IAEA Member States to install and operate nuclear power plants. Towards this end, AFRA is also working together with Member States and to the establishment of Africa Energy Commission (AFREC) to develop the expertise and infrastructure required to achieve the milestones for the implementation of nuclear electricity generation, in accordance with the Algiers’ Declaration; which has been adapted and political committment already made by African head of states in January 2007 in Addis Ababa [12].

However, there are major challenges to launch a Nuclear Power Programme in these countries; such as lack of funding, inadequate technical know-how, lack of information on the available resources, low grid capacity of nations, lack of required organizations and physical component of the infrastructure. There are also encouraging aspects such as commitment to expand electric supply to the public, strategic shift to diversify energy sources, availability of uranium (thorium) reserves, availability of

basic regulatory infrastructure in radiation protection and nuclear safety, and enhanced regional and international economic cooperation. Projects funded by different developmental partners to interconnect the electricity grids of some of these countries called East African Power Pool (EAPP) is also encouraging. These projects connect electric grids of four East-African countries in the sub-region; Ethiopia, Djibouti, Sudan and Kenya [8].

The Sub-Saharan countries are new to launch a Nuclear Power Programme, and if they consider to this programme in cooperation or independently, they should be committed highly to develop the basic infrastructure in stages [13]; which include: development of nuclear policy and its formal adoption by governments; confirm the feasibility of implementing a nuclear power project; establish inistitutional components of the infrastructure including a nuclear regulatory body (NRB); establish a physical component of the infrastructure such as grid, component manufacturing and material supply; develop, contract and finance the first nuclear power project; construct the first nuclear power plant to the established safety, quality and economic requirements; and safe, secure and efficient operation of the first nuclear power project [13]. This basic infrastructure may include: national legal framework and international agreements; nuclear safety regulatory body and environmental regulatory body; physical facilities; finance/economics; human resource, education and training; operational practices and processes to assure safety and performance throughout the life of the facility; and public information and acceptance [13]. This commitment include longer than 100 years of maintaining a sustainable national infrastructure throughout its operation, decommissioning and waste disposal [14].

4. CONCLUSION

In conclusion, social and economic development without affordable (or cheap) energy is unthinkable. The high level of poverty in Sub-Saharan countries mainly is due to lack of adequate energy and its poor coverage. It is vital to assert here that provision of sustainable and sufficient amount of energy in the region can greatly advance development, alleviate poverty and ensure stability. Besides, to come out of this cyclic challenge; countries based on regional economic cooperation, should interconnect their electricity grid like EAPP and commonly invest to launch Nuclear Power Programmes in relatively stable countries. Candid support of the international community is crucial, and IAEA should support and encourage such arrangements. Considering the time required to prepare, construct and operating power plants in these countries; which is not less than 15 years, they should now have to invest to build the required infrastructure systematically and IAEA, from its wealth of experience has to provide the right guidance and assistance.

Other developmental partners also should play their role of fighting poverty, by availing the required funds, technical assistances, and encouraging their companies in providing insurance and lending funds to this end. This can be a commitment of the developed world to fight global climate change and to meet the objectives of sustainable development issues. Added to this, consideration of the region’s contribution of the long term supply of uranium to their developments should also be taken into account. The idea of the International Fuel Bank can also be an important initiative that can complement such proposals. However, these countries should use the technology in responsible manner, maintained by effective implementation of international safeguards regime to ensure the concerns of the international community.

Moreover, if the Sub-Saharan countries go for nuclear then the best candidate would be the worldwide dominat water cooled reactors. This reactor types developed through evolution with numerous global experiences in operation and design; which are inherently safe, self-regulated and efficient designs, like AP1000 and EPR. However, for countries with low grid capacity and to assist remote communities or to carry out rural projects which are far-away from national grid systems, considerations for smaller reactor designs with affordable capital cost is required. In this regard designers should be encouraged to invest in R& D.

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