

NEPAD vision and the INGA hydro-electric scheme

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Abstract

The concept of power trading is considered in the context of the vision of the New Partnership for Africa Development (NEPAD). A most promising option is to utilise the rich water resources of the Democratic Republic of Congo for hydro-power generation. Present and anticipated future potential generating capacities are quoted. The development of the Inga 3 and the Grand Inga schemes could supply grid-connected African states with sufficient electricity to stimulate their respective socio-economic development. Today's situation and plans are outlined, emphasising requirements for success. These include financial investment through public-private partnerships, the all-important role of governments to ensure political stability and independent regional regulation for equitable wheeling charges.

Keywords: hydropower, NEPAD, governance, political stability, service delivery

1. Introduction

Africa is the sole continent where 25 – 30% of the population only has access to electricity, compared to Europe where 100% of the population has access. There is, however, an opportunity to change the African scenario since the Democratic Republic of Congo (DRC) has the hydropower potential to boost the electricity capacity within the Central African region, the Southern African Development Community (SADC) countries, and possibly, the entire continent.

Electricity is a vital part of economic stability and growth in Africa. Stability in electricity production could promote the development of different economic sectors. When a country has insufficient energy, in terms of electricity production, distribu-

tion and access, then problems arise in terms of the development of that country. African nations, in particular, require collaboration within their energy sectors in order to develop. The development of electricity production within the DRC has potential to attract foreign investment thus impacting on other Africa countries.

The aim of an electricity company is to produce and distribute electricity to its customers and to generate an acceptable income. In order to achieve this, utility companies should invest adequately in infrastructure which includes constant maintenance of the power supply. The Edison Electric Institute (2002) claims electricity is an important element in the achievement of social, sustainable development. The electricity industry considers access to an adequate supply of electrical energy a basic requirement towards the eradication of poverty (Edison Electric Institute, 2002).

This paper indicates how the Inga scheme, if managed properly, will contribute to the New Partnership for African Development (NEPAD) as well as to the SADC sub-region as a whole. The result can be achieved through regional co-operation in the electricity sector including the West African Power Pool (WAPP), based in Lagos (Nigeria); the East African Power Pool (EAPP), based in Nairobi (Kenya); the Central African Power Pool (CAPP) in Brazzaville; and the Southern African Power Pool (SAPP), based in Harare. These different pools seek to improve the electricity supply and its security within sub-Saharan Africa.

2. NEPAD vision of the energy sector

According to NEPAD (2001), energy plays a key role in the development process, providing primarily a domestic necessity. Energy is also a factor of production, directly affecting prices of other goods and services and the competitiveness of enterprises. There is an unequal generation capacity of energy across the African continent. This imbalance hampers progress. NEPAD has short listed priority proj-

ects, which could help stabilise the energy sector in Africa.

According to Sekose (2003) the African Development Bank has agreed to finance two of the project-linking electricity power grids in West and North Africa. The long awaited project to develop the Inga-electric power plant on the Congo River and to link it to other countries is a priority. Many feasibility studies have been conducted in different regions throughout Africa. A report was submitted to the most advanced countries, including recommendations on how the developed world could contribute to project implementation.

Many discussions have been held aimed at developing the energy sector within the African continent (World Summit on Sustainable Development, 2002). During that workshop the energy sector under NEPAD reported African countries should increase access to reliable and affordable commercial energy. Within 20 years, reliability should be increased and the cost of energy decreased to enable an annual economic growth of 6%.

In order to emphasise that view, Saunders (2002) argues there are six points, critical to NEPAD's success. These are: to inward investment and the need for increased investment in Africa's infrastructure; poor transportation and an inadequate electricity system in Africa are major barriers to economic development, adding to the overall cost of exports; peace and security on the Africa continent; capacity building for an economy of 6% growth every year in each country to help to reduce poverty; capacity building in finance and market access, a critical issue as Africa needs good financial mechanisms and fair trade with other partners; and increased investment in human development to secure rapid progress in education and the delivery of effective health-care systems. These points must be prioritised to achieve the project.

Since the private sector will not fund electrification that does not provide a positive return, it is worthwhile examining some examples of similar projects being funded by, including the construction of the Mepanda Hydropower Plant in Mozambique. Another project shared by the Economic Community of West African States. The United States of America International Development (USAID), the Banque Ouest Africaine de Development and others have been approached to buy into these projects. The price of electricity, once these projects become operational has yet to be determined.

Another project is the Grand Inga Integrator. The DRC government works hand-in-hand with other financial institutions raising funds for the construction of the largest hydro-electric scheme in sub-Saharan Africa. Construction of the Grand Inga may be considered a major priority in terms of harnessing African hydro potential. The DRC's new

democratic government has decided to prioritise the electricity sector. According to the CEO, Vika Di Panzu, of Societe Nationale d'Electricite (2005) the DRC government invited various stakeholders, including the World Bank, International Monetary Fund, Banque de Paris, and others who promised to inject funding for the Grand Inga project (Vika Di Panzu, 2005). Additional financial assistance will be provided by the African Development Bank.

3. Electricity supply

There is, therefore, a need for an African transmission network under NEPAD. The construction of such a network will materialise once a partnership between the government and the private sector is cemented. Each government should evaluate the possibility of involving internal investors for network construction. If local investors cannot invest, each government should invite international companies to participate for the success of the project. The transmission network will include those countries who want to buy electricity from the Grand Inga. The Inga site is 3 000 km from the southern African region, and 4 000 km from Egypt. The network in the SADC region will join the DRC to Angola, Namibia and South Africa. Major investment will have to be made in Angola, since most of the network was destroyed during the civil war. The cost of this network reconstruction remains unknown.

Ekongo (2004) has said the objective was to build an African transmission network to make it possible to regulate electricity throughout Africa. The power generating countries would then be in a position to supply electricity to countries with a shortage. The aim of NEPAD is to create a system, to ensure no country was without access to electricity at any given time. It emerged at the World Summit on Sustainable Development that as much as 70% of the total population of Africa lacks a basic service. The electricity, to be generated by Grand Inga, would therefore, reduce the numbers who lack access to electricity services in Africa by a 50% (WSSD, 2002). In terms of distribution this would depend on each country as distribution networks were already place in place in most countries. What would happen is most of the countries would join the upgrade of the distribution network to supply new customers.

4. INGA hydro-electric project

The Congo River has an annual flow rate of 42 000m³ per second (SNEL, 2000). It is one of the largest rivers in the world with a significant gradient along its lower course. Between Sikila Island and the Congo River mouth (15 km as the crow flies) there is a difference in altitude of 102 m. This difference in altitude produces a sequence of rapids which make the Inga Dam the largest single source of hydropower in the world.

4.1 Current plan

The DRC is the leader of potential electricity generation – 370 000 Gigawatt per hour (GWh), ahead of Cameroon 115 000 GWh and ahead of Madagascar's 320 000 GWh productions (SNEL, 2000). Figure 1 shows the site of Inga 1 hydropower with Inga 2 on the right hand side. In the same area, the DRC government and other SADC countries plan to build the third phases of Inga 3, while the construction of Grand Inga will not be far from these three hydropower plants.

In Table 1, the capacities of the various Inga hydro-power plants are given.

The hydro site has the potential for the DRC to produce up to 100 000 MW. The construction of the new sites requires investment, because others power plants require urgent refurbishment. Since 1996 the DRC's national consumption of electricity has decreased, after negative economic growth.

In 1998 the total domestic peak demand was

approximately 650 MWh. The mining industry, the single biggest consumer during the 1980s, with more than 60% of the total consumption, reduced its share to 25% in the last few years (Sadelec, 2000). The decrease of the electricity production was because in Inga 1 and Inga 2, some units were not operating because of a lack of spare parts. The actual production capacity in the DRC was only 750 MWh, although the total installed capacity stood at 2473 MWh.

The consumption of electricity began to change within the mining sector in Katanga Province between 2003 and 2006. Before the end of 2007 the actual production will increase with the rehabilitation of Inga 1 and Inga 2.

4.2. Future plan

Many countries struggle to distribute electricity internally because of poor management of utilities. The Mbendi Information Service (2003) has



Figure 1: Inga 1 and Inga 2 and where Inga 3 and Grand Inga will be constructed

Source: SNEL, 2005

Table 1: Inga hydro electric plants

| Element of hydropower | Inga 1 | Inga 2 | Inga 3 planned | Grand Inga planned |
|--------------------------|-----------|------------|----------------|--------------------|
| Number of unit | 6 | 8 | 7 | 52 |
| Total installed capacity | 351 MWh | 1424 MWh | 1344 MWh | 44 000 MWh |
| Height of water head | 50 metres | 58 metres | 60 metres | 150 metres |
| Gross energy capacity | 2 400 GWh | 10 400 GWh | 9 900 GWh | 324 900 GWh |

Table 2: Grand Inga and power higher ways*Source: SNEL, 2005*

| <i>Demand</i> | <i>Unit</i> | <i>2012</i> | <i>2014</i> | <i>2016</i> | <i>2018</i> | <i>2020</i> |
|--|----------------------|-------------|-------------|-------------|-------------|-------------|
| Northern highway (Egypt) | MW | 4 000 | 6 000 | 7 000 | 8 000 | 10 000 |
| Western highway (Nigeria) | MW | 4 000 | 5 000 | 6 000 | 7 000 | 8 000 |
| Southern highway (SADC) | MW | 3 500 | 5 000 | 6 000 | 7 000 | 8 000 |
| Total (including Central African Region) | MW | 11 500 | 16 000 | 19 000 | 22 000 | 26 000 |
| Installed capacity | MW | 13 500 | 18 000 | 21 000 | 24 000 | 27 750 |
| Number of units | # | 18 | 24 | 28 | 32 | 37 |
| Generation cost/ step | 10 ⁶ \$ | 5 661 | 981 | 654 | 654 | 818 |
| Cumulative generation cost | \$/kW | 419 | 369 | 347 | 331 | 316 |
| Transmission systems costs | 10 ⁶ \$ | 8 303 | - | 4 858 | - | 4 649 |
| Total cost | 10 ⁶ \$ | 13 964 | 981 | 5 552 | 654 | 5 467 |
| Revenue load factor | % | 70 | | | | |
| Electricity price | c\$/kWh | 3.5 | | | | |
| Annual energy | GWh | 70 518 | 98 112 | 116 508 | 135 000 | 159 432 |
| Annual revenue | 10 ⁶ \$/y | 2468 | 3434 | 4078 | 4722 | 5580 |

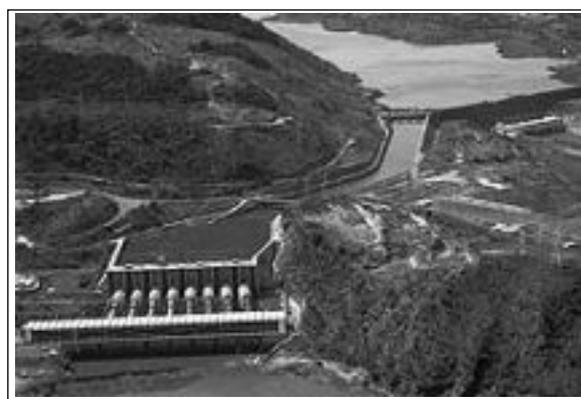
analysed the problems of power supply in Africa, concluding an inadequate power supply in many African countries, was a major barrier to economic growth. The causes of the supply difficulty are numerous and diverse. Civil wars in some African countries such as Angola have left generation and transmission facilities damaged. Based on the damage from civil war, many governments' financial plans have been stretched to the extent that the maintenance of electricity facilities has become a low priority. In addition, many countries have unreliable equipment and few means to upgrade them. African countries should, however, transform their energy sectors in order for to stimulate economic development.

In accordance with IEA (2003), developing countries account for a little more than a quarter of global electricity production. By 2030, this share is expected to increase to 44%. These countries could be producing as much electricity as the OECD. In order to provide for this rapid increase, they will need to invest more than US\$ 5trillion (R40 trillion) in electricity infrastructure. For most countries, this means that investment should increase to well above current levels.

The Grand Inga scheme could be one of the solutions for NEPAD's economic development of the continent. The DRC government itself cannot realise this vision. It requires the participation of stakeholders. The Electricite De France (EDF) made an evaluation concerning the construction of the Grand Inga. Table 2 presents the financial estimation done by the EDF on behalf of the DRC utility. This estimation could be changed in terms of the US\$ fluctuation in the international market.

The construction of Grand Inga will contribute positively to the socio-economic development of

different parts of the African continent. According to a feasibility study conducted in 1997 by EDF, the French electricity company, Grand Inga will supply Egypt appreciable from 2012 onwards, as well as other countries such as the Central Africa Republic, and Sudan. In Figure 2, Inga 1 and Inga 2 are shown.

**Figure 2: Photograph of Inga 1 and 2**

In the West Africa sub-region, Nigeria and the DRC have signed an agreement for the development of a transmission network from the DRC to Nigeria. The tapping of electricity from the DRC will solve some of the problems which Nigerian utilities face. The demand for electricity in Nigeria grows annually, but power outages occur frequently. The transmission of power within the DRC will reduce the problems of power failures within Nigeria. Power security will impact positively in terms of economic growth and social development. The power from the DRC will benefit not only Nigeria, but increase capacity in the Western African Power Pool, showing that the construction of the Grand

Inga is to be a priority requirement for the NEPAD programme.

The Southern Africa sub-region will also benefit from the Inga hydro-scheme, because of the construction of Inga 3, which has five participating countries. This project is called the Western Corridor Project with member states such as the DRC, Angola, Namibia and South Africa. The realisation of this project is a collaboration of five utilities (SNEL, Eskom, ANE, Nampower and BPC). These companies have decided to jointly contribute to the construction of Inga 3, while the head office of this Westcor Company is based in Gaborone. It has been shown that the construction of Inga 3 will probably boost the capacity of electricity in the SADC region. The introduction of the Westcor project will benefit the SADC in two ways as result of Inga hydropower. The eastern corridor network has the Inga Shaba network, which has links with Zambia, Zimbabwe and South Africa. The introduction of Inga 3 will increase the trading of power within the Southern Africa Power Pool. Currently, the trading of electricity has decreased because of a lack of capacity within the SADC sub-region. There is less capacity trading in the short term electricity market at SAPP (Muhiya, 2006), since most of the power is traded on bilateral agreements between countries.

5. Requirements for success

According to a director of the International Energy Agency (IEA, 2003), a US\$5 trillion investment within the electricity sector of developing countries would be a daunting task, particularly in Africa and India.

5.1. Financial

The investment for power generation for export could be hampered by financiers' perception of risk related to country specific issues, or to the multinational character of the project. The nature and degree of risk varies from country to country on the African continent. This could be civil war or political instability (Croussilat, 1998).

Transmission tariffs also play a major role in financing the creation and expansion of a transmission network. According to Croussilat (1998) where cross-border transmission has been developed, costs are bundled into a delivery capacity. Most countries should use the same technical standards for the transmission line.

The transformation of the electricity industry in Sub-Saharan Africa is a prerequisite for larger investments in the electricity sector. It is also argued by the World Bank Group (2003) that a regional perspective on the energy market and sector development presents significant benefits. Interconnection of national petroleum and the power market will encourage private investment, which increases

market size, thereby helping investors to manage commercial and political risk.

Interconnections encourage global scale projects. Investments in redundant facilities need to be avoided, and strategic and macroeconomic risks decreased by expanding a country's supply choices. Furthermore, energy interconnections create export opportunities. In the DRC, the energy sector is unique in its potential to forge closer economic ties among countries within the region.

Many investors are unprepared to invest in some African countries for differing reasons. For example, the problem of political instability discourages investors. This situation has, however, begun to change in some. For example, there is now peace in Sierra Leone, which has allowed the completion of the Bumbuna Hydropower project, with a capacity of more than 50 MWh, to continue until 2008. Currently, few households within the city of Freetown have access to electricity (Mazzei; 2005). The reason for this long delay is because of political instability and civil war. It took two decades for completion of that hydro-power plant.

Engineering News (2004) reported some of the international energy-sector investors' attitudes towards West Africa have become impartial, because of the small size of the region's countries and their history of military coups. This argument highlights the idea that African leaders should develop effective strategies in order to achieve NEPAD objectives as far as energy is concerned. The development of a power pool, through integrating the region's electricity sector, would result in a massive market, while well-managed and transparent cross-border energy trading, will alleviate investor concerns about high risk profiles of certain countries. There are others important issues such as a stable policy, feed-in tariffs, power purchasing agreements, and predictable rational regulation.

5.2. Role of government

Berg (2000) argues that change with regard to public policy of the electricity sector should take into account fundamental conditions within the electric utility industry. In the case of the DRC, there is no new policy in respect of the electricity sector. The utility works with a policy implemented in 1978 when the status of the company was approved under the legal framework of public enterprise. The new government has already considered the possibility of implementing reform in most public enterprises. SNEL is one company which the government seeks to reform, thereby reducing government control.

Political and economic stability not only contribute to a strong economy, but also have a strong positive external effect by providing steady markets for suppliers. Hill (2003) argues that electricity planning issues are more complicated in developing

countries than in developed. Many developing countries face problems of financing construction of new power plants, including many African states.

The success of NEPAD should have an impact on the political stability of several nations. Without political stability it could prove difficult for private partners to invest. The construction of Grand Inga will go hand-in-hand with political stability. It is an opportunity for the host government to develop a major platform for investments across the country within different sectors. The state should implement an improved policy, acceptable to the policy maker (government) and the private sector. An effective policy will guarantee an improved result where there is a strong institution to implement such policy. One responsibility concerns service delivery to citizens. In addition, governments should provide improved infrastructure as a means to attract investors. Following the same argument, Stiglitz (1997) suggests any attempt to assess the appropriate role of governments within development, should come to terms with the limitations of governments, as well as the limitations of markets. In countries where governments remain ineffective, the scope for their action should be correspondingly limited. It is well known in most of the developing countries that government's role is limited in terms of service delivery.

It is also important to discuss the cost of electricity in African countries, especially in relation to NEPAD objectives, although the cost of electricity was not discussed. In addition, experience shows that Sub-Saharan African countries have varying electricity prices. For example, electricity is expensive in Kenya compared to countries such as South Africa where the tariff is low. Botchway (2000) proves the role that governments can play to solve problems of electricity, is to allow nations to establish electricity companies. However, he demonstrates how the role of government is necessary for a good performance of the industry. An analysis of global changes shows that the state usually plays a major role within the industry. The electricity sector has been considered as part of a national security concern and requires an effective policy in order to control the utility. Another element to be noted is government control of the utility, which must ensure all have access to electricity.

According to Botchway (2000), the electricity industry has also been restrained by national borders with regard to where power is generated and to who it is supplied. To the extent that any significant international relations that existed, they are related mainly to financing and the equipment or technology supply aspects of the industry. An increasing emphasis on the international dimensions of such business is a new characteristic of the electricity industry. This is one reason why African countries have developed regional co-operation in terms of

electricity generation. Examples of this are the Southern African Power Pool, Western African Power Pool and the Eastern African Power Pool. The NEPAD vision for the energy sector should assist all regional bodies to work together cooperatively.

5.3. Regional regulations

Most governments suggest a regional regulatory body. It should begin to review the cost of electricity tariffs within the sub-region. This could be the case of the SADC, East Africa region, and the West Africa region. The regional regulatory body should be independent and different from the present Regional Electricity Regulators Association of Southern Africa (RERA). The regional regulatory body should fix and review the wheeling charge on the transmission network. Currently the wheeling charge is being discussed by member states and electricity companies in a power pool. Each participating country should nominate key knowledgeable personnel to serve on the electricity regulator. The old mechanism should be dropped to give the regional regulatory body effective control.

6. Conclusions

In line with NEPAD's vision, it is concluded that the challenges and security of electric power to sub-Saharan African countries could be met through power trading. This should be based on the development of the Inga 3 and Grand Inga hydro-power schemes in the Democratic Republic of Congo. Meaningful power trading between the West African Power Pool, the East African Power Pool; and the Southern African Power Pool is feasible and recommended.

Success of the outlined scheme depends largely on adequate financial resources to be raised by foreign investment in public-private partnerships. For this to materialise, respective governments will have to ensure political stability. The present and future potential generating capacities are cited, proving the technical feasibility of the proposed schemes. It is recommended that an independent regional energy regulator be established for this project, replacing the existing association of the various national regulators.

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