Boosting the Electricity Sector in West Africa: An Integrative Vision

By Edgard Gnansounou *

To improve peoples' living conditions, Western African countries need to considerably reinforce their electricity supply infrastructures. Retrofitting the existing installations and constructing new generation and transmission facilities require significant financial resources which are very difficult to attract due to the countries specific economic and political conditions. This paper discusses the low performance of the electric power sector of the West African countries and the solution they envisaged to cope with their present electricity crisis. It turns out that the cooperative approach the electricity systems are undertaking within the West African Power Pool project, although positive in number of initiatives, is not sufficient to cope with the challenge of attracting the required funds to meet future regional electricity demand. Another concept is proposed, based on an integrative approach that attempts to solve the capacity needs for the whole region through a competitive market. The restructuring underlying that vision is discussed. It is concluded that implementation of the proposed concept will require a necessary voluntarism and a strong commitment of the countries.

Introduction

For several decades, the populations of West African countries have suffered from limited access to electric power and endemic electricity shortages. This situation constitutes a bottleneck to their socio-economic development. The electricity crisis in West Africa has worsened during recent years in spite of the efforts made to construct new electric power plants and transmission networks. The gap is still large between the present trend of investments and actual needs. Reforms in the electricity industry have been gradually undertaken in the region under the initiatives of donors who sponsored them. The ongoing restructuring consists mainly in privatising the public electricity utilities in order to attract private funds to the electricity sector. Early in 2000, a regional strategy was launched seeking to reinforce these reforms, to exploit domestic primary energy resources and to improve the electricity interconnections between the national grids. The aim is to build up a West African Power Pool (WAPP), the objectives of which are defined as follows: to enhance cooperation among West African countries for developing electricity infrastructures, promote investment in the sector, improve electric system reliability, provide a forum for policymakers to share their views concerning the electricity sector, share the benefits of trade and investment and agree upon common rules to protect the public and the environment. After a few years of operation, the WAPP has succeeded in providing a forum for policy issues and in setting up some institutional organizations. Interconnection projects are also in process, financed by the World Bank and other international financial institutions. However, the role of the WAPP in attracting investment in West African electricity generation systems will remain small as long as it embraces the conventional vision of cooperative electricity import/export between national electricity sectors. The objective of this paper is to contribute to a new concept on the nature and direction of reforms in the electricity industry in West Africa. A model of electricity sector restructuring is proposed which allows for integrated development of the electricity supply industry at the regional level in West Africa. Two strategies are compared. The first strategy is based on adequate expansion of the national power systems and the electricity exchanges among the countries in sub-zones. It aims at optimising the management of national electricity generation systems. The second strategy, recommended in this article, leads to developing a regional electricity market in order to boost investment.

The remainder of this paper is structured as follows. Section 2 is devoted to a performance analysis of the region's electricity sector; the ongoing reforms in West Africa are reviewed as well. The WAPP project is presented in section 3 and its ability, as currently structured, to achieve its main goal is discussed. In section 4 a new concept is proposed for the future of the West African electricity sector and section 5 concludes with the need to develop a political voluntarism in order to meet the electricity demand of the West African economies in the future.

Performance of Electricity Supply in West Africa

A Low Quality of Service

During the last decade, the number of electricity supply interruptions increased dramatically in many countries of West Africa. In 1998, because of the drought, the lack of water in the Akossombo reservoir caused an electricity crisis

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in Ghana as well as in Benin and Togo. The latter two countries then suffered from electricity supply disruptions during several months and this led to an economic recession. A similar crisis of less severity occurred from late 2006 to September 2007. In 2001, Nigeria experienced rolling blackouts due to drought and draining of Kainji, the largest hydro power reservoir in the country. Senegal, Mali and Guinea have suffered for several years from frequent disruptions of electricity supply due to insufficient generation capacities and the low reliability of power plants. With the notable exception of the Ivory Coast, which somewhat adapted supply to demand, all other countries of the sub-region suffered from under-investment in electricity supply capacity. Furthermore the electric generating systems are structurally imbalanced. In countries like Ghana, Nigeria, Benin, Togo, Guinea and Mali, electricity supply relies significantly on hydropower, and this is subject to strong multi-annual variability because of fluctuating hydrological conditions. Meanwhile, other countries like Senegal, with electricity generation mainly based on oil, have experienced frequent power plant outages due to low reliability and the difficulty of fuel procurement stemming from the international oil price surge.

This situation impacts the economic development in multiple ways. For example, big companies, especially industrial consumers, have to install self-generation facilities as a complement to the unreliable supply from the grid. It results in a higher electricity supply costs and entails a loss of competitiveness. The low quality of electricity supply caused a direct increase in the companies' production costs and had a negative effect on capital productivity, in comparison with other developing regions such as Asian or South American countries. These factors caused significant losses of economic growth opportunities that resulted both in low capacity use by existing enterprises as well as less attractiveness to new ventures. That makes the deficiency of electricity supply in West Africa a strong barrier to poverty alleviation in the region which has the world's highest proportion of poor people.

Prescribed Solutions

The heavy debt of most of the utilities in the region, and their low financing capability, mainly explain the under-capacity of electric generating systems in West African countries. In addition, the governments are unable to provide the necessary funding for renovation and further development of electricity infrastructures. The obsolete equipment and management dysfunctions, in turn, help cause a weak performance of the whole electricity industry. The donor institutions led by the World Bank have offered many solutions: management consulting, bilateral aid, contracts for management and leasing (Hammons et al., 2000; Reyl, 1996). A complete privatisation of state-owned electricity companies was recommended to all countries of the region. This solution succeeded in the Ivory Coast but so far has been unsuccessful in several other countries, in particular in Guinea and Senegal. The efficiency of such a single solution is thus questionable. In some cases, privatisation was restricted to the management and operation of the utilities, their ownership remaining in the hands of the state. An important criterion in the selection of private operators was their capability to attract the necessary investments. The privatisation experiences that are ongoing consist in selling the utilities to private investors. However, experience in a West African context has shown that if priva-

Country	Fina Consumption 2005 (TWh)	Generation 2005 (TWh)	Share of Thermal Power Plants %	Share of Hydro Power Plants %	Installed Capacity 1/12005 (GW)	Thermal Capacity % of total	Hydroelectric Capicity % of total
Benin	0.59	0.11	99.05	0.95	0.122	45.08	54.92
Burkina Faso	0.48	0.52	80.54	19.46	0.180	82.22	17.78
Cape Verde	0.04	0.05	100.00	0.00	0.078	100.00	0.00
Ivory Coast	2.90	5.31	73.18	26.82	1.084	44.28	55.72
Gambia	0.13	0.15	100.00	0.00	0.029	100.00	0.00
Ghana	5.85	6.65	20.64	79.36	1.490	19.60	80.40
Guinea	0.71	0.77	45.10	54.90	0.274	52.92	47.08
Guinea-Bissau	0.06	0.06	100.00	0.00	0.021	100.00	0.00
Liberia	0.30	0.32	100.00	0.00	0.188	100.00	0.00
Mali	0.41	0.44	45.95	54.05	0.280	44.64	55.36
Niger	0.44	0.23	100.00	0.00	0.105	100.00	0.00
Nigeria	16.88	22.53	65.06	34.94	5.898	67.14	32.86
Senegal	1.46	2.22	87.94	11.88	0.300	100.00	0.00
Sierra Leone	0.23	0.25	100.00	0.00	0.118	96.61	3.39
Togo	0.58	0.18	58.52	41.48	0.021	85.71	14.29
Regional Total	31.05	39.76	60.58	39.41	10.19	59.46	40.54

Table 1
Overview of Electricity Generation Sector in West Africa
Source: EIA (2007)

tisation can be a solution to improve management and operation cost, it does not constitute a panacea for financing electricity sector expansion. Under the current state of national electricity infrastructures and regulations, private investors are not willing to heavily invest. Another option envisaged in this paper is the development of a more open integrated framework that could ensure the electricity security of supply by progressively opening the market to competition at the regional level.

Description of the Existing System

The situation presented in this section is mainly derived from statistics of the U.S. DOE, Energy Information Administration (EIA, 2007). In 2005 the total installed electricity generating capacities in Western Africa amounted to 10.2 GW, constituted by 59.5 % of thermal power stations and 40.5 % of hydroelectric plants (see Table 1).

Total electricity generation amounted to 39.8 TWh of which 61% was from thermal power plants; the main electricity producers being Nigeria, Ghana and Ivory Coast with, respectively, 22.5, 6.7 and 5.3 TWh. Total electricity consumption was 31.0 TWh with the following main consumers Nigeria (16.9 TWh), Ghana (5.9 TWh), Ivory Coast (2.9 TWh). These three countries were responsible of 87% of electricity generation and 83% of the consumption.

Nigeria

Only 40% of the Nigerian population has access to electricity, mainly in urban areas. It is estimated that the supply deficit is about 80% of the potential electricity demand of the country. The public authorities planned to boost the 4 GW available capacity in 2005 to 10GW by the end of 2007. Instead, the available power has decreased in 2007, fluctuating between 0.80GW and 3.5 GW whereas the country's peak electricity consumption was estimated to 7.60 GW; self-generation and back-up systems are used, leading to expensive electricity supply for the economy. This situation is due to unreliable power plants as well as irregular primary energy feed caused by frequent vandalism to condensate pipelines. Power sector restructuring in Nigeria started in March 2005 with the enactment of the law of the Electric Power Sector Reform. So far the main effect of the reform is on the sector's organization: corporatisation of the state owned utility that changed from NEPA to Power Holding Company of Nigeria (PHCN); unbundling of the PHCN with 18 descendant companies that are being privatised. A regulatory commission has been established and new power plants are projected by IPPs. The reform, however, has not proved to be attractive to private investors who still perceive the Nigerian electricity sector as significantly risky.

Ghana

The electricity industry in Ghana is dominated by three companies. The Volta River Authority (VRA), a state owned utility, is the main generation and transmission company. A small share of the generation is attributed to few IPPs and to the Takoradi International Company (TICo), a joint venture between VRA and CMS Energy Inc. of the U.S.A. The Electricity Company of Ghana (ECG) and the Northern Electricity Department, a subsidiary of the VRA, are two state owned companies that are responsible for distribution (RCEER, 2005).

The power generation system in Ghana is largely dominated by hydroelectricity. From late 2006 to September 2007, due to a severe drought and underinvestment in power capacity, Ghana's consumers were affected by endemic power cuts. The government has planned to expand national hydropower capacity by approximately 630 MW through a Build – Operate – Transfer (BOT) financing scheme. In addition to increasing the domestic electricity supply, this will allow the export of excess electricity to Burkina Faso, Mali and Ivory Coast. Ghana also plans to increase its thermal generating capacity. These projects, supported by the International Finance Corporation, will become feasible with the construction of the West African Gas Pipeline, which will deliver low priced natural gas from Nigeria and will allow the conversion of existing oil-fired facilities to natural gas. The present regulatory framework of the electricity sector in Ghana results from a reform in 1997 when the parliament enacted two laws which created the Public Utilities Regulatory Commission and the Energy Commission. The former is responsible for competition regulation and quality of service monitoring while the latter is in charge of technical standards and licensing of electricity utilities. There is no significant privatisation programme.

Ivory Coast

In Ivory Coast 73% of the country's annual electricity production in 2005 was generated by natural gas-fired power plants. Further expansion of natural gas-powered facilities is pending a satisfactory increase in domestic and regional electricity demand through the West African Power Pool (WAPP).

The capacity of hydropower plants in the Ivory Coast is also significant (about 27 % of the country's electricity production in 2005), although they no longer run at full capacity. The use of small scale fuel oil-fired power generators is also widespread throughout the country. The present institutions of the electricity sector have been in place since the restructuring of 1990 and 1998. The Compagnie Ivoirienne d'électricité (CIE) was created in 1990 and received from the government a 15 year concession for management and operation of the generation, transmission, distribution, retail and international trading of electricity; the ownership of the infrastructures remaining public. The reform of 1998 organised the public regulation of this private monopoly. The electricity supply of the Ivory Coast has been improved by the two restructurings with better performances compared with those of Nigeria and Ghana. However, deteriorating relations between the electricity institutions have raised concerns about the financing of the infrastructures' expansion. The concession was extended in 2005 for 15 years with new provisions, including regular monitoring of contract execution, creation of an infrastructures' development fund and the possibility of a revision of the contract every 5 years.

Senegal

Senegal has suffered in recent years from massive blackouts due to fuel shortages and low performances of its thermal power plants. Urgent measures have been undertaken, with the help of the international community, to return the national electricity system to normal operation. These measures include the shipment of fuel to Senegal's national power company, SENELEC, construction of fuel storage facilities and an examination of the possibility of building a new oil terminal in Senegal. However, the electricity crisis in Senegal continued in 2007. The government recently set up an ambitious investment programme in electricity generation that would add, by 2010, a 130 MW diesel plants and 125 MW coal fired power plant. According to December 2007 negotiations between the Senegalese Government and bilateral and multilateral financing agencies, the latter will fully participate in the funding of this programme only if institutional reform of the electricity sector is achieved. SENELEC, a state owned and vertically integrated utility, has a monopoly on electricity supply in Senegal. Two attempts in 1999 and 2001 to privatise this company resulted to failure and SENELEC is presently facing severe difficulties due to underinvestment in infrastructure, the increase of international oil prices and inappropriate electricity tariffs. In 2005, Senegal relied on oil fired power plants for 88% of its electricity consumption. The new investment programme will increase the dependence on oil even if the relative share will be more diversified with the introduction of coal.

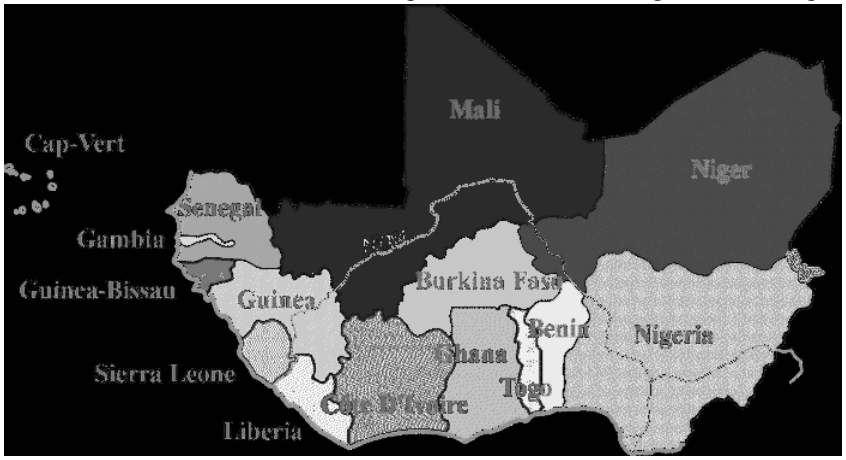

Figure 1
Countries of West Africa Sub-region
Source: Gnansounou et al., 2007

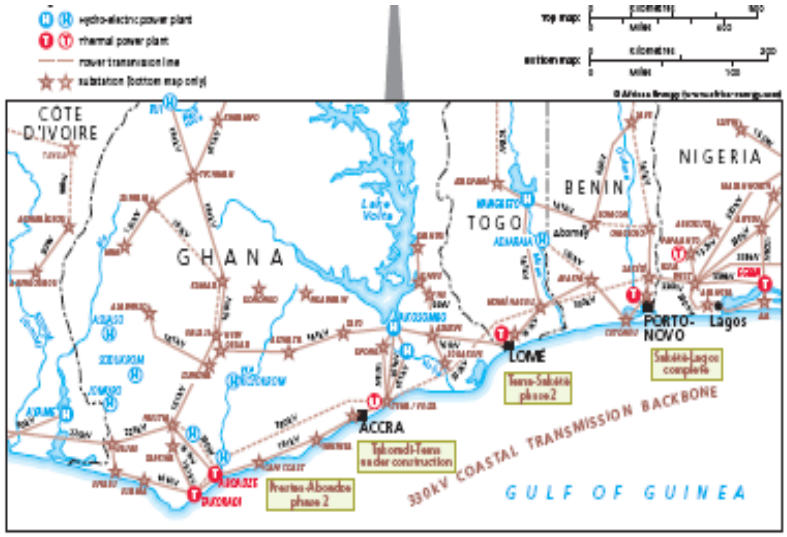

Figure 2
The Coastal Transmission Backbone (CTB) Along the Gulf of Guinea
Source: A E, 2007

Guinea

As a source of several major West African rivers (including the Gambia and Niger rivers) Guinea has a huge hydroelectric potential, estimated by EIA (2006) at 19400 GWh per year (technically feasible). Only ≈ 1% of this potential has been exploited. The major obstacle for construction of

large-scale hydropower facilities is the lack of financing capability and the reluctance of international organisations to be involved in projects with serious societal consequences such as displacement of 50000 inhabitants in the case of the 975 MW dam project in Souapiti Kaleta.

Other Countries

The electricity generation and distribution facilities in countries like Liberia and Sierra Leone were seriously damaged during recent military conflicts and construction has been disrupted. They are still seeking opportunities to rebuild their infrastructures with the help of the international community. Other countries of Western Africa are either without coastal access, such as Mali, Burkina Faso and Niger, which do not possess important energy resources and are likely to be dependent on electricity imports; and small countries of the coastal region (Benin, Togo) which already have established an integration of their bulk electric energy supply that can serve as a predecessor to an integrated regional approach.

The Ongoing West Africa Power Pool (WAPP)

The WAPP project was launched in October 2000 with the aim of enhancing development of the electricity generation and transmission infrastructure in the Economic Community of West African States (ECOWAS)[1], and to facilitate a well-functioning, cooperative and power pooling mechanism. An investment programme was set up with the World Bank (as financial leader), other international cooperation partners and financial institutions. This 20-year programme was divided into four phases. The first one, the completion of which was set for 2006, concerned the design of the interconnection regulation within and between zone A (Benin, Burkina Faso, Ivory Coast, Ghana, Nigeria and Togo) and zone B (Cape Verde, the Gambia, Guinea, Guinea Bissau, Liberia, Mali, Senegal and Sierra Leone). The second phase (2007-2012) involved completion of the interconnection within zone A and development of institutions for the management of international electricity trading. Phases three and four (2012-2023) were viewed as full and improved operational periods. The positive results of the WAPP include: the existence of a shared concept between the ECOWAS country members and their traditional international financial partners; and the achievement of an important programme of interconnection.

The successful progress of the Costal transmission backbone (see Figure 2) is a key factor for the interconnection of the zone A.Without this interconnection, the actual electricity exchanges between the countries of zone A will be severely restricted. However, the capacity of the designed transmission lines will not be sufficient to boost electricity supply in that zone which is facing a major barrier of underinvestment in generation. The design of the WAPP project does not fully cope with the challenge of attracting private investment into the region's electricity generation sector, even though the interconnection will create the necessary favourable conditions. The WAPP appears, in its concept as well as in its deployment, as mainly a loose pool oriented towards electric power import/export among the countries. As an example, in the Coastal Transmission Backbone (CTB) project, the import and export countries are labelled taking only into account the availability of local primary energy and the infrastructures are designed accordingly (see Table 2).

Maximum Transfer Capability (MW) for 330 kV operation

Exporting System	Existing 2003	Target 2011	Importing System
Ivory Coast	200	200	Ghana
Ghana	120	700	Benin/Togo
Ghana		500	Nigeria
Nigeria		650	Benin/Togo
Nigeria		450	Ghana

Table 2
Electricity Transfer Capability of the CTB

Source: http://web.worldbank.org/external/pro-

This design precludes a possible export from Benin/Togo to Nigeria which is less likely within a conventional cooperative concept but highly possible in the case of the proposed integrative concept.

Proposed Integrative Regional Electricity Market (IREM)

Description of the Proposed Concept

In the Integrative Regional electricity market (IREM) it is assumed that the restructuring of the regional electricity sector, instead of following the historical steps (from cooperation among countries to regional integration) jumps to the integrative model addressing the region as a whole. This leap can be justified first by the lessons learned from the present situation in industrialised countries where the interconnection previously designed with a cooperative vision is becoming a major barrier for optimising transactions in an open and competitive environment. Second, in the case of the availability of natural gas, as it is being experienced in West Africa, the location of the generation will mostly depend on the risk perception of the investors. Third, while integration is the ultimate goal of the process, going through a long process based on cooperative systems will be more costly than adopting an integrative approach from the begin-

	Cooperative Strategy		Integrative Strategy			
	Total Costs	**Levelised Electricity Cost**	**Total Costs**	**Absolute Levelised Electricity Cost**	**Relative Benefit of Integration Strategy**	**Reduction of Electricity Cost**
	Mil US $	*Cents/kWh*	*Mil US $*	*Cents/KWh*	*Mil US $*	*%*
Benin	522	6.1	513	6.0	9	1.6
Burkina Faso	506	7.2	436	6.2	70	13.9
The Gambia	280	14.1	152	6.9	128	51.1
Guinea Bissau	170	12.4	83	5.4	87	56.5
Liberia	987	7.4	788	6.4	199	13.5
Mali	720	5.0	273	2.0	447	60.0
Niger	622	9.7	253	2.9	369	70.1
Senegal	3393	10.6	2375	5.9	1018	44.3
Sierra Leone	92	5.4	39	1.9	53	64.8
Togo	961	7.5	800	6.1	161	18.7
Ivory Coast	4637	5.9	3503	3.1	1134	47.5
Ghana	4763	4.0	3634	2.5	1129	37.5
Guinea	8563	10.6	4829	3.3	3734	68.9
Nigeria	23627	6.6	13766	2.7	9861	59.1

Table 3
Economic Comparison of "Cooperative" vs "Integrative" Strategies (2010-2030)

Source (Gnansounou et al., 2007)

ning. A previous study (Gnansounou et al., 2007) compared the two West African strategies and concluded that the integrative strategy results in an electricity cost reduction for all country members of ECOWAS. In that study, a similar assumption was made as for WAPP on import and export countries.

In the IREM concept the regional electricity sector will follow a three-phase model as is outlined in Figure 3. The first phase will be devoted to retrofitting and improvement of management of the existing electricity companies, completion of the regional interconnection and acceleration of rural electrification within each country. This phase should be completed in 2012. Then the addition of new power generation units will be ensured preferably by new producers such as IPPs in order to increase competition.

The second phase during 2012-2017 will be characterized by the separation of production and transmission activities and the opening of the electricity market to competition at the wholesale market level. The assumed model during this second phase is "single buyer model". The activities of the national transmission companies will be limited to purchasing, transmitting and selling electricity to the distribution companies and to big consumers which in turn will be responsible for distribution as well as for retail. The concept is neutral concerning the ownership of infrastructures (public, private or mixed) because what is important is the management capability of the companies and especially their competitiveness at the regional level.

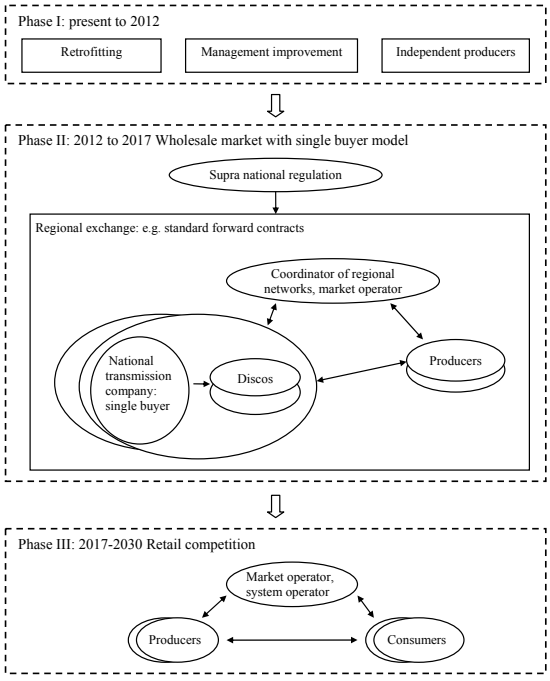

Figure 3
Three-phase Restructuring of Electricity Sector in the IREM

The electricity market will be structured around a regional power exchange offering standardized contracts as well as facilities for setting up forward contracts. The objective is to create a sufficiently large and transparent regional market in order to attract the private investment in electricity generation. A coordinator of the regional interconnected network will be established and will serve as market operator as well. National regulation commissions will supervise, on the one hand, the security of supply at the national level, and on the other hand, a fair transfer of the gain in productivity over the electricity selling prices to the consumers. Lastly, a regulation commission at a supra-national level will take charge of the efficient operation of the regional market and in particular insure the absence of collusion between the market operator, the producers and the national single buyers, especially in the case of the standardized market.

The third phase of the restructuring during 2017-2030 will be the market opening to retail competition. After this phase, all the consumers of the productive sectors will be able to purchase electricity directly at the regional market without having to pass through an intermediary, i.e., as is the case in the second phase with the manager of the national transmission grid.

Advantages of the Proposed Concept

The advantages of the IREM concept are as follows: private investors in electricity generation will address the whole market in investing where their perception of country-risk is more favorable; competition between generators will hasten the retirement of obsolete power plants and their replacement by more efficient plants; fast interconnection between the systems will reduce the quantity risk and irreversibility which characterize investments made on national basis; the sharing of the risk will be more favorable to consumers, contrary to the present power purchase agreements linked to BOO or BOT concessions; eventually a clear and complete concept, strengthened by a readable, even progressive implementation, will make investors more comfortable and confident in a stable and faith worthy restructuring process.

Conclusion

In spite of its present poverty, West Africa has a brilliant economic future. Nigeria on its own can be the driven-country of the whole ECOWAS. This populated country (50% of the region's population) is also potentially the richest with its high resources of natural gas and oil. Presently Nigeria is viewed as risky due to the turmoil in part of the country, a bad reputation of corruption and other governance malfunctioning. Despite the efforts of the public authorities to solve internal problems and to improve the international image of this big country, the positive results may be a long time coming if its neighbours do not share a regional strategic view with it. Through the West African Gas Pipeline Project, Nigeria will provide its natural gas to Benin, Togo and Ghana at an inexpensive price compared to the international market. This will create an opportunity to generate electricity at low cost not only for these countries but for the whole zone A, including Nigeria itself. Such a new concept will necessitate reinforcing the pipeline capacity in the coming years. With the perspective of the long-term depletion of oil and gas, West Africa can become attractive for those industries such as petrochemicals which need these raw materials. It will create the opportunity to develop the economy of West Africa based on value added products instead of reliance on raw material exports to industrialised countries. This perspective also addresses the issue of the optimal use of natural gas and the need to introduce other more sustainable energy sources. Such an industrialisation perspective, if based on credible and shared commitment, will enhance the economic value of the whole region and increase the willingness of investors to be involved in the development of the electricity infrastructures of the region. The integrative concept proposed in this paper, departing from the conventional approach by its ambition to accelerate regional integration, is in accord with the WAPP and the WAGP projects. Furthermore, by signing the energy protocol, all the ECOWAS country members agree *that open and non-discriminatory access to power generation and transmission encourages investment in generation and distribution facilities, and thereby increases competition in such subsectors of the power industry, in turn leading to reduced cost for power* (ECOWAS, 2003). Although the proposed IREM concept is in accord with that protocol, it will require a strong but necessary voluntarism and political commitment to be shared by all the West African countries.

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The Economic Community of West African States (ECOWAS) comprises the following countries: Benin, Burkina Faso, Cap-Vert, Ivory Coast, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. The research of Purdue University did not consider Cap-Vert but took into account Mauritania, previous member of ECOWAS.