

**Policy Challenges  
in the West Africa Electricity Project**

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### **Abstract**

Fourteen countries of the Economic Community of West African States (ECOWAS) have embarked on a seminal undertaking in their long-standing quest for regional integration, the creation of the West Africa Power Pool to permit electricity-trading among members. Key decisions must soon be taken regarding fundamental methodological issues such as the structure of the pool, pricing policies, national autonomy requirements for both generation and reserves, and data reporting requirements. Issues specific to West Africa include identification of the hourly demand function for each country, the effects of seasonality on hydroelectric power availability, and ensuring sufficient integration with the operating systems of the regional gas pipeline. Current efforts to model West Africa's electricity sector can show the region's actors that the benefits from increased electricity trade, power pooling, and collective regional approaches to new generation and transmission projects amount to billions of dollars in savings over many years.

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The 14 countries of ECOWAS are now engaged in the design of a power pool for trading electricity among themselves, hoping it will catalyze their efforts at regional integration and economic development.<sup>1</sup> Beginning with the signing of the agreement by the ECOWAS Energy Ministers in Ghana in November 1999, progress on the West African Power Pool (WAPP) through mid-2000 has involved preparations for arriving at implementing agreements to govern the structure and functioning of the power pool. The potential exists for these countries to agree soon on short-run and long-run trading arrangements in both energy and reserves which give great latitude for market forces to operate.

Building on the success of four years of collaboration with the Southern African Power Pool (SAPP), a team of engineers and economists from the State Utility Forecasting Group of Purdue University in Indiana and the Cambridge, Massachusetts-based consulting firm Associates for International Resources and Development (AIRD) has been providing technical assistance to the ECOWAS Secretariat and the WAPP since its inception. Financed by USAID under the African Trade and Investment Program (ATRIP) through the Equity and Growth through Economic Research (EAGER) cooperative agreement, the project has been playing an important role in clarifying the steps that the region's ministries and utilities must take in order to create an effective power pool to provide reliable electricity. A range of analytic and training tools is being placed at the disposal of the ECOWAS Secretariat and the ministries and utilities of the ECOWAS member states, including lessons learned from the relevant experiences in North America and southern Africa. The Purdue team is also engaged in building the first electricity-trading model ever in existence for the countries of West Africa.

In the task of considering the type of power pool to set up, an outside donor such as USAID can play a critical role in bringing together regional utility and ministry officials for training and conceptual development. Further, in an era of limited resources being devoted to development assistance, USAID has placed priority on building the capabilities of regional organizations, achieving economies of scale by reaching targeted sectoral audiences across a broader geographic area, such as through this work on electricity.

### **Factors Shaping Regional Integration in Electricity**

*Many governments throughout the OECD and the world are in the midst of substantial change in the regulation and structure of the electricity supply industry. They are introducing competition to their electricity-supply systems in search of greater economic efficiency. The goal of these changes is to reduce electricity prices to consumers by reducing the costs of inputs to electricity generation and supply.*

International Energy Agency (1999), *Electric Power Technology*

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<sup>1</sup> The 14 ECOWAS members are Benin, Burkina Faso, Côte d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. Mauritania recently decided to leave ECOWAS.

Regional cooperation on electricity in West Africa is broadly in line with the above-noted trend towards increasing the role of competition in electricity supply around the world. As a critical component of any country's economic infrastructure, electricity is often one of the last sectors to be exposed to competition, with substantial government involvement in investment and regulation. Assuring the functioning of the electricity sector even enters into the realm of national security considerations, so a regional engagement to trade electricity and reserves requires a high level of confidence in one's neighbors.

In West Africa, the conditions for successful cooperation on electricity are increasingly in place. Ten of the ECOWAS countries are members of the West African Economic and Monetary Union (WAEMU), finalizing a customs union free of official tariff barriers. With a single currency in the WAEMU countries, and the plans for the Second Monetary Zone among most of the other members of ECOWAS, much of the infrastructure for developing integrated regional markets is already in existence. More efficient electricity markets could underpin these initiatives and provide operational efficiencies to all economic sectors.

Furthermore, there is an urgent need for more reliable electricity in West Africa. In fact, the Barriers to Business Expansion project, under the Promoting and Sustaining Growth with Equity component of EAGER, found that lack of reliable electricity supply was the most frequently-cited constraint on business expansion.<sup>2</sup> The frequent power interruptions, outages and power surges pose numerous problems for West African businesses, particularly small and medium-sized enterprises. For example, sharp fluctuations in voltage current can permanently damage a firm's capital equipment, whether machine tools, refrigeration, or a computer. In dialogue with the World Bank and IMF, West African countries are being urged to undertake fundamental reforms of their electrical utilities, through steps such as privatization or opening up to competition. In this vein, the state-run Electricité de Mali is in the course of being privatised, with the government selling 60 percent of the utility.

Electricity could potentially represent *the* key sector around which regional economic integration can occur, much as the European countries formed around coal and steel in the early 1950s. One of the compelling reasons for cooperation is that efforts to achieve national self-sufficiency in electricity have been uneconomical due to the high cost of generation and transmission. Through participation in a power pool, ECOWAS countries can benefit from reducing the overall costs of electricity supply, even if it entails recognizing a neighbor's relative comparative advantage and buying part of the national needs from that neighbor under secure long-term trading conditions. Inter-utility cooperation on planning and investment could yield important improvements in the

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<sup>2</sup> Beltchika-St. Juste, N.; M. Thiam; J. D. Stryker; and P. I. Sow. (March 2000) "Barrières à l'Expansion des Affaires dans un Nouvel Environnement: Le Cas du Sénégal." Final research report prepared for the Equity and Growth through Economic Research/Trade Regimes and Growth cooperative agreement, USAID/Africa Bureau. Cambridge, MA: Associates for International Resources and Development.

reliability and competitiveness of the electricity sector for the sub-region as a whole. The role of the ministries is to minimize roadblocks facing inter-utility cooperation and to optimize the catalytic effects of electricity-trading on economic development and poverty reduction.

Reinforcing the movement towards a West Africa-wide electricity grid is the USAID-supported project to develop a gas pipeline from Nigeria across a half-dozen countries to the west. The gas pipeline activity, led by private sector investors but with significant involvement by national authorities of Nigeria, Benin, Togo, and Ghana, is the most immediate source of surplus energy for the region. The gas pipeline arrangement, currently set up for daily purchasing agreements, can play an important part in smoothing out the sharpest fluctuations in available electricity. Spreading the beneficial effects of the gas pipeline initiative beyond those countries in the Nigeria to Ghana corridor will require successful elaboration of an electricity power pool.

## **Key Methodological Questions**

### **Generation**

To date, electricity generation has been seen in West Africa more as a technical engineering question than an economic question. Increasingly, though, the costs of electricity generation will be evaluated against the price of buying electricity from neighboring countries. Security of supply, never very well-assured in the sub-region, should become more reliable with effective rules in place for electricity trading.

In most developed countries, power generation accounts for over 60 percent of the total cost of delivering electricity to end-users. In West Africa, that figure can be expected to be lower, due to the relatively inefficient transmission systems and high line losses. Furthermore, the unauthorized taking of electricity by individuals or businesses also serves to lower the relative weight of generation in total delivery cost. Losses incurred by state-owned utilities were simply covered from general budget receipts.

With the current trend toward privatization and competition, the actual costs of generation will come under increasing scrutiny, which should contribute to a reduction in unit operating costs as managers seek to improve performance. As new methods for financing construction or expansion of generation facilities inevitably develop, international investors will demand greater transparency in cost structures. Competition provides the surest method for upgrading the existing technology stock.

One of the key conceptual issues related to generation is the matching of plant size to expected load growth. The West African countries can improve the efficiency of operation through better understanding of their peak load versus base load requirements, and, ultimately, through recognition that a mix of peaking, load following, and base load plants (and possibly pumped storage) will be required to meet the daily, weekly, and seasonal fluctuations in electricity demand at least cost.

The advent of the gas pipeline promises to bring important changes to electricity generation in West Africa, meeting many of the criteria of *appropriate technology*. For instance, around the world, gas turbines have had the highest growth rate of any generation technology in the past decade as they are flexible, modular, and can be rapidly installed (IEA, 1999). Further, the economies of scale for gas turbines are obtained at lower unit capacities, which could certainly be helpful in matching plant size to expected load growth.

## **Transmission**

Electricity is for the most part a non-storable asset, except for some recent developments in small-scale storage. It can be moved, in the absence of significant line losses in the transmission grid, at relatively low cost. Therefore, trading electricity with other countries broadens the potential market of consumers available to utilities.

The grid for transmitting electricity in West Africa suffers from insufficient capacity, limited geographic coverage, a poor record of repair and maintenance, and unauthorized takings. The emphasis in most countries has been to build transmission lines to supply the major urban population centers. Little attention has been given to international transmission lines, which would, in effect, be directed towards the neighboring country's industrial or residential areas.

Transmission is the weakest link in the chain at the present time. In most OECD countries, transmission typically accounts for between 5 and 10 percent of total delivery costs, but that figure could be several-fold higher in West Africa. The carrying capacity of international transmission lines likely only amounts to about 50 MW. Gains must be realized through investment in more efficient control components, such as improved conductors and power conditioning equipment, as well as expanding the network of transmission-line towers to reach broader segments of the population.

Transmission systems usually are regulated as monopolies around the world, but competition can be introduced through providing access to the national grids for rival electricity suppliers. Once again, opening to competition tends to boost investment in modern technology for the infrastructure of the grid. West African transmission systems for electricity should reap benefits from the rapid growth in demand for telecommunication services, even though fixed line telephony has been lagging behind wireless telecommunications in the sub-region in recent years.

Finding the appropriate price for *wheeling*, or transmitting electricity from one country to another through the national grid of yet a third country, is going to be critical for the economic planning and infrastructure investment for small countries such as Benin and Togo, and the pivot countries for expansion to the north and west, Ghana and Ivory Coast. Region-wide agreements on rational wheeling charges can help prevent the unnecessary transmission of electricity any further distance than necessary, for example, to avoid high tariffs in country X. Countries in position to act as wheelers should seek fair returns for permitting the transmission of electricity across their grid, but must not

price the wheeling services so high that the delivered electricity becomes uneconomical for the end-purchaser

## **Pricing**

Pricing structures for regulated monopolies in developed countries are subject to an involved process of consultation with government and consumer interest groups. Typically, electricity prices are set using regulatory formulas taking into account the value of assets, fuel costs, and other expenses related to generation, transmission or distribution. In most cases, the public interest is served by guaranteeing a small profit to the regulated utility, which can go into the national coffers or be used for investment in the system.

In West Africa, the procedures for setting electricity prices are far from optimal for the efficient functioning and growth of the system. Often, political considerations result in prices being set below the actual costs of production. Such a tactic, intended to boost consumer demand, can in fact backfire, since utilities have little incentive to expand output and lose more money, when marginal return is below marginal cost.

Pricing policies are key to the rational development of the West African electricity grid. One of the particularities about trading within an integrated grid is the array of tariff jurisdictions one must cross in order to send electricity within West Africa. The ECOWAS countries must avoid the temptation to use electricity pricing as a tool of industrial competitiveness, e.g., under-pricing electricity in the hope of attracting more investment than your neighbor. A regional approach to price determination, such as harmonization of tariffs for different categories of end-users, can help in achieving reliable sources of electricity at competitive prices.

The interests of consumers, whether industrial users, small businesses, or households, tend to lie in stable electricity prices. In developed countries, a major preoccupation of consumer groups is the avoidance of high electricity prices during periods of peak demand, which can often result in enormous unexpected bills.

The gas pipeline will introduce an element of price stability into the electricity sectors of the ECOWAS countries. As a fixed line governed under long-term contracts, the gas pipeline will be relatively insulated from fluctuations in world prices for natural gas or other combustibles. Decisions regarding the price of the gas provided through the gas pipeline will strongly affect the relative competitiveness of all electricity generation in the region. Low natural gas prices will promote the construction along the route of the pipeline of combined cycle plants (now being built extensively across the USA), while high natural gas prices will still make new hydro schemes a viable option for new generation capacity.

The strong seasonality of electricity supply in evidence in West Africa leads to sharp spikes in the costs of production during the dry season. With better monitoring techniques for hydroelectric power availability, the needs for spot purchasing of

electricity, from combined cycle plants supplied by the gas pipeline, could become more predictable, lowering the risk premium hindering more efficient pricing at the present time.

### **Structure of the Power Pool**

At the present time, the ECOWAS members are involved in establishing the mechanisms for intergovernmental cooperation through elaboration of protocols and legal frameworks. Plans for the West Africa Power Pool feature an inter-utility management committee, a dispatch control or coordinating center for overseeing cross-border trading, a technical committee, a planning committee, and a tariffs committee. There may be tangible benefits to structuring the WAPP in a parallel fashion to the gas pipeline. The main gas pipeline management committee includes two representatives from each country's utilities and one representative from each of the national energy ministries. The gas pipeline also has subcommittees on finance, fiscal, legal, and environmental issues, which is involving a wide range of national officials (customs, attorneys-general, etc.) in cross-border energy issues, often for the first time.

In the near future, the ECOWAS members must consider *what kind of power pool* they wish to have. A *tight* power pool is characterized by unrestricted free trade among the members. As a tight pool serves to minimize the costs and maximize the benefits from centralized planning, a tight pool is preferable for accelerating investment, economic growth and poverty reduction. In a *loose* pool structure, countries largely operate on an independent basis except for some long-term fixed bilateral trade agreements. But in a loose pool, the bulk of the potential benefits from electricity cooperation are not realized. Participating in a loose pool structure offers members some operational advantages, such a surer supply of emergency power, but the economic gains are minimal. The investment environment is most attractive with a tight pooling structure, as market demand determines the efficient levels of electricity trade. Loose pooling will only result in increased trade between pairs of national governments, rather than a truly cost-effective, WAPP-wide electricity market such as is possible through a coordinating center tasked with determining optimal levels of trade.

The tools of cooperation for the power pool members could potentially include mechanisms for cost-sharing, common rules governing the regulatory and fiscal environment, and even guidelines on tax policies for attracting investment. As the power pool develops, the structure of the pool will affect financial sector issues such as the design of national or regional financing mechanisms for use as a means of pooling risk for investors.

Experience with the Southern Africa Power Pool (SAPP) suggests the appropriate strategy should be to pursue simultaneous top-down and bottom-up approaches, wherein the institutional development and formal integration proceeds concurrently with technical-level capacity building and informal cooperation. For it is in moving beyond the intergovernmental cooperation towards achieving inter-utility cooperation on planning and investment which will yield important efficiencies in generation and transmission for the sub-region as a whole. One useful feature of the gas pipeline that the power pool may consider instituting is an inter-utility project development committee.

## **Demand Estimation**

West Africa is without a doubt a “demand deficit” region. Whereas in better developed systems, demand for electricity can rise or fall in part due to the price to the end-user, West Africa has not yet reached the minimum supply threshold for such basic economic laws to operate.

For the purposes of long-term planning and investment, where the real benefits of inter-utility cooperation lie, it will be necessary to quantify potential demand in the 14 countries of the region. Yet at the present time, it is impossible to know what *potential* demand is when *existing* demand is unknown. Efforts are underway, including some financed by USAID, to better understand the electricity demand growth functions for each ECOWAS country. The variable nature of electricity demand by hour of the day and season of the year leads to a variable cost profile for electricity generation and transmission. Utilities understandably place a premium on being prepared for peak load demand, when electricity is most costly and potentially most profitable.

Much like the situation for aggregate demand, the debate over the trade-offs between meeting urban versus rural demand for electricity is still in the initial phases in West Africa. In general, the ECOWAS countries have focused on satisfying, as much as possible, the demand of urban consumers and industries. Rural electrification, with its strongly positive effects on poverty reduction, is widely held as a goal in West Africa, but the limited reach of the national electricity grids suggests limited progress to date. At the present time, rural demand remains much more of an issue at the *national* level, rather than an issue critical to *regional* cooperation on power-sharing. Yet once again, inter-utility cooperation, such as sharing experience on appropriate techniques for rural electrification, may be a way to improve national capacity for meeting rural demand.

## **Seasonality**

Hydroelectric power represents the most abundant potential energy resource found in most of the ECOWAS countries, representing slightly less than one-half of the electricity generated in the sub-region. The major rivers, in particular the Niger and the Volta, have become multi-purpose resources, being exploited for electricity generation, agricultural irrigation, and other river-based industries. Yet hydroelectric power alone cannot provide sufficient security of supply for electricity in West Africa, in part due to the sharp seasonal variations in water supply. In the sub-region, the dry season in the second quarter of the calendar year brings an increased frequency of power outages and overall unpredictability. The thorny paradox at work is that electricity demand is usually highest during the dry season, due to the increased use of air conditioning units.

As it is difficult to control the supply of the natural resource, water, gains in output must come from building or expanding new installations or from improving the efficiency of hydroelectric power generation and transmission. One partial remedy may be an increase

in pump storage, whereby during periods of low demand, such as at night when electricity generation is least expensive, water is transported back into the reservoir for re-use during peak daytime periods when electricity generation is more profitable.

As each of the ECOWAS countries experiences the dry season at a slightly different period during the year, at the margins of the seasons there could be significant gains in reliability and price from cross-border trade in electricity. But even more important may be the development at the regional level of techniques for forecasting load demand, so as to better husband the limited water available. A natural complement to the development of the power pool would be strengthened regional linkages for the national meteorological and hydraulic resource services.

The increased supply of natural gas through the gas pipeline, which is not subject to seasonality, will eventually be very beneficial in reducing the sharp seasonal fluctuations in electricity derived from hydro plants. But as of yet, the planning process for the gas pipeline has not fully digested the implications of seasonality. For example, the initial contracts under the gas pipeline specify a daily quantity of natural gas to be bought. Once again, adequate demand estimation should help rationalize the situation.

### **Country Autonomy and Reserve Requirements**

National autonomy in electricity supply has been a development goal of nearly every African country, although it may be unrealistic or unwise in practice. Self-sufficiency in electricity may result in the construction, or maintenance in operation, of power plants that are relatively less efficient than those in neighboring countries. Combined with pricing of tariffs below the costs of generation, transmission and distribution, such high-cost production can result in operating losses for utilities.

Factors related to political considerations or economic and military security may require in some countries that domestic electricity production be maintained at some prescribed fraction of domestic demand. In essence, policy makers are wary of being too dependent on their neighbors, fearing loss of autonomy over electricity supply could result in short-term crises while waiting for long-term investments in generation capacity to come on line.

While there is no easy solution for overcoming the fears that lead to imposition of national autonomy requirements, the process of regional integration already underway in West Africa offers encouragement for this to be less debilitating of an issue than elsewhere. The first step is to recognize that self-sufficiency (meeting 100 percent of national needs from own production) is not always desirable. From there, finding an appropriate or comfortable level of autonomy (most simply expressed as installed capacity as a percentage of demand), whether 80 percent or a higher or lower figure, becomes much easier. One of the best ways to boost confidence in the *security of supply* is to promote transparency in the regulatory and policy environment both in the national electricity sector and in that of the trading partners.

Reserve requirements are an integral part of any country's electricity sector, above all to maintain system reliability during peak demand. For a country without the possibility of trading electricity, the utilities must ensure that installed generation capacity always exceeds yearly peak demand, plus a reserve margin. This can result in excess capacity being a high multiple of the reserve margin outside the periods of peak demand. For countries with the possibility of trading electricity, such as in West Africa, such a wasteful situation can be avoided through trading in electricity, as imported electricity can cover the reserve margin. U.S. utilities routinely enter the electricity trading market to purchase firm power in order to satisfy their reserve requirements. In a power pool, members can agree to permit utilities to count on drawing upon a neighbor's reserve capacity in order to meet reserve margin requirements. Usually such an arrangement requires binding written commitments whereby the surplus provider guarantees that the reserve capacity is available upon demand. Periodically testing such a commitment, through unannounced purchases, would be one way to boost confidence in the system.

Beyond overcoming the question of reliance upon a foreign source, the countries of West Africa must seek ways of overcoming the natural reluctance of national utilities to give up their monopoly power in favor of a more reliable and cheaper regional electricity system. Entrenched interests may be difficult to convince that electricity trading for the greater public good is more beneficial than maintaining the status quo, for their own personal good. This points out the need for developing rules to equitably share the gains from trade, arising from the substitution of cheap imported power, with those economic actors directly harmed by the imports.

### **Data Reporting Requirements**

In order to promote the orderly development of a power pool, it may be advisable for the members to agree on a common set of data reporting requirements. Deciding on which statistical series to include, as well as the periodicity, would in and of itself be a useful exercise in inter-utility cooperation. There would likely even be some differences discovered in the definitions of certain variables. Those utilities and ministries unable to provide the common set of data would thus be identified as priorities for technical assistance to build said capacity.

A system for common data reporting would contribute to development of a region-wide market for electricity, in particular if all pool members had equal access to the information. Officials from one country would gain familiarity with the technical parameters specific to the neighbor's electricity sector, helping build the confidence needed to trust the neighbor on such a sensitive topic as providing capacity to meet reserve margins across borders. The power pool members would soon see the need for a regional body tasked with collecting, analyzing and disseminating the data in an impartial, objective manner. Modern communications technology, in particular the Internet, permits the rapid transmission of data for these types of purposes, given suitable protocols for data protection.

A full and up-to-date database of supply and demand parameters for each of the power pool members would provide much of the market information needed for spot trading in electricity

and reserves. The effect of changes in the cost of such important inputs as natural gas or water could be more quickly anticipated by all within the region, implying a greater responsiveness to market signals.

Perhaps more than anything, establishing common data reporting requirements would be a positive step in favor of *transparency*, historically a rare commodity in West Africa but absolutely vital to regional integration. Such a step would be particularly interesting to investors, as it would demonstrate the professionalism and irreversibility of the power pool.

## **Environmental Impacts**

As elsewhere in the world, the countries of West Africa are increasingly incorporating environmental protection into their economic planning and sectoral investment decisions. The valuation of environmental assets, i.e. how much is clean air or clean water worth in monetary terms, is one of the most difficult aspects of this task, since the economic and health consequences of pollution are often long-term phenomena. Furthermore, those most closely affected by environmental degradation tend to be the poorest segments of the population living in marginal areas. In West Africa, prolonged underdevelopment has led to an erosion of environmental quality as urban areas have grown in unplanned fashion, so local populations live in unsafe sanitary conditions often much worse than in traditional rural communities.

In the energy sector, safeguarding environmental quality starts with the investment planning phase. Foreign investors such as Chevron or Enron must conduct *due diligence* in order to obtain international financing for projects, as the potential for future lawsuits could pose enormous financial liabilities. Adequate assessment of the environmental consequences of a project thus form an integral part of its feasibility. Public support for a project can also be swayed by the perception of environmental risk. There has been some recent publicity, in Ghana for example, surrounding the potential dangers posed by the West Africa gas pipeline, although public support for the project remains very strong.

Project implementation, the building of the generation plants and transmission lines, tends to be when there exists the greatest danger of environmental hazard. The erection of dams for hydroelectric plants can have important effects on the environmental quality and sustainability of livelihoods of local communities. Selecting the paths for major transmission lines can affect economic development and fragile ecosystems along great distances.

Steps to safeguard environmental protection can in fact result in a *technology bias*, under which environmental regulations afford a particular technology a statutory preference. Environmental protection technology can account for a significant share of generation costs, although this is less important in West Africa, where there is so little reliance on coal-fired generating plants. Retrofitting is often much more costly than successfully foreseeing the environmental protection needs in advance and building those constraints and technologies into the initial project.

## The Purdue Modeling Framework

One of the tools available to the West African policy makers and technicians developing the WAPP is the long-term modeling framework developed by the State Utility Forecasting Group of Purdue University. Purdue's experience in modeling the likely cross-jurisdictional electricity flow consequences of electricity deregulation in the United States provided the basis for Purdue's now 4-year-old technical assistance effort to help in the development of the SAPP and now the WAPP.

The initial steps for developing the West Africa version of the model involved a review of the (limited) existing literature on the region's electricity sector. In March 2000, the Purdue team contracted with three West African consultants, nominated by the ECOWAS Secretariat, for the collection of technical operating parameters for electricity generation and transmission in all 14 ECOWAS member countries. This data collection effort, nearly completed by June 2000, represents an important step towards better understanding of the relative costs of generation and transmission across the sub-region. The fact that local engineers are already directly involved in the creation of the data base and modeling exercise augurs well for local "ownership" and incorporation of the model into the WAPP policy process. The intention is to eventually find a suitable home for the model in West Africa, most likely within a regional organization.

The types of scenarios that can be estimated by the model and presented in easy-to-understand map form include, for example: a doubling (or halving) of natural gas prices; changes in the thermal outage rates, particularly important for key countries such as Nigeria; the effect of a major drought period on electricity supply in the region. In most cases, the four most important variables used by the model for predicting and rationalizing the region's electricity trade are the marginal costs of exporters, the avoided costs of importers, the costs of new transmission lines, and estimates of the growth in hourly electricity demand over the planning horizon. Experience from the SAPP is that the model's *sensitivity analysis of capital costs*, based on capital recovery factors such as interest rates, can assist utilities in the process of finding acceptable levels of costs for new construction.

Unofficial preliminary results for the initial 7-country model (comprising Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali, Nigeria, and Togo), assuming 4-percent annual demand growth, suggest the potential need for a six-fold increase in international transmission capacity between the years 2000 and 2020. Further, the benefits from increased electricity trade, power pooling, and collective regional approaches to new generation and transmission projects amount to billions of dollars in savings over many years. The results of this initial modeling work are expected to be available in September 2000, when the Purdue/AIRD team will organize a training workshop on power pool concepts and policy challenges for the WAPP members at the ECOWAS center in Lomé, Togo. Results for the 14-country model will be developed at a later date.

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