



Economic Commission for Africa

# **Assessment of Power-pooling Arrangements in Africa**

Sustainable Development Division (SDD)





Economic Commission for Africa

Assessment of  
Power Pooling  
Arrangement in Africa

October 2004  
Sustainable Development Division (SDD)

For this and other publications, please visit the ECA web site at the following address:

<http://www.uneca.org>

Or contact

Publications

Economic Commission for Africa

P.O.Box 3001

Addis Ababa, Ethiopia

Tel.:251-1-44 31 68

Fax:251-1-51 03 65

E-mail:[ecainfo@uneca.org](mailto:ecainfo@uneca.org)

Material in this publication may be freely quoted or reprinted. Acknowledgment is requested, together with a copy of the publication.

# CONTENTS

ACKNOWLEDGEMENTS	iv
ACRONYMS	v
ABSTRACT	vii
EXECUTIVE SUMMARY	ix
INTRODUCTION	1
1. DEVELOPMENT AND OPERATION OF SELECTED POWER POOLS	5
1.1 Electricity Pool of England and Wales	5
1.2. US Power Pools	9
1.3 Nord Pool – The Nordic Power Exchange	14
1.4 Lessons learned from existing power-pooling arrangements	20
2. RATIONALE FOR POWER POOLING AND CROSS-BORDER ELECTRICITY EXCHANGE	21
2.1 Power pooling concept	21
2.2 Power pooling objectives	24
2.3 Potential benefits of power-pooling arrangements	25
2.4 Types of power-pooling arrangements	27
3. Electricity Exchange under Bilateral agreements in Africa	29
3.1 Historical background	29
3.2 Selected bilateral electricity exchange agreements	30
3.4 Bilateral agreement between Ghana and Togo-Benin	32
3.5 Bilateral agreements between Ghana and Côte d’Ivoire	32
3.6 Bilateral agreement between Côte d’Ivoire and Togo-Benin	33
3.7 Bilateral agreement between Côte d’Ivoire and Burkina Faso	34
3.8 Electricity exchange arrangement between DRC and Congo	34
3.9 Inter-utility bilateral electricity trading agreements in Southern Africa	35
3.10 Lessons learned from electricity exchange under bilateral agreements	36

4. THE SOUTHERN AFRICAN POWER POOL: A MODEL OF POWER POOLING	39
4.1 Historical background	39
4.2 Creation of SAPP	39
4.3 SAPP Governance Issue	40
4.4 Objectives and Roles of SAPP	41
4.5 Objectives of SAPP	41
4.6 Role of SAPP	41
4.7 The SAPP Coordination Centre	41
4.8 The SAPP Pooling Arrangements	43
4.9 Market Operations within SAPP	43
4.10 Electricity trading under bilateral agreements	43
4.11 The Short-term Energy Market (STEM)	46
4.12 Regional Electricity Regulation	48
4.13 The SAPP Pool Plan	49
4.14 Wheeling arrangements	49
5. THE WEST AFRICAN POWER POOL: A NEW APPROACH TO POWER POOLING	51
5.1 Historical background	51
5.2 Framework for the establishment of WAPP	51
5.3 Objectives of WAPP	53
5.4 The WAPP Institutional Framework	54
5.5 Organizational structure and membership of the WAPP	54
5.6 Legal and regulatory frameworks	54
5.7 Operation and management of WAPP	55
5.8 Development of the WAPP Interconnected Transmission Grid	57
6. PROSPECTS OF ESTABLISHING OTHER POWER POOLS IN AFRICA	59
6.1 Development of an East African Power Pool	59
6.2 Development of a Power Pool for the Great Lakes Region	60

6.3 Development of a North Africa/Mediterranean Power Pool	61
7. ASSESSMENT OF POWER-POOLING ARRANGEMENTS IN AFRICA	63
7.1 Issues for consideration in assessing power-pooling arrangements	63
7.2 Strengths and weaknesses of bilateral electricity exchange agreements	64
7.3 Strengths of bilateral electricity exchange agreements	64
7.4 Weaknesses of simple interconnections and related bilateral arrangements	65
7.5 Assessment of inter-utility bilateral electricity exchange arrangements	67
7.6 Effectiveness of the SAPP pooling arrangements	68
7.7 Bilateral electricity trading agreements	68
Wheeling arrangements	69
7.8 The Short-term Energy Market (STEM)	70
7.9 Reliability of the SAPP interconnected grid system	71
7.10 Challenging issues for SAPP	72
7.11 Overall assessment of SAPP pooling arrangements	73
7.12 Development of the West African Power Pool (WAPP)	73
8. CONCLUSION	75
REFERENCES	77

## ACKNOWLEDGEMENTS

This report is the result of a research work on existing inter-country and/or regional energy cooperation and integration initiatives through cross-border electricity exchange and joint development of hydropower resources.

The work was carried out under the general guidance of Yousif A. Suliman, the Director of ECA's former Regional Cooperation and Integration Division (RCID) (now Trade and Integration Division). His active support in making available the necessary resources to collect data from existing power pools and regional economic communities is highly appreciated. The work also benefited from the interest of all the staff of RCID, particularly Berhanou Haile Michael who provided research assistance.

The report could not have reached the required quality standard without the personal interest and involvement of Mr. Josué Dioné, the Director of the Sustainable Development Division (SDD) who, despite the fact that the report was produced within the purview of another Division, authorized the organization of an ad hoc expert group meeting to review and improve the draft report once the task that yielded the report was transferred to SDD.

The report was reviewed by high-level officials of regional power pools, regional economic communities (RECs) and national and/or bi-national power utilities involved in cross-border electricity trade in Africa.

Finally, the contribution of SDD staff to the organization of the ad hoc expert group meeting, particularly W/zo Sefanit Tessema, the Administrative Assistant, and Mr. Yinka Adeyemi, the Communication Officer, is highly appreciated.

## ACRONYMS

AFSED:	Arab Fund for Social and Economic Development
BPC:	Botswana Power Corporation
CEB :	Communauté électrique du Bénin
CIE :	Compagnie ivoirienne d'électricité
DRC:	Democratic Republic of Congo
EDM :	Electricidade de Moçambique
EECI :	Energie électrique de la Côte d'Ivoire
ENE:	Empresa nacional de electricidade
ESCOM:	Electricity Supply Commission (Malawi)
Eskom:	Electricity Supply Commission of South Africa
FCR:	Frequency Control Reserve
FERC:	Federal Energy Regulatory Commission
GW:	Gigawatt
GWh:	Gigawatthour
HCB :	Hidroelectrica de Cahora Bassa
HVDC:	High voltage direct current
ICT:	Information and communication technology
IEA:	International Energy Agency
IPP:	Independent power producer
ISO:	Independent System Operator
ITP:	Independent transmission provider
KPLC:	Kenya Power and Lighting Company
kV:	kilovolt
kW:	kilowatt
kWh:	kilowatthour
LEC:	Lesotho Electricity Supply Commission



LOLP:	Loss-of-Load Probability
MW:	Megawatt
MWh:	Megawatthour
NamPower:	Namibia Power Company
NEPOOL:	New England Power Pool
NETA:	New Electricity Trading Arrangements (United Kingdom)
NGC:	National Grid Company (United Kingdom)
NOPR:	Notice of Proposed Rule Making
Nord Pool:	Nordic Power Exchange
RECs:	Regional Electric Companies (United Kingdom)
RTO:	Regional Transmission Organization (United States)
SADC:	Southern African Development Community
SAPP:	Southern African Power Pool
SEB:	Swaziland Electricity Board
SMD :	Standard Market Design
SNEL :	Société nationale d'électricité (DRC)
SONABEL :	Société nationale burkinabè d'électricité
TANESCO:	Tanzania Electricity Supply Company
TSO:	Transmission System Operator
TW:	Terawatt
TWh:	Terawatthour
UEB:	Uganda Electricity Board
UETCL:	Uganda Electricity Transmission Company Ltd.
VOLL:	Value-of-Lost-Load
VRA:	Volta River Authority (Ghana)
ZESA:	Zimbabwe Electricity Supply Authority
ZESCO:	Zambia Electricity Supply Corporation
ZPC:	Zimbabwe Power Corporation

## ABSTRACT

Although Africa has an abundance of commercial energy resources, they are not uniformly distributed by form and location. Therefore, promoting regional cooperation and integration through energy pooling and cross-border energy flows would help to minimize the cost of supply as a result of economies of scale. A regional approach to energy resources development would also enhance reliability and security of supply.

Currently, there is only one operational power pool in Africa, namely the Southern African Power Pool (SAPP). A power pool is being established in the West Africa region, the West African Power Pool (WAPP). Additionally, inter-utility/country electricity exchanges under bilateral trading agreements have been in existence for almost half a century.

The terms and conditions provided for in power purchase agreements have remained unchanged over a long period of time and have not guaranteed the reliability of supply in the absence of a multi-country, interconnected power system. In SAPP, for example, rules of power-pool operations have helped member utilities to ensure mutual support in emergency conditions and improve reliability by sharing capacity reserves. In addition, transactions on the short-term energy market (STEM) allow pooling participation to complement bilateral power trading contracts. This happens by taking advantage of the short-term surplus of other participants to buy at the lowest price and profit from its own short-term surplus by selling to the best bidder.

This study seeks to assess the effectiveness of inter-utility/country electricity exchange arrangements under bilateral trading agreements and/or through selling and purchasing transactions for bulk electric power on a competitive wholesale power market operated by regional power pools.

## EXECUTIVE SUMMARY

Interconnections and cross-border electricity exchanges have been in existence in Africa for nearly half a century. Most of these interconnections originated from major hydropower projects, including the Owen Falls hydropower station in Uganda (1950s) the Kariba North hydropower station on the Zambia-Zimbabwe border (1960s) the Akosombo hydroelectric dam in Ghana (1960s) Inga 1 hydropower station in the Democratic Republic of Congo (DRC) in 1972, the Cahora Bassa hydroelectric dam in Mozambique (1974) and the Inga 2 hydropower station in the DRC (1982).

The search for a more reliable and secure electricity supply has been the determining factor in the decision to build power system interconnections and to enter into inter-utility electricity exchange agreements among neighboring countries around the world. Through the sharing of operational reserves and installed capacity interconnected power systems are able to avoid additional investment in generation infrastructure. Thus, power pooling among electric power utilities aims at effectively harnessing savings in operating costs and securing reliability benefits through coordinated interchange of power, energy and related services.

Development experience and operation of selected power pools in Europe and the United States indicate that the power-pooling arrangements have, for the most part, evolved from simple interconnections between neighbouring utilities to support each other in case of emergencies into more sophisticated formal legal entities with differing responsibilities in system operation and power market regulation.

Traditionally, there have been two types of power-pooling arrangements:

- a) Mandatory pool arrangements where all power-generating facilities were pooled and dispatched centrally and where no physical dispatch was allowed outside the pool (e.g., U.S. “tight” power pools and Electricity Pool of England and Wales); and
- b) Flexible or loose pool arrangements where power trading outside the pool was allowed (e.g., Nord Pool and U.S. “loose” power pools).

While traditional tight power pools were created to improve reliability, minimize operating costs through cost-based dispatch and accommodate decision-making control by large, vertically integrated companies, competitive power pools in Europe (Nord Pool and UK’s New Electricity Trading Arrangements - NETA) were created to maximize competition in generation (subject to accepted reli-

ability standards), competition on price, not cost openness, to all market participants. The latter are termed “new style” power pools as opposed to the “old style”, tight power pools and they are organized markets for trading in electricity commodities and services. They are open to all participants, following the example of Nord Pool, the Nordic Power Exchange.

In Africa, particularly in sub-Saharan Africa, arrangements for inter-utility and cross-border electricity exchange have taken the form of bilateral trading agreements between vertically integrated power utilities or transactions on a short-term energy market (STEM) within a regional power pool. STEM exists within SAPP.

With regard to simple, inter-utility bilateral trading agreements (outside a power pool), the terms and conditions provided for in the power purchase agreements (PPAs) have not changed over time, while there was no coordinated planning of power system expansion. This led to in-supply unreliability due to power generation capacity constraints which resulted in exporting utilities inability to meet their export obligations. Only Côte d’Ivoire has succeeded in attracting private sector participation in the electricity supply industry as independent power producers (IPPs), thanks to the implementation of its market-oriented power sector reform. Côte d’Ivoire has become a net energy exporter in the West Africa region since 1995.

Despite the problem of inadequacy and unreliability of supply mentioned above, inter-utility system interconnections and related cross-border electricity exchange arrangements should be considered as the building blocks for the formation of potential power pools within the different sub-regional economic communities (RECs). For example, SAPP was initially created as an “association of vertically integrated electric power utilities” representing twelve Southern African Development Community (SADC) member States.

SAPP pooling arrangements have been evolving from loose pool arrangements dominated by long-term bilateral contracts among vertically integrated utilities towards a competitive pool in which bilateral contracts are complemented by STEMs. These represent firm energy markets where electric power is traded on a daily basis for delivery the following day, with full obligation to pay, thereby expanding its operations to include more market players. The energy dispatch is bid-based but will be replaced by a cost-based system. However, transactions have often been limited by the tie-line capacities available, because bilateral trading agreements take precedence over STEM on the use of the tie lines.

Participation through STEM has been increasing steadily and volumes traded represented 10% of all SAPP trading transactions by mid-2002. However, because of the transfer capacity limits of tie lines within the three control areas and the priority given to bilateral contracts over STEM contracts for access to the trans-

mission grid, there have been problems connected with wheeling arrangements between some SAPP members.

While the performance of the SAPP operation and the effectiveness of related pooling arrangements are considered as satisfactory, there is a need to invest in high-capacity tie lines on the interconnected grid system to allow increased transactions on the STEM, thereby accelerating the transition to the regional spot market. A regional regulatory body should be created urgently to deal with such challenging issues as rules for access to transmission grid, transmission pricing, facilitation of competition, stimulation of regional trade and incentives for development of the regional transmission grid system.

The West African Power Pool (WAPP) is being formed taking due account of lessons learned from the establishment and development of SAPP. WAPP has also benefited from technical assistance provided by the United States Agency for International Development (USAID) to carry out studies designed to facilitate the development and operations of the power pool.

However, the Economic Community of West African States (ECOWAS) member States are facing hard challenges in connection with the establishment and operationalization of WAPP. In September 2001, ECOWAS Energy Ministers approved a master-plan which indicated that an estimated investment in the order of \$ US 10 billion was required for the construction of new electricity generation plants and for upgrading and building high voltage transmission lines over the next 15 years.

Prospects for establishing other power pools in Africa are mixed. The development of the East African Power Pool (EAPP) is being given a boost with the launching of a study on an East African Community (EAC) Power Master Plan with financing from the Swedish International Development Agency (SIDA) through the Trust Fund managed by the World Bank. The study is expected to define the least cost effective expansion programme for development of the combined power generation systems of the three EAC partner States. It provides a comprehensive plan for the development of the interconnected power system.

Finally, the establishment and operation of SAPP is a major achievement and a good example of successful regional electricity cooperation and integration. It serves as a model for establishment of other power pools in Africa in general, and WAPP in particular.

## INTRODUCTION

The security and reliability of electricity supply has been the driving force behind power system interconnections and promotion of cross-border electricity trade. Indeed, countries and/or utilities have interconnected their power systems to provide for increased quality and reliability of electricity service, lower electricity production costs among sub-regional trading partners, reduced levels of required reserve capacity in the connected grids, and improved national energy security, including mutual support in time of emergencies. In recent years, the development of interconnections between power systems as a means of electricity integration and power pooling within regional economic communities (RECs) has been encouraged in most developing regions.

Cooperation in establishing cross-border interconnections and associated electricity exchange in Africa can be traced back to the 1950s. Algeria and Tunisia first linked their electricity networks to exchange power in emergencies in the early 1950s, and a power line was constructed in 1958 to link Nseke in the DRC (then Belgian Congo), to Kitwe in Zambia to supply electricity for copper mines. This was followed by a number of interconnections linked to the development of most of the major hydropower projects, including:

- (a) The interconnection of Kenya and Uganda grids from the Owen Falls hydropower station;
- (b) The interconnection of Zambia and Zimbabwe grids from the Kariba South hydropower station;
- (c) The interconnection of Ghana to Togo-Benin grid through the Communauté électrique du Bénin (CEB) from the Akosombo hydropower station;
- (d) The interconnection of DRC to Congo Republic from the Inga hydropower station; and
- (e) The interconnection of Côte d'Ivoire to Ghana for electricity supply from the Akosombo hydropower station.

However, interconnections linked to hydro-based cheap and reliable electricity supply have not provided for the coordinated planning of generating capacity expansion. As a result surplus low-cost hydropower generating capacity soon became inadequate to meet growing domestic demand and exporting utility's obligations vis-à-vis exports to its contractual partners. Power crises have been experienced in countries connected to Ghana's Akosombo hydropower station

since 1998. In 1998 the amount of electricity to be supplied by Uganda's Owen Falls hydropower station to Kenya in the Kenya-Uganda Electricity Agreement of 1955 was revised downwards.

Cross-border interconnections and power-pooling arrangements that are being established seek to encourage integrated planning of generation capacity and transmission expansion in order to ensure security and reliability of the electricity supply to participating countries. Most of the RECs are considering the establishment of subregional power pools as a means of setting up the appropriate institutional framework for promoting cross-border electricity trade among member countries. In this regard the existence of SAPP in SADC and of the WAPP project being implemented in ECOWAS is noteworthy.

Successful sub-regional integration of electricity systems requires a framework for transactions to take place, arrangements for system operations, a system of tariffs for the use of the transmission infrastructure, and agreed principles and procedures for dispute resolution. Therefore, this study considers, among other things, the existence of electricity trade agreements, the effectiveness of planning and the operation of existing power pools, transmission system operation, including third party access and wheeling charges for transit fees, availability of electricity to meet growing domestic and export demand, problems encountered in implementing bilateral agreements, including payment of electricity import bills, among others.

The first part of this report briefly considers the development and operational experiences of selected power pools in Europe and the United States. The second part discusses the rationale of power pooling and cross-border electricity exchange. It introduces the power-pooling concept and discusses the objectives and benefits of such arrangements. The third part of the report reviews some of the bilateral agreements that govern inter-utility electricity exchange in Africa, particularly in sub-Saharan Africa.

The establishment of power pools in Africa is a recent phenomenon although most subregional economic groupings have been considering power pooling as the appropriate framework for addressing electricity cooperation and integration. This is why the operation of SAPP and the steps being taken to implement WAPP are extensively considered in chapters 4 and 5 respectively.

Since most of the subregional economic groupings are considering energy pooling through interconnection of electricity grids and establishment of power pools as means of fostering regional cooperation and integration, the report considers other potential power pools, namely the East African power pool, the Nile Equatorial Lakes power pool and the North Africa, or alternatively, the Mediterranean power pool.

In assessing the effectiveness of power-pooling arrangements in Africa, the report identifies the main criteria that help assess the performance of existing bilateral electricity trading arrangements, the performance of SAPP from the bilateral arrangements, the STEM perspective, as well as the provisions governing WAPP. The conclusion considers how bilateral electricity exchange arrangements relate to power-pooling arrangements and how they could ultimately lead to the creation of regional power pools.



# 1. DEVELOPMENT AND OPERATION OF SELECTED POWER POOLS

## 1.1 Electricity Pool of England and Wales

### Background

The restructuring of the British electric power sector took effect in April 1990, following the passing of the Electricity Act 1989, which set out the rules for establishing the market and privatizing the players. The Central Electricity Generating Board (CEGB), operated all generation, transmission and distribution facilities in England and Wales as a vertically integrated statutory monopoly from nationalization in 1947 until 1990. Decentralization created three generating companies, a new grid company, and twelve regional electricity distribution companies.

Power generation assets were divided into the three generating companies: National Power with 52% of total generating capacity, PowerGen with 33%, and Nuclear Electric with 15%. National Power and PowerGen were privatized, with 60% of their shares sold initially, while Nuclear Electric remained under public ownership. National Power's share in generating capacity gave it significant market power. High voltage transmission assets were transferred to a new private entity, the National Grid Company (NGC) under joint ownership by the twelve regional distribution companies, which were also privatized to become the Regional Electric Companies (RECs)

Until 1995, the Government held a so-called "golden share", a single equity share with the right to prevent acquisitions or mergers involving RECs without government approval. Both distribution by RECs and transmission by NGC were treated as natural monopolies and were subject to price cap regulation by the Office of Electricity Regulation (OFFER).

### Creation of the Pool

With the 1990 electric power sector reform, an entirely new institution, called the Electricity Pool of England and Wales, was created to act as a clearinghouse between generators and wholesale suppliers of electricity. The Pool was operated by the National Grid Company (NGC) separate from its transmission function, and was open to all generators and suppliers wishing to participate.

The commercial arrangements, which governed the sale of power in the wholesale market, were known as the Pooling and Settlement Arrangements (PSA), and reflected the two principal characteristics of the physical generation and supply of electricity in an integrated system:

- Impossibility of tracing electricity from a particular generator to a particular supplier; and
- Impracticability of storing electricity in significant amounts so that a constant matching of generation of electricity with demand was required.

The new commercial arrangements were based on two principles:

- Central control of stations; and
- Selling all output at a set price in each half-hour, to meet the combined requirements of all suppliers.

Generators and suppliers agreeing to buy and sell in this way were effectively “pooling” their resources, and had to sign the PSA, which governed the constitution and operation of the Pool and the calculation of payments due to and from generators and suppliers. The NGC acted as administrator of this system.

## Pool operations

All operators of generating stations subject to central dispatch were required to bid into the Pool. The bids were prices from which the generator was willing to generate electricity from each of its power stations for every half-hour period of the following day. With each bid the generators also declared the amount of electricity that the stations were willing to generate. NGC then ranked each power plant in order of increasing bid prices, the so-called “merit order”.

In parallel with this “merit order” ranking of power plants, the Settlement System run by NGC estimated the total electricity demand for England and Wales for each half hour based on such factors as historic demand levels and weather conditions and calculated the operating regime for all the generating stations that would meet the expected demand over the next day at a low cost, also called “economic schedule”. The calculations took into account, among other things:

- (a) Transmission constraints;
- (b) Power station characteristics; and
- (c) System stability.

A price was then determined by stacking the bids from generators in ascending order of price together with the quantity of electricity each station could generate. The price of the highest bid in the stack required to meet the estimated demand for the half-hour period concerned would become the basis of the Pool price paid for generation. This was known as the system marginal price (SMP).

The Pool price included a second element – the “capacity payment”. This was essentially a financial incentive paid to generators to ensure that they would be willing to build the new power stations needed to meet peak demand in the long term. The capacity payment was high, when there was only just sufficient electricity plant available to meet expected demand, but fell to zero when there was excess capacity. The size of the capacity payment for each half hour was determined by the Loss of Load Probability (LOLP) and the price that Pool members would be willing to pay in order to avoid a loss of supply, the Value of Lost Load (VOLL). Thus, the capacity payment was set to equal VOLL times LOLP where:

- LOLP was the probability of capacity being inadequate to supply demand in the particular half hour because of a sudden unexpected increase in demand or a sudden failure of plant such as a generating station; and
- VOLL was a measure of the price that pool customers were willing to pay to avoid a loss of supply and would be set at a level to ensure that quality of supply is maintained.

Normally, all generating power stations received the same payment from the Pool for each unit of electricity produced. This payment was equal to the SMP plus the capacity payment, known as the pool purchase price (PPP) and was represented by the following formula:  $PPP=SMP+(VOLL*LOLP)$ .

Suppliers buying electricity from the Pool were required to pay the pool selling price (PSP). PSP included an additional overhead or uplift over and above the PPP which was calculated to cover the Pool operating costs, as well as payments – mainly to generators – for special services provided to ensure the secure and stable operation of the grid system (i.e., certain ancillary functions such as reserve, plant availability, forecasting errors, transmission constraints, and marginal plant adjustments).

In the Pool operation transmission constraints have often complicated the functioning of merit order dispatch and related Pool prices. The essential problem grew because power generation and consumption had geographic and quantity dimensions. It has often been impossible to dispatch the least-cost generating stations, since transmission constraints might preclude use of that power to satisfy requirements elsewhere in the interconnected system. Instead, some other non-least cost (i.e., least generation cost) station might be the optimal source of power. Such “out-of-merit running” was simply a recognition that there were, at least temporarily, geographically distinct rather than unified power markets.

The British system addressed those contingencies with administrative actions. Some power plants were taken out of service despite lower generation costs. Those plants were termed “constrained-off” and were compensated by the difference between the pool price and their bid price. Other power plants required

to supply a subregion despite higher cost (“constrained-on”) were compensated at their bid price on the theory that the bid price represented their actual marginal cost. The excess costs resulting from those two types of compensation were recouped through the uplift charge, as described above.

## Effectiveness of pooling arrangements

Over time, electricity prices within the Electricity Pool of England and Wales have proven to be very volatile and subject to possible manipulation. There have been several allegations that, due to their dominant position in the Pool, National Power and PowerGen have been able to manipulate Pool prices. According to these allegations, ownership of some relatively high-cost marginal plants have enabled the two dominant utilities to attempt to ensure that these units were offered up to the Pool in such a way that they determine the SMP.

Generators could also raise pool prices above marginal costs in at least two ways. First, they could declare some plants unavailable, thereby raising the LOLP and the capacity payment. Second, the generators could manipulate the uplift factor. Recognizing likely transmission constraints, they could anticipate, certain of their units becoming “constrained-on”, i.e. required by the grid to operate out-of-merit order to ensure adequate supply in a sub-region.

The restructuring of the British electric power industry has been premised on the ability of private ownership, markets, and competition to perform tasks previously addressed by other institutions. The experiment has worked but some problems have arisen as a result of initial design defects. These include:

- The market power of generators that led to unwarranted price increase and persistent manipulation of other aspects of the system;
- Loose regulation of the distribution stage, whose initial specification of price caps allowed for substantial price and profit increases at the expense of customers; and
- The threat of reintegration of a portion of the industry, noted recently as efforts to merge vertical stages of production raise competitive concerns and move the industry into unexpected directions.

## Introduction of the New Electricity Trading Arrangements (NETA)

While it was considered that the Electricity Pool worked satisfactorily in maintaining quality and security of supply, a review of the arrangements found many shortcomings, including the fact that bids into the Pool by generators were not reflective of costs. Under the Utilities Act of 2000, which received Royal Assent in July 2001, it was agreed that the existing Electricity Pool would be replaced

with new trading arrangements designed to be more efficient and to provide greater choice to market participants, while maintaining the operation of a secure and reliable electricity system.

The New Electricity Trading Arrangements (NETA) were introduced in March 2001, as a new wholesale market, under which bulk electricity could be traded forward through bilateral contracts and on one or more power exchanges.

NETA also provides central mechanisms whose function is to:

- Help the NGC operator of the transmission system ensure that demand meets supply, second by second; and
- Sort out who owes what to whom for any surpluses or shortfalls.

A separate company, ELEXON, manages the Balancing and Settlement Code, which sets down the rules for central mechanisms and governance.

## 1.2. US Power Pools

### Background

Following the Northeast Blackout of 1965, the electric power industry organized regional councils to coordinate reliability practices and avoid or minimize future outages in the United States. The North American Electric Reliability Council (NERC) coordinates the activities of the regional reliability councils.

These councils were voluntary organizations of transmission owning utilities. They engaged in three primary activities:

- Establishing minimum standards for utility operating procedures;
- Undertaking transmission planning, including studies regarding potential improvements necessary to protect system reliability; and
- Providing support to the development of cooperative agreements to track flows over parallel transmission.

Responsibility for the operation of generating facilities and transmission networks across the United States is divided among approximately 150 control areas. Control areas are grouped into regional reliability councils, 10 of which there are in the 48 contiguous states, most of Canada, and a small portion of Mexico. In an operational sense, control areas are the smallest units of the interconnected power system. Historically, a control area was operated by either an individual utility or a power pool formed by two or more utilities tied together by contractual arrangements. A control area performs the following functions:

- Controls the operation of generation within its portion of the transmission grid;
- Schedules interchanges with other control areas; and
- Stabilizes the frequency of the alternating current to maintain the reliable operation of the interconnected regional system.

## US “tight” and “loose” power pools

A power pool was traditionally referred to as a formalized multilateral agreement among owners and operators of transmission, generation and distribution facilities to jointly use their power systems to achieve specific economic and reliability objectives. Historically, some power pools have addressed long-term generation and transmission planning although their primary focus was on the efficient operation of the integrated generation and transmission system. Power pools attempt to capture the coordination benefits associated with being part of a larger generation and transmission system without requiring pool members to surrender their ownership prerogatives.

The Pennsylvania-New Jersey-Maryland (PJM) Interconnection was the first power pool to be formed in the United States in the late 1920s. It centralized the operation of the generation and transmission resources of the utilities in the six-state area covering Pennsylvania, New Jersey, Maryland, Delaware, West Virginia and the District of Columbia. Since then, a number of power pools have been formed, the most well-known including: the New York Power Pool (NYPP) created following the “Northeast Blackout of 1965” to coordinate the statewide interconnected transmission system, and the New England Power Pool (NEPOOL) formed in 1971 to coordinate the operations of the generation and transmission facilities covering the six New England States.

There were two types of power-pooling arrangements: “tight” power pools, and “loose” power pools. Tight power pools were highly interconnected, centrally dispatched<sup>1</sup>, and had established arrangements for joint planning on a single basis. Historically, tight pools had restrictive membership requirements and complex rules and governance procedures requiring the agreement of a supermajority of members.

In contrast to tight pools, arrangements among utilities in loose power pools were quite varied and ranged from generalized agreements that coordinate generation and transmission planning to accommodate overall needs to more structured arrangements for interchanges, shared reserve capacity, and transmission services. Loose pools, however, did not provide control area services.

<sup>1</sup> Central dispatch refers to using one operator to dispatch all the generating facilities of several utilities within a control area to minimize overall costs.

## Restructuring of the US electric power industry

The “traditional” power pools have played a valuable role in improving the reliability and reducing the cost of utility service. They were developed to support an industry structure that was far different from the competitive markets emerging today. They were formed in an era dominated by vertically integrated utilities. Independent power producers and the potential for retail access were not a consideration. The pools’ detailed rules, restrictive membership requirements and the often-cumbersome governance was the result of detailed negotiations among the original pool members. Growing competition has placed pressure on pools to make fundamental changes.

Major changes were introduced into the structure of the US electric power industry following the passage of the Energy Policy Act of 1992 (EPACT). This legislation authorized non-utility companies, including independent power producers (IPPs), to build and operate power plants, and it broadened the authority of the Federal Energy Regulatory Commission (FERC) to order the provision of electricity transmission services through non-discriminatory open access to utility transmission systems.

In accordance with the provisions of EPACT, FERC issued Order No. 888<sup>2</sup> in 1996, by which it required all public utilities owning, controlling or operating facilities used for transmitting electrical energy in interstate commerce to:

- File open access non-discriminatory transmission tariffs containing certain minimum, non-price terms and conditions; and
- Functionally unbundle wholesale power services from transmission services.

Functional unbundling required public utilities to:

- Take wholesale transmission service under the same tariff of general applicability as they offer their customers;
- State separate rates for wholesale generation, transmission and ancillary services; and
- Rely on the same electronic information network that their transmission customers rely on to obtain information about the utilities’ transmission systems.

In Order No. 889, issued concurrent with Order No. 888, FERC also imposed standards of conduct governing communications and wholesale power functions

<sup>2</sup> Order No. 888 on “Promoting wholesale competition through open-access non-discriminatory transmission services by public utilities, and Recovery of stranded costs by public utilities and transmitting utilities”

to prevent the utility from giving its power marketing arm preferential access to transmission information. Under Order No. 889<sup>3</sup>, FERC required all public utilities owning, controlling or operating facilities used in the transmission of electrical energy in interstate commerce to create or participate in an Open Access Same-Time Information System (OASIS) that provides existing and potential transmission customers the same access to transmission information that would enable them to obtain open access non-discriminatory transmission service.

Order No. 888 also made special provisions for power pools. Under order No. 889, FERC required power pools and similar organizations to remove transmission access and pricing provisions that favoured members of the group or discriminated against outsiders; the same held true for bilateral arrangements that permitted preferential treatment in transmission pricing or access. FERC concluded that in order to remedy the undue discrimination in transmission access and pricing by public utilities that are members of power pools or other coordination arrangements, such public utilities must remove preferential transmission access and pricing provisions from agreements governing their transactions.

For the purpose of FERC Order No. 888, tight power pools included the New York Power Pool (NYPP), New England Power Pool (NEPOOL), and Pennsylvania-New Jersey-Maryland Interconnection (PJM). Loose power pools comprised the Mid-Continent Area Power Pool (MAPP), and the MOKAN (Missouri-Kansas) Power Pool.

### **Promoting competitive wholesale power markets**

In Order No. 888, FERC found that unduly discriminatory and anti-competitive practices existed in the electricity supply industry. FERC then stated that its goal was to ensure that customers had the benefit of competitively priced generation, and determined that non-discriminatory open access transmission services, including access to transmission information, and standard cost-recovery rules were the most critical components of a successful transition to the competitive wholesale electricity market.

In Order No. 888, FERC also encouraged the formation of independent system operators (ISOs) whereby utilities would transfer operating control of their transmission facilities to the ISO, and set forth 11 principles for assessing ISO proposals submitted to the Commission. Ownership of the facilities would remain with the utility, and utility participation in an ISO was voluntary. It was hoped that an ISO with no economic interest in marketing and selling power could fairly administer the open-access transmission tariff and eliminate discriminatory prac-

<sup>3</sup> Order No. 889 on "Open Access Same-Time Information System (OASIS) and Standards of Conduct"



tices, while at the same time trying to achieve the efficiency benefits from regional control of the grid.

Even though significant progress was made toward an open access transmission tariff with six ISOs in place and creation of OASIS, obstacles to the development of wholesale power markets and competition across the United States still remained. FERC then issued Order No. 2000 in December 1999, calling for the voluntary creation of independent Regional Transmission Organizations (RTOs). FERC's stated objectives in issuing Order No. 2000 were to promote efficiency in wholesale electricity markets and to ensure that electricity consumers paid the lowest price possible for reliable service. Specifically, FERC was seeking to:

- Improve efficiencies in transmission grid management;
- Improve grid reliability;
- Eliminate discriminatory transmission practices by vertically integrated utilities;
- Improve wholesale electricity market performance; and
- Introduce lighter-handed regulation.

In complying with the requirements of FERC Order No. 888 on the formation of ISOs and Order No. 2000 on the formation of RTOs, some tight power pools have evolved toward the establishment of a competitive wholesale market and power exchange. For example, the three northeastern tight power pools have created ISOs – PJM Interconnection, New York ISO and ISO-New England. These ISOs have also recently introduced centralized markets for buying and selling energy in their region. Box 1 presents the case of the New England Power Pool (NEPOOL).

#### Box 1: Case of the New England Power Pool (NEPOOL)

The New England Power Pool (NEPOOL) was formed in 1971 as a voluntary association of entities engaged in the electric power business in New England. For the last three decades, it has operated the electric transmission control area covering the six New England States, namely Maine, Vermont, New Hampshire, Connecticut, Rhode Island and Massachusetts. The NEPOOL members, referred to as participants, include investor-owned utility systems, municipal and consumer-owned systems, joint marketing agencies, power marketers, load aggregators, generation owners and end users. NEPOOL's members do not have an ownership interest in the association.

The relationship among NEPOOL members is governed principally by an operating agreement called the Restated NEPOOL Agreement. The Agreement includes provisions for the governance of the organization. It also establishes the key understandings concerning the operation of wholesale power markets in New England,

including the operation of a market-priced, bid-based power exchange pursuant to which participants can buy and sell electricity services. The Restated NEPOOL Agreement also includes, as an attachment, the NEPOOL Open Access Transmission Tariff, pursuant to which all entities are eligible to receive transmission service over Pool Transmission Facilities (PTF). These are transmission facilities in New England rated 69 kV and above that are used to move power throughout the region.

NEPOOL is a tight power pool that established a single regional network. Historically, it has coordinated, monitored and directed the operations of virtually all major generation and transmission bulk power supply facilities in New England. NEPOOL built a state-of-the-art Control Centre to centrally dispatch the bulk power system using the most economic generating and transmission equipment available at any given time to match the electric load of the region. This approach has resulted in significant savings for NEPOOL members and their customers, while it has increased the overall reliability of the bulk power system.

Source: [www.nepool.com](http://www.nepool.com)

FERC took a further step with the issuance of its notice of proposed rulemaking (NOPR) on standard market design (SMD). Order No. 2000 did not clarify what market designs and institutional arrangements would be acceptable in RTOs and provided significant latitude for how RTO characteristics and functions would be put into practice. Consequently, the above three northeastern ISOs took slightly different approaches to market-based management and pricing of energy imbalances, ancillary services, congestion management and transmission rights.

In its SMD NOPR, FERC proposed that all ISOs and RTOs operate markets for energy and for the procurement of certain ancillary services in conjunction with markets for transmission service. These markets should be bid-based, security-constrained spot markets operated in two time frames, namely a day ahead of real time operations, and in real time.

### 1.3 Nord Pool – The Nordic Power Exchange

#### **Background: Nordel – Electricity cooperation in the Nordic region**

Cooperation in power system interconnections and cross-border electricity exchange was developed between the Nordic countries (Denmark, Finland, Ice-

<sup>4</sup> Remediating Undue Discrimination Through Open Access Transmission Service and Standard Electricity Market Design, Federal Energy Regulatory Commission, Notice of Proposed Rule Making, July 31, 2002.

land, Norway and Sweden) in the 1950s. In 1963 Nordel was created as an association for electricity cooperation in the Nordic countries. Its primary task was to create prerequisites for efficient utilization of the Nordic electricity generation and transmission systems.

This cooperation faced a new challenge in 1991 when Norway adopted a market-oriented Energy Act. Nordel's organization has thus changed over time, with the developments that have taken place in the electricity sector in the Nordic countries, and its By-Laws having been amended several times. After the opening up of the electricity market following the passing of the Norwegian Energy Act in 1990, the By-Laws were first changed in 1993.

In 1995, the Nordic Energy Ministers agreed to step up cooperation to develop a common electric power market. It was expected that a common Nordic electricity market would significantly reduce the dominance of some large utilities and guarantee stronger competition.

In 1995, Nordel's Executive Board also appointed a working group to prepare a proposal for new By-Laws for Nordel, taking into account the developments of the electricity market from the mid-1990s onwards. Nordel's By-Laws were revised in August 1998 to respond to the demands set by the highly developed Nordic electricity market.

It was decided that the members of Nordel should comprise leading representatives of the transmission system operators (TSOs) and other actors with technical equipment of importance to the operation and development of the electric power system.

Nordel acts as an advisory and recommendatory body for co-operation between the Nordic system operators, and a forum for market participants and system operators in Nordic countries. Its primary objective is to create and maintain the conditions necessary for an effective Nordic electricity market. With the revision of its By-Laws in June 2000, Nordel has become an organization for cooperation among TSOs in Nordic countries.

#### Box 2: Nordel – Organization for electricity cooperation in Nordic countries

Nordel was created in 1963 as an association for electricity cooperation in Nordic countries. Its primary task was to create prerequisites for efficient utilization of the Nordic electricity generation and transmission systems. Its organization has changed over time with the developments that have taken place in the electricity sector in the Nordic countries. Since the revision of its By-Laws in June 2000, Nordel has become an organization for cooperation among Nordic transmission system operators (TSOs).

Nordel acts as an advisory and recommendatory body for cooperation among the Nordic TSOs, and as a forum for market participants and the TSOs in the Nordic countries. A Market Forum has been set up within the new Nordel organization in order to pursue dialogue between TSOs and the market players.

Nordel plays a non-commercial role in connection with electricity exchange. The purpose of its new organization is to contribute to technical coordination and recommendations within the following spheres:

- System expansion and transmission planning criteria;
- System operations, reliability of operations, reliability of supply and exchange of information;
- Principles for pricing transmission and ancillary services;
- International cooperation;
- Maintaining and developing links with organizations and regulatory authorities in the power sector, particularly in the Nordic countries and Europe; and
- Compiling and disseminating impartial information about the Nordic electricity system and market.

Nordel's highest decision-making body is the Annual Meeting and the Executive Board is its executive body. It has two permanent committees: the System Committee and the Operations Committee. Most of the work is carried out by its Committees and Working Groups.

Source: [www.nordel.com](http://www.nordel.com)

## Creation of Nord Pool

The development of Nord Pool, the Nordic Power Exchange covering Norway, Sweden, Finland, and Denmark, began in 1971, when Norwegian electricity generators formed an association called the Power Pool. The Power Pool or power exchange was designed as a tool for the power industry to optimize usage of all Norwegian hydropower resources. Its responsibilities were principally to provide a market for excess or deficient supply, and a basis for economic settlement using the Norwegian national grid.

The Norwegian Energy Act in 1990 mandated separation of grid transmission activities from competitive activities. The national power company was split into the nationwide grid company, Statnett, and a generating company, Statkraft in 1992. Responsibility for monitoring and operation of the power grid and its cross-border links was assigned to Statnett, which was also appointed TSO of Norway. The Power Pool was then incorporated within Statnett in 1993 as a fully owned subsidiary, and was renamed Statnett Marked.

Nord Pool was established in 1996 as a Norwegian-Swedish power exchange market, when Sweden bought a 50% stake in Statnett via its state-owned national grid company, Svenska Kraftnät. The jointly owned company formed the foundation for a competitive Nordic wholesale electricity market. The market was expanded to include Finland in mid-1998, the western part of Denmark (Jutland/Funen) in 1999, and Eastern Denmark (Zealand) in October 2000. The ownership structure of 50% Statnett and 50% Svenska Kraftnät has remained unchanged since that date.

## Nord Pool operation and markets

Throughout the development period that led to a common Nordic power market, five TSOs in the Nordic countries have cooperated to facilitate trade and promote competition. In the present power market, participants have a wide choice of products and market places. The freedom to choose counterparts and products, the presence of a liquid power exchange, and the cooperative attitude of TSOs in facilitating trade operations, have all contributed to the high trade activity in the Nordic power market.

Nord Pool, the Nordic wholesale power market, is a non-mandatory power exchange that competes with Over-The-Counter (OTC) and bilateral markets for trading financially settled and physical-delivery power contracts. It offers a choice for market participants to trade standardized contracts at the power exchange, or to trade in the bilateral market, where contracts can be tailored to the needs of the parties involved.

Nord Pool operates the Elspot, which is the market for physical day-ahead trading and Eltermin, which is the financial futures and forwards market. The balancing market in Sweden and Finland, Elbas, was set up in early 1999 allowing participants to trade physical power on a continuous basis until two hours before the delivery period. In late 1999 financial options were introduced under the name Eloptions.

The Elspot spot market is open to competitive bidding and provides price transparency, and is a day-ahead market where power contracts of a minimum of one-hour duration are traded for delivery the following day. The Elspot market operates in competition with OTC and bilateral market trading. All other services designed to maintain a secure and reliable power supply are handled through the real-time market and ancillary services managed by the Nordic TSOs.

<sup>5</sup> The five Nordic transmission system operators are: Eltra and Elkraft System for Denmark, Fingrid for Finland, Statnett for Norway, and Svenska Kraftnät for Sweden.

### Box 3: Development of the Spot Market within Nord Pool

Nord Pool's Nordic spot market (Elspot) was established in 1993 as a Norwegian market. In October 2000 the whole Nordic region became part of the Elspot Exchange Area when Eastern Denmark was listed as a separate Elspot price area. Sweden joined in 1996, Finland in 1998 and Western Denmark in July 1999.

Since its inception in 1993, Elspot has played an important role in promoting power exchange, including:

- o Providing a neutral, transparent reference price for both wholesale and retail markets;
- o Providing a reference price for power derivatives traded bilaterally and at the Nordic Power Exchange, Nord Pool ASA;
- o Serving as a reliable counter-party;
- o Providing easy access to a physical market at low transaction costs;
- o Serving a grid congestion management tool;
- o Creating the possibility of balancing portfolio close to time operation;
- o Distributing relevant neutral market information; and
- o Being a non-mandatory power exchange as an alternative to bilateral contract trade.

Source: [www.nordpool.com](http://www.nordpool.com)

Elspot prices are determined through auction trade for each delivery hour. The System Price (Elspot System Price) and Area Prices are calculated after all participants' bids have been received. Elspot market contracts are one-hour-long physical power (delivery to or take-off from the grid) obligations; the minimum contract size being 0.1 MWh/h. Box 3 gives key features of the Elspot market.

The contracts currently listed in Nord Pool's financial market are futures, forwards and options. Futures are listed for the shorter delivery periods, days, weeks and blocks, while forwards are listed for longer delivery periods, seasons and years. Futures and forwards differ as to how settlement is carried out during the trading period. Futures contracts have daily mark-to-market cash settlements while with forward contracts the profit/loss accumulates until the delivery period and then it is realized in equal, daily shares. The same risk/return profile applies, whether one trades in futures or forwards.

Nord Pool also lists a forward called Contract for Difference (CfD) which is a forward on the difference between various area prices and the system price (Cfd = Area Price - System Price). Since the financial contracts listed at Nord Pool have the system price as underlying and the participants take physical delivery in their respective area prices, there was a demand for an instrument that enables a perfect hedge. Nord Pool responded to this demand by listing CfDs.

An option is the right to buy or sell an underlying contract at a predetermined price at a predefined date in the future. Power options or options were introduced as tradable products at the Nordic Power Exchange in late 1999. The options traded on the Nordic Power Exchange's Financial Market are used to manage risk and forecast future income and costs related to trading in financial electricity contracts. The combined use of options and forward contracts offer greater opportunities for spreading and handling risks associated with power trading. Options may be used to insure a power portfolio against price declines or increases, or to increase a portfolio's yield

Spot market financial settlement is based on the net contractual volume of each participant which is invoiced weekly. The total settlement period, including the delivery week, spans two-to-three weeks. The value of contracts traded in this period represents the settlement risk of the Nordic Power Exchange. To cover this risk, Nord Pool requires a security deposit from each spot market participant. This deposit must equal or exceed the value of the participant's net spot market purchases during the preceding four-week period.

### **Effectiveness of Nord Pool**

Nord Pool is the world's first multinational exchange for trade in electrical power contracts. It organizes trade in physical delivery power contracts and financial market contracts and provides clearing services. In 2001 Nord Pool recorded growth in all three of its business areas: physical delivery market trade, financial market trade, and clearing, through growth in traded volumes as well as market shares. Nord Pool ended 2001 with increased market shares and record-high transaction volumes. The total volume of power contracts traded in 2001 was 1,022 TWh (1 TWh = 109 kWh). Financial markets recorded a 154% growth with a total trading volume of 910 TWh. In 2001, Nord Pool cleared a total volume of 1,748 TWh of power contracts traded in the OTC and bilateral power markets.

A testimony of success of this power exchange system is that it was selected, in 2001, to supply the trading system for France's newly established power exchange, "Powernext". The agreements between Powernext and Nord Pool include license agreements for the use of trading applications developed by Nord Pool. The Nordic Power Exchange will also perform technical system services for the French power exchange. The trading applications are already in use by both the Nordic market and the Leipzig Power Exchange (LPX) in Germany.

## 1.4 Lessons learned from existing power-pooling arrangements

The Electricity Pool for England and Wales was based on a fully integrated transmission system and highly centralized dispatching of power generation outputs. While it was considered that the Pool worked satisfactorily in maintaining quality and security of supply, a review of the pooling arrangements governing operation found many shortcomings, including the fact that price determination was subject to manipulation by large generators. This resulted in the replacement of existing pooling arrangements by the New Electricity Trading Arrangements (NETA), through which bulk electricity is traded forward through bilateral contracts and on power exchange.

Much experience has been gained from the development and operation of tight and loose power pools that were formed in the United States following the Northeast Blackout of 1965. They were established to improve reliability of the interconnected power system, indicating the need for restructuring the electric power industry in order to reduce the market power of vertically integrated utilities. Third-party access and ultimately, open access to transmission system networks were considered prerequisites to introducing competition between generators and promoting competitive wholesale power markets. Tight power pools in the Northeastern region, for example PJM, NEPOOL and New York Power Pool have adapted their pooling arrangements to the competition environment created by the Energy Policy Act of 1992 and by new FERC rules for introducing centralized competitive wholesale power markets.



## 2. RATIONALE FOR POWER POOLING AND CROSS-BORDER ELECTRICITY EXCHANGE

### 2.1 Power pooling concept

Delivery of electricity requires adequate generation capacity and supply, and the ability to move that electricity to its end users. Reliability for an electric power system is therefore defined as the degree to which the performance of the elements of the system results in power being delivered to consumers within accepted standards and in the amount desired. In order to provide electricity to consumers in a reliable manner, organizations that generate and transmit electricity must ensure that the generating and transmission line capacities are adequate to meet demand. They must also ensure that the proper operating procedures for the bulk power system<sup>6</sup> are followed.

Bulk power systems are fundamentally different from other large infrastructure systems such as natural gas pipelines or long-distance telephone networks. Electric systems have two unique characteristics:

- The need for continuous and near instantaneous balancing of generation and load, consistent with transmission network constraints: this requirement stems from the absence of technologies to store electricity easily and involves metering, computing, telecommunications, and control equipment to monitor loads, generation, and the transmission system, and to adjust generation output to match or reduce load to match available generation; and
- The passive nature of the transmission network, owing to very few “control valves” or “booster pumps” to regulate electricity flows on individual lines: power flows according to the laws of physics (Kirchoff’s Laws); and control actions are limited primarily to adjusting generation output and to opening and closing switches to reconfigure the network.

<sup>6</sup> The bulk power system includes the generation and transmission network facilities of an electric power system but excludes the distribution system.

These unique characteristics lead to three reliability consequences that dominate nearly all aspects of power system design and operations:

- Every action can affect all other activities on the grid;
- Outages can increase in severity and cascade over large areas: failure of a single element can, if not managed properly, cause the subsequent rapid failure of many additional elements disrupting interconnected transmission systems; and
- The need to be ready for possible contingencies, more than current operating conditions, dominates the design and operation of bulk power systems.

Therefore, a reliable, economic supply of electricity requires carefully coordinated operation and planning of the individual generating units and transmission lines that comprise the bulk power system. Coordinating the bulk power system involves three main functions:

- Following changing loads to balance the supply of power with ever-changing demand;
- Maintaining reliable operations; and
- Coordinating power transactions between interconnected systems.

In today's power systems, responsibility for coordinating planning and operation of generating facilities and transmission networks is divided among control areas. In an operational sense, control areas are the smallest units of the interconnected power system. A control area can consist of either a single utility, or two or more utilities tied together by contractual arrangements. The key characteristic is that all generating utilities within the control area operate and control their combined resources to meet their loads as if they were one system. If a single control area is used to dispatch the generating facilities of several utilities to minimize overall costs, the process is known as "central dispatch". Because most systems are interconnected with neighbouring utilities, each control area must assure that its load matches its own internal generation plus power exports, or interchange to other control areas (less power imports).

Thus, utilities tied together by coordination arrangements for the operation and planning of their generation facilities and transmission networks as if they were a single system can be considered as "forming a power pool". A power pool is traditionally referred to as an arrangement between two or more interconnected electric systems that are planned and operated to supply power in the most reliable and economical manner for their combined load requirements.

Pooling together total production from all the power plants would facilitate the dispatching of excess capacity from one system to another. This is why a power pool is also defined as an arrangement where output from different power plants

are “pooled” together, scheduled according to increasing marginal cost, technical and contractual characteristics, and dispatched according to this “merit order” to meet demand <sup>7</sup>.

According to this definition, centrally dispatched power pools are expected to achieve increased efficiencies by selecting the least-cost mix of generating and transmission capacity by coordinating maintenance of units, and by sharing operating reserve requirements. A central dispatch is believed to give more technical and economic efficiency than bilateral arrangements, as the reliability of a bulk power system requires balancing supply and demand at all times.

Because utilities transmission systems are interconnected, the operation and planning of the electric power system requires careful coordination among its users within a power pool. Power transfers between utility systems must be coordinated. Not only must these real-time operations be coordinated, but system planning must also be coordinated among interconnected systems to assure reliable operations.

Therefore, a fully coordinated power pool could also refer to a group of power systems, each under separate management or ownership, which are planned and operated under a formal pooling arrangement designed to encourage the systems to obtain and equitably share the maximum benefits available from the pooling arrangement.

Conditions that must be met before full coordination of a power pool is possible include:

- High-capacity intersystem tie lines among the participants in order to realize the benefits of the optimum capacity and energy transfers. These intersystem tie lines also contribute to improved system reliability;
- A central dispatching headquarters to coordinate the operation of the member systems so that maximum benefits from the high-capacity tie lines are obtained. The central office should be responsible for the accounting and allocation of savings and costs to the member systems in accordance with the principles incorporated into the formal agreement under which the pool operates; and
- Organization of work in committees representing each member system:
  - An administrative committee to set policy and to oversee activities of the other committees;
  - A planning committee to coordinate planning of major facilities; and
  - An operating committee to establish policies and practices of day-to-day operation and schedule maintenance outages of major equipment.

<sup>7</sup> Anne Ku , Power Pools, April 1997

## 2.2 Power pooling objectives

The search for more reliability and security of electricity supply has been the determining factor in the decision to build most of the existing power system interconnections between neighboring countries around the world. Through the sharing of operational reserves and installed capacity interconnected power systems were able to avoid additional investment in generation infrastructure. Thus, power pooling among electric power utilities aims at effectively harnessing savings in operating costs and reliability benefits through coordinated interchanges of power, energy and related services.

Indeed the security and reliability of electricity supply in an isolated power system is directly related to the type, size and amount of installed generating capacity within that power system. The requirement to provide operational reserves in proportion to the expected system contingencies would either significantly increase the costs of maintaining a reliable power system or preclude investment in certain generating facilities or technologies that would otherwise offer economies of scale. This is particularly true in the economies of small-sized countries or isolated subregions within a larger economy.

With the development of power system interconnections and pooling arrangements, individual systems can be operated and expanded as part of a larger regional system, thereby achieving economies of scale. Benefits derived from these economies of scale include:

- Sharing the responsibility for providing the reserve margin over the entire region rather than each individual system having to provide its own reserve margin;
- Introduction of larger generation facilities for better power quality and lower costs; and
- Optimization of investment in power supply infrastructure.

Individual power systems have also been interconnected with their surrounding neighbours to carry out integrated planning and operations on a multi-system basis through power-pooling arrangements or other forms of interconnection agreements. Such planning permits the installation of larger generating units without increasing overall reserve requirements and results in lower investment unit costs and lower operating expenses.

In addition to the long-term benefits of planning infrastructure expansion as an interconnected system, near real time operating of all the generating facilities of an area as a single power system (power pooling) lowers the cost of serving the next increment of demand. Economic interchange between entities has been the first

step in opening up electricity supply markets and sharing the benefits of operating efficiencies between electric power utilities. The trend is to favour freer electricity transactions within subregions and between countries and, in this regard, power system interconnections are vital to the opening up of electricity supply markets.

Power system interconnections and related pooling arrangements can contribute to the development of more environment-friendly sources of energy, such as hydropower and natural gas. The development of energy resources, such as hydropower, relies on power interconnection for delivery to major load centres. In the case of development of natural gas resources one of the main options would be to generate electricity at the wellhead and transmit it through the transmission grid to the load centres.

In developed countries, most power pools are being created primarily to reduce capital and operating costs by capturing the benefits of competition in generation and from savings arising from complementary means of production. Under competition generators typically have the option of entering their supply prices into a competitive “pool” that establishes a dispatch merit order based on the bids it has received. In market economies, so-called “new pools” or power exchanges are being formed, for the most part, by redesigning traditional power pools in order to create competitive wholesale markets for electricity supply to maximize consumer choice.

In developing countries with small domestic power systems the driving force behind the formation of a regional power pool is primarily to enhance the attractiveness of an entire sub-region and/or an individual country and its planned new power facilities in the highly competitive market for international investment capital. The creation of a regional power pool by a group of small economies is a way of pooling risks, thereby making the development of a country’s or subregion’s capital intensive power projects more attractive to both domestic and international investors and to bilateral and multilateral lenders.

Investors typically analyze both the “project risk” and “country risk” aspects of potential investments in great detail. Functioning power pools can reduce the risks associated with potential investments by creating broader regional markets so that a country’s economic and political problems, or a utility off-taker’s financial problems can be mitigated by sales or other regional pooling arrangements.

## 2.3 Potential benefits of power-pooling arrangements

The potential benefits of developing interconnections and pooling arrangements are related to cost savings that can arise from a reduction in:

- Operation costs due to economic power exchange;

- Investment costs in additional generating capacity due to least cost development of energy resources from a regional – as opposed to a national – perspective;
- Spinning reserve requirements as a proportion of peak load; and
- Coincidental peak loads relative to average loads.

These factors also result in a greater robustness to meet unexpected events, thereby improving reliability and security of supply. Indeed, improving reliability and security of electricity supply has often been achieved through, among other things:

- Mutual support during emergencies through short-term, non-firm power exchange;
- Sharing spinning reserve capacity on the interconnected system; and
- Complementarities in means of production involving hydro- and thermal- based power generation.

Reduction in operating costs could be obtained from:

- Utilization of most favourable or economical energy resources;
- Operational benefits (merit order loading); and
- Balancing non-coincidental peak loads.

Lowering investment costs would derive from:

- Merit order investments: The cheapest projects being carried out first;
- Economies of scale: Investments in larger projects with low unit cost being considered from a regional rather than a national perspective; and
- Reduced total reserve requirements.

Benefits arising from complementary power production mixes, particularly from integration and coordination of hydropower and thermal systems <sup>8</sup>, include reduction in operating costs achieved through:

- Increased hydropower generation in off-peak periods at almost zero cost, replacing thermal generation and thereby saving fuel in the thermal system;
- Reduced operation costs in the thermal system due to import in peak (high cost) periods and export in off peak (low cost) periods;
- Reduction or postponement of investments in new peak power capacity in the thermal generating capacity; and

<sup>8</sup> Ivar Wangensteen, International Perspective on Power Grid Interconnections, Norwegian University of Science and Technology.

- Reduced investment in the hydro system due to the possibility of importing in a dry year.

## 2.4 Types of power-pooling arrangements

Experience of creation of power pools around the world reveals that power-pooling arrangements between partners have, in essence, evolved from simple interconnections between neighbouring utilities to support each other in emergency conditions into more sophisticated formal legal entities with differing responsibilities in system operation and power market regulation. Table 1 shows some of the characteristics of the different types of power-pooling arrangements.

Table 1: Evolution of Power-Pooling Arrangements

	Interconnection	Loose Pool	Tight Pool	“New” Pool
<b>Operational System</b>	Synchronized Neighboring Utilities	Coordinated Dispatch	Centralized Dispatch	ISOs
<b>Capacity Trades</b>	Bulk Power Contracts Between Neighboring Utilities	PPAs Wheeling Agreements	PPAs Wheeling Agreements	Forward Contracts
<b>Energy Sales</b>	Emergency Support	Split Savings	Split Savings	Spot Market
<b>Cost Savings</b>	Economies of scale	Reserve Sharing	Leas-Cost Planning Merit Order Dispatch	Competition
<b>Regulation of Price</b>	Tariffs Set by Regulators	Price Caps Set by Regulators	Price Caps Set by Regulators	Market Price

Source: Institutional Study Related to the Establishment of the West African Power Pool.

A majority of exchanges take place under bilateral agreements, often on the basis of long-term contracts. In developing countries, particularly in sub-Saharan Africa, cross-border electricity exchanges occur between countries with a history of cooperation and mutual trust. Inter-utility electricity exchanges that have been taking place under such bilateral agreements include:

- Firm energy sales - a continuous exchange of base load energy with slight variations provided for in the contract, as well as interruptible power;
- Backup exchanges for emergency support;
- Marginal exchanges of spinning reserves;
- Occasional (economy energy) exchange in which no guarantee of capacity is given; and
- Compensation exchanges made in kind.

Power pools being established in various parts of the world provide for pooling arrangements, enabling themselves to evolve from cooperative pools among vertically integrated utilities to more competitive pools as integrated power systems develop. Thus, the “old style” tight power pools that have operated for many years in the United States are undergoing radical changes with the restructuring of the

electric power industry, and are evolving towards the so-called “new style” power pools.

It may be recalled that the “old style” U.S. tight pools were created to improve reliability, minimize operating costs through cost-based dispatch and accommodate control of decision-making by large, vertically integrated companies, while “new style” competitive pools are organized markets for trading in electricity commodities and services, following the example of the Nordic Power Exchange and NETA. They have been created to maximize competition in generation (subject to accepted reliability standards) to compete on price, not cost, and be open to all market participants. Table 2 presents some differences between the old style and new style power pools.

Table 2: Characteristics of Old Style and New Style Power Pools

	“Old style” Pools	“New style” Pools
<b>Dispatching</b>	Typically cost-based dispatch	Typically bid-price-based dispatch
<b>Membership</b>	Often a closed club among vertically integrated electric power utilities	Usually an open club among integrated and non-integrated power enterprises
<b>Capacity obligations</b>	Pool members are required to be self-sufficient suppliers through either ownership of generating units or long-term power purchase agreements	Pool members may or may not be required to be self-sufficient suppliers through ownership of generating units or long-term PPAs
<b>Expected benefits</b>	Provide emergency support and share operating and installed reserves to achieve targeted reliability levels at lower costs	Trading is the primary concern. Initial motivation is to create a competitive generation market
<b>Wholesale market</b>	Minimal incentives to trade because of assured recovery of fixed and variable costs from captive retail customers	Strong incentives to trade because generators are not guaranteed cost recovery and all enterprises are required to buy and sell from the pool
<b>Traded products</b>	Trading is for different products with different durations and degrees of firmness. Trading in capacity rights among pool members may take place outside of the pool agreement	Trading in the pool is usually for 1-4 products with a high degree of firmness. Non-pool trading is usually in financial hedging instruments that allow buyers and sellers to insure against price fluctuations
<b>Transmission service</b>	Transmission service is contractual, available usually for specific power sales only. No generalized “open access”	Pool operation is accompanied by generalized “open access” (at least at the wholesale level)

Source: “Governance and Regulation of Power Pools and System Operators: An International Comparison”, World Bank Technical Paper No. 382



## 3. Electricity Exchange under Bilateral agreements in Africa

### 3.1 Historical background

In Africa, particularly sub-Saharan Africa, cross-border electricity exchange is mostly characterized by bilateral agreements between vertically integrated power utilities. Power system interconnections and cross-border electricity exchanges have evolved around some of the major hydropower resource development projects. The first cross-border interconnection was the 132 kV transmission line linking Uganda's Owen Falls hydropower station to Nairobi used for bulk power supply to Kenya since 1958.

Then followed the construction of the Kariba South hydropower station on the border between Zambia and Zimbabwe, including the installation of the 330 kV transmission network in the two countries and the 330 kV power line linking the power station to Zambia's copper mine area in the mid-1960s.

Other major hydropower stations that contributed to the development of power system interconnections and cross-border electricity exchanges include:

- Ghana's Akosombo hydroelectric dam, which has been in operation since the mid-1960s which supplied electricity to Togo and Benin through the Communauté Electrique du Benin (CEB) via a 161 kV double-circuit line since 1972; and to Côte d'Ivoire via a 225 kV power line since 1984;
- The Inga hydropower station in the DRC, which comprises a 351 MW plant (Inga 1) commissioned in 1972 and a 1424 MW plant (Inga 2) which has been in operation since 1982. It supplied electricity to the Republic of Congo through a 220 kV line linking Inga to Brazzaville, as well as to other countries in the southern Africa region through the 500 kV HVDC linking Inga to Kolwezi (Katanga province) and then through the existing 220 kV power line linking DRC to Zambia; and
- Mozambique's Cahora Bassa hydroelectric dam, built in the 1970s primarily to supply electricity to South Africa through a HVDC transmission line linking the power station to the Apollo sub-station, which was damaged during the civil war in 1985, but was rehabilitated in 1997. It resumed its supplies to South Africa and also supplied electricity to Zimbabwe through a 330 kV line, since December 1997.

However, bilateral agreements governing cross-border electricity exchange through these interconnections were concluded when the electric power sector was dominated by vertically integrated utilities, simultaneously performing the three primary functions of generation, transmission and distribution. The terms and conditions of most of these agreements have remained unchanged for many years and have not been adapted to suit the new way of doing business in a restructured electric power industry.

## 3.2 Selected bilateral electricity exchange agreements

### 3.2.1 Bilateral agreement between Uganda and Kenya

The Agreement between the Uganda Electricity Board (UEB) and the Kenya Power Company Limited (KPC), known as “The Kenya-Uganda Electricity Agreement, 1955” was signed on 15th June 1955 for the supply of 30 MW electrical energy to KPC by UEB for a period of 50 years commencing on 1 January 1958.

Under the terms of the Agreement, a 132 kV transmission system linking the Kenya Bulk Supply Sub-station erected near Tororo, in Uganda, to the terminal point in Kenya called the Nairobi Sub-station, should be constructed and be ready for use on or before 1st January 1958. KPC should pay UEB, quarterly, an annual rent equivalent to 6.5% of the capital cost invested in the construction of the Kenya Bulk Supply Sub-station and the 132 kV transmission line connecting the sub-station to the connection-point with the 132 kV line constructed by KPC from the frontier with Kenya to the Nairobi sub-station.

The initial terms and conditions provided for in the Agreement were amended by four supplement Agreements. The first and second of these, dated 28th October 1964, did not bring any notable change to the initial terms and conditions. The third supplement agreement, dated 9th December 1988, modified the price applicable to electrical energy supplied to KPC starting on 1st November 1984, and provided for modalities of payment of the arrears resulting from the price increase from that date.

The fourth supplement agreement, dated 6th June 1997, provided for the next price review at the date of final completion of the rehabilitation of the Owen Falls Power Station, and for the supply of the minimum guaranteed capacity of electrical energy with effect from 14th October 1996, as follows:

(a) Minimum Guaranteed Capacity

05.00 a.m. – 06.00 p.m. - 10 MW

06.00 p.m. – 11.00 p.m. - 0 MW (but could supply 6 MVAR)

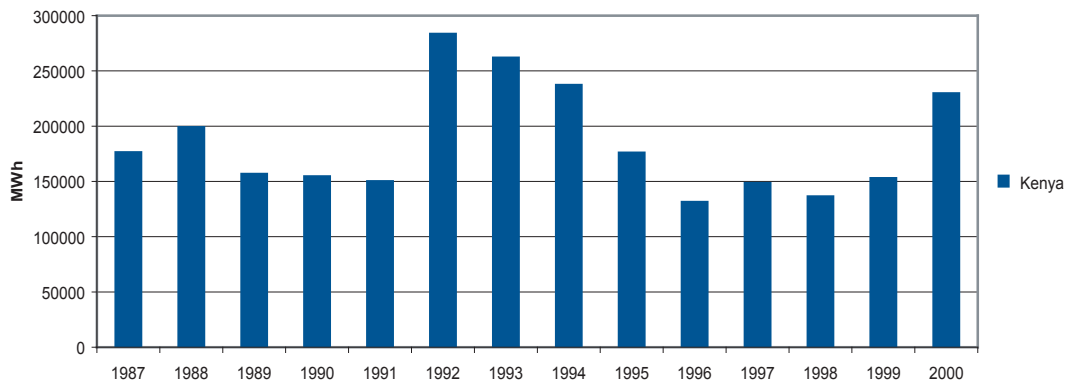
11.00 p.m. – 05.00 a.m. - 30 MW

## (b) Price – US Cents per Unit

Period	Year 1	Year 2	Year 3
05.00 a.m. – 06.00 p.m.	6.5	7.25	8
06.00 p.m. – 11.00 p.m.	6.5	7.25	8
11.00 p.m. – 05.00 a.m.	6	6	6

Following the commissioning of a new generating unit at the Nalubaale Power Station (formerly Owen Falls hydroelectric dam) in May 2000, the two Governments agreed on the increase of Uganda's electricity exports to Kenya from 30 MW to 50 MW after midnight. Uganda was previously supplying 10 MW to Kenya during the peak period at US ¢ 8.25 per unit. Fig. 1 below shows variations in the volumes of Uganda's electricity exports to Kenya varied constantly over the period 1987-2000, particularly between 1995 and 1999 where they were below 200000 MWh (200 GWh).

Fig. 1: Uganda's electricity exports to Kenya (1987-2000)



Source: Uganda Electricity Board (UEB) Report and Accounts of 1999, 2000

More recently, Uganda and Kenya have agreed to increase electricity supplies to Kenya when the 250 MW Bujagali hydropower project on the River Nile is commissioned in 2005/6. The Kenya Power and Lighting Company (KPLC) and the Uganda Electricity Transmission Company Limited (UETCL) signed a new power purchase agreement (PPA) for the additional capacity in Nairobi on 16th January 2002<sup>9</sup>. Under the new Agreement, which supersedes the one signed in 1955, Kenya will purchase 50 MW of firm capacity and an excess of up to 80 MW for a period of 14 years starting February 2006.

<sup>9</sup> Article on "Nairobi to Buy More Electricity From Kampala", from the Nation (Nairobi) of January 17, 2002, in AllAfrica.com

### 3.4 Bilateral agreement between Ghana and Togo-Benin

Ghana's Volta River Authority (VRA) has been supplying electrical power through the Communauté Electrique du Benin (CEB) to the neighboring countries of Togo and Benin since December 1972 under an international Agreement signed in August 1969. The first power exchange agreement between VRA and CEB was for a period of 25 years and VRA contracted to supply an average continuous power in the amount of 50 MW to CEB. This agreement ended in 1997 and a new one for the period 1997 to 2007 was signed. This provides for the supply of a minimum of 300 GWh of energy per year to CEB. VRA is supplying electrical energy to CEB from its Akosombo hydroelectric dam through a 161 kV transmission line consisting of a 130 km line from Akosombo to Lomé, Togo, and a 176 km line to Cotonou, Benin.

Although CEB and VRA have renewed the bilateral contract for electricity supply from end of 1997 to 2007, the non-availability of power output at the Akosombo hydropower station has prevented VRA from meeting its contractual obligations from 1998 onward. Ghana has imported some of its electricity from Côte d'Ivoire for export to Togo.

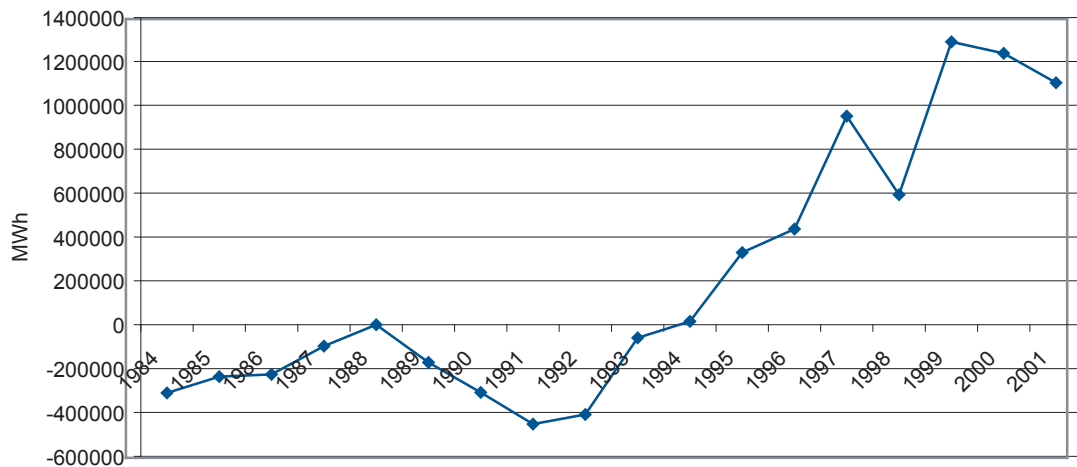
### 3.5 Bilateral agreements between Ghana and Côte d'Ivoire

The electricity grids of Ghana and Côte d'Ivoire were interconnected in June 1983, and in pursuance of the Inter-Governmental Protocol for the interconnection signed in January 1975, VRA has been exchanging electrical power with its Ivorian counterpart, Energie Electrique de la Côte d'Ivoire (EECI) since 27th February 1984. Côte d'Ivoire has been connected to Ghana by a 220-km long 225 kV transmission line since 1983. EECI's role as a power utility has now been taken over by the private consortium, Compagnie Ivoirienne d'Electricité (CIE).

If the bilateral agreement signed between Côte d'Ivoire's EECI and Ghana's VRA in 1984 provided for backup exchanges for emergency support and compensation exchanges made in kind until early 1990s, the balance of electricity supplies between the two power utilities became in favor of EECI/CIE starting in 1995. Due to electric power sector reforms and authorization of independent power producers (IPPs) that took place in Côte d'Ivoire since October 1990, the country succeeded in attracting private investment for two IPP projects, which enabled it to have excess generating capacity, and became a net exporter of energy in the sub-region. Since 1995, CIE has been exporting electrical energy to VRA (and CEB). Until 1999, bilateral agreements between VRA and CIE were lim-

ited to a one-year duration. However, since then, VRA and Côte d'Ivoire have committed to longer term energy supply agreements. Fig.2 shows the evolution of electricity exchange between EECI/CIE of Côte d'Ivoire and Ghana's VRA from 1984 to 2001.

Fig.2: Evolution of electricity exchange between EECI/CIE and Ghana's VRA (1984-2001)



Source: Compagnie Ivoirienne d'Electricité (CIE) – Direction des mouvements d'énergie

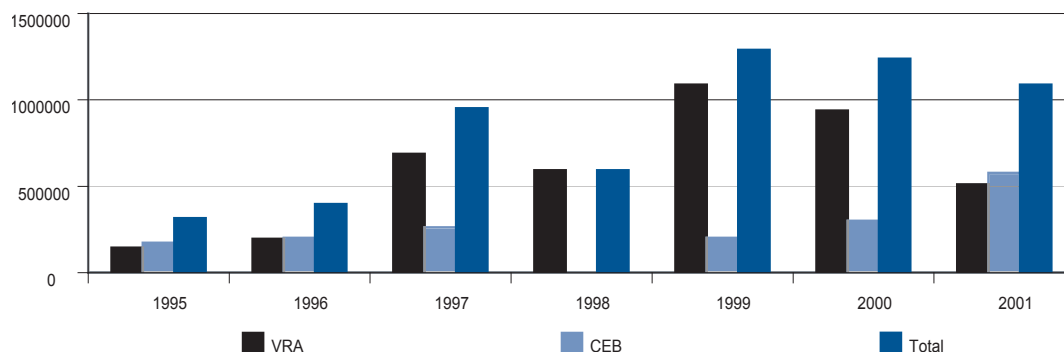
VRA and CIE are now negotiating a triennial, bilateral agreement for the supply of electrical energy at a minimum amount of 1100 GWh/annum. Agreement has already been reached for the supply of a minimum amount of 3300 GWh covering the period 2002-2004.

### 3.6 Bilateral agreement between Côte d'Ivoire and Togo-Benin

The bilateral agreement signed between the CIE and CEB, the bi-national utility of Togo and Benin, came into effect in 1995. Under the terms of this Agreement, CIE has to supply electrical energy for a maximum amount of 200 GWh per year to CEB through Ghana's transmission network.

CEB member countries of Togo and Benin have signed a wheeling arrangement for the transit of their imports from Côte d'Ivoire through Ghana. Although no electricity was exported to CEB in 1998, CIE's exports have significantly increased since then to reach almost 300 GWh in 2000 and 578 GWh in 2001 as shown in Figure 3.

Fig.3: CIE's electricity exports to VRA and CEB (1995-2001)



Source: CIE: Direction des mouvements d'énergie

### 3.7 Bilateral agreement between Côte d'Ivoire and Burkina Faso

The bilateral agreement between CIE and the Société Nationale Burkinabè d'Electricité (SONABEL) was signed and came into effect in April 2001. Under the terms of this Agreement, CIE has to supply electrical energy in a maximum amount of 100 GWh per year to SONABEL. SONABEL's imports from CIE reached a total of 66.665 MWh in 2001.

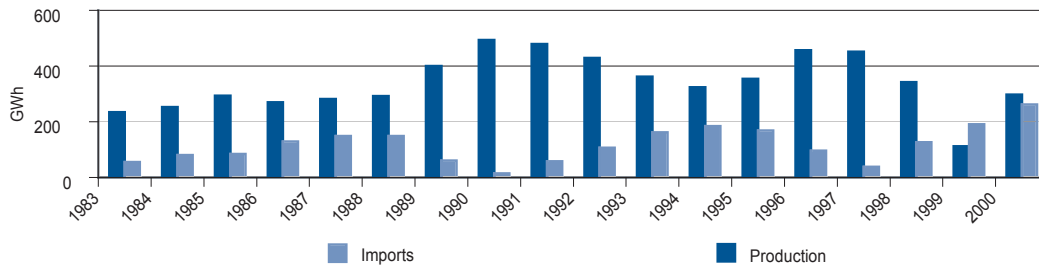
### 3.8 Electricity exchange arrangement between DRC and Congo

According to energy statistics from the Republic of Congo<sup>10</sup>, electricity exchange between the two countries of the Democratic Republic of Congo (DRC) and the Republic of Congo can be traced back to the early 1960s, when Congo was exporting limited quantities of electricity for less than 1 GWh to DRC.

Although these electricity exchanges between the two countries continued until early 1970, the balance became in favour of the DRC after the commissioning of Inga 1 hydropower station in 1972. Volumes of electricity exports from DRC to Congo became more significant starting in 1983, one year after the commissioning of Inga 2 hydropower station when Congo's imports from DRC reached 55 GWh. Figure 4 shows the evolution of Congo's electricity production and imports during the period 1986-2000.

<sup>10</sup> "The Collection of Energy Statistics in Congo" a paper prepared by Mr. Gilbert Nzobadila, Head of the Energy Statistics Department for the "Workshop on Energy Statistics", Addis Ababa, 10-13 Dec. 2002

Fig. 4: Congo's total electricity production and imports from DRC (1983-2000)



Source: National energy statistics and IEA Database

### 3.9 Inter-utility bilateral electricity trading agreements in Southern Africa

Before the establishment of SAPP in 1995, most of the electricity exchange between SADC member countries took place under long-term bilateral agreements between vertically integrated utilities. Zimbabwe's ZESA has been and still is a net importer of electricity, while South Africa's Eskom had been a net exporter of electricity to most of the neighboring national utilities until it resumed its imports from Mozambique's Hidroeletrica de Cahora Bassa (HCB).

Table 3 shows the current bilateral electricity trading agreements signed by Eskom with most of the utilities in the Southern Africa region. It should be noted that agreed firm energy capacities differ according to sources of data.

Table 3: Current trading arrangements between Eskom and neighbouring utilities

Utility	Eskom Purchase (MW)	Eskom Sell (MW)	Eskom Imports (MW)	Eskom Exports (MW)
Botswana (BPC)		200		190
D. R. Congo (SNEL)	110		110	
Lesotho (LEC)		24		85
Mozambique (EDM)		SpecialCase <sup>11</sup>		159
Namibia (NamPower)		200		400
Swaziland (SEB)		175		250
Zambia (ZESCO)	300		300	
Zimbabwe (ZESA)		150		150
Cahora Bassa (HCB)	1080			
<b>Total</b>	<b>1490</b>	<b>749</b>	<b>410</b>	<b>1034</b>

Source of data Eskom Transmission Trading <sup>12</sup> SAPP Co-ordination Centre

ZESA has made use of bilateral electricity trading agreements with various utilities in the Southern Africa region in meeting its energy requirements. It has diversified its sources of electricity supply. After the completion of the construction of the 400 kV power line linking Cahora Bassa power station to Bindura sub-station in northeastern Zimbabwe by end of 1997, ZESA has started importing power in the amount of 500 MW per year. Meanwhile, Eskom has reduced its exports to ZESA from 450 MW to 150 MW since 1999, and SNEL's exports are limited to 100 MW due to constraints in connection with transfer capability of the tie line DRC-Zambia.

Mozambique's HCB resumed its electricity supply to Eskom at the end of 1997 after the rehabilitation of the Cahora Bassa hydroelectric dam, and the reconstruction of the HVDC transmission line linking the power station to South Africa's grid. It also supplies electricity to ZESA in a maximum amount of 500 MW under bilateral contracts since the commissioning of the 400 kV Cahora Bassa - Bindura power line.

SNEL has been supplying electricity from its Inga hydropower station to Eskom and ZESA under bilateral contracts through the HVDC transmission from Inga to Kolwezi, and through a 220 kV transmission line linking Kolwezi to Kitwe in Zambia. SNEL's exports to Southern African countries are constrained by the limited capacity of the 220 kV power line linking DRC to Zambia. Thus, total imports from SNEL amount to 210 MW, including 100 MW for ZESA and 110 MW for Eskom.

### 3.10 Lessons learned from electricity exchange under bilateral agreements

Most of the bilateral agreements listed above initially provided for electricity exchanges between state-owned, vertically integrated utilities, based on least-cost power generation from some major hydroelectric power stations. However, contracting utilities have continued to carry out power generation planning from a national self-sufficiency rather than an inter-country perspective. As a result some utilities have faced problems in meeting their contractual obligations for sustained electricity supply to their importing utilities counterparts.

Most of the bilateral agreements were for firm energy sales, although increasing domestic demand for energy due to economic growth in exporting countries made it difficult to continue to guarantee contractual firm capacity. This is why the amount of electricity to be exported/imported under the terms and conditions of relevant bilateral agreements could not be sustained in some cases.



To be more effective cross-border electricity exchange under bilateral agreements should be supplemented by other pooling arrangements such as coordination in planning and operations of the interconnected systems, as well as dispute resolution mechanisms, particularly in connection with the settlement of outstanding electricity import bills.

## 4. THE SOUTHERN AFRICAN POWER POOL: A MODEL OF POWER POOLING

### 4.1 Historical background

Cooperation in the area of interconnection and regional electricity trade sector among countries in the southern African region can be traced back to the 1950s, with the construction of a power line between Nseke in DRC and Kitwe in Zambia's copper mine in 1958. The interconnection between the Zambia and Zimbabwe power systems followed the construction of the Kariba dam in the 1960s. South Africa was connected to Mozambique via a high voltage, direct current (HVDC) transmission line linking the Cahora Bassa hydroelectric dam to the Apollo sub-station near Johannesburg in 1975.

The drought experienced in the southern African region in 1992, which resulted in severe electricity shortages due to reduced hydro-electricity generation, highlighted the need for formalized regional power cooperation. Regional cooperation in cross-border electricity exchange among the countries of the region became a priority because of the uneven distribution of power resources in the region, as attested by a large reserve of low-cost hydro-electricity in the northern part (especially the Inga reservoir in DRC and the Cahora Bassa reservoir in Mozambique), large cheap coal deposits in South Africa, and the Kariba dam on the border between Zambia and Zimbabwe.

### 4.2 Creation of SAPP

SAPP was created in August 1995 when a majority of continental member countries of SADC signed an Inter-Governmental Memorandum of Understanding (MoU). Later that year an Inter-Utility MOU was signed by the national utilities of the SADC countries that were signatories to the MoU, because membership to SAPP is limited to the national utilities of the twelve continental members of SADC.

The twelve SAPP members are: Angola's Empresa Nacional de Electricidade (ENE) Botswana Power Corporation (BPC) DRC's Société Nationale d'Electricité (SNEL) Lesotho Electricity Supply Commission (LEC) Malawi's Electricity Supply Commission (ESCOM) Mozambique's Electricidade de Moçambique

(EDM) Namibia Power (NamPower) South Africa's Electricity Supply Commission (Eskom) Swaziland Electricity Board (SEB) Tanzania Electricity Supply Company (Tanesco) Zambia Electricity Supply Corporation (ZESCO), and the Zimbabwe Electricity Supply Authority (ZESA).

Due to the fact that some of the SAPP members are not yet connected to the grid, membership is divided into operating and non-operating members. ENE, ESCOM and TANESCO are still non-operating members of SAPP and therefore participate in all activities except those related to the operation of the power pool. Given the increasing activity of IPPs and ITPs, it was deemed necessary to give these new entrants into the regional energy market at least an observer status.

### 4.3 SAPP Governance Issue

SAPP can be defined as an “association of 12 member countries represented by their respective electric power utilities organized through SADC”, and is based on agreements rather than on law. SAPP is governed by four agreements:

- (a) The Inter-Governmental Memorandum of Understanding which enabled the establishment of SAPP;
- (b) The Inter-Utility Memorandum of Understanding which established SAPP's basic management and operating principles;
- (c) The Agreement Between Operating Members which established the specific rules of operation and pricing; and
- (d) The Operating Guidelines, which provide standards and operating guidelines.

The Inter-Governmental Memorandum of Understanding establishes that the SAPP agreements must be interpreted in a manner consistent with the SADC Treaty and that the final and binding dispute resolution forum is the SADC Dispute Resolution Tribunal. The energy ministers are responsible for resolving major policy issues in SAPP and for admitting new members to the pool.

SAPP is organized under the Executive Committee, which acts as the Board of Directors of the Pool, and a Management Committee, which oversees the administration of the pool. Three subcommittees serve under the direction of the Management Committee: the Planning Subcommittee (which focuses on reviewing wheeling rates annually and developing an indicative SAPP expansion plan every two years), the Operating Subcommittee and its associated Coordination Centre, and the Environmental Subcommittee. The Coordination Centre is responsible for such tasks as undertaking most pool monitoring activities, carrying out operating and planning studies, determining transfer limits on tie-lines, administering a regional database, disseminating maintenance schedules, providing technical advice, and fundraising. (see below).

## 4.4 Objectives and Roles of SAPP

### 4.5 Objectives of SAPP

The objectives of SAPP are to:

- Provide a forum for the development of a world class, robust, safe, efficient, reliable and stable interconnected electrical system in the region;
- Harmonize inter-utility relationships;
- Coordinate the development of common regional standards on quality of supply; measurement and monitoring; enforcement of standards; and
- Facilitate the development of expertise through training programmes and research.

### 4.6 Role of SAPP

The role of SAPP in achieving these objectives includes:

- Coordinating the planning and operation of the electric power system among member utilities;
- Reducing both capital and operating costs through coordination;
- Increasing system reliability through emergency support when required; and
- Providing a forum for regional solutions to electrical energy problems.

### 4.7 The SAPP Coordination Centre

The SAPP Coordination Centre is an organization that was established to:

- Implement SAPP objectives;
- Provide a focal point for SAPP activities; and
- Facilitate the Short-Term Energy Market (STEM).

The SAPP Coordination Centre has been established to act not as a control centre but as the organization responsible for the implementation of SAPP objectives. The Centre is located in Harare, Zimbabwe, and commenced operations in February 2000. It provides a focal point for SAPP activities, particularly through the technical oversight of pool operations and facilitating electricity trading. The Centre's primary responsibilities include:

- (a) Opening and developing a spot market for electricity in the region; and
- (b) Managing the transformation of a power pool from a cooperative to a competitive pool with an open market for electricity.

More specifically, the functions of the Coordination Centre include, but are not limited to the following:

- Monitoring:
  - Operation of the Power Pool;
  - Transactions between operating and non-operating members;
  - Time correction procedures;
  - Use of operating guidelines;
  - Inadvertent power flows and the returns in kind between Members;
  - Adherence to the Agreement by Operating Members, inter alia, regarding Accredited Capacity Obligation and calculating penalties for insufficient Accredited Capacity and their re-allocation among members;
  - Availability of the communication links between the Control Centres of the Operating Members and between these Control Centres and the Co-ordination Centre;
  - Protection performance on all tie lines and the co-ordination of their protection; and
  - Calculation and implementation of the various types of reserves;
- Facilitating trading in the STEM;
- Disseminating the generation and transmission maintenance schedules received from the Operating Members and advising on the adjustments that are required to maintain, at all times, the contractual pool reserves and the agreed upon services;
- Performing studies to determine transfer limits on tie lines and informing operating members accordingly. Monitoring adherence of operating members to these limits;
- Gathering and acting as the official custodian of data pertaining to transactions between operating members and non-operating members;
- Providing information and giving advice or support to members of the SAPP in matters pertaining to parallel operations;
- Convening, following a disturbance affecting the parallel operation of the pool, a post disturbance committee;
- Advising on the feasibility of wheeling transactions;

## 4.8 The SAPP Pooling Arrangements

The SAPP Agreements state that the purpose of the Pool is to allow its members to coordinate the planning and operations of their systems while maintaining reliability, autonomy and self-sufficiency and to share in the benefits of operating the pool, including reduction in required generating capacity and reserves, reduction in fuel costs and improved use of hydroelectric energy. The objectives include reduction in investment and operating costs and enhancement of the reliability of supply by providing opportunities to coordinate the installation and operation of generation and transmission facilities.

Under SAPP Agreements each member must meet its Accredited Capacity Obligation, a requirement that each utility must have for sufficient capacity to cover the forecast monthly peak. Each member is also obligated to supply emergency energy for up to six hours, provide automatic generation control and other facilities in its control area, allow wheeling through its system where it is technically and economically feasible, submit maintenance schedules, disclose information and costs related to thermal generating facilities and contribute toward the Centre's costs.

A key element in the operation of the pool is the SAPP pricing arrangement, set out in thirteen detailed schedules in the operating agreement. These schedules cover four broad types of transaction: firm power contracts of varying duration; non-firm power contracts of varying generating reserve, emergency energy, and control area services; and scheduled outage energy, energy banking, and wheeling.

## 4.9 Market Operations within SAPP

Within SAPP regional electricity cross-border trading is governed by fixed cooperative bilateral agreements, generally of a long-term duration. Since April 2001, STEM was introduced and is designed to work over and above the long-term bilateral contracts. The main feature in STEM for power sharing is that the available resources are shared equally to all qualified bidders of energy. The energy dispatch is bid based. This will be replaced by a cost based system.

## 4.10 Electricity trading under bilateral agreements

### Inter-utility power transactions

Inter-utility electricity trading under bilateral agreements is dominated by Eskom both as energy exporter and importer, ZESA, as an energy importer and HCB as an energy exporter. Table 4 summarizes the current bilateral agreements within SAPP.

Table 4: Current SAPP bilateral power trading agreements

Exporter	Importer	Agreed Power (MW)
Democratic Rep. of Congo (SNEL)	Zimbabwe (ZESA)	100
	South Africa (Eskom)	110
Zambia (ZESCO)	South Africa (Eskom)	300
South Africa (Eskom)	Zimbabwe (ZESA)	150
	Botswana (BPC)	190
	Namibia (Nampower)	400
	Mozambique (EDM)	159
	Swaziland (SEB)	250
	Lesotho (LEC)	85
Mozambique (HCB)	Zimbabwe (ZESA)	500
Zambia (ZESCO)	Botswana (BPC)	0
ZPC (Hwange Power Station)	Zimbabwe (ZESA)	0

Source: SAPP Coordination Centre

As indicated above, Eskom supplies electrical energy to the national utilities of Botswana (BPC), Zimbabwe (ZESA), Namibia (Nampower), Mozambique (EDM), Swaziland (SEB), and Lesotho (LEC). Table 5 shows the relative amounts of electricity exported by Eskom to neighbouring utilities during the period 1995-2001.

Table 5: Eskom's exports to neighbouring utilities during the period 1995-2001

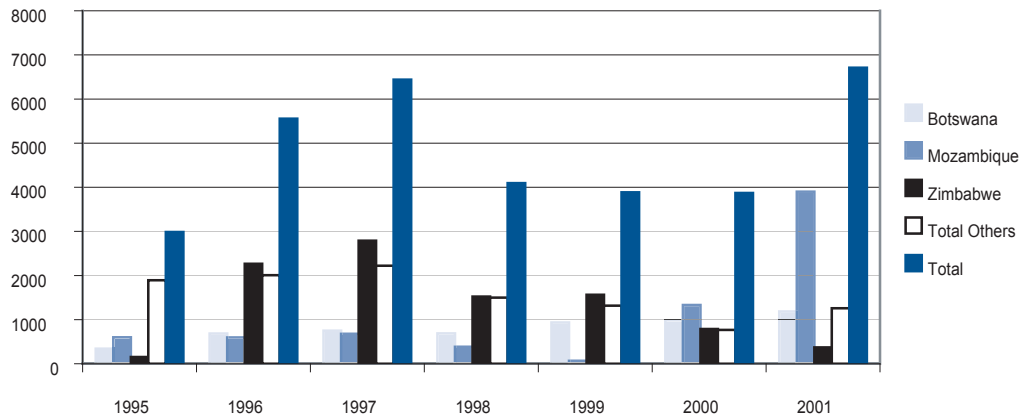
	1995	1996	1997	1998	1999	2000	2001
<b>BPC</b>	340	685	748	689	934	986	1183
<b>EDM</b>	600	596	680	385	68	1331	3899
<b>ZESA</b>	154	2267	2790	1521	1564	788	371
<b>Others (*)</b>	1892	2006	2221	1498	1318	767	1257
<b>Total</b>	2986	5554	6439	4093	3884	3872	6710

Source: Eskom Annual Report 2001

(\*) Others include: NamPower, SEB and LEC

Eskom's exports to ZESA have been declining since 1998 due to ZESA's imports from Mozambique's HCB, while exports to Mozambique recorded a sharp increase starting in 2000 (from 68 GWh in 1999 to 1331 GWh and 3899 GWh in 2000 and 2001 respectively) largely due to the amount of electricity supplies to Mozal Aluminium Smelter in Maputo, Mozambique, as shown in Figure 5.

Fig. 5: Eskom's electricity exports to neighbouring utilities (1995-2001)



Source: Eskom Annual Report 2001

Another major player in power trading through bilateral agreements in SAPP is Zimbabwe. Zimbabwe has diversified its sources of supply following completion of the construction of the 400 kV power line linking Cahora Bassa hydropower station in Mozambique to Bindura sub-station by the end of 1997.

Table 6 shows the relative amounts of electricity imported by ZESA from neighbouring utilities during the period 1994/1995 to 2001. It shows that ZESA's imports from Eskom have declined since 1999, and that its imports from HCB have represented, on average, more than 70% of the total volume of electricity imported during the period 1999-2001.

Table 6: ZESA's imports from neighbouring utilities during the period 1994/1995-2001

	1994/95	1995/96	1996/97	1997/98	1999	2000	2001
<b>Zambia</b>	1093	1445.1	805.2	766.1	62.5	289.2	235.5
<b>DRC</b>	1055.8	729.7	591.3	297.4	115.6	529.8	420.6
<b>HCB</b>	0	0	0	3813.5	3526.3	3484.9	3198.9
<b>Eskom</b>	159.8	1093.6	2615.2	2578.4	1567.1	787.7	208
<b>Others</b>	3	3.1	1.2	5.2	3.2	3	2.5
<b>Total</b>	2311.6	3271.5	4012.9	7460.6	5274.7	5094.6	4065.5

Source: ZESA Transmission Services Department



## Settlement of power transactions

The SAPP Coordination Centre has, among other functions, to monitor the operation of electricity trading among operating members and non-members of the Pool. Settlement of inter-utility power transactions under long-term bilateral trading agreements is governed by the conditions that are attached to such bilateral agreements. In this regard there are four legal documents covering the rights and obligations of the SAPP participants as follows:

- Inter-governmental memorandum of understanding (MoU) grants permission for the utilities to participate in SAPP and enter into contracts, and guarantees the financial and technical performance of the power utilities;
- Inter-utility MoU between participants defines ownership of assets and other rights, for example, provision for change in status from participating to operating member;
- Agreement between operating members determines the interaction between the utilities with respect to operating responsibilities under normal and emergency conditions; and
- Operating guidelines define the sharing of costs and functional responsibilities for plant operation and maintenance, including safety rules.

## 4.11 The Short-term Energy Market (STEM)

Creation and characteristics of STEM

Since April 2001, the SAPP Co-ordination Centre commenced the operation of the STEM which can be characterized by the following:

- It is a firm energy market;
- It is a “competitive” energy market;
- It constitutes a transitional market towards a regional spot market;
- It deals with short-term energy contracts (up to a month); and
- It currently represents 10% of all SAPP trading (volume).

### STEM operations

STEM is, as indicated above, a firm energy market dealing with short-term energy contracts (up to a month) and where electric power is traded on a daily basis for delivery the following day, with full obligation to pay. The energy dispatch is bid-based, and in future this will be replaced by a cost based system.

Trading in STEM involves the following:

- Energy is sold through offers and bids by daily, weekly and monthly contracts;
- Trading is done via email and internet;
- Offers and bids are sent to the Co-ordination Centre;
- Offers and bids are then matched by the Co-ordination Centre and successful bidders are published;
- Trading takes place;
- Unsuccessful offers and bids are published by the Co-ordination Centre on a Bulletin Board; Members negotiate for bilateral trades; and
- Financial settlement follows.

## Participation in STEM

Participation in STEM is open to all operating members and approved participants. The IPPs are required to pay a one-time participation fee, and buyers in the STEM will be levied a 1% administration fee. In addition participants must sign legal documents and comply with governing documents. Currently, volume traded on STEM represents 10% of all SAPP trading.

Five utilities are now participating in STEM: Eskom and ZESA joined STEM at the beginning, followed by Nampower in May 2001, while BPC started participating in December 2001, and EDM in 2002. Participants in the STEM trade energy on a day ahead hourly basis. Bids and offers are set in 1 MW increments. Participants need to be in a SAPP control area (ZESCO control area, ZESA control area or Eskom control area). This permits participants to take advantage of the short-term surplus of the other participants and also to profit from its own short-term surplus. A participant can also use STEM to cover a temporary shortage.

## Settlement arrangements

Payment and settlement in STEM are straightforward. Before participants are allowed to trade in STEM, they are required to provide a security deposit to the Co-ordination Centre. This is to ensure that if the participant fails to pay, the Co-ordination Centre would deduct any such payments from the participant's security deposit and make the settlement to the seller on behalf of the defaulting party.

## 4.12 Regional Electricity Regulation

There is an increasing integration of electricity systems in southern Africa with developments in SAPP providing a platform for further cross-border trade and cooperation. These developments are in line with broad international trends in which neighboring countries agree to form an integrated electricity market. This usually provides significant benefits arising from larger scale economies and shared resources.

Successful regional integration of electricity systems requires a framework for transactions to take place, arrangements for systems operations, a system of tariffs for use of transmission infrastructure, and agreed principles and procedures for dispute resolution. It is important that arrangements be established to remove barriers to trade, while at the same time creating systems that reward transmission operators and create appropriate incentives to invest in transmission capacity.

The project of construction of two 400 kV power lines by the Mozambique Transmission Company (Motraco), a joint ITP of the national utilities of Mozambique, Swaziland and South Africa to supply electric power to the MOZAL Aluminium smelter in Maputo is a typical example of the need for regional regulation. Different legal, regulatory and licensing systems existed in all three countries necessitating complex international agreements and arrangements. Therefore, it is important that arrangements be established to remove barriers to trade, while creating systems that reward transmission operators and create appropriate incentives to invest in transmission capacity.

Thus, the SADC Energy Ministers supported the proposal of the establishment of a Regional Electricity Regulatory Association (RERA) for the SADC region at their meeting held in Kinshasa, DRC, in June 2001. Information and experience exchanges within the envisaged association of regional regulators would become a vital catalyst for widespread regional reform of the electricity supply industry (ESI). A certain critical mass of national regional regulators is necessary to mature the worthy concept within an appropriate regional legal framework.

The objectives of RERA, provided for in its proposed Constitution, would relate to three core areas:

- Capacity building, information sharing and experience sharing among regulators;
- Coordination of regional policy/strategy/legislation, with a view to harmonizing regulatory frameworks that will enhance regional electricity trade and facilitate regional ESI systems integration; and
- Regulatory cooperation on issues affecting the economic efficiency of regional electricity trade with a view to deliberating and making recom-

mendations to the SADC Energy Ministers on issues outside the scope of jurisdiction of national regulators, and to undertake such duties as may be conferred on it through the Energy Protocol.

#### 4.13 The SAPP Pool Plan

The SAPP Planning Sub-Committee (PSC) has developed a twenty-year generation and transmission expansion plan. This plan clearly shows the benefits of coordinated planning and cost reductions that can be achieved over individual utility expansion plans. The coordinated plan requires the expenditure of \$ US 8 billion while the sum of the individual utility expansion plans requires \$ US 11 billion. Thus a saving of \$ US 3 billion can be realized through coordinated planning.

The Pool plan gives the timing and ranking of projects based on minimizing total capital and operating costs using the generation and transmission expansion model provided by Purdue University through the assistance of USAID. Priority power generation projects identified in the Pool plan that should be promoted for the benefit of SAPP as a whole are:

- The Inga 1&2 refurbishment in DRC;
- High Head pump storage in the northern part of South Africa;
- Kafue Lower in Zambia; and
- Mepande Uncua hydropower project in northern Mozambique.

One of the most pressing requirements for SAPP remains the need for a new and upgraded transmission infrastructure. The absence of any transmission connection to the grids of the other SAPP members remains, in the case of both Tanzania and Malawi, a tangible barrier to entry to the market.

The PSC performed the transmission and environmental studies and identified priority transmission projects as being:

- Zambia-Tanzania Interconnection;
- Mozambique-Malawi Interconnection;
- DRC-Zambia Reinforcement ; and
- Interconnection of Angola's ENE.

#### 4.14 Wheeling arrangements

In order to enable bilateral electricity trading between members of the pool, it was decided to apply an interim wheeling rate of 7.5% of the energy price although it was not unanimously accepted by all utilities. However, this has facilitated

remarkable trade in the region, while a study was being carried out to recommend wheeling charges acceptable to all utilities. The Wheeling Rates Study, commissioned to the consultant Power Planning Associates LTD of UK, came up with a proposal of a SAPP Wheeling Model presented to the Coordination Centre in August 2001. The SAPP utilities have come to an agreement to implement the recommendations of the study with some modifications. The study recommended the use a MW-km method.

## 5. THE WEST AFRICAN POWER POOL: A NEW APPROACH TO POWER POOLING

### 5.1 Historical background

Cooperation in the area of electricity trading under bilateral agreements in West Africa can be traced back to the early 1970s. In this regard, Ghana's Volta River Authority (VRA) supplied electricity from its Akosombo hydroelectric dam to Togo and Benin, grouped under the bi-national joint utility, the Communauté Electrique du Benin (CEB) since 1972, and to Côte d'Ivoire since 1984. Two or more countries have also been promoted cooperation in the joint development of hydropower projects, such as Togo and Benin for the construction of the Nangbéto hydropower project, or Mali, Mauritania and Senegal for the development of the Manantali hydropower project.

In November 1999 the ECOWAS Ministers of Energy adopted the indicative master plan for the development of energy production facilities and the interconnection of electricity grids of member States, including the establishment of the WAPP. This was an important step towards the establishment of a formal institutional framework for regional cooperation in electricity exchange.

Subsequently, the Authority of Heads of State and Government have accepted the principles of an ECOWAS energy exchange programme or power pool which would help to facilitate the production and exchange of electrical energy between the countries with surplus and the countries in short supply.

### 5.2 Framework for the establishment of WAPP

The ECOWAS Ministers of Energy adopted an Inter-governmental Memorandum of Understanding (MoU) on the establishment of WAPP at their meeting held in Lome, Togo in September 2000. The MoU set forth the mutual obligations of the Parties to the MoU and created an oversight, coordination, and administrative apparatus; the Steering Committee made up of the Energy Ministers of the Parties who are signatories to the MoU, and the Implementation Committee made up of the Chief Executives and General Managers of the national power utilities, to develop the WAPP under the aegis of ECOWAS.

The obligations of the Parties provided for in the MoU included:

- Supporting the implementation of priority interconnection projects, including rights of way and security;
- Allowing transmission system operators to develop and implement strategies and programs that facilitate regional electricity trading;
- Facilitating the formation and operation of the West Africa Power Pool by undertaking to:
  - Adopt appropriate tariff policies and regulations;
  - Harmonize their respective regulatory frameworks;
  - Enter into inter-government agreements to promote a uniform approach to WAPP's development and regulation;
  - Provide all necessary information and data to WAPP;
  - Facilitate cooperation among operators to administer settlements; and
  - Establish a regulatory framework to govern private investment within the West Africa Power Pool.

This was followed by the adoption of an Inter-utility Memorandum of Understanding by the Chief Executives and General Managers of the national power utilities representing the Transmission System Operators of the ECOWAS member States at their meeting held in Dakar, Senegal, in March 2001.

In the Inter-utility Memorandum of Understanding the Parties agreed to:

- Cooperate fully with the ECOWAS Secretariat to accelerate the implementation of WAPP;
- Cooperate fully with the ECOWAS Secretariat to accelerate the implementation of WAPP;
- Collect, validate and provide needed information and participate in technical and other studies;
- Participate in developing WAPP's framework agreements and governance documents;
- Support and facilitate the adoption of the legal and regulatory framework agreements; and
- Work toward the implementation of the priority generation and transmission projects in the Indicative Master Plan.

The Operators also agreed to work continually toward achieving a common understanding of regional energy economics, optimal resource utilization strategies from both national and regional perspectives in addition to national and regional supply and demand trends. They also endorsed the important principles

of fair, open, and transparent electricity trading; transparent and reliable decision making within WAPP; prompt settlement of transactions; harmonization of national legal and regulatory regimes; facilitating access to and participation in the power sectors by potential investors; and encouraging reforms in the national electricity sectors within the region.

### 5.3 Objectives of WAPP

At its 3rd meeting held in Accra, Ghana on April 5, 2002 the WAPP Steering Committee adopted Resolution No. 1 relating to the “Objectives of the West African Power Pool”. The objectives contained in this Resolution are based on the provisions of the above-mentioned Inter-governmental Memorandum of Understanding (MoU) and the Inter-Utility MoU, as well as on the ECOWAS Energy Protocol.

Henceforth, the WAPP objectives include:

- Institutionalizing more formal and extensive regional co-operation in the development of cost-effective electricity infrastructure and energy trading networks in order to increase energy supply and enhance energy security within the region;
- Improving electricity system reliability and power quality throughout the region;
- Lowering electricity system costs by:
  - Increasing economic trading of power and energy within the region;
  - Optimizing the utilization of energy resources in the region; and
  - Managing the region’s seasonal and weather-related imbalances more efficiently;
- Reducing the overall amount of capital needed for electricity system expansion in the region by promoting implementation of “bankable” projects on a least-cost basis;
- Creating an investment environment for the region’s power sector that will facilitate the financing of priority generation and transmission projects;
- Creating an ongoing forum in which regional power issues can be discussed and worked out within an agreed-upon policy framework and a set of operating principles;
- Creating a transparent and reliable mechanism for the prompt settlement of commercial electricity transactions; and



- Increasing the overall level of electricity service within the region through the implementation of priority generation and transmission projects as the basis for economic development and the extension of paid-for electrical service to more consumers.

## 5.4 The WAPP Institutional Framework

### 5.5 Organizational structure and membership of the WAPP

At the Accra meeting the WAPP Steering Committee also adopted Resolution No. 2 relating to the “Organizational structure necessary for the development of the West African Power Pool”. The Committee resolved that the organizational structure would include a General Assembly, a Board of Directors, Technical Committees for Planning and Dispute Resolution, and a General Directorate responsible for managing WAPP. Until the General Directorate is operational, a provisional management team, operating under the auspices of the Steering Committee, will fulfill the essential functions to achieve WAPP’s initial objectives.

Membership (Assemblée Générale) shall consist of all entities, public or private, who own or operate generation facilities with capacity of 50 MW or more or major transmission facilities in the region, which are physically interconnected and have an impact on system operations in the ECOWAS region. Distribution companies and large energy consumers whose activities may significantly affect the operations of the high voltage grid will also have the right to become members.

### 5.6 Legal and regulatory frameworks

Also at the Accra meeting, the WAPP Steering Committee adopted Resolution No. 3, relating to the “Development of appropriate legal and regulatory framework necessary for the development of the West African Power Pool”. In this Resolution the Committee resolved that all the necessary steps should be taken to create the institution of a regional regulatory body to become operational within three years of this resolution.

The regional regulatory entity to be created shall adopt arrangements for the performance of its regulatory functions deemed necessary as follows:

- Supervise the creation of an effective system for the resolution of disputes and enforcement of the regulatory functions;

- Establish and provide the enforcement of uniform technical rules for the management of trade on the interconnected systems so as to ensure their technical efficiency;
- Review bulk power transactions between systems of member State entities in order to analyse their efficiency and monitor their vulnerability to anti-competitive conduct; and
- Create effective communication with member State governments, regulators and utilities, as to matters of mutual concern to the regional and member State entities such as the prevention of anti-competitive conduct.

Until a regional regulatory body becomes operational, the Steering Committee will carry out the regulatory functions. The ECOWAS Executive Secretariat shall provide assistance to the Steering Committee and the Project Implementation Committee in order to ensure that the regulatory function is fulfilled to the extent necessary. It will be necessary to utilize required expertise in the field of economic regulation in order to:

- Develop a regime of enforceable rules for the provision of non-discriminatory access to generation sources and for the transit of power through the transmission systems of member States in order to ensure maximum efficient free trade in electricity; and
- Develop a related regime for the pricing of such generation and transmission services, which shall be non-discriminatory and designed to maximize efficient trading of electricity on or through the member State systems.

## 5.7 Operation and management of WAPP

According to the main findings of study on “Commercial and Capacity Building for the West African Power Pool Project”<sup>13</sup>, interconnection of national networks into a regional grid and establishment of a power pool implies the creation of separate organizations compatible with the regional sector structure. The study raises some critical issues for the operations of the WAPP. These include:

- (i) Establishing wheeling rates and rules;
- (ii) Setting and enforcing operations standards;
- (iii) Dispatching; and
- (iv) Transactions clearing.

<sup>13</sup> Commercial and Capacity Building Study for the West African Power Pool Project, prepared for ECOWAS and USAID, by PA Consulting Group, September 2002

Wheeling rates and rules used today result from bilateral negotiations. They raise the following concerns:

- (i) The underpaid and overcharged users; and
- (ii) No real guidelines available to specify and limit any right or obligation to wheel. Resolution of these issues is critical for WAPP's development.

Until they are resolved, short-term deals that would save money may not be accomplished because of the burden of non-standard contract negotiation. The ECOWAS Energy Protocol would help to address some of the transmission access issues by defining rights and obligations to wheel power in the ECOWAS region at a conceptual level.

With regard to setting and enforcing operation standards, the level of operational reliability commonly practiced in the different systems facing near-term interconnection is not uniform. Concerns have been raised both about prospects for problems resulting from new interconnections and about possible cross-border causes of historic problems. Operation standards, including protocols for coping with and limiting propagation of disturbances, need to be established in a forum that will be universally accepted by those about to interconnect. While an ad hoc group of operating company representatives could endeavor to address this issue, it would be most naturally addressed by WAPP.

As regards dispatching existing levels of international power trade are controlled through ad hoc arrangements between the parties. There are limitations on existing situations that include:

- (i) Heavy reliance on voice telephone communication between adjacent systems;
- (ii) Lack of data links and telemetry;
- (iii) Differences between systems; and
- (iv) Lack of control of international fault propagation.

Clearly, some remedy is needed, whether it be improvements in existing control meters at the national level coupled with a complex network of contracts to govern their interaction, or a new central pool dispatch/control centre. Either approach will need to:

- Fill the gaps between existing national systems, allowing management of many more and more complex transactions than systems in place can support;
- Offer real time dispatch of IPPs and others to match contracted requirements in another country, supporting full exploitation of flexibility of existing generation;

- Offer real time dispatch to all generations, optimizing use of all generation and minimization of variable cost, of power supply; and
- Bridge language gaps among French, English, and Portuguese speakers.

As for transaction clearing, several potential WAPP participants expressed the strongly held view that WAPP should clear transactions. This would have several effects:

- (i) It would make failure to pay a bill a WAPP issue rather than a bilateral issue; and
- (ii) It would minimize delinquency by netting monies owed to any participant against monies owed by that participant.

Clearing transactions has been a key strength of SAPP and of other pools and pool-like organizations, and could help substantially here in establishing WAPP credibility. A pool will not work if participants do not pay their bills, and netting out payments would mitigate impacts of delinquency by some participants.

## 5.8 Development of the WAPP Interconnected Transmission Grid

Interconnection of electricity grids in West Africa is still underdeveloped, especially in Sahelian countries, while it is fairly developed in coastal countries. This is why the Intergovernmental MoU provided for the setting up of two different zones for the implementation of the WAPP Project. Zone A comprises the following countries: Benin, Burkina Faso, Côte d'Ivoire, Ghana, Niger, Nigeria and Togo; while Zone B is comprises: Cape Verde, Guinea, Guinea Bissau, Liberia, Mali, Mauritania, Senegal, Sierra Leone and The Gambia.

At the Third Meeting of the ECOWAS Energy Ministers (WAPP Steering Committee) held in Accra, Ghana, on April 5, 2002, a report was presented on the progress made in view of mobilizing the necessary funds for financing the following projects:

- Interconnection of CEB-NEPA electricity grids;
- Interconnection of Ghana and Burkina Faso;
- Reinforcement of the interconnection Benin-Togo-Ghana;
- Interconnection of Côte d'Ivoire and Mali;
- Feasibility studies of Sambagalou and detailed studies of Fomi (Guinea);
- The creation and launching of an Information Centre for WAPP;
- Stability study of the interconnected ECOWAS networks; and

- 2nd phase of Côte d'Ivoire-Burkina Faso interconnection (line between Bobo Dioulasso-Ouagadougou).

Concerning the mobilization of financial resources for the implementation of priority interconnection projects, the West African Development Bank (BOAD) and the African Development Bank (AfDB) have already committed resources for the 330 kV CEB-NEPA transmission power line. The entire project consists of a new substation, Sakete, in Benin, a 70 km long single circuit 330 kV overhead line between Benin and Nigeria, an extension of an existing substation (Ikeja) in Nigeria and a fibre optic telecommunication system between Benin and Nigeria.

Other high priority transmission projects include:

- (a) Reinforcement of the capacity of the interconnection Benin-Togo-Ghana by upgrading its voltage from 161 kV to 225 kV); and
- (b) Interconnection of Côte d'Ivoire to Mali, enabling linkage of Zone A and Zone B through the Manantali hydropower station and the associated transmission lines to Dakar and Nouakchott.

## 6. PROSPECTS OF ESTABLISHING OTHER POWER POOLS IN AFRICA

### 6.1 Development of an East African Power Pool

In the East African Community (EAC) region, Kenya, Tanzania and Uganda are developing plans to share power supplies, including a regional energy interconnectivity plan that will enable any EAC country to connect with another nation's electricity supply system. This has led the EAC Secretariat to launch a project on an East African Power Master Plan with expected support from the World Bank. Under this project the three countries are committed to promoting development and transmission of electric power, and interconnection of electricity grids of member States within the EAC.

Electricity exchange under bilateral agreement has existed between Uganda and Kenya for nearly a half-century. Uganda has also extended its electricity supplies to northwestern Tanzania in Bukoba since 1993. Recently, the power utilities of Uganda and Kenya have signed a power purchase agreement (PPA) for additional power supply to Kenya to the amount of 50 MW, effective by 2005 with the commissioning of the Bujagali hydropower project being implemented by an independent power producer. Uganda would be able to tackle the capacity problems in connection with the electricity exports it is actually facing upon the commissioning of the 200 MW Kiira Power station and the completion of the rehabilitation/upgrading work on the transmission line between Uganda and Kenya. In addition Uganda would be able to increase its electricity exports to neighboring Kenya and Tanzania at the commissioning of the 250 MW Bujagali hydropower project.

Recent power shortages in Kenya and Tanzania, resulting from drought, have opened the way for the development of a power grid interconnection between the two countries and Zambia, thereby providing security for electricity supply obtained through the connection of their grid with SAPP. Plans for Kenya and Tanzania to connect their power grids to SAPP are at an advanced stage. Energy ministers from Kenya, Tanzania and Zambia agreed to launch feasibility studies on the interconnection of the electricity grids of the three countries at their meeting held in Lusaka, Zambia in April 2001.

The governments of the three countries also approved a project implementation programme that will allow a review of the studies and ensure that a developer is selected. The governments of Kenya and Tanzania have already commissioned a

feasibility study for a 250 km 220 kV transmission line to interconnect Nairobi to Arusha. In a related development Tanzania and Zambia were planning to carry out a feasibility study for the construction of a 670 km 330 kV transmission line from Mbeya in Tanzania to Pensulo in Zambia, as well as the reinforcement of the Tanzanian interconnection network to facilitate power transfer from SAPP to Kenya. The project will give Tanzania and Kenya access to low-cost, reliable electricity.

## 6.2 Development of a Power Pool for the Great Lakes Region

The Nile Basin Initiative (NBI) launched in February 1999, is a regional partnership within which countries of the Nile basin have united in the common pursuit of the long-term development and management of Nile waters. The Initiative is developing a basin-wide framework and is guided by the countries' Shared Vision "to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources". In the area of energy resources development, actions to be undertaken within the Shared Vision would include hydropower development and pooling, regional energy networks, power interconnection and gas pipelines.

A proposal for a Nile Basin Regional Power Trade Project <sup>14</sup> was developed in March 2001. The project's main components are:

- (a) The establishment of a power forum to support continued discourse and promote power trade among Nile Basin countries; and
- (b) Comprehensive basin-wide analysis of long-term power supply, demand, and trade opportunities in order to inform the planning of multi-purpose river basin management in the Subsidiary Action Programmes (SAPs) <sup>15</sup> of the NBI. Both the components are primarily of a capacity-building and knowledge-sharing nature and will be strengthened within the context of an institution referred to as the Nile Basin Power Forum.

The World Bank and the Energy Sector Management Assistance Programme (ESMAP) had commissioned Norconsult to carry out a study on "Opportunities for power trade in the Nile Basin" in 2000. The study concluded that a basin-wide power trade was unlikely in the near future, because at present there is very limited cross-border electricity trading between the countries of the Basin. The Nile Basin can be considered in two subregions, the Eastern Nile (EN) and the

<sup>14</sup> Shared Vision Programme: Nile Basin Regional Power Trade – Project Document, NBI Secretariat

<sup>15</sup> Within the overall framework of the NBI, SAP will comprise investment projects which provide mutual benefits to two or more countries.

Nile Equatorial Lakes (NEL). The former consists of Egypt, Ethiopia, Eritrea and Sudan while the latter includes the eastern part of the DRC, Burundi, Rwanda, Tanzania, Uganda and Kenya. At present there is no international power in the EN region, and there are also no interconnections in place between the countries of EN region. In the NEL region there is some (bilateral) trade of power at a rather modest level.

DRC, Burundi and Rwanda have jointly developed two hydropower stations (Ruzizi I and Ruzizi II) located in DRC. Ruzizi I is operated by DRC's SNEL, while Ruzizi II is operated by a joint power utility, the Société d'Electricité des Pays des Grands Lacs (SINELAC). According to an agreement with the DRC, Rwanda is at present able to import 3.5 MW from Ruzizi I, while Burundi imports electricity from Ruzizi I based on payment of SNEL's debts to Burundi with a background in the joint financing of the power station. Uganda already supplies electricity to Kenya and to some isolated centres in Tanzania and Rwanda. Rwanda also supplies electricity to the isolated district of Kisoro in Uganda.

There are plans to upgrade the interconnection line between Rwanda and Uganda from 30 kV to 132 kV in order to increase Rwanda's imports from Uganda.

Studies were carried out on the interconnection of the Tanzanian grid and the DRC/East/Rwanda/Burundi interconnected system in relation to the possible development of the Rusumo Falls hydropower project. According to the study, such an interconnection is technically feasible. Therefore, it appears that the power systems of the NEL region could be interconnected in which case they could serve as a basis for the establishment of a whole NEL region interconnected power system network. With the introduction of some flexibility in operation and development planning of generation and transmission facilities, this would ultimately lead to the formation of any form of power pool for the NEL region or the Great Lakes Power Pool.

### 6.3 Development of a North Africa/Mediterranean Power Pool

Electricity exchange among countries in the North African region can be traced back to the early 1950s when Algeria and Tunisia first linked their electricity networks to exchange power in emergency cases. This first emergency link was further strengthened in order to increase exchange capacity. In 1979 the two parties decided to start electric power exchange on a continuous basis, and capacity was increased with the addition of two new transmission power lines with higher voltage in 225 kV and 220 kV. Electricity interconnection between Algeria and Morocco started in 1988 with a 225 kV line. This was strengthened in 1992 with the addition of a second similar line and exchange capacity reached 400 MW.



Electricity interconnection between UMA countries is being given importance with the project aimed at linking Tunisia and Libya with two lines of 225 kV and an exchange capacity of 200 MW. Electricity interconnection between Morocco and Mauritania is also under investigation. Egypt is working on connecting its power grid to the Libyan-Maghreb power grid to the west, and the Gulf Cooperation Council grid to the east. Thus, a 225 kV link between Egypt and Libya became operational in 1998, while a 400 kV underwater link between the electricity grids of Egypt and Jordan was inaugurated in March 1999. In May 1998 Morocco's electricity grid was extended to Spain even though distribution and transmission remain in the hands of the state-owned Office National de l'Electricité (ONE).

It is anticipated that the Mediterranean Power Pool (MPP), which would link the power grids of North Africa (Algeria, Egypt, Libya, Morocco, and Tunisia), Spain and the Middle East (Jordan, Syria, Turkey, and Iraq), would be completed by 2015. The interconnection between Libya, Tunisia, Algeria and Morocco will be upgraded from 220 kV to 400 kV, and is one of the energy priority projects of NEPAD. Morocco and Algeria will be connected to Spain, while Egypt will be connected to the Middle East via Jordan.

## 7. ASSESSMENT OF POWER-POOLING ARRANGEMENTS IN AFRICA

### 7.1 Issues for consideration in assessing power-pooling arrangements

As noted earlier, security and reliability of electricity supply has been the driving force behind power system interconnections and other forms of pooling arrangements. Utilities involved in such interconnections and pooling arrangements could achieve this objective through, among other things:

- (a) Mutual support during emergencies through short-term, non-firm power exchange;
- (b) Sharing generation reserve capacity of the interconnected system; and
- (c) Complementarities in means of production involving hydro- and thermal-based power generation.

Improving the reliability of supply within an interconnected system implies, among other things, that there is adequate generation and transmission capacity available to meet projected customer needs for electricity and reserve for contingencies. Utilities and/or organizations involved in the production and transmission of electricity must therefore ensure that the power generation and transmission capacities are adequate to meet demand. They should also carry out planning of power generation and transmission expansion in an integrated and coordinated manner.

In Africa, a critical issue related to the implementation of bilateral electricity exchange agreements is the necessity for exporting utilities to ensure that there is adequate generating capacity to meet their long-term contractual obligations. Most of these utilities have relied on electricity generated by low-cost hydropower stations built in the 1950s and 1960s, and have not called for investment in new generating capacity required to meet both increasing domestic demand and export obligations.

In assessing the effectiveness of inter-utility bilateral electricity exchange agreements, it is therefore important to consider the extent to which the contracting parties have complied with the terms and conditions of the agreements in connection with the level of transactions, as well as transmission constraints and related wheeling arrangements (if any) and settlement of electricity import bills.

Cross-border electricity exchanges within a multinational power pool like SAPP are being carried out through bilateral trading agreements and STEM, pending introduction of regional spot markets. Issues of importance in assessing the effectiveness of pooling arrangements for a regional power pool include transmission facilities and related reliability conditions for bilateral trading agreements, wheeling arrangements, as well as transparency in setting prices and participation in the operation of STEM and other challenges related to the development of competitive power markets.

## 7.2 Strengths and weaknesses of bilateral electricity exchange agreements

Most of the bilateral agreements considered earlier provided for electricity exchange between state-owned vertically integrated utilities, based on least-cost power generation from some of the major hydroelectric power stations. Exporting utilities have continued to rely solely on the generating capacity of these hydropower stations for decades without considering any new investment in power generation expansion neither by the utilities through their own resources, nor by independent power producers (IPPs). As a result, some utilities have faced problems in meeting their contractual obligations for sustainable electricity supply to their importing partners.

Utilities involved in bilateral electricity exchange agreements have also continued to carry out power system expansion planning from a national self-sufficiency rather than at an inter-country perspective. This can lead to generation capacity constraints due to under-investment in some cases, coupled with over-investment in other cases. The cases of Ghana and Côte d'Ivoire provide a good example of what may happen if power generation expansion planning is not coordinated.

Power sector reform, including authorization of private sector participation in the electricity supply industry as IPPs, can result in timely power generation expansion. For example, Côte d'Ivoire succeeded in attracting private investment for two IPP projects, which enabled it to have excess generating capacity, and become a net exporter of energy in West Africa.

## 7.3 Strengths of bilateral electricity exchange agreements

As already indicated most of the bilateral electricity exchange agreements were signed in the 1950s and 1960s. If it had not been possible to comply with related initial terms and conditions of these bilateral agreements in the case of simple interconnections, most of them have contributed to the development of new interconnections and the signing of new bilateral electricity trading agreements.

They have also contributed to building trust and confidence among neighboring utilities, which could ultimately lead to the creation of regional power pools.

Examples of these developments in new interconnections and signing of related bilateral agreements include:

- The bilateral agreement signed between Uganda and Tanzania in 1993;
- The bilateral agreement signed between Uganda and Rwanda in 1995;
- The bilateral agreement signed between Côte d'Ivoire, Togo and Benin through CEB in 1995;
- The bilateral agreement signed between Côte d'Ivoire and Burkina Faso in 2001; and
- The bilateral agreement signed between Zimbabwe (ZESA) and Mozambique (HCB) in 1997.

Existing bilateral agreements could thus serve as a basis for fostering regional electricity cooperation and integration, and subsequently lead to the creation of formal power pools in the different regions. SAPP, currently the only functioning power pool in Africa, started as a cooperative association of vertically integrated national utilities, and is now moving from a cooperative loose pool to a competitive power pool. The West African Power Pool (WAPP) which is currently being established, will be based on lessons learned from SAPP, as well as existing interconnections and related bilateral agreements during the initial period.

## 7.4 Weaknesses of simple interconnections and related bilateral arrangements

### Inadequacy of generation resources

Most of the bilateral agreements considered earlier provided for electricity exchange between state-owned, vertically integrated utilities, based on least-cost power generated by some hydroelectric power stations. Exporting utilities continued to rely on generating capacity of these hydropower stations commissioned during the 1950s and 1960s, and did not plan investments in new generating facilities required to meet both increasing domestic demand for energy and power for contractual export obligations.

With increasing domestic demand for energy in the power exporting countries, utilities have been facing capacity problems in connection with their export obligations. This has been the case for Ghana's VRA, in connection with its electricity exports to Togo and Benin through CEB, during the second half of the 1990s. This has also been the case for Uganda's UEB electricity exports to Kenya at around the same period.

## Unevenness of electricity supplies

Statistical data on bilateral electricity trade compiled from annual reports of relevant utilities show that exports have often been below the agreed levels in the bilateral agreements. Examples of variations in the volume of electricity traded under some of these bilateral agreements are presented below.

Uganda's exports to Kenya from its Owen Falls hydropower station have been below the agreed level for long periods due to capacity constraints in the power system in Uganda since mid-1990s. As shown in Table 7, the growth rate of electricity exports to Kenya has averaged only 0.9% per year during the period 1993-2000.

Table 7: Variation in volume of electricity exported by Uganda to Kenya (1993-2000).

	1993	1994	1995	1996	1997	1998	1999	2000	AVG
<b>KPLC</b>	261837	237085	175810	131228	148320	136296	152777	229520	
<b>AGR</b>		-9.5	-25.8	-25.4	13.0	-8.1	12.1	50.2	0.9

Source: ECA, Statistical data from the UEB Report and Accounts of 1999 & 2000

VRA has faced serious problems in meeting its contractual obligations in connection with its electricity exports from its Akosombo hydroelectric station to CEB during the second half of the 1990s. VRA's exports to CEB have recorded an average decline of -1.8% per year during the period 1992-1999 as shown in Table 8.

Table 8: Variation in volume of electricity exported by Ghana's VRA to CEB (1992-1999)

	1992	1993	1994	1995	1996	1997	1998	1999	AVG
<b>CEB</b>	485097	310787	400344	284747	348099	422341	459535	325631	
<b>AGR</b>		-35.9	28.8	-28.9	22.2	21.3	8.8	-29.1	-1.8

Source: ECA, Data from the 38th Annual Report of the Volta River Authority, 1999

Volumes of Congo's electricity imports from DRC have considerably varied since exchanges started in the early 1960s. Table 9 shows that the growth rate of Congo's electricity imports averaged about 40% per year during the period 1991-2000, but registered a drop of more than -60% in 1997, due to the civil war in Congo.

Table 9: Variation in volume of electricity imported by Congo from DRC (1991-2000)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	AVG
Congo	58	106	162	139	166	96	38	126	191	262	
AGR		82.8	52.8	-14.2	19.4	-42.2	-60.4	231.6	51.6	37.2	39.8

Source: ECA, Data from IEA Energy Statistics of Non-OECD countries 1999-2000

## Wheeling problems

CEB signed a bilateral electricity supply agreement with CIE, taking effect in 1995, in order to diversify its supply sources. CEB also signed a separate wheeling agreement with VRA for the transit of its imports from CIE. However, CEB was not supplied with electricity in 1998, when its member countries were facing their worst energy crisis.

CEB has paid ¢ US 0.5/kWh of wheeling charges for its imports from CIE. This wheeling tariff doubled to ¢ US 1.0/kWh in mid-2002. Apart from 1998, when there was no delivery for CEB, CIE's exports to CEB have increased over time. Table 10 shows a steady increase in the volume of CIE's exports to CEB with an annual growth rate of more than 90% from 2000 to 2001.

Table 10: Variation in volume of electricity exported by Ivorian CIE to CEB (1995-2001)

	1995	1996	1997	1998	1999	2000	2001	AVG
CEB	171919	201334	262445	0.0	201656	299825	577240	
AGR		17.1	30.4	-100.0		48.7	92.5	17.7

Source: ECA, Data provided by CIE – Direction des mouvements d'énergie

## Delays in payment of electricity import bills

Collection of electricity import bills constitutes one of the most critical problems in bilateral power trading arrangements. One example is the dispute over settlement of outstanding bills by Ghana's VRA to CIE, which amounted to about \$ US 35 million by end of June 2002. Because the contracts signed between the IPPs and the Government of Côte d'Ivoire are of the type "single-buyer model", CIE has continued to supply electricity to VRA while waiting for political intervention for the settlement of VRA's electricity imports outstanding bills.

## 7.5 Assessment of inter-utility bilateral electricity exchange arrangements

Although cross-border electricity exchanges under bilateral agreements between vertically integrated power utilities have worked satisfactorily for many years, the lack of coordinated planning of power system expansion has resulted in generation capacity constraints for exporting utilities, thereby compromising reliability and security of supply. However, these bilateral electricity exchange arrangements serve as the basis for the establishment of regional power pools following the example of SAPP and WAPP.

## 7.6 Effectiveness of the SAPP pooling arrangements

Most electricity trading within SAPP is still via long-term bilateral contracts. In April 2001, the SAPP Coordination Centre introduced a new STEM whereby participants could trade daily volumes on a day-ahead basis on the Internet. This permits the participant to take advantage of the short-term surplus of the other participants and also to profit from its own short-term surplus. A participant can also use STEM to cover a temporary shortage that it may experience.

## 7.7 Bilateral electricity trading agreements

### SAPP transmission grid

The most pressing requirement of SAPP, and the continent in general, remains the need for new and upgraded infrastructure in order to facilitate power-trading transactions. Improved regional transmission network with high-capacity power lines would increase reliability and security of supply by facilitating the diversification of sources of supply, removing energy flow bottlenecks and thereby ensuring better transmission congestion management.

Although the completion of the 400 kV Matimba-Insukamini transmission line linking Eskom and ZESA power systems in October 1995 initiated the first linkage of system operations between the northern and southern electrical systems in the Southern African region, transfer capability in certain sections of the SAPP interconnected grid system is limited. This is particularly the case for the DRC-Zambia tie line, whose transfer capability is limited to 210 MW, and the Zimbabwe-Botswana portion of the Insukamini-Matimba tie line whose transfer capability is limited to 350 MW.

The effect of the interconnections is that countries are able to purchase electricity in bulk from different sources and then redistribute it nationally at cheaper prices. Bulk power supply through the SAPP transmission grid is coordinated via three control areas: ZESCO Control Area for the northern system (SNEL, ZESCO and transfer to ZESA), ZESA Control Area (ZESA imports and transfer to Eskom), and Eskom Control Area for the southern system (Eskom, NamPower, BPC, LEC, SEB, EDM, and transfer to ZESA).

Measures are being taken to upgrade the transfer capacity of the interconnected system. One of the most critical bottlenecks for bulk power transmission on the SAPP grid is Zambia-DRC tie line, which limits the transfer capacity from Inga power stations to 210 MW. Zambia and the DRC are to upgrade the existing interconnection to a much higher transmission level to allow other SADC countries to tap Inga's energy supplies.

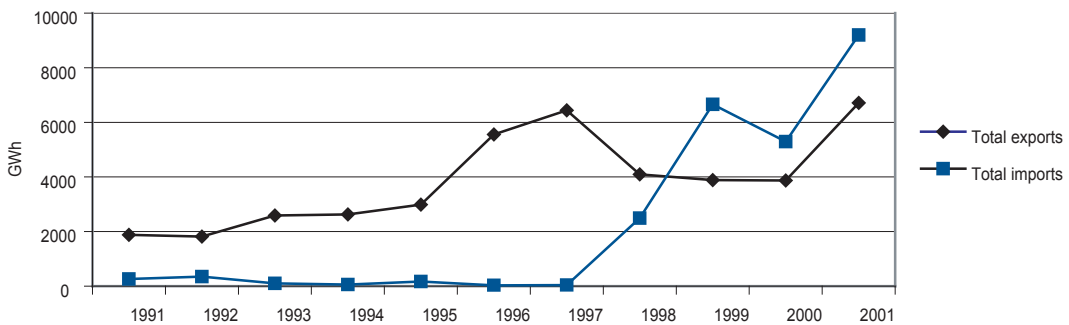
## Diversification of sources of supply

These bulk power transmission facilities contribute to the improvement of reliability and security of supply under bilateral electricity trading agreements within a power pool. Utilities are able to diversify their sources of supply and/or sell electricity to remote customers. Good examples of utilities that have taken advantage of these trading facilities are ZESA (Zimbabwe) and Eskom (South Africa).

Following the completion of the Matimba-Insukamini interconnector, which initiated the linkage of operations between the northern and southern power systems, ZESA and Eskom have increased their electricity imports from DRC's SNEL. But, as indicated above, the total volume of electricity imports from SNEL are limited to 210 MW due to transfer capability of the 220 kV DRC-Zambia transmission line.

After the rehabilitation of the Cahora Bassa hydroelectric dam and construction of the transmission line linking the power station to the Bindura sub-station in northeastern Zimbabwe, ZESA has imported 500 MW of power. On the other hand, Eskom has resumed its imports from Cahora Bassa towards end of 1997 and has become, for the first time, a net importer of electricity since 1998/1999 as shown in Figure 6.

Fig. 6: Eskom Electricity Trade (Total Imports&Exports) during 1991-2001



## Wheeling arrangements

Access to the transmission grid is open to all SAPP members and IPPs in the SADC region. Wheeling charges are, however, payable by the buyer of electricity. An interim wheeling rate of 7.5% of the energy price was decided by the SAPP Executive Committee, and enabled remarkable cross-border electricity exchanges under bilateral agreements in the region. This interim wheeling rate should be replaced by wheeling charges based on the MW-km method.



The application of the interim wheeling rate has often led to disputes over modalities of sharing wheeling revenues. This was the case in a dispute that arose between BPC and ZESA regarding the appropriate sharing of wheeling revenues for power flowing between ZESA and Eskom, a portion of which flows through the BPC 220/132 kV system. In January 2001 a Task Force chaired by the Coordination Centre, composed of representatives of BPC, Eskom and ZESA, was established to determine the technical facts, which could be used as a basis settlement. It was agreed that about 8% of the power flowing between ZESA and Eskom would be subject to a wheeling charge to be collected by BPC.

### **Settlement of electricity import bills**

ZESA, which had imported 13% of Zimbabwe's power needs from Eskom, slipped into arrears in 1999, running into an outstanding balance of 163 million rand (\$ US 20.74 million) by June 2000<sup>16</sup>. The arrears were first converted into a debt repayment agreement that was in place in November 1999. Zimbabwe, however, defaulted, resulting in South Africa cutting its exports to ZESA from 450 MW to 150 MW. Because of the stipulation of the regional South African Power Pool contracts, and the fact that Eskom was also importing power from Zambia and the DRC through Zimbabwe, power supplies to ZESA could not be terminated.

## **7.8 The Short-term Energy Market (STEM)**

### **STEM Operations**

STEM was designed to be a day-ahead and to compliment the bilateral market. Five utilities member of the SAPP were participating in the STEM by mid-2002: BPC, Eskom, Nampower, EDM and ZESA. IPPs such as HCB's Cahora Bassa hydropower station or ZPC's Hwange thermal power station are also participating in STEM. Transactions have often been limited by tie-line capacities available for STEM because bilateral trading agreements take precedence over STEM on the use of the tie lines. Transactions on STEM have increased steadily, recording 68 GWh in June 2002 and 116 GWh in July 2002, an increase of more than 70 %.

### **Pricing issues**

STEM provides another technique for the pricing of electrical energy. Currently, there is no agreed pricing arrangement. Bidders offer varying prices now ranging from 1.24 US¢/kWh to 2.4 US¢/kWh for long-term bilateral, and 0.45 US¢/kWh to 0.65 US¢/kWh.

<sup>16</sup> ZESA to pay upfront for future purchases: Eskom, from the Financial Gazette of March 08, 2001

Although STEM prices are lower than the prices in the bilaterals, bilaterals offer more security of supply than STEM. SAPP members still prefer to be supplied via bilaterals, although in the last few months, some members have opted to use STEM and secure the bulk of their requirements from STEM. Over 30% of ZESA's energy requirements now come from STEM.

### **STEM Performance**

In December 2001, eight months after STEM started, the Coordination Centre requested that all participants in STEM estimate how much they saved as a result of their participation. At the time, it was reported that around \$ US 800,000 had been saved. By end of July 2002, it was estimated that members participating in STEM had saved over \$ US 2.0 million.

## **7.9 Reliability of the SAPP interconnected grid system**

Responsibility for maintaining stability and reliability of operation of the SAPP interconnected transmission grid system is divided between three control areas: ZESCO Control Area, ZESA Control Area and Eskom Control Area. Eskom Control Area is the largest of the three and is responsible for maintaining stability of energy flow through the portion of the interconnected grid system directly concerned by power trade between Eskom and neighbouring utilities of BPC, EDM, Nampower, SEB, LEC, ZESA. The ZESA Control Area which acts as a buffer zone between the other two control areas is responsible for maintaining stability of energy flow through the portion of the interconnected grid system directly related to ZESA's imports from Eskom through the BPC grid, and from SNEL through the ZESCO grid, including direct imports from ZESCO and Mozambique's HCB, as well as wheeling Eskom's imports from SNEL and ZESCO. The ZESCO Control Area is responsible for maintaining the stability of energy flow through the portion of the interconnected grid system directly by ZESCO's exports to ZESA and Eskom as well as wheeling SNEL's exports to ZESA and Eskom through the DRC-Zambia interconnection.

Allocation of transmission capacity within each control area should be in accordance with tie line transfer capability. Tie lines capacity limits in the absence of operational constraints are:

- Eskom Control Area:
  - (i) from BPC to Eskom: 300 MW;
  - (ii) from Eskom to BPC: 450 MW;
  - (iii) from Eskom to EDM: 1000 MW;
  - (iv) from Eskom to NamPower: 750 MW;

- (v) from Eskom to LEC: 230 MW; and
- (vi) from Eskom to SEB: 400 MW.
- ZESA Control Area:
  - (i) from ZESCO to ZESA: 700 MW;
  - (ii) from ZESA to BPC: 350 MW; and
  - (iii) from EDM to ZESA: 500 MW.
- ZESCO Control Area:
  - (i) from SNEL to ZESCO: 210 MW; and
  - (ii) from ZESCO to ZESA: 700 MW.

The different types of energy contracts in order of priority of access to the transmission grid are:

- (a) Bilateral contracts;
- (b) STEM monthly contracts;
- (c) STEM weekly contracts;
- (d) STEM daily contracts; and
- (e) Hourly contracts emanating from STEM.

Because of the priority given to bilateral contracts over STEM contracts and the limited transfer capability of certain portions of the interconnected transmission grid system, disputes have arisen over third party open access when individual utility's interests are at stake. This was the case when Botswana's BPC had to give priority to wheeling Eskom's imports from SNEL and ZESCO and at the same time accommodate its own imports and those of other utilities within the Eskom Control Area from STEM. This is an area of competence for a regional regulatory body.

## 7.10 Challenging issues for SAPP

At the regional level, the role of a regulatory body includes:

- Rules for access to grid;
- Transmission pricing;
- Facilitation of competition;
- Stimulation of regional trade; and
- Incentives to continued development of regional transmission grid system

Although the SAPP Coordination Centre has been playing a key role in technical regulation and conducting studies on system operations, including wheeling charges and other transmission access issues, the necessity still exists for a regional regulatory body to deal with energy pricing matters and dispute resolu-

tion. Indeed, regulatory bodies are at different stages of development in most of the SAPP members, and the SADC Energy Ministers approved the establishment of the Regional Electricity Regulatory Association (RERA) at their meeting held in Kinshasa in June 2001.

### 7.11 Overall assessment of SAPP pooling arrangements

SAPP began as an association of vertically integrated power utilities within the SADC region, and inter-utility electricity exchanges were governed by long-term bilateral agreements. Since April 2001 the SAPP Coordination Centre has successfully introduced the Short Term Energy Market (STEM) designed to complement bilateral arrangements under long-term power purchase agreements (PPAs). It is a competitive energy market (as opposed to a cooperative energy market), where electric power is traded on a day-ahead basis, and constitutes a transitional market towards a regional spot market.

Transactions on STEM have increased steadily, and have involved IPPs such as Mozambique's HCB with Cahora Bassa hydropower station, Zimbabwe's ZPC with Hwange Power Station, and Zambia's KNBC. SAPP already serves as a model for the creation of other regional power pools in Africa as exemplified by WAPP.

However, contracts being operated by SAPP could be seriously limited due to inadequate transfer capability of the tie lines on the interconnected transmission grid system, and conflicting access to transmission grid system for bilateral contracts and STEM contracts. This issue of access to transmission grid system as well as related transmission congestion management will be addressed once a regional regulatory body is created, probably with operationalization of the Regional Electricity Regulatory Association (RERA).

### 7.12 Development of the West African Power Pool (WAPP)

As indicated earlier, WAPP is currently being formed and is taking into account lessons learned from the establishment and development of SAPP. WAPP has thus benefited from technical assistance provided by the United States Agency for International Development (USAID) to carry out studies designed to facilitate the development and operations of the power pool.

These studies include:

- Institutional study;
- Regulatory study; and
- Commercial and capacity building study.

The ECOWAS Secretariat succeeded in establishing a number of partnerships with aid and donor agencies for assistance in the implementation of the WAPP project. USAID, the World Bank, and the Agence Française de Développement, among others, are providing assistance to ECOWAS in various capacities for the implementation of the WAPP project.

However, ECOWAS member countries face tough challenges in connection with the establishment and operationalization of the West African Power Pool. In September 2001, ECOWAS Energy Ministers approved a master plan indicating that an estimated investment of \$ US 10 billion was required for the construction of new electricity generation plants and upgrading and building new, high-voltage transmission lines over the next 15 years.

But ECOWAS officials recognize that the sub-region is hampered in raising such a huge amount of funds via fresh foreign investments owing to its small size and investors' perception of the countries as belonging to a high-risk zone. Detering factors, according to this ECOWAS master plan, include the perceived socio-political instability in the region, even as "both domestic and international investors are discouraged by the high risk they see stemming from West Africa's wars, rebellion, coup, refugees, labor unrest, ethnic clashes and corruption"<sup>17</sup>.

The development of the East African Power Pool is being given a boost with the launch of a study on an East African Community (EAC) Power Master Plan, with financing from SIDA, through the Trust Fund managed by the World Bank. The Study is expected to define the least cost expansion programme for the development of a combined power generation system of the three EAC partner states, and to provide a comprehensive plan for the development of the interconnected power system.

<sup>17</sup> Article on "New Power Projects in West Africa to Gulp \$ US 10b", in the Guardian (Lagos) NEWS of October 3, 2001; Posted to the web October 3, 2001 on allAfrica.com

## 8. CONCLUSION

Experiences of development and operation of power pools in the United States and Europe show that power-pooling arrangements have evolved over time. They have often started as simple interconnections between neighboring utilities to support each other in emergency cases but have developed into more formalized multilateral agreements among owners and operators of transmission, generation and distribution facilities to jointly use their power systems to achieve specific economic and reliability objectives.

Thus, the old style loose and tight power pools have evolved into regional competitive wholesale power markets, while the New Electricity Trading Arrangement (NETA) has replaced the initial Electricity Pool of England and Wales, which was manipulated by power generators. Nord Pool, the Nordic Power Exchange, has become a role model for power-pooling arrangements and the establishment of the new style power pools or competitive wholesale power markets around the world.

In Africa, power pooling through establishment of regional power pools is a recent phenomenon although cross-border interconnections and inter-country bilateral electricity exchange arrangements can be traced back to the 1950s. A key characteristic of these bilateral agreements is that they were concluded between vertically integrated utilities, simultaneously performing the three main functions of generation, transmission and distribution. Arrangements governing these inter-utility electricity exchanges do not provide for coordinated planning of generating capacity expansion in order to maintain and improve the reliability of the interconnected system.

Therefore, utilities tied together by simple interconnections and related bilateral electricity supply agreements are not forming power pools per se. However, these bilateral arrangements deserve the credit of helping build confidence and trust among contracting parties, thereby serving as a basis for creating regional power pools. In this regard, the Southern African Power Pool, which is in operation in Southern Africa region, and the West African Power Pool, which is being established in the West Africa region, are good examples of such developments.

SAPP, the only functioning power pool in Africa, initially defined as an “association of 12 member countries represented by their respective electric power utili-

ties organized through SADC”, was based on agreements rather than on law. It began as a cooperative association of vertically integrated national utilities seeking to equitably share in the benefits of power-pooling arrangements.

Potential benefits of power-pooling arrangements would result in reduction in operating costs through:

- (i) Operation costs due to economic power exchange;
- (ii) Investment costs in additional generating capacity due to least-cost development of energy resources from a regional - as opposed to a national - perspective; and
- (iii) Sharing reserve requirements as a proportion of peak load.

## REFERENCES

African Energy (1999), Weaving the SAPP tapestry, Article from African Energy Volume 1 No. 2, 1999 Resource Publications, Roosevelt Park, South Africa

Aldrich Theunis (2000), The Southern African Power Pool: Meeting the Sub-continent's Electricity Needs, by Theunis Aldrich of the Institute for Global Dialogue, Johannesburg, Global Insight, Issue No.3, October 2000

Boshoff Nicoline (2002), Power Point Presentation on "Transmission Trader: Current Trading Arrangements", Johannesburg, July 2002

ECA (2002), Report ECA/RCID/029/02 of the mission to collect data and information on cross-border electricity trade in the West Africa region; 1-2 July 2002

ECA (2002), Report ECA/RCID/030/02 of the mission to collect data and information in the Southern Africa region, from 26 July-6 August 2002

DOE/EIA (2000), The Changing Structure of the Electric Power Industry 2000: an Update, Energy Information Administration, Washington DC, October 2000

DOE/SEAB (1998), Maintaining Reliability in a Competitive U.S. Electricity Industry: Final Report of the Task Force on Electric System Reliability, Washington DC, September 1998; [www.seab.energy.gov/publications/esrfinal.pdf](http://www.seab.energy.gov/publications/esrfinal.pdf)

ECOWAS (2001), Institutional Study Related to Establishment of West Africa Power Pool, ECOWAS Secretariat, December 2001

ECOWAS (2001), Regulatory Study for West Africa Power Pool Project, ECOWAS Secretariat, December 2001

ECOWAS (2002), Commercial and Capacity Building Study for the West African Power Project; ECOWAS Secretariat, September 2002

EEEOA (2000), Accord cadre relatif au Système d'Echanges d'Energie Electrique Ouest Africain (EEEOA) entre les Etats membres de la CEDEAO (Inter-Governmental Memorandum of Understanding); 29 septembre 2000

EEEOA (2001), Système d'Echanges d'Energie Electrique Ouest Africain (EEEOA): Accord de Cooperation entre les Sociétés d'Electricité des Etats membres (Inter-Utility Memorandum of Understanding); 23 mars 2001



Eskom (2001), Eskom Annual Report 2001, Sandton, Johannesburg, South Africa, April 2002

Eskom Enterprises (2001) Eskom Enterprises Annual Report 2001, Johannesburg, April 2002

FERC (1996), Summary of FERC Order 888: Commission Orders Sweeping Changes for Electric Utility Industry, Requires Wholesale Market to Open to Competition, Convergence Research, 12 May 1996.

FERC (2002), Notice of Proposed Rulemaking on “Remedying Undue Discrimination through Open Access Transmission Services and Standard Electricity Market Design”, Docket No. RM01-12-000, 31 July 2002

KPLC (2001), KPLC Annual Report and Accounts 2000/01; The Kenya Power & Lighting Company Limited

Morey J. Mathew and Hirst Eric (2002), Transmission Business Models: The Role of Independent Transmission Companies in Competitive Wholesale Electricity Markets, November 2002

Musaba Lawrence (2002), Power Point Presentation on The Southern African Power Pool (SAPP), Harare, August 2002

NBI (2001), Nile Basin Regional Power Trade: Project Document, Nile Basin Initiative (NBI) Secretariat, March 2001

NETA (2001), New Electricity Trading Arrangements (NETA), from the website: [www.british-energy.com/education/factfiles/items/item37.html](http://www.british-energy.com/education/factfiles/items/item37.html)

NEPOOL, [www.nepool.com](http://www.nepool.com)

Norconsult (2000), Opportunities for Power Trade in the Nile Basin – Final Scoping Study, Norconsult/Statnett, September 2000

Nordel (1995), Nordel: Development of Nordic Electric Power Cooperation, Report presented to the Annual Meeting of Nordel in August 1995

Nord Pool, [www.nordpool.com](http://www.nordpool.com)

OECD/IEA (2002), International Energy Agency: Energy Statistics of Non-OECD Countries 1999-2000, Paris, 2002

OFGEM (2001), What are the NETA?, from the website: [www.ofgem.gov.uk/elarch/retadocs/golive\\_explained.pdf](http://www.ofgem.gov.uk/elarch/retadocs/golive_explained.pdf)

Restructuring Blueprints, Restructuring of the Electricity Supply Industry in England and Wales; [www.energyonline.com/blueprints/blueprintsint6.asp](http://www.energyonline.com/blueprints/blueprintsint6.asp)

SAPP (2000), SAPP Annual Report 1999; Annual Review report: April 1997-March 1999, Harare, 2000

SAPP (2001), SAPP Annual Report 2001; prepared by the SAPP Co-ordination Centre, Harare, September 2001

The Kenya-Uganda Electricity Agreement, 1995 made between The Uganda Electricity Board and the Kenya Power Company Limited, 15th June 1995; and the four Supplement Agreements

UEB (2000), UEB Report and Accounts of 1999; compiled by Corporate Planning Department, Uganda Electricity Board

Vagma Henrik (2000), Nord Pool: The Emergence of a Nordic Power Market, from the website: [www.infrastructurejournal.com](http://www.infrastructurejournal.com), January/Fabruary 2000

VRA (2000), Volta River Authority 38th Annual Report 1999

WAPP (2002), West African Power Pool (WAPP): Third Meeting of the Steering Committee; Final Report, Accra, Ghana, 5 April 2002

World Bank (1995), Lessons from Power Sector Reform in England and Wales, by Robert Bacon, World Bank Note #61, October 1995

World Bank (1998), Promoting Regional Power Trade – The Southern African Power Pool, by Donald O’Leary, Jean-Pierre Charpentier, and Diane Minogue; World Bank Note No.145, June 1998

World Bank (1999), International Power Trade – The Nordic Power Pool, World Bank Note No. 171, January 1999