# Developing a competitive market for regional electricity cross border trading: The case for the Southern African Power Pool

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## 1. THE SAPP

The Southern African Power Pool (SAPP) is a regional body that was formed in 1995 through a Southern African Development Community (SADC) treaty to optimise the use of available energy resources in the region and support one another during emergencies. The Co-ordination Centre for the power pool is located in Harare, Zimbabwe. The pool comprises of twelve SADC member countries represented by their respective national power utilities, Table-1.

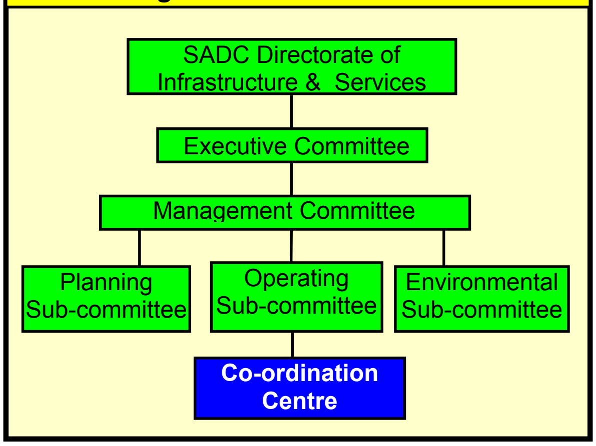
**Table-1**
*Current SAPP Members*

| *Full Name of Utility* | *Country* |
|---|---|
| *Botswana Power Corporation* | Botswana |
| *Electricidade de Mocambique* | Mozambique |
| *Electricity Supply Commission of Malawi* | Malawi |
| *Empresa Nacional de Electricidade* | Angola |
| *ESKOM* | South Africa |
| *Lesotho Electricity Corporation* | Lesotho |
| *NAMPOWER* | Namibia |
| *Societe Nationale d'Electricite* | DRC |
| *Swaziland Electricity Board* | Swaziland |
| *Tanzania Electricity Supply Company* | Tanzania |
| *ZESCO Limited* | Zambia |
| *Zimbabwe Electricity Supply Authority* | Zimbabwe |

SAPP is managed by the decision-making that occurs in the hierarchical structured committees illustrated in Figure-1. Reporting to the Energy Ministers of SADC is the Executive Committee that is composed of the Chief Executives of the participating utilities. Reporting to the Executive Committee is the Management Committee, which is composed of senior managers from the transmission system operations and energy trading divisions of each utility.

The Management Committee collates the proceedings of the sub-committees of Operating, Planning and Environmental, summarizes the proposals and recommendations and presents bi-annually the report to the Executive Committee.

**Figure 1. : SAPP structure**




## 2. THE SAPP GRID

### 2.1 Historic Development

Interconnection and regional bilateral trading in Southern Africa started in the 1950s with the line connecting the Democratic Republic of Congo (former Zaire) and Zambia. The line was meant to supply power to the Zambian mining industry on the Copperbelt province. Interconnection of Zambia and Zimbabwe systems started in the 1960s following the construction of Kariba Dam. In 1975 South Africa was connected to Mozambique via a 533 kV DC line from Cahora Bassa to Apollo.

As a result of these interconnections, two primary electricity networks were created in the region. The first network was the southern network based principally on thermal generation with transmission links interconnecting Namibia, South Africa and Mozambique. The second network was based on hydropower with transmission links interconnecting the DRC, Zambia, Mozambique's Cahora Bassa hydro power station and Zimbabwe (Figure-2). Until the end of 1995, when the 400kV line from Matimba in South Africa to Insukamini in Zimbabwe was constructed, the two systems were linked by 220kV and 132kV lines crossing Botswana.

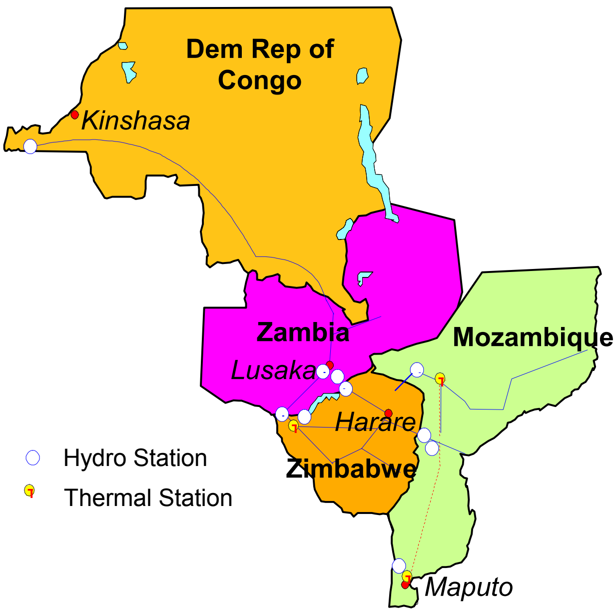



**Figure-2:** The Northern network

## 2.2 Recent Developments

In the last eight years, SAPP has commissioned the following transmission lines:

- The 400kV Matimba-Insukamini Interconnector linking Eskom of South Africa and ZESA of Zimbabwe in 1995. BPC Phokoje substation was tapped into the Matimba line to allow for Botswana's tapping into the SAPP grid at 400kV in 1998.
- The 400kV Interconnector between Mozambique and Zimbabwe was commissioned in 1997 and is being operated at 330kV.
- The restoration of the 533kV DC lines between Cahora Bassa in Mozambique and Apollo substation in South Africa was completed in 1998.
- The 400kV line between Aggeneis in South Africa and Kookerboom in Namibia was commissioned in 2001.
- The 400kV line between Arnot in South Africa and Maputo in Mozambique was commissioned in 2001.
- The 400kV line between Camden in South Africa via Edwaleni in Swaziland to Maputo in Mozambique in was completed in 2000.

## 2.3 Future Developments

### *2.3.1 Western Power Corridor*

The demand for power in SAPP is increasing. SAPP has estimated that after the year 2008, the region will run out of capacity and investment in generation should be done now to meet the future challenge that SAPP will face. A study conducted by SAPP in conjunction with Purdue University (SAPP Pool Plan, 2000) established that the Inga hydroelectric scheme in the Democratic Republic of Congo (DRC) could generate over 39,000MW of power for the region and part of this energy could be exported to other regions.

Inga-I and Inga-II were commissioned in 1972 and 1982 respectively. SAPP is interested in the development of Inga-III in the next ten years to meet the projected demand. The development of Inga III is now associated with the Western Power Corridor (WESTCOR) project.

The WESTCOR project is intended to exploit the environmentally friendly, renewable, hydroelectric energy of the Inga rapids site in the DRC. The Societé Nationale d' Electricité (SNEL) in the Democratic Republic of Congo owns and operates the two existing power stations, Inga-I and II, with a combined output of 1,770 MW. Inga-III is the next phase of the development of the Inga site, with an estimated rated output of 3,500 MW. The final phase is Grand Inga has a potential rated output of 39,000 MW.

The WESTCOR Steering Committee was formed under the auspices of the SAPP to initiate studies determining the technical and economic viability of the Western Power Corridor with source at Inga-III. The WESTCOR Joint Venture Company was registered in Botswana to fund the engineering and financial studies, and to build, own, and operate the infrastructure should the project prove to be viable.

Five utilities are participating in the project. Each utility is represented on the Steering Committee and will own 20% of the share capital of the proposed new joint venture company WESTCOR. The utilities are:

- NamPower, power utility company of Namibia
- Eskom, power utility company of South Africa
- Empresa Nacional De Electricidade (ENE), power utility company of Angola
- Societé Nationale d' Electricité Democratic Republic of Congo (SNEL),
- Botswana Power Corporation, (BPC), power utility company of Botswana

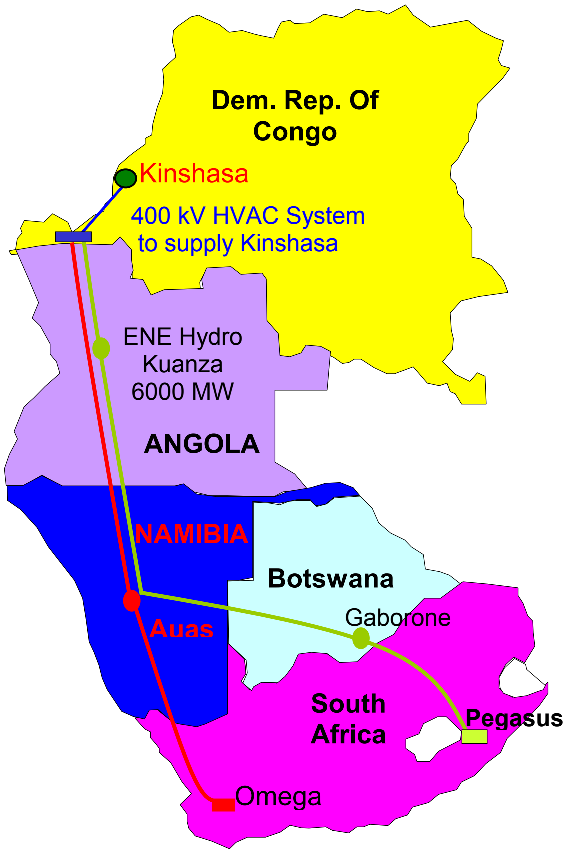



**Figure-3**: Projected WESTCOR transmission lines

### 2.3.2 *Other Priority SAPP Interconnectors*

The SAPP Planning Sub-Committee has identified several transmission projects, which have been classified as priority projects. These include several interconnectors that would improve system reliability and enable the exchange of energy to improve system economy. These projects are at different stages of development.

i.) *Zambia -Tanzania Interconnector* - A Ministerial Committee and a high level technical committee were set up to accelerate the project in view of the imminent shortage of power in Tanzania and persistent shortage of power in Kenya. The eventual Tanzania-Kenya Interconnector makes the project more viable. The whole project is expected to be constructed at 330kV and would move up to 300 MW of power from Southern Africa. The total cost of the project has been projected to be around USD160 million for the Zambia-Tanzania interconnector.

ii.) *Mozambique-Malawi Interconnector* - The Power Purchase Agreement negotiations are still in progress. Malawi requires the project for system security and reliability, particularly if there were a drought. It will also permit the exchange of economy energy. The project involves the construction of a 220kV line from Mozambique to Malawi at an estimated cost of USD46 million. The maximum power is estimated at 300MW. This interconnection may be the beginning phase of a transmission corridor to East Africa.

iii.) *DRC-Zambia Reinforcement* - A team of representatives from Botswana, the DRC, Zambia, Zimbabwe and South Africa is pursuing this project. The project is associated with the refurbishment of Inga-I and Inga-II in the DRC so that additional energy from Inga can be accessed by Countries south of the DRC. The initial phase of the project would include the refurbishment of Inga-I and Inga-II and the construction of a 220kV line from the DRC to Zambia at a total cost of USD94 million. The combined new and existing interconnection is expected to deliver about 500MW firm capacity.

At the end of the interconnection projects the new grid would be as shown in Figure-4.

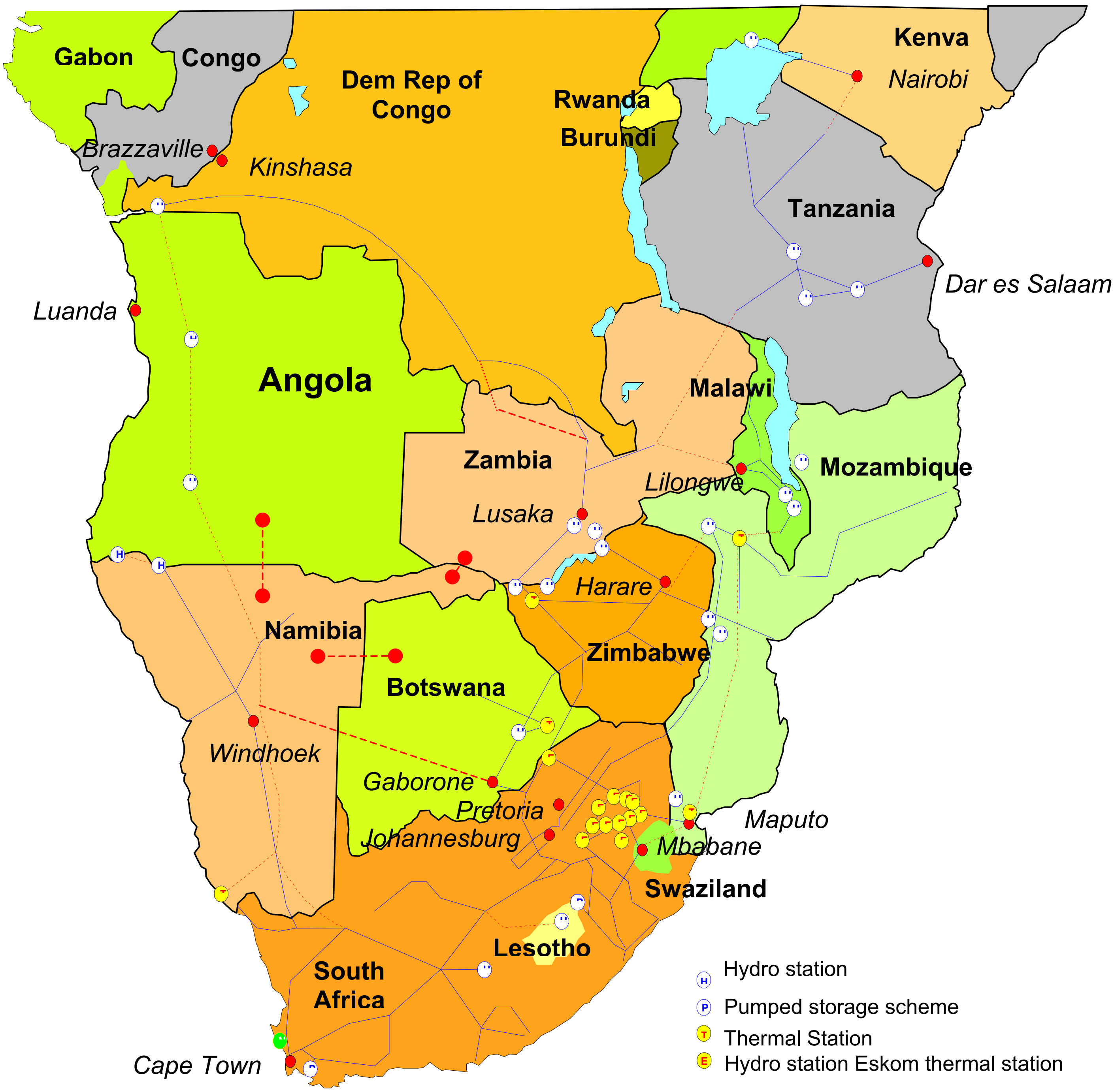



**Figure-4:** SAPP current and future grid

## 3. ELECTRICITY TRADING IN THE SAPP

### 3.1 Bilateral Trading

Based on intergovernmental agreements, the general trading arrangement in SAPP is for the national utilities to engage into long term bilateral contracts for the sourcing and consumption of electrical energy. The intergovernmental agreements and the bilateral contracts form the foundation for cross border electrical energy trading. The routine activities that follow include scheduling, settlements and the monitoring of quality of supply. Further on, based on events, detailed investigations are conducted into inadvertent energy flows and major power system faults and disturbances.

For the bi-lateral contracts, the pricing of electrical energy is negotiated and the outcome is generally based on the classical economics of supply and demand. At times of peak consumption, the price for electrical energy is generally higher and lower during off-peak times. Comparison of the difference in rates for peak and off-peak consumption for four countries in the Southern Africa market is given in Table-2.

The off-peak tariff in most countries is approximately 40% of the peak tariff. This difference promotes new business opportunities. Hence, we introduce a new process for pricing of electrical energy in the short term.

**Table-2**: *Difference in Rates for Peak and Off-Peak consumption for domestic customers with a monthly average consumption of 450 kWh in four countries in the Southern African Electrical Energy Market.*

| Country | Peak to Off-Peak Differences in rates |
|---|---|
| ***South Africa*** | Peak: 0.34 USc/kWh<br>Off-Peak: 0.14 USc /kWh<br>Difference: 0.20 USc /kWh |
| ***Zimbabwe*** | Peak: 0.51 USc /kWh<br>Off-Peak 0.20 USc /kWh<br>Difference: 0.31 USc /kWh |
| ***Botswana*** | Peak: 0.40 USc /kWh<br>Off-Peak: 0.16 USc /kWh<br>Difference: 0.24 USc /kWh |
| ***Namibia*** | Peak: 0.33 USc /kWh<br>Off-Peak: 0.13 USc /kWh<br>Difference: 0.20 USc /kWh |

The time-based differentiation in pricing arises from the physical constraint in that the produced electrical energy must be instantly consumed. The storage of electrical energy is not practical. Energy banking and pumped storage schemes are the exceptions for electrical energy storage for a very small percentage of the total electricity generated.

In 2002, the bilateral energy traded in SAPP is shown in Figure-5.

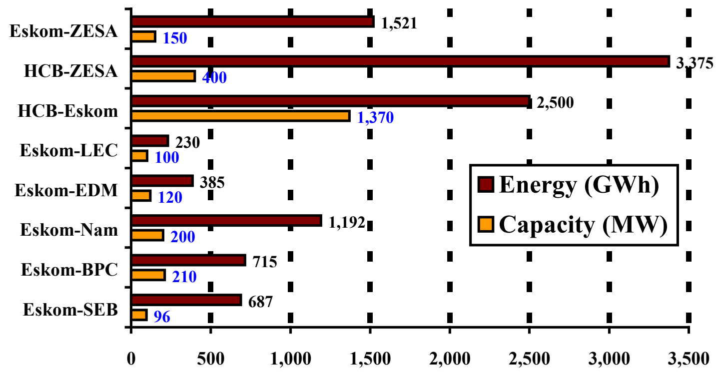



**Figure-5:** SAPP Bilateral Agreements - 2002

### 3.2 New Trading Arrangements

In April 2001, SAPP commenced the Short-Term Energy Market. The Short-Term Energy Market (STEM) designed to be day-ahead, compliments the bilateral market and provides another technique for the pricing of electrical energy in SAPP.

The goal of standard market design is to establish an efficient and robustly competitive wholesale electricity marketplace for the benefit of consumers. This could be done through the development of consistent market mechanisms and efficient price signals for the procurement and reliable transmission of electricity combined with the assurance of fair and open access to the transmission system.

For the design of the STEM, the following criteria were submitted as input:

i.) *Transmission rights* - Long and short-term bilateral contracts between participants have priority over STEM contracts for transmission on the SAPP interconnectors. All the STEM contracts are subject to the transfer constraints as verified by the SAPP Co-ordination Centre.

ii.) *Security requirements* - Participants are required to lodge sufficient security with the Co-ordination Centre before trading commences and separate security is required for each energy contract.

iii.) *Settlement* - Participants have the full obligation to pay for the energy traded and the associated energy costs. The settlement amounts are based on the invoices and are payable into the Co-ordination Centre's clearing account. It is the responsibility of the Participants (buyers) to ensure that sufficient funds are paid into the clearing account for the Co-ordination Centre to effect payment to the respective Participants (sellers).

iv.) *Currency of trade* - The choice of currency is either the United States American Dollar or the South Africa Rand dependent on the agreement between the buyer and the seller.

v.) *Allocation method* - The allocation of available quantities based on the available transmission capability is by fair competitive bidding with equal sharing of available quantities to the buyers.

vi.) *Firm contracts* - Once contracted, the quantities and the prices are firm and fixed. There are currently three energy contracts that have been promoted in the STEM as follows; monthly, weekly and daily contracts.

To commence the design process, three working groups were tasked to detail the parameters for settlements (Treasury Working Group), the parameters for trading (Trading Working Group) and the parameters of governance (Legal Working Group). The working groups were composed of specialists from the participating utilities. The work was conducted over a period of one year.

The results of the working group is summarized and given in Table-3.

**Table 3**: *Summary of Design Features for the Short Term Energy Market.*

| Working Group | Tasked Activities |
|---|---|
| ***Treasury Working Group*** | • Currency of trade.<br>• Security of Payments<br>• Clearing Institution & location<br>• Settlement process |
| ***Trading Working Group*** | • Trading Platform<br>• Wheeling Charges<br>• Trading Rules<br>• Daily Scheduling Procedures<br>• Market Structure |
| ***Legal Working Group*** | • Governance documents<br>• Regulatory Rules<br>• Agreements |

The trading platform for the new competitive short-term market was designed locally.

### *3.1.1 Analysis of Trading Results and Market Performance.*

- Excess capacity prevails in the regional market, generally during the off peak period. Electrical energy prices are generally, on average, lower than that for the bilateral market.
- The number of market participants increased from four in the first year to eight as at December 2003.
- The average tariff of energy traded is in the range from 0.3 to 0.6 USc/kWh. The highest matched price was 1.5 USc/kWh.
- The offer prices tend to increase as we approach the cold winter months when the SAPP regional peak demand occurs. This behaviour concurs with the economics of supply and demand.
- Transmission availability determines the potential volumes of trade. Transmission congestion mainly on the cross border tie lines constrains trade.
- Opportunity for short term trading is available. The highest monthly revenue was equivalent to USD380, 000.00. The figure is projected to increase.

### *3.1.2 Summary of the Day ahead market*

Figure-6 shows the supply and demand situation for the day-ahead market. At the start of the market, the supply was much higher than the demand, until a year after the market had started was when the demand became higher than the supply.

Figure-7 shows the energy traded together with the associated cost of energy. The energy traded on the STEM market has been increasing on a monthly basis. The main constraint to the trading has been the transfer capacity of tie-lines between the northern and the southern utilities.

### *3.1.3 Post STEM Market*

The Post STEM energy contracts are concluded outside of the STEM market between participants through bilateral negotiations. Unallocated STEM bids and offers are published on the Internet and these offers and bids are available for hourly trading on the trading day.
This market started in December 2001 and is now about ten percent of the energy traded on the STEM. A higher tariff than the STEM is agreed and trading takes place the next day. The results of this market are shown in Figure-8.

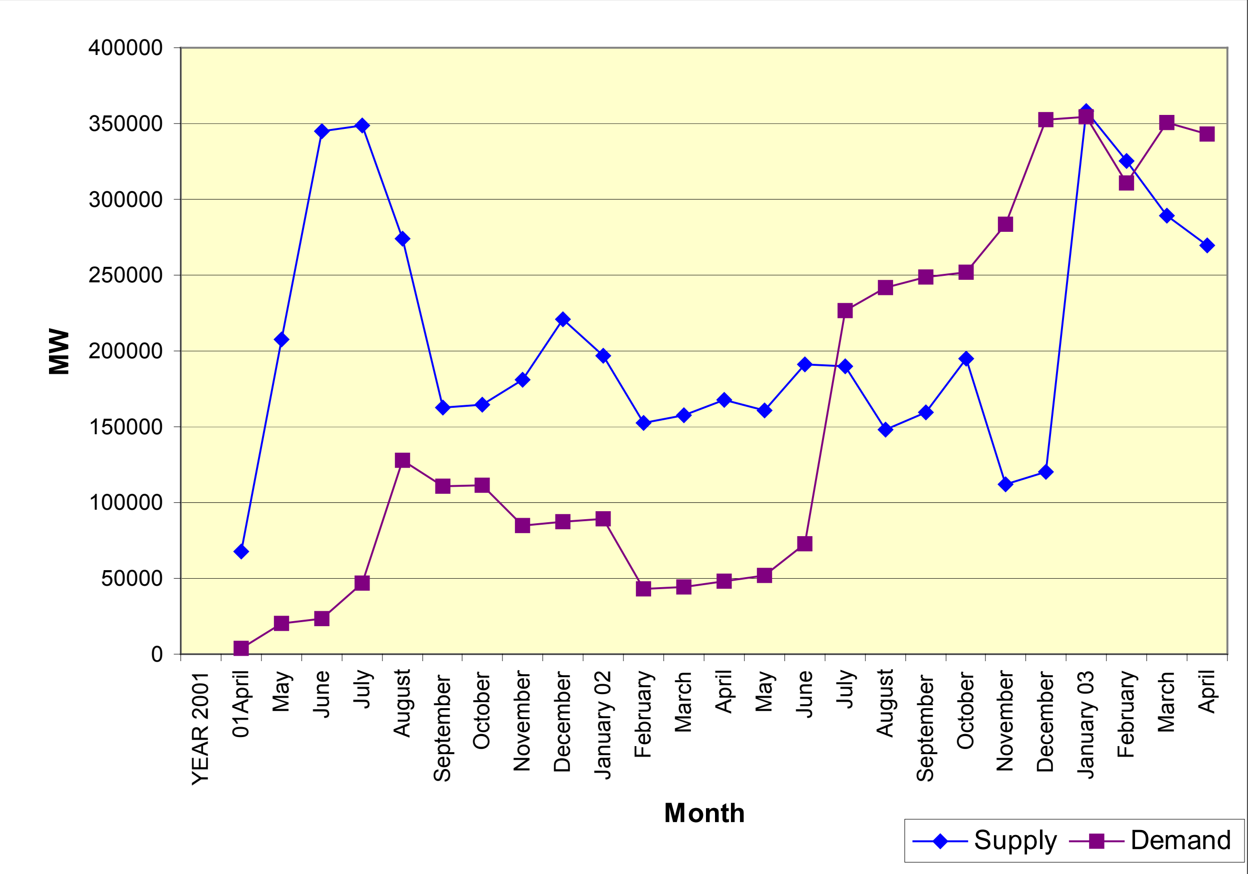



**Figure-6**: Supply and Demand

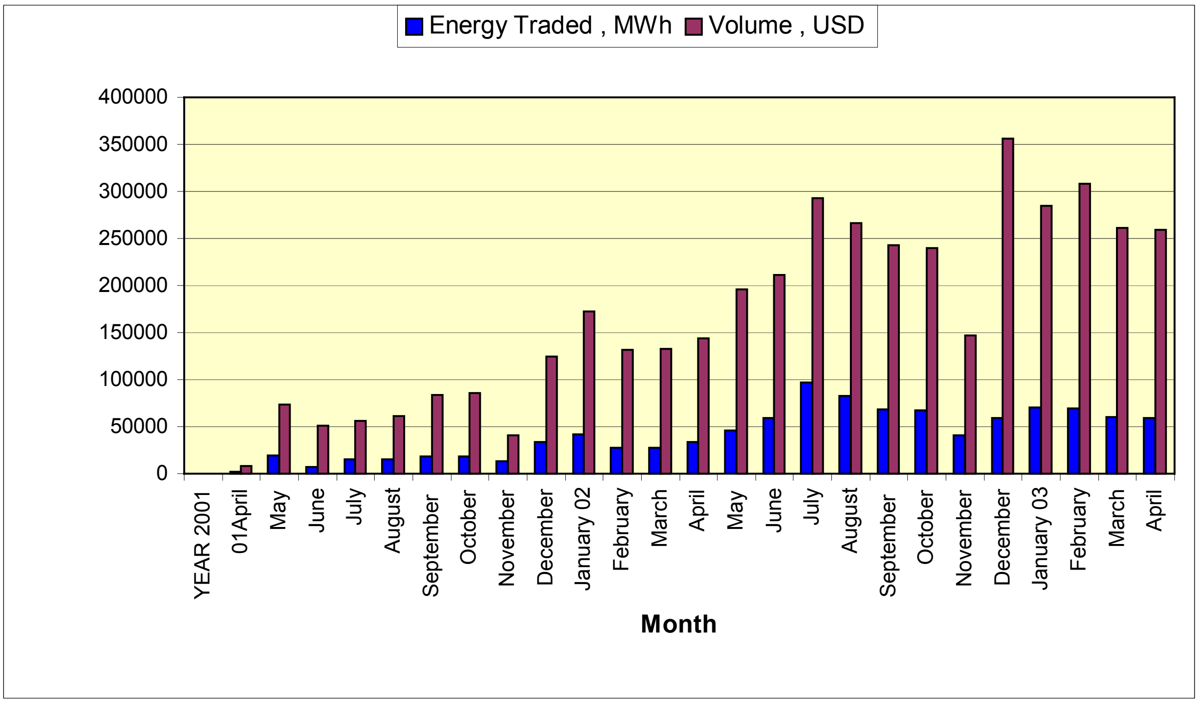



**Figure-7**: Energy and Volume Traded

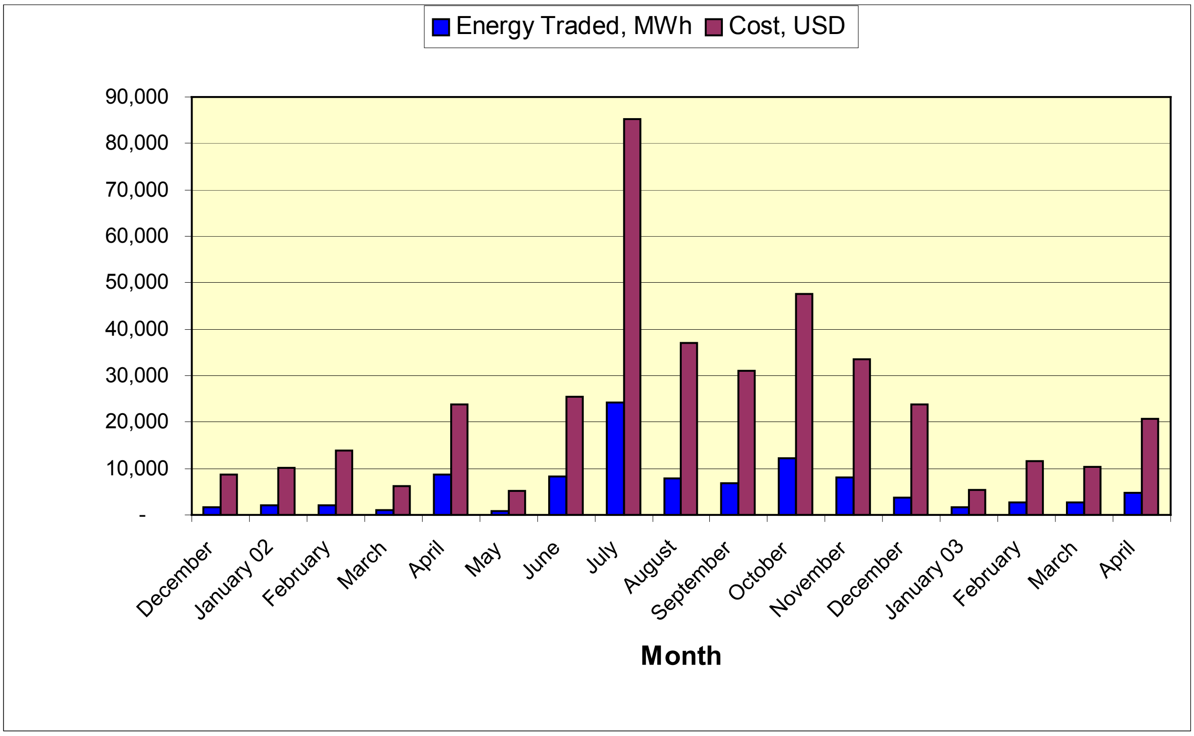



**Figure-8**: Energy and volume traded in the post STEM energy market

## 4 FUTURE TRADING

The bilateral agreements in SAPP provide for the assurance of security of supply but are not flexible to accommodate varying demand profiles and varying prices. SAPP has therefore designed and implemented the short-term energy market (STEM) to specifically mimic a real time dispatch. STEM is designed to be a day-ahead market and compliments the bilateral market through the provision of another technique for the pricing of electrical energy.

The ambition of SAPP is to establish a regional spot market where electricity would be traded in real time and provide the necessary basis for the development of subsequent financial markets.

The development of a spot electricity market in SAPP will be a challenging task. Most SAPP utilities are undergoing a restructuring process and are at different levels of reforms. The challenge for SAPP will be to manage the uncertainties created during the transition period, which will take various shapes and forms as the electricity sectors of member countries are undergoing major reforms. The political commitment towards a regional power cooperation and national restructuring of the sector indicates that there would be no special political risk connected to the creation of a spot market. Equally the commitment and involvement of the national utilities both in planning regional projects and the utilisation of STEM so far indicate that there would be no special risk that these uncertainties will threaten a successful implementation of the spot market.

## 5 REFERENCES


[1] *Principles on Standard Market Design*. Edison Electric Institute. July 2002.

[2] Southern African Power Pool Annual Report 2001.

[3] Southern African Power Pool Annual Report 2003.

[4] Short Term Energy Market - Book of Rules April 2003.