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The Potential of Regional Power Sector Integration

Cahora Bassa | Generation Case Study

Submitted to ESMAP by:

Economic Consulting Associates

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Abbreviations and acronyms

AFUR	African Forum for Utility Regulation
CNELEC	Conselho Nacional de Electricidade (Mozambique energy regulator)
DAM	Day Ahead Market
DRC	Democratic Republic of the Congo
EDM	Electricidade de Moçambique
EPC	Engineering, Procurement and Construction (form of contract)
ESCOM	Electricity Supply Commission of Malawi (but formerly also the Electricity Supply Commission of South Africa)
Eskom	South African electricity utility (formerly called ESCOM)
GPZ	Gabinete do Plano de Zambese (Zambezi Planning Office)
HCB	Hidroeléctrica de Cahora Bassa
HTP	Hidro-Tecnica Portuguesa
HVAC	High-Voltage Alternating Current
HVDC	High-Voltage Direct Current
IGA	Inter-Government Agreement
MFPZ	Missão do Fomento e Povoamento do Zambesi (Agency for the Promotion and Settlement of the Zambezi),
NERSA	National Energy Regulator of South Africa
PJC	Permanent Joint Commission
PPA	Power Purchase Agreement
RERA	Regional Electricity Regulatory Association of Southern Africa
SADC	Southern African Development Community
SAPP	Southern African Power Pool
STEM	Short-Term Energy Market
UCPTE	Union for the Co-ordination of the Production and Transmission of Electricity (in Europe)
ZERC	Zimbabwe Electricity Regulatory Commission

ZESA	Zimbabwe Electricity Supply Authority (now ZESA Holdings)
ZESCO	Zambia Electricity Supply Corporation (now ZESCO Limited)

Preface

This case study is part of an Energy Sector Management Assistance Program (ESMAP) project on Regional Power System Integration (RPSI). The objective of the project is to facilitate and accelerate RPSI projects in developing countries around the world. The project will draw on international experience and theoretical analysis in this area to provide a framework to assess:

- the economic, financial and environmental benefits that can accrue to regional power trading;
- the institutional and regulatory arrangements needed to sustain and optimize regional projects; and
- the ways in which obstacles to integration have been successfully overcome.

The final output of the project will be an umbrella report, *Regional Power Sector Integration – Lessons from Global Case Studies and a Literature Review*. This review will summarize the 12 case studies and literature review undertaken and analyze common themes on barriers to RPSI and solutions to overcome them.

Economic Consulting Associates was contracted to execute the project. In doing so, we are working closely with ESMAP and World Bank staff, as well as government officials, utility, power pool, and regional economic community personnel, and others directly involved in implementing regional power schemes.

This and other 11 Case Studies are prepared as clear, factual presentations of the selected projects. The intent is to provide a direct, easily digestible description of each of the selected projects without imposing an analytic framework or making judgments about the degree of success. Such analysis will be undertaken at the global level, considering the entirety of experiences from the Case Studies, in the aforementioned umbrella report.

All 12 Case Studies follow a uniform structure to facilitate ease of comparison and reference from one Study to the next. Some sections are longer than others, depending on the specifics of the Study. Additionally, there is some cross-referencing within each Study

1 Executive summary

1.1 Motivations/objectives for trade

Cahora Bassa is a 2,075 MW, 13,000 GWh per annum hydropower project on the Zambezi River in Mozambique established to supply power to South Africa via 1,400 km of high-voltage direct current (HVDC) transmission lines, with a small component set aside for supplies to Mozambique. The project was conceived during Portuguese colonial rule chiefly as a demonstration of Portugal's commitment to Africa and desire to bring economic development to its colonies.

Although there was an element of wanting to be seen to be working with other countries by the apartheid government, the motivation on the South African side was principally to have a source of supply of electricity which did not add to the environmental burden associated with coal-fired power stations. At the time the project was conceived, the issues in this regard were to do with air pollution and usage of scarce water resources. Greenhouse gas concerns are also significant in any contemporary environmental assessment of the project.

1.2 The trade solution put in place

The Cahora Bassa dam was being completed just as Mozambique achieved independence in 1975. During the subsequent civil war in Mozambique, the HVDC power lines were put out of operation in 1981 and a rehabilitation project was needed in the mid-1990s before flows of power could resume to South Africa. In the meantime, Zimbabwe negotiated a share of the Cahora Bassa output and built a high-voltage alternating current (HVAC) transmission line which was commissioned in 1997, one year before flows of power to South Africa finally resumed via the HVDC interconnection. Power is also supplied to Mozambique itself, partly through direct connections in central and northern Mozambique and partly in southern Mozambique through a buy-back arrangement from the South African utility Eskom.

The Cahora Bassa project is operated by a company set up for this purpose, Hidroeléctrica de Cahora Bassa (HCB). This was initially majority owned by the government of Portugal, but the Mozambique government became the majority shareholder in 2007. The payment to the government of Portugal for 67% of HCB shares was US$950 million (US$250 million of which was from HCB funds). This was after what is said to be a 90% write-down of the outstanding debt to the government of Portugal.

1.3 Current status and future plans

The current situation is one in which HCB is being operated at full capacity to satisfy markets in South Africa, Zimbabwe and Mozambique itself. The bulk of HCB firm energy goes to Eskom (around 55% or 1,150 MW). This includes an allowance of 300 MW that is sent back to EDM via the buy-back arrangement whereby Eskom supplies Maputo with power. Other direct HCB customers are EDM in central and northern parts of the country and the Zimbabwe Electricity Supply Authority (ZESA). A small amount also goes to other southern African utilities that belong to the Southern African Power Pool (SAPP). These other customers share the 925 MW not committed to Eskom, with only a portion of this being supplied on a firm basis.

With the shortage of generation capacity in the SAPP region, the Mozambique government though HCB is in a much stronger position to negotiate higher tariffs for exports than have previously applied and hence to derive greater national benefit from the export aspects of the Cahora Bassa project than was the case in the past. In terms of direct electricity benefits for Mozambique, the country currently relies on Cahora Bassa for nearly 90% of its electricity supplies.

Immediate HCB plans are to build the 200 kV interconnector with Malawi, but there is little room to accommodate Malawi's import needs when Cahora Bassa capacity is already being intensively used. Future plans are to develop additional hydropower capacity on the Zambezi—probably Mpanda Uncua downstream of Cahora Bassa first and then the north bank power station at Cahora Bassa, installing at least 850 MW. The ultimate capacity of Cahora Bassa (north and south bank) is said to be 3,300 MW.

2 Context for trade

2.1 Economic and political context[1]

Cahora Bassa is a 2,075 MW hydropower project on the Zambezi River in Mozambique, supplying power primarily to South Africa via 1,400 km of high-voltage direct current (HVDC) transmission lines. There are also HVAC lines supplying Cahora Bassa power to parts of Mozambique and to Zimbabwe. Cahora Bassa is located at Songo on the Zambezi River, downstream of the Kariba Dam—see Figure 1. The dam and the power station are owned and operated by the Mozambique-registered company Hidroeléctrica de Cahora Bassa (HCB).

Figure 1 Location of Cahora Bassa

The project was conceived during Portuguese colonial rule, and the dam was being completed just as Mozambique achieved independence in 1975. The turbines were commissioned in 1975–1977. By the end of 1980, however, the HVDC transmission lines had been put out of commission by sabotage linked to the Mozambique civil war that gathered momentum in the early 1980s. It was only in 1998 that the HVDC transmission lines would be recommissioned.

[1] Given the origins of the Cahora Bassa project more than four decades ago, this case study has more historical content than others. The contemporary economic and political context in Mozambique, South Africa and elsewhere in Southern Africa is given in the companion case study on SAPP.

The vicissitudes the project has been through are the result of the military and political struggles which resulted in significant changes in the character of the states involved. Colonial Portugal, minority-ruled Rhodesia, and apartheid South Africa gave way to independent Mozambique (1975), independent Zimbabwe (1980), and majority rule in South Africa (1994). The establishment of a democratic government in South Africa made it possible for the Southern African Power Pool (SAPP) to be formed in August 1995.

When the Cahora Bassa project was designed in the late 1960s, the HVDC transmission lines were deliberately routed around Rhodesia/Zimbabwe because keeping the lines in Mozambique was deemed to be a more secure option. In the event, the lines proved impossible to protect during Mozambique's civil war, and the Cahora Bassa generators had to remain all but idle for nearly two decades.

Once a transmission line had been built from Bindura in Zimbabwe to Cahora Bassa, exports from Cahora Bassa could resume. Given the original avoidance of the neighboring country, it is somewhat ironic that Zimbabwe came to be supplied with electricity in 1997 before supplies were restored to South Africa in 1998. Since that time, Zimbabwe has remained a significant market, notwithstanding difficulties in obtaining payment as the economic crisis in Zimbabwe unfolded from the year 2000.

2.2 Supply options

At the time the project was being conceived, the only market outside of the small electricity requirements in Mozambique itself willing to commit to import Cahora Bassa power was South Africa. As part of the negotiations, all of the capacity except that required for local supplies was allocated to Eskom, so that decades later the Zimbabwe Electricity Supply Authority (ZESA) had to obtain Eskom's agreement to release some HCB capacity before Zimbabwe could import Cahora Bassa supply. From this perspective, it is the supply and demand conditions in South Africa which need to be the primary focus in this and the next section of this case study.

For South Africa, the attraction of Cahora Bassa was low-cost power that did not involve the building of additional coal-fired power stations, which would put further pressure on scarce water resources and add to air pollution. In the late 1960s, South Africa had an installed capacity of around 7,000 MW, most of which was coal fired, so the power purchase agreement with HCB for up to 2,075 MW was a proportionally large source of supply.

During the 1970s and 1980s, Eskom rapidly increased its installed generation capacity, most of this being coal-fired but with some hydropower plants and a controversial nuclear station at Koeberg outside Cape Town (1,800 MW, commissioned in 1984). By the time the tariffs for the resumption of HCB power flows were being negotiated in 1997 and 1998, nominal installed capacity was just short of 40,000 MW.

Demand growth had been very rapid in the 1960s and 1970s, but had slowed in the 1980s (see next section). This had not been anticipated in the generation planning, and as a result there was excess capacity available (peak demand in 1998 was only 27,800 MW). This put Eskom in a strong position vis-à-vis HCB in negotiating the tariff for the resumption of electricity exports to South Africa.

2.3 Demand

Electricity demand growth in South Africa was 8.8% per annum in the 1950s and continued at high levels in the 1960s (8.1% per annum) and 1970s (9.6% per annum). Eskom planners clearly anticipated that high levels of growth would continue, but in fact in the next two decades the annual average rate of growth in electricity demand fell steeply to 4.5% per annum in the 1980s and 2.7% per annum in the 1990s. The reduced levels of growth reflected poor performance in the South African economy associated in part with the isolation of the apartheid regime and, after the installation of the democratically elected government in 1994, uncertainty about the country's economic policies.

GDP growth rates have improved in the new millennium from 1.8% per annum over 1991–2000 to 3.1% per annum over 2001–2008, but in the face of the global recession, GDP is forecast to fall by 0.3% in 2009.[2] Despite lower rates of GDP growth, the excess generation capacity "overhang" from the 1980s was finally eliminated around 2007, with rolling load shedding having to be implemented in 2007 and 2008. One side effect of the global recession is that the closure of mines and reduction in levels of activity by other electricity-intensive industries, together with a demand-side management programme, have succeeded in removing the necessity for load shedding in 2009. However, with the underlying rate of growth in electricity demand in SAPP being 4.6% pa, adequate reserve margins to meet regional demand are only projected to be restored around 2013.[3]

2.4 Energy tariffs

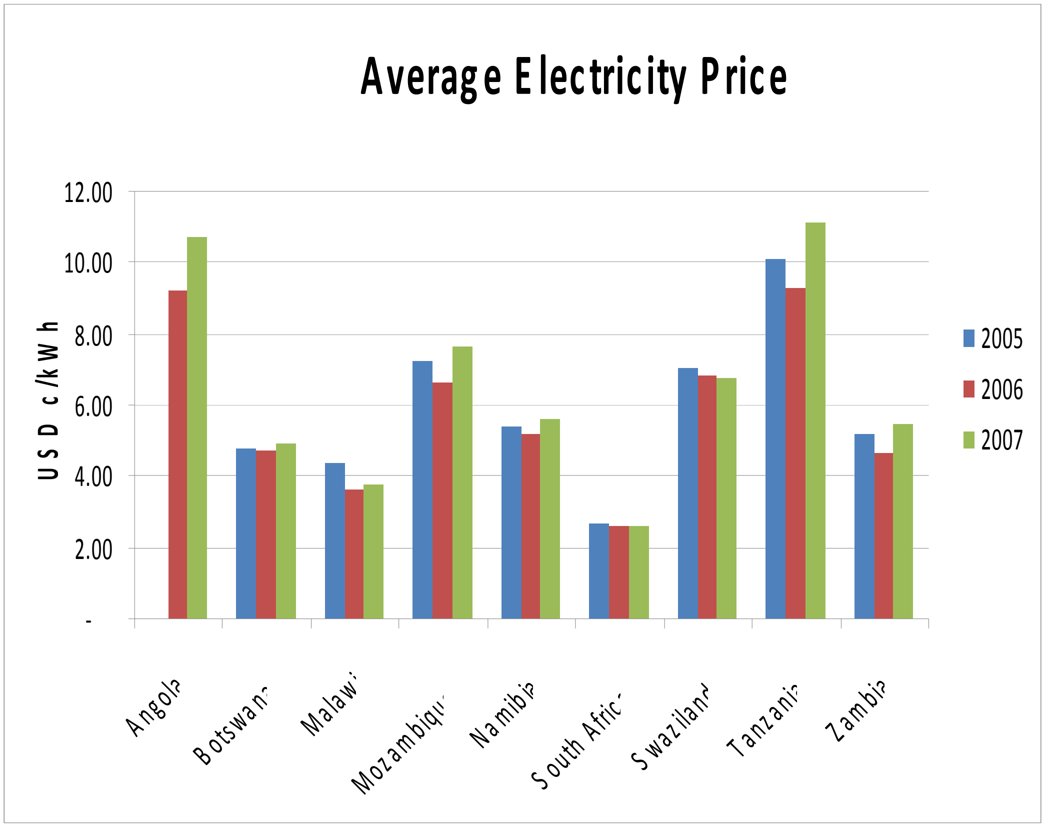
Low electricity tariffs in SAPP have been cited as part of the reason why the imbalance in supply and demand has arisen in the region in recent years. A tariff study conducted in 2008 by the Regional Electricity Regulatory Association of Southern Africa (RERA) concluded that electricity tariffs are generally not cost reflective and are insufficient to sustain the industry, failing to provide the correct signals for new investment and energy efficiency.

Figure 2 provides a summary of the results of the study (data refer to final user electricity tariffs averaged across all tariff classes). It shows tariffs in Mozambique to be in the range of 6.5 to 7.5 US cents per kWh in recent years.

[2] International Monetary Fund (2009).

[3] Details are provided in the companion SAPP case study.

Figure 2 Average Final User Electricity Tariffs 2005-2007



Source: RERA presentation to Maputo Energy Ministers' Meeting, April 2009

Historically, electricity tariffs have been particularly low in the key South African market. In 2002, for example, Eskom's average retail tariff was 15.0 Rand c/kWh, equivalent to approximately 1.4 USc/kWh. Since that time the average selling price has risen to 19.5 Rand c/kWh in 2008, but in US dollar terms the tariff has hovered around 2.5 USc/kWh over the period 2005–2008. The long-run marginal costs and cost of electricity from newly built capacity has been estimated by SAPP to be multiples of this level, 7.5 USc/kWh for conventional coal, for example, and 10 USc/kWh for nuclear.[4]

[4] Figures calculated from Eskom Annual Report. Future unit costs from RERA presentation to SADC Ministers of Energy in Maputo, April 2009. A 34% interim increase in electricity tariffs was approved by the South African regulator in June 2009 and implemented from 1 July. The multi-year tariff increase will be announced once the financing of Eskom's capital expenditure program has been agreed upon.

3 History of scheme

3.1 Overview including timeline/chronology

The origins of the Cahora Bassa project go back to the formation of the *Missão do Fomento e Povoamento do Zambesi* (MFPZ) (Agency for the Promotion and Settlement of the Zambezi), which was set up by the Portuguese government in 1957. The MFPZ was well staffed, and it effectively took about one-quarter of the land area of Mozambique out of the sphere of administration in Lorenço Marques (now Maputo), putting this part of the colony directly under the control of Lisbon. The first comprehensive plan for the development of the Zambezi was produced by MFPZ in 1965; see Table 1 for a summary of the chronology since that time.

Adverse security conditions greatly impeded the construction of Cahora Bassa and the operation of the facilities for two decades thereafter. When construction began in 1969, the Mozambican war of independence was already well underway, with the Cahora Bassa project being a particular target. After independence, the new government embraced the project, but when the country entered a period of civil war, the HVDC transmission lines were severely damaged by dissident groups backed by the South African government, and transfers of electricity to South Africa were stopped for over 17 years.

The original agreement and supply contract were suspended under *force majeure* and amended in an agreement reached in Cape Town in 1984. This agreement included new commitments to the security of the transmission line, with the governments of Mozambique and South Africa expressing the intention to take necessary measures to protect the line and to share the costs between them. However, the damaged lines remained out of service, and their rehabilitation did not begin until 1995 when a construction contract was awarded to a consortium of international engineering firms. Work on the first line was completed in 1997, and full operation was restored in 1998. The tariff agreement had to be reviewed yet again to take account of the costs of rehabilitation of the project.

The project was always intended to be primarily for exports to South Africa, although there was from the start provision for a small allowance to meet the electricity needs of Mozambique. Faced with shortages of power in the wake of the 1992 drought, Zimbabwe sought to import electricity from Cahora Bassa. Following negotiations with Portugal, Mozambique, and South Africa, which had prior claim on Cahora Bassa power, Zimbabwe constructed a 400 kV AC transmission link to Cahora Bassa which was completed in December 1997. Exports to Zimbabwe took place before power flows were restored to the HVDC lines to South Africa.

The original contract for Zimbabwe was for the period ending December 2003, after which it was envisaged that South Africa would get the full output from the existing power station on the south bank and Zimbabwe, among other countries, would get power from a proposed 850 MW power station on the north bank. In addition, Zimbabwe expected to have developed additional generation capacity at Hwange, Batoka and Kariba.

Table 1 Cahora Bassa Chronology

Year	Event
1957	Formation of Missão do Fomento e Povoamento do Zambesi (MFPZ)
1965	MFPZ complete the *Plano Geral* for the development of the Zambezi
1966	Portugal and South Africa sign Heads of Agreement for Cahora Bassa project
1969	Engineering, Procurement & Construction Contract, Inter-government Agreement and Power Purchase Agreement are signed, dam construction begins
1974	Portugal-Mozambique Peace Agreement is reached, completion of the Cahora Bassa dam
1975	Mozambique independence, first generation from the Cahora Bassa power station, creation of Hidroeléctrica de Cahora Bassa
1977	Commissioning of the remaining HCB turbines; first revision of the tariffs agreed between HCB and Eskom
1980	HVDC transmission lines put out of operation by sabotage and suspension of the HCB/Eskom contract; Zimbabwe independence
1984	Cape Town Agreement, inter alia establishing the Mozambique-Portugal-SA Permanent Joint Commission (PJC); revision of contracts between HCB, Eskom and EDM
1988	Second and third revisions of the tariff agreement between Eskom and HCB
1992	Permanent Peace Accord, ending the Mozambique civil war; regional drought of once-in-a-century severity; Zimbabwe agreements (Power Supply HCB/ZESA, Systems Operation HCB/EDM/ZESA, Wheeling Charges EDM/ZESA)
1994	First democratically elected government in South Africa
1995	Formation of the Southern African Power Pool (SAPP); award of contract to restore the HVDC transmission lines between HCB and Eskom
1997	Completion of new HVAC line between HCB and ZESA; export of power to Zimbabwe commences (initially on contract due to expire in 2003)
1998	New HCB-Eskom tariff agreement and resumption of electricity exports to SA
1999, 2004	Tariff disputes between HCB and Eskom
2003	ZESA negotiated to continue imports from HCB, but on less favorable terms
2007	Purchase of majority ownership in HCB by Mozambique government

As none of those projects had materialized, Zimbabwe negotiated a continuation of the power purchase agreement. The current situation is one in which exports to Zimbabwe and supplies to the national utility Electricidade de Moçambique (EDM) are met from the roughly 925 MW of capacity remaining after the contract for HCB to supply 1,150 MW of firm power to Eskom has been met. The Eskom amount includes 300 MW for resupply to Electricidade de Moçambique via HVAC transmission lines in the south of the country.

3.2 Project concept, objectives, and development

The Cahora Bassa project is a classic example of an enclave generation project being established to export power to a neighboring country with a large electricity market. Against the backdrop of the transmission lines being put out of operation for nearly two decades, it is tempting for those with the benefit of hindsight to say that an electricity export project of this kind should never have been attempted in a region where anticolonial struggles were being waged. Ironically, however, this was precisely the context in which certain people in the Portuguese colonial government were determined that the project should go ahead. They saw Cahora Bassa as an opportunity to demonstrate Portugal's commitment to Africa and desire to bring economic development to its colonies, thereby deflecting criticism from growing anticolonial forces.

The views of the proponents of the project were opposed by others in the Portuguese government and had to be forcefully argued. There were similar strong differences of opinion in South Africa. The remainder of this section provides details of these opposing views in Portugal and South Africa.[5] This history is interesting because it provides the context for perceptions of regional power system integration in Southern Africa which persist to this day.

On the side of Portugal, the original driving force for the Cahora Bassa project was the Overseas Ministry of the Portuguese government. In May 1965, Professor A. A. Manzanares was sent to survey the hydropower potential of the Zambezi inside Mozambique. His assessment could hardly have been more optimistic:

> The basin of the Zambezi in Portuguese territory contains more economic possibilities for the future than any other river in Africa or even the rest of the world.[6]

Manzanares's estimate of the hydropower potential was 40,000 MW. MFPZ was given the responsibility for carrying out the necessary studies for a hydropower project (see next section) and making the case for building Cahora Bassa. The concept developed by MFPZ was to pay for the cost of the dam and the development of industry and agriculture in the Zambezi Valley through exports of electricity. Side benefits of the new lake, such as tourism and fisheries, would also accrue. In the view of MFPZ, "for the price of a little faith, Portugal

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[5] The pre-1975 historical background given in this case study draws heavily on the book published in that year by Weidenfeld and Nicolson by the historian Keith Middlemas. It is entitled *Cabora Bassa - Engineering and Politics in Southern Africa* (in English at the time, the project was generally referred to as Cabora Bassa, but this is a misspelling, the correct form being Cahora Bassa). Much of Middlemas's book is based on interviews he carried out at the time with Cahora Bassa protagonists.

[6] Quoted by Middlemas (1975), page 17.

would have created an area of self-generating prosperity without parallel in the rest of Africa."[7]

With demand for electricity at a very low level in Mozambique (only 75 MW of Cahora Bassa's eventual 2,075 MW were to be set aside for domestic electricity needs), the project was crucially dependent on finding a secure export for the bulk of the electricity which would be produced. Although a range of countries was considered (including Zambia, Malawi, and Rhodesia), South Africa was the only country with sufficient demand to sign the sort of power purchase agreement which would be needed to finance the project.

In South Africa, the prominent initial advocate of the project was H. J. van Eck, chairman of the Industrial Development Corporation (IDC). Van Eck believed that South Africa's future development depended on expanding exports, and a pre-requisite for this would be cheap and reliable electricity. Van Eck hired Dr. Henry Olivier to investigate Cahora Bassa. Olivier was the country's foremost dams engineer with experience from projects in Rhodesia (Kariba), Uganda (Owen Falls) and Pakistan (Indus Basin) as well as South Africa. Olivier became an articulate supporter of Cahora Bassa, seeing the project in the context of what was to become, 30 years later, the Southern African Power Pool:

> Looking far ahead, Olivier spoke of a grid linking the Cunene, a thermal station at Wankie in Rhodesia, the Kafue dam in Zambia, Kariba north and south, the Shire river in Malawi, and Cahora Bassa with the South African system and the Oxbow Lake scheme in Lesotho. "This will make possible the regional interchange of energy on an import-export basis along the same lines as now operating successfully and profitably in the (UCPTE) grid in Western Europe which links more than thirteen countries."[8]

It is interesting to compare this view with the contrary position adopted at the time by ESCOM: [9]

> ESCOM's spinning reserve was normally maintained at 15 per cent of total capacity. Sträszacker (ESCOM's chairman) did not welcome the idea of half of this reserve coming from a dam a thousand miles outside South Africa, let alone from a Portuguese province torn for several years by guerrilla warfare. The security risk enhanced two natural suspicions: ESCOM was simply not used to European habits of importing and exporting energy across national boundaries, and was offended by the bland suggestion that it should help to finance Cahora Bassa at a time when its own resources were overstrained.

The South African mining conglomerate, Anglo American, had a crucially important influence in overcoming resistance within South Africa to Cahora Bassa. Anglo's chairman, Harry Oppenheimer, who had close relationships with people in Portugal and business interests in Angola and Mozambique, gave the project his backing. He saw Cahora Bassa as an important and necessary step in South Africa opening itself to the rest of Africa. Anglo was also able to bring to the table the prospect of its merchant bank, Union Acceptances,

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[7] Middlemas (1975), page 24.

[8] Middlemas (1975), page 31.

[9] Middlemas (1975), page 33. The South African electricity utility later changed its name to Eskom, and, within SAPP, ESCOM is now the Electricity Supply Commission of Malawi.

providing financing for Cahora Bassa. An Anglo American executive director was tasked with working with IDC to bring the Cahora Bassa project to fruition.

The Cahora Bassa project divided the South African cabinet, with the more outward-looking *verligte* faction arguing that the country had to accept that it was part of Africa and hence should embrace the Cahora Bassa project, while the *verkramptes* advocated self-sufficiency, particularly for something as fundamental as electricity. Changing macroeconomic conditions also had a role in shaping South Africa's position on Cahora Bassa. The balance of the argument shifted in favor of a project which would supply extremely cheap electricity when the 1964–1966 economic boom was replaced by a downturn.

Within Portugal, the decision on Cahora Bassa depended on resolving the differing viewpoints of the Finance and Overseas Ministries. Finance was concerned about the cost of the project adding to the already large outlays being made to defend Portugal's African colonies, while the Overseas Ministry saw the project as a means of justifying Portugal's claim to be developing its colonies and hence to be justified in resisting demands for independence.

While the political view ultimately prevailed (with Salazar himself providing the final arguments in favor),[10] the position of the Ministry of Finance was understandable. From 1961 to 1974 Portugal was involved in colonial wars not just in Mozambique, but also in Angola and Guinea-Bissau. The government budget increased significantly during the war years, with "extraordinary" military expenditures ballooning rapidly. These expenditures were to some extent offset by the resource rents appropriated by Portugal from exports from its colonies, notably diamonds and oil from Angola, but it was only in 1974 that oil prices rose significantly. Had the dictatorship not been overthrown that year, the colonial wars in all three countries could have been financed from Angolan oil exports.

3.3 Feasibility studies done

The first detailed studies which were done of Cahora Bassa were carried out by Missão do Fomento e Povoamento do Zambese (MFPZ), with assistance from Hidro-Tecnica Portuguesa (HTP) from Lisbon. A series of reports were produced, the *Relatorio Preliminar* in 1958, *Esquema Geral* in 1961, and the final 56-volume *Plano Geral* in 1965. These documents covered the development of the entire upper Zambezi, including the potential of future dams in addition to Cahora Bassa (such as Mpanda-Uncua) and economic activities outside of hydropower.

There were also studies which were specific to the Cahora Bassa project. At the time of the signing of the Heads of Agreement in 1966, HTP had completed feasibility studies of the transmission lines which showed that power could be delivered at the tariff demanded by Eskom (0.3 Rand-cents per kWh). The HTP design at that stage involved the transfer of 1,000

[10] The Council of Ministers meeting at which the final decision was made is dramatically reported by Middlemas (pg. 37): "Salazar gave a lucid and brilliant resumé of the arguments…. Clearly in favour, he remained scrupulously fair to the Treasury view and did not deny that the objections were great. At the end, he added an argument that was entirely novel: if Cahora Bassa is not built now we will never build it."

MW either via dual AC lines (500 MW each, operating at 525 kV) or one bipolar DC line operating at +/-400 kV.[11]

Subsequent studies were carried out by the three consortia which formed to bid for the project. Studies were also carried out by the export guarantee agencies involved in the financing of the project, as well as the successor to MFPZ, the *Gabinete do Plano de Zambese* (GPZ), which examined the broad development issues for the Zambezi valley.

In the mid 1990s, studies were carried out on the rehabilitation of the HVDC transmission lines and restoration of power exports to South Africa, as well as feasibility studies leading to the construction of the HVAC lines to Zimbabwe. More recent studies relate to the interconnection with Malawi and to the completion of the Cahora Bassa North project.

3.4 Assets built and planned

The main elements of the Cahora Bassa project are a dam on the Zambezi River at Songo in central Mozambique (171 m high by 303 m wide at the crest), a 2,075 MW hydropower station, and parallel 1,420 km HVDC transmission lines which terminate at the Apollo substation near Pretoria in South Africa. Conventional HVAC transmission lines were subsequently built to Bindura in Zimbabwe.

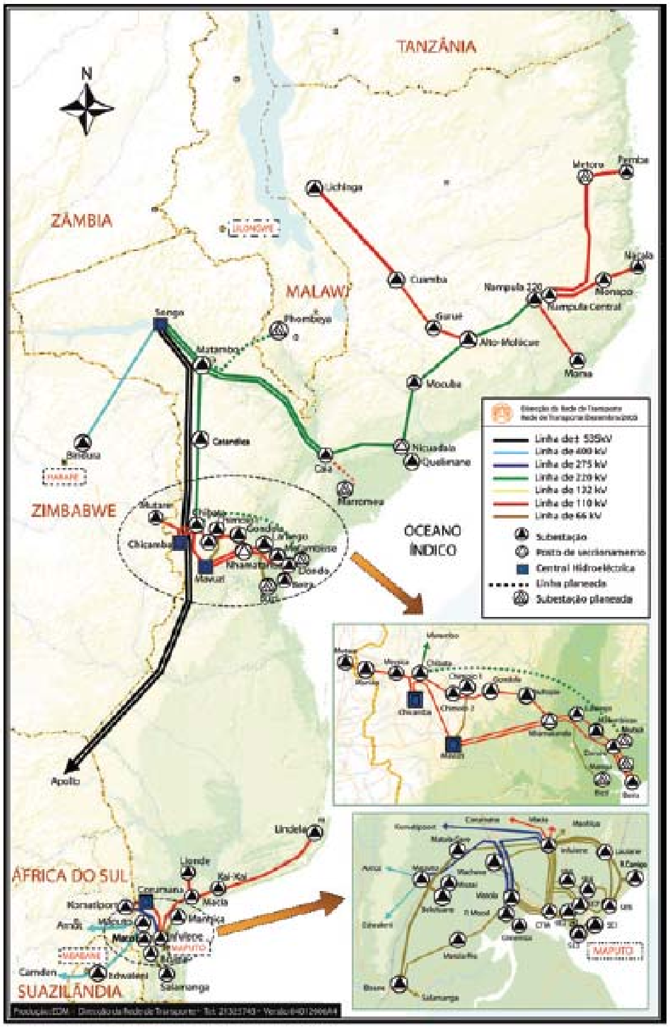
It is important to note that the interconnection to Zimbabwe was initially planned as a twin circuit for reliability and security reasons. The changed circumstances in South Africa in 1994 presented the opportunity for another interconnection between Zimbabwe and South Africa through Botswana. The latter interconnector could be designed to function as a backup to the Cahora Bassa line, so it was no longer necessary to have a twin circuit. The diversification of supply sources was another advantage. The 1992 power crisis had been due to a drought that affected the Zambezi basin. Connecting to the predominantly coal-fired Eskom system made it possible to avoid this vulnerability in the future.

The HVDC lines are capable of delivering 1,920 MW at a voltage level of +/-533 kilovolts (kV) and 1,800 amperes. The HVDC system consists of dual lines and an earth return. The second line, located 1 km parallel to the first, provides backup.

As shown in Figure 3, the national utility Electricidade de Moçambique (EDM) in central and northern Mozambique is supplied from Cahora Bassa via dual 220 KV lines. In the south, there is a complex supply system between Eskom and EDM that includes Motraco's 400 kV transmission lines. The interconnector from HCB to a ZESA substation at Bindura is also rated at 400 kV, although it is operated at the 330 kV voltage level in the Zimbabwe and Zambian interconnected network.

[11] Middlemas (1975), page 37.

Figure 3 Transmission Connections from Cahora Bassa (Songo)



Source: Electricidade de Moçambique *Caractarização do Rede de Transporte* 2006

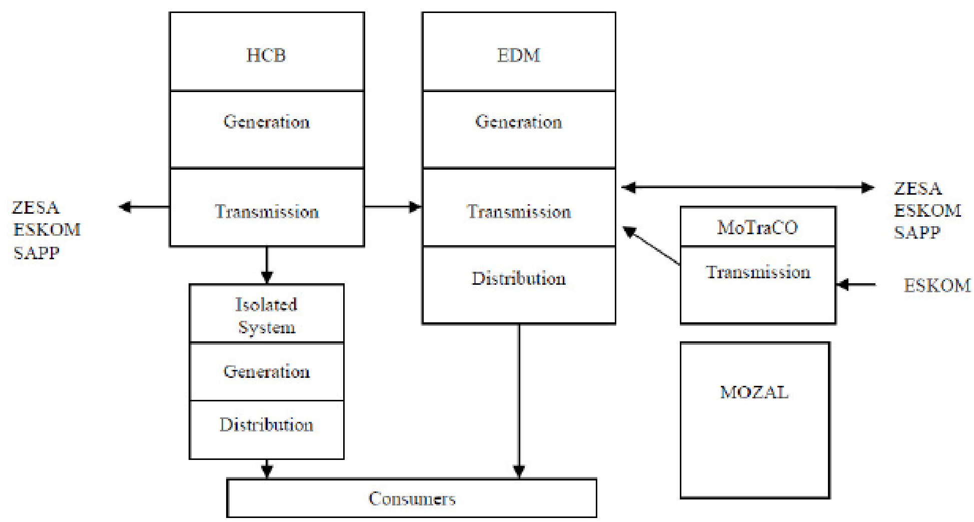
HCB power feeds directly into two of SAPP's three control areas, these being operated respectively by Eskom, ZESA, and the Zambian electricity utility, ZESCO. Each of these utilities is responsible for system operations in its respective area and for coordinating with the other two centers. EDM is responsible for managing the HCB power that is delivered to the domestic Mozambique grid.

3.5 Interconnections and electricity trade

The bulk of HCB firm energy goes to Eskom (around 55%). This includes an allowance that is sent back to EDM via the buy-back arrangement whereby Eskom supplies Maputo with power. Other direct HCB customers are EDM in central and northern parts of the country, the Zimbabwe Electricity Supply Authority (ZESA), and other southern African utilities that belong to the SAPP who receive a small amount.

The structure of Mozambique's interconnections and electricity trade is illustrated in Figure 4. As of June 2009, EDM had installed capacity of 233 MW, available capacity of 174 MW, and maximum demand of 416 MW (2008).[12] The difference is supplied, directly and indirectly, by HCB. These figures exclude the single largest electricity consumer in Mozambique, the aluminium smelter MOZAL which is at Matola, just outside Maputo. MOZAL, with a demand of 750 MW, is supplied by Eskom, with the power being wheeled by Motraco.[13]

Figure 4 Structure of Interconnections and Electricity Supply in Mozambique



Source: Andersson (2006)

When the proposed transmission line has been built to Malawi, the Electricity Supply Commission of Malawi (ESCOM) will also become an export market, though ESCOM also intends to use its connection to the SAPP grid to export in off-peak hours using SAPP's Day Ahead Market (DAM).

3.6 Environmental and social issues

The Kariba and Cahora Bassa dams were conceived and built in an era when the environment and the social issues associated with dam construction received much less attention than they do today. The Cahora Bassa project has nonetheless been criticized for failing to incorporate environmental lessons from Kariba (completed in 1959) and for failing to take into account scientific studies carried out in connection with the project.[14]

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[12] SAPP Secretariat presentation to Investor Roundtable held at Victoria Falls, July 2009. http://www.sapp.co.zw/viewinfo.cfm?id=78&linkid=2&siteid=1

[13] More detail on MOZAL and MOTRACO is available in the companion SAPP case study.

[14] Beilfuss (1999).

Outside of greenhouse gas aspects, there are two main areas of environmental concern:

- o the impact of the lake formed by the Cahora Bassa dam;
- o the impact of Cahora Bassa on the lower Zambezi valley.

The Cahora Bassa lake is the fourth-largest artificial lake in terms of surface area in Africa after Lake Volta, Lake Kariba and Lake Nasser (behind the Aswan Dam in Egypt)—see Table 2.

Table 2 Africa's Largest Artificial Lakes

Lake	Length (km)	Max Width (km)	Surface Area (km²)	Volume (km³)
Volta (Akosombo Dam)	520	140	8,502	148
Kariba	220	40	5,580	185
Nasser (Aswan dam)	550	35	5,250	111
Cahora Bassa	292	38	2,739	56

Sources: Various

The lake has made possible some new economic activities, notably tourism (not yet exploited to any great extent) and the export-oriented kapenta fishing industry. The main market is Zimbabwe, with exports in 2006 being worth US$7.6 million, but falling to US$2.7 million in 2007 due to the economic crisis in Zimbabwe. Prospects for growth in kapenta exports from Cahora Bassa are good once the Zimbabwe economy stabilizes.

The lake inundated an area that was relatively unpopulated. It was originally estimated that only 25,000 people needed to be moved, but this was later increased to 42,000.[15] There was no proper plan for this, and people were instead moved as part of the controversial *aldeiamento* program, whose main official purpose was said to be to improve security for the residents of the area.

Environmentalists have been less concerned about the impact of the lake than about the effect of Cahora Bassa on disturbing the seasonal flooding of the lower Zambezi valley. The main adverse impacts which have been identified are:

- o reduced prawn fishing in the Indian Ocean, because of reduced flows in the Zambezi delta area, which is an important prawn breeding ground (reduced coastal mangroves also associated with this);
- o coastal erosion, soil salination, salt water intrusion;

[15] Isaacman and Seddon (2003), page 7.

- o reduced artisanal fishing in the river;
- o reduced silt deposition and nutrient availability for farming;
- o failure of vegetation to recover from grazing;
- o replacement of wetland vegetation by intrusive upland species;
- o reductions in the number of wildlife species and the sizes of herds.

The benefit that might be expected from the upstream dams would be protection from extreme flood events. Unfortunately, however, experiences in 2001 and 2007 have shown that when the Zambezi is in full flood, Kariba and Cahora Bassa have not prevented devastating floodwaters from reaching the lower Zambezi valley. The human and livestock risks when extreme floods occur are much higher than in the period before the building of the dams because the people now live much closer to the river.

At first glance, the concern about the impact on the lower Zambezi seems surprising because Cahora Bassa was built downstream of Kariba, so the natural flow of the water in the Zambezi had already been disturbed. However, Kariba's floodgates are such that water over and above flows through the turbines can only be released when the level of the dam is high, whereas Cahora Bassa's design is such that water could be released on a planned basis to create artificial seasonal floods in the lower Zambezi. In a 1999 study, annual "prescribed" floods were estimated to require a 10% to 15% reduction in hydropower output, resulting in foregone revenues on the order of $20 to $30 million per annum at that time. Without specifying precisely how this cost to HCB should be met, the benefits in terms of augmented prawn catches, improved riverine fishing, agriculture, and grazing were claimed to easily exceed this cost.[16]

Turning to greenhouse gas issues, the positive impact that can be attributed to Cahora Bassa is the displacement of what would otherwise most probably be thermal electricity production from coal. The pollution as well as global warming effects associated with coal-fired electricity production is a major issue in South Africa. South Africa has one of the most carbon-emission intensive economies in the world with per capita CO^2 emissions per capita higher than those of more developed economies in Europe.[17] Much of this is attributed to the use of coal, particularly for electricity production. Total CO^2 emissions in South Africa are of the order of 415 million tonnes per annum: if the imported hydropower from Cahora Bassa would otherwise have been produced by thermal power stations, there would be an addition of up to 10 million tonnes of CO^2 per annum (adding 2.4% to the total for South Africa—this assumes 10,000 GWh being supplied from Cahora Bassa).[18]

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16 Beilfuss (1999).

17 Mukheibir (2007).

18 Estimated from data in Eskom Annual Report for 2008. To meet future growth in demand without increasing greenhouse gas emissions, the South African government is giving serious consideration to a massive increase in nuclear capacity (a further 19,000 MW) despite the much higher costs which will be involved. A nuclear procurement process was initiated in 2008 but was stopped reportedly due to a reconsideration of Eskom's financial constraints: http://www.engineeringnews.co.za/article/energy-minister-promises-emphatic-decisions-on-nuclear-energy-2009-06-23

As far as can be ascertained, no studies have been done of the countervailing influence of greenhouse gases produced from the decay of organic material in Lake Cahora Bassa. Research has, however, been conducted on the extent to which climate change will affect the hydropower potential of the Congo and Zambezi Rivers. Temperatures are expected to rise and rainfall patterns to become more erratic, resulting on increased evaporation, reduced runoff, increased risk of flooding, and increased siltation. All of these effects are expected to be more severe in the Zambezi as compared with the Congo basins, with increased evaporation and siltation being the most pronounced.[19]

HCB has an Environment Directorate, which was created when the transfer of majority ownership to the Mozambique government took place in 2007. The work of the Environment Directorate appears to be focused solely on matters pertaining to the Cahora Bassa Lake, with no mention being made in the description of its functions to concerns about environmental issues in the lower Zambezi or to carbon issues. In particular, despite some evidence of concern on the part of the government of Mozambique,[20] a policy of prescribed flooding has ***not*** been adopted and is not part of the planned annual operation of the Cahora Bassa dam.

[19] Mukheibir (2007).

[20] Some commentators accuse the Mozambique government of "post-colonial amnesia" when it comes to the plight of people living in the lower Zambezi valley. See Isaacman & Sneddon (2003).

4 Institutional arrangements

4.1 Governance structure

The main institution that is associated with the Cahora Bassa project is Hidroeléctrica de Cahora Bassa, which was registered as a company in Mozambique in 1975. As already mentioned, majority ownership of HCB has moved from the government of Portugal to the government of Mozambique; the details of the ownership structure and shareholdings are given in Section 5.2.

The governance structure of HCB as it stands today consists of:[21]

- General Assembly – three members, one from the government of Portugal (chair), two from the government of Mozambique
- Board of Directors – nine members, two from the government of Mozambique
- Finance Committee – three members
- Management Board – eight members, of which three are nonexecutive, the remaining five being heads of departments within the management structure of HCB. Nonexecutive members are chosen for their technical skills and experience.

4.2 Role of national governments and regional institutions

As explained in Section 3, the Portuguese and South African governments took the lead in the conception, design and construction phases of the project. After independence in 1975, the Mozambique government also became a player, but the Portuguese government remained dominant in HCB until the sale of its shares in 2007.

The reversal of roles of South Africa—from founder and staunch defender of the Cahora Bassa project while Mozambique was still a colony to becoming the backer of the resistance movement that put the project out of commission for 17 years—is certainly unusual in a regional power project. The agreement on Cahora Bassa reached in Cape Town in 1984, referred to earlier, was made in the context of the 1984 Nkomati Accord between the Mozambique and South African governments. In that accord, South Africa agreed to stop sponsoring Renamo if the Mozambican government expelled exiled members of the African National Congress. The Mozambican government did not, however, expel the ANC, and consequently the apartheid government continued to give military and logistical support to Renamo. It was only after a permanent peace accord was reached in Mozambique in 1992 that there were real prospects of restoring the HVDC transmission lines.

The Permanent Joint Commission, which was set up as part of the 1984 Cape Town Agreement, proved to be a most important forum for the resolution of tariff disputes and

[21] Information from HCB website: http://www.hcb.co.mz/

other issues pertaining to the Cahora Bassa project. As the PJC consists of representatives of the national governments—Mozambique, Portugal and South Africa—the PJC achievements are testimony to the national governments continuing to have a significant role in the project in the period after the re-commissioning of the HVDC transmission lines.

By contrast, regional institutions, such as SADC and SAPP, have had at most a peripheral role in the project. The causality may have run the other way, with Cahora Bassa providing some of the momentum which led to the formation of SAPP in the first place. The development of a mechanism by SAPP to encourage short-term trading of electricity—STEM, currently being replaced by the DAM—has enabled EDM to profitably sell electricity which is predominantly sourced from Cahora Bassa to other SAPP utilities.

Since 1998, HCB has had observer status in SAPP. The Revised SAPP Inter-Governmental Memorandum of Understanding, which was signed in 2007, *inter alia* allows electricity companies which are not national utilities to become full operating members of SAPP. The transmission company Motraco, for example, has applied and has become a SAPP member, but HCB has not yet done so.

Further discussion of the role of SAPP is contained in the separate SAPP case study in this Regional Power Sector Integration project.

4.3 Regulatory agencies

Formal infrastructure regulatory bodies only came to be established in the 1990s in Southern Africa. In South Africa, the Electricity Control Board was replaced by the National Electricity Regulator in 1995, this being subsequently expanded into the National Energy Regulator of South Africa (NERSA) in 2005. The Zimbabwe Electricity Regulatory Commission (ZERC) came into operation in 2003. In Mozambique, the Conselho Nacional de Electricidade (CNELEC) was formed in 1997 and given regulatory functions in 2005.

Other than taking account of the costs of Cahora Bassa power in the setting of tariffs, the national regulators have not had any significant role with respect to Cahora Bassa. The same comment applies to the regional regulatory body—the Regional Electricity Regulatory Association of Southern Africa (RERA) and the continent-wide African Forum for Utility Regulation (AFUR). South Africa was a founding member of RERA, which was established in 2002. ZERC joined RERA in 2006 and CNELEC joined in 2008. RERA and AFUR are representative bodies without any powers: they can advise on tariffs or standards for bilateral and regional electricity trade but have no implementation mandate nor powers of enforcement.

4.4 Role of outside agencies

The colonial context made it impossible for the Cahora Bassa project to be financed by agencies such as the World Bank and the African Development Bank. The only outside financing agencies involved were the export credit guarantee agencies. Planning and environment studies of possible new hydropower projects on the Mozambique part of the Zambezi (including the Cahora Bassa north bank power station) have been supported by bilateral and multilateral aid agencies. It is likely that these agencies will also provide financing and various forms of technical assistance when the projects come to be implemented.

5 Contractual, financial and pricing arrangements

5.1 Contracts

The first formal agreement for the Cahora Bassa project was the **Heads of Agreement** signed by the foreign ministries of Portugal and South Africa in 1966. This agreement made it possible for bidding documents to be issued for the single engineering, construction and procurement (EPC) contract which was envisaged. Bids were invited in September 1967, and adjudication took place in early 1968, followed by negotiations over the design and financing of the project to reduce the overall costs.

Three consortia bid for Cahora Bassa. When the bids were opened, the American consortium Cahora Bassa Builders was much more expensive than the other two contenders. To assist in adjudicating between Zamco and Concassa, the Overseas Ministry contracted a British firm of consulting engineers to evaluate the electro-mechanical alternatives. The final choice, however, seems to have been influenced by Concassa being predominantly British, and there were concerns in South Africa and Portugal that British sanctions against Rhodesia could result in problems for the project. The award was finally made to Zamco, which was led by Anglo American. The main civil engineering contractor for the project was an Anglo American subsidiary (LTA), while engineering consultancy and the electrical equipment were supplied by South African, French and German firms and the transmission lines by an Italian company working with South African suppliers.

A preliminary award of the EPC contract was made to the Zamco consortium in July 1968. The final **EPC contract** was signed between Zamco Limitada and the Portuguese government in September 1969. The contract price was 8.8 million contos (US$305 million) excluding the cost of financing and the installations in South Africa.[22] Even after this signing, there were further changes in the approach and the composition of the consortium, notably the withdrawal of the Swedish company ASEA, which had been accused of supporting apartheid by planning to participate in the Cahora Bassa project, and an abortive attempt to involve the American company GEC , this also being derailed by political pressure. The EPC contract was only fully finalized at the end of 1970, well after work on the project had commenced. From the signing of the Heads of Agreement to the eventual EPC contract took nearly five years.

An **Inter-Government Agreement** between the governments of Portugal and South Africa was also concluded in September 1969. This allowed construction to start, but by the time the dam was nearing completion Mozambique was no longer a colony, but a separate national entity which was to be brought into the picture. In the 1974 **Peace Agreement** between Portugal and Mozambique, 82% of the shareholding of Cahora Bassa was retained by the government of Portugal, while 18% was allocated to the newly independent government of Mozambique.

A critical agreement for the operation of the project was the **Power Purchase Agreement** (PPA) between HCB and Eskom. The exact contents of the initial PPA are not known, but

[22] Middlemas (1975), page 81; exchange rate US$2.40/£.

some indications are explored in Section 5.3. The take-or-pay commitments by Eskom in the initial PPA were probably no more than 500 MW. At the same time, Eskom retained the right to purchase the output of all of HCB's capacity, except for the 75 MW to be supplied to Maputo via the buy-back arrangement.

The first PPA was only effective for a few years before being overtaken by *force majeur* when Renamo sabotage of the HVDC transmission lines made exports of power from HCB impossible. As mentioned in Section 3.1, in an attempt to restore the operability of the Cahora Bassa project, the three governments (Portugal, South Africa and now also Mozambique) negotiated a fresh intergovernment agreement, the **Cape Town Agreement**, in 1984. This required a new supply contract between HCB and Eskom to be negotiated and to come into force on the same day as the intergovernmental agreement. The rand was designated as the primary currency for payments, a currency choice which, combined with inadequate provisions for resolving tariff disputes, was to create many subsequent difficulties—see Section 5.3.

In the case of exports to Zimbabwe, the contract which was signed with Zimbabwe in 1997 for the period ending December 2003 was for a minimum of 400 MW and maximum 500 MW of firm power. During the contract period, exports on the order of 3,400 GWh per year were delivered to ZESA. The ZESA contract had an expiration date of 31 December 2003, as it was expected that by then Zimbabwe's domestic generation projects would have been completed. In the event, no generation projects had been started by 2003. With supply conditions becoming tighter throughout the region, the best that ZESA could negotiate was a contract offering 50 MW firm and up to 400 MW nonfirm at a much higher tariff than it had previously been paying.

5.2 Ownership and finance

The dam, power station, inverter station and HVDC transmission line inside Mozambique are owned by the project operating company Hidroeléctrica de Cahora Bassa (HCB), while the HVDC lines inside South Africa and the Apollo inverter are owned by the South African electricity utility Eskom. The HVAC line to Zimbabwe is owned by EDM from Cahora Bassa to the Zimbabwe border and by ZESA within Zimbabwe. EDM collects a wheeling charge to cover its capital, operations and maintenance costs for the line.

With regard to financing, during negotiations in the 1960s between Portugal and South Africa, it was agreed that financing would be arranged by South Africa for the component in its territory, with Eskom managing the implementation and subsequent operations and management. The arrangements for the Mozambique component of the project were more complex to put in place. Around 1965, there appeared to be few options for the financing of the project. Elsewhere in independent Africa, large projects of this type, such as the Akosombo Dam on the Volta River, were being financed by the World Bank with the support of bilateral donors. Such finance was not available for projects in territories still under colonial rule. The Portuguese government could not undertake the project from tax revenues and would need private-sector support. Portuguese private investors would be most unlikely to be interested as there was increasing reluctance by Portuguese companies to invest in the colonies.

In the absence of alternatives, the financing approach that was envisaged in the MFPZ *Plano Geral* was to offer mining or other concessions to large international companies (such as Anglo American, Tanganyika Concessions and Union Minière) or governments like that of Japan in return for financing major infrastructure developments in the Zambezi valley, the first of which would be the Cahora Bassa project.

In the event, the financing of the Cahora Bassa project followed a more conventional route of a mix of government subventions, export credit agency and development bank resources and commercial bank loans. As of mid-1968, it was envisaged that the main elements of the financing package were to be provided by Coface of France (21% of the estimated total project), South African government principal loans (45%), plus smaller amounts from Eskom (4% for the transmission line) and IDC of South Africa (2% for the inverter equipment).[23] With no other export market being immediately available (or acceptable to the South Africans) and with South Africa providing a significant portion of the financing, Eskom was able to drive a hard bargain on the tariffs and the exclusivity of its rights over Cahora Bassa power.

A significant proportion of the remaining 28% of the financing was to come from commercial bank loans. The Portuguese government would be responsible for any remaining requirements, but more importantly would also, through its guarantees, assume the overall financial risk of the project. Concerns in South Africa about the extent of that country's financial involvement in the project were allayed with the following observation about the Portuguese government's role:

> From the Portuguese point of view…they derive very little benefit from the project until 1990 and yet they will bear the entire responsibility of guaranteeing the finances.[24]

In the event, the assumption of the financial risks of the project proved extremely costly for the Portuguese government. Not only did they have to face large cost overruns during the construction phase, followed by 17 years of zero revenues from the main HCB customer, but they also had to meet the costs of restoring the sabotaged HVDC transmission lines. By 2007, the total debt is reported to have accumulated to more than US$3,500 million, this large amount (relative to the original EPC contract price of US$305 million) presumably arising from unpaid interest, operational costs not covered by revenues due to the transmission lines being out of commission, and the additional loans required for the rehabilitation of the HVDC transmission lines. In the ownership transfer agreement finally reached with the Mozambique government, Portugal agreed to reduce its shareholding in HCB by 67% for a payment of US$700 million, plus an amount of US$275 million (paid out of HCB's own funds) to cover a portion of the debt. This made the government of Mozambique the majority shareholder in HCB with 85% of the company's shares. The US$700 million payment is funded through a loan from a consortium of European banks. This is being repaid out of HCB's sales of electricity.

[23] Details are given by Middlemas (1975), in Chapter 3.

[24] Quote from 1968 cited in Middlemas (1975), page 80.

5.3 Pricing arrangements

Overview

As the monopsonistic purchaser of Cahora Bassa power, Eskom negotiated very favorable tariffs, denominated in rand cents, both at the time the first power purchase agreement was signed in 1969 and again when the HVDC lines were recommissioned in 1988. Eskom then tried to keep the tariff fixed in nominal rand-cent terms, but as the real tariff level (measured in US cents per kWh) declined sharply, this imposed arduous financial conditions on HCB, and there were significant tariff disputes between the two sides in the late 1990s and early 2000s. The details are given in the next subsection.

As long as Eskom was the sole purchaser of Cahora Bassa electricity, HCB was always going to be in a weak position in tariff negotiations, but it can also be argued that Eskom had a sound economic reason to negotiate a low tariff in 1998: the sabotage of the HVDC lines had forced the utility to invest in more costly replacement generation. It is only in recent years when the Eskom surplus has given way to a general shortage of generation capacity in the southern African region that the balance of power in tariff negotiations has shifted in favor of HCB. Henceforward, tariffs should be high enough for HCB not just to cover its costs but accumulate resources and establish an international credit rating so as to be able to undertake major investment projects, the most obvious of which would be to install turbines on the north bank (see Section 6).

Details of tariff levels

The basic tariff level reportedly agreed in 1988—2 rand cents per kWh (0.88 USc/kWh)—had to be renegotiated in 1997–1998 when the transmission lines were finally ready for recommissioning a decade after the Cape Town Agreement. By 1997, 2 rand cents per kWh had fallen in US$ terms to 0.43 US cents per kWh, a derisory level from the viewpoint of HCB. At the time, however, Eskom had 5,000 MW of surplus generating capacity and extremely low production costs by world standards; hence it was only willing to import Cahora Bassa power at a very low tariff. However, with the HVDC lines about to be restored, there were important foreign policy reasons to come to an agreement. A compromise was reached as the line restoration was completed, and Cahora Bassa power started to flow once more to South Africa in July 1998.

The lack of an automatic tariff adjustment mechanism and the need for the governments (through the PJC) to negotiate tariff changes, rather than just leaving tariffs to be agreed between the utilities, have continued to cause problems. In addition, Eskom did not always adhere to agreements. By 2000, for example, when 2 rand cents per kWh had declined further to less than 0.3 US cents per kWh, HCB had resorted to arbitration following Eskom's refusal to implement the 1998 agreement which should have increased the rand-based tariff by 50% to 3 rand cents per kWh. After HCB disconnected Eskom and the PJC intervened, a tariff of 3.7 rand cents per kWh, equivalent in December 2000 to 0.5 US cents per kWh, was agreed to apply from 2001, together with a lump sum payment arbitration amount for Eskom to pay to HCB of R165 million (about US$22 million).[25]

The new tariff was to apply only to 2001, with a further agreement to be made during the year. When this did not happen, Eskom on 1 January 2002 reverted to the old price of 2 South African cents per kWh (equivalent initially to 0.16 US cents per kWh). After 9 months of futile negotiation, HCB decided to suspend exports to South Africa in October. The Mozambique government disapproved of HCB taking this action, and by November the power flow was restored, again through the intervention of the PJC.[26]

Table 3 Tariffs for HCB Exports to Eskom

Year	Nominal tariff Rand c/kWh	Nominal tariff US c/kWh	Real tariff US c/kWh	Comment
1966	0.3	0.42	2.78	Proposal at time of Heads of Agreement
1969	0.3	0.42	2.46	Tariffs agreed for mid-1970s project commissioning
1978	0.3	0.34	1.14	Realized tariffs at project start-up
1988	2.0	0.88	1.60	Tariffs agreed at recommissioning of HVDC
1997	2.0	0.43	0.58	Nominal tariff held at 1988 level
2000	2.0	0.29	0.38	Agreed tariff 3 Rc/kWh, equivalent to 0.57 USc/kWh real
2001	3.7	0.43	0.52	Tariffs for 2001 after intervention of PJC
2002	2.0	0.19	0.23	Tariff at start of 2002 before PJC had once again to intervene

Note: Real tariffs are in 2008 prices

The degree to which Eskom was squeezing HCB can only be fully appreciated when the nominal tariffs are converted to real values. Over the period from 1966, when the first Heads of Agreement was signed, to 2008, the United States Consumer Price Index increased from 1 to 6.64. The rand was stronger than the US dollar from its inception in 1961 until 1982 (R0.72 to 1 US$ in 1966). It depreciated significantly to a low point of R10.52 to the US$ in 2002, but recovered thereafter (e.g., to R6.36 to the US$ in 2005). The combined effect of inflation and rand depreciation was to produce a sharp decrease in real tariff as measured in US cents/kWh—see Table 3, where the real values are given in 2008 US cents per kWh.[27]

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[25] Arbitration was threatened again later. According to Mozambique News Agency report No.258, 28 July 2003, the 1999 incident unfolded as follows: "HCB had lodged an action against Eskom with the Paris Arbitration Tribunal in 1999. It suspended the case, and then dropped it altogether in October 2002 as part of a deal between Eskom and HCB after HCB had disconnected Eskom."

[26] Source for tariff negotiation information in these paragraphs is the archives of the Moçambique Information Agency, AIM: http://www.poptel.org.uk/mozambique-news/newsletter/

[27] The project had a mix of currencies in its financing. The US$ is used as a reference currency not because it was dominant in the financing but because US cents/kWh is the numeraire which is invariably used in discussions of electricity prices in Southern Africa.

The tendency throughout the history of the Cahora Bassa project has been for the tariff paid by Eskom to decline in real terms. The value of 2.78 US cents per kWh at the time of the Heads of Agreement is more than twice the real tariff paid when Cahora Bassa was commissioned, and thereafter the realized tariff has been as low as 0.23 US cents per kWh (measured in 2008 US dollar terms). This is surely the lowest tariff that any utility anywhere has paid for bulk supplies of energy.

Compared with its problems with Eskom, tariff and payment issues with HCB's other large foreign customer (ZESA) have been much less significant. The precise tariffs for HCB exports are not in the public domain, but ZESA's long-term import contracts (with DRC and Zambia as well as HCB) prior to 2003 averaged 1.5 to 2 US cents per kWh for firm energy. In the case of imports from Mozambique, the payments included a wheeling charge collected by EDM. The contracts negotiated subsequently by ZESA for firm imports from HCB are at unit costs (including wheeling charges) that are said to be at least two times higher.[28]

For sales of power to EDM, tariffs have also been satisfactory for HCB, but low enough for EDM to be able to sell surplus power into the SAPP short-term markets (STEM and henceforth DAM). In 2007, EDM exported nearly 20% of the net energy at its disposal.[29]

[28] Figures from World Bank (2007).

[29] Electricidade de Moçambique (2006b).

6 Future Plans

Under the post-2007 arrangements, with HCB being majority-owned by the Mozambique government and a general shortage of electricity capacity in the SAPP region, there is a better balance of power and influence and the Mozambique state should derive much higher benefits from Cahora Bassa. At the ceremony in November 2008 to mark one year since the Mozambique government took over majority control of HCB, it was stated that HCB was operating at close to its maximum production of 2,075 MW.

The immediate plan of the governments of Mozambique and Malawi is to build the long-discussed 200 kV interconnector between the two networks. The transmission lines will be owned by EDM and ESCOM, but HCB has a strong interest in any project which expands opportunities to trade. However, the present situation is one in which there is little room to accommodate Malawi's import needs when Cahora Bassa capacity is already being intensively used. Future plans are to develop additional hydropower capacity on the Zambezi—probably Mpanda Uncua downstream of Cahora Bassa first and then the north bank power station at Cahora Bassa,[30] installing at least 850 MW. The ultimate capacity of Cahora Bassa (north and south bank) is said to be 3,300 MW.

[30] The North Bank project would require Cahora Bassa lake level to be sharply reduced for a period. It makes sense therefore for Mozambique to execute a downstream project first. There may also be other more fundamental reasons for this project ordering.

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