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ECONOMIC CONSULTING ASSOCIATES

The Potential of Regional Power Sector Integration

Manantali | Generation Case Study

Submitted to ESMAP by:

Economic Consulting Associates

September 2009

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Contents

Tables and Figures

Tables

Figures

Abbreviations and acronyms

AFD	Agence Française de Développement
ADB	African Development Bank
ASCRB	Adjusted Separable Cost Remaining Benefits Methodology
BCM	Billion Cubic Meters
BOARD	West African Development Bank
CIDA	Canadian International Development Agency
CFA	West African Franc
CREE	Electricity and Water Regulatory Commission of Mali
DNHE	Ministry of Mines, Energy and Water, Mali
ECOWAS	Economic Community of West African States
EDM	Énergie du Mali (Mali energy utility)
EIB	European Investment Bank
EEM	Eskom Energie Manantali
ERG	Export Risk Guarantee
ERR	Economic Rate of Return
Eskom	South African Electricity Utility (Electricity Supply Commission)
ESMAP	Energy Sector Management Assistance Program
EUC	Electricity Utility Company
FADES	Arab Fund for Economic and Social Development
GDP	Gross Domestic Product
GNI	Gross National Income
GWh	Gigawatthour
IDA	International Development Association
IDB	Islamic Development Bank
ICR	Implementation Completion Report

KfW	Kreditanstalt für Wiederaufbau
kV	Kilovolt
MEMI	Ministry of Energy, Mines and Industry, Senegal
MW	Megawatt
NGO	Non-Governmental Organization
OERS	Organisation des Etats Riverains du Sénégal
OMVS	Organisation pour la Mise en Valeur du Fleuve Sénégal (Senegal River Basin Development Authority)
OMVG	Organisation pour la Mise en Valeur du Fleuve Gambie (Gambia River Basin Development Authority)
PASIE	Plan d'Attenuation et de Suivi des Impact sur l'Environnement (Environmental Impact Mitigation and Monitoring Plan)
pcpa	per capita per annum
RHDP	Regional Hydropower Development Project
RIMA	Réseau Interconnecté de Manantali (Manantali Interconnected Network)
RIO	Réseau Interconnecté de l'OMVS (OMVS Interconnected Network)
SAED	Société d'Amangement du Delta, Senegal
SENELEC	Société Nationale d'électricité du Sénégal (National Electricity Company of Senegal)
SOGEM	Société de Gestion du Barrage de Manantali
SONADER	Société Nationale pour le Developpement Rural, Mauritania
SOMELEC	Société Mauritanienne d'électricité (Mauritanian Electricity Company)
SONEES	Senegalese Water Corporation
WAPP	West African Power Pool

Exchange Rates Used

CFA 445.51 = US$ 1, average 1985

(Note: the CFA was pegged to the French Franc (F) at 1 CFA = 0.02 F; the average F to US Dollar rate in 1985 was 1 Franc = US$ 0.11223)

CFA 692.59 = US$ 1, average 2002

CFA 579.42 = US$ 1, average 2003

CFA 492.89 = US$ 1, average 2007

All conversions in the text are made at the rate for the corresponding year

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

The regional integration of the power sectors of Mali, Senegal and Mauritania was motivated by economic development considerations. Joining forces was seen as a way to achieve long-term economic goals, which included the development of large areas of land for agriculture and the construction of a shared hydropower facility which would increase the installed generation capacity in the region. An increase in capacity would help all three countries, which were faced with low supply and high cost of electricity. Electrification rates were low, and reliable electricity access was seen as an important driver of economic development.

Besides expanding energy production, the project also focused on facilitating irrigation and navigation potential. The motivation for the construction of the dam, besides the hydrogeneration facilities, was to alleviate the uncertainty of seasonal water variation in the river, floods and droughts being major problems for large-scale agricultural production.

Figure 1 shows the Senegal River basin, showing the upstream location of the Manantali dam and the position at the mouth of the river of the Diama Dam, which was built at the same time to prevent the intrusion of salt water into the lower valley and to raise river levels to reduce the cost of pumping.

Figure 1 The Senegal River Basin

Source: Goff, J. et al (2005): Appui de la coopération française l'organisation de la mise en valeur du fleuve Sénégal (OMVS): *Évaluation conjointe et partenariale (1994-2004)*

1.2 The trade solution put in place

The Manantali Dam has a storage capacity of 11 BCM of water and an installed hydropower capacity of 200 MW. Following a careful evaluation of the costs and benefits of different services which the project was supposed to provide (irrigation, hydropower and navigation), the countries agreed to fixed proportional shares of the energy produced at Manantali. Mali receives 52% of the electricity generated, Senegal 33%, and Mauritania 15%. The average energy output of Manantali over the period 2003–2006 was 767 GWh per annum. Tariffs for this power were calculated to ensure sufficient revenue to cover operational costs and repay project debt, and between 2002 and 2006 varied between 4.1 € cents/kWh and 5.4 € cents/kWh.

While most regional generation projects are started by an electricity organization, the Manantali dam was initiated by a water organization called Organisation pour la Mise en Valeur du fleuve Sénégal (OMVS), a joint initiative of Mali, Senegal and Mauritania. The OMVS facilitated the construction and initially oversaw the operation of the dam. When the subsequent hydropower component was being planned, a special purpose entity, the Société de Gestion du Barrage de Manantali (SOGEM), was established to be the asset holder and company responsible for the operation of the dam and the hydroelectricity system. Day-to-day operations are the responsibility of Eskom Energie Manantali (EEM), a subsidiary of Eskom of South Africa, which signed a 15-year management contract with SOGEM.

1.3 Current status and future plans

The construction of the project took place in two stages. The dam was completed in 1987. Though it had initially been scheduled to be completed along with the dam, construction of the hydroelectric power plant and transmission lines only began 10 years later and was completed in 2002. The second phase of the project also included a component to address adverse social and environmental issues, and to broaden the representativeness and responsiveness of OMVS to the needs of diverse water users.

The Manantali project has been successful in delivering electricity to the three participating countries. The payments due according to an agreed Tariff Protocol have not always been forthcoming, however, giving rise to payments arrears on project loans. The project guarantors are the governments of the three participating countries.

With the growing influence of the West African Power Pool (WAPP), future plans include the development of a number of hydropower projects similar to Manantali on the Senegal River and the Gambia River. The existing OMVS interconnected network is to be extended and eventually linked into a subregional West African grid.

2 Context for trade

2.1 Economic and political context

Mali, Senegal and Mauritania, which all attained independence from France in 1960, are low-income economies located in West Africa. While Mali is a landlocked country with 65% of its land covered by desert, Senegal and Mauritania both have access to the Atlantic Ocean. The Senegal River rises in Guinea and Mali and downstream forms the border between Senegal and Mali, before spilling into the Atlantic Ocean. Table 1 gives an overview of the most important economic indicators for the three countries involved in the Manantali project as of 2007.

Table 1 Indicators for Mali, Senegal and Mauritania (2007)

	Mali	Senegal	Mauritania
Population (millions)	12.3	12.4	3.1
Surface area (km²)	1,240,910	196,720	1,030,700
GDP (US$ billions)	6.9	11.1	2.6
GNI per capita (PPP)	1,040	1,650	2,000
GDP growth %	3	5	2
Inflation (GDP deflator annual %)	4	5	-3
Exports (% of GDP)	27	24	58
Electrification rate (%)	N/A	33	N/A
Electricity consumption per capita (kWh)	41	206	112
Life expectancy at birth (years)	54	63	64
Mortality rate under 5 years (per 1,000)	196	114	118

Source: *World Development Indicators (World Bank), 2007 data* & UNDP Human Development Report, 2007/2008

In 1985, before the completion of the Manantali dam, Mali had an installed capacity of 82 MW, Mauritania of 105 MW and Senegal of 207 MW, giving a total of 394 MW. Table 2 shows the increase of capacity over the period 1998–2006, which reached a combined total of 959 MW at the end of this period. It should be noted that the hydropower capacity from the Manantali dam first became available during 2002.

The 194 MW of operational installed capacity from Manantali is shared as follows:

- Mali receives 104 MW

- o Senegal receives 60 MW
- o Mauritania receives 30 MW

Table 2 Installed Capacity (MW)

Year	Mali	Senegal	Mauritania
1998	114	235	123
1999	114	235	126
2000	114	270	145
2001	190	282	145
2002	250	302	145
2003	280	412	168
2004	280	355	172
2005	280	400	172
2006	280	507	172

Source: Energy Information Adminsitration

In the 1970s, when the Manantali dam was being planned, all three countries relied on agriculture and fishing for large portions of their GDP, and the livelihoods of a large proportion of their populations were dependent directly or indirectly on the flow of the Senegal River. The rainfall in the region generally varies throughout the year, but is concentrated in the months July to October. As a result, before the building of the dam, there were limited flows in the river in the remaining months. Overcoming the extreme intra-annual variability, which hampered economic development opportunities in all three countries, was a major motivation for building the Manantali dam. An associated development objective was to increase power generation capacity, using the proceeds from sales of electricity to finance the dam, but in the event the power aspect was delayed to a second phase.

2.2 Supply options

Mali is estimated to have an annual hydroelectric potential of 1,050 GWh of which about 25% is currently being used by national generation facilities at Selingue, Sotuba and Felou. The hydro station at Selingue with 44 MW installed capacity is the biggest of the three owned by the national utility, Energie du Mali (EDM). Mali has always relied heavily on hydroelectricity, with 57% of generated energy (386 GWh) coming from hydro in 1997 before Manantali's hydropower became available.

In **Senegal**, electricity production has been a central focus of national policy, and the lack of sufficient supply of electricity, resulting in outages and uncompetitive pricing, is considered one of the country's largest challenges in achieving economic growth. Most household energy consumption is based on biomass such as wood and charcoal. Biomass makes up about 80% of national energy consumption, with the remainder being mostly petroleum based. The rate of electrification was about 33% in 2007 for the country as a whole, but less than 10% in the rural areas.

Before Manantali came online in 2001, generation by Société Nationale d'électricité du Sénégal (SENELEC) was almost 100% based on oil with a very small renewable sector. The dominant fuel used for electricity generation remains oil (85%), but in recent years hydro makes up almost 10% and other renewables the balance of 5%.

In **Mauritania**, prior to Manantali, electricity supply was limited to the output of 10 diesel thermal stations supplying isolated centers throughout the country, with Nouakchott being the most important. The country has traditionally been an importer of oil, but after discoveries of offshore oil fields, Mauritania became an oil producer in 2006. Electricity generation in Mauritania is still lower than in Mali or Senegal but as shown in Table 3, it doubled between 1998 and 2006. The national utility in Mauritania is Société Mauritanienne d'électricité (SOMELEC).

The output of Manantali is distributed in pre-agreed shares to the three countries. Mali receives 52% of the energy generated, Senegal 33%, and Mauritania 15%. Since 2003, the annual average total sales from Manantali have been 767 GWh (calculated from Table 4 in Section 2.4). Data on energy generated in the three countries is given in Table 3.

Table 3 Electricity Generation (GWh)

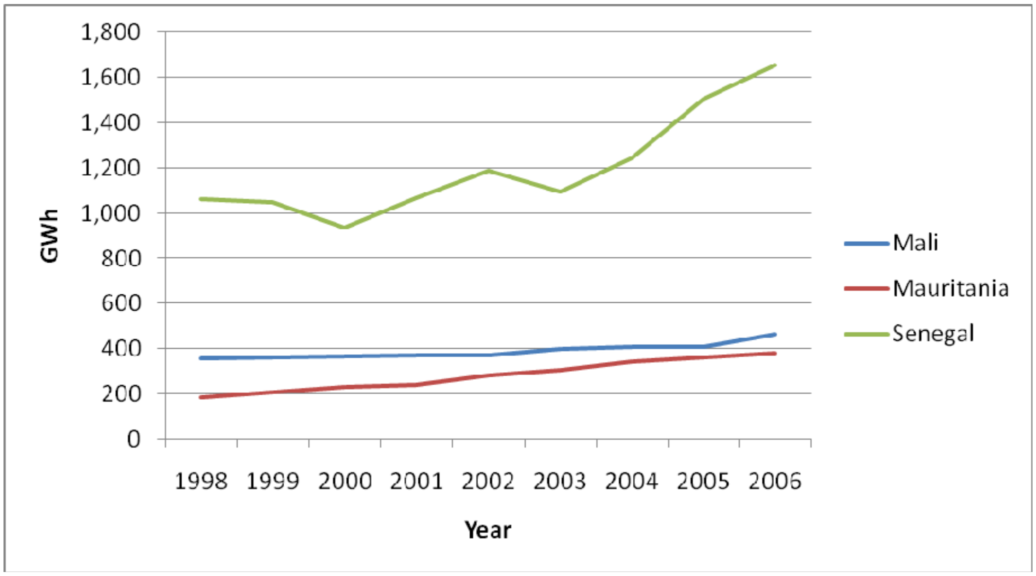
Year	Mali	Senegal	Mauritania
1998	387	1,277	201
1999	392	1,315	228
2000	399	1,437	252
2001	402	1,611	264
2002	404	1,791	305
2003	434	1,901	333
2004	444	1,992	370
2005	444	2,272	392
2006	505	2,279	412
% Manantali 2006	75%	10%	30%

Source: EIA and Table 4 (calculations in last row)

2.3 Demand

Electricity consumption has increased steadily in recent years, particularly in Senegal. Figure 2 illustrates this trend. However, as shown in Table 1, per capita levels remain very low (41 kWh pcpa in Mali, 206 kWh pcpa in Senegal and 112 kWh pcpa in Mauritania).

Figure 2 Electricity Consumption (GWh)



Source: EIA

Underlying demand for electricity has risen more rapidly, but has not been met with sufficient increase in supply. The Economic Community of West African States (ECOWAS) estimated that in 2007 as much as 46% of the electricity demand in the region was unmet.

2.4 Energy tariffs

The payments of the member utilities consist of both a fixed payment, which is intended to cover fixed expenses, and an energy charge that is determined by an indexed tariff that is linked to the Mali rate of inflation. The figures in Table 4 are average effective tariffs (in real terms), calculated as the total revenue due divided by the electricity for the year in question. The global fixed payment component is about $18 million per annum (CFA 9,098,200,000).

Table 4 Manantali Sales and Average Effective Tariffs

Year	EDM	SENELEC	SOMELEC
	Sales (GWh)		
2002	186.1	165.9	21.0
2003	285.9	335.9	146.8
2004	331.8	292.9	132.0
2005	391.4	266.9	143.0
2006	380.7	234.1	124.9
	Sales (million CFA)		
2002	5,090	4,527	608
2003	9,547	9,542	4,354
2004	8,837	10,279	4,494
2005	10,885	8,667	4,353
2006	11,728	7,340	3,719
	Tariffs (in constant € cents/kWh)		
2002	4.17	4.16	4.41
2003	5.09	4.33	4.52
2004	4.06	5.35	5.19
2005	4.24	4.95	4.64
2006	4.70	4.78	4.54

Source: Schmidt, W. & Seve, A. (2007): *Évaluation d'opérations: Évaluation de SOGEM – Système hydroélectrique Manantali Mali – Mauritanie - Senegal*

3 History of scheme

3.1 Overview including timeline/chronology

The Manantali project was initiated in the 1970s by the river basin organization, Organisation pour la Mise en Valeur du fleuve Sénégal (OMVS). The construction of the dam, which is located about 90 km from Bafoulabe in Mali, began in 1981, and it was completed by 1987. A second dam, at Diama close to the Atlantic Ocean, was built at the same time to prevent the intrusion of salt water into the lower delta. The original Manantali project was planned to include hydropower generation, but this was not pursued at the time.

A second, separately funded project called the Regional Hydropower Development Project (RHDP), was started 10 years later. This involved installation of 200 MW of hydropower capacity and construction of an interconnected high-voltage transmission network (known as RIMA—details are given in Section 3.5). Energy production at Manantali commenced in 2001.

There were several reasons why the hydropower component was not completed when the dam was built. These included a cost overrun on the dam itself, an absence of an agreement on the route of the line, and uncertainty about the hydroelectric generation potential as water flow was perceived to be decreasing. Furthermore, the belief that Mali, being upstream of the other two, had stronger incentives, particularly higher avoided costs of thermal generation, led Senegal and Mauritania to demand extra transmission facilities. When no agreement was reached, and the financing was not sufficient, the hydropower component was shelved.

In 1997 several donors offered additional loans to OMVS, and a new project was initiated, the RHDP, which led to the installation of the generation and transmission facilities. The project also included a component designed to alleviate some of the environmental and social problems that had emerged since the dam was completed (the Environmental Impact Mitigation and Monitoring Plan, PASIE).

A special-purpose company, Société de Gestion du Barrage de Manantali (SOGEM) was created by OMVS to be the asset holder and operator of the Manantali infrastructure. SOGEM in turn contracted Eskom Energie Manantali (EEM), a subsidiary of Eskom, the government-owned South African electricity utility, to manage the hydropower station and the associated infrastructure. In July 2001, Eskom signed a 15-year contract with SOGEM for the operation of Manantali.

Table 5 outlines the chronological development of Manantali.

Table 5 Chronology for the Manantali Hydroelectric Dam

Year	Event
1972	Mali, Senegal and Mauritania establish the Organisation pour la Mise en Valeur du fleuve Sénégal (OMVS) when Guinea leaves their previous river organization, Organisation des Etats Riverains du Sénégal (OERS).
1975	Structuring of OMVS into three entities: Heads of State Summit, Council of Ministers and the High Commission
1977	Council of Ministers commissions study on cost/benefit methodology
1978	Convention recognizing the legal status of jointly owned structures
1981	Construction of Diama and Manantali dams begins
1982	Convention recognizing the financing of jointly owned structures
1986	Diama dam completed
1987	Manantali dam completed
1988	Manantali dam operational (no generation facilities)
1992	OMVS Guinea protocol signed, allowing Guinea to attend OMVS meetings as an observer
1997	Donors provide US$450 million for the RHDP project; SOGEM is formed
1998	Creation of the Environmental Impact Mitigation and Monitoring Plan (PASIE)
2001	Eskom signs a 15-year contract for the operation of the Manantali generation and transmission facilities; EEM is formed and hydropower production commences
2002	RHDP completed

3.2 Project concept, objectives, and development

The initial development objectives of the Manantali and Diama projects were to accelerate economic development and to improve the income of the population living in the river basin. The stated goals included an increase in food self-sufficiency and a reduction of economic vulnerability to climatic fluctuations and other external factors. After the dams were built, the expected improvements were marred by adverse environmental and health impacts, particularly the curtailment of the annual floods, which disrupted traditional agriculture and disturbed delicate biosystems, and an increase in the incidence of bilharzia due to the elimination of salt water intrusion.

When the Regional Hydropower Development Project was planned 10 years after the dams were built, the new project's aims were cast as follows:

- reduce the long-term cost of electricity supply to the three countries;
- contribute to meeting debt service associated with building the Manantali dam;
- contribute to increasing the efficiency and reliability of power systems in the three countries;
- establish an effective organization to construct and operate the facilities and to mitigate environmental and health impacts;
- promote competitive private-sector participation;
- support the traditional agricultural sector downstream through the rational management of the reservoir.

The main steps taken to meet these objectives were the establishment of SOGEM, the successful operation of the hydropower facilities by EEM, and the implementation of PASIE. The biggest problem that has arisen relates to the second objective of debt service, in that inadequate payments have been made by the utilities, and funds have been used for purposes other than debt service by SOGEM. This is discussed further in Section 5.3.

The last objective of supporting traditional agriculture downstream was to be accommodated by a requirement in the RHDP project design that the Manantali reservoir be operated in such a way as to ensure an artificial flood sufficient to enable the cultivation of 50,000 ha, with this having priority over electricity generation. "While the value of the electricity thus foregone was significantly higher than the agricultural benefits from cultivation of the additional inundated land (US$14 million compared to US$4.5 million), the non-quantified economic and social benefits were considered to be sufficient to swing the balance in favour of the artificial flood."[1] In practice, with shortages of electricity in all three countries, hydropower generation has been given priority and apparently no artificial flood releases have been made.

3.3 Feasibility studies done

Feasibility studies were conducted for both phases of Manantali. In the early stages of planning the Diama and Manantali projects, a major issue was how the benefits of different services to be provided by the dams (such as irrigation, hydropower, navigation and flood control) were to be assessed and allocated between the three countries. OMVS contracted Utah State University to work on the cost/benefit methodology. It took several years to complete the studies and to choose a methodology. In the end, an "adjusted separable cost

[1] Bond et al. (2001), page 1015.

remaining benefit" method (ASCRB) was adopted. For more details on the ASCRB method and the resulting allocation, see Annex 0.

Although it was recognized that other costs and benefits would be relevant, benefits were analyzed in only three different categories:

- irrigation
- hydropower
- navigation.

For the energy costs, the calculation was based on the comparative cost of thermal power, estimated at the time (1985) to be 31.28 CFA (7 US cents) per kWh, less the direct hydropower costs. The generators at Manantali could produce up to 1,750 GWh per year depending on the availability of water and the amount released for artificial floods for recessional agriculture. Using the historical average flows, it was estimated that 800 GWh per year 90% of the time would still allow for an artificial flood of 50,000 ha. The total benefits of electricity at the rate of the cost of power were calculated to be US$48 million per annum.

Regarding irrigation, different scenarios on the profitability per hectare of newly available irrigable land were tested. Irrigation benefits were expected to be around 111 billion CFA (US$250 million). Although riverine transport thus far is almost nonexistent, a calculation of navigation benefits was based on comparative costs for rail and road transport. Benefits were calculated to be worth 530 billion CFA (US$1.2 billion).

These benefits were then divided among the participating countries and the resulting distribution, known as the *key*, agreed among them (details are given in Annex A1). In comparison with other river basin organizations, what is significant is the OMVS insistence on the principles and practice of benefit sharing. In other basins, the discussions tend to be over water allocations, as opposed to the more productive dialogue over the benefits derived from use.[2] The approach has ensured equitable benefit sharing among the three countries involved in the use of a common resource, but it has not resulted in equitable sharing of the benefits and costs among the population at large, as is discussed further in Section 3.6. Part of this is due to the fact that over time the actual usage and associated benefits have changed, with the most dramatic example being that no riverine transport has been introduced, removing one of the main components included in the key. However, despite calculations of benefits of other uses (such as fishing), the countries have been reluctant to change the key. The main practical effect has been to lock in the allocation of Manantali energy between the three countries.

[2] Yu (2008), page 25.

3.4 Assets built

The assets built as part of the Manantali project are the dam, the 200 MW hydropower station and the Manantali Interconnected Network (RIMA). The dam is shown in Figure 3 and the transmission system is shown in Figure 4.

The capacity of the transmission system has been more than adequate for the amount of energy that is available from the hydropower station, but that falls short of the demand for electricity in the three countries. The challenge for the dam operator (EEM) is to allocate the water over the entire year from the dam replenishment which occurs in the second half of the year, satisfying demand for water for irrigation and other purposes as well as hydropower.

Figure 3 Aerial View of the Manantali Dam

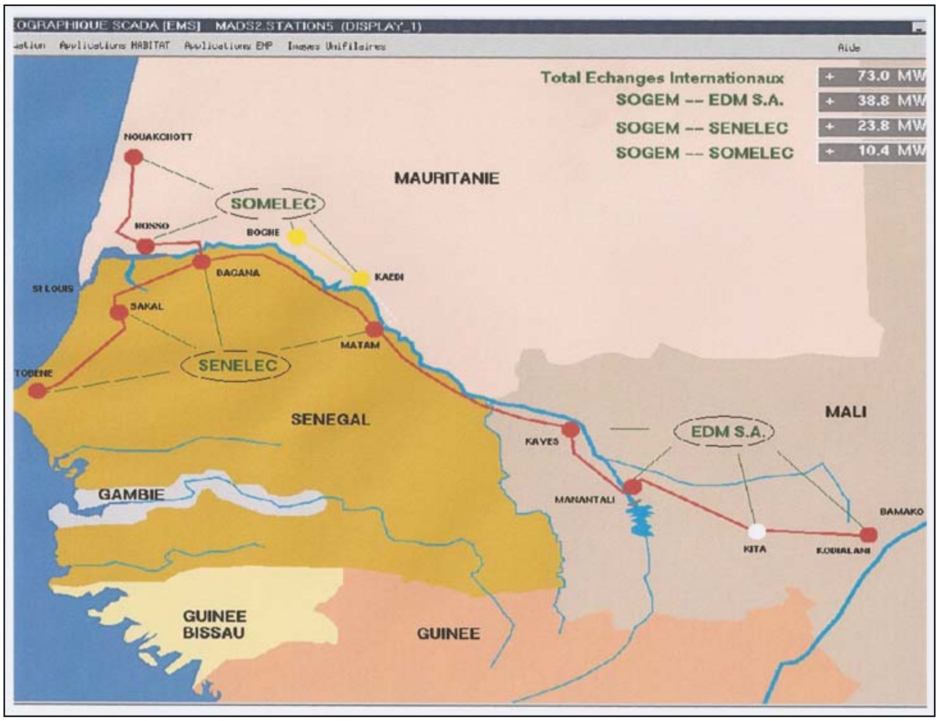
Source: JBICI Research Paper No. 36-3: Aid Effectiveness to Infrastructure: A Comparative Study of East Asia and Sub-Saharan Africa, Case Studies of Sub-Saharan Africa, July 2008

3.5 Interconnections and electricity trade

The transmission system from Manantali consists of two systems: the eastern system toward Bamako and the western system toward Dakar. The eastern system is 306 km long and is comprised of a single-circuit 225 kV transmission line from Manantali to Kodialani (Bamako). The western system is 945 km long, also a single-circuit 225 kV transmission line reaching from Manantali to Tobene. For supply to Mauritania, there is a branch from Dagana in Senegal to Nouakchott. Figure 4 shows the interconnections of the OMVS member countries.

The jointly owned Manantali Interconnected Network (RIMA) and the national networks of the three OMVS member countries together constitute the OMVS Interconnected Network (RIO). Part of the management contract of EEM gives the company responsibility for the operation and maintenance of RIMA. EEM is in charge of dispatch and operates the central Manantali dispatch center, which communicates with the individual country load dispatch centers. The contractual relationship is governed by the OMVS Interconnected Network Tariff Protocol and other agreements (details are given in Section 5.1).

Figure 4 Transmission System



Source: Presentation by Tshibingu, K., (2004): "Eskom Energie Manantali (EEM)," NARUC: Bamako July 26-30, 2004.

The relationship between EEM, the dispatch centers and the electricity utility companies (EUCs) is governed by an agreed annual power generation plan, which starts with an annual projection of available water and hence energy. The EUCs establish and communicate their energy needs on a weekly basis, and there is real-time communication between the Manantali dispatch center and the load dispatch centers in the three countries. The electrical energy that is generated has to meet immediate needs of the three utilities, while being distributed over the year in the agreed proportions (Mali 52%, Senegal 33% and Mauritania 15%).

3.6 Environmental and social issues

The Manantali and Diama dams have had several adverse social and environmental side - effects. In terms of environmental issues, the construction of the dams led to ecosystem changes, which included:

- altered estuarine and freshwater system dynamics
- the generation of invasive weeds and grasses
- disappearance of wetland areas
- degradation of fish populations
- reduced pasture lands
- river bank erosion in the upper valley
- increases in parasitic diseases in the valley

Social disruption has been associated with these effects and with the arrival of new-comers to the basin area, replacing flood-recession farmers. Environmental groups have criticized project planners for only addressing these issues after the dams were built.

Set against the negative environmental impacts, there are some positive ones, notably the displacement of diesel generation by hydropower, albeit that the greenhouse gas benefits would have to be net of any methane and other gases produced by the decomposition of organic matter as a result of inundation of the dammed area. As far as can be ascertained, no detailed analysis of the greenhouse gas impacts of Manantali have been produced, perhaps because the dam predated such concerns.[3]

As part of the RHDP, OMVS established the Environment Impact Mitigation and Monitoring (PASIE) Plan to address the adverse impacts of the dams and establish an optimal reservoir management program. The environmental mitigation plan had six components:

- impact mitigation (such as standards and monitoring agreements to minimize and mitigate the impact of the construction works)
- land acquisition (such as standards and procedures for acquisition, re-housing and compensations)

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[3] This is not the case for the proposed downstream OMVS Felou Regional Hydropower Project. In connection with that proposal, the World Bank Carbon Finance Unit observes that "Currently, the electricity generated in Mali, Mauritania and Senegal that is sent into the interconnected grid is relatively carbon intensive, with an operating margin emission factor of 0.8057 tCO2/MWh and a build margin emission factor of 0.1999 tCO2/MWh. The project is therefore expected to reduce emissions of greenhouse gases by an estimated 160,908 t CO2e per year during the first crediting period." See http://wbcarbonfinance.org/Router.cfm?Page=Projport&ProjID=38205

- o reservoir management
- o environmental health, including a pilot program to eradicate bilharzia and malaria from the valley
- o accompanying socioeconomic measures (including rural electrification and income generation projects for communities near transmission lines)

With respect to the last component, a feasibility study for the electrification of villages located near the transmission lines was undertaken. The village of Manantali was electrified in 2005 and an emergency rural electrification program was launched in 10 villages in each of the three member countries. A broader program covering villages of 300 to 10,000 inhabitants has been mapped out involving 9,716 rural localities, representing 83% of the basin's rural population.

In 2002, to address the social and environmental problems which had been experienced since the construction of the Diama and Manantali dams, a **Water Charter** was agreed upon and ratified by the three countries. The Water Charter establishes the policy for water allocation for a variety of uses in the basin. The scope and purpose of the charter are broader than the previous conventions and focus more on process than specific outcomes. The new objectives include:[4]

- o Establishing the principles and mechanisms of distributing the waters of the Senegal River between the different sectors (adding fishing, domestic use, health, and the environment as sectors)
- o Defining the mechanisms for reviewing new projects affecting the river
- o Determining the rules relating to the preservation and protection of the environment, particularly with regard to wildlife, flora, and ecosystems of the flooded plans and the wetlands
- o Defining the methods for stakeholder participation.

The charter introduced the concepts of sustainability and environmental protection, thus giving OMVS much more authority to respond quickly to these types of concerns. Environmental action plans are now required under the charter, which mandates the monitoring and evaluation of water quality and quantity. Institutional changes were also adopted to make OMVS more representative and responsive.

[4] Yu (2008), page 23.

4 Institutional arrangements

4.1 Scheme governance structure

OMVS, working with and coordinating the member countries, was responsible for planning the original Manantali project and was responsible for the construction and initial operation of the dam. OMVS was also instrumental in initiating the hydropower phase of development, raising the funds for the RHDP with the three member country governments providing the guarantees. OMVS has a four-tier structure:

- ***Conference of Heads of State and Government***

  This body is responsible for overall policies and major decisions.

- ***Council of Ministers***

  The council is made up of ministers responsible for water in each country, but others may be asked to join if a particular subject demands it. The council has the authority to obtain financing for projects.

- ***The High Commission***

  The High Commission is the executive arm of OMVS, responsible for regulating and monitoring water-related development in the basin.

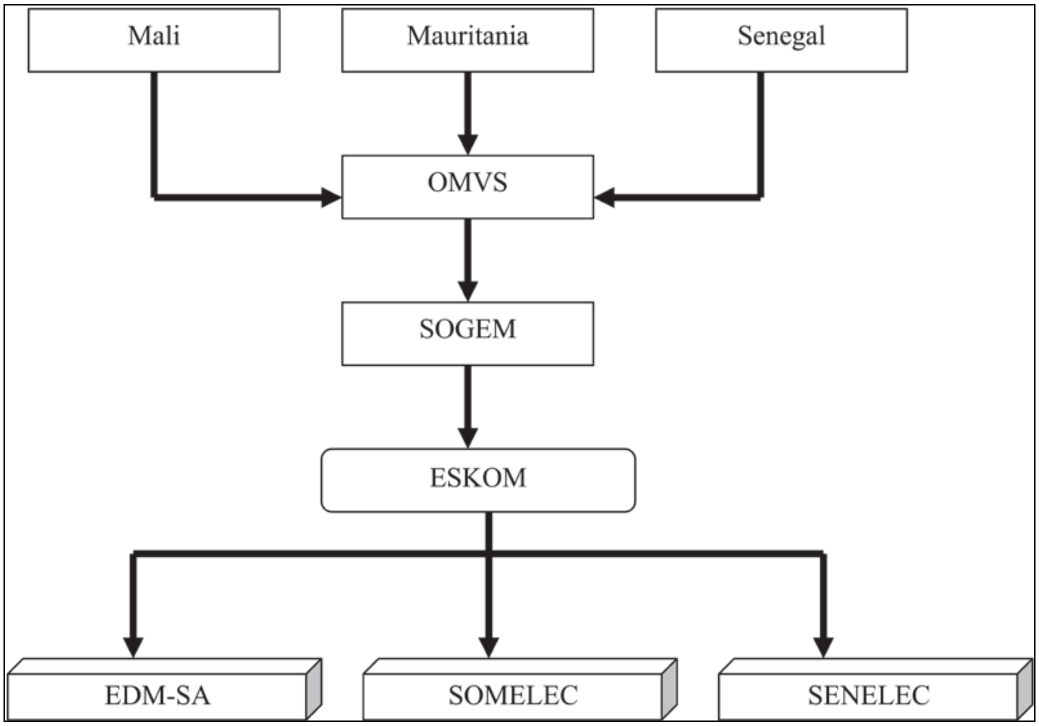
- ***The Permanent Water Commission***

  The Permanent Water Commission is a consultative group, consisting of representatives from the water-using sectors across the basin. The Water Charter principles of May 2002 extended the membership to include local farmers and fisherman as well as nongovernmental organizations (NGOs). The Permanent Water Commission considers the basis and means for water allocation among the different users in the basin.

As mentioned previously, as part of the RHDP project, SOGEM was formed in 1997 as a special-purpose asset holding company with responsibility for the operation of the Manantali infrastructure. In 2001, SOGEM signed a contract with Eskom Energie Manantali, making EEM responsible for managing the hydropower station and the associated infrastructure over the first 15 years after commissioning.

The relationship between the member states, OMVS, SOGEM and EEM is illustrated in Figure 5.

Figure 5 Interaction of the Organizations



Source: JBICI Research Paper No. 36-3: Aid Effectiveness to Infrastructure: A Comparative Study of East Asia and Sub-Saharan Africa, Case Studies of Sub-Saharan Africa, July 2008

4.2 Role of national governments and regional institutions

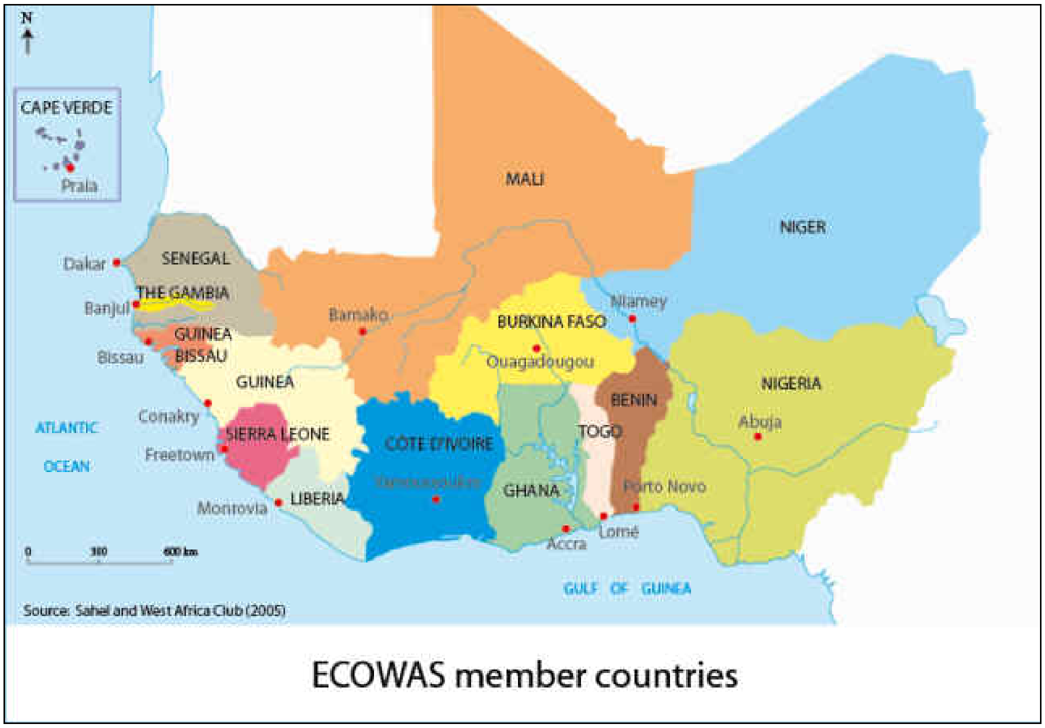
The three national governments have played an important role in both phases of the project. Through OMVS, they have participated in the planning and they are joint owners of SOGEM. In the financing of the investments, sovereign guarantees were crucial.

Two of the OMVS countries are members of two larger regional organizations which have developmental objectives related to those of OMVS:

- **Economic Community of West African States (ECOWAS)** is a regional group currently consisting of 15 countries which was founded in 1975. Both Mali and Senegal are part of ECOWAS, while Mauritania withdrew in 2000. Although ECOWAS is involved in the energy sector, the organization was not directly involved in the Manantali projects. Figure 6 shows the member countries of ECOWAS.

- **West African Power Pool (WAPP)** is a specialized institution of ECOWAS, created in 1999 with the mission to integrate the power systems of the ECOWAS countries and provide reliable and affordable electricity supply for all. As with ECOWAS, WAPP was not involved with the original Manantali project nor with the RHDP, but the organization is currently trying to use the hydro facilities and transmission system of Manantali as a starting point from which to increase the supply of hydroelectricity in the region by encouraging additional similar projects, and it is using the existing capacities of OMVS to do so. More details are given in Section 6.

Figure 6 ECOWAS Countries



Source: OECD

4.3 Regulatory agencies

Each OMVS member country has a separate regulator which interacts with EEM regarding electricity allocation, transmission and consumption.

- In Mali the Electricity and Water Regulatory Commission (CREE), a financially independent body, is responsible for the regulation of energy and water and for promoting competition in these sectors.
- In Senegal the Energy Regulatory Commission was founded in 1998 as an autonomous agency.
- The Mauritanian regulatory authority in charge of electricity, the Autorite de Regulation, is associated with the Ministry of Energy and serves as an advisor to that ministry regarding energy and water issues.

The ministers of ECOWAS member states adopted the concept of establishing a regional regulator in 2002. The Regional Regulation Development Office, located in Abuja, Nigeria, was finally established in 2008.

4.4 Role of outside agencies

The role of outside agencies in Manantali has mainly been in the financing of the two phases of development. As noted in Section 5.2, there were many donors and international financial institutions involved in this. France, through the AFD, played a particularly important role among the RHDP donors. While initially reluctant to fund the project, France in the end contributed a large component of the energy part of the project as well as providing technical assistance to implement PASIE and in the development of integrated water management capacities.

The World Bank was heavily involved in the procurement processes regarding the designation of firms for the construction components. The bank was also critical in initiating project preparation and the creation of the tariff agreement. The AFD, KfW and the World Bank put in place a consultative committee overseeing the electromechanical part of the project in an attempt to coordinate the many donors involved.

5 Contractual, financial and pricing arrangements

5.1 Contracts

Ownership of the infrastructure, the allocation of costs and the management and rules for the utilization of the water are governed by two conventions:

- **Convention concerning the legal status of jointly owned structures** (signed in December 1978)
- **Convention concerning the financing of jointly owned structures** (signed March 1982)

Together these conventions established the following rules:[5]

- All structures are the joint, indivisible property of the member states.
- Each co-owner state has an individual right to an indivisible share and a collective right to the use and administration of the joint property.
- The investment costs and operating expenses are distributed between the co-owner states on the basis of benefits each co-owner draws from exploitation of the structures.
- Each co-owner state guarantees the repayment of loans extended to the OMVS for the construction of the structures.
- Special-purpose entities are established to manage the jointly owned structures for the OMVS.

As described in Section 3.6, the **Water Charter** was signed in 2002, with the objective of extending the provisions of the earlier conventions so as to make OMVS better able to deal with social and environmental issues, and to be more representative and responsive to user needs.

At the time of RHDP, agreements were made to define the relationship between OMVS and SOGEM. As noted previously, in 2001 SOGEM signed a 15-year **operation and management contract** with EEM, giving EEM responsibility for the operation of the dam and the power generation and transmission facilities of Manantali, including the regional dispatch center.

The relationship between the member states, SOGEM and the electricity utility companies is governed by the **OMVS Interconnected Network Tariff Protocol**. This is the fundamental framework that governs the functioning of the hydropower generation system and the full

[5] Yu (2008) page 15.

interconnected transmission system (RIO) and guarantees the viability of the project over its expected 30-year life. The provisions for each of the contracting parties are as follows:

- The OMVS member states are guarantors of the project.
- The power generated belongs to the states and is put at the disposal of the utilities to manage and market.
- SOGEM, through the private operator EEM, undertakes to supply electricity on behalf of the OMVS states to the EUCs in the agreed proportions.
- The EUCs undertake to pay for and consume energy generated by Manantali.

There is also an **Interconnection Protocol**, which defines the technical framework for economical and reliable power generation, and **supply contracts** between the operator (EEM) and the three UECs.

Some of the practical implications of the agreements and protocols are as follows:

- An annual power generation plan is drawn up by EEM, in consultation with the EUCs, based on estimated water availability.
- EUCs estimate their power needs weekly, and EEM and the EUCs harmonize dispatch accordingly.
- The hourly voltages are drawn up by a Manantali generation plan.
- Congestion is managed through the power generation plan.
- There is to be constant dialogue between the dispatch center at Manantali and the load dispatch centers in the three countries.

5.2 Ownership and finance

The dam and electrical infrastructure is owned by the OMVS member countries through their shareholding in SOGEM.

Initial construction on the dam started with US $620 million in loans from 12 donors. The donors included the governments of Saudi Arabia, Kuwait, Abu Dhabi, Germany–Kreditanstalt für Wiederaufbau (KfW), France–AFD, Iran, the Canadian International Development Agency (CIDA) and the African Development Bank. The United States Agency for International Development (USAID) and the World Bank supported environmental assessments and provided financial and technical assistance for the resettlement of people displaced by the building of the Diama and Manantali dams. Export credit agencies cover subsidized loans for contracts awarded to German and Swiss firms.

There were conditions attached to some of the loans. In particular, the loans made by the African Development Bank specifically stipulated that:

- The borrowers (the country governments) make respective provisions in the OMVS budget for financing their share according to project cost in accordance with the financing plan.
- The borrowers find additional funds in the case of cost overruns.
- The borrowers should not use the loan money for the payment of duties and taxes on goods and services required for implementation of the project.

Furthermore, it was stipulated that electricity tariffs should be adopted that would meet the investment and operating expenses of the power station.

In the event, as the generation facilities were not completed during the first part of the project, there were no electricity revenues, and the OMVS states did not meet their loan obligations. The member states were put on suspension by the donors when they did not meet their commitments, but later ways of rolling over the debts were found, and some donors cancelled their debts altogether.

When the financing of the RHDP project was being considered, the costs were estimated at US$450 million. The donors for this project provided the bulk of the financing, the agencies involved being the International Development Association (IDA), AFD, KfW, CIDA, the African Development Bank, the Islamic Development Bank (IDB), the European Union, the European Investment Bank (EIB), the Arab Fund for Economic and Social Development (FADES) and the West African Development Bank (BOARD). The borrowers and guarantors were the governments of Mali, Senegal and Mauritania and the beneficiary was SOGEM. Repayment was envisaged through a debt service portion of the revenues, which was to be collected by EEM and passed on to SOGEM.

Some of the loans had certain conditions attached, such as clauses of origin for materials and services supplied. This sometimes complicated the work as it was impossible to treat pieces of the project independently in order to ensure that the conditions were met for only one particular donor's portion of the overall loan. Other donor conditions referred to energy sector restructuring being required in the OMVS countries.

The World Bank estimated the rate of return on the RHDP to be 16% in 1997, but the implementation completion report in 2005 cites an economic rate of return (ERR) of about 21%. The calculation is based on the assumption that there is an annual output of 807 GWh, with the exception of a drought every five years where annual output is assumed to drop to 300 GWh.

5.3 Pricing arrangements

As noted in Section 5.1, the Tariff Protocol is the fundamental framework governing the functioning of the jointly owned electricity system. The detailed aspects of the Tariff Protocol make provision for:

- the methodology for calculating, indexing and revision of tariffs
- the approach to project risks and risk management.

EEM is responsible for collecting the fixed and energy-related components of the payments due from the EUCs, and transmitting the revenue to SOGEM less EEM's fixed contract fee.

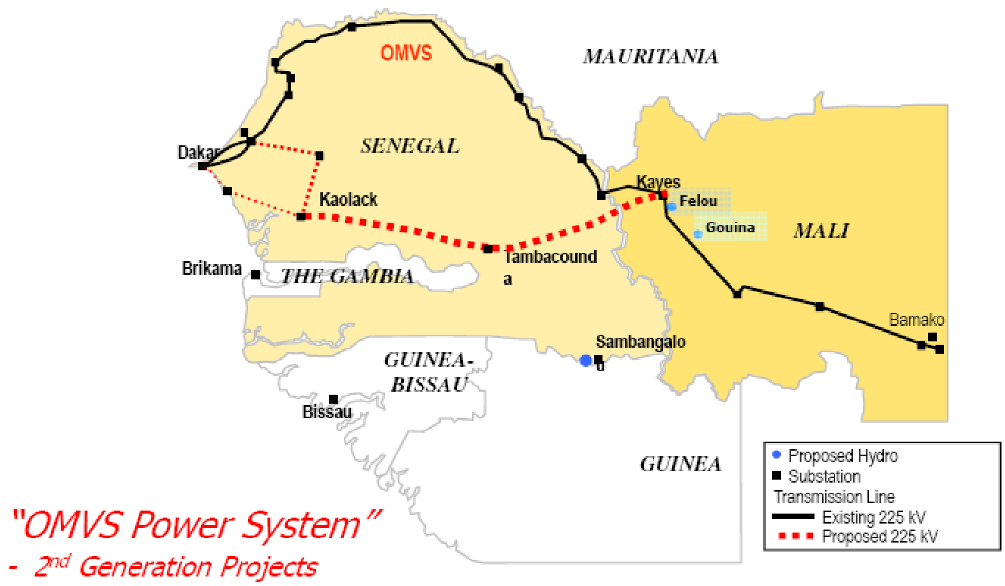
In practice, the EUCs have not always paid the amounts due, and from its limited resources SOGEM has not always given priority to the debt repayment commitments and making provision for risks. A report written in 2007 notes that the security accounts which SOGEM was supposed to establish to provide for the risk of low hydrological delivery and server equipment failure have never been built up, while SOGEM has "engaged financial resources in rural electrification projects, the construction of OMVS registered office and lately in thermal generation in Dakar to try to mitigate the energy crisis."[6]

[6] Tshibingu (2004), pages 8-9.

6 Future plans

WAPP, working with the river basin organizations, is seeking to build on the operational Manantali model by promoting similar projects elsewhere in West Africa. To expand supply to the existing OMVS interconnected network, a run-of-river 60 MW hydropower project at Felou and 69 MW facility at Gouina, both located in Mali, are being planned. These projects would help to overcome the persistent power deficits throughout the region. The main funding for the generation and an extension into central Senegal of the 225 kV network is expected to come from IDA. The layout is shown in Figure 7.

Figure 7 OMVS System Expansion

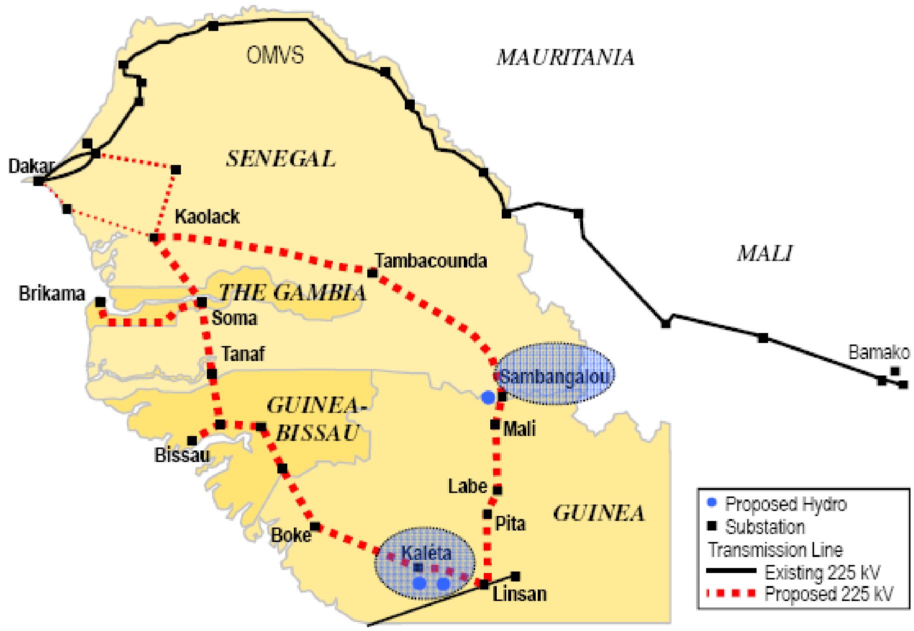


Source: WAPP Secretariat (2007)

In parallel with the OMVS initiatives, hydropower projects in Guinea and Senegal are being planned by Organisation pour la Mise en Valeur du Fleuve Gambie (OMVG). As shown in Figure 8, hydropower plants are planned at Sambangalou in Senegal (128 MW) and at Kaleta in Guine (240 MW), with associated transmission being interconnected with the existing and planned OMVS network. A smaller facility is also planned at Gourbassi (25 MW).

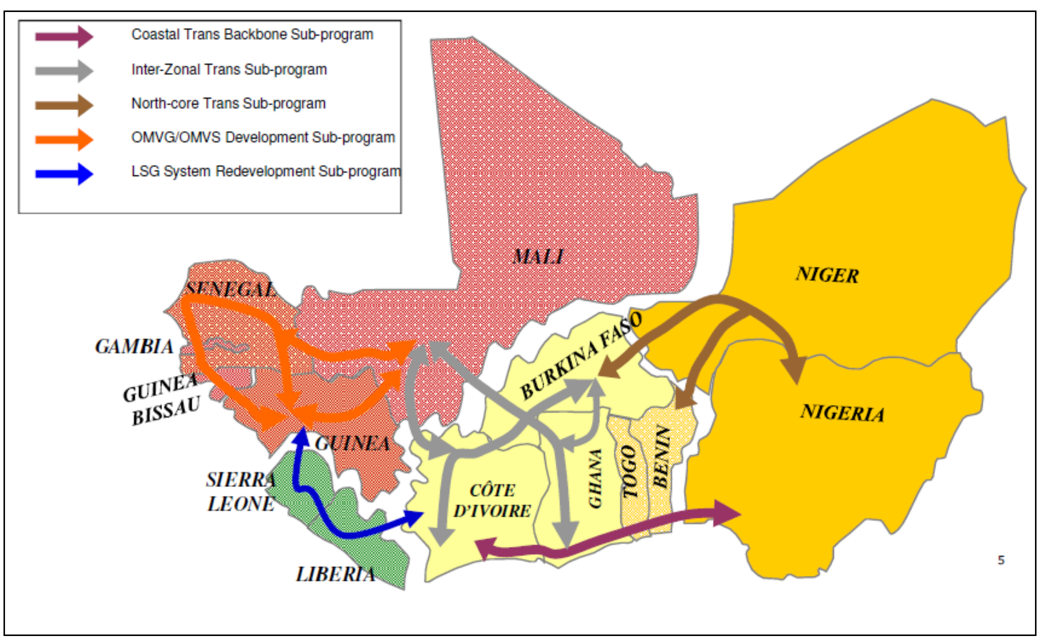
The WAPP plans make provision for the progressive integration and reinforcement of the interconnected network throughout the region. The OMVS interconnected system, presently linking Mali, Senegal and Mauritania, is to be connected to the network of Guinea, Guinea-Bissau, and the Gambia, with a further loop to Liberia, Sierra Leone and Guinea. The transmission network constructed with the RHDP funding will thus become part of a larger West African network as shown in Figure 9.

Figure 8 OMVS System Expansion



Source: WAPP Secretariat (2007)

Figure 9 WAPP Network



Source: WAPP Secretariat (2007)

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A1 Adjustable separable cost remaining benefits methdology (ASCRB)

In a project that has multipurpose benefits, it is difficult to determine costs of different services and hence user fees for cost recovery. The adjusted separable cost remaining benefits methodology (ASCRB) is one approach that is used to allocate costs over a variety of different services. It is based on comparing the benefits derived from these services to the services' costs.

Total costs can be divided into two types of costs: separable costs and joint costs.

- Separable costs are costs that can be associated with a certain project service. The separable cost is the difference of the cost of a project with that service as compared to without that service. For instance, power turbines would be a specific cost for hydropower for a multipurpose reservoir. Thus, since the cost of the power turbines would increase the cost of the multipurpose reservoir, that incremental increase is separable from the hydropower service.

- Joint costs cannot be directly identified with one particular service. The difference between the sum of the separable costs and the total costs are the joint costs. With the ASCRB, the joint costs are allocated in proportion to the ratio of remaining benefits for each service.

In the case of Diama and Manantali, the services identified were:

- irrigation
- hydropower
- navigation
- flood control

Only the first three services were costed in the Utah State University Report, in which 22.4% of the cost was allocated to the irrigation service, 30.8% to the energy service, and 46.8% to the navigation service. The three member states informally agreed on an allocation based on the potential use by each member state of the three identified services. The agreement included the area of land that could be developed for irrigation in each nation, the projected river transport use in terms of volume and distance, and the quantity of power consumed by potential consumers in each nation. By 1981 these informal agreements were approved by the council of ministers. The economic benefit of a unit of use for each member state was assumed to be the same for all three countries.

The agreement on costs and benefits that was adopted by the Council of Ministers in 1985 became known as the key. Table 6 shows how costs and benefits were allocated across countries.

Table 6: Cost and Benefit Break Down

Country	Cost	Irrigation Potential	Energy Generated	Navigation
Mali	35.3%	~0%	52%	~88%
Mauritania	22.6%	31%	15%	12%
Senegal	42.1%	58%	33%	~0%
Services		22.4%	30.8%	46.8%

After the key was calculated and adopted, more information became available (including potential environmental and social costs), and the cost/benefit numbers were adjusted and recalculated, but they were never formally readopted by the council. In practice, navigation services have never been developed, so benefits have been limited to hydropower and navigation.