



## **CASE STUDY**

# **Bumbuna Hydroelectric Project, Sierra Leone**

## **Preface**

This case study was developed for the purpose of the CABRI Dialogue on Ensuring Value for Money in Infrastructure Projects. It has been elaborated with the support and contributions of the Ministry of Finance of Sierra Leone, Bumbuna Hydroelectric Project, African Development Bank, World Bank, UK Department for International Development, Studio Pietrangeli, Salcost and Bumbuna project site.

The purpose of this study is to reflect on the challenges with which decision makers are confronted when appraising, financing, implementing and monitoring infrastructure projects and thus to provide with the framework for debate among participants and representatives of the case study country at the Dialogue.

In the case of the Sierra Leone case study the selected set of issues concern the establishment and running of the Bumbuna Hydroelectric Project between 1970 and 2009.

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## Abbreviations

AfDB	African Development Bank
BHPA	Bumbuna Hydro Power Agency
CABRI	Collaborative African Budget Reform Initiative
DfID	Department for International Development
HEP	Hydro-Electric Power
GNP	Gross National Product
GoI	Government of Italy
GoSL	Government of Sierra Leone
MW	Mega-Watt
MoFD	Ministry of Finance and Development
NPA	National Power Authority
WB	World Bank

# The Bumbuna Hydroelectric Project, Sierra Leone

By Matthew Smith<sup>1</sup>

## 1. Introduction

1.1 The Bumbuna Hydroelectric project involves the construction of a 50 mega-watt hydropower station on the Seli River at Bumbuna, 200km north east of the capital city Freetown. The dam will be 90m high and 440m wide, and the newly created reservoir will have a length of around 30km<sup>2</sup>. The project also includes building a transmission line which will transfer the power to Freetown as well as to the provincial towns of Lunsar and Makeni, and the village of Bumbuna itself.

1.2 The focus of this case study surrounds the lessons which can be learnt from the implementation problems which the project has had, and a summary of the key problems are as follows:

- bilateral engagement with, and reliance on, one main funding bilateral government;
- project commencement without assured funding and consistent delays in funding along the project duration;
- civil war forcing construction works to be halted;
- vandalism of electricity cable and pylons; and
- weak underlying electricity infrastructure limiting project effectiveness.

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<sup>2</sup> More technical details can be found in Appendix 3

## 2. The Case Study

### Background

2.1 Sierra Leone has a population of 6 million and a GNP of US\$1.5bn, or US\$ 260 per capita (ranked 203/209 in the world<sup>3</sup>). The life expectancy at birth is 43, and three-quarters of the population live on under two US\$ per day, whilst the adult literacy rate is 50% for males and 27% for females<sup>4</sup>.

2.2 One of the main impediments to growth, particularly in the industrial sector, is the level of electricity produced – in 2005 the country only had capacity of 11 mega-watt<sup>5</sup>, and it was estimated that only 5% of the country's population had access to electricity<sup>6</sup>. The average annual per capita consumption is around 18kWh, compared to a sub-Saharan average of 460 kWh. Sierra Leone also has one of the highest costs of energy production and electricity in the world.

2.3 The Bumbuna Hydroelectric project involves the construction of a 50 mega-watt hydropower station on the Seli River at Bumbuna, 200km north east of the capital city Freetown. The dam will be 90m high and 440m wide, and the newly created reservoir will have a length of around 30km<sup>7</sup>. The project also includes building a transmission line which will transfer the power to Freetown as well as to the provincial towns of Lunsar and Makeni, and the village of Bumbuna itself.

2.4 What follows is a detailed history of the project starting in the 1970s and continuing to the present day. Through this history, the particular decision-making points will be highlighted and group discussion should take place around these issues.

### **Issue 1: Sole-Source Contracting**

2.5 In the early 1970s a UNDP-funded study was undertaken by a Swiss firm, Motor-Columbus, for a 15-year electricity supply development plan, which proposed hydroelectric power as a main solution to fulfil the country's energy needs. It was decided that the dam for hydroelectric power should be constructed in the Bumbuna area of the country.

2.6 A feasibility study was carried out in 1972-73 by the Italian firm Carlolottia who was a subcontractor for an Italian construction firm Salini Costruttori<sup>8</sup>.

2.7 In 1974 a firm of Italian consulting engineers, Studio Pietrangeli, reviewed this feasibility study. They compared four alternative sites for the dam in the Bumbuna area. The following year a contract was signed with Studio Pietrangeli to carry out a hydrology study of the Seli River and an electricity load forecast. This was reviewed by GoSL and World Bank (WB) and it was decided that a second feasibility study was needed. In 1978 the ToRs were agreed for this study and it was carried out by a Consortium lead by Studio Pietrangeli, and was completed and endorsed by GoSL and WB in 1980.

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<sup>3</sup> For 2007, as found in 2009 World Development Indicators, World Bank, Washington DC, April 2009

<sup>4</sup> Data from 2009 World Development Indicators, World Bank, Washington DC, April 2009

<sup>5</sup> See World Bank PAD 31844-SL, 20 May 2005

<sup>6</sup> <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/EXTAFRREGTOPENERGY/0,,contentMDK:21649802~pagePK:34004173~piPK:34003707~theSitePK:717306,0,0.html>

<sup>7</sup> More technical details can be found in Appendix 3

<sup>8</sup> Hereafter referred to as Salini. Also known as Salcost.

2.8 Studio Pietrangeli were then asked in 1981/2 by GoSL to prepare documentation for a WB-funded tender process, which they completed in 1983.

2.9 Meanwhile, whilst the documentation for the tender process was still ongoing, Salini independently brokered a deal between GoSL and the Italian government and in 1981/82, the Government of Italy (Gol) gave US\$20 million loan paid through Mediconredito Centrale (their overseas funding department) for the construction of the permanent and resident engineers camp (Contract A0 signed with Salini in 1981) and also Contract A1 for preliminary works (signed with Salini in late 1981). This was a sole source contract. Contract A1 was ongoing from 1982 to 1985 and the Contract was signed ahead of the Gol loan and so Salini pre-financed themselves initially. This caused some donors to withdraw their support for the project.

***Issue 2: Lack of Consistency in Financing: 1983-2007***

2.10 In 1983, the WB asked for a scaled down version of the project plans owing to the poor economic conditions in Sierra Leone at the time, which Studio Pietrangeli completed in 1984.

2.11 During this cost cutting exercise, the scope of the project was significantly curtailed, such that it became known to the engineers involved as the 'Bumbuna Light' project. A second dam higher up the river at Yiben was removed from the plans, meaning that the generation capacity of the project reduced from 100MW to 50MW. In addition, cuts were made to the dam construction itself, for example the planned inspection chamber at the base of the dam was removed from the design.<sup>9</sup>

2.12 In 1985, the WB declared that owing to the poor economic conditions, the entire project should be abandoned.

2.13 But under Gol funding, the preliminary works continued and by 1986 they had been completed. In 1988, Contract A2 Civil Works and Contract B Hydraulic Steel structures (especially the pressure tunnel) was signed with Salini. Also in 1988, the Gol approved in principle financing of US\$112 million, subject to funding being found for the electro-mechanical facilities eg a power station and transmission lines and a substation in Freetown. In 1989 an agreement was signed between GoSL and Gol which ratified the US\$112 million payment which was made in the same year.

2.14 In 1991, a loan agreement was signed in principle between AfDB and GoSL, which allowed the work to begin for Contract A2 and B, and this continued throughout 1992. In 1993, Contract C (Electromechanical equipment) was signed with Bumbuna Falls European Consortium (including Salini as leader) and in the same year, Contract D (Transmission line and sub-station) was signed with ABB Sae Sadelmi/ABB Schaltanlagen.<sup>10</sup> Also in 1993, there was a debt write-off by Gol of the US\$20 million loan which was turned into a grant and out of the US\$112 million, US\$80 million were turned into a grant.

2.15 But in November 1993, Contract A2 and B were suspended due to exhaustion of funds.<sup>11</sup> No more funds were forthcoming from Gol and so funding was sought from AfDB. In 1995, funding was found from AfDB who provided a \$US23.5 million loan, allowing work on Contracts A2, B to continue and Contract C to start. In 1996 construction work continued well.

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<sup>9</sup> This has hampered progress in 2009 to eradicate some leakage found going through the dam

<sup>10</sup> Salini were not part of this consortium

<sup>11</sup> Salini worked from June to November without any new funds

2.16 By 1997, one year prior to its planned commissioning, the construction was 85% complete and most of the plant equipment was on site. In addition the transmission line to Freetown had almost been completed.

2.17 But then in May 1997 construction work was halted owing to the site being attacked by rebel soldiers during the civil war.<sup>12</sup> Sierra Leonean army soldiers along with South African mercenaries (Executive Outcomes) successfully defended the entire site perimeter from rebels keen to destroy a prized government project. Over six years elapsed with no work being performed.

2.18 In 2002, the civil war was finally brought to a close and the following year a meeting was held with donors and the project re-financing agreement was made. In 2004 a technical assessment was made by Studio Pietrangeli of the state of the dam and the plant. It was found that the transmission lines had not been damaged significantly during the war (but unfortunately from 2004 to 2007, 90 miles of cable were stolen and 100 pylons were vandalized in order to obtain scrap metal).

2.19 In 2005, Salini was re-mobilized with a new contract addendum signed in July for Contracts A2, B (both with Salini), and C (formerly a consortium, but now solely with Salini). In addition in 2005, a World Bank-funded Resettlement Action Plan was submitted, whose aim was to provide a fair compensation package for all occupants of dwellings inside a clearance zone of 7m around the proposed route of the transmission line.

2.20 In 2006, good progress was made on Contracts A2, B and C. And following funding from OPEC in 2006 for US\$ 10 million, Contract D (transmission line) was signed in December with Sae Powerlines (same management team as in ABB consortium), who made good progress to repair and replace the transmission lines - the task was completed in April 2009.

2.21 In 2007, an election year, the contractor was undertaking only minimum work owing to a lack of financing and in May work was entirely suspended on Contracts A2, B and C. Salcost argued that the government owed US\$38 million plus US\$6 million interest from the 1990s.<sup>13</sup>

### ***Issue 3: World Bank Partial Risk Guarantee***

2.22 During the funding crisis of 2007, Salini was considering taking out a commercial loan from an Italian bank and the World Bank had set aside US\$38.0 million funds to provide a partial risk guarantee. But in the end the government decided against this course of action owing to the level of interest being charged by the particular bank, and also it was reported that Salini would not accept the World Bank transparency clauses. So the deal fell through.

2.23 Instead, the government appealed for donor assistance, but without success.

2.24 However, a new government was elected in September 2007 and in October donors agreed to pledge US\$35 million, in loans and grants, with US\$6.5 million coming from GoSL. In early 2008 following these pledges, works resumed and during the rainy season of that year the reservoir was allowed to fill for the first time.

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<sup>12</sup> The Civil War had started in 1990

<sup>13</sup> It is important to note that this figure has never been subject to independent audit. The debt is also HIPC eligible and since the debt is from an Italian company, it falls under the Paris Club agreement and is therefore eligible for reduction to 18%



2.25 In 2008, as reported above, further funding was found from an AfDB loan, DfID, GoI and GoSL, so works resumed on Contracts A2, B and C. The filling of the reservoir commenced. In April 2009, water level was lowered. In July, reservoir filled again. In September, electricity was first generated. In November, the project was commissioned.

***Issue 4: Recovery of Previous Debts***

2.26 Though works resumed in 2008, Salini did not give up its claim to previous debts and sought to recover some of this debt by negotiating a deal with the Ministry of Energy and Power to own 51% of a new Bumbuna Dam company, and with it more than half the future ownership of the dam and rights to cashflow from it for a 20-25 year period.

2.27 This scheme was passed in Cabinet, but never through Parliament, and so never became legally binding. Later this deal was scrapped by Government which insisted on owning 100% of the dam.

***Issue 5: Finding a Future Operator for the Plant***

2.28 On the day of final commissioning, planned for 6<sup>th</sup> November 2009, responsibility and all risk will pass over from Salini to the Bumbuna Hydro Power Agency (BHPA) on behalf of GoSL, who will then sell electricity to the National Power Authority (NPA). There will be no guarantees on plant or equipment after this date and this was agreed to by GoSL because of the long time it has taken to implement the project<sup>14</sup> and particularly the delays that occurred owing to the civil war and the subsequent degrading of some of the plant and equipment.

2.29 It is likely that Salini will then be contracted to operate the plant for the next 12-18 months<sup>15</sup>, at which point it will be decided whether to renew this contract or put out to public tender.

***Issue 6: Implications of Accepting Bilateral Assistance Towards Follow-on Phase***

2.30 The next stage of the project is to build another Dam at Yiben, 28km upstream. This will allow better regulation of the reservoir level and enable an additional two turbines to be built in the original Dam. The capacity of the project will be increased from 50MW to 160MW.

2.31 The GoI have pledged an additional \$25 million to support the preparatory works for the next phase. This is budgeted for feasibility studies, social and environmental assessments, an access road to site and the erection of base camp. They argue it does not pre-judge the result of any international competitive tender which will be launched.

***Issue 7: Need for Coordination Between HEP Project and Electricity Infrastructure Provider***

2.32 Electricity in Sierra Leone is run by the government-owned NPA. There are currently no definitive plans for the NPA to be privatized and there is no government regulator for electricity.

2.33 Currently, NPA has a monopoly on distribution, but not of generation – this ended in 2006 and since then various IPPs have been brought in to generate power. For example the Global Trading Group has been providing emergency electricity in Freetown since December 2007.

2.34 Unfortunately the electricity infrastructure owned by NPA is relatively dilapidated and cannot handle the high level of power available now from Bumbuna. Thus until this

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<sup>14</sup> It should be noted that hydroelectric projects, for example the Guibe IV 1,900 MW project in Ethiopia, have been built and commissioned in around 5 years

<sup>15</sup> Since no other firms followed up their expressions of interest and submitted full tender proposals

infrastructure is upgraded, Bumbuna will only be operating at half capacity, producing a maximum of 22-23 MW. World Bank, JICA and DFID are all contributing to improved electricity infrastructure in Freetown.

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## Appendix 1 – Project Budget

The table below shows the actual cost of the project. Unfortunately no total project budget could be provided to compare to this actual expenditure:

Year	Italian Govt	ADB Loan	Grant	GoSL	DFI D	OPEC	Total* \$US mill.	%
1982	20.0						20.0	7%
1989	112.0**						112.0	38%
1990		41.7	3.3				45.0	15%
1995		23.5					23.5	8%
2004	23.4						23.4	8%
2006						10.0	10.0	3%
2008	15.6	11.2		6.5	9.1		42.4	14%
Vari- ous				21.7			21.7	7%
<b>Total</b>	<b>171.0</b>	<b>76.4</b>	<b>3.3</b>	<b>28.2</b>	<b>9.1</b>	<b>10.0</b>	<b>298.0</b>	<b>100%</b>
%	57%	26%	1%	9%	3%	3%	100%	

Source: Bumbuna Hydroelectric Project PIU (NPA), GoSL additional financing figure obtained from AfDB

\*Whilst the World Bank did not contribute any funds for the actual construction of the project, they paid for an initially feasibility study, and more recently some associated environmental works. For example, in 2004/05 the World Bank began financing environmental and social mitigation efforts and in particular the relocation and resettlement of people affected by the project. The total environmental and social costs pledged by the World Bank has been around US\$22 mill., with \$12.5 mill. already disbursed to date.

\*\* Some sources record this was US\$ 105 mill.

## Appendix 2 – Detailed Timeline

Years	Year	Description
0-1	1970-71	UNDP-funded study undertaken by a Swiss firm, Motor-Columbus, for a 15 year electricity supply development plan, which proposed a HEP.
2-3	1972-73	It was decided that the HEP dam should be constructed in the Bumbuna area. A feasibility study was carried out in 1972-73 by the Italian firm Carlolottia who was a subcontractor for Italian construction firm Salini
4	1974	A firm of Italian consulting engineers, Studio Pietrangeli, reviewed this feasibility study. They compared 4 alternative sites for the dam in the Bumbuna area.
5	1975	In May a contract was signed with Studio Pietrangeli to carry out a hydrology study of the Seli river and electricity load forecast. This was reviewed by GoSL and WB and it was decided that a second feasibility study was needed.
6	1976	In order to access the site for a geological investigation, the development commences of a UNDP-funded access road from Magburka to Bumbuna Village and a temporary camp established at Bumbuna village. The contractor was Salini.
7	1977	The access road was completed.
8	1978	Terms of Reference were agreed for a WB-funded feasibility study to be carried out by a Consortium of independent engineering firms - including 3 local engineering firms, as well as Motor Columbus, and lead by Studio Pietrangeli.
9	1979	Feasibility study commenced.
10	1980	Feasibility Study published, reviewed and endorsed by GoSL and WB.
11-12	1981-1982	Studio Pietrangeli were asked by GoSL to prepare documentation for WB-funded tender process, and also to make an economic analysis of the prospective project. Whilst the documentation for the tender process was still ongoing, Salini brokered a deal between GoSL and the Italian government and in 1981-82, the Italian Govt gave US\$20m loan paid through Mediconredito Centrale (their overseas funding department) for the construction of the permanent and resident engineers camp (Contract A0 signed with Salini in 1981) and also Contract A1 for preliminary works (signed with Salini in late 1981). This was a sole source contract. Contract A1 was ongoing from 1982 to 1985 and the Contract was signed ahead of the Italian govt loan and so Salini pre-financed themselves initially.
13	1983	Studio Pietrangeli completed all tender documentation and submitted to WB and GoSL for review. WB asked for scaled down version because of the poor economic conditions in SL at the time.
14	1984	Studio Pietrangeli undertook WB-funded supplementary feasibility study for a scaled down project.
15	1985	WB declared that the project should be abandoned owing to the poor economic conditions in SL.
16	1986	End of the construction work of the tunnel under Contract A1.
17	1987	GoSL approached Italian Govt for funding for the project.
18	1988	In Feb, Contract A2 Civil Works and Contract B Hydrolic Steel structures (eg pressure tunnel) signed with Salini. In July, Italian government approved financing of US\$ 112 mill., subject to funding being found for the electro-mechanical facilities eg power station and transmission lines and substation in Freetown.

19	1989	Financial convention signed between GoSL and Italian Government and payment made in October through Medicocredito Centrale.
20	1990	No financing in place for Contract C and D from AfDB and so no work could start until this was agreed.
21	1991	Loan agreement between AfDB and GoSL signed in principle. Work began for Contract A2 and B.
22	1992	Work continued for Contract A2 and B.  In June, Contract C (Electromechanical equipment) was signed with Bumbuna Falls European Consortium (including Salini as leader) and in September, Contract D (Transmission line and sub-station) was signed with ABB Sae Sadelmi/ABB Schaltanlagen (Salini were not part of this). Also,
23	1993	there was cancellation of debts by Italian Government of the US\$ 20 mill. loan which was turned into a grant and out of the US\$ 105 mill., US\$ 80 mill. was turned into a grant. In November, Contract A2 and B was suspended due to exhaustion of funds. (Salini worked from June to November without any new funds) No more funds were available from Italian government and so funding was sought from AfDB.
24	1994	Work continued on Contract D (Contract C could not start since it was linked with Contract A2 and B).
25	1995	Funding found from AfDB who provided a \$US 23.5 mill. loan. Work on Contracts A2, B continues and C starts.
26	1996	All works continue.
27	1997	In May, project work was halted due to Civil War. The Camp was protected by Executive Outcomes (from South Africa).
28	1998	Project suspension.
29	1999	Project suspension.
30	2000	Project suspension.
31	2001	Project suspension.
32	2002	Civil War ends.
33	2003	First post-war meeting with Donors and project re-financing agreement signed.
34	2004	First post-war technical assessment of the condition of the works was undertaken by Studio Pietrangeli for all Contracts A2, B, C and D.
35	2005	New contract addendum signed in July for Contracts A2, B (ie both with Salini), and C (formerly a consortium, but now solely with Salini).
36	2006	Contracts A2, B and C continue. Following funding from OPEC in 2006 for US\$ 10 mill., Contract D (transmission line) was signed in December with Sae Powerlines (same management team as in ABB consortium)
37	2007	Work starts on Contract D. In May, works were suspended on Contracts A2, B and C owing to a lack of financing.
38	2008	In February, further funding was found from AfDB loan, DfiD, Italian Government and GoSL, so works resume on Contracts A2, B and C. Commence filling of the reservoir.
39	2009	In April, water level was lowered. In July, reservoir filled again. In September, electricity was first generated. In November, the project was commissioned.

## Appendix 3 – Data Sheet

DATA SHEET		
Value	Unit	Description
<b>RESERVOIR</b>		
241.95	m a.s.l.	Maximum water level
241.25	m a.s.l.	Maximum operating level
210.00	m a.s.l.	Minimum operating level
480	M m3	Total capacity at max water level
35	M m3	Flood routing capacity
445	M m3	Total capacity at max operating level
350	M m3	Operating capacity
95	M m3	Inactive capacity
21	Km2	Surface level at max operating level
<b>ROCKFILL DAM</b>		
88	m	Maximum height
440	m	Crest length
4	m	Crest width
2.5	M m3	Embankment volume
51,000	m2	U/S asphaltic concrete area
		Foundation grouting:
21,500	m2	curtain area
39,000	m	drilling length (49mm dia)
1,200	t	total cement take
7,000	m3	Cut-off concrete volume
<b>RIVER DIVERSION TUNNELS (2 No.)</b>		
9	m	Diameter
620	m	Length
15,800	m3	Total concrete lining volume
<b>MORNING GLORY SPILLWAYS (2 No.)</b>		
31.6	m	Bellmouth diameter
65	m	Maximum height
23,600	m3	Total concrete volume
3,000	m3/s	Total design discharge
<b>INTAKE TOWER</b>		
7.5	M	Internal diameter
93	m	Height
7.5x6.0	m	Cylindrical gate
7,400	m3	Total concrete volume
<b>ACCESS FOOTBRIDGE</b>		
3.6	m	Width
100	m	Length
<b>POWER TUNNEL</b>		
205	m	Steel lining
7.4x7.0	m	Radial gate
<b>POWER HOUSE</b>		
41x17x24	m	Machine Hall dimensions
9,200	m3	Total concrete volume
2	No.	Francis Turbine (25 MW)
80/47	m	Max/min head
80	m3/s	Maximum turbine discharge
2	No.	Vertical synchronous generators 33.7 MVA at voltage of 13.8 kV
2	No.	Step-up transformers 13.8/161 kV, rated at 33.7 MVA
<b>POWER AND ENERGY PRODUCTION</b>		
50	MW	Installed Power
18	MW	Firm Power
315	GWh	Total average annual energy production
158	GWh	Annual firm energy production
157	GWh	Annual average secondary energy production
<b>HYDRAULIC STEEL STRUCTURES</b>		
4,000	t	Total weight
<b>161 kV SINGLE CIRCUIT TRANSMISSION LINE</b>		
200	Km	Length
500	No.	Galvanised steel towers
400	mm2	ACSR conductors
<b>SUBSTATION</b>		
2	No.	Freetown step down transformers 161/34.5/11-kV, rated at 40/30/15 MVA
1	No.	Makeni step down transformer 34.5/11 kV, rated at 3,500 kVA 3.5 MVA