Bujagali II – Economic and Financial Evaluation Study

Final Report

Executive Summary

February 2007

Executive Summary

Power Planning Associates was appointed by the IFC in January 2006 to carry out an economic and financial evaluation study of the 250 MW Bujagali II hydropower project in Uganda. The ToR for the assignment are reproduced in Appendix A. The purpose of this study is to evaluate the economic viability of the Bujagali II project taking into account economic, financial, social and environmental aspects.

An Interim Report was submitted in February 2006; the report was presented to the Government of Uganda (GoU) and other stakeholders in Kampala in March 2006. Work was then held up for a number of months whilst the World Bank carried out an independent review of the analysis of the hydrology presented in the Interim Report. The demand forecast was also reviewed and amended to include updated GDP estimates and a detailed assessment of the assumptions of future levels of technical and commercial losses. The revised forecast was presented to GoU and other stakeholders in Kampala in September 2006.

The Draft Final Report was submitted to IFC in December 2006 and presented to the government and other stakeholders in Kampala in mid-January 2007. The report was also presented to the Bujagali lenders in London at the end of January.

We now present a brief synopsis of the results and conclusions of the study following the order of the sections in the Main Text of the Report. The Main Text volume is supported by Appendices which are included in a separate volume.

Background

The economic and financial analysis of the Bujagali project in this study includes an update for the hydrology of the lake and development of potential future hydrological scenarios, both for the short and medium term. Had the Bujagali project been commissioned in 2005/06, as envisaged back in 2000, the current problems would not have arisen, or at least not to the same extent. In the intervening years there has been continuing demand growth, coupled with severe supply constraints that would have been alleviated had Bujagali come into service in 2005. The experience has demonstrated the high cost penalties of long term delays in the Bujagali project that was needed to meet the growing electricity demand of Uganda.

Electricity Demand Forecast for the Uganda System

A demand forecast for the Ugandan grid has been derived using the most recent data on the economy and the electricity sub-sector[1]. The forecast is predicated on assumptions for the growth of the economy, connection of new consumers, and the reduction of system losses, in particular commercial losses. The base case forecast is summarised in the table below.

Year	Peak Demand (MW)	Generation (GWh net)	Sales (GWh)
2005 (actual)	354	1921	1131
2010	375	2208	1521
2015	545	2959	2361
2020	789	4287	3421

Note: Figures in table above exclude exports to Tanzania and Rwanda.

High and low sensitivity forecasts have also been derived based on alternative economic growth and consumer connection assumptions. The base, high and low forecasts are predicated on forecast tariffs during the period up to 2011 when Bujagali is expected to come into service. The tariff projections are based on the financial requirements of the short-term emergency thermal power generation programme and the estimated generation availability from Nalubaale – Kiira.

The 2007 to 2011 tariff assumptions have been derived from the detailed financial analysis of an independent consultant contracted by the World Bank as part of the appraisal of the emergency thermal power project, for which GoU is seeking IDA funding. The tariff assumptions are for increases in real tariffs of 37% in 2006, 45% in 2007[2] and 15% in 2008. *A reduction of 15% is assumed in 2011, when the commissioning of Bujagali should reduce thermal generation substantially*. The demand forecast, least cost planning studies and associated financial/tariff analysis were carried out on the basis of the above tariff assumptions. The resulting cost of supply and imputed tariffs were then checked against the original tariff assumptions to ensure that the price

[1] Note: data collection for the demand forecast was carried out in January 2006.

[2] Tariffs were in fact increased by approximately 42% in November 2006, which was not known when the load forecast was finalized. This increase will have its full impact on 2007 demand, almost in line with the Consultant's assumption.

elasticity effect which has been factored into the demand forecast remained valid. It was found that the assumed tariffs were above the cost of supply, post-2011, by approximately 1.2 US¢/kWh (7%). Even if the tariff were to drop in line with cost of supply, the positive impact on the demand forecast would be minimal.

Hydrology and Energy Outputs of Hydro Plants

A detailed review has been carried out of the hydrology of Lake Victoria. Our conclusion is that the whole period of record from 1900 should be used to determine the future dependable flow for power generation at hydro power stations on the Victoria Nile.

Significantly contrasting values of Net Basin Inflows (NBI) have been observed between the periods 1900 to 1960 and 1961 to 2000, and the low inflow situation observed since 1999. The approach to hydrological risk has been to adopt two separate hydrological flow release scenarios for the 20 year period after 2010 over which the evaluation is being conducted, corresponding to a low hydrology scenario and a high hydrology scenario. The high hydrology scenario is based on the period 1961 to 2000 and the low hydrology scenario on the period 1900 to 1960. The likelihood of the low hydrology occurring has been assessed substantially higher than the high hydrology. The relative probabilities have been calculated at 79%/21% for the low/high hydrology scenarios.

The estimated energy generated at Bujagali and Karuma under the defined low and high hydrological conditions is summarised in the following table.

			Low Hydrology	**High Hydrology**
Hydro plants	Units	**Qmax** m^3/s	Mean Energy GWh/yr	Mean Energy GWh/yr
Bujagali	Units 1 to 5	1240	1 165	1 991
Karuma	Units 1 to 4	792	1 324	1 609

(1) energy figures include the impact of scheduled maintenance.
(2) Qmax is the flow required to produce the total rated output of the turbine generators.

Interim Generation Programme

In order to meet the short term generation shortfall, GoU has contracted 100 MW of leased high speed diesel plant burning distillate fuel (AGO), and is planning a further 50 MW supported by IDA. This has been done to relieve the load shedding that has been exacerbated by the regional drought, and to allow Uganda to adhere to the agreement to restrict releases from Lake

Victoria to the "Agreed Curve"[3]. A further 50 MW of medium speed diesel plants burning heavy fuel oil (HFO) is expected to be installed as an Independent Power Project (IPP). The emergency thermal plant is intended to fill the generation capacity gap until 2011 when Bujagali is expected to enter service. The thermal plant will be supplemented by several small hydro projects to be developed as IPPs. In addition, UETCL has negotiated contracts with two sugar producers for 15 MW of power produced from bagasse (sugar cane residue).

Geothermal Potential

We have made a detailed review of the geothermal potential of Uganda and conclude that the resource may be substantially lower than previously estimated. It is considered that only approximately 40 MW of geothermal power generating capacity may be developed economically on the basis of present knowledge, as discussed in detail in Appendix D.

Bujagali and Karuma Cost Estimates

A detailed review and update of the cost estimates for Bujagali and Karuma has been carried out. These are considered to be the only two major hydro plant options for the medium term. These estimates take into consideration the information received from the Bujagali sponsor on the EPC contract negotiations and on development costs relating to Bujagali.

The total economic cost estimates for Bujagali and Karuma resulting from our review are as follows (in constant 2006 US$)[4]:

[3] The "Agreed Curve" represents the allowable outflow from Lake Victoria into the Nile, corresponding to the flow that would have occurred in the absence of man-made intervention, e.g. the dam at Nalubaale-Kiira.

[4] Just after this report was completed, BEL informed PPA and the Bank Group of the most recent results of on-going negotiations with the EPC contractor, indicating the addition of a $20 to $ 30 million risk premium in exchange for a comprehensive turnkey contract, plus another $ 5 to $10 million for improvements to the electro-mechanical works, bringing the total EPC cost increase into a range of $30 to $35 millions, nominal and undiscounted. At the same time, BEL and the contractor are negotiating an incentive scheme to accelerate commissioning by 3 to 4 months, which would create for Uganda a real economic cost saving on thermal plant operation estimated at $30 to $40 million (in dollars of 2006). The net impact of these proposed changes on the project's economic viability is judged to be minimal.

ITEM	**Bujagali 5 units (US$ million)**	**Karuma 4 units (US$ million)**
Direct construction costs: - Civil works - Equipment	 227 187	 315 117
Connection to the grid	28	79
Engineering and coordination	28	33
Environmental and Social Impacts	26	15
Development Costs	25	29
Total Implementation Cost (excluding Interest During Construction)	**521**	**588**

Environmental and Social Costs of Bujagali and Karuma

The Consultant undertook a field mission to Uganda in July 2006 to collect data on the E&S costs of the Bujagali and Karuma projects. Moreover, Burnside, who prepared the Bujagali Social and Environmental Assessment reports, estimated the project's environmental and social impact cost based on substantial and detailed field investigations and compilation of new cost data. We have reviewed and commented on the Burnside figures and have used them for the economic analysis of Bujagali. We have also prepared E&S cost estimates for Karuma based on the existing ESIA, which was undertaken in 1999. The cost estimates adopted for Karuma take cognisance of the higher unit cost rates derived from the Burnside studies. The total incremental E&S expenditures for Bujagali and Karuma are shown in the cost table above.

Least Cost Generation Expansion Plans

Detailed least cost generation expansion plans were developed for the Ugandan system for the period from 2010 to 2020 using the WASP IV system expansion program. The analysis was undertaken for base, high and low demand forecasts; low hydrology and high hydrology scenarios; base, low and high fuel price projections; and base, low and high Bujagali cost estimates. Alternative least cost sequences were determined for both the 'with Bujagali' and 'without Bujagali' cases. Karuma was retained as a candidate plant in both the 'with Bujagali' and 'without Bujagali' cases. A total of 72 cases were evaluated to cover the full risk analysis, and 13 further cases were considered for additional sensitivity analysis. The main results showed that Bujagali commissioned in 2011 was part of the least cost programme under all demand forecast scenarios with the low hydrology, and also for the high and base demand with high hydrology. In the high hydrology, low demand cases, the least cost expansion plan comprises only new thermal plant up to 2020, i.e. neither Bujagali nor Karuma could be justified. However, the total probability of occurrence of these cases is low, estimated at 5.5%, and the maximum probability of any one case occurring is only 1.5%.

Sensitivity studies were carried out to confirm the optimum timing of Bujagali, by delaying commissioning from 2011 to 2012 for the base demand. This leads to higher present worth (PW) costs for the low hydrology and marginally higher costs for the high hydrology. The analysis also showed that a 4-unit Bujagali design was less attractive economically than the 5-unit reference design. A further sensitivity study confirmed that Karuma commissioned before Bujagali (by forcing Karuma in 2012) leads to higher PW costs, and that the cost of Bujagali would need to increase by 49%[5] to justify the commissioning of Karuma as the next plant before Bujagali.

A full risk analysis was made for the 'with Bujagali' and 'without Bujagali' cases, with the following probabilities assigned to the key variables:

Demand forecast:	base/high/low - 40%/30%/30%
Hydrology:	high/low - 21%/79%
Fuel Prices	base/low/high – 40%/30%/30%
Bujagali Cost	base/low/high - 60%/20%/20%

Assigning the probability weightings to the PW costs resulted in a total net present value (NPV) advantage of US$ 184.0 million (in 2006 US$ with discounting to 2006) in favour of the 'with Bujagali' cases. The NPV value is robust in respect of the assumption on hydrology. For example, if 100% probability is assigned to either the low or the high hydrology scenarios, the NPVs, representing the differences between the 'with Bujagali' and 'without Bujagali' programmes, are:

Low hydrology	US$ 202 million, and
High hydrology	US$ 116 million

in favour of the 'with Bujagali' cases.

[5] This result was obtained by progressively increasing the cost of Bujagali in the simulation analysis until the WASP program no longer selected Bujagali as the next major plant. In this case the least cost sequence included Karuma in 2012.

Bujagali Economic Internal Rate of Return (EIRR)

The EIRR for the Bujagali project was estimated by evaluating the cost and benefits of the project in terms of the capital and operating costs of Bujagali and the incremental transmission and distribution capital and operating costs associated with meeting the increment of demand supplied by the project. The benefits were measured in terms of the displacement of costly thermal power and incremental demand of the various categories of consumer, that is met by Bujagali, valued at their respective willingness to pay.

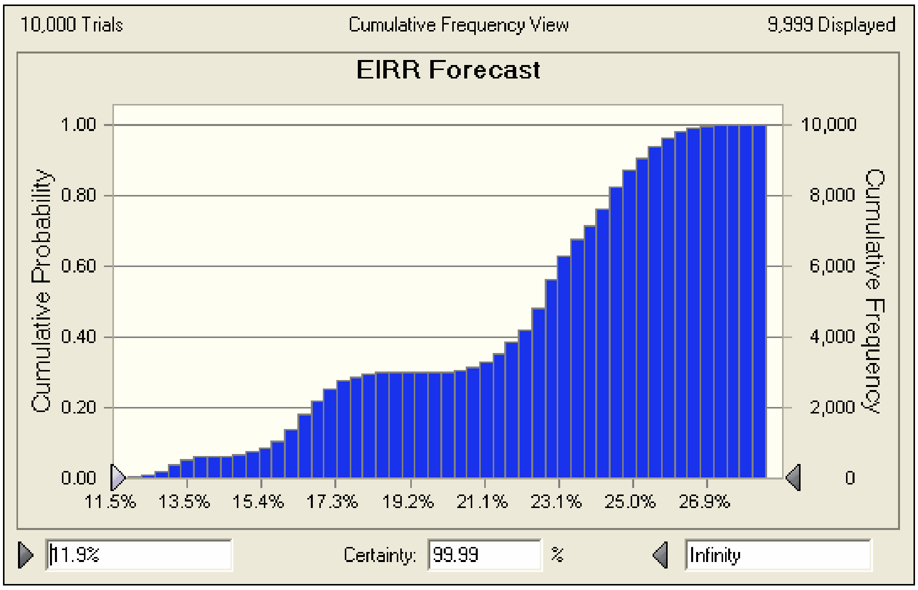
The EIRR values for the references cases obtained are summarised in the table below.

	High hydrology	Low Hydrology
EIRR	21.7%	22.0%

When the benefits of avoided greenhouses cases are included the EIRRs increase to 22.0% for the high hydrology and 22.9% for the low hydrology.

Sensitivity studies indicate that the project EIRR is robust against all key risk factors, including: hydrology, demand forecast, fuel prices and the capital cost of the project. The demand scenario has the greatest impact on EIRR, but in the most adverse combination of scenarios using the low demand case the resulting EIRR value of 12.5% remains comfortably greater than the 10% benchmark discount rate for World Bank Group-supported projects.

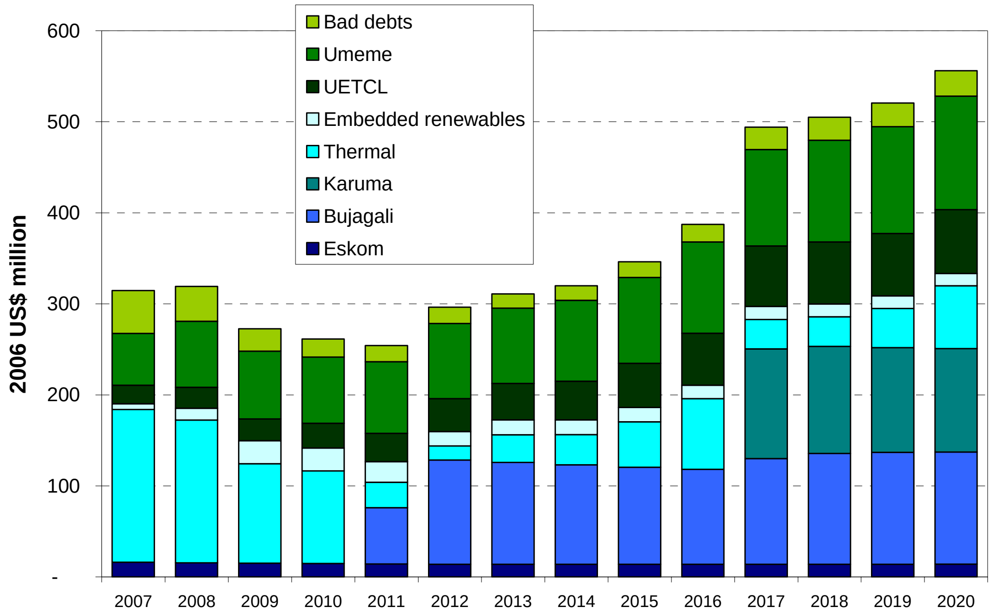
In addition to the sensitivity studies, a probabilistic risk analysis was undertaken on the EIRR value using the Crystal Ball software package with the following parameters subject to a probabilistic range of outcomes: demand forecast, crude oil price, Bujagali capital cost, T&D capital costs, willingness-to-pay of newly-connected customers, and hydrology. The following chart presents the Cumulative Probability Distribution of EIRR forecasts including the impact of greenhouse gas credits to the project. This chart shows there is a 100% probability of the EIRR being above the 10% benchmark discount rate, and a 100% probability of an EIRR greater than 11.7%. The same cumulative probability distribution can be used to show that there is a 50% probability of the EIRR being above 22.7%.



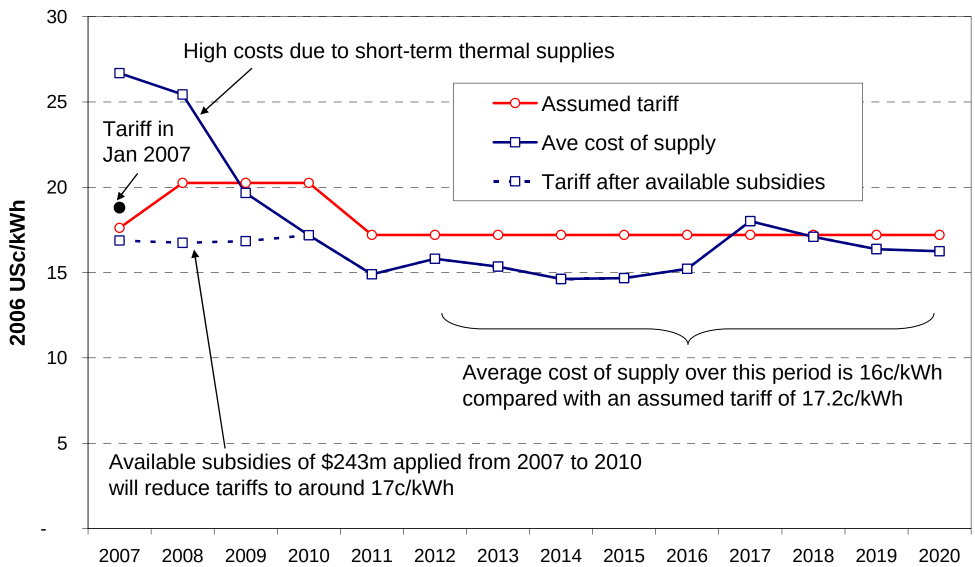
The Cumulative Probability Distribution of EIRR forecasts without greenhouse gas benefits is very similar. There is also a 100% probability of the EIRR being above the 10% test discount rate, and a 100% probability of an EIRR greater than 11.5%. There is a 50% probability of the EIRR being above 21.9%. The greenhouse gas benefits are therefore not significant in the economic justification of the project.

Financial Analysis

The financial analysis evaluated the cost of supply for the reference (least-cost) expansion plan with Bujagali commissioned in 2011 – base demand forecast and low hydrology – over the period to 2020. The components of the costs and the resulting cost of supply/tariff assumptions are shown in the following chart.



The chart below compares the average cost of supply with the assumed average tariff over the period to 2020. In the period up to 2008, the assumed tariffs are below the calculated unsubsidized average cost of supply – largely due to the high costs of thermal generation. The IDA credit to assist Uganda in overcoming the consequences of the emergency thermal programme should be more than sufficient to offset the estimated subsidies required to bring average tariffs down to 17 US¢/kWh over the period 2007 to 2010.



Over the period 2009-2011, the assumed tariffs and the calculated tariffs are close, although it is possible that tariffs could come down faster than assumed. The analysis was continued beyond 2012 to examine the impact of additional capacity requirements in the expansion plan, including the tariff impact of the Karuma plant. After 2012, the average tariff is approximately 1.2 US¢/kWh lower than the assumed constant tariff level of 17.2 US¢/kWh.

Macro-economic Impact

A macro-economic analysis was undertaken to evaluate the impact of Bujagali on the Ugandan economy. Overall, the impact of Bujagali relative to the next best option without Bujagali (which includes Karuma in 2012) is relatively small, and positive. There will be an immediate positive impact from Bujagali in 2011 resulting from the balancing of supply and demand, and therefore an end to load shedding. The main macro-economic impacts will be provided through power sector investments, which will add a maximum of 0.3 percent to GDP in 2009. In the longer term, the 'with Bujagali' expansion plan should afford 5 percent lower electricity tariffs than the 'without Bujagali' plan.