Export Price of Electricity in Bhutan: The Case of Mangdechhu Hydroelectric Project

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Abstract

There has been substantial cost escalation on the ongoing hydropower projects in Bhutan, exerting pressure on already ballooning national debt. This has raised concerns on whether the benefits of hydropower projects outweigh the costs and on the preciseness of its costing. Based on data available in the detailed project reports and the agreement signed between India and Bhutan, this paper examines the financial viability of Mangdechhu project by employing two different methods: cost-plus method and financial cost-benefit analysis. The results show that cost-plus method undervalues the total cost of the project. The impact of changes in several parameters and cost overrun on tariff is also analyzed in this paper.

Introduction

For more than three decades one of the main drivers of the economy of Bhutan has been hydroelectricity, and it continues to play a bigger role in the economy. In financial year 2012-2013, 17.3 percent of the total revenue was generated from electricity sector[1] and it comprised of 14.18% of nominal GDP in 2013[2].

The construction of first hydropower plant - Chhukha Hydroelectric plant - commenced in 1979, which has an installed capacity of 336 MW[3]. The total installed capacity

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[1] *National Revenue Report 2012-13*, Department of Revenue and Customs, Ministry of Finance, Thimphu, p. 22, 2013

[2] *National Accounts Statistics 2014*, National Statistics Bureau, Thimphu, p. 36, 2014

[3] Chhukha Hydropower Plant. Retrieved on January 5, 2015 from

as of 2015 is 1606 MW (336 MW Chhukha Hydropower plant, 64 MW Basochhu Hydropower Plant, 60 MW Kurichhu Hydropower Plant, 1020 MW Tala Hydropower Plant, and 126 MW Dagachhu). Some are in advanced construction phase such as Punatsangchu I (1200 MW), Punatsangchu II (990 MW), and Mangdechhu (720 MW). Bhutan has potential to generate 30,000 MW of electricity of which 23,760 MW is technically feasible in Bhutan.

Chhukha Hydroelectric project was fully funded by the Indian government with 60 percent grant and 40 percent loan at 5 percent interest rate per annum; however, for Tala Hydroelectric project the interest rate on loan was increased to 9 percent. For Puntshangchu I project, the funding modality was reversed, that is, it composed of 40 percent grant and 60 percent loan, with 10 percent interest rate on loan. Now the funding modality has worsened to 70 percent loan and 30 percent grant at 10 percent interest rate for recent projects such as Mangdechu project. As the loan component and interest rate increases debt obligation naturally increases with lesser returns on equity. These projects are based on Inter-Governmental (IG) mode which means that these projects would be taken over by Druk Green Power Corporation (DGPC) when they are commissioned. For project under Joint Venture (JV) mode, such as Wangchu, Bunakha, Kholongchu and Chamkharchhu I, DGPC will have only 50 percent share.

In 2013, Bhutan exported about 74% of the total production of 7549.84 million units of electricity while importing 112.26 million units during lean seasons[4]. However, the net export of the country as a whole from year 2000 onwards has been negative except in 2007, and this trend has been deteriorating in recent years. In 2013, Bhutan exported goods and services worth Nu 42,636.41 million while importing goods and services

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DGPC website http://www.drukgreen.bt/index.php/chp-menu/about-chp

[4] *National Accounts Statistics 2014*, National Statistics Bureau, Thimphu, p. 51, 2014

worth Nu 65,625.05 million[5]. The GDP growth rate mirrored the declining export; the real GDP growth rate was 2.05% in 2013, the lowest since this century (2000s). With weak export and growth rate, the total government debt has soared in 2013 to 96.33% of GDP[6]. The share of hydropower debt to the total external debt is 65.2% as of 30th June, 2014[7]. Since the sale of electricity generates revenue to service national debt, it is important to study the nature and structure of pricing in order to arrive at optimal tariff.

Although export tariff is based on power purchase agreement in the case of inter-governmental (IG) projects, where the surplus power from the project will be bought by India, the negotiation to set the rates of parameters is in the hands of negotiators for which understanding the derivation of the tariff is an indispensible prerequisite. By knowing how to calculate the tariff, insights can be drawn when different parameters and its rates are used to examine the changes in tariff.

Electricity should be priced at competitive rate in order to secure comparative advantage and for economy to gain as a whole. Cost escalation and delay of hydropower project will only shoot up the price. When the export price increases domestic price will naturally increase since the domestic price is set higher than the export price. Local industries, especially power intensive industries, may barely breakeven while a few may even run at a loss if domestic price is high.

Price can be made competitive by reducing the cost of building the plant and increasing its output. This will require installing efficient technologies and doing things in new ways. For instance, EcoSmartHydro project, which does not require a dam and a tunnel, is cost effective than both run-off the river and dammed projects[8]. A hydropower plant that

[5] Ibid., p. 33
[6] Ibid., p. x
[7] *National Budget Financial Year 2015-16*, Ministry of Finance, Thimphu, p. 85, May 2015
[8] See EcoSmartHydro pilot project joint venture. Available at

does not need to have a dam and a tunnel will have very less environmental damage to forest and river systems, and also to agricultural land and religious sites.

Preempting cost escalation is imperative given that glaciers are retreating fast - Bhutan has lost 23.3 percent of its glacier area in the last three decades[9] - as it would reduce output. Most of the rivers in Bhutan and Asia in general are fed by glacier. It is estimated that by 2100, glaciers in the Hindu Kush-Himalayan (HKH) region could see a reduction of 70%-99%[10] of its volume. In the short term, retreating glaciers causes flood, which would cause severe damage to dams; in the long term, there will be reduced melt-water. Bhutan has a history of cost escalations: from the initial estimate (given in the Detailed Project Report) Chukha's cost has escalated by 197 percent and 193 percent for that of Tala[11]. Whether Bhutan should not invest in hydropower energy will not be examined in this paper, although Mitra et al. (2014) found that there will be diminishing marginal returns to capital investment in hydropower.[12]

This paper will first study the method of cost-plus tariff

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http://www.kuenselonline.com/ecosmarthydro-pilot-project-joint-venture/#.VXfJ2s-qqkr

[9] See 'Longevity of Bhutan's glaciers questionable" at http://www.kuenselonline.com/longevity-of-bhutans-glaciers-questionable/#.VXfD2s-qqkq

[10] See "Most glaciers in Mount Everest area will disappear with climate change – study" at http://www.theguardian.com/environment/2015/may/27/most-glaciers-in-mount-everest-area-will-disappear-with-climate-change-study?CMP=share_btn_fb. See also Shea, J. M. et al. (2014), Modelling glacier change in the Everest region, Nepal Himalaya, *The Cryosphere Discuss*. 8, 5375–5432.

[11] See "Council questions hydropower policy" at http://www.kuenselonline.com/council-questions-hydropower-policy/#more-122692

[12] See Mitra, Sabyasachi; Carrington, Sarah; Baluga, Anthony (2014). *Unlocking Bhutan's Potential: Measuring Potential Output for the Small, Landlocked Himalayan Kingdom of Bhutan*. ADB South Asia Working Paper Series No. 32

calculation (also known as levellised tariff method) and then use financial cost-benefit analysis to examine whether the project is viable from financial perspectives when the tariff derived from cost-plus pricing is imputed in the benefit stream. Cost-plus pricing method, the terms and conditions of which is specified by the Central Electricity Regulatory Commission (CERC), India, is used for calculating export price of electricity in Bhutan. As cost-plus method takes into account only financial cost of hydroelectric projects, the calculation of economic cost-benefit analysis will not be presented in this paper. It will discuss the differences between the two methods, and identify what should be and should not be taken into account while calculating the tariff. This paper will not discuss the domestic pricing of electricity as the aim is to study only the export price of electricity.

Methodology

Data Source

The main sources of data are Detailed Project Reports (DPRs), March 2010, of the Mangdechhu Hydroelectric Project prepared by NHPC (National Hydroelectric Power Corporation) and the Agreement between the Government of the Republic of India and the Royal Government of Bhutan regarding the Mangdechhu Hydroelectric Project (hereafter AIBMP) dated 30/4/2010.

Cost-Plus Method and Financial Cost-Benefit Analysis

In cost-plus method whatever cost is incurred in the development of the project will be captured by the tariff, which will be derived when the project is commissioned. The tariff is levellised using an appropriate discount rate. Financial cost-benefit analysis, on the other hand, will examine whether the project is worth undertaking after assessing its financial costs and benefits. Cost-benefit analysis is essentially designed to quantify the costs and benefits of an investment project. In financial cost-benefit analysis, economic costs such as pollution and benefits such as travel time reduced due to construction of roads are not taken into account. In the DPR,

financial cost-benefit analysis is not shown; therefore, this paper intends to fill this gap.

Cost and Assumptions

Fixed cost and interest on working capital is recoverable at an annual generation of 2925.25 million units of electricity in a 90% dependable year.

Fixed Cost: The components of fixed cost are given below:

1. *Interest on loan*: The interest on loan is assumed to be fixed at the rate of 10% per annum to be repaid in thirty equated semi-annual installments. The first repayment has to be made one year from the date commercial operation. Interest during construction is not included in the total cost of this project.

2. *Depreciation*: According to the Agreement signed between India and Bhutan regarding Mangdechhu Project, the depreciation rates has to be equal to similar projects in India. In the DPR of Mangdechhu Project, the depreciation rate works out at 5.67% for the first 12 years and the rest amount [{5.67% of 90% of total cost less cost of land (excluding Rehabilitation & Resettlement)} minus {amount booked for initial 12 years}] has been considered uniformly over balance life of the project (23 years). Depreciation is allowed up to 90% of the capital cost of asset which has a salvage value of 10%. It is highly likely that there will not be any changes to this depreciation rate.

3. *Operation and Maintenance Cost*: The O&M cost is fixed at 2% of the total cost with escalation factor at 5.72%. This escalation factor is Indian inflation rate. Indian inflation rate is used as almost all the equipments and goods for the plant will have to be purchased from India without applying tax and duty.

4. *Return on Equity*: The post tax return on equity has

been taken as 16% as per DPR and CERC norms.

5. *Taxes*: Taxes are allowed only as pass through to the tariff so as to let a nominal return on equity after taxes. For this project at 2008 price level, Minimum Alternate Tax (MAT) of 11.33% is applied to the tariff. The concept of MAT has been introduced in India in order to curb the malpractice of companies paying very low tax or no tax to the government although high book profits are declared by these companies. MAT is a form of corporate tax in India, where "where the income tax computed under the Act [Finance Act] in respect of any previous year relevant to the assessing year, is less than 18.5 percent of its book profits, such book profit shall be deemed to be the total income of an assessee and tax payable on such total income shall be 18.5 percent of the same" (Finance Act 2011 cited in Kumar 2011). MAT rate was 10 percent from 2007-2010, 15 percent in 2010-2011, and 18.5 percent in 2011-12 (Kumar 2011). In Bhutan, corporate tax is 30% of the net profits (Ministry of Finance 2001).

Working Capital

Interest on Working Capital: An interest rate of 12.5% is charged on working capital. Working capital is composed of three elements: O&M expenses for one month; maintenance spares at 15% of O&M expenses; and receivables equivalent to two months average billing.

Other costs and assumptions are given in Table 1. The allocation of project cost across three major activities are shown in Appendix Table A1. Until the commercial operation of the project, goods (such as construction materials and machineries) and services imported from India for use in the construction of the project are to be exempted by Bhutan. Further, taxes and duty on goods and services exported to Bhutan are to be exempted by India.

Table 1. Basic Assumptions

Parameter	**Value**
Generating capacity	720 MW
Total project cost	28,962.93 million Nu
Construction time	7 years (including infrastructure works)
Annual energy generation	2925.25 Million Units
Auxiliary consumption	1.2%
Free power	12%
Net saleable energy	2543.33 Million Units
Debt : Equity ratio	70:30
Cost of R&R (Rehabilitation & Resettlement)	120 million Nu
Cost of Land (Excluding R&R)	21.23 million Nu
Interest on loan	10%
Depreciation	5.67% for the first 12 years and the rest amount uniformly over 23 years
O&M cost	2%
O&M escalation factor	5.72%
Return on Equity	16%
Tax	11.33%
Interest on Working Capital	12.5%
Discount rate	12%
Useful life of the Project	35 years

Source: DPR and AIBMP

Results and Discussions

Comparison of Cost-plus Method and Financial Cost-Benefit Analysis

Table A2 in Appendix shows the calculation of tariff based on cost-plus method. The total cost at March 2008 price level in Table A2 is the sum of interest on loan, depreciation, return on equity, MAT, O&M cost, and interest on working capital. The tariff calculated using cost-plus method has to be levellised using appropriate discount rate in order to derive the export price of electricity. Discount rate is used to discount the tariff to the net present values of year 2017. For the base case, using assumptions in Table 1, the levellised tariff is Nu 1.9591 per unit (1 unit=1 kWh) at 12% discount rate. The tariff is exclusive of duty, surcharge and any other form of levy. The tariff is to be reviewed at the end of every three years as per AIBMP.

The opportunity cost of capital may increase by 2017 when the project is scheduled to be commissioned. Hence, keeping the basic assumptions in Table 1 unchanged, the tariff at 14% and 16% discount rates comes to Nu 1.9911 and Nu 2.0206 respectively.

The financial cost-benefit analysis is shown in Table A3 to examine the viability of the project. The financial cost-benefit analysis requires setting up annual estimation of revenues (inflow) and expenses (outflow). The total cost is the sum of capital cost, O&M cost and investment in working capital. The revenue is calculated using tariff rate at Nu 2.3036 per unit in order to obtain IRR of 12%, net present value (NPV) of 0.03 and B/C ratio of 1. Nu 2.3036 per unit is the optimal tariff in order to make the project financially viable and feasible. Any project or investment is viable only if NPV is greater than equal to zero and B/C ratio greater than equal to one.

If the tariff of Nu 1.9591 per unit, calculated from cost-plus method, is imputed into the revenue part, it results in IRR of 9.98%, NPV of -8022.48 and B/C ratio of 0.85, which does

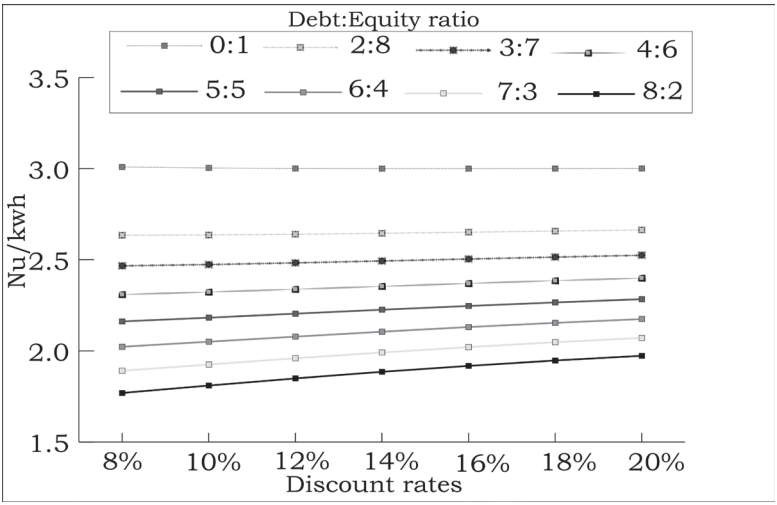
not make the project at all viable. Therefore, this shows that cost-plus method undervalues the cost of the project and hence results in lower tariff compared to the tariff that is optimally required in the financial analysis. What this implies is that export price of electricity should be fixed at Nu 2.3036 per unit at 2008 price level, which is the optimal tariff, and not at Nu 1.9591 per unit. Having pointed out how cost-plus method undervalues the project cost, the paper will next discuss the effects of changes in parameters on levellised tariff, as an alternative to cost-plus method is not foreseeable anytime soon.

The Effects of Changes in Parameters on Levellised Tariff for Cost-plus Method

The relationship among debt:equity ratios, discount rate, useful life of plant, interest rate of loan in relation to tariff will be explored in this section.

Figure 1 summarizes how varying debt:equity ratios and discount rates affects levellised tariff keeping other basic assumptions given in Table 1 unchanged. As the proportion of equity increases in relation to debt, tariff increases. This is because the interest on loan decreases while the return on equity and tax increases. Figure 1 also shows that levellised tariff increases when discount rates increases. However, the marginal increase in tariff decreases as discount rate increases for 8:2 and 7:3 debt:equity ratios. The effect of discount rate on tariff is negligible when debt:equity ratio is 0:1 (that is when equity is 100% without any loan).

Figure 1. Levellised tariff based on varying debt:equity ratios and discount rates



Source: Author

The effect of increase in useful life of the project on tariff is minimal. An increase in the useful life of the project by 10 years increases tariff only by a very small amount (Nu 0.01) to Nu 1.9699 per unit using basic assumptions given in Table 1.

The effect of interest rate of loan on tariff is slightly greater: 1 percent increase in interest rate increases tariff by Nu 0.04. From Table A2, it is evident that tariff is higher in the early years of operation because the duration of the loan is shorter than the life of the plant. Increasing the duration of the loan decreases tariff, albeit by a very small amount. Therefore, interest on loan is more important than loan repayment period. Also, it is not difficult to see that delaying the construction of the plant will increase the cost of the project, thereby increasing the tariff.

Sensitivity Analysis

Given that cost-plus method is used for determining tariff, sensitivity analysis based on cost-plus method will now be performed in order to understand the changes in tariff when inputs or parameters seem to be uncertain.

From the sanctioned cost of Nu 28,962.93 million at March 2008 price level the overall project cost has increased upward by 38.82% to Nu 40,206.303 million (or Nu 40.206 billion) at March 2014 price level, which is the latest available figure. Nu 40,206.303 million is the vetted and finalized project cost, examined by Central Electricity Authority and Central Water Commission of India, although the revised cost estimate submitted by Mangdechhu Hydro Project Authority (MHPA) was Nu 42,812.63 million. If the project meets the expected commissioning date, that is March 2018, the project cost is likely to rise by at least 55% to Nu 45 billion (*Kuensel* May 9, 2015). For sensitivity analysis, cost overrun of 55% and 65% will be used.

Dams may have to be decommissioned after the useful life of the plant if it has silted up, degraded river ecosystems, have become unsafe, or when it has become expensive to maintain the dam. Sediment disposal is one of the most expensive costs while decommissioning the dam. The cost of dam decommissioning typically cost between 5 to 50% of construction costs (Oldham 2009). Sometimes it cost more than the cost of building the dam. For sensitivity analysis, 50% of construction cost is used as decommissioning cost.

As time passes by the cost of capital will increase as the cost of equity and tax rate increases. Hence, it is reasonable to assume that by 2018 discount rate may hover around 14%.

MAT rate was 18.5 percent in 2011-12. If the project is commissioned in 2018, MAT rate to be applied to the tariff should be higher than 18.5%. The effective rate will increase when surcharge and cess is applied. Hence, for sensitivity

analysis, MAT rate of 20% and Bhutan's corporate tax of 30% will be used.

5.72% O&M cost escalation is low considering that average annual inflation, at wholesale prices, of India for the last 6 years, from 2008 to 2014, is 6.53% (Office of the Economic Adviser 2015). For spares, repairs and maintenance wholesale prices needs to be applied but for employment and administration costs consumer prices is more appropriate. Consumer prices of Bhutan should be applied instead of that of India because employment cost and administration expenses will be incurred in Bhutan. The consumer price inflation of Bhutan from 2008 to 2014 is 8.08% (NSB 2015). Therefore, taking the average from India's wholesale price inflation of 6.53% and Bhutan's consumer price inflation of 8.08% will be used for the calculation of tariff: that is 7.31%.

Table 2. Sensitivity Analysis

Sl.no	**Project cost**	**Levellised tariff**
1	Base case	1.96
2	Cost increased by 55%	3.08
3	Cost increased by 65%	3.29
4	Cost increased by 65% and 50% decommissioning cost	3.31
5	Cost increased by 65% and 14% discount rate	3.33
6	Cost increased by 65% and MAT rate of 20%	3.37
7	Cost increased by 65% and tax rate of 30%	3.46
8	Cost increased by 65% and 7.31% rate of increase of O&M	3.42
9	Cost increased by 65%, MAT rate of 20% and 7.31% rate of increase of O&M	3.5

As shown in Table 2, the levellised tariff projects to Nu 3.08 per unit when the total project cost increases by 55% from the base case; it is Nu 3.29 per unit when the cost increases by 65%. The projected tariff for cost overrun of 65% and 50% decommissioning cost is Nu 3.31 per unit. Keeping 65% increase in project cost same, 2 percent increase in discount rate and 1.59% increase in O&M from the base case increases tariff by a higher margin compared to comparable rate of increase in tax rate and decommissioning cost. Considering 65% cost overrun, MAT rate of 20% and 7.31% rate of increase of O&M should be taken into account at a minimum, which will give a tariff of Nu 3.5 per unit.

Conclusions

This paper showed that cost-plus method undervalues the cost of building the hydropower project in that the levellised tariff derived from the cost-plus method when imputed in the financial cost benefit analysis returns negative NPV and B/C ratio less than 1, making the project unviable. Therefore, some provision should be kept to set the tariff that is amenable to both buyer and seller.

Given that cost-plus method will not be supplanted by another method, sensitivity analysis based on cost plus method with a realistic 65% cost overrun, MAT rate of 20% and 7.31% rate of increase of O&M keeping all other parameters unchanged from the base case generated a tariff of Nu 3.5 per unit.

The power purchase agreement spells out that carbon revenue generated from clean power shall be shared between India and Bhutan. The percentage of share should be higher for Bhutan as the dams are being built in Bhutan. Before discussing the issue of sharing mechanism, the implementation of the project on a sustainable manner, conforming to best practices, will determine whether the project is eligible for carbon revenue.

The cost of generation of power in Bhutan is one of the lowest in the world. In North America the levellised cost of electricity is USD 0.09/kWh which translates to Nu 6.03 per kWh (1

USD=Nu 67) for large hydro and USD 0.10/kWh or Nu 6.7 per kWh in Europe (IRENA 2015). The cost of power generation is Nu 3.8 per kWh in India for small hydro projects (5MW to 25MW) for financial year 2014-15, according to CERC. Therefore, the average cost of generation in Bhutan, which is Nu 1.99 per unit as of 2013 (DGPC 2013), is lower than India. Hence, power generation is competitive in Bhutan; however, if the project cost is undervalued and if optimal tariff is not derived then hydropower debts will not be self-liquidating. It is imperative that escalation of project cost be prevented as far as possible to make it price competitive. A colossal cost escalation will render it uncompetitive in regional and international markets. Judging by the competitive cost of power generation in Bhutan at the moment in international market, hydropower projects should be advanced from economic point of view but the scale and timing of exploitation is another matter that merits a separate paper.

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Appendix

Table A1. Abstract of Project Cost (March 2008 Price Level)

ABSTRACT OF COST		
Sl. no.	**Description**	**Amount in Nu million**
A	**CIVIL WORKS**	**March 2008 Price level**
1	**DIRECT CHARGES**	
	I - Works	
	A. Preliminary	674.22
	B. Land	141.23
	C. Works	5073.31
	J. Power Plant Civil Works	10721.14
	K. Buildings	635.64
	O. Miscellaneous	539.77
	P. Maintenance during construction	170.1
	Q. Special Tools & Plants	63.06
	R. Communication	580.4
	X. Environment and Ecology	300
	Y. Losses on Stock	42.53
Total of I - Works		**18941.41**
	II – Establishment (6% of I - Works - B Land)	1128.01
	III - Tools and Plants	20
	IV – Suspense	0
	V - Receipts and Recoveries	-59.61
	Total Direct Charges	**20029.81**
2	**INDIRECT CHARGES**	

I	Capitalised value of abatement of land revenue (5% of Cost of Culturable Land)	0.16
II	Audit & Account Charges (0.25% of I - Works)	50
	Total Indirect Charges	**50.16**
	TOTAL COST OF CIVIL WORKS	**20079.98**
B	**ELECTRICAL WORKS**	**6032.95**
	Total Cost (Civil + Electrical)	**26112.93**
C	**TRANSMISSION WORKS (with cost of land)**	**2850**
	TOTAL COST	**28962.93**

Source: Detailed Project Report (Amended Volume II) Cost Estimates and Project Planning, 2010, p.6.8

Table A2: Calculation of tariff based on cost-plus method

Year	Interest on loan	Depre-ciation	Return on equity	MAT	O&M cost	O&M for 1 month	Mainte-nance spares	2 months average billing	Interest on Working Capital	Total cost	Charges/ unit (Nu)	Dis-counted tariff (Nu per unit)
1	2027.41	1642.20	1390.22	157.51	576.86	48.07	86.53	989.11	140.46	5934.66	2.33	2.33
2	1863.19	1642.20	1390.22	157.51	609.85	50.82	91.48	966.94	138.65	5801.63	2.28	2.04
3	1698.97	1642.20	1390.22	157.51	644.74	53.73	96.71	945.10	136.94	5670.58	2.23	1.78
4	1534.75	1642.20	1390.22	157.51	681.62	56.80	102.24	923.60	135.33	5541.63	2.18	1.55
5	1370.53	1642.20	1390.22	157.51	720.61	60.05	108.09	902.48	133.83	5414.89	2.13	1.35
6	1206.31	1642.20	1390.22	157.51	761.82	63.49	114.27	881.75	132.44	5290.50	2.08	1.18
7	1042.09	1642.20	1390.22	157.51	805.40	67.12	120.81	861.43	131.17	5168.59	2.03	1.03
8	877.87	1642.20	1390.22	157.51	851.47	70.96	127.72	841.55	130.03	5049.30	1.99	0.90
9	713.65	1642.20	1390.22	157.51	900.17	75.01	135.03	822.13	129.02	4932.77	1.94	0.78
10	549.43	1642.20	1390.22	157.51	951.66	79.31	142.75	803.20	128.16	4819.18	1.89	0.68
11	385.21	1642.20	1390.22	157.51	1006.10	83.84	150.91	784.78	127.44	4708.68	1.85	0.60
12	220.99	1642.20	1390.22	157.51	1063.65	88.64	159.55	766.91	126.89	4601.45	1.81	0.52
13	56.77	275.70	1390.22	157.51	1124.49	93.71	168.67	517.02	97.43	3102.12	1.22	0.31

Year	Interest on loan	Depre-ciation	Return on equity	MAT	O&M cost	O&M for 1 month	Mainte-nance spares	2 months average billing	Interest on Working Capital	Total cost	Charges/ unit (Nu)	Dis-counted tariff (Nu per unit)
14	29.20	275.70	1390.22	157.51	1188.81	99.07	178.32	523.59	100.12	3141.56	1.24	0.28
15	1.63	275.70	1390.22	157.51	1256.81	104.73	188.52	530.81	103.01	3184.88	1.25	0.26
16		275.70	1390.22	157.51	1328.70	110.72	199.30	543.13	106.64	3258.78	1.28	0.23
17		275.70	1390.22	157.51	1404.70	117.06	210.71	556.44	110.53	3338.66	1.31	0.21
18		275.70	1390.22	157.51	1485.05	123.75	222.76	570.52	114.63	3423.11	1.35	0.20
19		275.70	1390.22	157.51	1569.99	130.83	235.50	585.40	118.97	3512.40	1.38	0.18
20		275.70	1390.22	157.51	1659.80	138.32	248.97	601.13	123.55	3606.79	1.42	0.16
21		275.70	1390.22	157.51	1754.74	146.23	263.21	617.76	128.40	3706.57	1.46	0.15
22		275.70	1390.22	157.51	1855.11	154.59	278.27	635.35	133.53	3812.07	1.50	0.14
23		275.70	1390.22	157.51	1961.22	163.44	294.18	653.93	138.94	3923.60	1.54	0.13
24		275.70	1390.22	157.51	2073.40	172.78	311.01	673.59	144.67	4041.51	1.59	0.12
25		275.70	1390.22	157.51	2192.00	182.67	328.80	694.36	150.73	4166.17	1.64	0.11
26		275.70	1390.22	157.51	2317.39	193.12	347.61	716.33	157.13	4297.95	1.69	0.10
27		275.70	1390.22	157.51	2449.94	204.16	367.49	739.55	163.90	4437.27	1.74	0.09

Year	Interest on loan	Depre-ciation	Return on equity	MAT	O&M cost	O&M for 1 month	Mainte-nance spares	2 months average billing	Interest on Working Capital	Total cost	Charges/ unit (Nu)	Dis-counted tariff (Nu per unit)
28		275.70	1390.22	157.51	2590.08	215.84	388.51	764.09	171.06	4584.57	1.80	0.08
29		275.70	1390.22	157.51	2738.23	228.19	410.73	790.05	178.62	4740.28	1.86	0.08
30		275.70	1390.22	157.51	2894.86	241.24	434.23	817.48	186.62	4904.91	1.93	0.07
31		275.70	1390.22	157.51	3060.44	255.04	459.07	846.49	195.07	5078.95	2.00	0.07
32		275.70	1390.22	157.51	3235.50	269.62	485.32	877.16	204.01	5262.95	2.07	0.06
33		275.70	1390.22	157.51	3420.57	285.05	513.09	909.58	213.46	5457.47	2.15	0.06
34		275.70	1390.22	157.51	3616.23	301.35	542.43	943.85	223.45	5663.11	2.23	0.05
35		275.70	1390.22	157.51	3823.07	318.59	573.46	980.09	234.02	5880.53	2.31	0.05

Levellised Tariff (LT) = **Nu 1.9591 per unit**

Note: Amount in million Nu at March 2008 Price Level

Source: Author's calculations

Table A3: Financial cost benefit analysis

Year	Capital cost	O&M cost	Investment in working capital	Total cost	Total revenue	Net benefit	Discounted net benefit
-7	1444.72			1444.72		-1444.72	-3193.82
-6	1765.87			1765.87		-1765.87	-3485.51
-5	3973.90			3973.90		-3973.90	-7003.37
-4	5172.38			5172.38		-5172.38	-8138.84
-3	8259.63			8259.63		-8259.63	-11604.19
-2	7179.12			7179.12		-7179.12	-9005.49
-1	1167.31			1167.31		-1167.31	-1307.39
1		576.86	1096.90	1673.76	5858.79	4185.03	4185.03
2		609.85	-14.47	595.38	5858.79	5263.40	4699.47
3		644.74	-13.70	631.04	5858.79	5227.75	4167.53
4		681.62	-12.89	668.73	5858.79	5190.05	3694.18
5		720.61	-12.03	708.58	5858.79	5150.20	3273.05
6		761.82	-11.11	750.71	5858.79	5108.07	2898.46
7		805.40	-10.15	795.25	5858.79	5063.54	2565.34

Year	Capital cost	O&M cost	Investment in working capital	Total cost	Total revenue	Net benefit	Discounted net benefit
8		851.47	-9.13	842.34	5858.79	5016.45	2269.19
9		900.17	-8.06	892.12	5858.79	4966.67	2005.95
10		951.66	-6.92	944.75	5858.79	4914.04	1772.05
11		1006.10	-5.71	1000.38	5858.79	4858.40	1564.28
12		1063.65	-4.44	1059.21	5858.79	4799.58	1379.76
13		1124.49	-235.69	888.80	5858.79	4969.99	1275.67
14		1188.81	21.58	1210.39	5858.79	4648.39	1065.29
15		1256.81	23.09	1279.90	5858.79	4578.89	936.93
16		1328.70	29.09	1357.79	5858.79	4501.00	822.32
17		1404.70	31.05	1435.75	5858.79	4423.04	721.49
18		1485.05	32.82	1517.87	5858.79	4340.91	632.23
19		1569.99	34.70	1604.70	5858.79	4254.09	553.20
20		1659.80	36.69	1696.48	5858.79	4162.30	483.27
21		1754.74	38.78	1793.52	5858.79	4065.26	421.43
22		1855.11	41.00	1896.11	5858.79	3962.67	366.78
23		1961.22	43.35	2004.57	5858.79	3854.22	318.52

Year	Capital cost	O&M cost	Investment in working capital	Total cost	Total revenue	Net benefit	Discounted net benefit
24		2073.40	45.83	2119.23	5858.79	3739.55	275.93
25		2192.00	48.45	2240.45	5858.79	3618.33	238.38
26		2317.39	51.22	2368.61	5858.79	3490.18	205.30
27		2449.94	54.15	2504.09	5858.79	3354.70	176.19
28		2590.08	57.25	2647.32	5858.79	3211.46	150.60
29		2738.23	60.52	2798.75	5858.79	3060.04	128.12
30		2894.86	63.98	2958.84	5858.79	2899.95	108.41
31		3060.44	67.64	3128.08	5858.79	2730.70	91.15
32		3235.50	71.51	3307.01	5858.79	2551.77	76.05
33		3420.57	75.60	3496.17	5858.79	2362.61	62.87
34		3616.23	79.93	3696.15	5858.79	2162.63	51.38
35	**-2896.293**	3823.07	84.50	**1011.28**	5858.79	4847.51	102.83

Note: Amount in million Nu at March 2008 Price Level, and discount rate at 12%

Source: Author's calculations