



# Technical Assistance Consultant's Report

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Project Number: 37399  
February 2009

## Bhutan: Preparing the Bhutan Power Development Project (Financed by the Japan Special Fund)

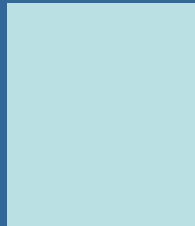
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In association with Nippon Koei Co. Ltd.,  
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For Department of Energy  
Bhutan Power Corporation

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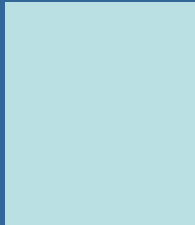




## Final Report – Dagachhu Hydro Power

# TA 4916 BHU: Preparing the Bhutan Power Development Project (TAR: 37399)

February 2009



**PRICEWATERHOUSECOOPERS** 

In association with

Nippon Koei Co. Ltd.,  
Ongdi Consulting Services (OCS),  
M. G. Ramachandran & Associates.



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# 1 ENGINEERING ASPECTS

## COMPONENT 3: HYDROPOWER

### Scope of works

1.1 For Dagachhu Hydropower Project component, two engineers of a hydropower engineer and a geological/geotechnical engineer conducted the following tasks.

A hydropower engineer tasks includes the followings:

- (1) review hydrological data and conditions for the hydropower plant site,
- (2) assess the risks on the design of major structures and recommend mitigation measures.
- (3) conduct field survey to confirm the suitability of the current design,
- (4) examine and finalize construction cost,
- (5) examine and finalize construction plan and schedule, and
- (6) prepare a procurement plan including preparation of bidding documents for the initial stage of the ensuring loan project following ADB guidelines and its standard format.

A geological/geotechnical engineer tasks includes the followings:

- (1) review geological data and reports prepared during Dagachhu feasibility study,
- (2) conduct field survey to confirm the result of review,
- (3) propose and conduct additional geological investigation,
- (4) assess the geological risks and take mitigation measures as necessary, and
- (5) review and assess the result of additional geological investigation.

### Hydrological review

- (1) Purposes
- 1.2 Hydrological data and hydrological conditions for Dagachhu Hydropower Project were reviewed to assess the hydrological risks for the project. Hydrological risks would directly affect to the annual energy output from the Dagachhu hydropower station. Such annual energy would affect to the annual income generated from Dagachhu hydropower Project.
- 1.3 In this connection, review, assessment, and analysis works were conducted through (i) review of FS report conducted by Austrian consultant, (ii) collection of additional hydrological and meteorological data, and (iii) additional examinations to confirm hydrological features.
- (2) Conclusions
- 1.4 As a result of review, assessment, and analysis, the followings are the results and conclusions:

- 1) Average annual discharge estimated during FS was 27.8 m<sup>3</sup>/sec, while reviewed figure was 27.7 m<sup>3</sup>/sec, which is almost the same as the FS figure. This means that FS estimate was confirmed to be at an adequate level through the review and analysis from different viewpoints.
- 2) Average annual energy was estimated as 493 GWh, which is 1.4% less than the FS estimate of 500 GWh, but still stays in the same level as FS.
- 3) From the annual energy duration curve prepared, it was read that annual energy varied in a range of 390 to 620 GWh, which corresponded to +26% to -21% of the average annual energy of 493 GWh.
- 4) 90% dependable annual energy was estimated as 388 GWh, which was about 8% more than FS estimate of 360 GWh.
- 5) Although hydrological and meteorological data were very limited, average annual discharge and average annual energy were confirmed to be in adequate levels through additional assessment, data collection, and analysis.

	FS report	Review Result
(1) Average annual discharge	27.8 m <sup>3</sup> /sec	27.7 m <sup>3</sup> /sec
(2) Average annual energy	500 GWh	493 GWh (-1.4%)
(3) 90% dependable annual energy	360 GWh	388 GWh (+7.8%)

Details of Hydrological Review results are presented in Annexure-HP1

## Geological/geotechnical review

1.5 For geological/geotechnical review, the following works were conducted by the team's geologist:

- Review of the Dagachhu Hydropower Project F/S report prepared by Bernard and Engineers (2006)
- Geological Investigations consisted of a drilling survey at the portal of Headrace Tunnel-North and ground mapping covering the project area
- Geological Assessment for major structures
- Recommendation on supplemental geological investigations

Major findings and conclusion of geotechnical assessment are as follows:

- 1.6 The project area is underlain mainly by relatively massive metamorphic rocks, which are assessed to be suitable for the foundation of the structures.
- 1.7 The drilling survey BH-10 carried out in this stage has revealed that no landslides were detected at the portal of the Headrace Tunnel-North and unconsolidated overburden above the portal site is almost negligible.

- 1.8 Some mica schist dominated sections and small fracture zones in the tunnel alignment may have potential for excessive overbreak. Necessary tunnel supports should be applied based on the geological condition for safe and smooth excavation works.
- 1.9 Additional geological investigations including drilling survey are recommended to verify the foundation level and design of important structures as shown in Table 15 of Annexure-HP2 in Volume I. Drilling holes along the intake dam axis have top priority, and are recommended to be carried out in Preconstruction Stage.
- 1.10 Detailed geological/geotechnical assessment results are given in the Annexure-HP2

### Cost estimate

- 1.11 During the Feasibility Study of Dagachhu Hydropower Project conducted by Austrian consultant, Bernard and Engineers, project cost was estimated at 2006 level. The cost was reviewed by the PPTA team taking into consideration of the following items:
  - 1.12 (1) Civil construction cost
    - 1.13 In view of comparison at international price levels, project cost data were collected which have similar sizes and similar types of development. Such project data were collected from Bhutan, Laos, Viet Nam, Indonesia, Kenya, etc. For underground structures, costs data of Nepal and India were also referred to.
    - 1.14 (2) Electrical and mechanical equipment (E&M) cost
      - 1.15 Turbine and generator costs which consist major part of the E&M costs, were reviewed by comparing with international price levels. Comparison was made by converting costs for turbines and generators into unit cost per weight. By applying empirical equations derived from several hundred projects, comparison was made with projects having similar type and size of development. After comparison of cost levels, adjustment was made accordingly.
      - 1.16 (3) Physical contingency
        - 1.17 After the technical review of Feasibility Study Report 2006, technical risks and their countermeasures were estimated as costs, and secured as physical contingency. Detailed descriptions of technical risks are given in Annex-HP-3.
        - 1.18 (4) Price contingency
          - 1.19 Based on the estimate in 2006 during the Feasibility Study, price escalations were estimated considering disbursement schedule of the project. Annual price escalation of 0.8% was applied for foreign currency, and 5.0% for local currency.

1.20 Based on the above assumptions and considerations, project cost was reviewed and estimated as follows:

### Cost Estimate for Dagachhu Hydropower Project

		No.	Subdivisions	Mil. USD	% to Total Base Cost	Mil. USD	% to Total Base Cost
Investment Cost	1. Civil Works	01	Diversion weir	8.284	5.1%	80.496	49.7%
		02	Connection to Desilter	2.798	1.7%		
		03	Desilter	8.647	5.3%		
		04	Tunnels - Shafts	37.500	23.2%		
		05	Powerhouse	15.959	9.9%		
	2. E&M Works	06a	Mobilization & Demobilization (Civil)	7.308	4.5%	59.215	36.6%
		06b	Mobilization & Demobilization (E&M)	4.386	2.7%		
	3. Local Works	07	E&M Equipment	54.829	33.9%	13.946	8.6%
		08	Roads & Bridges	12.896	8.0%		
		09	Power Lines	1.050	0.6%		
			<b>Sub-total</b>	<b>153.657</b>	94.9%		
Recurrent Cost	10	Administration, Supervision, Pre-operative cost	5.850	3.6%	8.263	5.1%	
	11	EMP Cost	2.413	1.5%			
		<b>Sub-total</b>	8.263	5.1%			
			<b>Total Base Cost</b>	<b>161.920</b>	100.0%		
Contingency	12	Contingency			20.321	12.5%	
		Physical Contingency	8.021	5.0%			
		Price Contingency	12.300	7.6%			
		<b>Sub-total</b>	<b>20.321</b>	12.5%			
Financing Charges During Implementation	13	Financing Charge	14.100	8.7%	19.230	11.9%	
		(Guarantee Premium)	5.130	3.2%			
		<b>Sub-total</b>	<b>19.230</b>	11.9%			
			<b>Total</b>	<b>201.471</b>		<b>201.471</b>	

## Procurement Plan

### 1.21 (1) Packaging

Discussions were made during the 2<sup>nd</sup> interim workshop in January 2008 on procurement plans for Dagachhu Hydropower Project. The procurement plan was finalized during the fact finding mission in May 2008. It was decided that the major project works were divided into two procurement packages, namely, Civil Construction Works and Electrical & Mechanical (E&M) Works. Civil construction works will be mainly financed by ADB and other equity partners in the kingdom of Bhutan. E&M Works will be financed by Austrian export credit called OeKB loan. Engineering, procurement, and construction (EPC) contracts are applied for both Civil Construction Works and E&M Works in view of early completion of the project.

1.22 The following table shows the procurement plan and packaging of Dagachhu Hydropower Project.

Package No.	Work Items	Financiers	Contract Type
Package 1	Civil Construction Works	ADB, Government, and others	EPC
Package 2	E&M Works	OeKB	EPC

OeKB: Oesterreichische Kontrollbank Aktiengesellschaft (OeKB), Austria's main financial and information service provider for the export industry and the capital market.

1.23 Apart from above major works, work items like “08 Roads and Bridges” and “09 Power Lines” will be conducted using government budget with local contractors. Budgets for access road construction were secured by Dagachhu Hydroelectric Project Authority in 2007 and the work started from the end of 2007. The works are well in progress at the site as of May 2008.

#### 1.24 (2) Preparation of Bidding Documents

PPTA team prepared the following part of bidding document for:

- 1) Package 1 – Civil Construction Works, and
- 2) Package 2 – E&M Works.

PART I Bidding Procedures  
 Invitation for Bids  
 Section 1 Instruction to Bidders (ITB)  
 Section 2 Bid Data Sheet (BDS)  
 Section 3 Evaluation and Qualification Criteria (EQC)  
 Section 4 Bidding Forms (BDF)  
 Section 5 Eligible Countries (ELC)

PART III Conditions of Contract and Contract Forms  
 Section 7 General Conditions of Contract (GCC)  
 Section 8 Particular Conditions of Contract (PCC)  
 Section 9 Contract Forms (COF)

1.25 The above documents were drafted up by PPTA team and submitted to Dagachhu Hydropower Corporation Limited (DHPC) for finalization.

- 1.26 There is another technical assistance (TA) provided by Austrian government for the preparation of bidding documents (Austrian TA). Department of Energy, Ministry of Economic Affairs coordinated the works demarcation between Austrian TA and ADB PPTA teams. It was decided that Austrian TA team should prepare the technical part of the bidding document, namely, “Employer’s Requirement” for both “Package 1 - Civil Construction Works” and “Package 2 - E&M Works,” while PPTA team should prepare the commercial part of the bidding documents as listed above. After discussion among DOE, DHPC, ADB and the PPTA consultant, it was decided that the following procurement methods are to be applied:

Package1: Civil Construction Works – single stage two envelop procedures, and  
Package2: E&M Works – single stage one envelop procedures.

- 1.27 The bidding documents are to be finalized by DHPC and Austrian TA team.

### Implementation Schedule

- 1.28 To enjoy the benefit of CDM, it is necessary to start power generation of Dagachhu Hydropower Project at the early stage of the year 2012. Though the construction schedule seems to be a bit tight one, such implementation schedule was prepared to enable early procurement, early commencement and early completion of the project construction works. Advance Action is considered which enables the authorization of the draft bidding document prior to the loan approval and start the bidding procedures from the beginning of July 2008. Implementation schedule for the whole project works are as shown in Figure 1.
- 1.29 Referring to the Figure 1 Implementation Schedule, conceivable annual expenditures are estimated as shown below.
- 1.30 **Annual expenditures estimate for Dagachhu Hydropower Project (Base Cost)**

	2007	2008	2009	2010	2011	Total
<b>Civil Works</b>	-	-	48.052	16.860	15.584	<b>80.496</b>
FC	-	-	33.558	11.724	10.831	56.113
LC	-	-	14.494	5.136	4.753	24.383
<b>E&amp;M Works</b>	-	-	14.036	16.888	28.292	<b>59.215</b>
FC	-	-	12.017	15.111	25.287	52.415
LC	-	-	2.019	1.777	3.004	6.800
<b>Road &amp; Power Line</b>	3.869	9.657	0.420	-	-	<b>13.946</b>
FC	-	-	-	-	-	-
LC	3.869	9.657	0.420	-	-	13.946
<b>Sub-total</b>	3.869	9.657	62.508	33.748	43.876	<b>153.657</b>
FC	-	-	45.576	26.834	36.118	108.528
LC	3.869	9.657	16.932	6.913	7.758	45.129
<b>Contingencies</b>						
Physical	0.275	0.660	3.468	1.724	1.894	8.021
Price	0.223	1.141	4.258	2.640	4.038	12.300
Sub-total	0.498	1.801	7.726	4.364	5.932	<b>20.321</b>
<b>Total Base Cost</b>	4.367	11.458	70.234	38.112	49.808	<b>173.978</b>



## 2 FINANCE AND ECONOMIC ASPECTS

### COMPONENT 3: DAGACHHU HYDRO POWER

#### Project Cost Estimation

- 2.1 The Capital Cost of the Dagachhu Project has been estimated on the basis of Feasibility study conducted by Bernard Engineers and subsequently revised by Nippon Koei Company Limited, Japan and PricewaterhouseCoopers, India under ADB PPTA.
- 2.2 The Dagachhu Project is expected to be set up at an aggregate cost of USD 201 millions, comprising expenditure towards roads, civil and building works, plant and machinery like electro mechanical works, other miscellaneous electro mechanical works, contingencies, preliminary expenses, other miscellaneous expenses, guarantee fees, interest during construction and margin money for working capital. A summary of the various components of cost is presented below:

**Table 1: Cost components of Dagachhu**

Particular	USD millions	% of Total Cost
Roads & Power Lines	14	6.97%
Civil & Buildings	80	39.80%
Plant & Machinery	59	29.35%
Pre-operative	2	1.00%
Administration & Supervision	4	1.99%
EMP Cost	3	1.49%
Contingencies (Price & Physical)	20	9.95%
<b>Total Hard Costs</b>	<b>182</b>	<b>90.55%</b>
Interest during implementation	14	6.97%
Guarantee premium	5	2.49%
<b>Total Soft Cost</b>	<b>19</b>	<b>9.45%</b>
<b>Total Project Cost</b>	<b>201</b>	<b>100.00%</b>

#### Roads & Power Lines: USD 14 Million

- 2.3 The DoE has decided to take the following road combination for realization, taking into consideration the expected lower cost for upgrading and maintenance of the existing Daga road and shorter access from the powerhouse to Dagapela (hospital, school) and to the staff quarters:

- Upgrading of the Daga road to Chineythang, from there down to the Dagachhu along the river upstream to the weir/intake and desilter.
- From the Daga road in Bhalegoan down to the Dagachhu towards the powerhouse and further to side adit and surge shaft. The total estimated cost for building the roads comes around USD 14.66 million.

**Civil and Building Works: USD 80 Million**

- 2.4 The civil works include Diversion weir, Intake Pipe, Desilter, Headrace, Surge Shaft and Presusure Shaft, Power House, Tailrace etc as mentioned in the project details chapter.

**Plant and Machinery: USD 59 Million**

- 2.5 Power plant expenditures cover all the items as mentioned under section on Plant and Machinery and includes hydro turbine, generator, main inlet valves, governing systems, electrical control and protection, auxiliary units, cooling water system, fire protection system, hand operated crane, ventilation, station battery and battery charging, switchyard equipment, earthing, interconnection with grid. Tender bids are being evaluated.

**Preoperative Expenses: USD 2 Million**

- 2.6 The preliminary expenses comprises of legal charges, financing charges including upfront fees, consultancy charges and fees of the Lender Legal Counsel and Lender Independent Engineer.

**Supervision & Administration Costs : USD 4 million**

- 2.7 The Supervision & Administration Costs comprises establishment expenditure like salary, wages, rent rates taxes, if any, temporary construction, and other miscellaneous expenditure during the construction period.

**Environment Management Plan Cost: USD 3 million**

- 2.8 The costs for conducting environment impact studies and thereafter environment management plan is likely to be USD 3 million.

**Contingencies: USD 20 million**

- 2.9 Both physical and price contingencies has been considered for equipment and civil costs and the same is considered at USD 20 million.

**Interest during Construction: USD 14 Million**

- 2.10 The Interest during Construction (“IDC”) has been calculated assuming an implementation period of 36. The funds drawdown schedule has been created based on the cost schedule, debt to non-debt ratio considered for the Dagachhu Project and after accounting for expenditures already incurred.
- 2.11 The interest rate has been considered based on the weighted average calculation from two term loan streams:
- a) From ADB with tenure of 30 years (door to door) and interest rate linked to LIBOR.
  - b) From OeKB with tenure of 19 years (door to door) and has floating interest rate for 10% of the loan value and the balance 90% of the loan value has fixed interest rate at 5.20%.
  - c) From other lenders with a tenure of 10 years (door to door) at an interest of 10% p.a.
- 2.12 The weighted average tenure is 21 years and the interest rate is 9.25%. The door to door tenure includes 3 years of construction, i.e. a grace period of 1 year; the remaining is the repayment period. The ADB loan will be linked to 6 month LIBOR. Interest has calculated on monthly basis while repayment (along with interest) shall be quarterly.
- 2.13 The working capital requirement has been calculated on the basis of the cycle of operations as presented below –

Receivable due to sale of power	1 months of Net Revenue from sale of power
<b>O&amp;M Expenses</b>	1 month of O&M payable from Plant operating cost

- 2.14 25% of the first full year of working capital required has been considered as working capital Margin and has been included in the cost of the Dagachhu project. Rest of the working capital required will be financed @ 12.00% p.a from local banks.

#### **Guarantee Premium for OeKB finance: USD 5 Million**

- 2.15 OeKB finance being supplier’s credit has a guarantee premium of USD 5 million.

## Means of Financing for Dagachhu Hydro Power Component

2.16 The sources of finance for the Dagachhu Project are as follows:-

(\$ million)	
Item	Amount
Project Cost	201.5
Debt:Equity	60:40
Equity (Total)	80.0
Government	7.0
Government (through ADB hard-term ADF loan)	29.0
Druk Green Power Corporation	11.0
National Pension and Provident Fund	12.0
Tata Power Company	21.0
Debt (Total)	121.5
ADB (OCR loan)	51.0
National Pension and Provident Fund	15.0
OeKB (Austrian Export Credit Agency)	55.5

ADB = Asian Development Bank, ADF = Asian Development Fund, OCR = ordinary capital resources, OeKB = Oesterreichische Kontrollbank Aktiengesellschaft.

Source: ADB staff estimate.

## Financial Viability Analysis of Dagachhu Hydro Power Component

### Main assumptions:-

#### The key assumptions underlying the financial projections of Dagachhu Project

1. Gross capacity of plant taken at 114 MW.
2. The COD is considered in January 2012.
3. Debt/non-debt ratio considered at 60:40.
4. Upfront equity infusion taken at 50%
5. Load Factor for Full year operation has been taken as 50%.
6. Tariff has been taken as Rs. 2.40 per unit with escalation of 2.00% p.a. on the base tariff.
7. The interest rate has been considered based on the weighted average calculation from two term loan streams:
  - d) From ADB with tenure of 30 years (door to door) and interest rate linked to LIBOR.
  - e) From OeKB with tenure of 19 years (door to door) and has floating interest rate for 10% of the loan value and the balance 90% of the loan value has fixed interest rate at 5.20%.
  - f) From other lenders with a tenure of 10 years (door to door) at an interest of 10% p.a.
8. The weighted average tenure is 21 years and the interest rate is 9.25%. The door to door tenure includes 3 years of construction, i.e. a grace period of 1 year; the remaining is the repayment period. The ADB loan will be linked to 6 month LIBOR.

Interest has calculated on monthly basis while repayment (along with interest) shall be quarterly.

9. Interest rate on working capital finance is taken at 12.00%.
10. Auxiliary and Transformation losses has been considered at 0.60% of gross generation.
11. O&M expenses have been considered at 1.00% of Project cost with 3% per annum escalation.
12. Working Capital is taken as 1 month of O&M expenses and receivables of 1 month from Sale of power.
13. The rate of depreciation is taken at 3.30%.
14. Income tax is taken at 30% on profits.
15. Transmission loss is considered at 0.60% of gross generation.
16. The project life is considered at 30 years for the purpose of calculation of project IRR.
17. Debt Service Reserve Account is considered to be maintained at two succeeding quarters' interest and one quarter's principle installment.
18. 83% dividend has been considered.

## Financial Projections and Feasibility Analysis

- 2.17 Based on the cost estimates and assumptions outlined above, the key financial parameters for first five full years of operations are given below:-

Nu. in millions

**Table 2: Key financial parameters of Dagachhu project**

Key Ratios	2012	2013	2014	2015	2016
PAT	137	261	293	341	377
ROCE	4.7%	10.4%	10.6%	11.5%	12.1%
FACR	1.66	1.65	1.76	1.82	1.88
PBDIT/Sales	1.11	1.10	1.10	1.12	1.11
PAT/Sales	0.28	0.27	0.29	0.33	0.36
DSCR	2.53	1.72	1.46	1.54	1.60
Minimum DSCR	1.46				
Average DSCR	2.15				
Project IRR (pre tax)	12.53%				
Project IRR (post	10.4%				

Key Ratios	2012	2013	2014	2015	2016
tax)					
Equity IRR (pre tax)	15.63%				
Equity IRR (post tax)	12.06%				

2.18 From the above summary, it is observed that the average DSCR during the tenure of the loan is 2.15 and the minimum DSCR is 1.46. The post tax Project IRR is 10.4 %. The component is financially viable and capable of servicing its debt through internal sources.

### Sensitivity Analysis

2.19 Variations in base Average DSCR have been further analyzed for their sensitivity to certain key assumptions being at a deviation to the base case parameters. The results of the sensitivity analysis are summarized below –

**Table 3: Sensitivity Analysis for Dagacchu project**

Scenario	Particular	Min. DSCR	Avg. DSCR
Base Scenario	Base case	1.46	2.15
Scenario 1	Project cost increased by 10%, i.e. cost increased to USD 230.20 million	1.34	1.96
Scenario 2	Generation reduced by 20%, i.e. MU reduced from 500 to 400 MU	1.21	1.75

## Economic Viability Analysis of Dagachhu Hydro Power Component

### Parameter

2.20 Dagachhu Hydro Power Project is a 114 MW run of the river project and is planned to be implemented under the Clean Development Mechanism (CDM) as defined in the Kyoto Protocol. The power generated will be sold to India, where it will displace fossil fuel based thermal power generation in the Northern Indian power grid. The resulting reduction of Greenhouse Gases (mainly CO<sub>2</sub> emissions) is quantified and registered under the CDM. As a consequence, Bhutan will obtain emission certificates (Certified Emission Reductions, CERs) that can be sold to neighboring countries to provide additional revenues to the project.

### Methodology

2.21 The construction duration is of 3 years (36 months), with a construction start forecasted in September 2008 and the effective commissioning date is assumed to be July 2012.

2.22 According to hydrological series, the average annual net generation is estimated to 492 GWh (500 GWh including the transmission losses). According to the latest terms of negotiations, the selling price of Energy to India is settled at 2.35 Nu/kWh. The transmission fee is set at 0.125 Nu/kWh. Subsequently, the associated annual revenues should be about Nu. 1094.7 millions.

2.23 As per the discussions between Tata Power and DGPC on 21 May 2008, it is decided that Tata Power will underwrite the CDM benefits over the 30 year duration at a rate of Euro 6.5 per CER (i.e. 405 Nu per CER).

2.24 The list of costs and benefits to consider in this economic assessment is synthesized in the table below:

	<b>Economic cost</b>	<b>Economic Benefits</b>
Dagachhu project	<ul style="list-style-type: none"> <li>- Investment in Dagachhu HPP</li> <li>- Investment in Dagachhu interconnection</li> <li>- O&amp;M costs of both assets</li> <li>- Socio-economic &amp; environmental costs</li> </ul>	<ul style="list-style-type: none"> <li>- Revenues of Dagachhu HPP</li> <li>- Indirect revenues (impact during construction)</li> <li>- Carbon emission valuation</li> </ul>

## Results

2.25 The main techno-economic indicators for Dagachhu project are synthesized here after:

$$\text{EIRR} = 15.86\%$$

$$\text{NPV (12\%)} = 1532 \text{ millions Nu 2007}$$

2.26 According to ADB economic principles, we can consider that a project presenting an EIRR higher than the classical threshold of 12% is attractive and should be developed, if the environmental, financial and political criteria are also satisfied. But, the extension of the construction period and the final investment cost plays a crucial role to make this project viable.

2.27 To test the robustness of the results, a sensitivity analysis has been implemented based on a variation of the following parameters tested separately

- Energy generation (from 90% dependability to 10% surplus generation)
- Investment cost ( $\pm 10\%$ )
- O&M cost ( $\pm 10\%$ )
- Tariff of electricity ( $\pm 10\%$ )
- Duration of construction (+ 1 year) with an investment distribution of respectively 20%, 30%, 30% and 20% since 2009

**Table 4** : Results of sensitivity analysis

Parameters	Unit	Base Case	Energy Generation		Investment cost		O&M cost		Commissioning date	Tariff of electricity	
			90% dep E	10%	-10%	10%	-10%	10%		1	-0.1
Generation cost	GWh	492	388	541	492	492	492	492	492	492	492
Investment cost	Million Nu	7042.5	7042.5	7042.5	6338.3	7746.8	7043	7043	7042.5	7042.5	7042.5
O&M cost	% of investment	1%	1%	1%	1%	1%	0.90%	1.10%	1%	1%	1%
Commissioning date	Year	2012	2012	2012	2012	2012	2012	2012	2013	2012	2012
Tariff of electricity	Nu/kWh	2.35	2.35	2.35	2.35	2.35	2.35	2.35	2.35	2.25	2.45
EIRR	%	15.9%	12.6%	15.9%	15.9%	15.8%	15.9%	15.8%	12.27%	15.3%	16.4%

- 2.28 According to ADB economic principles, we can consider that a project presenting an EIRR higher than the classical threshold of 12% is attractive and should be developed, if of course the environmental, financial and political criteria are also satisfied. But, the extension of the construction period plays a crucial role to make this project viable.

## Preparation and Finalisation of Power Purchase Agreement and the Shareholders' Agreement for Dagachhu

- 2.29 The Term Sheet for purchase of power from the Dagachhu project by TPTCL was finalised and the signed between DGPC and TPTCL of in January 2008. Subsequently the consultants prepared the draft Power Purchase Agreement for the Dagachhu project. This was discussed with DGPC and DHPA. Subsequently, the consultants assisted DGPC and DHPA in discussing, negotiating and finalising the PPA during the visit of TPTCL representatives to Bhutan in May 2008.
- 2.30 Some key clauses which were negotiated between DGPC/DHPA and TPTCL during the discussions are:
- a. **Consequences of Termination of the PPA:** the parties agree that where the Agreement is terminated by TPTCL for a DHPC Event of Default, the DHPC shall pay compensation to TPTCL, an amount upto the actual revenue losses to TPTCL towards booking of transmission evacuation system and consequential losses towards liquidated damages by TPTCL to its buyer for the contracted power and in no case exceeding Rs 5 crores. In case the PPA is terminated by the DHPC for a TPTCL Event of Default, DHPC will make best efforts to sell the power on an on going basis at the best available terms and claim the difference in price plus cost and expenses from TPTCL for a period of three years.
  - b. **Royalty Power to RGoB:** With respect to Royalty Power to RGoB from the Dagachhu project, the TPTCL delegation agreed to provide 12% Royalty to RGOB for the first 12 years and 18% Royalty for the balance 18 years free of cost.
  - c. **CDM benefits underwriting by TPTCL:** Regarding CDM benefits, TPTCL made an offer to DGPC that TPTCL is willing to underwrite the CDM benefits over the 30 year duration at a rate of Euro 6.5 per CER. A formal agreement has been agreed between TPTCL and DGPC and the agreement has been sent to both the parties on 13<sup>th</sup> January 2009. DGPC informed that the first right to reject purchase of CER based on best offer through bidding process had already been committed to KPC of Austria. It was agreed that the project would try to sell the CERs at best price. In case this is not possible, the fall back situation would be to take up TPTCL's offer of Euro 6.5 per CER.
  - d. **Quantum of Power to be sold by DHPC to TPTCL:** The Term Sheet signed in January 2008 had provided that the project will sell its surplus power (at least 85% of generated power) to TPTCL. However, during the May 2008 discussions, the parties agreed that DHPC will sell the entire power generated from the project net of Royalty Power to TPTCL

- e. **Dispute Resolution:** DGPC/DHPC and TPTCL agreed to have a cooling period of 60 days in case of any disputes during which the Parties shall meet to settle such Dispute amicably. Further, the parties agreed that arbitration for any disputes will be under the rules of the Singapore Chamber of Commerce and the venue of arbitration shall be at Singapore.
  - f. **Investment by tata Power in DHPC:** The parties agreed that TPTCL and its Affiliates will have 26% equity shareholding in the Dagachhu project.
- 2.31 Since the DHPA has already been converted into a company (DHPC), DGPC decided that the PPA will be signed between the DHPC as the project company and TPTCL as the offtaker.
- 2.32 The minutes of the meeting between DGPC/DHPC and TPTCL on the PPA and SHA are provided in the Annexure of this section in Volume I. The final PPA agreed between DGPC/DHPC and TPTCL is also provided in the Annexure of this section in Volume I.

### 3 SOCIAL ASPECT

#### Socio-economic profile and social safeguard plans

##### DAGACHHU HYDROPOWER PROJECT

- 3.1 One of Bhutan's most abundant natural resources is its swift flowing rivers and streams that its mountainous terrain bequeaths. If harnessed well, this natural resource can be employed to generate clean and renewable energy with very few negative impacts on the natural environment. The Kingdom's enormous hydropower potential is its primary development asset that makes Bhutan a net power exporter and the only country in South Asia with power surplus.
- 3.2 Hydropower has, and will, play a crucial role in guiding the country towards economic self-reliance, an avowed goal of the RGOB. Until 1987, Bhutan relied primarily on foreign aid to fund its development programmes<sup>1</sup>. Domestic resource mobilization prospects drastically improved with the commissioning of the Chukha Hydropower Project in 1987. By 2007, the hydropower sector's contribution to national revenues stood at over 45 percent.
- 3.3 Real GDP in Bhutan has grown at an annual average of over 9% during the 9th Five Year Plan (2002-2007). The power sector accounts for over 45% of the national revenue and 25% of the gross domestic product (GDP). Thus it is apparent that the main thrust to Bhutan's economic growth has come from the hydropower sector on which the nascent but burgeoning industrial sector has piggybacked making optimum use of the distinct comparative advantage provided by the cheap and reliable power made available. The establishment and development of industries will broaden the country's economic base and structure, leading to economic diversification and industrial development. The future of the Kingdom's economic growth will continue to hinge on the development of the hydropower sector as an economic imperative that will fuel Bhutan's engines of economic growth and sustainable development.
- 3.4 Hydropower development also has a social role to play as it generates the resources required to maintain investments in social services and the development of the much-needed physical infrastructure necessary to raise the standard of living and the quality of life as well to expand the level and pace of economic activity.

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<sup>1</sup> Bhutan National Human Development Report 2,000 – Planning Commission Secretariat

- 3.5 Against this background the Dagachhu Hydroelectric Project is being earnestly pursued by the RGOB. However, the Dagachhu Hydroelectric Project (DHP) will be fundamentally different from past hydropower projects in that; (i) the DHP will be structured as the first Public Private Partnership (PPP) hydropower project in the country and operated through Independent Power Procedures, and; (ii) the DHP will be a pilot project as the first cross-border Clean Development Mechanism Project (CDM) under which the power generated from the Dagachhu plant will displace fossil fuel based thermal power generation in the northern Indian power grid. The resulting reduction of greenhouse gases equivalent in CO<sub>2</sub> emissions can be quantified to 500,000 ton every year.
- 3.6 The DHP is located in Dagana Dzongkhag along the Dagachhu between river kilometer (Rkm) 10.5 and 20.2 upstream of the Dagachhu-Sunkosh confluence. It will have an installed capacity of 144 MW and will be a run-of-the-river project that is expected to generate 500,000 MWh annually. The power generated by DHP will be exported to India through the existing grid connected to India.
- 3.7 The main components of the DHP are the weir/intake, desilter, headrace channel and tunnel, surge shaft, pressure shaft, powerhouse (cavern) with two Pelton turbines and transformers for 220 kV power transmission.
- 3.8 The DHP will require land for the construction of the above-mentioned project components. Although most of the land required for the DHP falls under government-owned land, there is some land required by the project that belongs to private individuals. Since ADB policy applies to all resettlement effects, irrespective of the scale of land to be acquired and regardless of the numbers of people affected, a Resettlement Plan (RP) is a mandatory requisite for all ADB financed projects. Therefore, a RP has been prepared in keeping with ADB policy and in accordance with ADB's "Handbook on Resettlement – a guide to good practice" attached as an annexure to this report (Volume I).
- 3.9 The RP defines Affected Persons (APs) as; those who stand to lose, as a consequence of the project, permanently or temporarily, all or part of their physical and non-physical assets, including homes, communities, productive and non-productive lands, resources such as forests, community lands, or important cultural sites, commercial properties, tenancy, income-earning opportunities, and social and cultural networks and activities.

- 3.10 The DHP is classified as having “non-significant” resettlement effects since it does not involve relocation and resettlement of any households and since the number of households affected is only 25, and the total number of affected persons in the 25 households number 145, which is less than 200 (the stipulated figure for a project to be classified as having “significant” resettlement effects). Moreover, the project does not affect any structures (house or living quarters, other physical structure, commercial or industrial structure, and rented or occupied commercial premises) or religious, community or cultural sites. Therefore, following ADB’s guidelines, a “full” resettlement plan is not required for the DHP since the resettlement effects are not severe enough to warrant it, and a “short” resettlement plan will sufficiently protect the interests of the APs.
- 3.11 The objective of the Resettlement Plan is to assist the project affected persons to enable them to improve or restore their living standards to pre-project levels
- 3.12 In order to minimize the effects of resettlement, as far as possible vacant government land has been identified for the location of project infrastructure and the acquisition of private land has been kept to the essential bare minimum. Other measures to minimize resettlement effects have been; (i) access road contractors have been instructed to avoid affecting homesteads even if it causes some realignment of the access roads design; (ii) efforts were made to avoid affecting larger settlements. As a result no families will be displaced; (iii) during design stage extra care will be taken to ensure that religious structures/ public property are avoided, and; (iv) locating stone crushing units and other noise-generating activities away from residential areas as far as possible will mitigate the effects of noise pollution. Similarly, air pollution caused by dust, will be alleviated by locating the machinery and equipment that cause air pollution away from residential areas.
- 3.13 The Detailed Measurement Survey was conducted from March 27 to April 13 2008, which accurately identified the amount of private land to be acquired by the project including the amount of crops and fruit trees affected by the project. The DMS was carried out by the Dzongkhag authorities in conjunction with the DHPA staff and with the participation of the AP’s who verified the amount of land to be acquired from each of them. The DMS results revealed a total of 25 Affected Households (AH). None of the 25 AH will lose their homesteads or be displaced, but all 25 AH will lose some portion of their land to the project, however no community structures and facilities will be affected.
- 3.14 The total amount of land to be acquired for the project from APs is 27.42 acres. Out of this, about 19.99 acres is Kamzhing (dry land including orange orchards) and 7.43 acres is Chhuzhing (wet land or paddy fields). Of the 27.42 acres, 2.61 acres falls under Kana gewog, 16.27 acres falls under Khebisa gewog, and 8.54 acres is under Goshi gewog. Overall, about 2.7 percent of the total population of the 3 affected gewogs (a combined population of 5,363 persons) is affected by the project.

- 3.15 The total amount of standing crops affected is 3.1 acres of paddy and 8.16 acres of maize. The total number of fruit trees affected is 388 orange trees.
- 3.16 The RP provides a review of Bhutan’s policy framework and laws and regulations pertinent to this project and its effects, including the identification of policy gaps in land acquisition, land replacement, and cash compensations. It also provides an overview of ADB’s policy on resettlement and recommends measures to make Bhutan’s policies compliant to ADB’s policy on resettlement.
- 3.17 The basic principles adopted in the RP are; (i) involuntary resettlement and loss of land, structures and other assets and incomes shall be avoided and minimized by exploring all viable options; (ii) APs shall be provided with compensation for their lost assets, incomes and businesses, and provided with rehabilitation measures sufficient to assist them to improve or at least maintain their pre-project living standards, income levels and productive capacity; (iii) lack of legal rights to the assets lost will not bar the affected persons from entitlement to such compensation and rehabilitation measures; (iv) replacement of affected assets (land, crops, fruits, structures etc.) shall be provided at the 2008 rates fixed by the Property Assessment and Valuation Agency (which is expected to be released in June/July 2008). However, if the difference between the rates adopted by PAVA is found to be significantly lower than current local market rates an independent assessment of current local market rates will be undertaken and this will be used as a basis for making compensations; (v) preparation of resettlement plans and their implementation shall be carried out with participation and consultation of affected people; (vi) schedule of budget for resettlement planning and implementation must be incorporated into the overall project, and; (vii) payment of compensation or replacement of affected assets must be completed prior to the award of civil works contract, apart from the access roads the construction of which has already begun.
- 3.18 In order to implement the project principles mentioned above, 16 policies have been developed in the RP, which shall be applied when implementing this RP and is detailed in the main report.
- 3.19 A detailed section on entitlements is provided in the RP and covers; (i) eligibility, and; (ii) entitlements for various categories of losses. The entitlement matrix is provided in the table below.

**Table 5: Entitlement Matrix**

Type of loss	Application	Definition of entitled persons	Compensation policy	Implementation issues
Temporary loss of arable land	a) Arable land in the project area.	a) farmers who cultivate the land. b) Owner of	a) Cash compensation for loss of net income, damaged assets, crops and trees at	a) AP’s have been compensated for their crop-loss. However, the compensation for crop-loss has been paid following the

Type of loss	Application	Definition of entitled persons	Compensation policy	Implementation issues
		the plot.	rates approved by PAVA in 2008. (b) Restoration of land to former state.	1996 compensation rate guidelines for the time being. AP's will be paid the 2008 rates retroactively when the new rates are finalized and released. b) Price of agricultural products in the local market will be checked for comparison with the new compensation rates when it is released by PAVA to ensure there is coherence between the two. c) APs will be provided with cash compensation for restoration of land to former state.
Permanent Loss of arable land	a) Arable land located in the project area	a) farmers who cultivate the land b) Owner of the plot	a) Provide equivalent land nearby b) Provide cash compensation for preparation of replacement farmland	a) Available vacant government land is required. b) Assistance to farmers to develop new crops and increase production.
Loss of standing crops	a) Crops located in the project area	a) farmers who cultivate the crop	a) Compensation in cash for crops based on productivity of the land in the past	a) Price of agricultural products in the local market have to be checked for comparison with the new compensation rates that PAVA is expected to finalize and release in June/July 2008.
Loss of fruit trees	a) Fruit trees located in the project area	a) Farmers who cultivate the trees.	a) Compensation in cash based on type and age of trees	a) Only private owners will be compensated for trees.

3.20 Compensation for land acquired by the project will be on a land-for-land basis as far as possible. Cash compensation for land acquisition will only be made if the AP concerned insists on it even after being advised otherwise. The replacement land must be of equivalent size as the land acquired and of similar productivity standards and potential. The replacement land must, as far as possible, be within the immediate vicinity of the affected person or close to it to avoid causing inconveniences to the already affected person.

- 3.21 If paddy fields are acquired and undeveloped land is provided as replacement land then the AP is entitled to “land development costs” for converting the undeveloped land into paddy fields. The market rate for such “land development costs” is estimated to be Nu. 60,000.00 per acre. This rate was arrived at after consulting with Dzongkhag officials, the APs in the project area, and farmers in other Dzongkhags.
- 3.22 Cash compensation will be paid for loss of standing crops and fruit trees. The compensation rates will be determined by PAVA (PAVA expects to finalize the 2008 compensation rates by June/July 2008), which is an agency instituted by the RGOB to fix compensation rates. It is expected that the 2008 compensation rates will be made in line with current local market valuation, hence it is expected to be a “fair” rate.
- 3.23 Site selection for replacement land will be carried out by the AP’s themselves in consultation with the Dzongkhag Land Records Officer and the gup of the gewog. This has been agreed to by the Dzongkhag Authorities. The AP’s will be given the choice to choose replacement land of their preference from within the same gewog (if vacant government land is available) in order to avoid causing encumbrances to APs and to minimize complaints and grievances about the replacement land. In fact many APs have already selected and identified their replacement land.
- 3.24 A two-tier grievance redress committee had been set up for the APs who will have the right to file complaints and/or grievance on any aspect of land acquisition and resettlement such as inventories, valuation, and entitlements. Any AP who has had his/her land, crops, fruit trees, or structure expropriated or altered and believes that they have not been compensated or assisted in compliance with their entitlements will be able to express their grievances through the two-tier grievance redressal mechanism that has been instituted under this RP. The grassroots redressal committees are called the Gewog Grievance Redressal Committee (GGRC) and three such committees have been set up (one in each of the three affected gewogs). The GGRC’s comprise of members elected by the APs themselves and selected on the basis of who could best represent and voice their grievances. Over 90 percent of the GGRC members are AP’s themselves. The Gup of the respective gewog will chair the GGRCs.
- 3.25 A second, and more high-level, Grievance Redressal Committee has been set up at the Dzongkhag-level. This committee is called the Dzongkhag Grievance Redressal Committee (DGRC) and is chaired by the Dzongdag of Dagana. The DGRC comprises of the Dzongkhag Agricultural Officer (DAO), Dzongkhag Forest Officer (DFO), Dzongkhag Land Record Officer (DLRO), Dzongkhag Finance Officer, and the Dzongkhag Engineer (DE) as its members.

3.26 If the grassroots grievance redress committee is unable to resolve the grievance at its level it must, within one week, put up the unresolved grievance to the Dzongkhag Grievance Redressal Committee (DGRC). It is expected that the DGRC will be able to address all such grievances at its level. However, if an extraordinary circumstance emerges where the DGRC is unable to resolve the grievance at the Dzongkhag level then the DGRC must, within 2 weeks, refer the complaint/grievance to the National Land Commission (NLC) which is the highest body to approve land replacement and compensation allotments in the country. If, even the NLC is unable to resolve the grievances referred to it, then the AP's have the right of appeal to the courts or to His Majesty, the King of Bhutan who is the ultimate arbitrator in the country.

3.27 The grievance redress procedures are provided in the table below.

**Table 6: Grievance redress procedure**

**Step 1:** GGRC deals with grievance **within seven days** of receipt of complaint from AP. If unresolved,

**Step 2:** DGRC deals with grievance **within two weeks**. If unresolved the grievance is forwarded to the NLC,

**Step 3:** NLC deals with grievance. If unresolved,

**Step 4:** AP's have the right of appeal to courts or to His Majesty, the King of Bhutan.

3.28 The RP will be disclosed to the APs and the public (all stakeholders) for review and comments on the various mechanism and entitlements suggested for the implementation of the RP on 15.6.2008. The intention of this procedure is to receive comments from the project affected families in particular so that appropriate suggestions can be incorporated in the RP and also at later stages of implementation. Relevant components of the draft RP will be translated into Dzongkhag and will be placed at the gewog office, office of the DHPA, website of DHPA when it develops one, and at the Dzongkhag office.

3.29 An institutional framework has been prepared as a separate section and it assigns specific roles and responsibilities to relevant agencies and individuals to implement the RP. Various committees such as the Dzongkhag Resettlement Committee, Internal Monitoring Committee, and Resettlement Cell with the DHPA have been established. Moreover, the Resettlement Commissioner, Chief Resettlement Officer, and Dzongkhag Resettlement Officer have been identified and their roles and responsibilities have been designated to them. The main report provides further details on the functions, role, and responsibilities of individual officials and committees.

3.30 The budget required to meet the implementation of the RP is provided in the table below. However, it should be noted that the resettlement cost estimate and budget presented below is subject to revision when PAVA finalizes the compensation rates for 2008, particularly for standing crop loss and loss of fruit trees.

**Table 7: Resettlement cost estimates and budget**

<b>Category</b>	<b>Cost items</b>	<b>Cost in Nu.</b>
Land acquisition	Compensation for land acquired will be on a land-for-land basis, therefore no costs are reflected under this category.	00.00
Resettlement preparation and compensation	a) Compensation for standing crops. b) Compensation for 388 orange trees. c) Compensation for converting undeveloped replacement land into paddy fields (7.43 acres). d) Cost of information translation, printing, dissemination, and consultation e) Cost for community education campaign	88,120.00 270,352.00 445,800.00 125,000.00 50,000.00
Administrative costs	a) Training / workshop b) Monitoring and evaluation c) Independent Monitoring Consultant d) Travel and miscellaneous expenses for Resettlement Commissioner, CRO, Dzongkhag Resettlement Officer, GRC's Internal Monitoring Committee, Dzongkhag Resettlement Committee, etc.	50,000.00 200,000.00 600,000.00 300,000.00
	<b>TOTAL</b>	<b>2,129,272.00</b>
Contingency	10 percent of total	212,927.20
	<b>GRAND TOTAL</b>	<b>2,342,199.20</b>

3.31 An implementation plan has been prepared to guide the schedule of implementation of the RP and is presented below.

Table 8: Implementation Schedule

Activity	2008												2009						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Selection of consultants		■																	
Establishment of Resettlement cell in DHPA			■																
Conduct of DMS			■	■															
Review of DMS by APs				■															
Payment of interim compensation					■														
Complete land acquisition						■													
Finalization of compensation rates for crop-loss							■												
Endorsement of RP						■													
Disclosure of RP to APs						■													
Training/Wshop for RP implementation personnel							■												
Community education campaign																			
Preparation and maintenance of RP database						■	■	■	■	■	■	■	■	■	■	■	■	■	■
Internal Monitoring of RP implementation						■	■	■	■	■	■	■	■	■	■	■	■	■	■
External Monitoring of RP implementation									■	■	■	■							
Effect revised and final compensation payments									■	■	■	■							
Complete land replacement procedures												■							
Advance notice for clearance from project site												■							
Clearance of encumberances in project site												■							
Award of civil works contracts for project const.													■						
Post-resettlement impact evaluation																	■		
Quarterly progress reports									■	■	■	■			■	■	■	■	■

- 3.32 Monitoring and evaluation of the implementation of the RP will be done by the Internal Monitoring Committee that has been established within the DHPA, and by an Independent Monitoring Consultant. The monitoring parameters and indicators are provided in the RP, including the monitoring methodology to be followed. The monitoring timeframe and reporting requirements have also been detailed in the RP.
- 3.33 The DHPA will evaluate the performance of the progress of the APs two years after all resettlement activities have been completed and evaluate them against the indicators listed in the RP. This will provide a picture of whether the socioeconomic situation of the APs was better off before the project, or after the project.
- 3.34 Certain assurance have been made to the APs and are mentioned in the RP, they are: (i) The cash compensation made to APs for loss of crops and fruit trees on 1.5.2008 is an interim measure aimed at alleviating APs need for cash until the final 2008 compensation rates are finalized and released by PAVA. All cash compensations for crops and fruit loss will be made latest by 30.9.2008, and; (ii) All land replacement procedures will be completed and ownership titles (thrams) will be delivered to the APs latest by December 2008.

## **Key Issues of Dagachhu Social Safeguard Development**

### **Valuation of land and property and compensation rates**

- 3.35 Replacement cost is defined as being equal to market cost plus transaction cost. The consultant, for the purpose of budgeting, tried to estimated the replacement costs through consultation with engineers, contractors, Dzongkhag authorities, gewog administrations, affected communities in the project area, local market, and the National Land Commission Secretariat (NLCS) in order to reflect fair and realistic compensation rates for land and crops in the project area but was informed categorically by the NLCS that the RGOB would not approve compensation rates other than those approved by the RGOB and stipulated in the Land Compensation Rate 1996 to ensure uniformity of compensation rates in all Government projects and for all APs across the nation, irrespective of the where the project is located. The consultant was informed, in January 2008, that if the project found the existing compensation rates low then it would have to wait till the Property Assessment and Valuation Agency (PAVA) revised the compensation rates in April 2008. The consultant met with the Chairperson of PAVA and was informed of the same.
- 3.36 However, even at the time of writing this (June 2008), PAVA has still not come up with the revised compensation rates.

- 3.37 In order to alleviate the problems APs may face from the loss of their standing crops due to land acquisition, as interim measure APs were paid compensation as per the 1996 Land Compensation Rates for the time being. When PAVA releases the revised compensation rates (which is expected to be much higher than the 1996 rates) the difference between the 1996 and the 2008 compensation rates will be paid to the APs.

### **Strengthening the capacity of DHPC, Grievance Redressal Committees, and the Dzongkhag Resettlement Committee**

- 3.38 Good implementation of the RP can prevent impoverishment of affected persons and can even reduce their poverty by building sustainable livelihoods. However, improper implementation and non-adherence to the RP can induce local retroactive resistance to the project, cause project delays, increase AP tensions, and procrastinate the flow of project benefits.
- 3.39 The responsibility for implementing the RP rests with the executing agency (DHPC) and it is important to develop adequate institutional capacity of the DHPC in order to facilitate the effective implementation of the RP and its policies. The DHPC has established an internal Resettlement Unit headed by a Chief Resettlement Officer and an Internal Monitoring Committee headed by the General Manager. However, the fact that all the DHPC staff (including the Chief Resettlement Officer and the General Manager) are new recruits could prove an impediment to the effective and efficient implementation of the RP. In order to meet the standards of implementation defined by ADB policy it is imperative that the executing agency (DHPC), and more importantly its Resettlement Unit and the Internal Monitoring Committee, be familiar with every aspect of the RP and its implementation procedures, including the project's policies, project impacts, entitlement matrix, implementation plan, grievance redress mechanism and procedures, monitoring and evaluation etc, since it is the DHPC that will be implementing the RP.
- 3.40 With improved capacity, many of the delays and inconveniences normally encountered in such projects can be avoided.
- 3.41 It is not only the DHPC and its recently-established Resettlement Unit that needs to strengthen its capacity in order to efficiently implement the RP, the capacities of the three Gewog Grievance Redressal Committees at the grassroots level, the Dzongkhag Grievance Resettlement Committee, and the Dzongkhag Resettlement Committee also need to strengthen their capacities so that they can fulfill the functions and responsibilities delegated to them through the RP.

### **Financing of the RP**

- 3.42 The DHPC informed on the consultant on 10.6.2008 that the budget for the Dagachhu Hydropower Project had been more or less finalized and that the budget did not reflect the cost of the RP activities. As per ADB policy, the budget of the Resettlement Activities has to be built into the overall Project cost but this has not been done.

## **The Way Forward**

### **Valuation of land and property and compensation rates**

- 3.43 If PAVA fails to come up with the revised compensation rates by mid-August 2008, the DHPC will have to undertake a local market assessment to determine the valuation of land and crops at market cost plus transaction cost to ensure that APs receive 'fair compensation' before the end of September 2008 as reflected in the Implementation Plan set forth in the RP.

### **Strengthening the capacity of DHPC, Grievance Redressal Committees, and the Dzongkhag Resettlement Committee**

- 3.44 A training program will have to be conducted to build the capacities of DHPC (including its Resettlement Unit and Internal Monitoring Committee), Gewog and Dzongkhag Grievance Redressal Committees, and the Dzongkhag Resettlement Committee. This will ensure that the implementation agency and the various committees have the required capacity to effectively implement the RP.

### **Financing of the RP**

- 3.45 The budget required to implement the RP will need to be reflected in the overall cost of the Project.

## 4 ENVIRONMENTAL CLEARANCE

### BACKGROUND

#### Terms of Reference

4.1 The Terms of Reference describe the scope of the Environmental Management Component as follows:

- i) Conduct and report an Initial Environmental Examination (IEE), Summary IEE, Environmental Impact Assessment (EIA) and Summary EIA as required for each component of the ensuing loan project. Pay special attention to the project's proximity to and anticipated impacts on culturally and ecologically protected areas.
- ii) Prepare an Environmental Management Plan (EMP) as necessary. Include monitoring program (indicators, frequency and reporting) and recommend mitigating measures, and budgets and institutional arrangements to implement them, and assess the activities' environmental benefits.
- iii) Document and organise public consultations at least once in representative project sites, and invite local stakeholders to them. For environment category-A components (eg hydropower development), carry out two public consultations (once during the early stages of EIA field work, and once when the draft report is available and before loan appraisal by ADB).
- iv) Work closely with EA/IA staff to ensure that the National Environment Commission of the Government and the Department of Forests, and other relevant agencies timely clear the proposed IEE, EIA and/or EMP. Help the EA/IA finalise IEE, EIA and/or EMP and their summary in accordance with the ADB format.
- v) Help policy specialists, economists and finance specialists incorporate the impacts of the Clean Development Mechanism (CDM) in the policy framework and economic and investment analyses. Evaluate the options of CDM arrangements, including the ADB Asian Pacific Carbon Fund, on the ensuing loan project.

4.2 The ToR state that the work should be conducted in accordance with relevant policies and guidelines of RGOB and ADB, in particular the ADB Environment Policy (2002), Environmental Assessment Guidelines (2003) and Operational Manual on Environmental Considerations (2006).

4.3 The studies were conducted by one international and one domestic environmental specialist through inputs of 2.5 and 9 person-months respectively.

#### Changes in the Scope of Work

4.4 With the agreement of ADB certain changes were made to the scope of work, to take account of:

- Studies already completed by DoE and BPC;
  - Changes in the loan modality made by ADB;
  - Additional work requested by ADB.
- 4.5 The amendments in the scope and approach to the work were discussed with ADB and presented and explained in the Inception Report and 1st and 2nd Interim Reports, submitted to ADB and DoE. No objections or comments were received. The rationale for the changes is explained below.

### **Studies already completed by DoE and BPC**

- 4.6 Early in the Inception Period, copies of previous environmental documents relating to the project were obtained and reviewed. This revealed that EIA reports had already been prepared for two of the three components (the Dagachhu Hydropower Project and the Dhajay to Gelephu Transmission line) by the responsible GoB agencies (DoE and BPC respectively). These documents are:
- Dagachhu Hydropower Project Environmental Assessment Report: DoE/ BHUCORE, 96 pp, July 2006;
  - EIA Report for the Proposed 220/132 kV Transmission Line from Tsirang to Gelephu: BPC/Druk Consultancy, 70 pp, July 2006.
- 4.7 Both documents were prepared in compliance with national law, specifically the RGOB Environmental Assessment Act (2000) and the Regulation for the Environmental Clearance of Projects (2002). Both reports were submitted to the Government environmental regulator the National Environment Commission (NEC) in support of an application for Environmental Clearance, which is required before construction of a project may begin.
- 4.8 At that time NEC had already approved the EIA for the Transmission Line (TL) component (NEC letter: NEC/EA/BPC/1172/2006/1449 of 6 October 2006) and approval of the EIA for the Dagachhu Hydropower component was expected. This was subsequently confirmed in June 2007.
- 4.9 The Bhutanese EIA law and procedure were developed with assistance from ADB, so the requirements are similar to those of the ADB Environment Policy and EIA Guidelines. The EIA documents were approved by NEC, so it is likely that they would also be acceptable to ADB. If this was the case it would not be necessary to prepare new EIA or IEE reports and summaries for these components as there have been no major changes in the design. This would allow more effort to be expended on the rural electrification (RE) component, for which there were no previous environmental studies.

- 4.10 The EIA documents were therefore submitted to ADB by DoE in October 2007 for ADB review/comment or approval. The consultant advised DoE and ADB that, in compliance with the Item (iv) of the ToR, their environmental specialists would provide assistance in amending the EIA and SEIA documents if comments were received from ADB during the PPTA period.

### **Additional work requested by ADB**

- 4.11 Projects are screened by ADBs Social and Environmental Safeguards Division and assigned to an Environmental Assessment category (A, B or C) according to their likely environmental impacts. Each category requires a different level of environmental study:

Category A: Projects that could have significant environmental impacts. An Environmental Impact Assessment (EIA) is required.

Category B: Could have some adverse impacts, but of less significance than those for category A. An Initial Environmental Examination (IEE) is required to determine whether significant impacts warranting an EIA are likely. If an EIA is not needed the IEE is regarded as the final environmental assessment report.

Category C: Unlikely to have adverse impacts. No EIA or IEE is required, although environmental implications are reviewed.

- 4.12 Where a project consists of several components the project is normally classified according to the highest category of any of the components. In this case the project is assigned to category A because it includes a hydropower element (the Dagachhu Hydropower project).

- 4.13 Hydropower schemes can cause significant negative impacts on ecology (from loss of habitat in the reservoir and downstream impacts from changes in flow in the river) and people (displacement of communities and loss of land in the reservoir). However in this case the design involves a run-of river scheme, where the perennial flow of the river does not require the formation of a reservoir, so many of the impacts normally produced by a hydropower project will not occur.

- 4.14 It would seem appropriate for this component and therefore the scheme as a whole to be re-allocated to a lower category (B), as this is more commensurate with the likely impacts. ADB therefore requested the consultant to prepare two additional documents to support an application to the Social and Environmental Safeguards Division for a reclassification. These were:

- A paper presenting the case for reclassifying the Dagachhu Hydropower Project from Category A to Category B; and

- A completed Rapid Environmental Assessment (REA) Checklist (from Appendix 1 of the ADB EA Guidelines), summarising the potential impacts of the Dhajay to Gelephu TL component.

## Approach

### Hydropower Component

4.15 The work of the hydropower component consisted of the following:

- Detailed review of the EIAs for each component prepared by DoE and BPC;
- Discussing the documents with DoE and suggesting that they submit both to ADB with a request for ADB to review each to determine whether they comply with bank procedure and indicate what amendments are needed if any;
- A field visit to inspect the proposed site of the Dagachhu plant and access road in January 2008 with the ADB Environmental Specialist;
- Conducting the two items of additional work requested by ADB, which involved preparation of:
  - A paper presenting the case for reclassifying the Dagachhu Hydropower scheme from Category A to Category B; and
  - A completed REA Checklist summarising the potential impacts of the Dhajay to Gelephu TL component.

4.16 The results and conclusions from these studies are summarised below.

4.17 The consultant also informed ADB and DoE in the Inception and Interim Reports that their environmental specialists would assist DoE and BPC in updating the EIA reports and SEIAs for the Dagachhu and TL components to address any comments from ADB. No comments were received during the PPTA study.

## DAGACHHU HYDROPOWER PROJECT

### Background

4.18 The Dagachhu Hydropower Project will be located towards the centre of Dagana Dzongkhag on the Dagachhu (river), approximately 10 km upstream of Dagachhu bridge in Trashiding geog. The infrastructure will consist of a 20.5 m high, 21.7 m long concrete gravity diversion dam across the river, plus an 8 km tunnel through the adjacent hillside to carry water to an underground powerhouse near Babithang village in Khebisa geog. The powerhouse will be equipped with two turbines, with an installed capacity of 57 MW each. A new access road is already under construction on the hillside between the highway and the powerhouse site; and the project will also include a 19 km Transmission Line (TL) from Dagana to Dhajay in Tsirang Dzongkhag.

- 4.19 On completion of the project, power will be conveyed through the TL to another longer TL (45 km) between Dhajay and Gelephu, to be provided by the second component of this project (see below). This will connect the western and eastern parts of the national grid, enabling power from the Dagachhu station (and other hydropower plants in the west) to be supplied to the central and eastern regions of Bhutan. Excess power will also be exported to India, supplementing existing power export arrangements.
- 4.20 The Dagachhu project is being implemented under the Clean Development Mechanism (CDM) as defined in the Kyoto Protocol. Energy sold to India will replace electricity that would otherwise have been generated from fossil fuels, and will thus contribute to a reduction of carbon emissions to the atmosphere. This will be verified by Greenhouse Gas Emission Reduction Certificates issued by the United Nations Convention on Climate Change. These are sold to industrialised nations to offset their own carbon emissions, providing revenue that the Bhutan Government can use in developing this and other projects to generate energy from renewable sources.

## The Environment

- 4.21 The project is located in a remote area in the south-west of Bhutan, where the environment is not especially sensitive. The project site lies mainly in a narrow, steep gorge, with wooded slopes leading down to the riverbed, and there is little flat land. The altitude is 825 m on the riverbed at the dam-site, so this is one of the lowest regions of Bhutan. The climate is sub-tropical, with a hot and humid summer and a cooler winter, and heavy monsoon rains between June and September.
- 4.22 There are no protected areas in the vicinity of the project site, the nearest being the Phibsoo Wildlife Sanctuary 30 km away. The broadleaf and chirpine forest on the hillsides is disturbed to an extent by human activity, but is said to support two protected mammals (the leopard and leopard cat) and one globally-threatened bird (the rufous-necked hornbill). Surveys revealed only five fish species in the river, none of which are rare or endangered, and only one of which migrates upstream to spawn in the summer.
- 4.23 There are a few small communities in the vicinity of the project site, but none in any of the locations in which elements of the project will be built or created, including the small impounded area. Most people are engaged in mixed subsistence agriculture, mainly on land owned by the farmer. The predominant methods are kamzhing (dryland) or chuzhing (in natural wetlands), and the main crops are paddy rice, maize, millet, potatoes, buckwheat, oranges and cardamom. Incomes are generally somewhat higher than the national average of Nu 1200 per month.
- 4.24 There are schools, health facilities and sites of religious or cultural importance in the Dzongkhag, but none in the project area. Around 40% of households have

piped water through rural water supply schemes, and the remainder collect water from rivers. There is no sewerage and almost all households use pit latrines, and waterborne diseases are common. There is little gender discrimination in Bhutanese society and inheritance rules favour females. Around 40% of households in the project area are headed by women, and women play an integral role in both urban and rural society.

### Impacts and Mitigation

- 4.25 As noted above, the Dagachhu is a perennial river, with a mean annual flow of 27.8 m<sup>3</sup>/s, so there is no need to retain water in a reservoir to enable power generation throughout the year. The scheme has therefore been designed as a run-of-river system, in which the function of the dam is not to retain water, but merely to deflect it through a tunnel into the power house. Water will be returned to the river downstream, and the EIA recommends the release of a minimum of 1.4 m<sup>3</sup>/s of water from the dam (5% of the mean annual natural flow) to sustain aquatic life in the 6.6 km of river between the dam and the point at which water will be returned below the powerhouse.
- 4.26 The dam will impound a maximum of 200,000 m<sup>3</sup> of water in an area of 4-5 ha, and careful site selection has ensured that this will affect no houses or locations of special importance, and no privately-owned land. The remainder of the facilities (desilting chamber, pressure shaft, switch yard, access road and transmission line) will occupy 83 ha, of which 13 ha is farmed. This will be purchased under the Land Act (1998) and compensation will be paid on the basis of officially established rates that are currently being updated (2008). Additional compensation for any income-generating assets that may be lost (standing crops, fruit trees) will be provided through a Resettlement Plan.
- 4.27 The environmental impacts of the scheme, during both construction and operation should therefore be much less significant than those that are normally associated with a standard hydropower scheme. Table 9 shows the impacts predicted by the EIA study and the mitigation that is proposed to reduce each to an acceptable level (columns 1 and 2). The independent review conducted during the PPTA concluded that, if all mitigation and monitoring proposed in the EIA is implemented in the manner suggested, all negative impacts should be reduced to the level of no significance.

**Table 9: Dagachhu Hydropower Project: Summary of environmental impacts identified by the EIA study, and the proposed mitigation and monitoring plan**

ENVIRONMENTAL MANAGEMENT PLAN		MONITORING PLAN		
IMPACT	PROPOSED MITIGATION	Indicator	Responsibility	Frequency
<b>LOCATION</b>				
<b>Watershed Erosion:</b> Dam and reservoir site may be subject to increased erosion and landslides because of construction of access roads and fluctuation in reservoir levels	Biological: planting shrubs and trees Engineering: build check dams, gabion walls, stone masonry etc Monitor areas requiring slope stabilization Catchment: designate as watershed reserve forest; prohibit mining, grazing, forestry; raise awareness	Exposed cut slopes; landslide; rate of soil erosion; sedimentation to water course	Contractor, ECU	Monthly during construction and operation
<b>Fish Migration:</b> If any fish migrate upstream to breed this would be prevented by the dam. Changes in flow regime and sediment deposition would affect fish mobility and spawning conditions	Broad evaluation of fish populations, distribution of species, migration and spawning; measurement of water temperature. A fish farm should be provided to sustain the species if breeding migrations are affected	Loss of fish species and problem in fish mobility	ECU	Weekly Monthly
<b>Agriculture:</b> Project will occupy 83 ha, including 13 ha of farm land and the remainder broadleaf and conifer forest and scrub. The agricultural land is owned by 41 households, who are losing an average of 16% of their holding, from which they obtain most of their income	Survey agricultural production; recommend how to improve water utilisation, availability of seeds and fertilizers, information about scientific farming Purchase land through Land Act 1998 (at rates updated in 2008), or provide replacement land if possible. Give additional compensation for loss of crops and trees via Resettlement Plan. Provide jobs in operational period to 1 person per affected family	Agricultural production	DHPP, ECU	Quarterly
<b>Wildlife:</b> Leopard and leopard cat inhabit the project area and are protected by the Forest and Nature Act 1995. The globally-threatened rufous-necked hornbill inhabits tall trees in the project area and feeds on fruit bearing trees	Prohibit encroachment into the prime habitat of the two mammals, which are thickly forested areas upstream of the reservoir and near the addit, and do not locate labour camps in these areas. Prohibit cutting of tall or fruit bearing trees	Decrease in numbers as revealed by surveys before and during construction	ECU	Monthly
<b>DESIGN</b>				
<b>Road:</b> The proposed 19.3 km of access roads will remove 12.3 ha of agriculture and 24 ha of forest which could cause physical impacts (landslides, erosion, runoff, etc) and loss of income	Plant trees, shrubs, bushes in unstable areas; build retaining walls and other slope stabilisation methods; provide culverts and other drainage for storm runoff; use salvage soil in reclaimed land. Schedule construction with farming cycle so that local people can take up employment. Compensate losses in income via the Resettlement Plan.	Numbers of dead trees and clearing of bushes and shrubs. Incidence of erosion and landslides	Contractor, ECU	Monthly, half-yearly, yearly during construction and operation
<b>Fish Screens:</b> Screens to prevent fish entering power house and ladders to enable fish to migrate upstream of the dam may be necessary if surveys show significant numbers of migratory fish	Investigate species and numbers of long distance migrators and amend design to include fish lift/ladder and intake screens if necessary	Loss of migratory species and observed mobility problems	ECU	Further investigations
<b>Transmission Line:</b> 19 km TL is 220 kV so will have a RoW of 40-50 m, and 3-4 towers per kilometre. It will not be necessary to clear the RoW, but obstructing vegetation will	Limit cutting to vegetation higher than 3 m and limit construction of access pathways. Re-vegetate areas with steep topography to stabilize slopes; and provide measures to control drainage. Provide involvement	Cutting of trees and clearing of shrubs and bushes; land slides, soil	Contractor, ECU	Monthly, half-yearly, yearly in construction and

ENVIRONMENTAL MANAGEMENT PLAN		MONITORING PLAN		
IMPACT	PROPOSED MITIGATION	Indicator	Responsibility	Frequency
be selectively cut back to 3 m height	and awareness program for local people.	erosion		operation
<b>CONSTRUCTION</b>				
<u>Soil Excavation:</u> Over 400,000 m <sup>3</sup> of waste spoil will be excavated to create the tunnel, power house, de-silting chamber. This needs to be safely disposed of so that it does not adversely affect drainage, water quality, etc	Transport spoil to designated dumpsite, level after deposition, provide storm drainage and runoff control and afforest the disposal site. Minimise the release of sediment to rivers to protect water quality	Appearance, topography, dust	Contractor, ECU	Weekly, monthly
<u>Worker Safety:</u> The health and safety of workers and the public must be protected throughout the construction period	Provide first aid kits, safety equipment (hard hats, gloves, boots, etc), safe drinking water, toilets, safety barriers, mosquito control, etc. Produce and implement an Occupational Health and Safety Plan	Incidence of accident, injury, waterborne disease, malaria fever	Contractor, ECU	Daily, weekly, monthly
<u>Air Quality and Noise:</u> Air and noise pollution may be produced by blasting, excavation, drilling, crushing and other construction activities	Sprinkle water on exposed dry soil; maintain all construction vehicles and equipment; fit crushers with cyclone filters; prohibit blasting at night; provide local communities with advanced notice of blasting operations	Levels of noise and dust, blasting operations	Contractor, ECU	Weekly, monthly
<u>Water Quality:</u> Construction will increase erosion and sediment loads in rivers and there could be spills of oil, fuel and other chemicals. The increase in workers and people supplying services could cause water pollution from discharge of untreated sanitary effluent	Provide adequate pit latrines at labour camp and prohibit disposal of sewage to river. Use settling tanks and prevent silt laden water from tunnelling and other activities from entering river. Prevent chemical spills. Conduct sampling and analysis of water quality in the river, plus temperature measurements	pH, turbidity, dissolved oxygen, BOD, phosphate, nitrate, temperature	ECU	Monthly
<u>Solid and Liquid Waste:</u> Various types of solid and liquid waste are produced during construction and these will need to be disposed of responsibly	Design and provide a landfill away from human settlements, water bodies and critical habitats. Deposit solid waste to landfill; export metal, rubber, plastic and batteries for recycling; use wood for fencing and fuel; use sawdust for soaking up spilled oil; store waste liquids in drums and export to India for reprocessing	Land and water pollution. Engine oil collected and exported for reprocessing	ECU	Weekly, monthly
<u>Waterborne Diseases:</u> water in the river may be polluted so there is a risk of workers contracting disease if it is consumed without treatment	Periodically sample water sources for faecal coliforms and other parameters. Abstract water upstream of labour camp and treat with chlorine and slow sand filtration. Raise awareness of need to boil water before drinking. Include measures in OHS plan	Coliform bacteria in water and increase in incidence of waterborne diseases	ECU	Weekly, monthly
<u>Fire Outbreaks:</u> The site is forested so fire could be caused by use of explosives, or wood and kerosene for cooking	All explosives must be stored and used according to Ministry of Home and Cultural Affairs' Rules. Proper fire fighting equipment and trained personnel should be present at all sites. Labour camps must have common mess facility using gas for cooking and use of wood should be prohibited.	Smoke in air	Contractor, ECU	As and when required
<u>Poaching of Wildlife:</u> Ecological damage can be magnified near labour camps if workers fell trees and engage in fishing and poaching	Erect barriers and check posts around labour camp and work sites, including the TL route to prevent illegal poaching, fishing and felling of trees	Decrease in wildlife numbers	ECU	Monthly
<u>Cultural Invasion:</u> An estimated 1500 unskilled workers plus	Construct separate labour camps for migrant workers and follow the	Local complaints	Contractor, ECU	Monthly

ENVIRONMENTAL MANAGEMENT PLAN		MONITORING PLAN		
IMPACT	PROPOSED MITIGATION	Indicator	Responsibility	Frequency
200 staff will be imported, mainly from India. Their culture and behaviour could have negative impacts on the host community	construction schedule strictly to limit the length of stay for migrant workers. Provide training in the local religion, culture, tradition, lifestyle so that workers are aware of local sensitivities			
<b>OPERATION</b>				
<b>Downstream Flow Variation:</b> 6.6 km of river between the dam and the powerhouse will be depleted of water in the 9-month lean season. A minimum flow of 1.4 m <sup>3</sup> /s will be provided to sustain aquatic life and riparian vegetation. Reduced flows will encourage people to cross the river bed, so sudden release of water could lead to loss of life and erosion of river bed.	Collect hydrological data and flow measurements. Maintain the guaranteed minimum flow at all times in the diverted section and apply a start and stop procedure that provides a smooth increase and decrease in water level & flow. Provide a system to warn people of changes in flow. Monitor river bed conditions and slope erosion downstream of the dam.	Flow rate	DHPP, ECU, CEM	Monthly
<b>Reservoir Management:</b> Inappropriate operation of the dam and reservoir could exacerbate difficulties downstream caused by the variations in flow rate	Design energy dissipators to reduce downstream scour and monitor shoreline for cracks and erosion. Install warning system for emergency spillway release or gate opening when normally closed in dry season. Consult community to discourage use of reservoir water for drinking or irrigation. Operate reservoir to provide minimum compensation flow. Vegetate shoreline to prevent erosion and sediment increase.	Large variation in water level in reservoir	DHPP, ECU	Monthly
<b>Downstream Water Quality:</b> River water may be polluted by sewage, wastewater and spills of chemicals used on site, such as fuel, oil, etc.	Prohibit discharge of untreated waste to the river. Treat and disinfect drinking water and regularly test the quality of river water and domestic water. Raise workers' awareness of risks of waterborne disease. Adopt best practice for storage and disposal of oil, other hazardous substances and waste. Provide effective site drainage that prevents spills entering the river.	Spread of waterborne disease; loss of fish; total suspended solids; total settleable and non-settleable solids	DHPP, ECU	Monthly
<b>Insect Vectors of Disease:</b> The increase in aquatic habitat provided by the small impounded area may increase the number of anopheline mosquitoes	Provide a first aid post and dispensary on site and implement malaria control by spraying insecticide in areas where adults and larvae may be present (not in the river water). Monitor the incidence of mosquitoes fortnightly	Reported cases of malaria	DHPP, ECU	Weekly, Monthly

**KEY:**

DHPP = Dagachhu HPP Authority; ECU = Environment and Community Unit of DHPP; CEM = Central Environment Monitor/NEC

4.28 The positive impacts of the scheme are mainly economic and social, and include:

- Increased foreign revenue for the Government from the sale of electricity and Certified Emission Reductions earned under the CDM;
- Improved living conditions in communities supplied with electricity in the vicinity of the plant and in the centre and east of the country;
- Improved health in these communities from reduced exposure to smoke and other pollutants from the burning of wood and kerosene;
- Ecological benefits from reduced felling of trees for firewood in communities provided with electricity;
- Global benefits from reductions in the production of greenhouse gases.

### **Environmental Management and Monitoring Plans**

4.29 The Environmental Management Plan (EMP) for the Dagachhu Hydropower component is summarised in Table 9. This comprises:

- Actions recommended in the EIA to mitigate negative environmental impacts;
- Monitoring the effect of each mitigation measure, in terms of indicators, frequency and responsibility for implementing the monitoring.

4.30 The EIA identifies impacts that are a result of the location, design, construction and operation of the project, and the EMP specifies action to mitigate the negative impacts, which needs to be taken in the pre-construction, construction and operational phases. The principal actions required by the EMP in each phase are as follows:

#### Pre-construction:

- Obtain Environmental Clearance from NEC as required under the Environmental Assessment Act 2000 (obtained in June 2007);
- Prepare a Resettlement Plan to identify and compensate where appropriate losses of income and income-generating assets caused by the project;
- Incorporating environmental requirements in project design, particularly inclusion as clauses in construction contract documents;
- Monitoring implementation of the Resettlement Plan.

#### Construction:

- Establishing a project Environment and Community Unit (ECU) to be a focal point between the project and the community and oversee environmental and social enhancement measures;
- Coordination with the engineering unit to incorporate environmental concerns into operations contracts, guidance documents and Operation and Maintenance Manuals;
- Environmental capacity building including the contractor's engineer;
- Monitoring the execution of civil works;
- Monitoring of wildlife, environmental quality and social indicators;
- Reporting and remediation where necessary.

Operation:

- Monitoring downstream flow variations, reservoir management, downstream water quality and the management of insect disease vectors;
- Mitigating any further impacts revealed by the monitoring if necessary.

**Reclassification of the Dagachhu Hydropower component**

- 4.31 The paper presenting the case for reclassifying the Dagachhu Hydropower component and thus the project as a whole from environmental assessment category A to category B is shown in Annex Env 1. This is based on the ADB Rapid Environmental Assessment (REA) Checklist, which is a tool used by ADB to screen the impacts of projects when determining their environmental category.
- 4.32 Checklists for various types of infrastructure are provided by ADB in Appendix 1 of the Environmental Assessment Guidelines (2003). Each poses a series of questions regarding the location and impacts of the project, which assist the user in identifying impacts and assessing their significance or importance. The questions focus on what are known (from ADB experience and studies reported in the literature) to be the main impacts of each type of development.
- 4.33 The checklist for hydropower development includes 28 questions, which are answered in Annex Env 1 by referring to data presented and/or conclusions drawn in the EIA report. The relevant section of the EIA report is quoted alongside each answer. The completed checklist shows that of all the potential impacts that can be caused by hydropower stations, only one is likely to occur as a result of this scheme. This is the increase in waterborne or water-related diseases, and the EIA proposes a series of measures that should reduce this impact to the level of non-significance (see Table 9).
- 4.34 The ADB Guidelines also give examples of the types of location and types of impact, which if affected or produced by the scheme in question would generally result in a category A classification. These include: sensitive and valuable ecosystems, cultural heritage sites, densely populated areas; and destruction of natural habitat, loss of biodiversity, displacement of large numbers of people, etc. Table 9 and Annex Env 1 show that most of these will also not occur as a result of the project.
- 4.35 The main reasons for proposing a reclassification are as follows:
- This is a run-of-river design, not a standard hydropower scheme with a dam and reservoir, and is located in an area that is not environmentally sensitive;
  - Most of the environmental impacts associated with hydropower development will therefore not occur, and those that may occur should be reduced to the level of no significance by mitigation measures proposed in the EIA;

- There are no designated or sensitive areas near the site and no areas that are of major ecological, cultural or social significance;
- There is a good flow in the river throughout the year so it is not necessary to impound water for power generation, and the function of the 20.5 m high dam is merely to deflect water through a tunnel to the powerhouse;
- The impounded area will be small (4-5 ha) and will cover an area of degraded mixed forest, in which there is no inhabitation, no farmland, no land that is privately owned, and no features of special importance;
- No people will be relocated and no buildings will be removed in any location;
- A small amount of private land will be purchased under the Land Act (1998) at rates that are currently being updated, and additional compensation will be paid for loss of crops and other income-generating assets;
- Water will be returned to the river downstream of the powerhouse, so only 6.6 km of the river will be affected by variations in flow; a minimum flow of 5% of the annual average will be provided to maintain ecology in this area;
- The EIA for the project includes an Environmental Management Plan through which all mitigation measures will be provided and monitored;
- The cost of mitigation and monitoring is estimated in the EIA and the amounts have been included in project budgets.

## DOCUMENTS PREPARED

4.36 The documents prepared during the PPTA study in compliance with ADB policy and procedure and Bhutanese national law are all provided in appendices attached to this report. These are as follows:

Annex Env 1: Paper presenting the case for reclassifying the Dagachhu Hydropower Component;

Annex Env 2: Completed REA Checklist for the Dhajay to Gelephu Transmission Line Component;

## 5 ANNEXURES

(Provided in separate volume- Annexure Dagachhu Hydro Power)



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