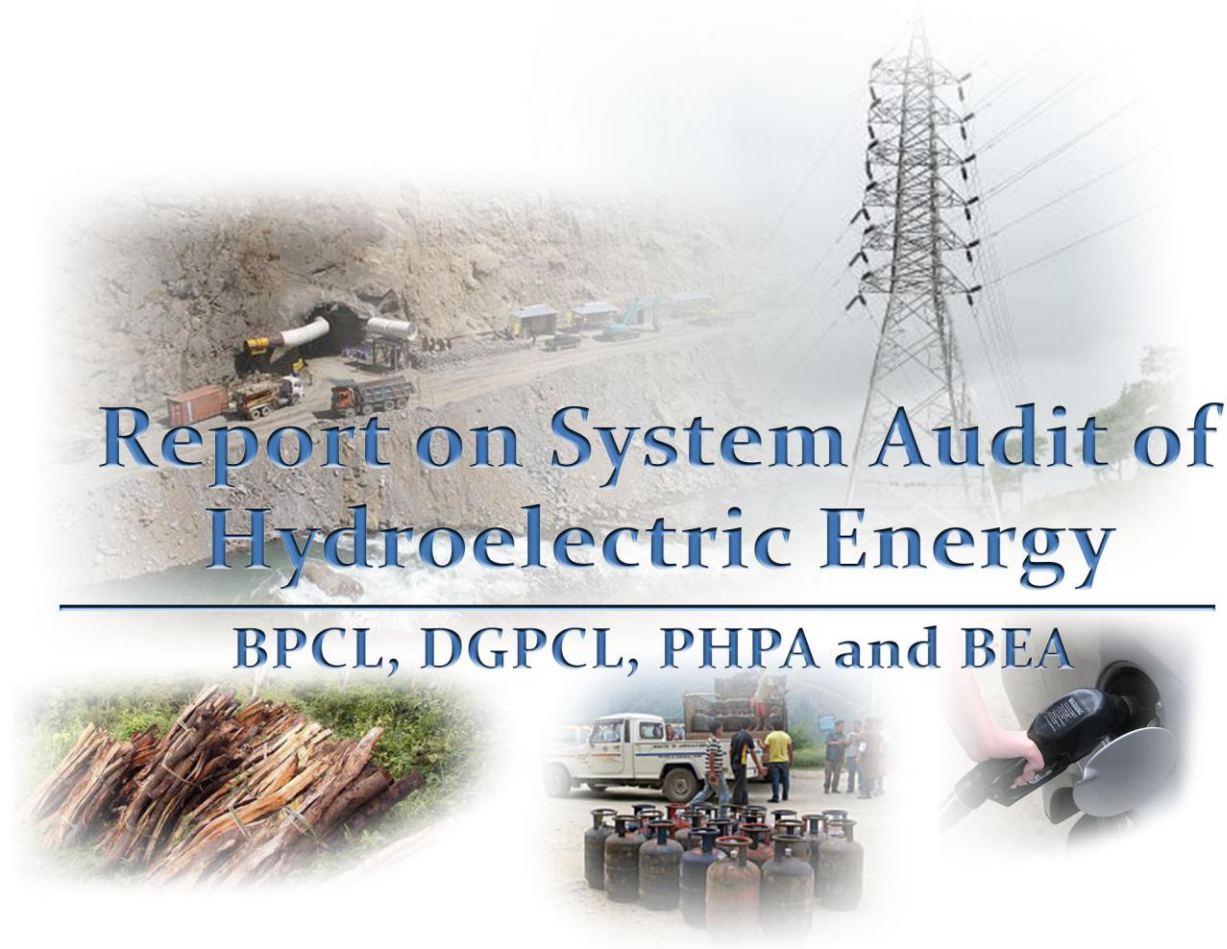
Royal Audit Authority
(DT)



Report on System Audit of Hydroelectric Energy

BPCL, DGPCL, PHPA and BEA

January 2013

Reporting on Economy Efficiency and Effectiveness on the use of public resources

ROYAL AUDIT AUTHORITY (DT)

Bhutan Integrity House

Reporting on Economy, Efficiency & Effectiveness in the use of Public Resources

RAA(PSAD/SAS)/2013/*23* 4th January 2013

The Hon'ble Lyonpo
Ministry of Economic Affairs
Thimphu

Subject: Report on System Audit of Hydroelectric Energy

Your Excellency,

Enclosed herewith, please find a copy of the report on the ***"System Audit of Hydroelectric Energy"***. The Royal Audit Authority (RAA) has conducted the audit in line with the mandates of the Royal Audit Authority as enshrined in the Constitution of the Kingdom of Bhutan 2008 and the Audit Act of Bhutan 2006.

The audit was conducted with the objective to ascertain the economy, efficiency, and effectiveness in generation and distributions of hydroelectricity by power utility companies, namely the Druk Green Power Corporation Limited (DGPCL) and Bhutan Power Corporation Limited (BPCL) and suggest recommendations in areas where improvements are desirable.

The RAA noted many significant accomplishments during the course of audit. The BPCL and relevant agencies have made commendable efforts towards achieving the Royal Government's targets of *'Electricity for every Home by 2013'*, recording achievement of 80% as of March 2012. The BPCL and DGPCL had also initiated several socially responsible activities besides enhancing their efficiency in operations and delivery of services. The RAA noted significant reductions in transmission losses as well as reduced incidences of power disruptions.

The DGPCL had also made various efforts towards increasing the power generations during the lean seasons. Notwithstanding all of these achievements, the RAA also noted certain shortcomings and lapses where improvements are desirable. Some of the significant issues include:

- Inadequacies were noted in the Tariff Determination Rules & Regulations (TDR 2007) which may result in computing inappropriate power tariff by the BPCL and DGPCL;
- At block 3, the rate for LV consumers is higher than the rates charged for HV and MV consumers i.e., for industrial uses. There has also been decreasing trend in per household consumption of energy primarily attributed to annual increase in tariff as revealed from the analysis carried out by the RAA;
- Despite increasing connectivity of hydropower electricity, there is still considerable dependence on other forms of energy such as firewood, kerosene, LPG, etc which may have

possible negative impact on the economy (i.e., adverse balance of payments, INR problems etc.) as well as on the environment;

- There may be a need for coming up with the preferred policy option on the pricing and domestic use of energy vis-à-vis use of other forms of energy having regard to their impact on the economy and on the environment as well as affordability of citizens at large;
- Profit of BPCL is significantly driven by annual increase in tariff besides other operational factors. The extent to which the power tariff revisions and other factors such as operational efficiency and volume variances etc have impacted the profitability of the Corporation needs to be analyzed and ascertained for better information, controls and decision making including determining performance based incentive schemes, bonus etc;
- Due to inappropriate billing limitation imposed by the BEA, the DGPCL will have to bear the extra cost of importing energy during lean seasons when the import exceeds the allowed import figures computed based on historical average of DGPLC's power imports;
- The power reliability determination of the BPCL was inadequate as compared to other countries where it is determined based on several parameters including, SAIFI, SAIDI, CAIDI, CEMMI-4, CELID-8 and MAIFI, and also including all interruptions;
- There is increasing trend in distribution loss of BPCL and transformation and generation losses of the DGPCL's power plants and some of BPCL's ESDs necessitating further measures to curtail such losses;
- Existing Guidelines on compensatory reforestation are not adequate requiring appropriate review and improvements;
- Despite requirement to utilize water resources in a sustainable manner for hydropower generation, and to protect water catchment areas by promoting sustainable agricultural & land use practices and nature conservation works, existing legislations and strategies on the sustainable use of water were found to be inadequate; and
- Environmental unit was not found established at the THPA. Besides, there were cases of non-compliance of some of the environmental rules and regulations at PHPA.

As discussed above, the RAA is of the opinion that there is a need for a clarity on the preferred policy option of encouraging use of renewable hydro electricity energy vis-à-vis other forms of non-renewable and environmentally less conducive energy as conservation of environment is our national priority. An appropriate policy intervention in this regard may also contribute towards addressing current INR situation considering that increasing import of LPG and other fossil fuel also significantly led to depletion of hard currency reserves. It is, therefore, imperative to carry out appropriate analysis and explore possibility of encouraging use of hydro electricity as import substitution by rendering it more affordable.

It is also to apprise Your Excellency that the draft reports were issued to the Ministry of Economic Affairs and other relevant agencies for factual confirmation and comments. The report has been

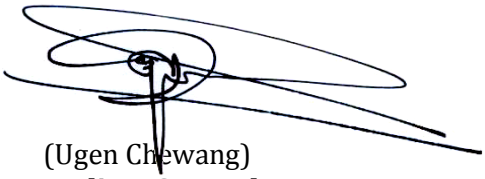
finalized after reviewing and incorporating the comments of the Ministry in this report. The detailed written responses received from the Ministry are enclosed in this report as **Appendix I**.

Based on the audit findings and comments received, the RAA has made series of recommendations that may be desirable for efficient and effective operations of both, the BPCL and DGCPL. We hope the findings and recommendation provided would be useful inputs in making informed decision and further improving the system wherever appropriate.

The RAA would remain grateful if Your Excellency could also kindly direct the Ministry to submit a detailed **Action Plan with clear and definite time frame** for implementing the audit recommendations and instituting appropriate controls and corrective measures **on or before 31st March 2013**. We would also like to acknowledge the cooperation and assistance extended to the team by the officials of the Ministry of Economic Affairs and the concerned agencies which facilitated timely completion of our assignments.

We remain ever grateful to Your Excellency and the Ministry for encouraging response and feedback on the draft report and for providing continuous support to the RAA in fulfilling our role on auditing and reporting on the economy, efficiency and effectiveness in the use of public resources.

Yours most respectfully,



(Ugen Chewang)
Auditor General

Copy to:

1. The Hon'ble Lyonchhen, Royal Government of Bhutan, Thimphu;
2. The Hon'ble Gyaldron, His Majesty's Secretariat, Tashichho Dzong, Thimphu;
3. The Hon'ble Speaker, National Assembly of Bhutan, Thimphu;
4. The Hon'ble Chairperson, National Council of Bhutan, Thimphu;
5. The Hon'ble Lyonpo, Ministry of Agriculture & Forests, Thimphu for necessary perusal;
6. The Hon'ble Chairperson, Public Accounts Committee, National Assembly of Bhutan, Thimphu. ***(Enclosed five copies)***
7. The Hon'ble Chairperson, Druk Holding & Investments, Thimphu as the DGPCL and BPCL covered by the system audit are subsidiary companies of the DHI;
8. The Secretary, Ministry of Economic Affairs, Thimphu for appropriate action;
9. The Secretary, Ministry of Agriculture & Forests, Thimphu for appropriate action;
10. The Secretary, Gross National Happiness Commission, Thimphu for appropriate action;
11. The Director General, Department of Hydropower & Power System, MoEA, Thimphu;
12. The Director General, Department of Agriculture, MoA&F, Thimphu;
13. The Director General, Department of Forest & Park Services, MoA&F, Thimphu;
14. The Secretary, National Environment Commission Secretariat, Thimphu;
15. The Chief Executive Officer, Druk Holding & Investments, Thimphu;

16. The Managing Director, Druk Green Power Corporation Limited, Thimphu;
17. The Managing Director, Bhutan Power Corporation Limited, Thimphu;
18. The Chief Executive Officer, Bhutan Electricity Authority, Thimphu;
19. The Managing Director, Punatsangchu Hydropower Project Authority, Thimphu;
20. The Managing Director, Tala Hydropower Project Authority, Thimphu; and
21. Office Copy.

TITLE SHEET

1.	Title of the Report	:	System Audit of Hydroelectric Energy
2.	Audit Identification No.	:	10990
3.	Executing Agency	:	BPCL, DGPCL, PHPA and BEA
4.	Period Covered by Audit	:	2005 – 2010
5.	Schedule of Audit	:	April 2011 – August 2012
6.	Name of Inspecting Team	:	i) Chhoden, Audit Officer ii) Krishna P. Adhikari, (Focal Person) iii) Roshna Pradhan, Asst. Audit Officer
7.	Name of Supervising Officer	:	i) Bhanu B. Chhetri, Sr. Dy. Auditor General, Department of Performance & Commercial Audit ii) Tashi Tobgay, Asstt. Auditor General, Performance & System Audit Division

DISCLAIMER NOTE

The audit was conducted in conformity to the RAA Auditing Standards and Performance Audit Guidelines. The review confined to assessing the activities and operations of the DGPCL, BPCL and PHPA (environmental aspects). The audit was based on audit plan prepared by the Royal Audit Authority and the findings are based on the information and documents made available and accessible to the audit team by the DGPCL, BPCL, PHPA and BEA.

This is also to certify that the auditors during the audit had neither yielded to pressure, nor dispensed any favor or resorted to any unethical means that would be considered as violation of the Royal Audit Authority's Code of Good Conduct, Ethics and Secrecy.

ACRONYMS

BEA	Bhutan Electricity Authority
BHPCL	Bhutan Hydro Power Corporation Ltd.
BPCL	Bhutan Power Corporation Limited
CAIDI	Customer Average Interruption Duration Index
CELID-8	Customers Experiencing Longest Interruption Duration (outages exceeding 8 hours)
CEMMI-4	Customers Experiencing Multiple Momentary Interruptions (4 or more interruptions in a day)
CoD	Cost of Debt
CoE	Cost of Equity
CHPCL	Chukha Hydro Power Corporation Ltd.
DHPS	Department of Hydropower and Power Systems
DGM	Department of Geology and Mines
DGPCL	Druk Power Corporation Limited
DHI	Druk Holding Investment
DoE	Department of Energy
DoT	Department of Trade
DPR	Detail Project Report
EIA	Environmental Impact Assessment
ESD	Electricity Service Division
GNHC	Gross National Happiness Commission
GoI	Government of India
GWh	Giga Watt Hour
HR	Human Resource
HV	High Voltage
IEE	Initial Environment Evaluation
IMF	International Monetary Fund
INR	Indian Rupees
KHPCL	Kurichu Hydro Power Corporation Ltd.
kW	Kilowatt
kWh	Kilowatt hour
LPG	Liquid Petroleum Gas
LV	Low Voltage
MAIFI	Momentary Average Interruption Frequency Index
MoAF	Ministry of Agriculture and Forest
MoEA	Ministry of Economic Affairs
MV	Medium Voltage
MW	Mega Watt
N/A	Not Available

NEC	**National Environment Commission**
O&M	**Operation and Maintenance**
PAT	**Profit after Tax**
PBIS	**Performance Based Incentive Scheme**
PBT	**Profit before Tax**
PCAL	**Penden Cement Authority Limited**
PHPA	**Punatsangchu Hydro Power Project Authority**
RAA	**Royal Audit Authority**
RE	**Rural Electrification**
REV	**Revenue**
RGoB	**Royal Government of Bhutan**
RoE	**Return on Equity**
RoWC	**Return on Working Capital**
RE	**Renewable Energy**
SAIDI	**System Average Interruption Duration Index**
SAIFI	**System Average Interruption Frequency Index**
THPA	**Tala Hydro Power Authority**
TDR	**Tariff Determination Regulation**
WACC	**Weighted Average Cost of Capital**

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CHAPTER 1 Executive Summary

WHY RAA DID THIS STUDY?

Hydropower sector is the largest contributor to the country's exchequer, contributing 17.6% to GDP in 2010[1]. Therefore, the Royal Government of Bhutan accords huge importance on development of hydroelectricity and rural electrification. Correspondingly, there has also been significant increase in the use of electricity in Bhutan with the progress of rural electrification and emergence of industries. The Royal Government of Bhutan also targets electricity connectivity in the whole country by the year 2013 and reduce dependence on other sources of energy. As of March 2012, 80% households in the country have received the benefits of electricity[2].

Therefore, the importance of hydroelectricity is entwined into country's economy. Recognizing such facts of Bhutan being heavily reliant on the hydroelectricity for its economy, the RAA as mandated by the Constitution of the Kingdom of Bhutan and the Audit Act 2006 conducted performance audit of Hydroelectric Energy to assess the progress made and identify constraints and problems, if any. In doing so, the RAA not only looked at *"what has been done"*, but also *"what has not been done"* to achieve the organization's ultimate objective.

The RAA conducted the audit with an overall objective to *'ascertain the economy, efficiency, and effectiveness in its activities of generating and distribution of hydroelectricity'*.

The specific objectives are to:

- ☑ Study the rationality and impact of power tariff revision;
- ☑ Ascertain the efficiency and effectiveness of operations in the power utility companies on the quantity of domestic consumption and the dependence on alternative energy supply mix; and
- ☑ Study the environmental aspects of hydropower development.

Emphasis was also placed on the consumption of fossil fuel and fuel wood in comparison to the increase in electricity connectivity/consumption. Tariff revision of the BPCL and DGPCL made during 2010 was assessed and verified.

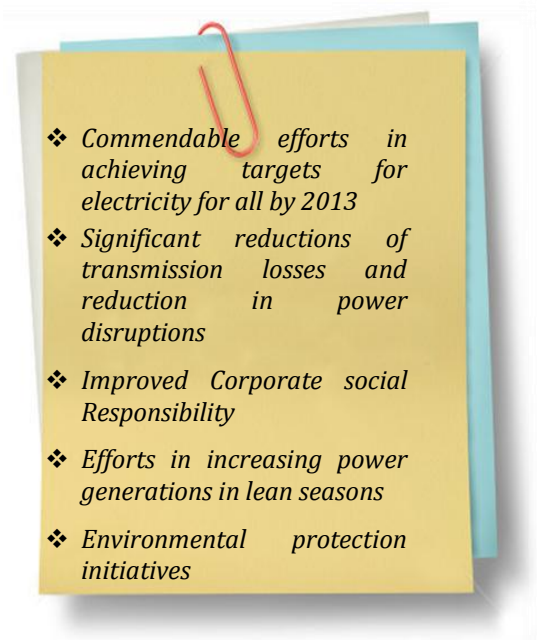
[1] Statistical Year Book of Bhutan 2011 (including both Electricity and Water)
[2] Fourth Annual Report to the Ninth Session of the First Parliament on the State of the Nation (July 2012)

The RAA also looked into significant achievements made by power utility companies towards supporting the socio-economic developments of the country. Comparisons with international best practices were also made wherever possible to encourage development of Bhutan's standards.

The results of the study were used to identify and recommend measures to address the constraints and challenges faced by the agencies involved.

WHAT RAA FOUND?

Several accomplishments were noted during the course of audit. The BPCL made commendable efforts towards achieving the Royal Government's targets of electricity for all by 2013. The audit also observed significant reductions in transmission losses and incidences of power disruptions by BPCL.



Likewise, the DGPCL had made various efforts towards increasing the power generations during the lean seasons by diverting two streams to Chukha dam, thereby increasing the power generation by 67 million units, representing 18.61% increase from its existing generating capacity. They also projected an investment of Nu. 510 million to divert two streams to THPA dam for increasing generation by 10MW (approx). The DGPCL also participated in corporate social responsibilities like electrification of 41 households at Bongo gewogs in Chukha. The DGPCL as a part of their contribution towards environmental protection, granted Nu. 22.75 million to GNHC through THPA for rehabilitation of degraded areas along Wangchu-Pachu valley. The THPA also initiated weekly mass cleaning, disposal of waste and also plantation works around its site.

However, some deficiencies were also observed during the audit. The following are the significant findings of the study:

- Several inadequacies were noted in the Tariff Determination Rules & Regulations (TDR 2007) which could lead to inappropriateness in the computation of power tariff of the Hydropower Utility Companies;

- DGPCL has to bear the costs of importing the extra electricity resulting in decrease in their returns on imports of more power than the forcasted imports during the lean seasons for meeting domestic HV demands;
- The power reliability determination of BPCL was inadequate as compared to other countries where it is determined based on CAIDI, CEMMI-4, CELID-8 and MAIFI, including all interruptions, besides SAIFI and SAIDI;
- Some of the ESDs like in Bumthang, Dagana, Lhuntse, Mongar, Pemagatshel, Thimphu, Trongsa, Trashigang and Trashiyangtse have higher distribution losses as compared to the BPCL's annual average losses, requiring further measures to curtail such losses;

> - *Inadequacies in the Tariff Determination Regulation 2007:*
> - *Higher auxiliary power consumption rate for DGPCL plants at 1.2%*
> - *Unrealistic return allowance*

- There was a significant variation in unit cost per km/substation in creating distribution assets through the Rural Electrification Projects across the country;
- The increasing connectivity of hydro power has not resulted in reduction on the dependence in other sources of energy. Instead there is an increasing use of other forms of energy such as firewood, kerosene, LPG, etc. Such consumption pattern of energy may have possible negative impact on the economy (i.e., adverse balance of payments, INR problems etc.) and on the environment;
- Profit of BPCL is significantly driven by annual increase in tariff besides other operational factors. The impact of power tariff revisions on its operational efficiency and volume variences etc needs to be ascertained for better decision-making and appropriate policy interventions;
- Existing Guidelines on compensatory reforestation are not adequate requiring appropriate review and improvements;
- Despite requirement under Bhutan Sustainable Hydropower Development Policy 2008, existing legislations and strategies on the sustainable use of water were found to be inadequate; and
- Environmental unit was not found establishment at the THPA. Besides, there were cases of non-compliance of some of the environmental rules and regulations at PHPA.

WHAT RAA RECOMMENDS?

The deficiencies and lapses could impede development of the energy sector towards providing reliable, affordable, and quality energy services to the nation and export service to earn increased revenue. The lapses, therefore, may require proper attention and remedial measures. The RAA recommends the following measures to address the deficiencies and lapses observed in the operations of the BPCL, DGPCL, PHPA and the BEA.

- The TDR 2007 should be reviewed and all necessary changes incorporated;
- Applicable International standards and practices should be benchmarked for power reliability determination, and generation/transformation loss trends in Bhutan to enhance the efficiency of BPCL and DGPCL;
- Use of electricity should be encouraged to initiate gradual reduction in use of other forms of fuel and prevent environmental hazards;
- DGPCL should work towards further reducing the transformation and generation loss, and BPCL towards reducing its distribution loss;
- The BPCL should study the impact of various factors such as tariff revision, volume and efficiency variances etc in the increased profitability for improved decisions and better controls in pricing, formulating objective reward and incentive systems, initiating cost reduction and controls measures etc;
- Electricity affordability or energy poverty study may be conducted to rationalize tariff determination;
- Household income and affordability constraints may be included in the tariff determination process in view of decreasing trend in the low voltage consumption and likely impact in other forms of energy ;
- There should be adequate guidelines, legislation and strategies for environmental protection and utilization of water resources to encourage sustainable use of water resources for hydropower generation; and
- All power plants should establish environmental units and initiate environment protection measures.

CONCLUSION

The BPCL has made commendable efforts towards achieving the Royal Government's targets of electricity for all by 2013. It has also successfully controlled the transmission losses and incidences of power disruptions, exhibiting enhanced service delivery. However, the BPCL has been constantly increasing the electricity tariff over the years, thereby increasing its profit significantly through higher tariff charged to its

domestic consumers. Such objectives of increased revenue and tariff charged to encourage energy efficiency may need to balance affordability and discouraging use of alternate forms of energy which are more detrimental to the environment and economy of the country.

Likewise, the DGPCL has also made commendable efforts towards optimizing the investment made on power plants through such efforts of augmenting power generations during the lean seasons. However, it has yet to control the transformation and generation losses of power plants.

The RAA also noted some inadequacies in the provision of TDR 2007 which may have potential in undermining the objectivity in tariff determination by the BPCL and DGPCL. Some of the cost elements considered in the TDR 2007 may lead to inappropriate determinations of tariff.

Further, inadequacies in the determination of power reliability, non-compliance to the environmental protection regulations, and lack of adequate rules and strategies for sustainable use of water for hydropower may also contravene with the energy policy of providing reliable, affordable, and quality energy services to the nation and export service to earn increased revenue.

CHAPTER 2

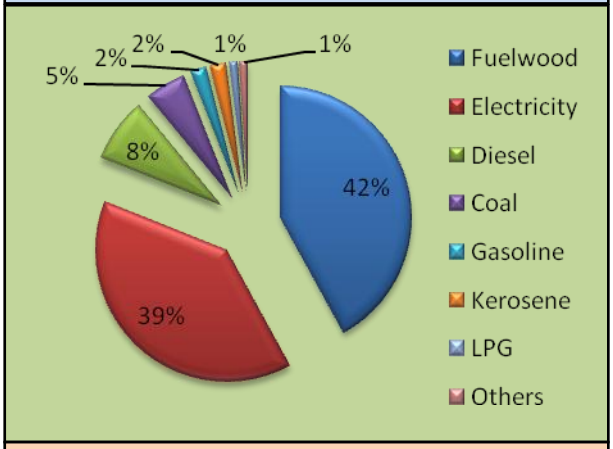
Introduction

2.1 BACKGROUND

Energy is one of the main pillars of the modern developing society, and the availability and cost of energy resources are the determining factor in a country's economic growth. Energy is also recognized to be a means to achieve the goals of a healthy economy and a healthy environment.

Energy resources in Bhutan presently comprises of hydropower, fuel wood, fossil fuel, bio mass, biogas and solar. The main source of energy in Bhutan was fuel wood and electricity as of 2005. The fast ongoing economic development in the country has initialized the economy to be more dependent towards hydroelectricity and fossil fuels like oil. The energy supply mix for the year 2005 has been shown in the Figure 2.1.

Fig. 2.1: Energy Supply Mix 2005

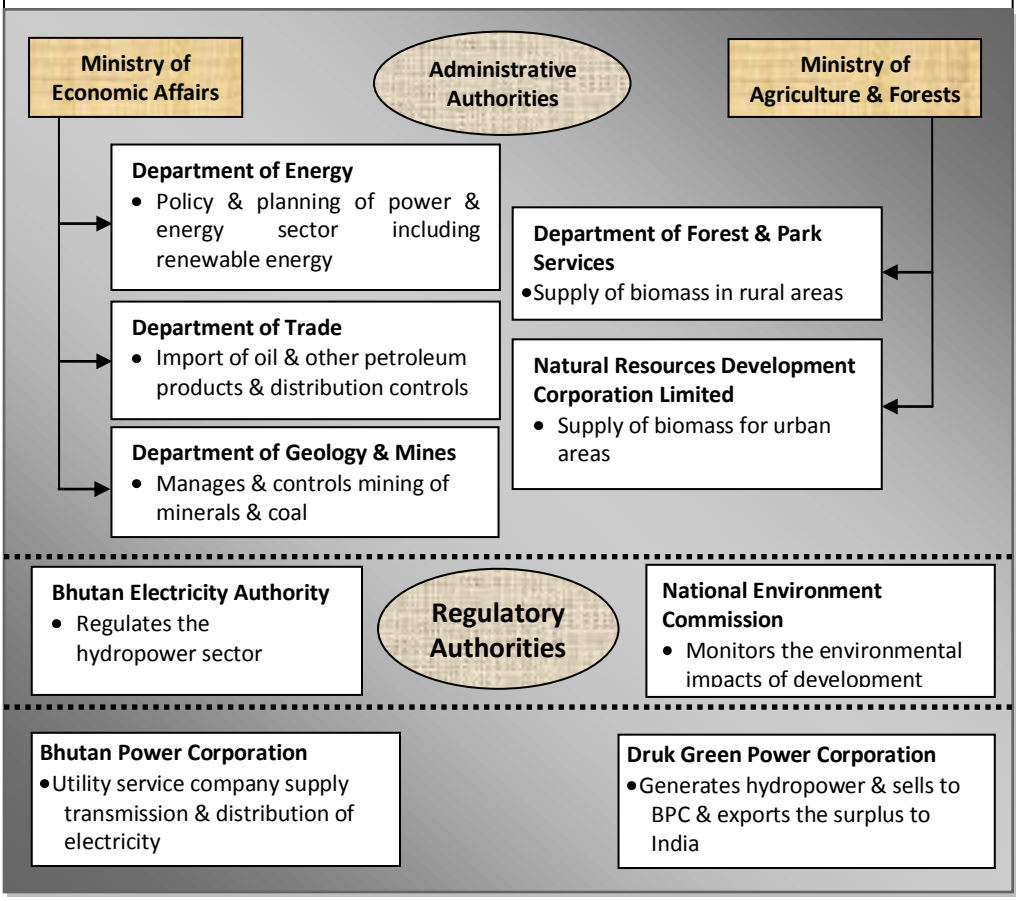


Source: *Overview of Energy Policies of Bhutan, MoEA*

Hydropower, fuel wood and oil consumption dominates Bhutan's energy mix among other widely used fossil fuels like coal and gasoline. However, the use of diesel and gasoline is limited for transportation and coal is used for industrial purposes.

2.2 OVERVIEW OF ENERGY SECTOR OF BHUTAN

Fig. 2.2: Overview of Energy Policies of Bhutan



The energy sector of Bhutan is administered by two ministries, viz., MoAF and MoEA. The former is mainly associated with the administration of biomass while the latter is responsible for policy formulation, planning, coordination and implementation of conventional energy generation, consumption, exports and imports of fossil fuels.

BEA is an autonomous body that regulates the electricity sector, whereas the NEC is responsible for environmental regulation and compliance checks. DGPCL and BPCL are the two utility companies. While the BPCL looks into transmission, distribution and generation of few mini hydropower plants, the DGPCL looks after the generation of power from the major plants viz., KHPCL, CHPCL, THPA and BHPCL. The BPCL also procures power from the DGPCL for distribution and transmission within domestic and export markets.

Hydro Electricity in Bhutan

Electricity plays a major role in the Bhutanese economy and it is one of the highest contributors to the national exchequer. The Overview of Energy Policies of Bhutan 2009 states that Bhutan has enough generation to meet the internal

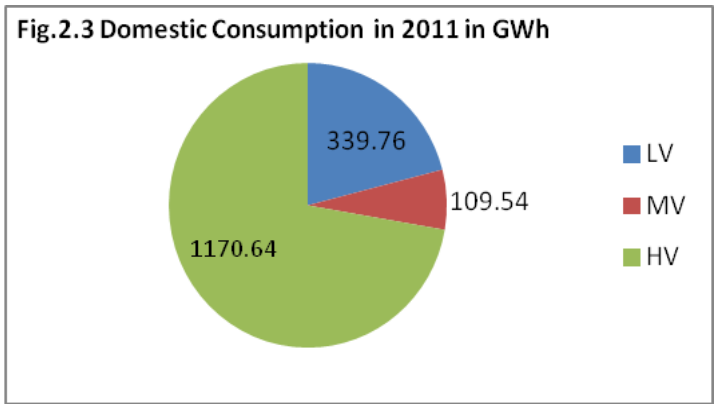
demands of the country even if the entire country is electrified and all people are given access to electricity. It also states that there will never be shortage of power generation to fulfill the power requirements of the country in the foreseeable future other than challenges in transmitting power to the scattered consumer centres. However, due to low river flow volume during the winter months, the generation and supply of power had been limited and Bhutan has to import power from India. A brief summary of the Hydro-electricity statistics is presented in the Table 2.1.

Table 2.1: Brief summary of Hydro-electricity statistics

Sl. No.	Particulars		Units
1	Total hydro-power potential		30,000 (MW)
2	Techno-Economically feasible		24,000 (MW)
3	Tapped Hydro-power till date		1,488 (MW)
4	Targeted electricity tapping in 2020		10,000 (MW)
5	Generation for 2011:	CHP	1,774.13(GWh)
		KHP	361.80(GWh)
		THP	4,588.07(GWh)
		BHP	332.27(GWh)
		Mini Hydro & Diesel generation of BPCL	21.3(GWh)
		Total	**7,077.57(GWh)**
5	Annual Export (2011)		5,273.10(GWh)
6	Annual Imports (DGPCL & BPCL) 2011:		40.32 (GWh)
7	Customers as of 2011:		116,354 (nos)
	a) LV+LV Bulk		116,293 (nos)
	b) MV customers		46 (nos)
	c) HV customers		15 (nos)

Source: 1.BPCL(2011)Power Data Book
2.DGPCL

The domestic consumption of the hydroelectricity consumptions for the year 2011 is as depicted in Figure 2.3.



2.3 POWER TARIFF

The BPCL's tariff schedule from 2006 till 2012 is presented in Table 2.2.

Table 2.2: Approved tariff rates of BPCL

Domestic Customer		2006	2007	2008	2009	2010	2011	2012
Block I (0-100 kWh)		0.70	0.75	0.75	0.75	0.85	0.85	0.85
Block II (101-300 kWh)		1.20	1.25	1.35	1.4	1.47	1.54	1.62
Block III (301^{+}kWh)		1.45	1.55	1.7	1.85	1.94	2.04	2.14
LV Bulk		1.35	1.55	1.70	1.85	1.94	2.04	2.14
MV	EC	1.25	1.30	1.43	1.55	1.63	1.71	1.79
	DC	54	65	75	85	95	105	115
HV	EC	1.20	1.29	1.4	1.51	1.51	1.54	1.54
	DC	54	65	75	85	85	105	105

Source: BPCL

Power tariff in Bhutan is proposed by the licensees (DGPCL and BPCL) to the BEA which approves power tariff in accordance to the TDR 2007. The TDR provides the basis for determination of electricity prices in accordance with the Electricity Act of Bhutan 2001. The BPCL and DGPCL made proposals for tariff revision (2010-2013) and were approved by the BEA.

The RAA in pursuance of its objective of ascertaining economy, efficiency and effectiveness in its operations carried out an audit of hydroelectric energy to also ascertain the impact of power tariff revision towards the consumers, utility companies and country's economy as a whole.

The RAA also studied on areas covering tariff determination, use of other forms of energy in comparison to hydro electricity, environmental mitigation and management activities at THPA and PHPA and also aspects of efficiency and effectiveness of operations of BPCL and DGPCL. The RAA noted commendable achievements made by the utility companies in providing their services to the nation and its citizens.

CHAPTER 3

Findings

The audit findings and opinions were primarily inferred from the documents and information made available to the audit team. The findings are as detailed below:

TARIFF DETERMINATION REGULATION 2007

3.1 Inadequacies in the Tariff Determination Regulation 2007

A guideline was issued for determining power tariff of Bhutan in 2007. It provided systematic procedure for power utility companies to determine electricity tariff. However, the audit team observed few inadequacies in the TDR 2007 which may lead to incorrect determination of power tariff.

3.1.1 Higher auxiliary power consumption rates of the generation plants

The auxiliary power consumption limit was kept at 1.2% for all DGPCL plants. As such, the DGPCL in its tariff revision proposal has also applied for an auxiliary power consumption level of 1.2% of the annual generation for all plants under its management.

However, the practices in other countries indicated that the standard auxiliary power consumptions of the power plants in Bhutan are very high. The auxiliary consumption standard applicable in India is 0.5% and in Zimbabwe is 0.3%. Such high auxiliary power consumption will result in forecast of lower sales and decrease in the revenue of the generation plants. This will have an effect on the power tariff determination with lower volumes projected for sales.

In response, the Department of Hydropower and Power Systems indicated that the auxiliary consumption of the DGPCL power plants were inclusive of the generation/transformation losses and the auxiliary consumption. Therefore, the limitation prescribed by the TDR of 1.2% is deemed reasonable.

The RAA, however, maintains that without separate allowances for losses and auxiliary consumption, it would be difficult for assessing the performance of the companies and their efforts in curbing and reducing such losses.

3.1.2 Non-bifurcation of assets acquired through grants and others at DGPCL for determination of RoA

On the review and verification of the tariff proposal and tariff review report of the DGPCL, it was noted that the assets were not classified into those acquired through grants and others for the determination of Return on Assets, thus inflating the total cost of supply. It has ultimately led to determination of higher tariff charged to the BPCL. The assets acquired through the grants of Government of India which constitutes 60% of the DGPCL's assets should not be earning any return as was the case in the BPCL where it was not allowed to earn return on the assets related to Rural Electrification Projects financed through the grants from donors.

3.1.3 Inadequate criteria to determine efficiency gain

The TDR states that the determination of the operating and maintenance allowance shall take into consideration:

- Historical costs incurred by the licensee (adjusted for inflation);
- Industry benchmarks applicable to the licensee as set out in Schedule A;
- Opportunities for efficiency improvements; and
- May include comparison with benchmarks from comparable utilities in the region.

However, on review of the TDR and related documents, it was noted that the TDR does not specify how the efficiency gain should be determined and what parameters should be used for determining the efficiency gain to be used for adjustment in the Operation & Maintenance Allowances.

The Department of Hydropower and Power Systems accepted that the BEA could review and look into the inclusion of additional criteria for the determination of efficiency gain targets to make the assessment more exhaustive.

INADEQUACIES IN TARIFF DETERMINATION OF BPCL AND DGPCL

3.2.1 Tariff structure for HV industrial consumers not encouraging efficiency of consumption

The Tariff Determination Regulation (TDR) 2007 does not specify how to transform average tariff per customer group into detailed tariff schedule but it sets out principles for tariff schedule. One of the significant principles to be followed is that the tariff structures should provide signals to consumers to improve efficiency of consumption energy. However, the current tariff

schedule for HV consumers as shown in Table 3.1 does not encourage efficiency of consumption.

Table: 3.1 Approved Tariff Rates and Structure for HV consumers of BPCL for the period from 1st August 2010 to 30th June 2013

Customer Category		1st Aug 2010 to 30th June, 2011	1st July 2011 to 30th June 2012	1st July 2012 to 30th June 2013
HV	Energy charge(Nu./KWh)	1.51	1.54	1.54
	Demand charge (Nu./kW/month)	85	105	105

Source: BPCL Power Data Book, 2011

The BEA in their BPCL's tariff review report stated that "A generally accepted method for determining the maximum demand charges to large customers is so that this charge recovers asset-related costs (RoA and DEP) allocated to these customers (since these are largely driven by growth in maximum demand). It further states that it would provide an average demand charge of around Nu.260 /kW for MV customers and around Nu. 185/kW for HV customers (BPC applied for 135-250 Nu/kW for MV and 198-421 Nu/kW for HV)". Thus the RAA is of the opinion that the demand charge levied to the HV consumers is comparatively low which would encourage the consumers to make high or unrealistic contract demands than what is actually required. The consumption of HV industries for 2011 is exhibited in **Annexure-I**. Of 1,661,158,800 KWh energy demanded by HV industries, only 983,025,140 KWh was withdrawn by HV industries. Therefore only 59.18% of the contracted amount was withdrawn by HV industries. The practice has allowed capacity hoarding thereby preventing the allocation of the hoarded energy to meet the increased demand of other group of consumers and also inefficient use of BPCL's infrastructures.

Thus, the RAA is of the opinion that a constant energy charge and an increasing trend of demand charges and a cost reflective tariff would encourage the HV industries who are also the maximum domestic consumers for an energy efficient consumption pattern. The RAA felt the need for a detailed study and revisit of the tariff structure.

The DHPS accepted the observations made by the RAA and the tariff structure will be reviewed during the next tariff review period of 2013.

3.2.2 Inappropriate billing limitation on imports made during lean seasons

As per the tariff review report of DGPCL, the actual import costs should be billed to the BPCL by the DGPCL. It also states "Import of power from India is necessary for the BPCL to meet the domestic HV demand during the lean seasons and should be included in the BPCL HV tariff. The BEA recognizes

that the DGPCL import may be a practical way of arranging some of the import requirements. However, forecasted import cost should be deducted from the DGPCL allowances for the additional price. It should instead be billed separately to the BPCL based on the actual import cost, and the forecasted import costs will be included in the BPCL allowances".

On review of the Tariff Determination Regulation 2007, Tariff Review Report, BPCL and DGPCL and related documents, the audit team is of the opinion that the import forecast by the DGPCL and limitation fixed by the BEA were inappropriate. The BEA viewed the use of forecasted import figures as inappropriate and decided that the tariff calculations should be based on a historical average of the DGPCL's power imports. The historical average of the last four years is 49.5 GWh per year. The average annual import cost is estimated to Nu. 92.07 million. The DGPCL over the next three years can bill the BPCL at the maximum sum of 3 x 92.07 Nu. million = 276.210 Nu. million for the recovery of import costs.

The import figures in the table 3.2 for the past seven years shows huge fluctuation with the lowest import during 2008 at 6.82 GWh and the highest import made in the year 2010 at 128.31 GWh. Although DGPCL's import forecast of 850.24 units from 2010-2014 could be gravely inaccurate, the BEA has not provided any option to the DGPCL if it has to import more than 49.5GWh per year. The year 2010 showed an import of 128.31 GWN which is more than double the yearly forecast made for the next three years. With the government focusing on rural electrification and electrification for all by the year 2013, it is evident that the domestic demands will increase therefore increasing the need for import during the lean seasons. Thus, under such circumstances, in situations when the DGPCL has to import more power than the allowed quantity, the DGPCL will have to bear the cost of importing the extra electricity resulting in decrease in their returns.

Table 3.2: Electricity Imports made by DGPCL

Year	Import (GWh)	Import (Mil.Nu)
2004	20.42	30.73
2005	16.41	32.77
2006	31.59	63.13
2007	19.67	37.73
2008	6.82	14.26
2009	61.6	111.02
2010	128.31	233.87

source: DGPCL

The Department of Hydropower & Power System (DHPS) responded that a more appropriate solution of establishing the risk sharing module between the DGPCL and BPCL should be considered as the demand for import of power shows huge fluctuations.

3.3.1 BPCL's profitability significantly driven by annually increasing tariff

The audit reviewed the trend of electricity tariff of BPCL as shown in Table 3.3 and noted that the tariff has been increased annually over the years. On the backdrop of increasing annual tariff, the audit analyzed the financial performance of the Corporation for the period 2007 to 2011, assuming constant tariff of 2006 applied over the period.

Table 3.3: Approved tariff rates of BPCL from Aug. 2005 to July 2011

Particulars	Aug 2005	July 2006	July 2007	July 2008	July 2009	Aug 2010	July 2011
Block I (0-100kWh)	0.6	0.7	0.75	0.75	0.75	0.85	0.85
Block II (101-300 kWh)	1.1	1.2	1.25	1.35	1.4	1.47	1.54
Block III (301^{+}kWh)	1.30	1.45	1.55	1.70	1.85	1.94	2.04
Low Voltage - Bulk	1.25	1.35	1.55	1.7	1.85	1.94	2.04
Medium Voltage	1.1	1.25	1.3	1.43	1.55	1.63	1.71
Demand charges	54	54	65	75	85	95	105
High Voltage	1.05	1.2	1.29	1.4	1.51	1.51	1.54
Demand Charges	54	54	65	75	85	85	105

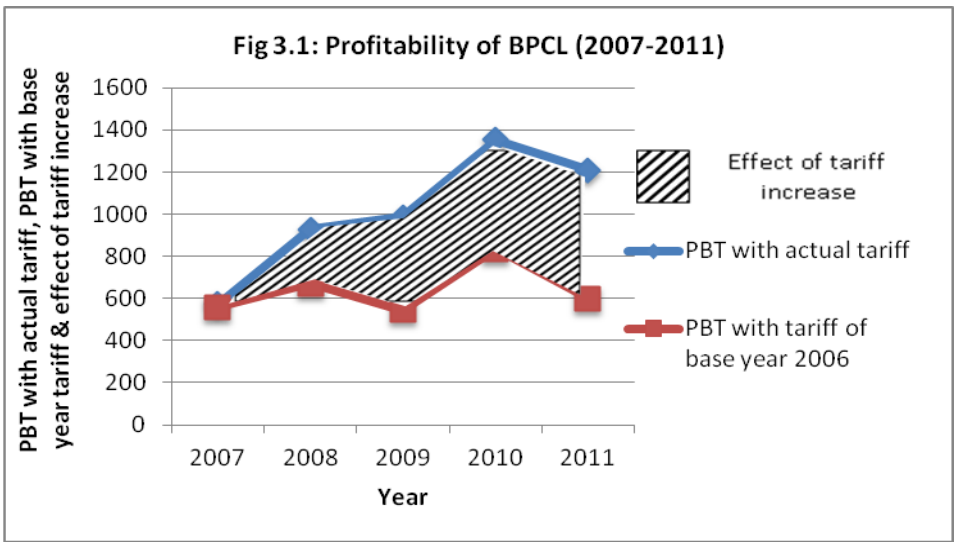
The analysis indicated that the profit of BPCL has resulted significantly from the annual increase in tariff, representing as high as 50.45% of PBT in 2011 as exhibited in the Table 3.4 and Figure 3.1. The detailed analysis is shown in **Annexure II**.

Table 3.4: Profitability trend of BPCL

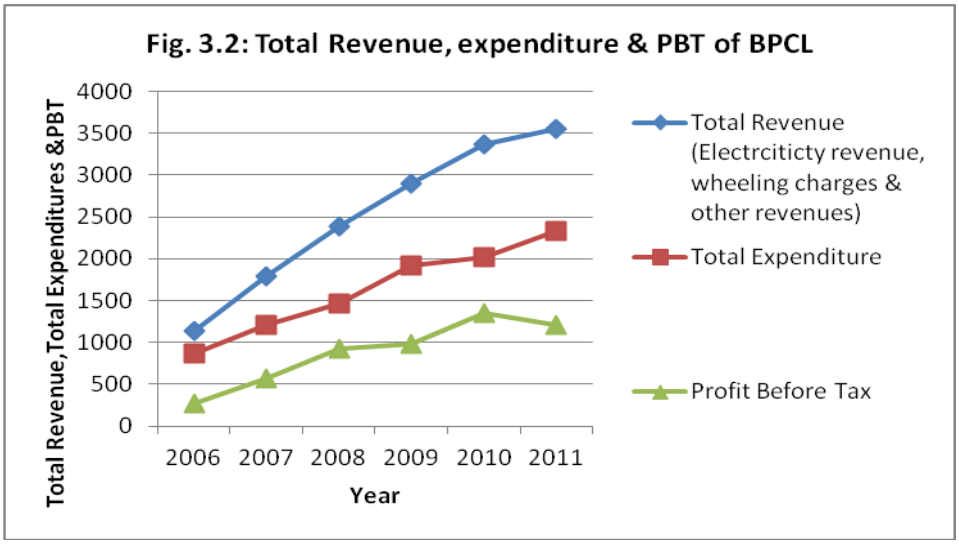
Particulars	2007	2008	2009	2010	2011
(A) PBT with actual tariff	573.15	927.13	986.45	1353.20	1209.01
(B) *PBT with tariff of base year 2006	557.53	670.92	545.25	833.90	599.04
Effect of increase in tariff (A-B)	**15.63**	**256.21**	**441.20**	**519.30**	**609.97**
% of profit driven by tariff	**2.73**	**27.63**	**44.73**	**38.38**	**50.45**

Assumptions: ***1. Demand charges are same as that of actual tariff.***
2. Tariff was taken as that of the tariff of base year 2006, since the Corporation has the turnaround for the first time in 2006.

For comparison of actual PBT earned with the profit computed keeping the tariff of 2006 constant, the audit applied the constant tariff on the actual units of energy billed.



Correspondingly, the audit also observed that the profit and total revenue of the Corporation had been increasing steadily over the years despite minimal increase in number of units sold, and the constant revenue from wheeling charges and other sources as exhibited in the Figure 3.2, corroborating that the increased revenue had been earned primarily from annual increase in tariff.



On the other hand, the Corporation had paid its employee huge incentives over the years as shown in Table 3.5, attributing to their enhanced performance. The RAA is of the opinion that the performance indicator such as the increased profit achieved had been significantly driven by annual increase in tariff. Therefore, distribution of Performance Based Incentive Schemes (PBIS) by Corporation to its employees as shown in the Table 3.5 may not commensurate with their performance. For a utility Corporation like BPCL providing services to citizens at large, increasing its profitability mainly through annual tariff revision may be seen as unnecessarily

burdensome to the public at large. Further, the existing system of performance evaluation does not adequately analyze and recognize the effect of price revision, increased volume and other factors on the profitability of the Corporation. For better decisions, it is imperative that the impact of tariff increase, efficiency and other factors on the profitability are appropriately analyzed and recognized.

In response, the DHPS indicated that the annual increasing tariff was allowed to avoid steep increase in tariff and that the financial performance target consists only of 30% of the overall achievement and balance 70% includes quantifiable non-financial and operational targets. However, the annual increasing tariff could also be the main factor in increasing the profitability rather than the improved performance of the company. A detailed analysis of impact of tariff increase, volume variances and other factors on the profitability of the Corporation may, therefore, be necessary for informed decision making.

Table 3.5: Performance Based Incentive Scheme (PBIS) of BPCL

Particulars	2007	2008	2009	2010	2011
PBIS	27.64	33.26	33.43	41.86	41.91

3.3.2 Inadequacies in Power reliability determination of the BPCL

On review of the power reliability determination of the BPCL and upon comparison with international practices, the audit observed that there were no appropriate standards and practices for determination of power reliability.

Internationally, reliability metrics should include at a minimum SAIFI, SAIDI, CAIDI, CEMMI-4, CELID-8, and MAIFI for the entire system and include all interruptions (e.g., major storms). These metrics should be reported by voltage level (e.g., below 34kV, 34kV to 138kV, and above 138kV) and by substation for each local government, for large developments and for customers served by a single meter or substation. Each category reflects fundamentally different design and cost structures (GEI, 2011). However, in BPCL, the reliability indices depends only on two indices namely SAIFI & SAIDI. These two indices only record the power disruption and the duration. The BPCL lacks information on the voltage level and other relevant indices which could be beneficial in ascertaining the reliability of electricity in Bhutan. Lack of information on other indices like the MAIFI, CAIDI, etc. could hamper the performance of the company and such problems may be overlooked resulting in unreliable supply of electricity to the consumers.

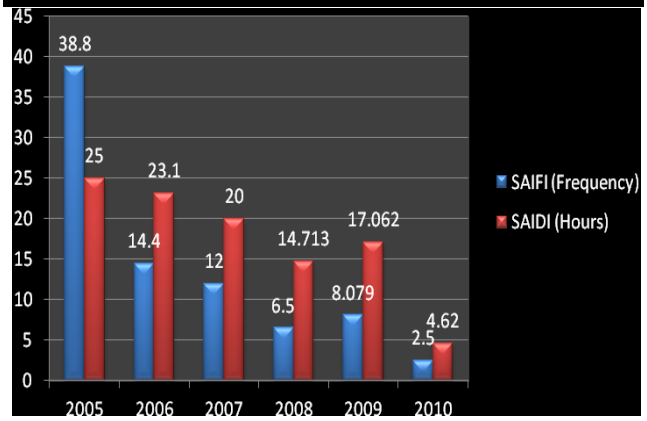
Although the DHPS states that the BPCL's adoption of the SAIFI and SAIDI as adequate measures for power reliability in Bhutan, the RAA is of the opinion

that indices to measure the voltage level in highly important. Many far flung houses are connected with long LV wires which could result in "electricity without functionality" for the users. Internationally adopted practices would also enable the BPCL in providing better services to the customers.

3.3.3 Power reliability indices below the international levels

SAIFI & SAIDI indices for BPCL should be in line with the compact agreements signed with the DHI. The BPCL has made significant achievement in power reliability in both transmission and distribution. The reduction in SAIFI (interruptions/ customer/ year) has been about 93.63% since 2005. There has also been huge reduction in the SAIDI (hours/ customer/year) of the BPCL of about 81.52%. Although there were some fluctuations in the BPCL power reliability indices from 2005 to 2010, an overall status shows improvement to a great extent. The SAIFI and SAIDI of BPCL for the past five years have been as shown in Fig 3.3.

Fig 3.3: Power Reliability of the BPCL



However, on review of the SAIFI and SAIDI performance of the BPCL and on comparison with few European and Asian

Table 3.6: Power reliability Indices of Bhutan and some other countries

Country(2010)	SAIDI (Minutes)	SAIFI(Interruptions per year)
Austria	72	0.9
Denmark	24	0.5
France	62	1.0
Germany	23	0.5
Italy	58	2.2
Netherlands	33	0.3
Spain	104	2.2
UK	90	0.8
Bhutan	277	2.5
Region(2008)	**SAIDI (Hours)**	**SAIFI(Interruptions per year)**
Thailand	0.26	6.62
Indonesia	6.8	332
Malaysia	0.287	68.6
Philippines	0.8-1.3	70-90
India	1.62	80
Bhutan	14.713	6.5

Source: 1. BPCL Power Data Book, 2011

2. Sustainability challenges for electricity industries in ASEAN newly industrializing countries

countries, it was observed that the target set by the DHI for the SAIDI and SAIFI indices are far behind those countries as shown in the table 3.6. Bhutan remains way behind in comparison with the developed countries of Europe. The SAIDI of Bhutan for the year 2010(4.62 hours) is also much higher than that of the developing countries during 2008 except Indonesia.

While the reliability indices of BPCL show progression of the corporation, it will still be unreliable if it does not attain the international levels of reliability in the future. The RAA felt the need by BPCL to adopt practices which will enhance its reliability and thus, strive towards achieving the international levels in SAIFI and SAIDI. These countries also study the reliability of the SAIFI and SAIDI data provided by the power companies which could also be necessitated in Bhutan. The reliability of data provided by the power companies also indicates the efficiency of operations and information sources.

The comparison of Bhutan's electric utility performance indicators has been made both with developed countries as well as developing countries to assess the power reliability more objectively. The regional and developing countries performances provide actual indication of where Bhutan stands in terms of power reliability.

3.3.4 Variances in expenses made on distribution assets of Rural Electrification Projects

The government has a target to provide electricity for all by 2013. The BPCL has been entrusted with the responsibility of providing electricity connection to over 40,000 rural households during the 10 FYP. JICA and ADB have been funding these activities. The audit reviewed 25 completion reports of the Rural Electrification projects under JICA and ADB funding for the period 2009-2011 and found significant variations in the expenses incurred on the following distribution assets, summarized in Table 3.7. The analysis is detailed in **Annexure III**.

Table 3.7: Variation in the expenses made on distribution assets of Rural Electrification Projects					
Sl. No	**Distribution assets & Specification**	**No of Packages**	**Maximum cost per Km/ transformer/ household**	**Minimum cost per Km/ Transformer/ household**	**Variation in %**
MV Lines :variation in cost per KM					
1	11 KV (3P)(Dog)	3	1,227,092.24	467,727.99	61.88
2	11 KV (3P) (Rabbit)	9	596,187.91	439,865.28	26.66
3	33 KV (1P)(Rabbit)	7	514,719.95	384,219.87	25.35
4	33 KV (3P)(Dog)	7	729,209.76	482046.46	33.89
5	33 KV (3P)(Rabbit)	9	697,351.25	510,597.70	26.78
LV Lines: variation in cost per KM					
1	ABC Conductor 0.415	18	447,710.76	270,515.71	39.58
Distribution Substations: variation in cost per transformer					
1	11/0.240kV, 10 Kva	3	339131.66	203454.75	40.01
2	11/0.240kv, 16kva	2	293,726.72	212418.86	27.68
3	11/0.240kv, 25kva	3	302344.005	225978.62	25.26
4	11/0.415kv, 16kva	5	438,469.04	227,367.05	48.15
5	11/0.415kV, 25Kva	9	468,475.67	223,369.72	52.32
6	33/0.240KV,10kVA	7	342753.32	178,270.29	47.99
7	33/0.240KV,16kVA	9	345941.71	178,270.29	48.47
8	33/0.240kv, 25kva	9	429,044.18	203,737.48	52.51
9	33/0.415kv, 25kva	6	398,534.38	286840.2	28.03
10	33/0.415kv, 63kva	8	530,618.46	333,615.66	37.13
11	33/0.415kv, 125kva	5	803,299.94	445,145.64	44.59
Service Connection: variation in cost per household					
1	Service Connection	25	6680.10	4084.80	38.85

Thus, the audit is of the opinion that the wide variation in the cost per km/substation and households needs to be studied and rationalized by BPCL to initiate cost control measures by studying the cost effective methods of construction of distribution lines. While the response of DHPS attributed the variations to open competitive bidding, remoteness, scale of works etc., there is considerable scope for reviewing the reasons for wide variances and initiating appropriate measures.

3.3.5 Distribution losses increasing over the years and the loss being consistently high in some ESDs

The BPCL has made an effort to reduce distribution losses to meet the target set in its compact signed with DHI. It has also made efforts in reducing the distribution losses in various ESDs by tying up the energy loss reduction with the incentive (PBIS). The review of the distribution loss % of the corporation from 2008-2011 indicated loss % of between 2.21% to 3.34 as depicted in table 3.8.

However, the loss % has been notably high in ESDs like Bumthang, Dagana, Lhuntse, Mongar, Pemagatshel, Thimphu, Trongsa, Trashigang and Trashiyangtse where the losses ranges from 7.95% to 14.10% which were significantly higher than the BPCL's annual average loss. The details have been shown in **Annexure IV**. Thus, there is still considerable scope for further reduction of distributions losses in various ESDs.

Table 3.8: Distribution loss% of BPCL

2008	2009	2010	2011
2.21	2.80	3.34	2.50

ELECTRICITY AFFORDABILITY & USE OF OTHER SOURCES OF ENERGY

3.4.1 High Tariff charged for low voltage domestic consumers as compared to the industrial users

On review of domestic tariff structure of BPCL effective from July 2012 as shown in the Table 3.9, it appeared that the low voltage domestic consumers are charged higher electricity tariff as compared to the industrial users and the export tariff of Nu.2/kWh. The individual consumers are charged as high as Nu.2.14/KWh (Block III) as compared to the Medium Voltage and High Voltage users with Nu.1.79/KWh and Nu.1.54/KWh respectively, without taking into account the demand charges.

Table 3.9: Domestic Energy Tariff of 2012

Consumers	Low Voltage				Medium Voltage		High Voltage	
	Block I	Block II	Block III	LV (Bulk)	Energy	DC	Energy	DC
Tariff (Nu./kWh)	0.85	1.62	2.14	2.14	1.79	115	1.54	105

Such a tariff structure may not be consistent with the government policy of providing affordable and quality energy services to the nation. Moreover, such tariff regime does not encourage individuals in using environmental friendly energy as substitutes to other forms of alternate energy that are more detrimental to the environment as discussed in para 3.4.2 (below). The existing tariff proves to be more expensive for individual domestic consumers as observed from the consumption trend over the years as discussed in para 3.4.3.

The RAA accepts that due to geographical terrain and location, the cost of supply to LV users is generally high in comparison to the MV and HV users. However, considering the increasing profitability of BPCL and decreasing trend of per household LV consumption of energy vis-à-vis likely adverse environmental impact due to possible increase in use of other forms of energy, there is a need to review the existing tariff structure of LV users.

3.4.2 Increase in the use of other forms of energy

One of the main objectives of the BPCL keeping in line with the government policy of electricity for all by 2013 has been intensified rural electrification. With almost all urban houses connected by electricity, the focus has shifted towards the electrification of rural and far flung villages and households. However, with the increase in the number of houses being electrified every year, the dependence on fuel wood, coal and LPG has also increased simultaneously, indicating increasing dependence on other alternate source of energy. The table 3.10 shows that from the use of 896 m^3 of firewood and 57,251 KGs of briquette in 2005, urban households presently consume 541,190 KGs of briquette and 45,580.76 m^3 of firewood (including wood chips and bamboo chips, representing 4,987.14% of increase in fuel wood and 845.29 % increase in the use of Briquette in the urban households with adequate access to electricity and electrical appliances.

Fuel wood is largely used in our Bhutanese households but it is difficult to obtain the data due to unaccounted use of firewood collected from forest. Thus, information obtained from the Department of Forest and Park Services, MoAF could be negligible as the data contains only those fuel wood harvested through issue of permits and where the volume harvested were recorded by forestry offices. Even with limited data, certain increase in the use of firewood in the rural areas can also be noted in table 3.10.

Table 3.10: Use of Other forms of energy

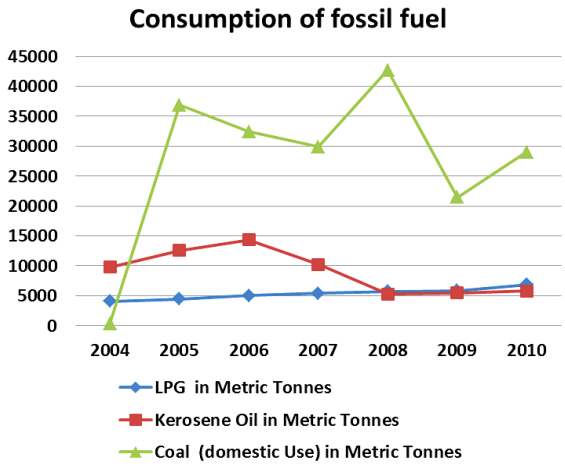
Year	Urban fuel wood consumption		Rural Fuel wood consumption (M^3)	Consumption of fossil fuel		
	Fuel wood, woodchips & Bamboo (M^3)	Briquette (KGs)		LPG in Metric Tonnes	Kerosene Oil in Metric Tonnes	Coal (domestic Use) in Metric Tonnes
2004	896	57251.00	N/A	4054	9781	340.06
2005	21200	207566.00	N/A	4472	12545	36,902.10
2006	18496	391991.00	N/A	4980.37	14370	32,420.31
2007	22406	465705.00	37389.1	5405.53	10207	29,895.02
2008	44689.64	549035.00	44932.25	5724.74	5252	42,728.30
2009	60915.19	618655.00	32188.5	5856.82	5427	21,468.71
2010	45580.76	541190.00	36898.65	6834.16	5780	28,996.82

Source: 1. DoF, MoAF. 2. NRDCL & 3. DoT, MoEA

With rapid developments throughout the country and rural and urban households getting electrified, there should have been significant reduction in the use of other forms of fuel. However, the use of LPG and Kerosene has

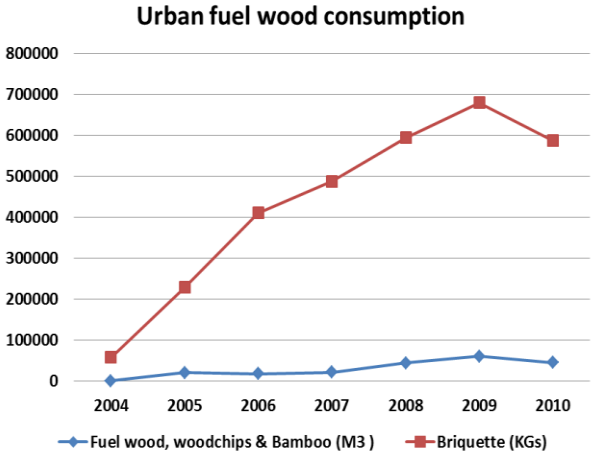
also been increasing. The table 3.12 and Figure 3.4 show that import of LPG has been increasing from the year 2004 till 2010. The use of kerosene, however, declined in the year 2007 & 2008 and has been increasing marginally since then. The small but increasing trend of kerosene since 2008 also indicates that there are still people preferring to use fossil fuel for heating, cooking and lighting. The use of coal is limited to big industries like the PCAL and there have been fluctuations in the domestic use of coal since 2004. The increase in the use of fuel wood and fossil fuels shows that electricity is not making remarkable progress on influencing people to resort to the renewable source of energy for their daily use.

Figure 3.4



With such increasing trend in the use of both fossil fuel and fuel wood despite more houses getting connected to electricity, the affordability of electricity is also questionable in all sections of the society. With the customer base increasing every year, similar trend in the reduction on use of fuel wood and other sources of energy is yet to be seen. There is also lack of clarity as to the preferred policy option of encouraging use of green energy vis-à-vis other forms of non-renewable and environmentally less conducive energy such as firewood, LPG, Kerosene etc particularly when the existing tariff regime seems to discourage low voltage consumption of energy while conservation of environment has always been our national priority. Thus there is a need for harmonizing the options for hydro-electricity energy uses vis-à-vis other forms of energy with due regard to environmental impacts.

Figure 3.5



3.4.3 Consumption of electricity per household has been decreasing for low voltage consumers

With the increase in customer base and import of electricity combined with the rapid rise in domestic demand, one would expect the household consumption of electricity for all sectors to increase. Shift from traditional cooking, lighting and heating method is expected in both the urban and rural centers.

However, on review of the consumption pattern of the society, especially on the use of electricity by rural and urban households, it was observed that there has been a decreasing trend in the low voltage consumption per-household whereas the expenditure per household on the electricity consumption both for urban and rural households had been increasing over the years as depicted in the Figure 3.6. & 3.7.

Figure 3.6:
Electricity Consumption per household in rural & urban Bhutan

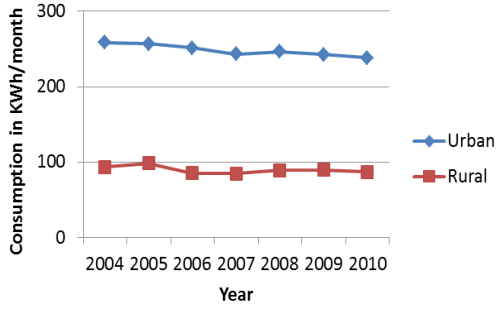
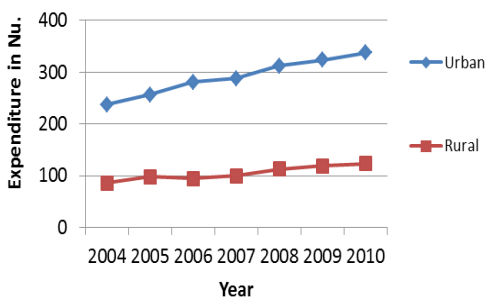


Figure 3.7:
Electricity Expenditure per household in rural & urban Bhutan



While there could be many reasons for the decreasing trend, it indicated that electricity is not an affordable choice of energy both for rural and urban population. The increasing tariff could be attributed for the decrease in individual household electricity consumption which is further substantiated by the regression analysis carried out as shown in **Annexure V**.

When running the regression with Average Low Voltage Price as Independent Variable(X) and Low voltage power consumption per household as dependent variable(Y), the coefficient of correlation(r) is -0.875 and coefficient of determination (r2) is 0.76.

The coefficient of correlation of -0.875 states that there is inverse relationship between the average tariff and the consumption of the energy per household, which means with the increase in the average tariff of electricity, the electricity consumption per household tends to decrease for the low voltage consumers. The coefficient of determination (r2) of 0.76 states that the 76% of the variation in the consumption of electricity per

household is explained by the variation in the average power tariff. This has also been statistically proved significant by the t-test. Thus, the regression analysis also concludes that average low voltage consumption tends to decrease when the average low voltage power tariff increases.

Thus, the above analysis indicated that electricity may not be a preferable choice as source of energy for the low voltage consumers which could be either because of increase in tariff and non affordability of the consumers which can only be substantiated by a thorough study on affordability of electricity.

3.5.1 Lack of guidelines on compensatory reforestation

On review of the environmental rules and regulation and the DPRs of the concerned projects, the audit team noted that there were no proper guidelines on compensatory reforestation for the conversion of forest lands to non forest purposes. Due to lack of such guidelines, the developers of the DPR for PHPA followed the practice in India and suggested the development of degraded forest lands covering an area of 2,912.70 hectares which is double the area of forest land to be acquired by the project. Lack of guidance on the management of the affected forest due to developmental activities may not hold the project implementers accountable for not conducting the reforestation activities. It may also set negative precedence to other upcoming hydropower projects. Thus, the consequences may undermine the Constitutional wisdom of maintaining 60% land under forest coverage with many hydro power projects coming up in the country.

3.5.2 Inadequate legislations and strategies on the sustainable use of water

Bhutan Sustainable Hydro Power Development Policy 2008 states that in order to utilize water resources in a sustainable manner for hydropower generation, it is important to protect water catchment areas by promoting sustainable agricultural & land use practices and nature conservation works. On review of policies, documents and site visits, it was found that there was no proper legislation for sustainable use of water in hydro power generation and the strategies for protection of water catchment area and promotion of sustainable use of water were inadequate.

In the past, there were no requirements by any rules, regulation, acts and laws for the hydro power plant developers as well as operating agencies to take up any activities to protect water catchment areas. However, the Bhutan

Sustainable Hydropower Development Policy 2008 requires the MoA&F in collaboration with MoEA to work out the modalities for integrated sustainable water resources management. A minimum of 1% of royalty energy in cash should be made available on annual basis to MoAF for the purpose.

Only the new hydro power projects like the Mangdechu has focused on the environmental sustainability by identifying the watersheds and water catchment areas and developing the management plans for protection of catchment and water sheds. Till date, the DGPCL has granted Nu.22.75 million to GNHC for the rehabilitation of degraded areas along Wangchu for the year 2008 through to 2013. As per the available reports, as of June 2011, a total of 65.3 hectares (161.20 acres) of barren area were taken up for plantations along the Wangchu-Pachu valley. Presently there are no clear modalities for integrated sustainable water resource management activities carried out by MoA&F and the contribution of 1% of royalty energy in cash on annual basis to MoA&F has not been clear.

Since hydro power generation is the main contributor to the country's economy, the unsustainable use of water resources may have negative impact on the economy in the long-run. Lack of proper legislation and strategies on sustainable use of water for hydro power generation may lead to similar flaws and problems in the future hydro power projects.

COMPLIANCE TO ENVIRONMENTAL RULES AND REGULATIONS AT THPA

3.6 Observations related to environmental requirements, rules and regulations

THPA as part of their environmental initiative has carried out some plantation work around their premise. They conduct weekly mass cleaning, collection and disposal of waste in and around the compound. As a part of the corporate social responsibility, the DGPCL through the THPA initiated the rural electrification of 15 households in Toktogom and 26 households in Phasuma village under Bongo Gewog, Chukha with the estimated cost of Nu. 6.76 million. This will not only improve socio economic development of the people in these communities but also contribute towards the environmental protection as it will reduce the dependence on the forest for fuel. While it was encouraging to see some of the commendable initiative by the plant, the RAA also observed certain weaknesses as follows:

3.6.1 Lack of documents related to environmental mitigation, management and monitoring

The DPR requires the conduct of environmental mitigation and management activities to be taken up during the construction and operation of the power project. However, the audit team could not get any documents related to the environmental mitigation and management activities noted in the DPR. The records on the environmental monitoring conducted by respective agencies were also not made available to the audit team. This could be mainly because of the weaknesses in the internal control system and lack of proper system of recording and documenting the environmental mitigation, management and environmental monitoring activities.

Thus, due to the lack of documents, the audit team was unable to assess and ascertain the conduct of the environmental management and mitigation activities committed in the DPR except for few afforestation activities. The team was also unable to assess the adequacy of the environmental monitoring activities by the concerned authorities. Therefore, the team could not establish the impact of THPA on the environment.

3.6.2 Lack of Monitoring on environmental aspects

Chapter 8 of the DPR on Environmental Monitoring Programme requires specific activities to be carried out during the construction and operation phases. It specifies monitoring process to ensure the execution of the stated activities during the operation phase of the project. However, on review of the documents and on conversation with the key personnel, the audit team noted that in three years since its operation, there has been no monitoring on the compliance to environmental requirements of the DPR by the NEC or DGPCL.

Although the activities stated for the operation phase of the project are minimal and may only cause limited damages to the environment if not carried out, there is a possibility of other projects following the similar system. This could lead to similar lapses throughout the country and aggregate to substantial damages to the environment.

3.6.3 Lack of Fish Mitigation Measures in Wangchu River Basins

DPR of THPA states that the fish ways and fish lifts are provided at dam sites to help the migratory fish to negotiate the dam height. It further states that for the fish way structures to be successful, it should take into consideration the hydraulics of the stream and physiology and behavior of the migrating fish. The floor properties of a fish way should be such that the effort required

on the part of the fish to negotiate the fish way remains well under limit of the capability of the fish to do so.

However, it was known during the field visits that there weren't any kind of mitigating measures initiated in Wangchu river basin for fish conservation. No fish ways and lifts were provided at the THPA dam as required and stated in the DPR. It does not provide passage for fish to swim upstream of the dam. The fish can only migrate downward of the dam. Non provision of such facilities would reduce the migratory fish population and thereby affecting the ecological balance along the river basin.

COMPLIANCE TO ENVIRONMENTAL RULES AND REGULATIONS AT PHPA-I

3.7 Observations related to environmental requirements, rules and regulations

The project is at its construction phase and the environmental requirements mentioned in the DPR were complied to a certain extent. It was also observed that there were certain monitoring and supervision by the Environment Wing of the project, Dzongkhag Environment Office and the NEC. The environment wing of the project has already undertaken compensatory afforestation programmes of 5 hectors and 5 hectors were to be taken up later. The project has also signed memorandum of understanding with the GNHC for carrying out compensatory afforestration through the Department of Forest and Park Service at the cost of Nu. 14.25 million for a period of 5 years accounting to 75-100 hectors. Out of this, 32 hectors has already been taken up by DoF and Dzongkhag Forestry Sector. The project has also done some road side plantation and established a forest nursery in a 5 acre land at Lobeysa.

However, the audit team could not conclude that the project has fulfilled the afforestration requirement of the DPR as the team could not determine the overall afforestration plans for the project whereas the DPR suggested the development of degraded forest lands covering an area of 2912.70 hectors which is double the area of forest land to be acquired by the project. Despite the considerable afforestration initiatives of the project, the RAA also noted some weaknesses in environmental management of the project as discussed hereunder:

3.7.1 Inadequate muck disposal sites

As per the section 5.2.4 of the DPR, a large quantity of muck is expected to be generated as a result of tunneling operation and construction of roads. Based on the geological nature of the rocks and engineering properties of the soil, a part of muck can be used as construction material and the balance requires to be suitably disposed off. It further states that adequate area has been earmarked which can cater to entire quantity of the soil.

Picture 3.1

Picture 3.2

However, on review of the related documents and on visits to the site, the RAA noted the failure to plan and identify adequate muck disposal sites. Total quantity of muck likely to be generated as per the DPR was 1.285Mm3 and there were no subsequent number of muck disposal sites. They identify the disposal sites as and when the muck is generated. As of now, works on sixteen muck disposal sites have been completed. Lack of adequate muck disposal sites and lack of proper planning for the muck disposal may lead to disposing muck at wrong sites. This can cause environmental damages and pollution if appropriate and timely actions and interventions are not made.

3.7.2 Improper dumping of muck and excavated materials and inadequate slope stabilization activities

As per the DPR of PHPA, the excavated materials should be disposed at a designated site with suitable protection measures like retaining wall and restoration of site through vegetation. It states that the stripped materials will have to be collected and dumped in designated muck disposal area which will have check dams to prevent the mucks to flow down to river. It further states that the holder shall ensure that proper drainage system is maintained within the mine and along the access road for drainage surface

and runoff water. However during the site visit by the audit team the following irregularities were noted:

i. At the Dophutsawa Stone Quarry site, the excavated materials were dumped downhill along the slope of the on-going approach road. Although drains were constructed at the ongoing quarry site, it was found blocked either because of the debris and boulders falling down as shown in the picture. This will create increased erosion after the quarry operation starts.

   Since there were no arrest barriers/gabion wall erected, the excavated materials might flow downstream and create blockage and ultimately flood the nearby areas.

ii. Muck and some plastic sack bags were also found dumped along the road while the audit team visited the area as shown in the picture 3.2.

On inquiry it was understood that the driver has to make eight trips a day and is left with no option than to dump the muck along the road side or downhill and go for another trip. It was also known that a driver gets paid based on the number of trips performed in a day. The disposal of the mucks along the road minimizes the road width making it difficult for the commuters. It also affects the natural flow of the river ecology.

3.7.3 Air Pollution around the project vicinity

As an environmental pollution management measure during the construction phase, the DPR requires regular spraying of water over unpaved stretches of road. Periodic spray of water from a water tanker of nine thousand liters at the rate of one to four times a day is indulged in daily sprinkling of water along the national highway to suppress the dust, but since the area is exposed to sun most of the time, there's not much of an effect. Thus, the dust produced from the project effects the travelers along the national highway. It has the potential to penetrate nearby homes and cause health problems, such as respiratory problem, allergies, hay fever, etc. Precipitation events have the potential to wash loose fines from the unpaved road bed into nearby streams, and subsequently cause an increase in sedimentation

CHAPTER 4

Recommendations

Based on the findings discussed in the preceding Chapter, the RAA recommends following course of actions:

4.1 Tariff Determination Regulation 2007 should be reviewed and updated

Considering the inadequacies in the TDR 2007 concerning apportionment of various cost elements, impact of funded assets, auxiliary power consumption etc. in the determination of tariff, it is necessary to ensure that these cost elements are considered in the best possible manner while arriving at the tariff structure. The shortcomings of the TDR 2007 should, therefore, be reviewed and appropriately addressed to improve tariff determination system and development of acceptable national standards.

4.2 Impact of tariff revision, volume of energy consumption and operational efficiency on the profitability of BPCL should be analyzed for better pricing and other decisions

As per the RAA's analysis, the profitability of BPCL has been significantly impacted by the successive revisions in energy tariff besides other factors. A detailed analysis of impact of tariff increase, volume variances and other factors on the profitability of the Corporation should, therefore, be carried out to ascertain the extent to which these have impacted the profitability for better information, improved decision and exercising controls. Since payment of incentives including bonus is also based on financial and other targets, analysis of such nature would also facilitate improving the existing incentive schemes.

4.3 Applicable international standards and practices should be benchmarked for power reliability determination and generation/transformation loss trends in Bhutan to enhance the efficiency of the BPCL and DGPCL

Despite the improvement in its power reliability indices, the BPCL still remains far behind the international standards. The audit team also noted that the transformation and generation loss of the DGPCL power plants had been at an increasing trend.

Thus, the power reliability and generation & transformation loss standards should be benchmarked with the international standards to ensure that power utility companies achieve better efficiency and effectiveness in their

operations. Besides, striving towards international standards will promote improved practices and operational efficiencies.

4.4 The BPCL should ascertain the reasons for huge variations in expenses made on distribution assets of Rural Electrification Projects across the country

There is a significant variation in unit cost per km/substation in creating distribution assets across the country. There were many similar activities of laying distribution lines and construction of Distribution Substations in different part of the countries at significantly varying unit cost. While there were many activities executed at very reasonable costs, there were still some similar activities being carried out at higher costs. Therefore, the BPCL should analyse the cost of laying and construction of Distribution Substation across the country and ascertain the reasons for variations for initiating cost control measures.

While the management indicated that works were carried out through competitive bidding process and that cost differences also occur due to different geographical terrains etc, the BPCL may need to review their own cost estimation process for similar activity in different locations to provide appropriate benchmarking and cost control.

4.5 Use of electricity should be promoted to encourage gradual reduction in the use of other forms of fuel and reduce pressure on environment

The RAA noted decreasing trend in the low voltage consumption per-household whereas the expenditure per household on the electricity consumption had been increasing over the years. On the other hand the consumption of other forms of energy had been at an increasing trend.

Thus, the RAA recommends a study to know the causes for the increase in the use of other forms of energy. This will help the power utility companies in formulating better strategies to encourage the use of environmentally friendly sources of energy like hydro-electricity and solar energy. It may also be imperative to take into account the affordability of the hydro energy by the individual domestic users with existing tariff which is higher at block 3 as per tariff schedule for LV consumers as compared to the industrial users (Medium and High Voltage consumers) and the export tariff.

The BEA should also conduct a detailed study on the tariff revision of the BPCL, and review its policy on determination of energy tariff for the Low Voltage consumers to encourage use of renewal energy sources as substitutes to other alternate sources of energy, such as firewood, kerosene,

coal and LPG. There should also be a clarity on the preferred policy option of encouraging use of green energy vis-à-vis other forms of non-renewable and environmentally less conducive energy as conservation of environment is our national priority. Since import of LPG and fossil fuel deplete our hard currency reserves especially INR reserves and country is currently severely impacted by INR shortages, it is imperative to carry out appropriate analysis and encourage use of hydro electricity as import substitution by rendering it more afforadable. While block tariff rates for LV consumers tend encourage energy saving, the authorities may also explore the options of encouraging use of energy saving devices.

4.6 Electricity affordability study or energy poverty study should be conducted

Due to limited data available on household income, the audit could not conduct a study on the affordability of hydro power energy. However, the team conducted analysis on electricity consumption per house hold with the average low voltage price and found that the consumption of the electricity per house hold had been decreasing over the years, while the cost had always been on increasing trend. The RAA also found the consumption of other forms of energy at an increasing trend. Such trend may be attributed to the increase in power tariff, thereby making electricity energy unaffordable. However, this could not be confirmed without proper study on affordability. The RAA thus recommends that an affordability study or an energy poverty study may be conducted which would help making informed decision and appropriate interventions. The study should take into consideration household income and affordability aspects in determining the tariff.

Tariff ceilings could be applied on different categories of consumers whereby the tariff should not exceed certain percentage of the average household income. This had also been the practice in many developed as well as developing countries around the world.

4.7 Differences in existing pricing structure between industrial use and LV customers should be reviewed

The existing pricing structure of HV and LV consumers vary with reference to energy and demand charges for HV and MV consumers and progressive rates at different consumption blocks for LV consumers. Analysis indicated that at the block 3 rate for LV consumers is higher than charges for industrial users. Further, there is also a possibility of unnecessary capacity

hoarding by industrial users through exaggerated demands thereby preventing effective use of available energy.

The RAA, therefore, recommends proper review and revisiting of existing tariff structure as well as ascertaining reasons for increased cost of power supply for low voltage consumers for appropriate pricing decisions and cost control measures.

4.8 Adequate guidelines, legislation and strategies should be framed for environmental protection and utilization of water resources for sustained hydropower generation in the long run

Hydropower is the backbone of the Bhutanese economy providing adequate energy for growth and there are many hydro power projects in the process. Despite the hydro power projects being the main source of revenue to the economy, it also has its negative environmental impacts especially on the forest coverage as a considerable portion of the forest gets destroyed by the projects. The lack of adequate strategies for protection of water catchment area may also result into unsustainable use of water.

Thus the concerned authorities should develop proper guidelines for the development and rehabilitation of the forest affected by the hydro power project development. Proper plans and strategies should be developed and implemented by the hydro power plants both during the construction and operation phase to contribute towards the sustainable use of water resources.

4.9 All power plants should establish environmental units or the DGPCL should establish and strengthen the Environment Division

With the government according high priority to the preservation of the environment and the policy of following the middle path on all its developmental activities, the power plants should establish environmental units or the DGPCL should establish and strengthen their Environmental Division to coordinate environmental monitoring and implementation of environmental mitigation measures. The Division should ensure that the environment mitigation measures are carried out as indicated in the DPRs and as per the environmental rules and regulations. These initiatives and activities will ensure harmonization of economic developmental activities with the environmental protection policy of the country.

4.10 THPA should document its environmental mitigation, management and monitoring activities and should institute Emergency Action Committee

Lack of documents and data on environmental mitigation, management and monitoring at THPA impaired audit verification process. The non availability of the documents would impair timely decision making, effective monitoring and evaluation. Thus, all the documents related to environmental mitigation, management and monitoring should be properly filed with appropriate indexing. Availability of these documents would allow the management to make informed decisions as good documentation and information helps proper planning, analysis, coordination, effective monitoring and effective decision-making.

Also as per the requirement of the DPR, the THPA should also institute its Emergency Action Committee at the earliest for coordinated action to prevent disasters arising due to dam failure. This will not only prevent such unforeseen mishaps but also gauge some of the aspects in their control and come up with mitigation measures in line with action plans of the DPR.

4.11 PHPA should adhere to the environmental requirements of the DPR and comply with environmental rules and regulation

In PHPA, lack of proper planning for the need of disposal sites lead to disposing muck at wrong sites, into the river and along the roadside and this could cause environmental pollution if appropriate interventions are not made on time. Environment related activities should be carried out in strict compliance to the DPR and the related environmental rules and regulation. The disposal of the excavated mucks should be done properly. There should be designated dump yard for the excavated materials. Gabion walls should be constructed along the river to stabilize the approach road. Proper plantation of the trees and vegetation along the slope should be initiated and encouraged. There should be proper monitoring of the drivers dumping the muck at a designated site.

The RAA also recommends assessing, identifying and planning the muck disposal sites at the earliest and also carry out the appropriate study of disposing muck on the private land.

4.12 Measures should to be put in place to reduce air pollution around the project vicinity of PHPA

The air pollution control measures adopted by the PHPA like the spraying of water to suppress the dust has not much of an effect since the area is exposed to sun most of the time. In order to reduce the air pollution around the project vicinity, the project authority could either increase the periodic spray of water or adopt dust suppressing organic and inorganic chemical mixes to synthetic fabric to contain the road material. The project authority should ensure the reduction of vehicle speed on unpaved roads. The enforcement of reduced vehicular speed within the Project boundary will reduce the amount of fugitive dust that would be generated by passing construction traffic. Adequate re-plantation should be done in the disturbed areas and also the areas should be graveled to reduce wind-blown dust. This kind of erosion control measures would limit deposition of slit on roadways and run-off of slit into nearby wetlands and streams.

APPENDICES

Audit Scope, Objective, Criteria and Methodology

Scope:

The energy audit was primarily focused on Hydro Electric energy. It emphasized on ascertaining the economy, efficiency, and effectiveness in the activities of generating and distribution of hydroelectricity. The audit also covered the environmental aspects of an ongoing and a completed hydro power project, the Puna Tsangchu Hydro Power Project and the Tala Hydro Power Projects respectively. The audit covered the period from 2005 – 2010.

Audit Objectives:

The RAA conducted the system audit of Energy-Hydro Electric energy with an overall objective to 'ascertain the economy, efficiency, and effectiveness in the use of public resources in generating and distribution of hydroelectricity'.

The specific objectives were:

- ☑ To study the rationality and impact of power tariff revision
- ☑ Ascertain the efficiency and effectiveness of operations of the power utility companies on the quantity of domestic consumption and the dependence on alternative energy supply mix; and
- ☑ To study the environmental aspects of hydropower development

General Audit Criteria:

1. The primary mandate of providing reliable, affordable, sustainable, environmentally sound, and efficient energy to raise the living standard of the people and earn maximum revenue by exporting hydropower energy to India should be adequately addressed.
2. All strategies and activities of the DGPCL and BPCL should be towards achieving the Missions and Vision of the respective corporations.
3. Provisions of the Electricity Act of Bhutan, 2001 should be adhered to.
4. Issues related to environment must be adhered in accordance to the Power Sector Master Plan and the related Acts, rules and regulations.

Specific Audit Criteria:

1. Tariffs should be set and revised in accordance to the Electricity Act of Bhutan 2001 and the TDR 2007.
2. The tariff determination should be based on section 6,7,8,9 and the relevant schedules of the TDR 2007.
3. The tariff revision by BPCL should ensure an adequate revenue base for supporting their planned activities besides allowing it to earn a 10% return on cost of equity (post-tax) as allowed by the BEA's tariff regulation.
4. The tariff revision by DGPCL should ensure:
5. Reflection of actual costs of efficient business.
6. Investments in the acceleration of hydropower development.
7. Steady flow of revenues to the Royal Government of Bhutan.
8. Cost and treatment of imported energy
9. The generating and distribution licensees should maintain a required profitability as defined in the Compact Agreements signed with the DHI.
10. The trend of contribution from both DGPCL and BPCL should be increasing in form of dividend as a result of increased tariff.
11. The tax contribution should be at an increasing trend.
12. The provision of benefits to employees should be in the manners prescribed by the Service Rule and Performance Based Incentive Schemes of the respective companies
13. The preparation of the tariff schedule should be guided by the principles under section 9.6.2 of the TDR 2007 where it states:
14. Tariff structures shall ensure affordability for the poor, through the application of low prices for small quantities of electricity;
15. Tariff structures may create opportunity for low-cost revenue collection mechanisms in rural areas, including the option of non-metered supplies, provided signals to consumers that improve efficiency of consumption patterns.
16. The Transmission, distribution and generation losses should be within the prescribed loss allowance as per TDR 2007.

17. The BPCL should align their activities towards achieving their mission to reliably and efficiently wheel electricity for domestic consumption and export.
18. The BPCL should maintain the SAIFI and SAIDI in accordance to the compact signed with the DHI.
19. The DGPCL & BPCL should achieve the set planned targets for power generation and distribution.
20. The Royal Government should continue to meet the growing domestic energy requirements while taking advantage of export opportunities.
21. The Royal Government should ensure national energy security through capacity allocation, development of storage hydroelectric projects, and through development of solar, wind and other renewable energy
22. What is the shortage of power during the lean seasons and what impact it has on financial performance of the companies?
23. What are the plans and activities taken up in increasing hydro power generation during the lean seasons?
24. Concerned authorities should ensure the protection of the environment affected by the development of hydro power?
25. While applying the license for the power business, the BEA should take into consideration, as far as adequate for project applied for; the needs to protect the environment and to conserve the natural resource.
26. The licensee should observe the environmental guideline and regulations in force and do as little damage as possible while exercising his right over the private, public and government land and premises.
27. Environmental code of practices for construction of Hydro-power projects must be adhered to.
28. IEE and EIA should be carried out for all the hydro power projects as per the environmental legislations of the Kingdom of Bhutan.
29. The environmental damage mitigation measures identified through the IEE and EIA for the hydro power projects should be implemented.
30. Hydropower should be harnessed in sustainable manner.
31. Water catchment areas should be protected by promoting sustainable agricultural/land use practices and nature conservation works.

32. The MoA in collaboration with MoEA should work out the modalities for integrated sustainable water resources management.
33. A minimum of 1% of royalty energy in cash should be made available on annual basis to MoA for the above purpose.
34. The Hydro power projects should contribute some percentage of its revenue directly for integrated management of water resources.
35. Are there any watershed management plans by BPCL & DGPCL?
36. Recognizing hydropower as a national resource, it should be provided at affordable rates to reduce non-renewable energy use.
37. Has there been increase or decrease in the usage of fossil fuel and fuel wood over hydropower electricity?
38. Does the rural populace still use fuel wood and fossil fuel?

Audit Methodology:

The following audit methodologies were used during the audit:

1. Qualitative Analysis through the review of procedures, reports, documents and activities
2. Enquiry and confirmation
3. Interviews and discussions
4. Field Visits and
5. Quantitative analysis using secondary data

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ANNEXURES