OVERVIEW OF ENERGY POLICIES OF BHUTAN

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Overview of Energy Policies of Bhutan

1. Country Profile

Bhutan is a small country in the eastern Himalayas and Thimphu is the capital city. It is a land-locked nation sandwiched between two giant neighbours and fastest growing economies in the world - China in the North, India in the East, West and South. It occupies an area of 38,394 sq. km and is inhabited by about 650,000 people. The country is sub-divided into twenty districts or administrative regions. The geography of the Himalayan mountain terrain has physically kept the country in isolation and the modernization process started only from the early sixties. Even today after the completion of four decades, mountainous and rugged terrain has impeded the development efforts where the cost of building modern development infrastructures such as roads, schools, rural electrifications, drinking water supplies, etc. have been prohibitively high in addition to being difficult and time consuming. The literacy rate of Bhutan is 59.5% and per capita GDP is about US$ 1,400 with unemployment rate of 2.5%. The Buddhism is the predominant religion of the country. Bhutan's economy is one of the smallest and least developed (low income) in the world which is based on agriculture and forestry that provides the main livelihood to more than 69% of the population. As of 2008, only 66% of the total households have access to electricity and the government has mandated to provide electricity to all by 2020. Hydropower, cement, wood and food products constitute its main industries. Bhutan has a forest cover of 72.5% and the new constitution further mandates the forest cover to be maintained at 60% for all times to come. The rich cultural heritage, pristine environment and of late the adoption of a distinct and holistic growth philosophy of Gross National Happiness – a policy most constructively defined as favouring sustainable development, cultural preservation, social wellbeing and happiness over Gross Domestic Product has made Bhutan a top destination for tourists and topic of discussions in the academia worldwide. The country has been unanimous in maintaining that, economic growth as it is achieved in the west is not the solution for true development in the country, rather the development should encompass efforts to sustain economically, culturally and ecologically. According to a recent study on happiness by sociologist Adrian White, University of Leicester, United Kingdom, Bhutan is the eighth happiest country in the world. Yet, Bhutan remains a poor country, heavily reliant on foreign aid and with little industry other than tourism. India is the largest donor and trading partner as the country's economy is intrinsically linked with that of India's through strong trade and monetary arrangements. The hydropower export and tourism are the main revenue earners and the source of foreign exchange. The average share of annual national revenue contributed by the hydroelectric sales was 38.52% since 2000 and is expected to provide 60% in 2009. In 2006, Bhutan commissioned the 1,020MW hydropower project more than tripling the country's total generation, the largest facility in the country which was financed by India. However, this represents only 5% of the country's hydropower potential, estimated at 30,000MW.

On the political front, the remarkable political change initiated by the 4th King had transformed the country from monarchy to constitutional democracy and is the youngest democracy in the world. As such, there was a sudden change in national policies and outlook on development activities under a new government while the long-term national goal will be to achieving self sufficiency and becoming a strong, happy and a dynamic nation.

Also, Bhutan is endowed with rich potential for harnessing hydropower, because of its mountainous terrain, high gradient rivers flowing through rocky & steep gorges, good

weather and other favorable (political, social, economic) conditions. Most of schemes identified are run-of-the river types and they are found to be techno-economically least-cost and environment-friendly. Few reservoir schemes are also identified with limited and/or no environment impact in the Southern belt before the Bhutanese rivers fan-out and enter the Indian plains.

2. Rationale for Energy Policy

Bhutan being a fast developing country there is a need for increasing productivity and, therefore, for energy resources. Like any modern industrial society, Bhutan will one day also become an energy-intensive society and the availability of reliable and affordable energy will become key issue of the country. As the living standard of the people keeps on improving every year, there are equally a lot of pressure on energy resources and supplies. Today, Bhutan exports more than 75% of the hydroelectricity produced to the neighbouring country, India and this export has become crucial in terms of revenue earnings as well as the foreign exchange. In this context, the energy policy of the country has to gear towards fulfilling two mandates: providing reliable, affordable and quality energy service to the nation and export service to earn increased revenues. Therefore, the need for a energy policy for Bhutan is becoming apparent due to the following reasons:

- As of date, there is no such policy framework to provide guidance to the energy sector of Bhutan and it is imperative that Bhutan needs to develop a comprehensive energy policy covering all parts of the energy sector as an integral part of the general economic management and the national development plan.

- There is a need to adopt a policy addressing the sustainability of the sources of energy including supply, consumption and most importantly the energy security. The primary mandate of the policy should centre to providing affordable, reliable, environmentally sound, and efficient energy to raise the living standards of the people and earn maximum revenue by exporting hydro power energy to India.

- The framing of the energy policy requires the evaluation of very many scenarios and policy decisions and implementation schedules that produce the desired scenarios. With the policy instruments like Hydropower Master Plan, Integrated Energy Management Master Plan and the National Energy Data Directory in place, development of an overall Energy Policy that emphasizes hydropower development with clear set goals, targets and that fulfils national development objectives becomes necessary and appropriate.

- With the rapid pace of economic development, Bhutan's primary energy source is shifting from biomass to other conventional energy sources, viz., hydroelectricity and fossil fuels like oil. While the fossil fuels (oil, coal & gas) constitute the main components of the energy mix of the developed countries, hydropower dominates the Bhutan's energy mix. A policy needs to be framed for this particular renewable energy development.

- Not only the social objectives like electricity for all by 2020 should be given renewed emphasis and targets achieved before the deadline, the country must ensure that rural

populations in particular and weaker sections of the society in general have access to reliable and affordable supply of energy for years to come. There is a need to provide access to cleaner cooking fuels to the villages where biomass is the traditional source of their daily energy needs through a clear framework by further disseminating energy efficient cooking technologies, because rural populace have less purchasing power to use modern forms of energy.

Bhutan must draw a policy that will fully ensure reliable, affordable, sustainable and environmentally sound energy for years to come. Bhutan's growing economy, increasing population and rising living standards should be sustained by a plausible energy policy with emphasis on universal provision of affordable energy services for a long time to come.

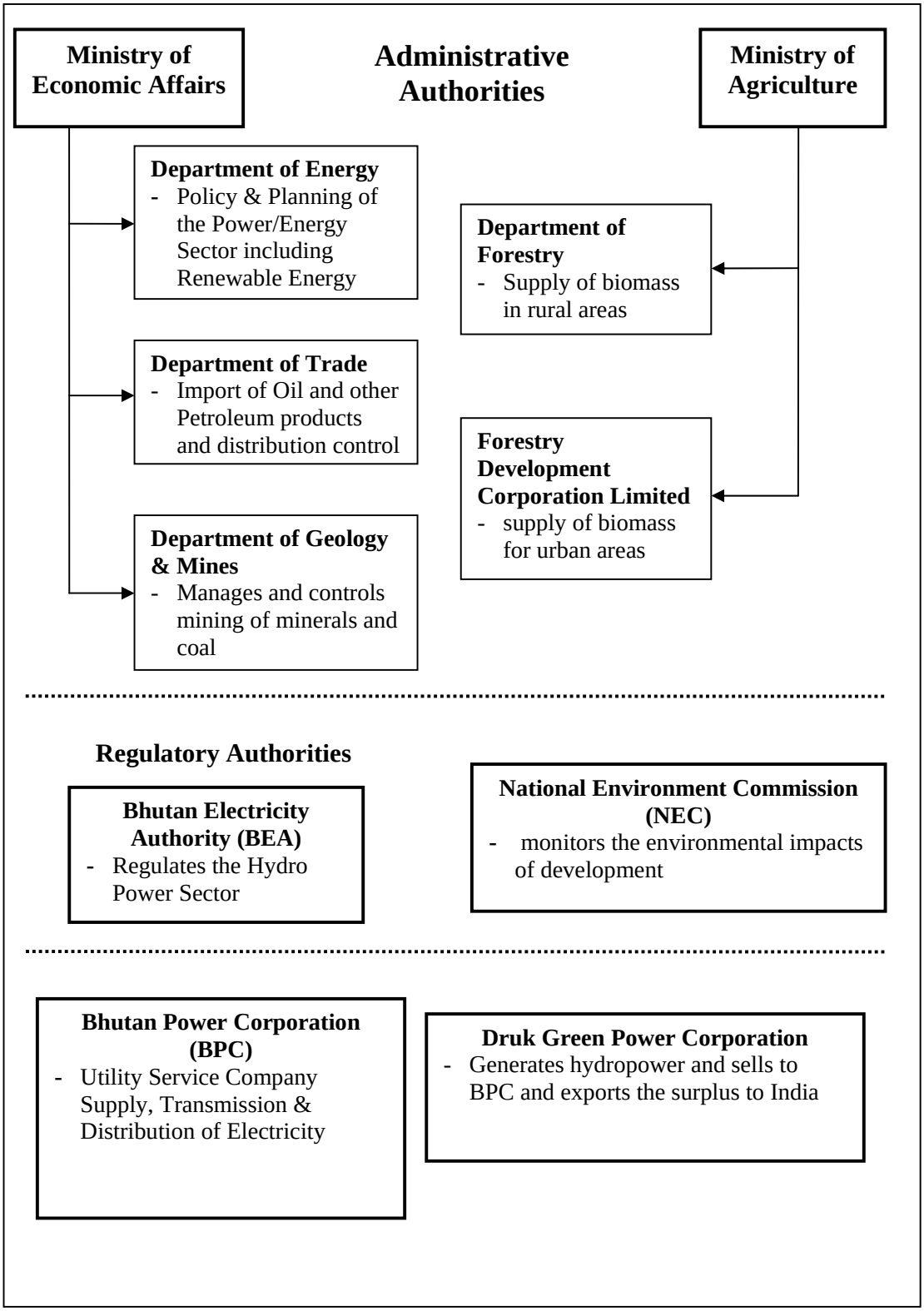
3. Energy Institutions

The energy sector of Bhutan is administered under two ministries, viz. Ministry of Agriculture and Ministry of Economic Affairs. 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 and exports and fossil fuel imports. The structure of the energy sector is as shown in Figure 1.

Figure 1 Organizational outline of the Bhutan's Energy Sector

Organisation chart on next page.....

Overview of Energy Policies of Bhutan



Under the Ministry of Economic Affairs, three departments, viz., Department of Energy (DOE), Department of Geology & Mines (DGM) and Department of Trade (DOT), the regulatory authority - Bhutan Electricity Authority (BEA) and government owned corporations (BPC&DGPC) are the main players in the energy sector. The Department of Energy is a government agency responsible for formulation of policies, plans, projects and programmes, and other initiatives related to hydropower and alternative forms of energy in the country, while the Bhutan Electricity Authority is an autonomous regulatory agency which regulates the electricity sector.

4. Energy Supply

Renewable energy sources dominate the present energy supply in Bhutan. Firewood is the main source of primary energy for the people of Bhutan, and it represents the largest slice of energy consumption. More than 60% of population lives in the rural areas where they have no access to modern forms of energy supplies and fuel wood is easily available from the nearby forests wherein, 70 % of country's land mass is covered with forests. Bhutan is also endowed with huge hydropower potential which could be harnessed from the perennially snow-fed north-south flowing rivers. Hydropower generation, though still relatively small in comparison with the rest of the world has shown unprecedented growth due to the importance accorded in the Bhutan-India relations. As said by our 4th King during the press conference in New Delhi, "Water is to us what oil is to the Arabs". So is also being said by the outside observers, "What clocks are to Switzerland, water can be for Bhutan". More recently, hydroelectric power has become the most prominent source of energy in urban and rural places alike.

The total energy supply for 2005 was 554,752 tons of oil equivalent (TOE). The major contributions to the energy supply mix came from biomass and electricity from hydropower generation. The per capita energy supply for the year 2005 was 0.87 TOE which was 51% below the world's average supply for the same year. The 99% of electricity generation in Bhutan is from hydro resource and rest comes from diesel generating plants.

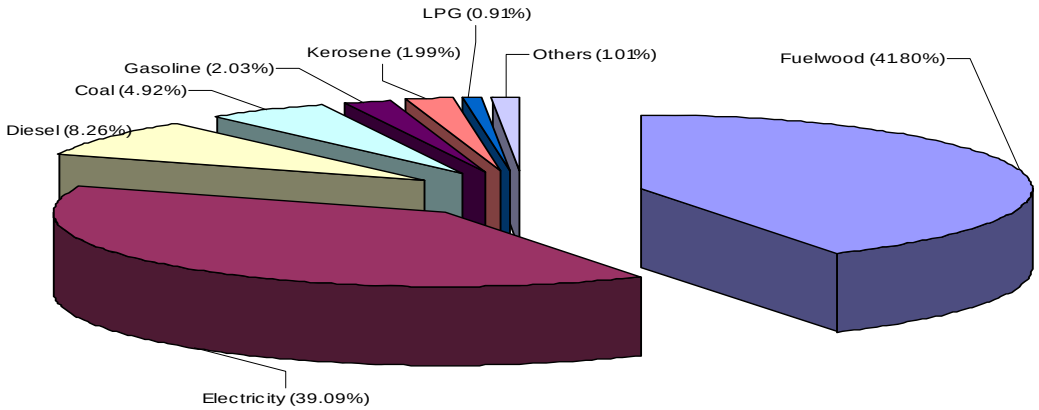


Figure 2 Energy Supply Mix 2005

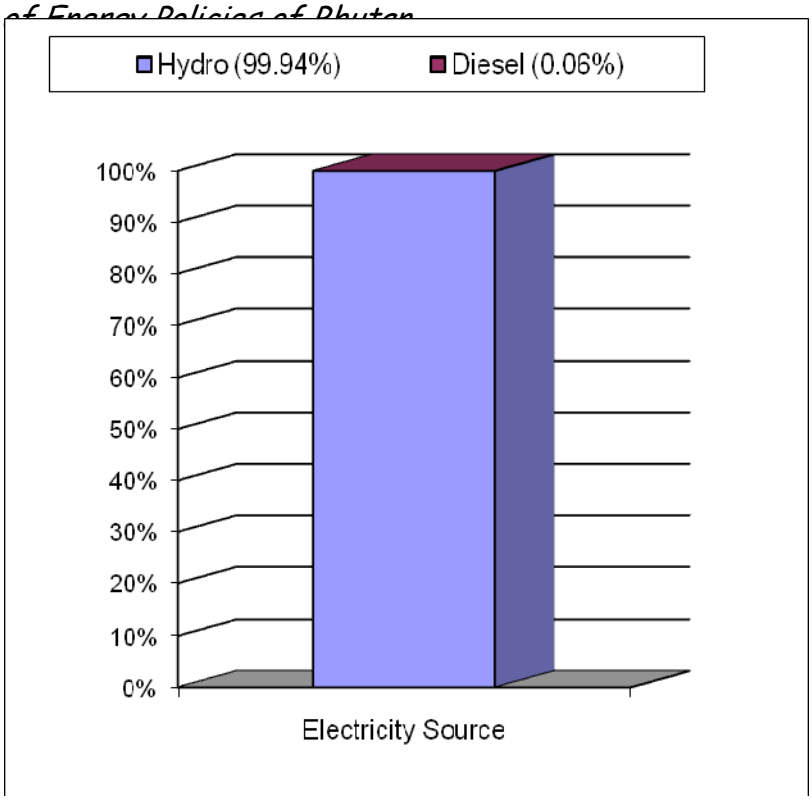


Figure 3 Renewable energy dominates the electricity generation in the country

The supply scenarios with respect to the principal energy supply sources in the country are discussed below.

- **Biomass Supply**

Biomass refers to a variety of plant materials which can be used as feed stocks for conversion to useful fuels and products. The plant materials with the greatest potential are trees, forestry, and agriculture residues. The most obvious source of biomass energy in Bhutan is wood, a renewable resource that is certainly not a new form of fuel.

The main source of primary energy supply for the majority of Bhutanese population are traditional fuels such as firewood, wood chips and animal dung which are used for cooking and space heating. Today, biomass is the predominant fuel and forms the large share of the overall energy supply. In general, biomass includes wood, wood waste, peat, wood liquors, railroad ties, pitch, wood sludge, municipal solid waste (MSW), agricultural waste, straw, tires, landfill gases, fish oils, and other waste materials. The entire rural populace use fuel wood as its main source of energy while the urban and suburban populace uses it for space heating during the winter. Bhutan consumed about 725,000 tons of fuel wood in 2005 which accounted for 57.7% of the total primary energy supply mix and studies reported Bhutan as the highest per capita consumer of fuel wood in the world. However, this scenario is slowly changing with the increase in rate of rural electrification and the government's policy of duty-free import of wood saving electrical gadgets like rice cookers, water boilers, curry

cookers, etc. According to the Bhutan Energy Data Directory 2005, biomass accounted for 91% of residential energy use while at the same time the residential sector emerged as the largest energy-consuming sector, accounting for 46.8% of the total energy consumption. Today, wood provides about four seventh of the country's total energy needs and provides a significant contribution to the current energy security of the country.

- **Fossil Fuel Supply**

Bhutan has no known reserves of petroleum resources, nor there are any refineries set up for import of crude oil and its processing. While the entire petroleum products are imported from India through a special long-term agreement, coal is mined in south-eastern parts of the country where deposits are found along the 35 mile-long stretch and the total reserve of coal is estimated at 1.96 million tons. And with the average annual extraction rate of 4.6%, this reserve would last only up to 2028. Also, some of the coals are exported while equal amounts are also imported depending on the grades of coal.

The imported commercial energy sources include petroleum products like diesel, gasoline, kerosene, LPG, lubricating oils, etc. where diesel and gasoline are used for transportation, kerosene for space heating and lighting in urban and rural homes respectively, and LPG is used mainly for cooking in the cities and some rural places. Along with the above fuels, certain quantities of octane petrol, furnace oil, bitumen, high speed diesel, aviation-grade gasoline, etc. are also imported. The prices of fossil fuels mentioned above and the other petroleum related products are exposed to changes as per the increase and decrease of its prices in India which in turn were influenced by demand and supply of crude oil in the international markets. Oil imports have been steadily increasing over the past few years due to the rapid growth in number of vehicles in the country and the oil imports increased by over 8 times in the years between 1995 and 2005.

The prices of kerosene and LPG are subsidized by the government since they are used mainly for domestic purposes and by the rural populace. Following the recent hike in international crude oil prices, there has been an increase in prices of oil in Bhutan which shows that in this world of increased globalization; all nations and consumers alike are subject to oil price surprises which is ever going on the increase.

- **Hydroelectricity Supply**

Hydropower is largest renewable energy resources in Bhutan. Hydropower, the source for 99% of country's electricity generation today is widely abundant in terms of hydropower potential estimated at 30,000MW. However, the total hydroelectric potential technically exploitable capacity based on all practicable sites for head development and assuming average water flows is estimated at 23,500MW.

The hydropower generation in Bhutan began during the late 60's. Earlier, electricity generation was based on small diesel generating plants and micro hydro stations, providing limited supply of electricity to few places only until the commissioning of the 336MW Chukha Hydropower Project in 1988, where Bhutan saw a quantum increase in her electricity generation and since then became a net exporter of electricity to India after internal demand was met. However, the internal demand as of today is due to demand from

the 60% of total 126,115 households which has access to electricity and a handful of manufacturing industries that uses electricity. The internal demand of the country was found to be 120MW in 2005. The domestic consumption of electricity has been marginal but should increase with the spread of rural electrification which is being carried out with the support of government and the external loans and bilateral donor contributions.

Table below shows the list of hydropower (Large & Small) generating stations in operation as of today. From the table, we can see that hydropower generation is a recent phenomenon but has shown impressive growth over the recent years. The total energy generations by major power plants in 2006 is about 1500 MW.

Name of Plant *(Year of commissioning)*	**Capacity (MW)**	**Cumulative Energy Generation up to 2006 (MU)**	**Percent exported**
Tala *(March 2006)*	1,020	1,001.30	100%
Kurichhu *(2001)*	60	1,055.40	85.4%
Basochhu Stage-I *(2002)*	24	412.57	Consumed internally
Basochhu Stage-II *(2004)*	40	114.68	Consumed internally
Chukha *(1986-88)*	336	34,836.799	82%
Micro/Mini	4	20	Consumed internally
Total as of 2006	**1,484**	**37,440.749**	

- **Other Renewable Supplies**

Other forms of energy available in abundance are the solar and wind power. Solar contribution to Bhutan's energy supply has been almost negligible compared to the hydroelectricity but has been crucial in that the solar energy is used mainly for rural electrification of far-flung and isolated communities including the social institutions like schools and monasteries, telecommunication centres, etc. where extension of grid electricity has been impossible due to prohibitive costs, climatic and environmental conditions. Wind power has remained elusive and unexplored so far although some efforts have been made in the past to tap it but without any success. Solar power is mainly used to provide lighting and has become an important part of rural electrification. So far the total installed capacity in the country is a marginal 0.239MW. The use of solar energy for space heating and domestic hot water production purposes has received little attention from public as well as private mainly due to high cost of solar PVs and availability of cheap hydroelectricity which has somehow diverted the attention of the consumers. The solar resource in the southern and northern parts of the country were found to be 4.0 kWh/m^2 and 5.0kWh/m^2 per day respectively according to the study carried out by the United Nations Environment Programme (UNEP). The growth of solar energy is hampered due to economics - high price and lack of adequate financing, inadequate documentation and evaluation of the many solar projects that have been undertaken, lack of skills in operation and maintenance, etc.

Wind energy is the fastest growing form of energy in the world today but its development in Bhutan has been neglected due to the emphasis on the more reliable hydropower resource. In addition, there are no studies conducted so far on wind resources potential to pursue its development. Other renewable energy sources like, municipal solid waste, geothermal energy, etc. also remains unexploited as of today mainly due to budget paucity and absence of technical expertise.

5. Energy Demand

The various end-users of the energy are categorized as residential, industrial, institutional and commercial, transportation and agriculture. As stated earlier, the residential sector is the highest energy-consuming sector, accounting for 48.7% of the total energy consumption, of which 91% of the demand is met by biomass and rest from other conventional supplies, while in the developed countries like USA, industrial sector consumes the most energy followed by transportation, residential and commercial entities. But there is a whole lot of difference in the pattern of energy consumption between the two countries. About 69% of the total population lives in the rural areas while only 40% of the total rural households are electrified. The rest of them meet their energy needs from the fuel wood. The residential sector accounts for 14.1% of the total electrical energy consumption which also uses kerosene for lighting and LPG for cooking purposes.

The industrial sector consumes 25% of the total energy and is the largest consumer of electricity in the country accounting for 64.7% of the total electricity consumed in the country. The transport sector accounted for 14.3% of the total energy and this is one area of energy which is fully dependant on imports. Oil is the dominant source of energy for transportation industry. The commercial sector accounted for 10.2% of the total energy consumption meeting the energy needs from the electricity besides fuelwood and LPG. The agriculture sector which is the mainstay of the Bhutanese economy involving 79% of the population, primarily meets its energy from the human and animal power. In 2005, the sector accounted for only 1.2% of the total energy consumption. The shares of energy consumed by the various economic sectors are as shown in figure below. The total consumption of energy in 2005 was 392,467 TOE where most energy was consumed by the residential and industrial sectors. The per capita energy consumption for the same year was 0.62 TOE which was 65.7% below the world's average of 1.81 TOE in 2005. The electricity consumption increased rapidly from no electricity to 1,084 kWh per capita since 1961.

6. Regional and Global Standpoint

The per capita supply and consumption of energy and electricity respectively are way below world average although from the regional context, Bhutan tends to lead, yet the per capita use of energy and electricity is only about one third and two fifth of the world's average. However, the high per capita energy consumption is somewhat skewed since majority of energy used in Bhutan comes not from commercial fuels such as oil and coal but from traditional principal fuel of firewood. Also, the high per capita consumption of electricity does not necessarily represent the individual's personal use of electricity but is largely attributed to the share of industries' usage in manufacturing and production as discussed before. There is a huge disparity in per capita energy use among the developed countries like USA, EU & OECD member countries and the developing country like Bhutan.

Country	GDPper Capita (constant 2000 US$)*	Per Capita Energy Supply (TOE)	Per capita energy Consumption (TOE)	Per capita Electricity Supply (kWh)	Per capita electricity Consumption (kWh)*
Bangladesh	402	0.16	0.15	140	127.70
Bhutan	**695**	**0.87**	**0.62**	**3,971**	**942.07**
India	538	0.53	0.50	457	434.80
Nepal	231	0.34	0.32	69	67.90
Pakistan	566	0.49	0.44	425	407.80
Sri Lanka	962	0.49	0.42	345	325.10
Myanmar	-	0.28	0.27	104	101.10
China	1,323	2.36	1.11	2,140	1,378.50
Norway	39,005	6.50	5.81	22,859	23,195.80
USA	36,655	7.82	7.63	12,187	13,243.00

Table showing comparison of per capita energy and electricity supply and consumption for selected countries

7. The Challenges

We must appreciate that energy is one of the building blocks of modern society and that the availability and cost of energy resources are key factors in a country's economic growth. Energy is not an end in itself but a means to achieve the goals of a healthy economy and a healthy environment. Bhutan faces a daunting task in terms of technology, skilled manpower and financial resources to provide adequate, quality and affordable energy to its citizens in a sustainable manner. There are several dimensions that make the planning and management of energy sector and hydropower/energy investments especially complex and challenging. The following illustrates some of the difficulties and bottlenecks faced by the energy sector of the country:

1. Due to the geographic nature of the country the cost of rural electrification has remained prohibitively high for the government and the donor agencies. Therefore, the effort to provide clean, affordable and convenient "lifeline" energy to the rural populace and poorer societies who cannot fully pay for it and the services remains evasive.
2. A majority of the people use traditional fuels such as firewood and animal dung for cooking and heating where these fuels causes indoor pollution and heavy burden on

women and children in the rural places. We need to improve the quality of life and alleviate poverty especially in the rural areas by providing reliable and affordable electricity as stimulant for socio-economic development.

3. With the economic development, import dependence on oil is growing rapidly which raises serious concerns about Bhutan's energy security. There comes the need to import crude oil and set up crude oil processing plants as well as import fuel efficient vehicles and improve road conditions in the country.
4. Energy efficiency and conservation measures shall be promoted for sustainable supply and end use. The Government shall encourage general improvements in the energy performance standards of buildings for lighting, heating, ventilation and insulation levels.
5. Achieving the national goal of "Electricity for All" by 2020 and thereafter operating and maintaining those extensive and expansive networks of transmission lines and consumer terminals would require skilled manpower and huge amount of resources against insufficient revenues and budget. Securing investments for the construction of major transmission lines to link western, central and eastern grids remain a challenge while such interconnection would provide smooth transfer of power from the surplus to deficit areas inside the country thus avoiding re-imports from various points from India and would bring balanced regional development and power pooling.
6. Bhutan today has enough generation to meet the internal demand of the country even if the entire country is electrified and all people are given access to electricity. There will never be any shortage of power generation to fulfill the power requirements of the country in the foreseeable future other than the challenge of transmitting power to the scattered consumer centres. However, due to the low river-flow volume in the winter months, the firm power available may not leave room for export thereby curtailing the revenues. Since hydropower forms the backbone of the country's economy, emphasis is given to export as much power available as possible and improve revenue earnings each year which has a bearing on the country's economy.
7. The hydro resource base is abundant but requires a heavy investment in hydropower development amount to several millions of dollars which gives rise to formidable problems in the scale of investment financing from different sources, all external as of today. Since, energy investments tend to be large with long gestations periods, projects have to be carefully planned and quickly executed. The cost of delay or failure becomes enormous and adds to the overall debt. Hydropower projects have long gestation period. The pre-feasibility study generally takes one to two years, and thereafter the detailed survey and investigations for the preparation of Detailed Project Report take another two years. The construction for a Project of the size of 1020 MW in an interior location would generally take 8-10 years to complete. Therefore, right from concept to commissioning phase, it will take 11-14 years. There is additional risk of uncertainty due to geology during the construction phase. Hydropower projects are quite capital-intensive and have slow return on cash flow in the beginning. After a hydropower project is commissioned, initial 12-15 years' time goes mostly on debt servicing and only thereafter, the cost of generation comes down and the investor starts getting solid return on his equity as hydropower project has no other variable cost unlike in thermal power plant. The investor is averse to investment with such slow rate of return in the beginning and does not like to wait.

That is the difficulty and generally, hydropower projects' infrastructures are generally built on public funds. Being a land locked and mountainous country, the transportation cost of the project is also very high. So far Government of India has been providing us 60% grant and 40% loan for investment in hydropower projects. The situation is becoming difficult as India themselves needs huge capital investment in infrastructures development and as a result opportunity for such financing is becoming difficult even if Government of India desired to assist us.

8. There is a huge deficit of power in our neighbouring country, India. The Ministry of Power in India has declared that it would need to add 100,000 MW by 2012 and increase the hydro-thermal mix from the existing 25:75 to 40:60. There is clearly an opportunity for Bhutan. Nepal is also very keen to export power to India. The north eastern states of India also have huge hydropower potential. Bhutan needs to act quickly and make clear plans to enhance its electricity export to India.

Subject of Interest:

As hydro potential is abundant in Bhutan and the hydro electricity being the most predominant source of energy in the country and also due to the huge deficit of power in the neighbouring country, India, currently the country's major thrust is in the development of as many projects as possible in the accelerated form of development. Basically looking at the shortage of firm power during the lean season of the year, Bhutan encourages the development of reservoir scheme of hydro power generation with minimum environmental degradation.

Bhutan aims at providing additional power of 10,000 MW by the year 2020 purely for export to India.

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The End