CHAPTER–I

INTRODUCTION

1.1 Background

Nepal is a small landlocked country wedged between two neighboring economic powers, India and China. It is a mountainous country consisting of 17%. Terai, 68% hill and 15% Himalaya out of total area 1, 47,181 sq km. Agriculture is the main stay of Nepalese economy. Agriculture sector witnessed a dismal performance in spite of a top priority accorded to it in almost all the plans. The distinct topography of Nepal with its high hills and more than 6000 rivers and innumerable rivulets criss-crossing the country provides vast opportunities for the development of hydropower. Nepal is estimated to have theoretical hydro power potential of 83000 MW of which 42000 MW is economically feasible (Warnock, J.G. 1989, pp 26-32).

Nepal is a water rich country, but efforts towards harvesting water resources and developing hydropower have been quite moderate. Energy is a basic necessity for survival. It is necessary for development activities to promote education, health care, transportation, and infrastructure for attaining a reasonable standard of living and is also a critical factor for economic development and employment. Till today, Nepal has no other natural sources of energy besides the immense water resources. It has been recognized that Nepal's main natural resources is its abundant hydropower potential.

Energy plays a significant role in the economic development and technological advancement of societies and in human welfare. The supply of energy is often a major constraint factor in the development of a country's economy.

Most of the rivers and streams flow with great speed from the mountain region i.e. from North to South. So hydropower generating capacity of Nepalese river is greater than the rivers in the other countries. It is estimated that 2.27% of world's total hydropower potentiality is in Nepal. It can generate equivalent to the combined hydropower potentiality of USA, Mexico and Canada and nearly equal to Brazil (Koirala, R.P. 1990, pp 57). It is a land of magnificent mountains topography, formed during various geological periods and controlled by different orogenesis (B. Shrestha, 2003, pp -11). Climatically Nepal lies in monsoon region. The availability of coal, oil and gas resources has not yet been ascertained. Nepal has relative abundance of fresh water, and therefore has comparative advantage in hydro-electricity generation and irrigation. This means that irrigation and hydro-electricity can plays a leading role in the development and modernization of Nepal. (Bhadra, 2004).

The word hydropower is made of two terms " hydro" and power. Hydro comes from the Greek word hydro, meaning water. It is the electricity produced by the movement of fresh water from rivers and lakes. Also called hydropower, it is a renewable energy source dependent upon the hydrologic cycle of water, which involves evaporation, precipitation and the flow of water due to gravity. Gravity causes water flow down wards and this downward motion of water contains kinetic energy that can be converted into mechanical energy, and then from mechanical energy into electrical energy. At a good site, hydropower can generate very cost effective electricity. Hydropower represents an important source of energy, accounting for one-fifth of the world's electrical supply. Most of the technically and economically feasible hydropower potential has been exploited in the developed countries.

Developing countries, too, realizing the significance of this source of power for the higher sustained economic growth and development of their respective economies, have been embarking on the various phases of the hydropower development process.

In the modern days, it was only in 1882 that the first hydropower plant was built in Wis consin USA. In Nepal, the first hydropower plant was established at Pharping (500 KW) in 1911, during prime minister Chandra Shamsher Rana's time to meet the energy requirements of the members of the ruling classes. Though some 60% of Nepal's population remains deprived of electricity while the capital city continues to be thirsty for drinking water and suffers from regular load shedding even at present, it is fascinating to note that Nepal had such an early start in the hydropower generation.

In the world today, the highest producers of hydropower are Canada, United States, Brazil, China, Russia, and Norway. Among the various countries, Canada ranks, first in the production of hydropower as it has abundant water resources, and a geography that provides many opportunities to produce low-cost energy.

Though, Nepal has abundant water resources, it hasn't been harnessed properly .At the end of FY 2004/05, a total of 556.800 MW (which is only 0.67 percent compared to total capacity) hydropower was generated from various projects of the country (Economic survey, 2006). Energy consumption ratio is increasing year after year in comparison to its production of the total energy consumption too, traditional energy has prominent share. If the potentiality of hydropower is harnessed properly, it would not only help to bring almost significant changes in different facets of the economy but also enhance exports which can be an accelerator to growth through the multiplier process.

1.2 Statement of the Problem

Despite the tremendous hydro-power potentials, energy consumption of Nepalese people is lowest not only among the SAARC countries but also among most of the countries of the world. It is really ironic that a large majority of Nepalese people are bound to live in darkness although the country is endowed with immense hydropower resources. Nepalese economically exploitable hydropower potential of 44000 MW remains virtually unexplored. A large proportion of people still use traditional type of energy. Among various sources of energy, hydroelectric energy is cheaper and perennial because most of the Nepalese rivers flow from the high Himalayas and with high current flow. Only a small portion of total population, mostly in urban areas, has access to electricity, while a vast majority of rural people are deprived of access to electricity. This shows the urgency of exploiting hydropower potentiality not only for enabling people to use hydropower for meeting energy needs, but also for increasing power supply to industrial use. Effective development as hydropower is hindered by the lack of development finance, scarcity of local expertise and presence of difficult geology and inaccessible terrain at site where projects are located.

It is also evident that the domestic demand for electricity will remain diminutive compared to the potentials that exist. This obviously requires that Nepal seek to use its prime resources for application on the regional basis in south Asia. But the fact is that this potential of the country goes waste year after year.

A number of problems, which inhibit the exploitation of hydro potential of the country, are mentioned below:

- The pace of development in hydropower industry is slow in comparison to the growing demand of electrical energy.

- There is no clarity of export tax on power export. While developing multipurpose project by the private sector, the process and mechanism to provide the down-stream benefit has not been mentioned.
- Limited domestic market is one of the major hurdles in hydropower development in Nepal. This may be attributed to the small size of the country and low level of industrialization. Nepal has not been able to export hydropower to neighboring markets i.e. India, Bangladesh and Tibet Autonomous Region of China due to high cost of electricity. This may be attributed to difficult topography of the country, lack of infrastructure, costly consultancy fees, high cost of foreign equipment and construction materials etc.
- Some anomalies have been observed between existing policies and legal provisions related to power sector and the policies and legal provision of other government agencies. It has obstructed the smooth development of power sector.
- Various types of risks are involved in the implementation of hydropower projects, such as commercial, legal, political, natural calamities, and so on. Since there is no clear policy on what types of risks would be borne by private sector and what types of risks would be borne by government sector, it is getting difficult to reach an agreement with the private investors.
- Another major issue is the financial implication of hydropower development. It is most capital intensive energy generating option, which requires huge amount of capital, which may not be possible to arrange internal funding, is a must.

- In the present power system, the leakage is about 25%, of which a small percentage is due to the technical reason and rest is due to the illegal misuse of electricity .The effort to minimize the leakage has not produced expected result.
- Lack of coordination between different institutions working in this field is added to the previous one. There is a need of improve energy efficiency by taking positive action regarding subsidy and tariffs.

Dependency on foreign assistance in hydro-electricity sector has resulted in heavy debt and debt service burden, which may eventually push the country into debt trap. A day may come when Nepal may have to receive new loan for the repayment of interest and principal of past loan (Bhattarai, 2004)

1.3 Objectives of the Study

The objectives of the study are as follows:

- To analyze the consumption pattern of energy in Nepal
- To analyze the development of Hydro-electricity in Nepal
- To analyze the contribution of hydropower to national economy
- To analyze the cost of hydropower projects and case study with reference to a successful project.
- To present recommendations.

1.4 Research Methodology

1.4.1 Research Design

The research method is descriptive. Data and information to meet the objectives of this study were collected from secondary sources. These included documents, newspapers, economic journals, magazines, books, unpublished dissertations, government publications, etc.

1.4.2 Data Collection

This study is absolutely based on secondary data. Most of the data and information related to hydropower and other energy were collected from secondary sources.

The data were collected from various publications of Nepal Electricity Authority (NEA), Water and Energy commission secretariat (WECS), Department of Electricity Development (DOED), Central Bureau of Statistics (CBS), National planning commission (NPC) Ministry of Finance (MOF), Nepal Rastra Bank (NRB), Central Library of T.U. and Few other resource center and institutions relevant to hydropower.

1.5 Limitations of the Study

As mentioned earlier, the study is based on secondary data, which is the major limitation of the study. No attempt has been made to collect primary data and information by carrying out survey. Further more, this study doesn't cover different aspects of hydropower like Engineering criteria, selection of the projects; feasibility study procedure etc .It is only the macro study. The Micro level data are not available in the secondary sources.

1.6 Organization of the Study

This study is divided into five major chapters. The first chapter consists of introduction; chapter two covers the review of literature relevant to hydropower development in Nepal. Chapter three deals with consumption pattern of energy in Nepal. In chapter four, hydropower development in Nepal, cost of different hydropower projects, contribution of hydropower to national economy and foreign exchange saving from hydropower development are analyzed. The last chapter, i.e. fifth present summary, conclusion and recommendations.

CHAPTER–II
LITERATURE REVIEW

In order to find out what articles have been written or researched, available literature in the area of hydropower development in Nepal is reviewed. The review includes major books, articles and reports on hydropower development in Nepal.

The power sector "Master Plan, JICA" (1974:35) states that the power market in India is large and growing at an annual rate of more that 10 percent, which may be mainly consumed by northern and eastern regional of India alone. As the report further state that Nepal has a lot possibility in hydropower, if this power can be produced in Nepal at a competitive cost compared to India, Nepal will have access to huge Indian market along the border areas. It cites the example of Bhutan which has become richer than Nepal by selling Hydro-electricity to Indian from "Chukha" hydro project.

Dangol (1979) in the book "Role of hydropower for economic development of Nepal" explains that power is the most important thing for making country industrialization and in modern era-industrialization of any country plays an important role in economic development. Exploitation and utilization of energy sources have contributed so much to the development of industry, agriculture, transport etc. According to him per capita energy consumption is the basic factor not only for the comparison of living standard of the people of Nepal but also for the measurement of the role of economic growth of the country.

Shrestha, (1991) in his book "Hydropower in Nepal: issues and concepts of development" attempted to retrace the history of hydropower development to identify possible course of future evolution. Himself being an engineer, he has endeavored to analyze different aspects of

power development especially hydropower development in Nepal. He was dissatisfied with policy formulating issues and asserted" Although hydropower is in its initial stages of development, a practice of giving no option but pet projects threatens to irreversibly lock Nepal into a policy that will cripple wise management of water resources development. This situation has arisen in Nepal because most of secretariats and other high level decision making are saturated with technocrats who lack practical experience, adequate technical expertise and ability as financiers."

The book critically assesses the concepts and planning of hydropower development in Nepal on the basis of past experiences and presents trends using available data from various agencies and conceptualized planning processes that will not only contribute to the development of vast hydroelectric potential but also will yield long term benefits to Nepal in economic, environmental and human terms.

It also describes general geography, economic settings, historic load growth, contribution of existing power plants, power supply patterns. In this book, concept for development of hydropower in Nepal is proposed with several working models of institutionalized for all three organizations concerned with hydropower, the ministry of water resources, the water and energy commission secretarial and the Nepal Electricity authority.

The intent of this book is to bring the debate on the sustainable utilization of resources in open and change policy before time runs out.

Practical Action (1993, Formerly ITDG) had prepared a report on "Hydropower development in Nepal: taking a sector wide view" makes the case for further study of small and medium scale hydropower schemes developed Asian local capabilities in the context of the overall

development of the hydropower sector in Nepal. In particular it claims that:

– Many studies exist which have looked at the potential for medium and small scale hydropower development. These have largely been ignored.

– A substantial local capacity for designing and implementing hydropower projects already exists within Nepal and this should be used and development.

– There is a need for further appraisal of the small and medium scale options in the context of a sector wide view of hydropower development.

The paper has arisen in the context of the debate over the approval of the large hydro project Arun III so gives more important to the small and medium scale project to launch.

(a) WECS (1995),in its publication “Energy Resources base of Nepal”, prepared by water and energy commission secretariat has the only objective to prepare a joint perspective energy plan for the country which can survive the vigour, of public debate and thus from a consensus for energy planning while entering into 21st century. The book was the technical background document prepared towards the preparation of a perspective energy plan for Nepal to explore the issues and options for a long term energy development strategy.

In this context the book has discussed the different sources of energy in Nepal, their present status, potentiality and how the different energy sources can be prominent in Nepal.

As the discussion on different sources of energy in Nepal, Hydropower is the prominent source of energy having a lot of potentiality

but not reaped properly. The book highlights that it is the tragedy of our country that the contribution of Hydro-electricity in the overall energy consumption of Nepal is low although its share has been increasing. Regarding hydropower as a source of energy the book mentions "Nepal's steep topography copied with the favorable hydrology and dense river network, provides great opportunities for the development of hydropower plants of any capacity."

(b) WECS (1995), the report published by water and energy commission secretariat on socio-economic issues in energy development that energy is basic necessary for survival. It is necessary for development activities to promote education, health care, transportation and infrastructure for attaining a reasonable standard of living and it is also a critical factor for economic development and employment. Shortage of biomass fuels has forced urban households and industries to switch from biomass fuels to imported fossil fuels and other commercial form of energy. Deforestation and desertification are threatening to traditional energy supplies and agro-based rural economy. For the promotion of rural sector energy sources and needed.

The concluding idea of the report was that, this report discussed sustainable development as the key word for need oriented, self reliant and environmentally sound development and says that increased economic activities will require more energy input. Nepal relies excessively on the form of renewable energy, i.e., wood from forest and its role in balancing ecosystem has been decreasing. We have large amount of water resources, which could be exploited for hydropower, hydro based energy used in the domestic and industrial sector. It contributes development of the country as a whole.

IIDS (1995), in its report “Nepal country report” states that power development in Nepal should aim at maximizing the economic benefits from hydropower development through an optimum development of the country's river basins taking into consideration water requirements in other sectors, particularly, irrigation, domestic, industrial water supply and waterway transportation.

Jha, (ed, 1996) in "Sustainable Development of small hydropower in Nepal" endeavors to analyze the government policy towards the development of small hydropower in Nepal and also the cost effectiveness of this sector. He highlights the essentiality of small hydropower development not only from point of view of power development but also from the point of view of reducing regional imbalances in development and for arresting the migration of population from the hills to the tarai.

He concludes that despite the fact that per unit cost of production is huge as compared to the medium/large project, important of small hydropower in economic development is not less. He means to say that neither small hydropower can be substituted for the medium/large nor medium/large can be for small. Therefore, small hydropower and medium/large hydropower projects can only be complementary rather than competitive to each other.

In his paper Mohan Dhoj Karki, states how small hydropower could increase irrigation potentiality and there by contribute to the growth of agricultural sector of the country.

Similarly Indu Shumsher Thapa, presents retrospective and prospective views about the impact of small hydropower on the development of cottage and rural industries.

Hydropower development has multiplier effect on the economy is the overall conclusion of the different articles included in the book. An analytical study has been made in chapter five by Mr. Ramesh C. Aryal about the projects of the development of the tourism sector by promoting small hydropower.

Shrestha (1996) in "Historical development of hydro-electricity and its problem" highlights different aspects of hydropower in Nepal. The sole objective of his paper was to show historical development of Hydro-electricity in Nepal, present status and its potentiality along with its problems.

As he has mentioned the only sellable market for Nepal's hydropower is India. So he has highlighted the need for power exchange between India and Nepal. It is the reality of Nepal that our country is extremely poor in coal and petroleum resources, so the only alternative left to the country is the development of Hydro-electricity. On the same periphery, he has mentioned a few points which shows the necessity of developing Hydro-electricity, among which important are as follows:

– Nepal being extremely poor country in coal and petroleum resources, the only alternative left to the country is the development of hydro-elasticity.

– Essential for developing agriculture, industry, transport like trolleybus and rope way services.

– To shift large amount of money in other development sector which we spent to import diesel and kerosene.

Some problematic aspects which he highlights are:

– Lack of capital.

– The river projects in Nepal are run-off river type and they are costly in power generation.

– The price of electricity per K.W. for different sectors of economy are quite high compared with other countries.

The conclusion of the paper was that the water power potentiality of Nepal is greatest which is second position in hydro electricity potentiality in the world and first position in Asian country. For the prosperity of country it can play a leading role leaving other sectors far behind.

Malla (1996), while emphasizing the need for private sector participation in hydropower development to meet the growth in demand in the future, advocates for a long term plan to export power to neighboring countries. He argues that Nepal's requirement of hydropower being far less than its potential, surplus power may be exported to India for the country's benefit.

Upadhaya,(2002) in “Hydropower Development in Nepal issues of equity and environmental justice” states that hydro-electricity properly harnessed can contribute to economic growth, poverty alleviation and environmental conservation enhancing the quality of life and promoting human development. Improper development of Hydro-electricity on the other hand can lead to social inequality environmental destruction, social conflict, collapse of growth and ultimately to aggravation of poverty. So the objective of the study was to examine the overall impact of hydropower development on social and environmental equity to identify the research need on issues on hydropower development.

His conclusion was that Nepal has not paid much attention to the aspects of social equity and environmental justice in hydropower development.

Various policies, acts and regulations have emphasized the physical side of the environment more than the socio-cultural aspects. So he suggests emphasizing this aspect and says "These were not must of issue until now since local communities were not aware of their rights and civil society was not capable of defending their rights. However, with local communities and civil societies becoming increasingly vocal, unless these issues of social equity are dealt with properly, the development of hydropower is likely to be retard in the future.

Bhadra, (2004) in the article "Hydropower Development in Nepal: problems and prospects" highlights the prosperity that Nepal can achieve and can accelerate the development pace by harnessing it. Along with prosperity, there are some hurdles in harnessing this large potential:

– Serious gaps in planning and policy making.

– Lack of integration of Hydro-electricity with the development process.

Bhadra's conclusion was that for the betterment of the country, instead of thinking for the export of hydropower market, we should concentrate to integrate hydropower in different aspects of economy such as small industries, transportation and communication, lift irrigation, cooking etc.

Dhital, (2004) has highlighted different status of hydro power such as cost, revenue, demand and environmental aspects of Hydro-electricity in the article, "hydropower development in Nepal".

He comes to the conclusion that hydropower development should be considered as one of the most important facets of economic development. He further states that the process of electrification should be demand oriented rather than project oriented. It is because of the high development costs, generation, the question of competitiveness is always

haunting Nepal. So we have to find practical ways to reduce cost to make tariff affordable to the common Nepali and after competitive prices to secure the export market at the backdrop of the emerging possibilities of regional trade in hydropower.

Bhattarai, (2004) in his book" Hydropower Development in Nepal" presents the estimates of financial resources for the development of hydropower in Nepal for the next 30 years. He also discusses energy consumption pattern, source, trend and different financial resources in the present condition and requirement for coming 30 years.

According to Bhattarai, electricity generated by different sources is mainly consumed by domestic sector, so we should concentrate our effort to use electricity in the small and large industries so that it can accelerate development pace, Per capita electricity consumption has been growing significantly. So in order to meet the domestic demand, Nepal should increase investment in hydropower but reality is that we cannot manage that much of finance from our internal source. Because of such situation foreign aid plays an important role in harnessing hydropower potentiality.

On the basis of his study he recommends small – Medium and micro hydropower for Nepal. He further states that preference should be given to mobilize domestic financial resources by encouraging private sector investment in hydropower project.

Adhikari, (2006) in his book “Hydropower Development in Nepal” highlights the prospects and challenges of hydropower. As the country has abundant water resource she has a lot of prosperity but there are challenges too.

– Producing hydropower in sufficient quantity and quality to meet the requirement is a challenge out due to financing and cost considerations.

– To maintain the regional balance in production and distribution capacity.

He concludes hydropower potential of Nepal is huge and sustainable hydropower development becomes the key to make Nepal's economic growth scenario brighter, gaining deep inroads into the national goal and priority of poverty reducing.

Neupane (Aug. 16, 2006) in the Article "Hydropower: opportunities and challenges" published in The Kathmandu post states that only at a time of petroleum products price hike, the debate of new hydropower projects becomes hot. If there is no such news, the issue falls on shadow. Highlighting the present condition of demand and supply of hydropower in Nepal, he states that demand increases when supply decreases. During dry season there is deficit power but during wet season the power becomes excess." So to overcome such imbalances on demand and supply run-of-river projects are to be slotted to address base load where as peak load is to be met by storage projects like Kulekhani.

According to him, though after the liberalization of the economy, private sector's participation has increased but the attraction of the private sector is still lower than the expectation due to government procedural complications, political instability, political instability and insufficient infrastructure.

Though hydropower projects are capital intensive and the government is unable to arrange adequate financial resources to finance such projects, investment of private sector is essential. Indian interest for power trade between Nepal and India is very crucial for Nepal to be able to capture the benefit from the Indian power crisis. He comes to the conclusion that procedural complication should be simplified by the government and play role to create favorable environment for investment by the private sector rather than the regulatory and investing role.

CHAPTER–III

CONSUMPTION PATTERN OF ENERGY IN NEPAL

3.1 Importance of Energy

Energy consumption is used as one of the indicators of life standard. Energy plays an important role for the modernization of agricultural, industrial and other sectors. The modern human life is impossible to imagine without energy especially that of electricity. In agricultural sector, the use of agricultural implements such as pump set, tractor, harvester, needs some kind of energy. So energy plays an important role for the acceleration of economic development of a country like Nepal.

Energy is heart and soul of industrialization. The objective of industrialization can not be achieved without energy. Not a single machine of the modern world can operate without energy though whatever form it may be. Thus the importance of energy is not only in the economic activities of a country but also in social improvement of the people. Energy also influences the relationship between different countries significantly in this modern era.

3.2 Consumption of Energy in Nepal

Hydro-electricity, biomass, coal, petroleum products, and alternative energies such as solar, wind, etc are the most important types of energy consumed in Nepal.

3.2.1 Biomass

Biomass is a term used in the context of energy to define a range of products derived from photo synthesis. Annually, through photosynthesis, solar energy equivalent to several times the world's annual use of energy

is stored in the leaves, steams and branches of plants. Of the various renewable sources of energy, biomass is thus unique in that it represents stored solar energy. In addition, it is only renewable source of carbon, and is able to be converted into convenient solid, liquid and gaseous fuels.

The biomass energy constitute about 92% of total energy consumption of which fuel wood share about 69%, agricultural residue - 15% and dung 8% [WECS, 1994]

Biomass resources suitable for energy production encompass a wide spectrum of materials. These range from fuel wood collected from and natural forest, farmlands and through agricultural and forestry crop grown especially for energy purpose, agricultural and forest residues, food and timber processing residues, municipal solid waste and sewerage. In the context of Nepal the following are the major biomass resources.

a. Fuel Wood

As the data in Table 3.1 shows fuel wood consumption is increasing every year, implying rapid deforestation. The higher rate of fuel wood consumption is directly related to the forest damaged. In the first eight months of 2005/2006, consumption reached maximum as of 6878 T.E. Over the years, the area covered by forest has been decreasing. There might be other causes of deforestation beyond firewood but it is the prominent one.

Table 3.1 Consumption of fuel wood

('000 Tonne of oil Equivalent)

FY	Fuel wood Consumption
1990/91	4980
1991/92	5084
1992/93	5191
1993/94	5300
1994/95	5412
1995/96	5525
1996/97	5574
1997/98	5694
1998/99	5816
1999/2000	5941
2000/01	6068
2001/02	6325
2002/03	6451
2003/04	6591
2004/05	6733
2005/06*	6878*

Source: Annex V

* estimate of first eight months.

b. Agricultural Residues

It is a traditional kind, natural source of energy used in Nepal. The contribution of agricultural residue in total energy consumption was 3.80 percent in 2004/2005. Rice husk, rice straw, rice bran, maize, cobs, maize straw, wheat straw, jute stick, etc are the major agricultural residues used as sources of energy.

c. Animal Dung

Animal residue is used for cooking either in the form of dung cakes or in family scale biogas digests. Dung is mostly dried and burned directly for cooking purpose. Alternatively it is used for biogas plants in which it is used both for energy and organic fertilizer. It is the traditional source of energy which is very much popular in the terai region.

Table 3.2: Consumption of Dung Cake

('000 Tonne of oil equivalent)

FY	Consumption of Animal Dung
1995/96	412
1996/97	421
1997/98	430
1998/99	439
1999/2000	448
2000/01	457
2001/02	446
2002/03	477
2003/04	487
2004/05	497
2005/06*	507

Source: Annex V

* estimate of first eight months

3.2.2 Petroleum Products and Coal

Petroleum products and coal are the commercial sources of energy, which are not available in our country. These are imported from the neighboring country India. So a huge amount of money is drained to import petroleum products and coal. With the increasing urbanization, vehicles are also increasing day by day; use of kerosene in urban areas for cooking, lighting in rural areas is also increasing with rapid population

growth. So the consumption and import of petroleum products and coal have been increasing year after year. Petroleum products occupies 69.5% out of total commercial energy consumption in 2004/2005.In overall energy consumption scenario it occupies 8.18 percent. Similarly coal product occupies 14.99 percent out of total commercial energy consumption, but its share is comparatively less than petroleum in the overall energy consumption scenario i.e. only 1.76 percent.

Consumption trend of petroleum products and coal are presented in the Table 3.3, which show an increasing consumption pattern.

Table 3.3 Consumption of Petroleum Products and Coal

('000 Tonne of oil equivalent)

FY	Consumption of petroleum product	Consumption of coal
1995/96	507	72
1996/97	554	60
1997/98	625	61
1998/99	661	68
1999/2000	709	246
2000/01	734	174
2001/02	758	154
2002/03	753	134
2003/04	747	171
2004/05	705	152
2005/06*	724*	241*

Source: Annex V

* Estimated of first eight months

3.2.3 Alternative Sources of Energy

Since a long time back efforts have been made to search for appropriate alternative technologies in Nepal. In view a acute situation of energy and the implication of growing imports of POL products in the BOP of the economy, efforts have been made towards development of

alternative sources of energy. From the biogas plants, although it has not yet reached at a level as it could save fuel wood and petroleum products.

As compared to other alternative sources of energy, biogas helps to conserve valuable forest resources. So far as solar energy is concerned, the prospect of developing this source seems feasible but due to the very sophisticated technology and high cost, this source has not expanded much. Solar energy has been used traditionally for drying such things as crops, cloths, fuel wood, and crop residues. The solar energy potential in Nepal is estimated to be about 26 million MWQ. Currently there are two types of solar energy technologies in the country: solar thermal system and solar photo voltaic (PV) system.

Solar water heaters and solar dryers are the two main types of solar thermal device. Of these solar water heaters have the widest distribution in Nepal. There are 30 to 35 firms, mainly concentrated in Kathmandu, that manufacture them. The present installed capacity in estimated to be around 300,000 liters per day (WECS, 1996). These heaters are suitable for use throughout the country excepting those regions that have long and harsh winters where the temperature falls below freezing point. However because of the high cost (Rs. 23,000 for a 200 liters system) this technology is too expensive for most people.

About 15 different types of solar dryers have been used in the country for drying species, fruits, vegetables and herbs. The fabrication of solar dryers is simple and they can be constructed using locally available materials. However, solar dryers have not been able to establish their credibility because of high capital investment required and lack of proper type designs for different products and quantities. Such designs require a multidisciplinary knowledge of science and technology related to drying.

Solar cookers were introduced by the Research Centre for Applied Science and Technology (RECAST) in 1977 as parboiling cookers. Because of their high cost, this technology has not become popular. Although various types of solar cooker have been developed to reduce cost, effects to improve the efficiency of solar cookers have not been encouraging.

The solar PV system is another technology which converts solar energy directly into electricity. The NEA has carried out solar photovoltaic based rural electrification in different locations with an installed peak power of 130 KW. Forty-three airport sin the country use solar PV energy. Nepal Telecommunications has also installed solar PV sets in 16 locations. The cost of a centralized solar PV-based power system is high, however compared to electricity generation by smaller micro hydropower units.

Lately, private entrepreneurs and non-governmental organizations (NGOs) have been showing interest in the dissemination of solar PV home fighting systems. The cost of a SPV home system (30-35W) ranges from NRs 30,000 to NRs 35,000 depending on the system's capabilities and facilities. These home systems are gaining popularing in some areas of Nepal (Shrestha and Bajracharya 1998).

Another alternative source of energy is wind energy which is not a dependant source, has not been in an extensive use as well, and is still in its initial experimental phase. But while considering its geographical feature and wind velocity, there is possibility to develop wind energy.

A wind power system was installed in Kagbeni to generate about 201 KW of electrical power (annual energy of 50 MW/h) but was damaged as a result of the poor design. The high installation cost (about US$ 6800 per KW/h doesn't justify further development (WECS 1994 e).

Another renewable energy technology is improved cooking stoves (ICS). ICS have the potential to save fuel wood used for household cooking. About 11 million tonnes of fuel wood are burnt annually for cooking alone. Theoretically, it is possible to reduce fuel wood consumption for cooking by 50 percent. ICS have an efficiency factor in the range of 15 to 30 percent, whereas the efficiency of traditional mud stoves varies from three to fifteen percent. There are various types of ICS and the efficiency of these stoves varies (Bajracharya and Gangal 1998). The amount of fuel wood saved depends among other things on the type of ICS, the condition of the fuel wood, the type and amount of food prepared, and the type of pots used for cooking. Even with a low performance of 11% fuel wood savings, estimates indicate that one ICS can save an average of one tonne of fuel wood annually.

3.3 Energy Consumption by Source and Sector

The energy sector in Nepal is characterized by a heavy reliance on traditional energy sources, particularly fuel wood which mostly comes from the forests. Despite the declining share of fuel wood in total energy consumption, the relative share of traditional energy has remained almost stagnant over the past decade as the use of animal dung and agricultural resides for fuel has increased. Consumption of commercial energy in the country is growing at a faster rate than consumption of traditional energy, although the consumption level is still very low as a result or the country's lack of industrialization and low level of development. Table 3.4 shows energy consumption by source.

Table 3.4: Energy Consumption Pattern by Source

Energy Consumed ('000 to e)					Percentage of energy consumed			
Year	Traditional	Commercial	Other	Total	Traditional	Commercial	Other	Total
1993/94	5933	483	6	6422	92.4	7.5	0.1	100
1994/95	6059	582	8	6649	91.1	8.8	0.1	100
1995/96	6185	651	11	6847	90.3	9.5	0.2	100
1996/97	6268	691	15	6974	89..9	9.9	0.2	100
1997/98	6403	769	21	7193	89.0	10.7	0.3	100
1998/99	6540	811	25	7376	88.7	11.0	0.3	100
99/2000	6681	1044	29	7754	86.1	13.5	0.4	100
2000/01	6824	1095	34	7953	85.8	13.8	0.4	100
2001/02	6996	1169	39	8204	85..3	14..2	0.5	100
2002/03	7240	1,003	39	8282	87.4	12.1	0.5	100

Source: Economic Survey, 2006.

If we analyze the energy consumption pattern by sector, residential sector has dominated all the other sectors like industrial commercial, transport, agricultural sectors which are very important from the perspective of economic development. Tables 3.5 and 3.6 show the energy consumption by sector.

Table 3.5: Energy Consumption by Sector ('000 GJ)

Sector	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Residential	254853	260951	267542	274341	281533	287815	295159	301143	314655	320368
Industrial	9231	11084	11771	6417	6921	7522	15717	12998	12537	11969
Commercial	2206	2558	2840	3179	2919	3215	3708	4128	4921	4081
Transport	6682	7839	8721	11942	13546	14849	12798	13592	12025	13850
Agricultural	535	640	690	966	1099	711	2968	3152	2776	2888
Other	206	243	262	293	322	342	355	409	454	484
Total	273712	283315	291827	297139	306339	314454	330706	335421	347369	353541

Source: Water and Energy commission Secretariat, Kathmandu, 2005 unpublished data file.

Table 3.6 Share of Energy Consumption by Sector (in percentage)

Sector	1994	2003
Residential	93.1	90.6
Industrial	3.4	3.4
Commercial	0.8	1.2
Transport	2.4	3.9
Agricultural	0.2	0.8
Others	0.1	0.1
Total	100.0	100.0

Source: Water and Energy commission Secretariat, Kathmandu, 2005 unpublished data file.

In overall energy consumption electricity has contributed very low than fuel wood and POL products. The fact can be seen from the table below.

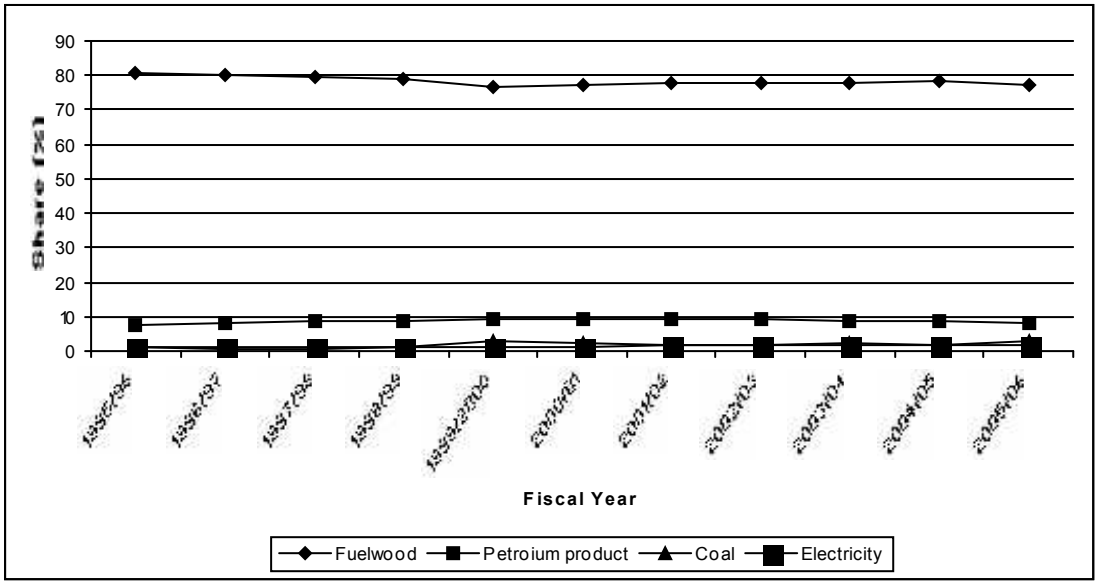
Table 3.7: Share of Different Types of Energy in Total Energy Consumption

(in percentage)

Year	Fuel wood	Petroleum Products	Coal	Electricity
1995/96	80.70	7.41	1.05	1.05
1996/97	79.95	7.95	0.86	1.05
1997/98	79.26	8.70	0.85	1.15
1998/99	78.83	8.96	0.92	1.21
1999/2000	76.57	9.14	3.17	1.28
2000/01	77.12	9.33	2.21	1.38
2001/02	77.69	9.33	1.87	1.46
0002/03	77.78	9.08	1.62	1.54
2003/04	77.53	8.78	20.5	1.65
2004/05	78.14	8.78	1.76	1.83
2005/06*	77.25	8.13	2.71	1.88

Source: Annex V

Figure 3.1 : Trend of Energy Consumption



From table 3.7 it can be seen that fuel wood accounts for the largest proportion of energy consumption followed by petroleum products. The hydropower has contributed only 1.05 percent in 1995/96 and increased only 0.83 percentage points within one decade and reached 1.88 percentages in 2006. The share of petroleum products in total energy consumption is almost eight times higher than that of hydroelectricity. This has entailed expenditure of a large amount of foreign exchange to import POL products .The import bill is increasing year after year because of the price hike of POL products in international market. To decrease the import bill of POL products and increasing income of the rural communities through establishing or expanding cottage and small scale industries, hydropower generation is very important .By supplying households with power for cooking and lightening purpose we can reduce the consumption of fuel wood too. On the one hand consumption of fuel wood caused the depletion of forest, on the other hand it caused indoor air pollution .So the higher demand for fuel wood can be reduced by building micro hydel plants. The import of POL products is increasing. This has accelerated the debt problem of the country. The import of POL products

could be reduced to minimum essentials such as aviation fuel, if hydro-electricity could be expanded with greater efficiency.

In overall, energy consumption pattern, traditional energy source, domestic sector has prominent and dominant role.

3.4 Government Policy on Energy and Hydropower Sector

Prior to the introduction of planned system of development in 1956, there was no hydropower and energy development policy in Nepal. Some Rana rulers had adopted ad-hoc policy in regard to hydropower development in the country. So, policies begun to be formulated with the introduction of First Plan in 1956.

The Tenth Plan (2002-2007), Hydropower development policy 2001, Renewable Energy Perspective Plan of Nepal 2000-2020, Perspective Energy Plan 1991-2017, Water Resource Act 1992, and Electricity Act 1992 are the main policy planning and legislative documents guiding the development of energy sector in Nepal.

For the first time, the first five year plan introduced a policy to study the feasibility of small and medium size hydro projects in Nepal. This policy was also incorporated in the village development program. Apart from that, no other energy related policy was outlined in the first plan.

Establishment and expansion of transmission lines and diesel plants on temporary basis to meet the demand, until the hydropower plants in some big towns like Kathmandu, Birgunj, Hetauda, Biratatnagar etc were completed. This plan also didn’t specifically mention about the energy policy of the government though Electricity Corporation was established in 1964. To improve the administration of Department of

Electricity and Electricity Corporation, policies were formulated in Third plan.

The Fourth Plan (1970-1975) laid emphasis on transmission and network improvement, fixing of power tariff, and power purchase from India for various projects, use of foreign exchange to build diesel plants to meet the demand of Bagmati and Narayani zones. A policy was also formulated for power development categorizing it into five headings, such as construction, transmission lines, small hydel projects, diesel installations and survey.

In Fifth Plan (1975-1980) policies were formulated to fulfill the short term and, long term demand within the country and to export excess power to India and to expand village electrification to promote agriculture development, village industries and production activities.

The Sixth Plan (1980-1985) laid emphasis on the development of small hydel projects in the mountain and remote areas. In order to find out alternative sources of cheaper energy, research and survey activities were initiated. The plan also laid emphasis on narrowing down of regional imbalance in power distribution.

In the Seventh Plan (1985-1990) policies were adopted to initiate projects to meet the long term and medium term power supply with preparation of inventory of hydropower project and to make project attractive from economic point of view. The plan also proposed gradual provision or necessary facilities, incentives and encouragement to the private sector in the establishment and operation of micro hydro plants. In order to expand hydro-electricity in the rural areas during the plan period, Nepal Electricity authority (NEA) was established merging Electricity Department and Nepal Electricity Corporation (NEC).

Comprehensive policies for hydropower and energy development were formulated in Eighth Plan (1992-1997). A policy was formulated to encourage the sole or joint venture of one or more private national investors as well as joint venture with the government and a single or more national or foreign investors. Hundred percent investment from one or more foreign investors was permitted for joint venture or national and foreign investors. Furthermore, private sector was provided concessional loan with a provision to use the network of NEA. Nationalization of hydropower and royalty on power generation up to 100 KW was ruled out. Similarly import license fee, sales tax and custom duty in the import of construction equipment meant for hydropower was exempted. Financial grant was to be provided to the users of devices related to alternative energy. The promoters of alternative energy, non-governmental organization and private sector were given technical and financial assistance for the work. Necessary steps were taken to extend the use of bio-gas plants, improved stoves and the extension of solar energy based equipment such as solar cookers, solar water heater, solar dryer etc to minimize the pressure on forest for fuel wood.

The Ninth Plan (1997-2000) enunciated a long-term policy with a view to raising the share of electricity in total energy consumption from about 1% to 35% in the next 20 years. The major policies mentioned in the plan included institutional reforms to attract private sector in power generation and distribution for maximum utilization of local resources, materials, and indigenous talent and involvement of private sector in developing transmission lines. Emphasizes was laid on implementation of small and micro hydro projects in remote hill areas through people's participation and NGO's in order to achieve balance between demand and supply of electricity.

The plan reinforced the policy of development of alternative energy. The plan proposed setting up alternative energy promotion center for the development and promotion of low cost alternative sources of energy. Special emphasis was given to replace kerosene and diesel by generating micro-hydel, solar and other forms of energy for lighting and other purpose. The private sector was to be attracted and encouraged to conduct feasibility studies and research and promote, disseminate, establish, operate and develop alternative sources of energy through various support and incentives, such as subsidy and government purchase of energy.

The Tenth Plan (2002-2007) lays emphasis on the construction of small and medium reservoir type of hydro projects. The plan intends to promote integrated development of water resources (large as well as export oriented projects) involving private and public sectors and domestic and foreign investments. The plan also lays emphasis on rural electrification, control of unauthorized leakage of electricity and private sector involvement in generating, transmission and distribution. The plan also gives priority to the development of micro hydro electricity, gobar gas, solar energy, wind power and improved chulo etc through private sector and local initiatives and establishment of rural Energy Fund. The plan proposes to improve existing institutional infrastructure for the development of alternative energy and encourage Private and cooperative ownership in this regard.

3.5 Major Issues of Renewable Energy Technologies

In Nepalese context renewable energy technologies received importance only in the Eighth Plan (1992-97). This plan provides detailed policy descriptions and programmers, including the provision for an institutional set-up for the development of renewable energy in Nepal.

Despite relatively attractive economic gains, the development of renewable energy technology in the overall energy scenario is still far from satisfactory as a result of a number of issues that have emerged in relation to its development (WECS 1994e).

The main issues are:

- Social issues related primarily to non-acceptance of the technology;
- Planning and policy issues dealing mainly with the lack of willingness at the policy level;
- Institutional issues dealing with the non existence of responsible coordinating bodies;
- Financial issues dealing with high initial investment costs;
- Technical issues; and
- Managerial and marketing aspects

CHAPTER–IV

HYDROPOWER DEVELOPMENT AND SOME ECONOMIC ASPECTS

4.1 Development of Hydroelectricity

4.1.1 Introduction

It is not a new knowledge that flowing water creates energy that can be captured and turned into electricity. Hydro comes from the Greek word 'hydra' which means water. It is the electricity produced by the movement of fresh water from rivers and lakes. It is a renewable energy source generated from the hydrologic cycle of water which involves evaporation, precipitation and the flow of water due to gravity. Gravity causes water to flow downwards and this downward motion of water contains kinetic energy that can be converted into mechanical energy, and then from mechanical energy into electrical energy.

Hydropower in Nepal is used in two forms – mechanical and electrical. The practice of using hydropower in the form of mechanical energy through traditional water wheels (caused ghettas) goes back to time immemorial. However, the first hydroelectric plant to generate electricity in Nepal was established only in 1911 [Energy resource base of Nepal: 1996]. Hydro-electricity is the most important of the clean, economically feasible, renewable energy options, can be a major benefit of a water resources development projects. Hydropower stations integrated within multipurpose scheme offer other vital facilities such as irrigation, water supply, improved navigation, flood mitigation, recreational facilities so on.

Hydropower has major role to play in the future days of Nepal both in terms of energy supply and water resources development. As with all

options, there is a need to develop the resources according to the highest social, environmental, economic and technical standards.

4.1.2 Characteristics of Hydropower

The most important characteristic of hydropower can be summarized as follow:

- Its resources are widely spread around the world. Potential exist in about 150 countries and approximately two third of the economically feasible potential remains to be developed. This is mostly in developing countries, where the capacity is most urgently required;
- It is a proven and well-advanced technology, with more than a century of experience. Modern power plants provide extremely efficient energy conversion.
- It plays a major role in reducing green house gas emissions in terms of avoiding generation by fossil fuels. Hydro is a relatively small source of atmospheric emissions compared with fossil fired generating options.
- The production of peak load energy form hydropower allows for the best use to be made of base load power from other less flexible electricity sources. Its fast response time can add substantially to the reliability and quality of the electrical system.
- It has the lowest operation costs and longest plan life compared with other large scale generating options. Once the initial investment has been made in the necessary civil works, the plant life can be extended economically by relatively cheap maintenance and periodic replacement of the electromechanical equipment;

- As hydro plants are often integrated within multipurpose developments, the projects can help to meet other fundamental human needs (for examples, irrigation for food supply, domestic and industrial water supply, flood protection). The reservoir water may also be used for other functions such as fisheries; discharge regulation downstream for navigation improvements, and recent hydropower plants can help to finance these multipurpose benefits. In the area, such as the creation of wild life habitats;
- The fuel (water) is renewable and is not subject to fluctuations in market conditions. Hydro can also represent energy independent for many countries.

4.1.3 Advantages of Hydropower Projects:

Indeed, hydropower projects have many benefits which can be universally accepted. Not only accessing hydropower projects by naked eye but, if we autopsy hydropower projects comparing with other power generating projects, it is superior to them. The main advantages of hydropower are as follow:

- Power is produced at a fairly constant rate so that there is little need for storage batteries, and power is available at any time.
- The technology is easily adapted for manufacture and used in developing countries and remote areas.
- No fuel is required i.e. hydropower plants produce electricity without consuming power and maintenance cost are low.
- The technology is simple and robust, leading to life times of over 20 years without major new investment.

- Hydropower provides a reliable, efficient, safe and economic source of power for increasing effectiveness of the decentralized industries system.

- In the process of power generating from hydro power, there is almost, possibility of multi-purpose water use and water management such as irrigation and regulations of river flows both during flood season and low flood periods.

- Independence of fluctuating fuel prices and supply disruptions, a renewable energy source, save consumption of fossil, fuel or firewood which constitute classical energy sources that contribute to the greenhouse effects or atmosphere pollution.

4.1.4 Hydropower Potential of Nepal

In the world scene the total annual energy potential has been calculated theoretically to correspond roughly to 80,000 TWH. Of the estimated probable potential, technically and economically useable energy has been assessed as 10,000 THW. About 48 %of this total belongs to the developing countries (Nigma P.S., 1986).

Not only among many developing countries but also in the world scenario too, Nepal has dominance in water resources. The geography has blessed Nepal hydropower potential of 83,000 MW (based on an average flow), of this potential about 42,000 MW (some also estimate 44,000 MW) has been assessed to be economically feasible. The mountainous topography of the country provides the possibility of a series of high dams, which can hold huge quantities of water for multipurpose use. This storage has the potential to augment dry season flow by about 5,400 m^3/Sec. Similarly, flood damages at downstream reaches caused by monsoon rain could be substantially mitigated.

Table 4.1 shows Nepal's theoretical, technical and economic hydropower potential. Karnali and Mahakali rivers from theoretical, technical and economic prospective possess the highest potential. Southern rivers possess low potential because they do not flow from the Himalayan region like other major rivers.

Table 4.1: Hydropower potential in Nepal

In million KW

River Basin	Theoretical Potential	Technical Potential	Economic Potential
Sapta Kosi	22.35	11.40	10.860
Sapta Gandaki	20.65	6.66	5.270
Karnali and Mahakali	36.18	26.57	25.125
Southern Rivers	4.11	0.98	0.878
Country's' Total Potential	83.29	45.61	42.133

Source: Energy Synopsis report, WECS, Nepal 1992/93

4.1.5 Classification of Hydroelectric Schemes

Classification schemes, based on the size, differ from country to country. It is generally guided by the size of demand, planning horizon and timeframe of implementation of schemes. These are grouped under categories as follows:

(i) Micro scale, up to 1 MW schemes, to serve for individual, community and rural enterprise in remote areas;

(ii) Small scale up to 10 MW scheme, to serve the isolated and/or local gird supply including with option to feed into main grid;

(iii) Medium scale up to 500 MW to meet the national demand and export, in excess, for increasing return from their investments; and

(iv) Large-scale schemes above 500 MW to satisfy the long-term national requirement as well as for large scale export to the neighboring countries.

- Under small category, HMG provide the subsidy to promote development of micro or mini hydro schemes of up to 100 KW.

4.1.6 Nepal's Status in Hydropower among SAARC Countries

As already mentioned, Nepal is rich in hydro resources, with one of the highest per capita hydropower potentials in the world. A comparison of Nepal's position with the world in general and SAARC countries in particular reveal certain interesting facts in hydropower potentiality, utilization of hydro-electricity generation and consumption. It has been shown in Table 4.2.

Table 4.2 Nepal's Position in Hydroelectric Power in the World and SAARC

	Total potential (million kW)	Share of World potential (%)	Utilization as percent of potential (%)	Share of Hydroelectric power in total electricity generation (%)	Share of Hydro electric power in total electricity consumption (%)
Total world	2494.00	100	27.83	18.53	19.50
Nepal	**83.29**	**3.34**	**0.36**	**91.67**	**92.86**
India	75.40	3.02	33.16	17.79	14.87
Bangladesh	0.230	0.01	0.00	6.61	8.00
Bhutan	20.00	0.80	NA	95.96	95.96
Maldives	NA	NA	NA	NA	NA
Pakistan	20.77	0.83	24.07	35.58	37.91
Sri Lanka	1.18	0.05	84.75	68.33	72.58

Note: 'NA' means not available

Source: A study of Demand for electricity and financial requirement up to 2030, Bhattarai, 2004.

In Nepal, only 0.36 % of total potentiality has been harnessed .So far it is very low in comparison to India, Pakistan, and Sri lanka.

Sri Lanka has the lower potentiality of 1.18 million KW in SAARC but the utilization 84.75 Percent, highest in the region. The share of hydroelectric power in total electricity generation in Nepal is second highest next to Bhutan. NEA has forecasted that until 2020 A.D. Peak load demand would be 1804.0 MW. So while formulating future plans and strategies these should be taken into account.

4.1.7 Development of Hydroelectricity in Nepal

The history of hydropower in Nepal can access dividing into two categories:

a. Before Planning

The history of power development in Nepal is not old. In Nepal the first hydropower plant was established at phrping (500 KW) in 1911 A.D, during Prime Minister Chandra Shamsher Rana's time to meet the energy requirements of the members of the ruling class. At that time the domestic consumption of electricity was limited to higher-class people.

In order to meet the growing demand of electricity another power plant was established at Sundarijal at the time of Juddha Shamsher Rana in 1939.The installed capacity of that power plant was 900 KW. Morang Electricity Company was established in 1936 along with other several diesel plants. Before 1956 utilization of water resources for electricity generation was negligible.

Table 4.3 shows electrical installations that were in operation in country before the introduction of First Plan.

Table 4.3: Electrical Installations before 1956

Name of the Plant	Power supply in K.W.

1. Pharping Hydal Plant	500
2. Sundarijal Hydal Plant	640
3. Mahendra Diesel Plant	1728
4. Biratnagar Jute Milles Power	
(a) Steam	1400
(b) Diesel	750
5. Morang Hydro-electricity Company	677
6. Birganj Electricity Company	225
Total	**5,920 KW**

Source: Electricity Development Report, 1996

Until 1951 when the 104 years Rana regime was there ,There was hardly any policy for the development of the country. Until the beginning of First Plan in 1956 government sector was confined to kathmandu valley and private sector was confined to Biratnagar and Birgunj.

b. Power Development under Different Plans

Considering the link between energy consumption and economic development, energy development needs to be accorded high priority in Nepal's development planning. So with the beginning of plan period this matter was begun to address.

i. First Plan (1956-1961)

The first plan proposed to increase the generating capacity to 20,000 KW at a cost of Rs. 30 million during 1956-61. The power plants installed and commissioned during the first plan are listed in Table 4.4.

Table 4.4: The power plants installed and commissioned during First Plan

	Name of Plant	Power Supply in K.W.
1.	Teku Diesel plant	500
2.	Bhaktapur Diesel Plant	200
3.	Naxal Diesel plant	500
4.	Lalitpur Diesel Plant	500

	Total	1750 KW

Source: First Plan, NPC, HMG.

At the same time Preliminary work on investigation and design were undertaken for (i) Trisuli Hydal project (ii) Thadokhola Hydal project

(iii) Panauti Hydal Projec (iv) Karnali Hydal Project

During this plan period an additional supply of 750 KW of power was added to the system mainly by Teku (500 KW) and Bhaktapur (250 KW) diesel power plants in Kathmandu valley. In the interim plan also was added to the system by the completion of Lainchour (528 KW) and Naxal (528 KW) diesel power plants. We see a rapid growth of diesel power in this period to meet the immediate demand of the valley.

ii. Second Plan (1962-1965)

Top priority was accorded to power development in the second plan, conforming to its principal objective of creating the basic 'Overheads' for future plans. A sum of Rs. 91,000,000 which constituted 15% of the plan outlay, as against 9% in the First plan.

During this plan period the main aim was to create favorable condition for the implementation of long term development plan by developing infrastructure. In this plan first priority was given to transport and electrical development programme.

Accordingly, the target was set for the generating 22,000 KW of additional power from various projects as shown in Table 4.5.

Table 4.5: Targated projects of the second plan

	Name of the Project	Power Supply in K.W.
1.	Panauti Hydal Project	2400
2.	Trisuli Hydal Project	9000
3.	Thadokhala Hydal Project	350
4.	Micro Plants	

	a. 4 Diesel Plants of 100 KW each	400
	b. 4 Water Turbines	100
5.	Nepalgunj Diesel Plant	2500
6.	Birgunj Diesel Plant	500
7.	Biratnagar Diesel Plant	3000
8.	Hetauda Diesel Plant	4470
	Total	27740 KW.

Source: Second plan, NPC, HMG.

Achievement of the second plan period was limited to Panauti Hydel Project having capacity of 2400 KW. The most important achievement in this plan was the establishment of Nepal Electricity Authority.

iii. Third Plan (1966-1970)

The third plan set the target of supplying additional electric power of about 60,000 K.W. in three areas namely eastern, central and western from three major rivers.

The target of the Third Plan period was to generate additional 58790 kw electricity from both diesel and hydro plants.

Table 4.6: Target of Third Plan

	Name of the region	Power Supply in K.W.
A.	Central Region	
1	Hetauda Diesel Plant	5000
2	Pokhara Project	500
3	Trisuli Hydal Project	18000
4	Gandak Hydal Project	10000
5	Marsyangdi, Kali and Kulekhani Hydal Project	16000
B.	Eastern Region	
6	Biratnagar Diesel Plant	1470
7	Kosi Hydal Project	7500

C.	Western Region	
8	Diesel Plant	500
	Total	**58,790**

Source: The Third Plan, NPC, HMG

In this plan Marsyangdi, Kaligandaki and Kulekhani were surveyed. This survey estimated 16,000 KW extra hydro-electricity from these projects.

iv. Fourth Plan (1970-1975)

In the Fourth Plan government accorded second emphasis on electricity development. Rs 225.3 million rupees were allocated which accounted for 8.79% of total budget to the development of electricity. In this plan 35,000 KW was estimated to be generated from large hydel projects, 500 KW was estimated from the small micro plans and 6,220 KW from diesel plants. The fourth plan had set a target of generating a total of 403,000 KW of power from various projects (Table 4.7).

Table 4.7: Target of Fourth Plan

	No. of Project	Power Supply in K.W.
1.	Trisuli Hydel Project	9,000
2.	Sunkosi Project	10,000
3.	Gandak Hydel Project	10,000
4.	Kosi Hydel Project	6,800
5.	Diesel Plants	4,000
6.	Micro Hydel Plants	500
	Total	**40,300**

Source: Fourth Plan, NPC, HMG.

The fourth plan had generated only 25,800KW of power from large hydel project, 240 KW from small hydel project and 2,462 KW from several diesel plants.

The achievement in hydro electricity was near 71.74%.Feasibility study of Kankai Project and the beginning of Devighat and Kulekhani Hydal Project were other achievement of fourth Plan. During the plan period 12 new districts were electrified and 152.2 km electricity transmission line was constructed.

In 1974, Eastern Electricity Corporation was established in accordance with Nepal Electricity Corporation Act in the eastern development region with view to bring about uniformity and regularity in the region. The corporation took over the ownership of Morang Hydel Electricity Company.

Table 4.8: The Achievement of Fourth Plan

	Name of Project	Achievement in K.W.
1	Trisuli Hydel Project	9,000
2	Sunkosi Hydel Project	10,000
3	Gandak Hydel Project	not achieved
4	Kosi Hydel Project	6,800
5	Diesel Plants	4,000
6	Micro Hydel Plants	500
	Total	**30,300**

Source: Fifth Plan, NPC, HMG

v. Fifth Plan (1975-1980)

In the fifth Plan period, power generation station, conduction of transmission line, electrification and survey of new projects were included. The plan had set power production target of 58,845 to 58,945

KW (Table 4.8). Regarding transmission line, the target was construction of 345 km of different KV line.

Table 4.9: Target of Fifth plan

	Name of Project	Target in KW.
1	Devighat Hydel Project	14,000
2	Kulekhani I	30,000
3	Gandak Hydal Project	10,000
4	Shikharbas Hydel Project	2,400
5	Small Hydel Project	545
6	Biratnagar Diesel plant	1,500
7	Pokhara Diesel Plant	500
	Total	**58,945 KW**

Source: Fifth Plan, NPC, HMG.

In this plan period, small hydel included 3 projects generating electricity of 445 KW to 545 KW. The Jhupra small hydel project, situated in Surkhet district was to be constructed during the plan period, which was carried from Fourth Plan.

The Fifth Plan also laid targets for distribution of electricity transmission line by constructing transmission lines of different KV (Table 4.10).

Table 4.10: Transmission lines in Fifth Plan

1	Hetauda	▪ Gandaki (This programme was started 4th plan)	132 kv line
2	Gandaki	▪ Butwal	132 kv line
3	Bharatpur	▪ Pokhara	66 kv line
4	Butwal	▪ Tansen	33 kv line

Source: Fifth plan, NPC, HMG

During the Fifth Plan period survey and feasibility studies of i. Gandaki and Koshi valley masterplan ii. Bagmati, Kulekhani II and Rapti hydro electricity survey and potentiality study iii. General study of

Karnali hydel project and iv. Central administrative building finishing programme were completed .

In this plan target of electricity generation and construction of transmission line was high. But achievement was very low in both. Total achievement of electricity was just 18,712 KW. On this achievement, 16,220 KW from different hydel projects and 2,492 KW from diesel plants. In the field of transmission line only 182 km line was finished.

Table 4.11: Achievements of Fifth plan

	Name of Project	Achievement in K.W.
1	Hydro Electricity	16,220
	a. Large Hydro Project	15,000
	b. Small Hydro Project	1,220
2.	Diesel Plant	2,492
	Total	18,712
3.	Transmission line	182km

Source: Sixth plan, NPC, HMG

In this plan period the achievement in electricity production was 31.75 percent of its total target. Similarly in transmission line 50.14 percent was achieved as that of targeted.

vi. Sixth Plan (1980-1985)

In this sixth plan, like other previous plans electricity sector was given high emphasis with particular focus on development of hydro power station. New project survey and electrification in new places with the help of new transmission lines and stations were proposed.

This Sixth Plan had set to generate 1, 24,000 KW from Large Hydel Project and 5,829 KW from small hydel project. In this way 129,923 KW from hydro power and 15,000 KW were to be from diesel plant. Thus it makes total power production of 144,923 KW. The achievement of the plan is presented in Table 4.12

Table 4.12: Achievement of Sixth Plan

	Name of Project	Production in K.W.
A.	Large Scale Hydel Project	
	1. Kulekhani (I)	60,000
	2. Devighat	14,000
B.	Small Scale Hydel Project	
	1. Gorkhe	64
	2. Phidium	206
	3. Dhading	32
	4. Doti	200
	5. Jomsom	260
	6. Syangja	80
	7. Jumla	200
	8. Baglung	175
	Total	75,217

Source: Seventh Plan, NPC, HMG.

The sixth plan has achieved 57.89 percent of its target in hydropower generation.

This sixth plan has conducted some survey and study about some new projects. In the field of transmission line, those were under construction and its achievement was nearly 90%.

vii. Seventh Plan (1995-1990)

During the Seventh Plan period, construction of Kulekhani Hydro-Electricity Project, Phase II (32,000 KW), Marsyangdi Hydro Project (66,000 KW) and Andhi Khola Hydro Project (5,100 KW) were presently under construction and which were carried over from the Sixth Plan were to be completed. Also other small hydro-electricity projects were to be completed. The projects planned for completion during the seventh plan are presented in Table 4.13.

Table 4.13: Power Projects Planned in the Seventh Plan

	Name of Project	Power Supply in KW
1	Taplejung	125
2	Khadibari	250
3	Teharthum	100
4	Bhojpur	260
5	Namche	484
6	Salleri	200
7	Okhaldunga	125
8	Ramechhap	75
9	Manag	80
10	Chame	50
11	Tatopani (Myagdi)	1000
12	Chourjahri	150
13	Syarpudaha	200
14	Bajura	200
15	Bajhang	200
16	Darhula	50
	Total	**3,549**

Source: Seventh Plan, NPC, HMG.

Regarding transmission, different transmission line projects were carried over from the sixth plan. During Seventh plan period different project potential study and engineering work were conducted by HMG to fulfill the demand of the country.

The progress in the electricity sector and alternative sources of energy during the Seventh Plan (1985-1990) and the interim period (1991-1992) is given in Table 4.14.

Table 4.14: Progress during Seventh Plan and Interim Period

	Item	Seventh Plan 1985-1990	Interim Period 1991-1992
	Electricity		
1.	Generation (KW)		
	a. Hydropower	108,055	6,690
	- Medium and large projects	101,000	51,000
	- Small projects	2,000	1,590
	b. Fuel operated	-	26,000
2.	Transmission line (km)	1,226	197
	- 132 kv	723	-
	- 33kv (Sub-grid)	503	197
3.	Alternative Sources of Energy		
	a. Small Hydropower (KW)	1,145	239
	b. Solar energy generated (KW)	80	30
	c Wind energy (KW)	20	-

Source: Eighth Plan, NPC, HMG.

viii. Eighth Plan (1992-1997)

Like previous plans, Hydro-electricity was given high emphasis in the Eighth Plan. The target was to gradually electrifying the rural areas where majority of the people live. Electrification work was proposed to be undertaken in about 1,200 villages of 21 districts.

Construction of New Hydroelectric Projects

All the construction work of Jhimruk hydro-electric projects with an installed capacity of 12.5 MW under construction in Pyuthan was to be completed. Construction of the Kaligandaki 'A' hydroelectric project with an installed capacity of 100 MW was proposed to be started. Work related to the first phase of Arun III hydroelectric project was to be

initiated in order to generate power from the Arun River. A total of 29.7 MW of additional hydropower was to be generated during this plan period with the respective contribution of 12.2 MW, 12.5 and 0.5 MW respectively by refurbishing Trishuli-Devighat hydropower station, the Jhimruk hydro-electricity project and small hydroelectric projects.

Programme for Construction, Extension and Strengthening of Electric Transmission lines

Programmes for the construction, extension and improvement of the electrical transmission lines have been incorporated to distribute the electric power generated from different power stations in the kingdom with the minimum leakage to different places and settlements as per demand. Construction of 42 KM long Dhabi-Kataiya 132 KV transmission line had to complete .Similarly,construction of 200 KM long 132 KV transmission line between Banke (Kohalkpur and Kanchanpur (Mahendranagar) of the remaining portion of the control grid was to be constructed during 8th plan period. Similarly, 105 KM long Atariya-Dadeldhura-Dipayal 66 KV transmission line and various 100 KW long 33 KV sub grid lines were proposed to be completed within the plan period. In addition to this 132 KV and 66 KV transmission lines passing through high electricity consumption areas especially of the central grid i.e. Biratnagar-Kathmandu valley and Hetauda-Bharatpur, Birgung and Butwal-Bharatpur sectors were to be strengthened.

In the process of development, construction and study of hydropower projects in the eighth plan period, medium projects such as Arun III (402) MW and Kali Gandaki 'A' (144 MW) and small projects such as Powa (6 MW) Chilime (20 MW) and Modi (14 MW0 were initiated. Out of these Arun III could not be implemented because the

donor agencies withdrew from the project while arrangement was in the final stage.

Survey, Feasibility Studies and engineering designs

In view of the necessity of developing hydro-electricity projects to meet the projected electricity demand in the decade of 2003 A.D. and there after, detailed engineering studies of various projects were proposed to be conducted from among the projects, such as the upper Karnali, Bagmati, Kamala and Budhigandaki. Feasibility studies of the Bhotekosi, Khimti Khola, Naumure and lower Arun hydro-electric projects whose preliminary and pre-feasibility studies were undertaken in the Seventh Plan were also targeted to be completed.

In Eighth Plan, the feasibility study of upper Karnali (300 MW) was to be completed and feasibility study of Bhote Koshi (36 MW) and Khimti (60 MW) had to be completed. Detailed engineering design of Sapta Gandaki a multipurpose project (225 MW), west Seti (360 MW), upper Karnali (240 MW), Bagmati (140 MW), Kamala and Budhi Gandaki 600 MW) and feasibility study of Bhotekoshi, Khimti, Naumure and lower Arun were proposed.

Table 4.15: Achievement in the Eighth Plan

Details	FY 1991/92	1996/97	Increment in figures (%)
1. Total installed			
A. Hydropower Stations	238,563	252,418	13,855 (5.8%)
B. Diesel or Multi fuel	683	47,266	46,583 (13.5%)
C. Solar Power	130	130	
Total	**239,376**	**299,814**	**60,438 (25.2%)**

Source: Ninth Plan, NPC, HMG

ix. Ninth Plan (1997-2002)

The Ninth plan enunciated a long-term policy with a view to raising the share of electricity in total consumption from about 1% to 3.5% in the next 20 years. The plan also laid emphasis on the development of multipurpose projects like Kosi 4,700 MW, Karnali 10,800 MW, and Mahakali 4,680 MW for domestic use as well as for export. The major policies mentioned in the plan included institutional reform to attract private sector in power generation, distribution and transmission.

The Ninth Plan had set the following objectives in hydropower set as:

– To develop hydropower in a least effective way so as to meet the energy demand from agriculture, industry, transportation, domestic, commercial and other sectors.

– To develop hydropower with minimum adverse impact on the environment.

In the Ninth Plan, the target was to increase hydropower from 546 MW from the existing 253 MW. Transmission line was targeted to expand 3,926 KM from existing 2,902 KM. Similarly 6,067 KM of distribution line was targeted. A total of 8, 28,000 were to be benefited by electric power by the end of Ninth Plan.

Survey, Feasibility Study and Engineering Design

Feasibility studies of most attractive medium scale hydropower projects were targeted to be completed in the early years of the Ninth plan. Feasibility studies started in the Eight Plan were also to be completed and feasibility studies of 12 other projects were to be started and completed in the Ninth Plan period.

Power Generation and Supply

From the hydropower projects, 293 MW additional electricity was targeted to generate from various projects (Table 4.16).

Table 4.16: Power Generation in Ninth Plan

Projects	Power generation capacity
Kaligandaki A	144 MW
Puwa Khola	6 MW
Modi Khola	14 MW
Chilime	20 MW
Khimti	60 MW
Bhote Koshi	30 MW
Indrawati	5 MW
Tanakpur	8 MW
Kalikot	500 (KW)
Dolpa	160 (KW)

Source: Ninth plan, NPC, HMG

For export-oriented projects, the plan listed West Seti (750 MW) for implementation from the private sector. Detailed engineering was already completed of Arun III (402 MW) to be initiated from the private sector.

Transmission and Extension of lines

Strengthening of transmission line was necessary to meet the demand for electricity in urban areas. For this Ninth Plan targeted 1,024 KM of high voltage transmission line consisting of 140 KM of 220 KV 814 KM of 132 KV and 70 KM of 66 KV. Similarly, construction of 260 MVA high voltage substation and 350 MVA capacity substations of 33 KV and 11 KV were to be completed.

Table 4.17: Ninth plan Targets

Details	Total	1997/98	1998/99	1999/2000	2000/01	2001/02
1. Electricity generation supply system						
A. Large and medium hydropower (MW)	293	–	6	104	183	-
B. Small hydropower projects (KW)	660	160	500	-	-	-
C. Extension of multi fuel power house (MW)	13	13	-	-	-	-
2. Construction and Extension of transmission line (KM)	1024	-	-	286	267	471
3. Rural Electrification (KM)	6067	1220	597	1620	1650	980
4. Survey, feasibility study and Detailed engineering design (No.)	31	7	5	8	7	4

Table 4.18: Targets and Achievement of the Ninth Plan

Area	Unit	Target	Achievement	Achievement in Percent
Hydropower Installed Capacity	MW	538	527.5	98.04
Solar Energy Installed Capacity	MW	60	57	95.00
Transmission line (132.66 KM and 33 KV)	KM	3926	4324	110.13
Capacity Substation at higher level (132 and 33 KV)	MVA	650	393	60.46
Distribution line (11 KV and 400/230 Volt)	KM	6067	8400	138.45
Number of Consumers	thousand	828	878	106.04
Benefited people	percentage	20	40	200

Source: Tenth Plan, NPC, HMG

x. Tenth Plan (2002-07)

This plan lays emphasis on the construction of small, medium, large and reservoir type of hydro projects. It intends to promote integrated development of water resources involving private and public sectors and domestic and foreign investments. It also lays emphasis on rural electrification, control of transmission and distribution. In the power sector, private sector is given full freedom for investment. As a result, private joint venture companies have initiated to construct some hydro-projects under the BOOT system. For the development of hydropower properly the Plan has set following objectives:

- To produce electricity at low cost harnessing the existing water resources.
- To expedite rural electrification so that it could contribute to the rural economy.
- To develop Hydro-electricity as an exportable item.

The qualitative targets of the plans are as follows:

- Hydropower projects will be constructed to supply 842 mega watt electricity out of which 70 mega watt could be exported.
- Additional 10% people will be supplied electricity through the national grid for which power will be supplied to 2,600 village development committees though the national grid and additional 5% people will be supplied power through alternative sources of energy.
- Per capita electricity consumption will be raised to 100 kilo hour.

The programs of the power sector in the tenth plan have been divided into four sub- categories on the basis of their nature:

a. Electricity production and supply

b. Electricity transmission and consolidation

c. Distribution, expansion and electrification

d. Surveys, studies and promotional activities

These Programmes are to be implemented through the agencies under the Minister of Water Resources like the Secretariat of the Commission for Water and Energy, Department of Electricity Development and Nepal Electricity Authority.

Following are the brief introduction to the programme to be carried out in every sub sector in the tenth plan.

Electricity production and supply

A total of 315 Megawatt electricity will be generated and supplied from both the public and private sector during the plan period to meet the domestic demand. The public sector will produce 101 megawatt and the private sector 214 megawatt. The contribution of 70 megawatt middle Marsyangdi hydropower project and another 74 megawatt power generated from small hydropower projects during the plan period will be remarkable.

Construction of hydropower projects with a total capacity of 1,938 mega watt will be begun during the tenth plan. Arun with 402 mega watt, upper Karnali with 300 mega watt and upper Tamakoshi with 250 mega watt capacity are among the major projects.

Electricity transmission and consolidation

Construction of a total of 430 KM long transmission lines of various Kilovolts will be completed during the tenth plan. Of the total 301 KM transmission lines will be constructed by the public sector of which the 127 KM long Chameliya-Attariya 132 KV transmission line is

worth mentioning. In additional to it, the construction of 140 KM Hetauda-Bardaghat, 75 KM Khimti-Dhalkebar and 40 KM Hetauda-Thankot 220 KV and 14 KM Dumre-Damauli 132 KV transmission lines will be commenced during the plan period. Beyond, 129 KM transmission line will be constructed by the private sector.

Electricity distribution, extension and electrification

The tenth plan has given special emphasis expanding electricity to the rural areas considering the unavailability of the facility. During the plan period, 965 KM long transmission and distribution lines of 33 KV, 4,977 KM of 11 KV and 940 KM of 400/200 MVA and 33/11 KV distribution substations of a total capacity of 143.5 has planned to construct for the purpose.

This will facilitate additional 1,000 village development committees and 7, 05,600 consumers. Electricity will be extended to additional 14 districts during this plan period through the national grid.

Surveys, studies and promotional activities

The plan lays emphasis on studies of reservoir projects during plan period. Surveys and studies will be commissioned on various projects with a total capacity of 13,376 megawatt of which 12,239 megawatt will be produced from the public sector and 1,137 megawatt from the private sector.

Studies being commissioned with bilateral cooperation on Pancheshwor multipurpose project (6,480 megawatt), Sunkoshi-Kamala diversion and Saptakoshi multipurpose project (3,400 megawatt) will be completed during this plan period.

Table 4.19: Hydroelectricity Projects to be commenced

S.N.	Name of the Projects	Capacity (MW)
	Under Public Sector	
1	Kulekhani II	42
	Total	42
	Under the joint investment of Public and Private Sector	
1	Upper Tamakoshi (Rolwaling)	250
2	Khimti II	27
3	Thulo Dhunga	24.7
	Total	301.7
	Under Private Sector	
1	Western Seti	750
2	Arun III	402
3	Upper Karnali	300
4	Likhu-4	51
5	Upper Marsyangdi "A"	50
6	Myagdi	22
7	Upper Madi	19.2
	Total	1594.2
	Grand Total	1937.9

Source: Tenth Plan, NPC, HMG

4.1.8 Projects currently under construction

The power project being constructed at present under the public sector is the 70 MW middle Marsyangdi hydro project until date, about 72% of its construction is completed other small isolated power projects presently being constructed under the public sector are Gamgad (400 KW) in Mugu district and Heldung (500 KW) in Humla District where as, under the private sector, power projects currently beings constructed are seven in number– such as Khudi Khola (3.45 MW), Lower Nyadi (4.5 MW), Barmchi Khola (999 KW), Thopal Khola (1.4MW), Sisne Khola

(750 KW), Sali Nadi (232 KW) and Pheme Khola (995 KW) amounting to total of 12.326 MW.

Proposed Action plan

To enhance the existing electricity supply capacity of the grid, NEA has put forward a few hydro projects for their implementation in the near future. These projects are Kulekhani-3 (14 MW), Chameliya (20 MW), Upper Trishuli "A" (61MW), Kankai (90 MW), Upper Tamakoshi (309 MW) and upper Seti Damauli (122 MW) with these project implementation by the year 2012/13, an additional or about 626 MW of electric power will be possible to the grid. In order to evaluate the power produced at these projects, several transmission line projects and system reinforcement will also be necessary which need to be implemented simultaneously with in the same time frame.

Beside the above proposed projects, if other like Kabeli-A (30 MW), Rahughat (27 MW), Likhu-4 (51MW), Upper Modi-A (42 MW), Upper Karnali A (300 NW) etc. as planned under the corporate development plan 2005 of NEA are implemented under private sector, and public and private joint venture the nation will reach a stage in the year 2013, at which the integrated system will not only be able to supply the domestic demand of electricity but also be able to export surplus power bringing economic prosperity to the nation. However, in order to be capable of supplying the continuing growing electricity demand, the development of cheap and reliable power projects should be recurrent in the country.

4.1.9 Power summit 2006(7th Sep to 8th Sep)

With a view to develop electricity between Nepal and India, Independent Power Producers Association of Nepal (IPPAN) and Power

Trading Corporation (PTC) India limited had come together to jointly host the event "Power Summit 2006" in Kathmandu on 7th and 8th September 2006.The events focus was on kick-starting private sector initiative for hydropower development in Nepal. Further, various issues of exchange of indo-Nepal hydropower assistance and the assistance that could be extended by private sector of India in hydropower development of Nepal were discussed.

Though Nepal has already traversed almost a century in hydropower development, still the achievement is not huge .So the government alone is not able to harness it .So the role of private sector has increased day by day to get the benefit of nation's white gold. Government of Nepal can accelerate hydropower development only in coordination with private sector of neighboring countries. The summit was important from this point of view. Nepal has huge potentiality and India is facing power crisis so to maintain the growing pace of economic development, power is essential .So to address the problem of power private sector can play very important role .

The specific outcomes expected from the events were:

- Identification and presentation of the projects that are ready for development and others that are in the pre-development stage.
- Identifying models for financing of the projects and likely issues in financing.
- Identification of significant risks perception of investors in both countries.

Around 150 electricity entrepreneurs including independent electricity Producers Company from both countries took part in the conference .The participants were from the following business entities.

- EPC contractors
- Equipment manufacturers
- Financial institutions, including Nepal Rashtriya Bank.
- Insurance companies.

With participations by business entities from various segments, it was expected that the event would give an opportunity for start-up of financiers for specific projects.

This power summit would assist to energize the private sector in both countries to invest in the power sector of Nepal. So it's high time for private sector to take initiative and start talking business. The power summit is expected to be a match-making event between Nepal's attractive hydropower projects and Indian investors.

In the power summit, Indian entrepreneurs expressed their readiness to invest in hydropower projects in Nepal to cover the increasing short fall of power in India. Indian power producers, investors and distributors however emphasized for the conductive atmosphere in Nepal for investment. To make the huge investment in hydropower sector of Nepal, they expect the Nepal's government commitment to help by hand to hand. Their expectations of assistance from government side were related to matters such as land acquisition, effective regulatory machinery and transparency in granting license. They further raised the issue that the government should extend the period from 30 years to 40 years .The Indian companies demonstrated their willingness to invest in Nepal whether individually or jointly with local investors. The power summit emphasized that the investment in hydropower in Nepal and high voltage transmission connection to India should be initiated

simultaneously. Due to the lack of transmission lines, Nepal is facing difficulties importing 50 to 100 megawatt of electricity from India to cover the short fall during winter. For the same reason the country is also not able to export spillover electricity to India during the rainy season. All such issues were discussed in the conference.

In the concluding day of the programme, president of IPPAN highlighted that for active participations of private sector either from Nepal or India, problems such as political instability, insufficient roads and transmission lines, lack of clear law and policy structure, delay in the implementation of electricity agreement should be properly addressed.

This type conference would make the government more accountable for the implementation of proper policy, formulating new strategies and finding the new ways to accumulate finance required for the development of this sector.

So strategy should be formulated in such as way that political interest of whatsoever should not be allowed in hydropower development process of Nepal. Conductive environment for private sector investment should be created by introducing appropriate policies.

Nepal lacks political will, required infrastructure, economic resources and legal provisions to exploit the potential of hydro-electricity. With a tune of time, we should leave no stone unturned to address these matters properly. If we do so, definitely we can have a new dawn in the history of hydropower development of Nepal.

4.1.10 Decade wise Development of Hydropower

As we mentioned our power development history begins from 1991 A.D. Since than, Nepal passed nine and half decade. So, how our power

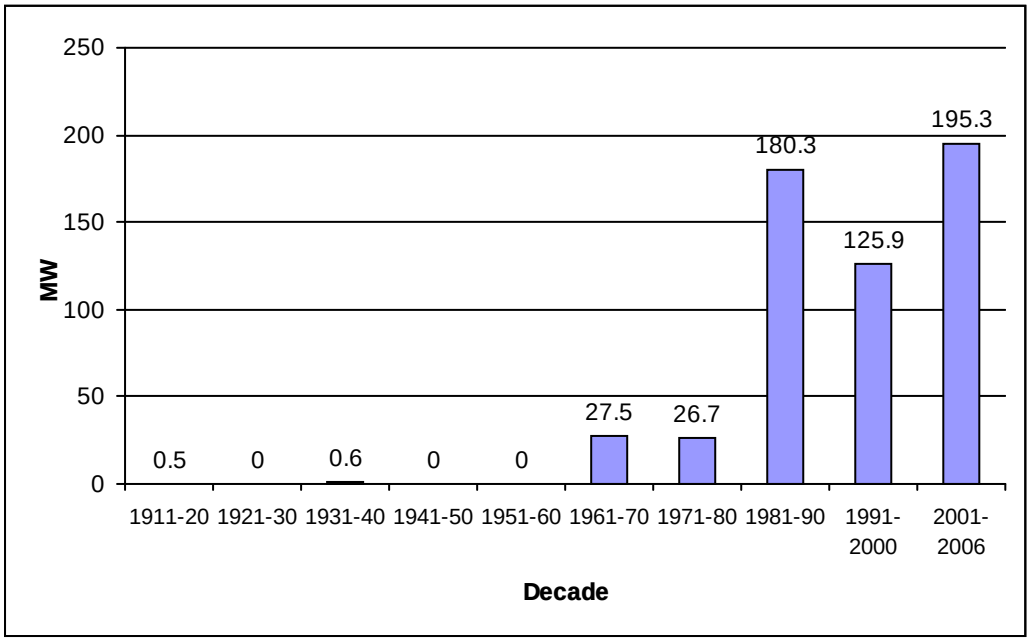
development status was in different decades has been shown in table 4.5 below. The highest growth of hydropower took place during 2001-2005 where in 195.3 MW (35.1 percent of the total) was produced followed by the decades of 1981-90 and 1991-2000 decades which saw the production of 180.3 MW (32.4 percent of the total) and 125.9 MW (122.6 percent of the total) respectively. The period since 1981 produced 501.5 MW (90.1 percent of the total), implying that only 55.3 MW (9.9 percent of the total) was produced during the entire period of 1911-1980.

Table 4.20: Decade wise Development of Hydropower

Decade	Generation	Cumulative
	Megawatts	Megawatts
1911-1920	0.5	0.5
1921-1930	0.0	0.5
1931-1940	0.6	1.1
1941-1950	0.0	1.1
1951-1960	0.0	1.1
1961-1970	27.5	28.6
1971-1980	26.7	55.3
1981-1990	180.3	235.7
1991-2000	125.9	361.5
2001-2005	195.3	556.8
Total	556.8	1242.2

Source: NRB, Economic Review, April 2006.

Figure 4.1: Decade wise development of hydropower generation (MW)



Hydropower developments in different development regions and installed capacity have been presented in the Table 4.21

Table 4.21: Installed Capacity of Hydro Power in Different DR

In KW

Development Regions	Hydropower Capacity	% of Total
Eastern Development Region	14,794	2.68
Central Development Region	267,422	48.43
Western Development Region	254,490	46.08
Mid Western Development Region	13,895	2.52
Far western Development Region	1,600	0.29
Total	**552,201**	**100**

Source: Statistical Year Book of Nepal, 2005.

In these five development regions central development region has highest capacity where as far western development region has very lowest hydropower capacity accounting 1600 kw. Central and western development region occupied highest percentage capacity of 48.43

percentage and 46.08 percent respectively. Other three development regions accounts very smaller percentage in comparison to central and western development region.

Table 4.22: Number of Households Having Connection to Electricity

	No. of domestic consumers, NEA and other systems	No. of hh connected to solar home systems	No. or hh connected to micro hydro schemes	Total no. of hh having connection to electricity	Total no. of hh (Census 2001) E	served hydroelectricity % of household
Eastern DR	1,66,677	11,761	11,832	1,90,270	10,12, 968	18.78
Central DR	4,67,731	6,405	13,560	4,87,696	14,75,477	33.05
Western DR	2,22,138	16,723	31,477	2,70,338	8,63,045	31.32
Mid-Western DR	66,586	2,670	5,752	75,007	5,34,310	14.04
Far-Western DR	39,774	3,470	6,284	49,528	3,67,420	13.48
Total	9,62,906	41,029	68,905	10,72,840	43,53,220	24.64

Source: Renewable energy Data of Nepal, 2003.

As hydropower generation capacity is highest in the central development region, the number of household connected to electricity is also higher which accounts 33.05 percent of total population lived there. Similarly western, eastern, mid and far western has lower number of people connected to electricity respectively. In total number of households only 24.64 percent are served by hydro-electricity.

4.1.11 National Water Plan (2002-2027)

The national water plan (NWP) is prepared to operationalize the water sector strategy (WSS) of Nepal, approved by Government of Nepal is January 2002. The NWP includes programmes in all strategically identified output activities so that all these programmes, in consonance with each other, will contribute to maximizing the sustainable benefits of water use.

Nepal has experience in the preparation and implementation of not only national periodic plans but also other sectoral plans such as the agriculture perspective plan, forestry plan, and sectoral master plans and so on. However development issues started getting increasingly complex during the last two decades as development paradigms shifted more towards human, societal and environment development aspects from the traditional economic growth models. Also governance issues became more pronounced as demands for popular participation grew.

The NWP recognizes these broader development needs; therefore, the wider social environmental and institutional components have been included as critical factors in the policy framework for achieving targeted national goals. The plan postulates doctrines such as the integration, coordination, decentralization, popular, participation and implementation of water related programmes within the framework of good governance and equitable distribution.

Integrated water resource management (IWRM) has been adopted as one of the principal themes of the NWP. IWRM principles profess that water must be viewed from a holistic perspective, both in its natural state and in balancing the competing demands on it i.e. domestic, agricultural hydropower, industrial, cultural and environmental. Management of water resources service needs to reflect the integration between different demands, and so must be coordinated within an across the sectors. More equitable, efficient and sustainable regime will emerge, provided, cross-cutting requisites are met, along with horizontal and vertical integration within the management framework of the water resources and services preparation of NWP immediately followed the approval of the WRS. The sub sector water plan has been develops, among which hydropower is one.

a. Targets in Hydropower Sector

By 2007

Up to 700 MW generating hydropower capacity is developed to meet the projected domestic demand base case scenario without export.

- Laws making participation of national contractors or consultants mandatory in all types of projects are promulgated.
- Thirty-five percent of the households are supplied with INPS electricity, 8% by isolated (micro and small) hydro systems and 2% by alternative energy.
- Per capita electricity consumption of 100 KW is achieved.

By 2017

- Up to 2035 MW hydropower electricity is developed to meet the projected domestic demand at base case scenario, excluding export.
- 50% of the households are supplied with INPS electricity, 125 by isolated (Micro and small) hydro systems and 2% by alternative energy.
- Per capita electricity consumption of 160 KWH is achieved and
- NEA is corporatized.

By 2027

- Up to 4,000 MW of hydropower is developed to meet the projected domestic demand at base case scenario, excluding export.
- Seventy-five percent of the households are supplied with INPS electricity, 20% by isolated (micro and small) hydro systems and 5% by alternative energy.

- Per capita electricity consumption over 400 KWH is achieved.
- Substantial amounts of electricity exported to earn national revenue.
- NEA unbundled and privatized.

b. Action Programme

The priority of the hydroelectric power programmes during the first five years is placed on identifying and developing cost effective small and medium hydro power projects that are capable of meeting domestic needs, including ground water pumping for irrigation, at affordable prices. At the same time, Micro hydro programmes will be continued Micro hydro programmes will be continued with vigor to give fulfill to the minimum electric power needs of the communities not connected to INPS.

In the following ten year, substantial benefit will be realized by maximizing hydropower development for different markets, including energy intensive industries, agriculture sector, transport sector and power exports. By the end of twenty-five years, the country will have a total hydropower capacity of about 4,000 MW, excluding export. More than 75% of all households will be provided with electricity from the INPS. In addition, it is expected that the basic electricity energy requirements of the remaining population will be catered through isolated, mini and micro hydropower plants and other alternative energy sources.

Large projects will be developed mainly for export purposes, where as small as medium hydropower projects will take to various in country needs. However, multipurpose projects will be developed for both export and domestic purposes.

Five action Programmes have been proposed. They are:

(a) Programme to develop cost-effective micro, small and medium hydropower.

(b) Programme to enhance rural electricity.

(c) Programme for power sector reform and development.

(d) Programme to encourage private investment

(e) Programme to improve power system planning.

A total of twenty-seven activity have been proposed.

Annual costs for institutional restructuring and institutional requirements will continue to manage through Government of Nepal and public institutions' recurring budgets.

4.1.12 Problems of Hydropower Development in Nepal

Geographically, Nepal is a very small mountainous and landlocked country. Nepal has hydropower potential of 83,000 MW from its perennial rivers emanating from snow-capped mountains. There are different problems in hydro power development .The major problems can be listed as followed:

1. Most of the rivers are snow-fed rivers and travel through different topography. During the period rivers travel from the beginning to the reservoir, water runs to minimum. Thus the output of the hydropower also goes to minimum capacity.

2. Hydropower projects are capital intensive and the government is unable to arrange adequate financial resources to finance such projects, ignoring more priority sector like health, education and infrastructure development. (Neupane, Aug, 16, 2006)

3. There is no clear provision of export tax on power export, while developing multipurpose project by the private sector, the process and mechanism to provide the down-stream benefit has not been

mentioned. There is not provision of competition among the private parties for hydropower development.

4. Lack of sufficient market in this field is another great problem. There is at present no assured markets that can observe the vast power potential of by projects.

5. Size of the project is another problem in this field. When the government intends to launch big hydro-electricity project foreign aid is needed. Such hydro power projects are expensive due to heavy reliance on bilateral and multilateral financing agencies, costly foreign consultants and contractors, limited manufacturing capability of power generation, transmission and distribution-related equipment, inefficient management and high cost of preparatory works as well as unfavorable geological condition.

6. Financing and cost considerations provide major challenges in the process of materializing the hydropower potential of Nepal. It is estimated that the government developed medium-sized hydropower cost an average of US$ 2800/KW while private generators have been able to produce at US$ 1000/KW. In this context raising the efficiency of government in hydropower development presents an important challenge.

7. The major hurdles to the promotion of electricity use (supply plus demand promotion) are, however, likely to crop up from the institutional side. The promotion of private sector participation in the development of hydropower requires provisioning of a "safety net" for the private and community investors, primarily because of the long-term nature of the project. But such provision has not yet been introduced (Bhadra, 2004).

8. Some anomalies have been observed between existing policies and legal provisions related to power sector, and the policies and legal provision of other government agencies. It has obstructed the smooth development of the power sector.

9. There are varieties of risks involved in the implementation of hydropower projects, such as commercial, legal, political, natural calamities and so on. Since there is no clear policy on what types of risks to be borne by Pvt. Sector and what type of risks to be borne by government sector. It is getting difficult to reach an agreement with the private investors.

4.2 Contribution of Hydropower to National Economy

4.2.1 Contribution to GDP

It is a known fact that hydro electricity has a great potential to contribute a large proportion to Nepal's GDP. But because of the low level of development of hydropower, it's contribution to GDP is very low. It can be seen from the data presented in Table 4.23 The contribution of hydropower to GDP has increased in recent years compared with a decade ago, but it is not even 2.5 percent.

Table 4.23: Contribution of Electricity in Gross Domestic Product by ISIC Division

In Percentage

Year	Contribution of Electricity
1994/95	1.36
1995/96	1.50
1996/97	1.65
1997/98	1.51
1998/99	1.40
1999/2000	1.62
2000/01	1.89
2001/02	2.13

2002/03	2.49
2003/04	2.39
2004/05*	2.37

Source: National Accounts of Nepal, 2005, CBS
* Revised Estimate

In Seven years from 1994 to 2001, its contribution has not increased even by more than one percentage point. Within this one decade its contribution has increased only 1.1 percentage i.e. 1.36 to 2.37.

4.2.2 The Contribution of Electricity to Commercial Energy

Share of electricity in commercial Energy is not so high as that of POL products. It has contributed only 9.37 percent in 1999/2000 which is lowest of this decade, whereas it has contributed highest percentage accounting 17.12% in 2000/01. The share of Electricity has not increased much in this one decade. It is shown in the Table 4.24.

Table 4.24: Contribution of Electricity to Commercial Energy

(in %)

FY	Commercial energy			
	Petroleum products	Coal	Electricity	Others
1995/96	77.88	11.05	11.05	1.53
1996/97	80.16	6.68	11.14	1.88
1997/98	81.27	7.93	10.79	2.08
1998/99	80.80	8.31	10.88	2.44
1999/2000	67.26	23.33	9.39	2.27
2000/01	72.24	10.62	17.12	2.85
2001/02	73.66	11.56	14.77	3.20
2002/03	74.18	12.61	13.20	3.84
2003/04	70.53	13.31	16.14	4.24
2004/05	69.52	15.48	14.99	4.43

Source: Annex V

The share of POL products in commercial energy ranges from 70 to 81 percent. There is a decline in the percentage share of POL products in 2003/04 and 2004/05.The reason for this was the decline in demand for POL products by industries due to internal conflict. If the share of petroleum product is to be reduced use of the electricity should be promoted. The share of coal shows ups and down. But in overall, its share is also increasing. Likewise, share of other sources is increasing slowly over time.

4.2.3 Revenue generation from electricity

Government revenue in Nepal is divided into two categories: tax revenue and non tax revenue. Revenue received from electricity is categorized under non tax revenue. The contribution made by electricity in non tax revenue is given in Table 4.25

Table 4.25: Revenue from electricity

Rs. in Million

Year	Total non tax Revenue	Contribution of electricity	% Share
1998/99	8498.1	201.7	2.37
1999/2000	9741.6	226.6	2.32
2000/01	10028.8	229.6	2.29
2001/02	11115.0	230.3	2.07
2002/03	13642.7	219.3	1.60
2003/04	14158.0	247.0	1.74
2004/05	16018.0	245.7	1.53

2005/06	6874.1	177.0	2.57

Source: Economic Survey, 2005/06

Table 4.25 shows that its contribution hovers around 2 percent. Its share has decreased in 2002/03 and 2004/05. During the first eight month of 2005/06 its share has increased to 2.57 percentage which is the highest so far.

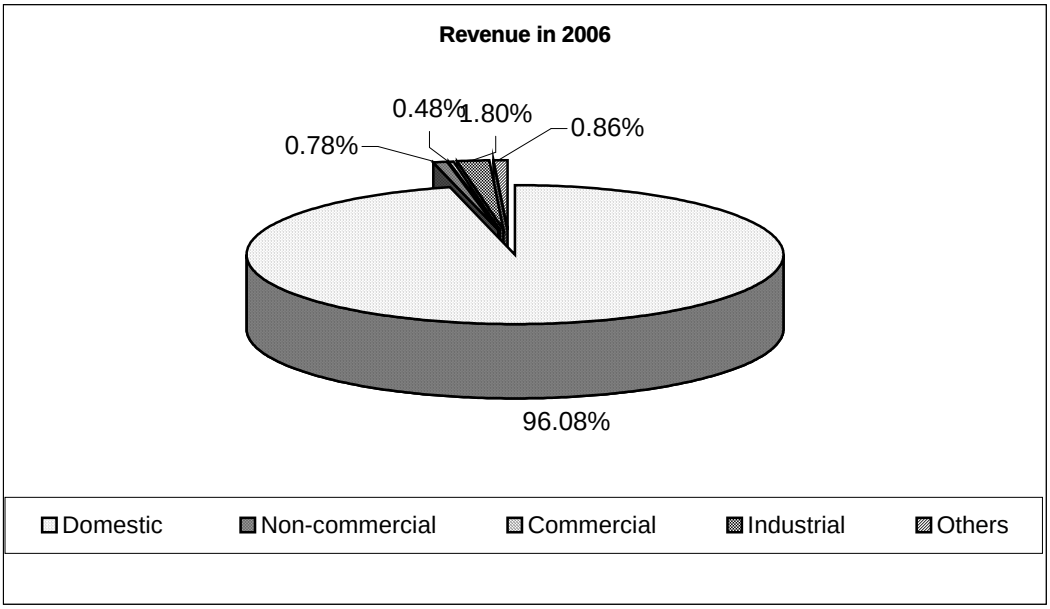
Revenue generated from the domestic sales of electricity is highest accounting for 38.28%. But it is less in comparison to percentage of number of consumers. Industrial sector generates 36.12% of revenue only having 1.80% of total consumers. It can be seen from the table 4.26 and figure 4.2 below.

Table 4.26: Consumer sales and revenue

User Group	No. of Consumer (% of total consumers)	Sales (%)	Revenue (%)
Domestic	96.08	39.21	38.28
Non-commercial	0.78	4.89	6.63
Commercial	0.48	5.97	8.12
Industrial	1.80	38.88	36.12
Others	0.86	10.92	8.84
Total	100	100	100

Source: NEA, FY 2005/06 - A Year in Review.

Figure 4.2: Revenue in 2006



Source: NEA, FY 2005/06 - A Year in Review.

4.3 Cost of different hydropower projects

4.3.1 Cost of Hydropower Projects

The cost of hydropower projects consists of construction cost and generation cost. Construction cost is the cost consisting of land, buildings, power houses, equipment, machine dams, roads etc. Generation cost is the cost of operation and maintenance, depreciation of fixed assets, interest of short and long term loans and associated materials, etc. The average construction and generation cost by size of power plant and by public/private ownership is presented in Table 4.27

Table 4.27: Cost of Hydropower Projects by size

S.N.	Category of Projects	Average construction cost MW (Rs. in million)	Average generation unit cost/KW in Rs.
1.	Medium Hydro Projects (Govt)	144.76	4.91
2.	Small Hydro Project (Govt)	481.41	16.32
3.	Butwal Power company (medium)	80.56	2.73
4.	Micro hydro projects (private)	74.56	2.53

Source: Bhattarai, "A Study of Demand for Electricity and Financial Requirement up to 2030", 2004

Small hydropower projects appear to be costly as the construction cost is highest Rs 481.41, while the same for the medium project is Rs. 144.76 in the government and Rs. 193.13 in private sector. So, medium sized projects seem to be economical. Relying on this information, we can say that to fulfill the increasing demand of electricity, priorities should be given to medium size projects.

4.3.2 Cost Comparison of different projects at 2005 price

Electricity cost of foreign aided projects seems very high in comparison to domestically financed projects. Though Nepal has to

depend on external assistance in both aspects (technical and financial) for large scale projects, it can reduce its dependency and generate electricity in low cost by mobilizing its own resources.

Table 4.28: Comparison of different projects cost

Projects	Cost	Year	Cost at 2005 price	Capacity (MW)	Unit cost US$/kw	Energy Cost US KW cents/kw	Weighted average	
							Unit cost US$/kw	Energy cost US cents/kwh
CHEP	33.3	2003	34.99	22.1	1583	3.2	1902	3.82
Piluwa	4.65	2002	4.89	3.2	1527	3.13		
Indrawati	21.08	2002	22.7	7.5	3027	5.72		
Chaku	2.7	2005	3.3	1.5	2200	4.06		
Khudi	7.5	2006	7.5	4	1875	3.84		
Sunkoshi	6.1	2005	4.42	2.6	1700	3.84		
KL-I	117.8	1982	207.94	60	3466	12.34	3197	11.67
KL-II	53.9	1986	86.17	32	2693	10.31		
KG-A	338.27	2002	364.28	144	2530	5.42	2530	5.42
MMHP	349.37	2005	349.37	71.8	4866	10.99	4817	9.87
MHP	221.51	1989	328.83	69	4766	8.9		

Source: Assessment of Diversified Modes of hydropower development in Nepal, 2006. Lila Nath Bhattarai.

Note: The cost figures are in Million US$ unless specified.

The units cost of the projects that are conducted by Nepal are comparatively very cheaper than those of foreign aided projects. The projects that are launched by Nepal are small and have less capacity in comparison to other projects such as KL-I, KG-A and so on.

Weighted average unit cost of Nepali projects in US$1902/KW. The table further shows that the unit development cost of all projects other than Kulekhani-1, Marsyangdi (MHP) and Middle Marsyangdi (MMHP) is below US$ 3000/KW. KL-1 slightly exceeds this Margin. However, that of MHP and MHEP is excessively high, up to the order of US$ 5000/KW. Nepal can not launch larger scale projects with higher scale capacity, emphasises should be given to projects with lower capacity so that it can be generated at cheaper cost in comparison to foreign aided big projects.

4.3.3 Investment Requirement

It was only in the Ninth plan that the financial requirement for electricity development was estimated to be Rs. 123607.7 million, of which the allocation of public and private sector was Rs. 61522.4 million (49.78%) and Rs 62079.3 million (50.22%). The share of electricity in development budget was 18.70 % of total development outlay.

In the Tenth plan (2003) the allocation of budget to electricity sector was Rs. 38210 million which constituted 14.4% of total development budget. As mentioned in the "National Water Plan, 2005", estimated programme cost for hydropower development for 11th, 12th, 13th, 14th plans is NRS million 47058, 113549, 132225, 159862, 181451 respectively. Similarly different other institutions, researchers have also estimated the cost of hydropower development.

R.B and company (NEA 2000) has estimated the fund requirement and sources of resources of NEA from 2001 to 2007 as given in Table 4.29.

Table 4.29: Fund Requirements and Sources

Year	2001	2002	2003	2004	2005	2006	2007	Total
Total required investment	10989	13457	12723	15946	14940	10668	7373	86096
Sources of Finance (in percent)								Total average in percent
Equity	5	5	5	5	5	5	5	5
Foreign loan	80	79	76	73	72	74	71	75
Local Banks	12	15	15	15	15	15	15	15
NEA-Internal source	3	1	6	7	8	6	9	5
Total	100	100	100	100	100	100	100	100

Source: Bhattarai, "A Study of Demand for Electricity and Financial Requirement up to 2030", 2004

The contribution of equity, foreign loan, banks and NEA's own sources are 5, 75, 15 and 5 percentages respectively. All the activities of government related to electricity are conducted by NEA.

External assistance (bilateral and multilateral loan and aid) plays important role in the hydropower development of Nepal as it occupies 75 percent share in total. Further lets analyze the percentage share of foreign aid disbursement in power sector.

The required programme cost for the long run estimated by national water plan is given in Table 4.30.

Table 4.30: Estimated programme cost of Hydropower development

Rs in Million (at 2003/04 Price level)

S.N.	Programmes	Short Term	Medium Term		Long Term		NWP Total
		10th Plan	11th Plan	12th Plan	13th Plan	14th Plan	
1.	Small and Medium Hydropower Development	29,173	91,873	1,10,089	1,28,296	1,49,419	5,08,851
2.	Enhance Rural Electrification Structural	12,883	12,353	12,353	21,328	21,328	80,245
3.	Improve Power System Planning	4,846	8,846	9,230	9,615	10,000	42,537
4.	Encourage Private Sector Investment	-	-	-	-	-	-
5.	Power Sector Reform and Development	156	477	552	623	407	2517
	Total	**47,058**	**113,549**	**132,225**	**159,862**	**181,451**	**634,144**

Note: The above cost doesn't include the cost for alternative energy.

Source: WECS, National Water Plan, 2005.

Nepal has not been able to finance a large amount to the hydro-power projects which were constructed in the bygone days .On this experiences how the poor economy like ours can manage huge amount of Rs 634,144 million in the long run i.e. until fourteenth plan .It may be difficult to generate 4,000 MW power by 2027.So the challenge is to manage finance to generate the targeted power in different plans that national plan proposed.

Table 4.31: Foreign Aid Disbursements

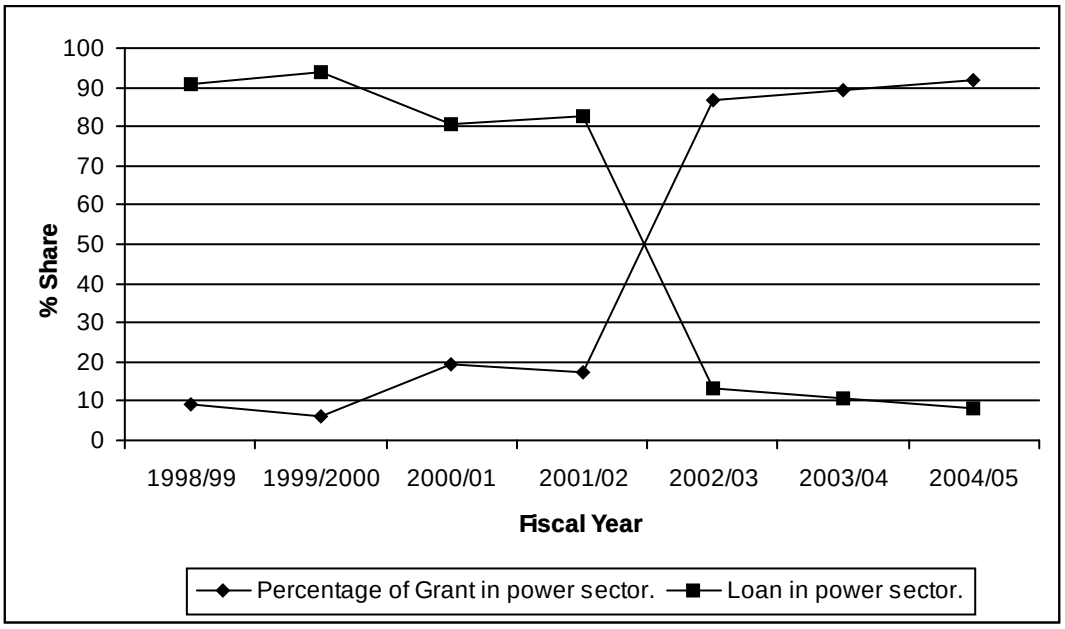
Rs. in Million.

Year	Total Aid disbursement	Aid in power sector	Percentage of foreign aid in Power sector.	Percentage of Grant in power sector.	Percentage Loan in power sector.
1998/99	16189.0	4671.1	28.85	9.35	90.65
1999/2000	17523.9	5517.4	31.48	5.89	94.11
2000/01	18797.4	5747.2	30.57	19.49	80.51
2001/02	14384.8	3341.4	23.22	17.30	82.70
2002/03	15885.5	3547.0	22.32	86.67	13.33
2003/04	18912.4	4238.4	22.41	89.38	10.6
2004/05	23657.3	6159.2	26.03	91.71	8.29

Source: - Economic survey, 2006

In total foreign aid disbursement, power sector occupied significant percentage. The remaining percentage in different years were taken by different sectors such as agriculture, irrigation, forestry, transport, communication, industry and commerce, social services, administrative reform etc. In the initial years, foreign assistance in power sector was in the form of loan was significantly larger than grant but it has decreased slowly after 2000. There was a dramatic fall in the percentage share of loan in total assistance since 2002. Similarly in the initial years, share of grant was quite low on power sector in comparison to loan. But after, 2001/02 it has increased surprisingly and accounted for 86.67 percentage in 2002/03. It further increased slowly and reached 91.71 percent in 2005. So while attracting grant we need to properly utilize it.

Figure 4.3: Percentage Share of Grant and Loan in Power Sector



But in the foreign aided projects, politics is always an issue to launch the project in time. On the other hand, production cost of foreign aided projects are high. Given this solution, we may not be able to export and even use electricity domestically. So the matter of managing internal resources and reducing production cost should not be forgotten. Big projects, such as Arun project, which was about to start was heavily politicized and as a result, it was cancelled. Since of foreign aid is very volatile, it would he prudent not to depend too much on it in the long run. Our policies and strategy should acknowledge the role of private sector for power development in Nepal.

4.3.4 Projects Under Operation

There are all together fifteen projects under operation. Pharping hydropower station is not mentioned here because of inadequate information. All these projects were financed by bilateral and multilateral donor agencies. Most of the projects in Nepal are run -of -river types. Of these, only Kulekhani-I and II are of Reservoir type. Such projects should be developed in Nepal to meet the peak demand of the country. Table

4.33 presents the summary of all these projects. Among which Marsyangdi is the largest one having the installed capacity of 69MW. Sundarijal, a small one among these is the Run of -the -river type project with installed capacity of only 640 KW.

Table 4.32: Summary table of the projects under operation

S.N.	Name of hydropower station	Type	Installed capacity in	Project construction cost	Financed by
1.	Kaligandaki 1	Peak-run-of-river	14 MW	NA	ADB, FINNIDA, UNDP
2.	Marsyangdi	Peak-run-of-river	69 MW	221.57 Million USD	HMG/N, IDA, KFW, KFED, SFD and ADB.
3.	Kulekhani-I	Reservoir	60 MW	117.84 Million USD	WB, Kuwait Fund, UNDP, UECF and OPEC Fund.
4.	Kulekhani-II	–	32 MW	NRs 1240	HMG/N, OECF Japan
5.	Trishuli	Peak-run-of-river	24 MW	I.C.14 Corers	Government India and HMG of Nepal.
6.	Gandak	Run of the river	15 MW	NRs 17Corers	Nepal and Indian Government
7.	Modikhola	Peaking-run-of-the river	–	30 Million USD	HMG/N, NEA and EDCF (Korea)
8.	Devitghat	Run of the river	14.1 MW	NRS. 75 Crores	Indian government
9.	Sunkoshi	Peaking-run-of-River	10.05 MW	NRS. 109.37 Million	WB, Kuwait Fund, UNDP, OECF and OPEC Fund
10.	Puwakhola	Run of the river	6.2 MW	15.7 Million USD	HMG/N and NEA
11.	Chatara	Run of the river	3.2 MW	NRs 162.585 Million	IDA
12.	Panauti	Peaking-run-of-the river	2.4 MW	NRS 2.7 Million	USSR and Nepal Govt.
13.	Seti	Run of the river	1.5 MW	-	China and HMG/N
14.	Fewa	Canal drop	1.0 MW	–	Indian and HMG/N
15.	Sundarijal	Run of the river	640 (KW)	–	Britain government

Source: NEA, Aug, 2006, Generation, Fourth Issue, Kathmandu, Nepal

4.3.5 Chilime hydropower project as an example of successful project

Chilime hydropower project developed by a public company named Chilime Hydropower Company (CHPCL) with the use of indigenous resources (both finance and expertise) local manpower and construction industries to the maximum extent possible is considered a successful hydropower project. It is a run of river scheme owned by Chilime hydropower company limited and is located in the Bhote Koshi Basin in Rasuwa district. The scheme has an installed capacity of 22.56 MW, generating a maximum delivered power of 20 MW based on the power purchase agreement with Nepal Electricity Authority (NEA). The project is designed to generate 137 GWh energy per annum. The power plant gets water from a snow fed Chilime Khola. a tributary of Chilime Khola is also tapped as an additional source to augment discharge in the dry months. The environmental hazard and impacts to the local surroundings has been minimized setting almost 89% of the project components underground.

This project didnot seek international financing for its development. The project is funded with a debt equity ratio of 60:40. The debt portion is covered receiving short and long-term loans from financial institutions of Nepal with Karmachari Sanchaya Kosh and Nagarik Lagani Kosh as the major financers. The equity structure of the investment is 51% from NEA, 25% from NEA employees and the remaining 24% from the general public. Project studies at various phases, such as identification; feasibility study and detail engineering and construction engineering and supervision were completed by using manpower of Nepal Electricity Authority.

Construction work of the project was started in 1996 and it was planned to complete in 1998. However, due to non performance by the then main civil contractor, CGGC, the contract had to be terminated after expiration of the contract period in October 1998. Then the contracts

were split into different lots and packages to facilitate participation of national contractors. All the works were awarded through competitive bidding among national contractors. Several national contractors participated in construction works. The power plant came into commercial operation from August 25, 2003. The total cost of the project at completion amounted to Rs. 2497,200,000 which was 7.5% higher than the original estimate of 2,323,189,000 (CHEP, 2005).

CHEP has proven that the Nepalese are capable to undertake engineering venture of such a scale and see it through most efficiently. The CHEP approach of hydropower development demonstrates the way to produce cheaper electricity, capacity building to make Nepal self reliant and maximize local economic spin-offs. This is remarkable in the context where hydropower projects have historically been synonymous with foreign assistance. The project approach represents a paradigm shift from dependency to self-reliance in Nepal's hydropower development. It embodies the philosophy that the future of Nepal's hydropower development lies in producing power at affordable cost through the maximum participation of Nepali capacity in technical, financing, management and construction fronts.

(a) Characteristics of the project

- The project was constructed and completed utilizing Nepalese expertise and national resources without any technical or other assistance from out side.
- To the till date, it is the largest project in Nepal completed with the use of indigenous resources.
- The technical infrastructure developed in this project are similar to the projects developed by foreigners.
- The generation cost of electricity from this project is 50 percent less than those projects developed by foreigners.

- The project and its owners are widely recognized from almost all sectors of Nepalese society.
- Selection of the project as one of the eight candidate projects from all over the world for Blue Planet Award is the international recognition of the technical, social, economic and environmental criteria and excellence.

(b) Reasons behind the success of the project

According to the project manager Lila Nath Bhattarai of CHEP, the following are the reasons behind the success of the project:

- Key decisions were taken by Nepali management.
- The challenging but attainable goal of the Chilime project motivated the project personnel to work hard with full attention and efforts.
- The use of indigenous resources.
- The industriousness of all the technicians.
- The vision and mission of the projects were very clear.
- The assurance of transparency maintained by the management.
- Investment made by persons of all walks of life.
- People's help to communicate the vision of the project management to build the project as a model project at comparatively low cost utilizing the Nepalese resources including manpower.
- Proper integration of indigenous resources both expertise and finance.

It is said that with the successful completion of this project, the development era of hydroelectricity has begun in Nepal.

4.4 Foreign Exchange Saving from Hydropower Development

Nepal is becoming more dependent year after year with the increasing trend of import of POL products. Oil prices have been more

volatile during the last several years. Given the increasing oil price volatility and increasing price trends, the impact on the developing and oil importing country like Nepal will be much more fierce in future than at present.

4.4.1 Import of Petroleum Products

Nepal spends large amount of foreign currency every year to import petroleum products. Import trend of POL products and their share in total imports are presented in Table 4.34

Table 4.33: Share of the Petroleum Products in Total Import

Rs in million

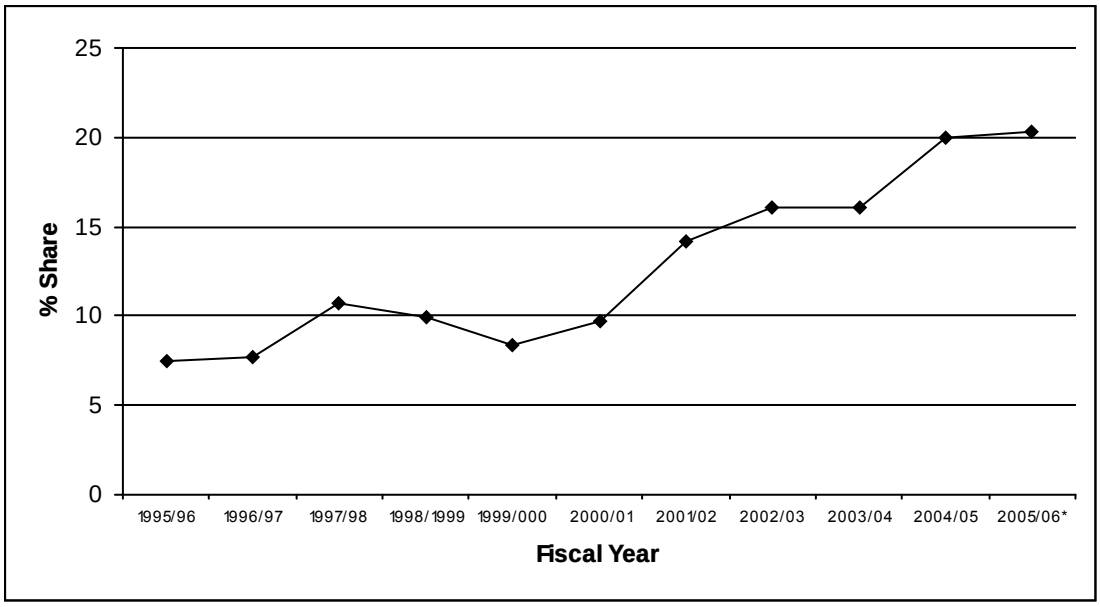
Years	Total import	Import of Petroleum Products	share (%)
1995/96	74454.5	5549.3	7.45
1996/97	93553.4	7160.3	7.65
1997/98	89002.0	9537.3	10.71
1998/1999	87525.3	8737.5	9.98
1999/000	108494.9	9097.9	8.38
2000/01	115687.2	11269.2	9.74
2001/02	107389.0	15200.8	14.15
2002/03	124352.1	19944.1	16.03
2003/04	136277.1	21904.1	16.07
2004/05	149473.6	29927.3	20.02
2005/06*	117482.1	23811.6	20.26

Source: Economic survey 2006

* Provisional.

Imports of POL products have been increasing both in absolute and relative terms. During a period of 10 years import of POL products have increased more than four fold in value terms. The share of POL products in total imports has gone up from 7.45 percent in 1995/96 to 20.26 percent in 2005/06.

Figure 4.4: Trend of Import of petroleum products



The price of POL products is increasing in international markets and this has accelerated the burden. It would really be difficult to sustain the economy if this growing trend goes on unabated. While the country is spending millions of rupees annually to import POL products, the white gold of the country is flowing unutilized by which we could not only reduce the foreign exchange burden but also make a benefit by exporting it.

4.4.2 Import of Petroleum product against commodity export

From the table 4.35 it can be seen that import of petroleum product has been increasing against our commodity export one after another year.

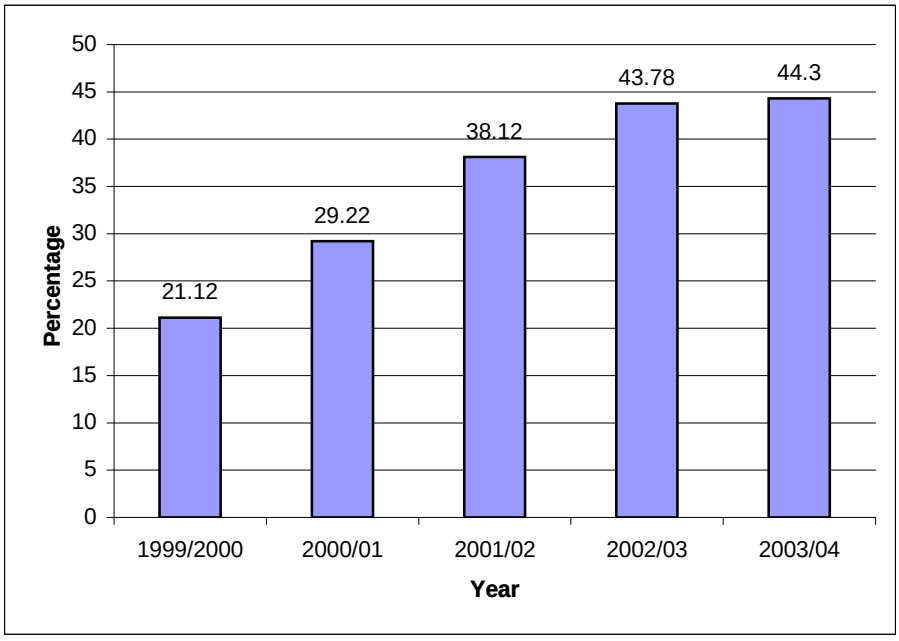
Table 4.34: Import of Petroleum Product against Commodity Export

In percentage

Year	Import against commodity export
1999/2000	21.12
2000/01	29.22
2001/02	38.12
2002/03	43.78
2003/04	44.30

Source: Petroleum pricing in Nepal and an overview and some suggestions 2005 paper presented in a talk programme by Prof. Amrit Nakarmi.

Figure 4.5: Import of Petroleum Product against Commodity Export



The total amount of money that the nation received from commodity export has to be spent on the import of petroleum products. The share of petroleum product has doubled within a period of five years from 1999/2000 to 2004. It was 21.12% in 1999 and reached 44.30% in

2003/04. So Nepal's dependency has been increasing day by day in spite of the huge possibility to decrease this increasing dependency.

4.4.3 Import of POL Products by Type

Nepal can save huge amount of foreign exchange that are spent every year to import POL products. To analyze the foreign exchange saving through the development of hydropower, import bills of different types of POL products have been presented in Table 4.36.

Table 4.35: Import of POL Products by Type

(Rs. in million)

FY	Petrol		Kerosene		LPG		Diesel		Others %	Total Amount
	Amount	%	Amount	%	Amount	%	Amount	%		
1998/99	477.21	6.44	2646.60	35.74	420.53	5.67	3022.38	40.81	11.34	7404.51
1999/2000	642.89	7.17	3527.73	39.37	628.16	7.01	3257.51	36.35	10.1	8960.39
2000/01	953.74	6.75	5278.65	37.38	1245.91	8.82	5120.23	36.26	10.79	14122.30
2001/02	1086.52	7.05	6577.46	42.68	1394.03	9.05	5136.16	33.33	7.89	15409.39
2002/03	1416.73	7.54	6963.75	37.06	2263.54	12.05	6722.79	35.77	7.58	18792.14
2003/04	1620.37	8.29	6748.40	34.53	2336.21	11.95	7109.26	36.37	8.86	19545.54
2004/05	2235.00	8.77	7427.13	29.15	3422.95	13.43	10090.80	39.60	9.05	25482.70

Source: NOC, Account Section

Note: In this amount of money, Government revenue hasn't included.

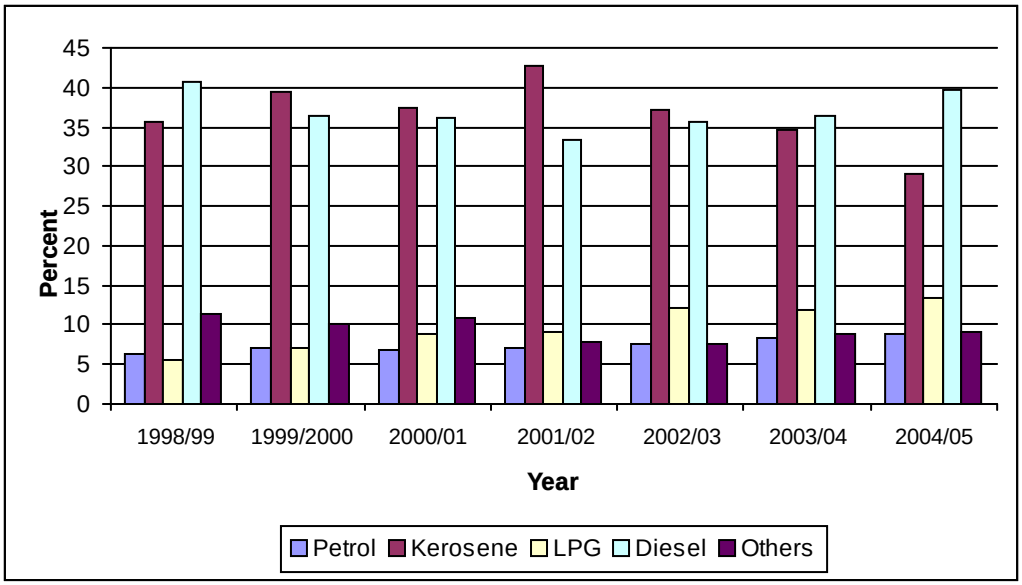
In the total POL product import, diesel occupied the highest proportion in 1998. After that kerosene accounted for the largest proportion up to 2003/04.LPG is in the third position and petrol in the fourth position.

Nepal is spending millions of rupees every year to import various types of petroleum products to fulfill energy requirement. The question is how long this can be continued? Despite having huge hydropower potential, the country has not made a breakthrough in this direction.

LP Gas that has become the basic necessity for cooking in urban areas can be substituted by producing hydropower. It would save foreign exchange for other development purpose.

Although after 2000 import of petroleum product has declined, it is not due to substitution by hydropower. But because of conflict situation in the country. New industries were not opened, and transportation was also disrupted, and no additional roads were constructed. But the demand for kerosene and LP Gas has been increasing. These are going to be our basic necessity. So it is time to think over to substitute imports of kerosene and LP Gas by hydropower in the days to come.

Figure 4.6: Import of petroleum products in different years



The figure also shows increasing pattern of kerosene and diesel in POL Products. Kerosene is used for cooking in urban and semi-urban areas by households of lower income status.

CHAPTER–V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

Nepal is a mountainous, landlocked country wedged between two growing economic powers India and China. Agriculture sector is the main stay of life but this sector witnessed dismal performance in spite of a top priority in different periodical plans.

Nepal, a poorest country of the world has a lot of possibilities in hydropower sector by which the nation can overcome her poverty. Hydropower is known as white gold. Nepal is the second richest country of the world and it has 3.34% share of world's hydro- potential i.e. 83.29 million. MW. But till date, a total of 556. 800 MW which is only (0.67 percent compared to total capacity) was generated from various projects of the country.

Though, Nepal has a long history (since 1911) of development of hydroelectric power, its development is still at an infant stage. Before the beginning of planning period, Hydro-electricity and other energy generated was only for ruling class people. So there were no specific rules in this sector. It was only after the beginning of first plan in 1956, certain policies were introduced to develop hydropower sector. Since than slowly and gradually hydropower has been developing but the pace is not quite satisfactory. Still we are not able to meet the domestic demand. The Ninth Plan (1997-2002) adopted a long term policy with a view to increase the share of electricity in total energy consumption from about 1% to 3.5% in the next 20 years. The Tenth Plan document lays emphasis on the construction of small, medium, large and reservoir type of hydro projects. The plan intends to promote integrated development of

water resources involving private and public sectors and domestic and foreign investments.

Energy consumption in Nepal is increasing. In 2004/05 energy consumption increased by 1.3% compared to 20003/04 and expected to increase by 3.34 percent in 2004/05 in comparison to previous year. In the energy consumption pattern traditional energy consumption accounts for a higher proportion than commercial. On the other hand the energy used by household sector is 0.3 percent industrial use 3.5 percent commercial use 1.6 percent and agriculture and other use 0.8 percent and 0.2 percent respectively.

Hydropower projects are advantageous form many perspectives. It is renewable, multi-purposeful, no raw material cost and from environmental perspective too. Hydropower development in Nepal has been facing different problems such as government procedural complications, political instability, insufficient infrastructure; most of the rivers are of run of type, unnecessary condition, imposed by multilateral and bilateral countries while providing financial assistance too.

Hydropower projects are capital intensive and the government is unable to arrange adequate financial resources to finance such project, ignoring more priority sector like health, education and infrastructure development. So on one hand foreign aid has played an important role in public financing of investment in the electricity sector, on the other hand investment of private sector is essential. Though, after the liberalization of Nepalese economy, private sector investment has increased but attraction of private sector is still lower than the expectation.

It is because of our financial constraints and capital intensive nature of hydro power projects, by mobilizing our internal scattered

resources, we can develop hydropower for which medium size projects are judged to be feasible.

Realizing the issue Government of Nepal has announced National Water Plan 2005, where Hydropower sector was also endeavored to address properly and by 2027, 7,000 MW hydropower is supposed to develop and per capita electricity consumption is supposed to reach 400 KWH.

If we observe the number of domestic consumers of electricity in different development Regions, Central development region is far a head. Similarly installed capacity of hydropower is also more in central development region than in other. There is no equality in electricity distribution between different development regions .Urban people have more access in electricity than rural people.

Now it’s time to scratch the new way for hydropower development by accumulating scattered money within country for investment as well as proper utilization of foreign assistance and encouraging private sector by removing different hurdles existed in the hydropower development sector.

5.2 Conclusion

The hydropower potential of Nepal is huge and the sustainable hydropower development becomes the key to make Nepal's economic growth scenario brighter, gaining deep inroads into the national goal and priority of poverty reduction. But the primary challenge encountered by Nepal for hydropower development in the twenty first century is how to supply reliable, affordable and cheaper electricity to the domestic population. Not least important is the problem of developing electricity as an exportable commodity to the neighboring countries like India.

Hydropower offers a means of responding within seconds to changes in load demand. Fortunately, Nepal is rich in hydro-resources, with one of the highest per capita hydropower potential in the world. However, at present, the total hydropower generation has been 556.8 MW merely 0.67 percent of the potential, with connection to 40 percent of the people. It is notable to mention that, by the end of the Tenth plan (2002-07), 55 percent of the population will have connection to the electricity. Use of environment-friendly technologies and implementation of sound legal and institutional issues are critical to increase the access of the population to the hydropower. Putting into place a favorable environment for increasing investment in cost effective projects would definitely contribute to make this target a reality. The question of competitiveness always embarrassed Nepalese power development perspective due to the high development costs of generation reflected in our electricity tariff. Thus it is imperative to find practical ways to reduce cost to make tariff affordable to the common Nepali and offer competitive prices to secure the export market at the backdrop of the emerging possibilities of regional trade in hydropower. In spite of its high possibility hydropower has not contributed enough in GDP of Nepal neither it has generated huge amount of revenue in national economy. In the present global scenario where the oil prices are shooting up and future provides an uncertain outlook with respect to oil, optimal utilization of hydropower, would reduce Nepal's import cost substantially, contribute in improving the relative competitiveness of the economy both on a regional and global basis, and fulfill the desire of double-digit sustainable growth in the coming decades.

5.3 Recommendations

Located in between two large growing economies, which have the largest number of the world's population, we can export our hydropower to the neighboring countries to fulfill their energy demand. If Nepal can develop and export hydroelectricity, it can earn billions of foreign currency. To expand the market of electricity, development of hydropower must be done in an efficient, cost effective and planned way. The government of Nepal should implement the National Water Plan properly for the development of hydropower sector.

If we review sectoral energy consumption data, we find that domestic sector is dominant in consuming energy. So the energy consumption in domestic sector should be shifted to other highly important sectors, particularly electricity-based industries, and transportation. Regional balance in Electricity accessibility has not maintained well. Regional balance in production and distribution capacity needs to be maintained for both socio-political and techno-economic reasons. The government of Nepal should assure all people that they are part of the overall national development process, and this will occur in important indicators of development such as availability of hydropower to them. So, the accessibility of electricity should be extended to rural areas of the country. Large scale export potential should not be entertained without first achieving a strong domestic base because once Nepal's needs are adequately met, It will be in a more comfortable bargaining position for export in border towns, with the generosity of the Bihar and Uttar Pradesh Electricity Boards.

The major recommendations are grouped under five broad headings:

1. National Consensus and Priority

– There is a need for national consensus among major political parties on the issues of utilization of Nepal's water resources. Maoist stance should also be reflected, as the party is also going to be a major political party.

– Hydropower development should be considered as one of the most important agenda of economic development. It should be taken as exportable good to the neighboring country, so that not only the foreign currency could be saved but trade deficit with these countries could also be decreased considerably.

2. Mobilization of Domestic Resources

– Preference should be given to mobilize domestic financial resources by encouraging private sector to invest in hydropower projects. Government should provide loans at concessional rate to encourage local people for the promotion of small and micro hydro projects.

– Though big projects are supposed to be export oriented, before that domestic demand of nation should addressed properly. On this basis of domestic demand hydropower projects should be launched which can be completed from Nepal's own resources.

– To be less dependent on foreign aid for financial resources even in big hydropower projects, government can float "Hydropower Development Bonds" in the market to mobilize people's saving and reduce investment in unproductive sector.

3. Cost Reduction

– The government developed medium-sized hydropower projects which cost an average of US$ 2800/KW while private generators have been able to produce at US 1,000/KW. In this context, reduction of the cast of government-developed hydropower to the level of private sector, should be given serious attention.

– The process of electrification should be demand oriented rather than project oriented. Just launching the project is not the major task rather people should have access into cheaper unit cost. Further more, the supply of hydropower should be reliable.

– Foreign loan should be accepted and invested in such hydro projects where adequate return would be generated to repay back the loan.

4. Attraction to FDI by legal and institutional reform

– The existing legal as well as institutional problems hindering FDI in hydropower sector should be resolved. Various problems associated with FDI such as: lack of investment guarantee, heavy and dual taxation on earning, lack of provision of re-investment of earning, lack of promotion of private sector partnership for investment should be addressed properly and in time.

– Licensing Application process for hydropower development should be fast and encouraging instead of being tedious and requiring the potential investors to run one after another window.

– So far as the FDI is concerned , efforts to attract investment for neighboring countries particularly from India in Hydropower and Electricity based industries should be encouraged with in the country.

5. Others

– Infrastructure development is a pre-requisite for hydropower development. So concerned authority should be give due attention to this aspect.

– Hydropower research and development should be given top priority.

– Government should promote the use of electric cars which have been recently introduced in Nepal by waiving customs duties on the imports of such cars. This will help reduce the import of petrol and control environmental pollution

REFERENCES

ADB and ICIMOD (2006), ***Environmental Assessment of Nepal: Emerging Issues and Challenges,*** Kathmandu, Nepal.

Adhikari, Deepak (2006), "Hydropower Development in Nepal", ***Economic Review,*** Occasional Paper, Number 18, NRB

Bhadra, Binayak (2004), "Hydropower Development in Nepal: Problems and Prospects", ***The Nepalese Economy,*** New Hira Books Enterprises, Kathmandu.

Bhattarai, Narayan P. (2004), ***Financial Resources for the Development of Hydropower in Nepal.***

CBS (2001), ***Statistical Pocket Book Nepal,*** Kathmandu

Dahal, Madan K. (2004), "Nepalese Economy towards Building a Strong Economic Nation-state", ***The Nepalese Economy,*** New Hira Books Enterprises, Kathmandu

Dhital, Komal (2004), "Hydropower Development in Nepal", ***The Nepalese Economy,*** New Hira Books Enterprises, Kathmandu.

Dhungel, K.R. (2003), ***Income and Price Elasticity of the Demand for Energy: A Macro level Empirical Analysis,*** Pacific and Asian Journal of Energy Vol. 13 (2).

International Journal on Hydropower and Dams, 1998.

International Journal on Hydropower and Dams, Volume 13, Issue 2, 2006.

Jha, Hari Bansh (ed.) (1995), ***Sustainable Development of small hydropower In Nepal,*** Lalitpur Centre for economics and Technical Studies, Nepal.

Koirala, R.P. (1990), ***SAARC: Nepal's Role in Collective Utilization of its water Resources,*** The Team Publication Pvt. Ltd, Kathmandu, Nepal.

Ministry of Science and Technology (2003), ***Micro-hydro Year Book of Nepal,*** Alternative Energy Promotion Centre, Kathmandu

Ministry of Water Resources (1995), ***The Energy Resources Base of Nepal,*** WECS, Singha Durbar, Kathmandu, Nepal.

_____ (1996), ***Energy Synopsis Report, Nepal 1994-95,*** Singha Durbar, Kathmandu, Nepal

_____ (2001), ***The Hydropower Development Policy,*** Singha Durbar, Kathmandu, Nepal.

MOF (1999), ***Economic Survey,*** HMG/N, Ministry of Finance, Singha Durbar, Kathmandu, Nepal.

_____ (2006), ***Economic Survey,*** HMG/N, Ministry of Finance, Singha Durbar, Kathmandu, Nepal

National Planning Commission (1956), ***The First Plan (1956-1961),*** NPC, HMG, Singha Durbar, Kathmandu, Nepal.

_____ (1962), ***The Second Plan (1962-1965),*** NPC, HMG, Singha Durbar, Kathmandu, Nepal.

_____ (1966), ***The Third Plan (1966-1970),*** NPC, HMG, Singha Durbar, Kathmandu, Nepal.

_____ (1970), ***The Fourth Plan (1970-1975),*** NPC, HMG, Singha Durbar, Kathmandu, Nepal.

_____ (1975), ***The Fifth Plan (1975-1980),*** NPC, HMG, Singha Durbar, Kathmandu, Nepal.

_____ (1980), ***The Sixth Plan (1980-1985),*** NPC, HMG, Singha Durbar, Kathmandu, Nepal.

_____ (1985), ***The Seventh Plan (1985-1990),*** NPC, HMG, Singha Durbar, Kathmandu, Nepal.

_____ (1992), ***The Eighth Plan (1992-1997),*** NPC, HMG, Singha Durbar, Kathmandu, Nepal.

_____ (1997), ***The Ninth Plan (1997-2002),*** NPC, HMG, Singha Durbar, Kathmandu, Nepal.

_____ (2002), ***The Tenth Plan (2002-2007),*** NPC, HMG, Singha Durbar, Kathmandu, Nepal.

NEA (2005/06), ***Fiscal Year 2005/06 - A Year In Review,*** Kathmandu, NEA.

_____ (2006), ***Generation,*** Fourth issue, NEA, Kathmandu, Nepal.

_____, Various issues, ***VIDYUT,*** NEA, Kathmandu, Nepal.

Neupane, Apar (16 August 2006), ***Hydropower, Opportunities And Challenges,*** The Kathmandu Post, Nepal.

Practical Action (1993), ***Hydropower Development in Nepal: Taking a sector wideview,*** Kathmandu, Nepal

_____ (1994), ***Power Guide: An International Catalogue of Small-scale energy equipment with Introductions by wim Hulscher and Peter Fraenkal,*** Kathmandu, Nepal.

Renewable Energy Data of Nepal, 2003.

Rijal, Kamal (ed.) (1999), ***Energy Use in Mountain Areas, Trends and Patterns in China, India, Nepal and Pakistan,*** ICIMOD, Kathmandu.

Shrestha, Arjun P. (1991), ***Hydropower In Nepal: Issues and concepts of Development,*** Kathmandu, Resources, Nepal.

Shrestha, B. (2003), ***Antecedence of Kaligandaki River in Central Nepal,*** The Himalayan Geographer, Pokhara, Nepal.

Subba, Bhim (2001), ***Himalayan Water Promise and Potential problems and Politics,*** The Panos Institute South Asia, Kathmandu.

UN (1982), ***Renewable Sources of Energy, Small Hydropower Development,*** Economic and Social Commission for Asia and the Pacific

Upoadhaya, Shyam K. (2002), ***Hydropower Development in Nepal: Issues of Equality and Environmental Justice,*** Winrock International, Kathmandu, Nepal.

Warnock, J.B. (1989), ***The Hydro Resources of Nepal,*** Water Power and Dam Construction, U.K.

WECS (2002), ***Water Resources Strategy Nepal,*** Singha Durbar, Kathmandu, Nepal

_____ (2005)**,** ***National Water Plan 2005****,* Singha Durbar, Kathmandu

ANNEX-I: Development of Hydropower Projects in Nepal (1911-2005)*

S.N.	Hydropower Projects	Commissioned Year	Capacity (KW)	Cumulative Generation (KW)	Type	Located District	Gird Status	Ownership
1.	Pharping**	1911	500	500	RoR	Kathmandu	Grid Connected	NEA
2.	Sundarijal	1936	640	1,140	RoR	Kathmandu	Grid Connected	NEA
3.	Panauti	1965	2400	3,540	RoR	Kavre	Grid Connected	NEA
4.	Phewa	1967	1088	4,628	RoR	Kaski	Grid Connected	NEA
5.	Trisuli	1967	24000	28,628	RoR	Nuwakot	Grid Connected	NEA
6.	Dhankuta	1971	240	28,868	RoR	Dhankuta	Isolated	NEA
7.	Sunkosi	1972	10050	38,918	RoR	Sindupalchowk	Grid Connected	NEA
8.	Jhapra	1977	345	39,263	RoR	Surkhet	Isolated	NEA
9.	Dhading	1978	32	29,295	RoR	Dhading	Isolated	NEA
10.	Tinau	1978	1024	40,319	RoR	Rupendehi	Grid Connected	NEA

11.	Gandak	1979	15,000	55,319	RoR	Nawalparasi	Grid Connected	NEA
12.	Baglung	1981	200	55,519	RoR	Baglung	Grid Connected	NEA
13.	Doti	1981	200	55,719	RoR	Doti	Isolated	NEA
14.	Phidim SHP	1981	240	55,959	RoR	Panchthare	Isolated	Leased
15.	Gorkhe	1982	64	56,023	RoR	Ilam	Isolated	NEA
16.	Jumla	1982	200	56,223	RoR	Jumla	Isolated	Leased
17.	Jomsom	1982	240	56,463	RoR	Mustang	Grid Connected	Leased
18.	Kulekhani I	1982	60,000	1,16,463	Storage	Makawanpur	Grid Connected	NEA
19.	Devighat	1983	14,100	1,30,563	RoR	Nuwakot	Grid Connected	NEA
20.	Syngja	1984	80	1,30,643	RoR	Syangja	Isolated	NEA
21.	Helambu	1985	50	1,,30,693	RoR	Sindupalchowk	Isolated	NEA
22.	Seti (Pokhara)	1985	1,500	1,32,193	RoR	Kaski	Grid Connected	NEA
23.	Salleri	1986	400	1,32,593	RoR	Solukhumbu	Isolated	NEA
24.	Kulekhani 2	1986	32,000	1,64,593	Storage	MaKWanpur	Grid Connected	NEA

25.	Chame	1987	45	1,64,638	RoR	Manang	Isolated	Leased
26.	Manang	1988	80	1,64,718	RoR	Manang	Isolated	NEA
27.	Tehrathum	1988	100	1,64,818	RoR	Tehrathum	Isolated	Leased
28.	Taplejung	1988	125	1,64,943	RoR	Taplejung	Isolated	Leased
29.	Chaurjhari	1989	150	1,65,093	RoR	Rukum	Isolated	Leased
30.	Ramechhap	1989	150	1,65,243	RoR	Ramachhap	Isolated	NEA
31.	Serpodaha	1989	200	1,65,443	RoR	Rukum	Isolated	Leased
32.	Bajhang	1989	200	1,65,643	RoR	Bajhang	Isolated	Leased
33.	Dolpa	1989	200	1,65,843	RoR	Dolpa	Isolated	NEA
34.	Khandbari	1989	250	1,66,093	RoR	Sankhuwasabha	Isolated	Leased
35.	Bhojpur	1989	250	1,66,343	RoR	Bhojpur	Isolated	Leased
36.	Marsyangdi	1989	69000	2,35,343	RoR	Lamjung	Grid Connected	NEA
37.	Okhaldhunga	1990	125	2,35,468	RoR	Okholdhunga	Isolated	NEA
38.	Bajura	1990	200	2,35,668	RoR	Bajura	Isolated	NEA
39.	Rupalgad	1991	100	2,35,768	RoR	Dadeldhura	Isolated	NEA
40.	Arughat	1991	150	2,35,918	RoR	Gorkha	Isolated	NEA
41.	Surnaiyagad	1991	200	2,36,118	RoR	Baitadi	Isolated	NEA

42.	Tatopani 1 and 2	1991	2000	2,38,118	RoR	Myagdi	Grid Connected	NEA
43.	Andhi Khola (BPC)	1991	5100	24,218	RoR	Sangja	Grid Connected	Pvt. Sector
44.	Darchula	1992	300	2,43,518	RoR	Darchula	Isolated	NEA
45.	Namche	1993	600	2,44,118	RoR	Solukhumbu	Isolated	NEA
46.	Chatara	1994	12,300	2,56,418	RoR	Pyuthan	Grid Connected	Pvt. Sector
47.	Achham	1995	400	2,56,818	RoR	Achham	Isolated	NEA
48.	Chatara	1996	3,200	2,60,018	RoR	Sindupalchwok	Grid Connected	NEA
49.	Kalikot**	1999	500	2,60,518	RoR	Kalikot	Isolated	NEA
50.	Puwa Khola	1999	6,200	2,66,718	RoR	Ilam	Grid Connected	NEA
51.	Modi Khola	2000	1,4800	2,81,518	RoR	Parbat	Grid Connected	NEA
52.	Chilime (CPC)	2000	20,000	3,01,518	RoR	Rasuwa	Grid Connected	Pvt. Sector
53.	Khimti Khola (HPL)	2000	60,000	3,61,518	RoR	Dolakha	Grid Connected	Pvt. Sector
54.	Sange Khla (SHP)	2001	183	3,61,701	RoR	Lumjung	Grid Connected	Pvt. Sector

55.	Bhotekosi (BKPC)	2001	36,000	3,97,701	RoR	Sindhupalchowk	Grid Connected	Pvt. Sector
56.	Chaku Khola (APCO)	2002	1,500	3,99,201	RoR	Sindhupalchowk	Grid Connected	Pvt. Sector
57.	Indrawati (NHPC)	2002	7,500	4,06,701	RoR	Sindhupalchowk	Grid Connected	Pvt. Sector
58.	Kali Gandaki A	2002	144000	406701	RoR	Sangja	Grid Connected	NEA
59.	Piluwa Khola (AVHP)	2003	3,000	5,53,701	RoR	Sankhuwasabha	Grid Connected	Pvt. Sector
60.	Rairang (RHPD)	2004	500	5,54,201	RoR	Dhading	Grid Connected	Pvt. Sector
61.	Sunkosi-Small (SHP)	2005	2,600	5,56,801	RoR	Sindhupalchowk	Grid Connected	Pvt. Sector

* Hydropower Stations Producing Less than 100 KW are excluded.

** Not in normal operation.

Source: NRB, Economic Review occasional paper number 18 and NEA

ANNEX-II: Small Hydropower Projects (up to 1000 KW)

S.N.	Hydropower Projects	Capacity (KW)	Type	Commissioned Year	Located District	Gird Status	Ownership
1.	Dhading	32	RoR	1978	Dhading	Isolated	NEA
2.	Chame	45	RoR	1987	Manang	Isolated	Leased
3.	Helambu	50	RoR	1985	Sindupalchowk	Isolated	NEA
4.	Gorkhe	64	RoR	1982	Ilam	Isolated	NEA
5.	Sangja	80	RoR	1984	Sangja	Isolated	NEA
6.	Manang	80	RoR	1988	Manang	Isolated	NEA
7.	Tehrathum	100	RoR	1988	Tehrathum	Isolated	Leased
8.	Rupalgad	100	RoR	1991	Dadeldhura	Isolated	NEA
9.	Taplejung	125	RoR	1988	Taplejung	Isolated	Leased
10.	Okhaldhunga	125	RoR	1990	Okhaldhunga	Isolated	NEA
11.	Chaurjhari	150	RoR	1989	Rukum	Isolated	Leased
12.	Ramechhapp	150	RoR	1989	Ramachhap	Isolated	NEA
13.	Arughat	150	RoR	1991	Gorkha	Isolated	NEA
14.	Sange Khola	183	RoR	2001	Lamjung	Grid Connected	Private Setor

15.	Baglung	200	RoR	1981	Baglung	Grid Connected	NEA
16.	Doti	200	RoR	1981	Doti	Isolated	NEA
17.	Jumla	200	RoR	1982	Jumla	Isolated	Leased
18.	Serpodaha	200	RoR	1989	Rukum	Isolated	Leased
19.	Bajhang	200	RoR	1989	Bajhang	Isolated	Leased
20.	Dolpa	200	RoR	1989	Dolpa	Isolated	NEA
21.	Bajura	200	RoR	1990	Bajura	Isolated	NEA
22.	Surnaiyagad	200	RoR	1991	Baitadi	Isolated	NEA
23.	Dhankuta	240	RoR	1971	Dhankuta	Isolated	NEA
24.	Phidim SHP	240	RoR	1981	Panchthar	Isolated	Leased
25.	Jomsom	240	RoR	1982	Mustang	Grid Connected	Leased
26.	Khandhari	250	RoR	1989	Sankhuwasabha	Isolated	Leased
27.	Bhojpur	250	RoR	1989	Bhojpur	Isolated	Leased
28.	Darchula	300	RoR	1992	Darchula	Isolated	NEA
29.	Jhupra	345	RoR	1977	Surkhet	Isolated	NEA
30.	Salleri	400	RoR	1986	Solukhumbu	Isolated	NEA

31.	Achham	400	RoR	1995	Achham	Isolated	NEA
32.	Pharping**	500	RoR	1911	Kathmandu	Grid Connected	NEA
33.	Kalikot**	500	RoR	1999	Kalikot	Isolated	NEA
34.	Rairang	500	RoR	2004	Dhading	Grid Connected	Private Sector
35.	Namche	600	RoR	1993	Solukhumbu	Isolated	NEA
36.	Sundarijal	640	RoR	1936	Kathmandu	Grid Connected	NEA
Total		8,439					

Source: NRB, Economic Review occasional paper number 18 and NEA

ANNEX-III: Medium-sized Hydropower Projects (more than 1000 KW)

S.N.	Hydropower Projects	Capacity (KW)	Type	Commissioned Year	Located District	Gird Status	Ownership
1.	Tinau	1,024	RoR	1978	Rupendehi	Grid Connected	NEA
2.	Phewa	1,088	RoR	1967	Kaski	Grid Connected	NEA
3.	Seti (Pokhara)	1,500	RoR	1985	Kaski	Grid Connected	NEA
4.	Chaku Khola (APCO)	1,500	RoR	2002	Sindhupalchowk	Grid Connected	Private Sector
5.	GTatopani 1 and 2	2,000	RoR	1991	Myagdi	Grid Connected	NEA
6.	Panauti	2,400	RoR	1965	Kavre	Grid Connected	NEA
7.	Sunkosi-Small (SHP)	2,600	RoR	2005	Sindhupalchowk	Grid Connected	Private Sector
8.	Piluwa Khola (AVHP)	3,000	RoR	2003	Sankhuwasabha	Grid Connected	Private Sector
9.	Chatara	3,200	RoR	1996	Sindhupalchowk	Grid Connected	NEA
10.	Andhi Khola (BPC)	5,100	RoR	1991	Sangja	Grid Connected	Private Sector
11.	Puwa Khola	6,200	RoR	1999	Ilam	Grid Connected	NEA
12.	Indrawati (NHPC)	7,500	RoR	2002	Sindhupalchowk	Grid Connected	Private Sector
13.	Sunkosi	10,050	RoR	1972	Sindhupalchowk	Grid Connected	NEA

14.	Jhimruk (BPC)	12,300	RoR	1994	Pyuthan	Grid Connected	Private Sector
15.	Devighat	14,100	RoR	1983	Nuwakot	Grid Connected	NEA
16.	Modi Khola	14,800	RoR	2000	Parbat	Grid Connected	NEA
17.	Gandak	15,000	RoR	1979	Nawalparasi	Grid Connected	NEA
18.	Chilime (CPC)	20,000	RoR	2000	Rasuwa	Grid Connected	NEA & Private Sector
19.	Trisuli	24,000	RoR	1967	Nuwakot	Grid Connected	NEA
20.	Kulekhani-2	32,000	Storage	1986	MaKWanpur	Grid Connected	NEA
21.	Bhotekosi (BKPC)	36,000	RoR	2001	Sindhupalchowk	Grid Connected	Private Sector
22.	Kulekhani-1	60,000	Storage	1982	MaKWanpur	Grid Connected	NEA
23.	Khimti Khola (HPL)	60,000	RoR	2000	Dolakha	Grid Connected	Private Sector
24.	Marsyangdi	69,000	RoR	1989	Lamjung	Grid Connected	NEA
25.	Kali Gandaki A	1,44,000	RoR	2002	Sangja	Grid Connected	NEA
Total		**8,439**					

Source: NRB, Economic Review occasional paper number 18 and NEA

ANNEX-IV: Up-coming Hydropower Projects (Under-Construction)

S.N.	Hydropower Company	Name of River	Capacity (KW)	Located District
1.	Gautam Buddha Hydro Power Company	Sisne Khola	750	Palpa
2.	Unique Hydro Power Company	Baramchi Khola	999	Sindhupalchowk
3.	Khudi Hydro Power	Khudi Khola	3,450	Lumjung
4.	Lower Nyadi Hydroelectric Project	Lower Nyadi	4,500	Lumjung
5.	Molnia Power Pvt. Ltd.	Mailung Khola	5,000	Rasuwa
6.	Gitec. Power Pvt. Ltd.	Upper Modi Khola	14,000	Kaski
7.	Kathmandu Small Hydro Power System	Sali Nadi	232	Kathmandu
8.	NEA	Middle Marsyangdi	70,000	Lamjung
9.	NEA	Chameli	30,000	Darchula
10.	NEA and Private Sector	Chilime	11,000	Rasuwa
11.	NEA	Kulekhani III	14,000	Makawanpur
12.	NEA	Gomgad	400	Mugu
13.	NEA	Heldung	500	Humla
Total			**1,54,831**	

Source: NRB, Economic Review ,occasional paper number 18 and NEA

ANNEX-V: Structure of Energy Consumption

Energy Source	1980/81	1981/82	1982/83	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94
Traditional	4411	4483	4578	4678	4780	4882	4988	5098	5208	5321	5576	5691	5811	5933
Fuel wood	3382	4004	4089	4178	4269	4361	4456	4553	4652	4753	4980	5084	5191	5300
Agri. Waste	584	179	183	187	191	195	199	204	208	213	224	228	233	238
Animal Dung	445	300	306	313	320	326	333	341	348	355	372	379	387	395
Commercial	180	180	166	166	255	267	201	279	274	289	349	419	430	483
Coal	49	49	37	37	83	85	10	54	50	45	42	58	26	32
Petroleum	117	117	113	113	151	158	164	193	186	204	257	306	348	391
Electricity	14	14	16	16	21	24	27	32	38	40	50	55	56	60
Total	4591	4663	4744	4873	5035	5149	5189	5377	5610	5688	5929	6115	6247	6422

Energy Source	1994/ 95	1995/ 96	1996/ 97	1997/ 98	1998/ 99	1999/ 2000	2000/ 01	2001/ 02	2002/ 03	2003/ 04	2004/ 05	2005/ 06*
Traditional	6059	6185	6268	6403	6540	6681	6824	7066	7240	7397	7558	7721
Fuel wood	5412	5525	5574	5694	5816	5941	6068	6315	6451	6591	673	6878
Agri. Waste	243	248	273	279	285	292	299	305	312	319	328	336
Animal Dung	404	412	421	430	439	448	457	446	477	487	497	507
Commercial	581	651	691	769	818	1054	1016	1029	1015	1059	1014	1133
Coal	67	72	60	61	68	246	174	152	134	171	152	241
Petroleum	448	507	554	625	661	709	734	758	753	747	705	724
Electricity	66	72	77	83	89	99	108	119	128	141	157	168
Total	6647	6846	6972	7188	7378	7759	7869	8128	8294	8501	8617	8904

*Estimate of First eight months.

Source: Economic Survey 1999/2006

Note: in this structure beyond above mentioned i.e. (other) energy sources are not included.

ANNEX-VI: Source and Uses of Electricity

In Million KWH

Fiscal Year	Household	Industrial	Commercial	Export	Other	Total	Power Loss	Production & Import	Peak Load MW	Import	Export
1974/75	54.1	21.4	7.9	4.6	3.8	91.8	37.0	128.8	36	4.3	4.6
1975/76	61.8	32.1	9.2	5.9	4.2	113.2	43.0	156.2	40	8.0	5.9
1976/77	65.8	39.0	10.4	6.1	4.4	125.7	45.8	171.5	46	11.9	6.1
1977/78	71.3	42.8	13.1	6.0	4.5	137.7	54.7	192.4	51	13.8	6.0
1978/79	77.2	47.8	18.0	6.2	5.9	155.1	63.0	218.1	53	16.7	6.2
1979/80	74.8	52.1	25.2	5.2	9.1	166.4	67.3	233.7	57	17.5	5.2
1980/81	79.0	53.8	23.2	3.8	8.6	168.4	66.4	234.8	59	18.8	3.8
1981/82	90.6	68.1	17.8	5.2	8.5	190.2	85.0	275.2	75	22.8	5.2
1982/83	119.0	82.0	21.3	6.0	8.5	236.8	110.2	347.0	84	24.0	6.0
1983/84	129.6	88.8	19.5	10.3	6.9	255.1	127.4	382.5	97	25.0	10.3
1984/85	155.9	100.1	21.2	10.6	10.0	297.8	123.8	421.6	104	38.0	10.6
1985/86	140.6	110.4	19.3	21.5	49.6	341.4	147.1	488.5	110	57.8	21.5
1986/87	162.3	148.5	21.9	20.5	49.4	402.6	168.5	571.1	125	32.6	20.5
1987/88	185.7	161.6	25.4	16.1	76.4	465.2	163.4	628.6	141	68.3	16.1
1988/89	193.3	175.3	30.8	17.6	79.2	496.2	176.2	672.4	150	113.9	17.6
1989/90	231.4	178.3	33.7	23.3	81.4	548.1	225.8	773.9	176	60.7	23.3
1990/91	261.4	206.9	36.6	80.6	83.8	669.3	236.9	906.2	201	33.7	80.6
1991/92	275.2	246.4	45.2	85.4	85.1	737.3	243.7	981.0	216	54.9	85.4

1992/93	259.8	273.8	47.6	46.1	82.1	709.4	253.9	963.3	214	82.2	46.1
1993/94	275.1	304.0	49.0	50.5	105.3	783.9	247.0	1030.9	231	102.8	50.5
1994/95	301.6	328.3	58.6	39.5	111.3	839.3	278.2	1117.5	244	133.8	39.5
1995/96	328.7	358.7	62.9	87.0	99.4	936.7	325.2	1261.9	275	73.0	87.0
1996/97	355.1	376.7	67.6	100.2	128.2	1027.8	340.8	1368.6	300	154.0	100.2
1997/98	378.8	413.7	71.5	67.4	120.0	1051.4	321.8	1373.2	317	210.3	67.4
1998/99	410.6	441.0	77.3	64.2	120.5	1113.6	361.4	1475.0	326	232.4	60.0
1999/2000	467.1	508.4	81.8	95.0	117.1	1269.4	380.8	1701.5	352	232.2	95.0
2000/01	518.4	520.6	94.1	126.0	148.0	1407.1	461.3	1868.4	391	226.5	126.0
2001/02	557.9	596.7	90.4	133.9	161.1	1540.0	526.3	2066.3	426	238.2	133.9
2002/03	617.1	629.5	92.7	192.2	170.1	1701.6	559.5	2261.1	470	149.9	192.2
2003/04	676.4	629.8	108.1	141.2	196.7	1812.2	569.3	2381.5	515.2	185.6	141.2
2004/05*	758.2	464.0	109.3	110.7	222.2	1964.4	678.4	2642.8	557.2	241.4	110.7
2005/06**	474.8	479.0	70.5	64.6	126.5	1216.1	437.4	1653.8	610	125.4	64.6

*Revised

**Estimate of First Eight Month

Source: Nepal Electricity Authority

ANNEX-VII: Production and Consumption of Electricity by Type, 1994/95 to 2003/04

Items	1994/95	1995/96	1996/97	1997/98	1998/99	1999/2000	2000/01	2001/02	2002/03	2003/04
Electricity Production and import (MWH)										
Hydro Generation	903006	1153620	1166596	1043068	1120760	1414951.416	1615887.8	1832838	2464566	2185872
Diesel Generation	80820	38673	39729	106489	111507	66775.200	26103.7	17007	4462.3	9920
Others (Solar, Wind)	187	-	-	-	95	-	92.9	90	87	58
Received from India under					-	-	-	-	-	-
Koshi Agreement	85070	-	-	-	-	-	-	-	-	-
Import Export Agreement	110000	70540+	129622+	210290+	225609+	196948.08+	186120.5+	232124+	135636+	185647+
Total	1179083	1262833	1335947	1359847	1457971	1678674.696	1828204.9	2082059	2604751.3	2381497
Electricity Consumption (MWH)**										
Domestic	309328	333704	352234	378189	407682	447265.255	492963.2	554171	611403	684246
Industrial	328110	358443	376465	400228	440720	483622.637	537685.5	592517	631113	697574

Commercial	59485	62482	67400	70732	77137	86425.484	91767.2	121381	92850	107760
Export	42416	90340	100218	63329	64158	98680.908	112094.4	132437	187511	139079
Others	90184*	106899*	114284*	118830*	123882*	134616.672*	149493.8*	157251*	171393*	207444*
Total	829523	950868	1010601	1031308	1113579	1250610.956	1384004.1	1557757	1694270	18361036
Electricity Loss (MWH)	287447	310845	325347	328539	344392	428063.740	444200.8	524302	910481.3	545394
Maximum Power Demand (KW) (In a day of the year)	244000	275000	300110	317000	326410	352620.000	391000	426000	470330	515240

+ Total units received from India * including self consumption. ** Incl. Public Sector Consumption only.

Source: Nepal Electricity Authority.

Statistical Year book of Nepal, 2005

ANNEX-VIII: Electricity Generation by Type of Power for Development Region, 1994/95 to 2003/04

Year	Development Region								
	Eastern			Central			Western		
	Hydro	Diesel	Others	Hydro	Diesel	Others	Hydro	Diesel	Others
1994/95	5130	58812	-	505789	15528	-	388210	6480	-
1995/96	N.A.	28340	-	546740	10333	-	561980	-	-
1996/97	N.A.	29853	-	566011	9412	-	550180	464	-
1997/98	86	1043248	-	478302	-	-	509876	2141	-
1998/99	1437	87095	-	479685	22206	-	613741	2206	-
1999/2000	10081.335	53825.660	-	815176.655	11017.200	-	528570.795	1932.340	-
2000/01	28293.2	19310.8	-	1012432.3	5196.7	-	541343.2	1596.2	-
2001/02	27651	13661	-	1134243	3045	-	619614	301	-
2002/03	294095	4212	-	1233639	247.2	-	935198	3.1	-
2003/04	53188	8743	-	1201602	1117	-	901026	60	-

Contd...

Year	Development Region								
	Mid-Western			Far-Western			Total		
	Hydro	Diesel	Others	Hydro	Diesel	Others	Hydro	Diesel	Others
1994/95	853	-	144	3024	-	-	903006	80820	187
1995/96	44900	-	-	N.A.	-	-	1153620	38673	-
1996/97	50405	-	-	N.A.	-	-	1166596	39729	-
1997/98	54804	-	-	N.A.	-	-	1043068	106489	-
1998/99	23344	-	95	2553	-	-	1120760	111507	95
1999/2000	59668.549	-	-	1454.082	-	-	1414951.416	66775.200	-
2000/01	32049.8	-	92.9	1769.3	-	-	16515887.8	26103.7	92.9
2001/02	49557	-	90	1773	-	-	1832838	17007	90
2002/03	-	-	87	1634	-	-	2464566	4462.3	87
2003/04	28542	-	58	1514	-	-	2185872	9920	58

Statistical Year Book of Nepal, 2005, CBS.

ANNEX-IX

Foreign Aid Commitment and Disbursement in Power Sector

Rs in million

FY	Commitment		disbursement		
			Grand	Loan	Total
1975/76	**8854**	*/666.6*	14.2	8.5	22.7
1976/77	**1988**	*/157.2*	8.6	16.8	25.4
1977/78	**4757**	*/1.7*	15.4	192.4	207.8
1978/79	**7395**	*/614.3*	46.7	161.8	208.5
1979/80	**310.8**	*/295.2*	145.1	261.3	406.4
1980/81	**175.6**	*/175.6*	202.0	358.3	560.3
1981/82	**866.6**	*/723.6*	186.0	129.3	316.2
1982/83	**683.6**	*/683.6*	151.9	161.8	313.7
1983/84	**512.4**	*/497.0*	119.2	343.7	462.9
1984/85	**1839.8**	*/1018.0*	41.8	286.8	328.6
1985/86	**4392.9**	*/4244.9*	188.1	703.4	891.5
1986/87	**108.4**	*/108.4*	9.4	831.9	931.3
1987/88	**631.1**	*/631.1*	536.4	1135.1	1671.5
1988/89	**1296.3**	*/1296.3*	296.1	1439.3	1735.4
1989/90	**3187.6**	*/3187.6*	526.1	1275.4	1801.6
1990/91	**585.5**	*/585.5*	356.7	806.9	1163.6
1991/92	**2767.4**	*/2797.4*	300.3	943.1	1243.4
1992/93	**4474.7**	*/4190.6*	429.0	1579.5	2008.5
1993/94	**670.5**	*/670.5*	50.9	1581.4	1632.3
1994/95	**1952.4**	*/1952.4*	51.6	1201.8	1253.3
1995/96	**3144.5**	*/2183.4*	817.4	2084.7	2902.1
1996/97	**18879.5**	*/18879.4*	1303.0	2565.5	3868.5
1997/98	**2993.9**	*/2993.9*	828.8	3289.8	4118.6
1998/99	**3318.0**	*/3318.0*	437.0	4234.1	4671.1

1999/2000	**4174.4**	*/4174.4*	325.1	5192.3	5517.4
2000/01	**1158.7**	*/1158.7*	1120.4	4626.8	5747.2
2001/02	**758.5**	*/758.5*	578.3	2763.1	3341.4
2002/03	**6282.1**	*/6282.1*	3074.5	472.5	3547.0
2003/04	**1866.4**	*/1866.4*	3788.6	449.8	4238.4
2004/05	**0.0**	*/0.0*	5645.2	510.0	6159.2
2005/06	**1230.3**	*/1230.3*	-	-	-

Note: figures in italic indicate commitment made by members of Nepal Development Forum.

* First Eight Months

Source: Economic Survey 1999/2006

ANNEX-X

Hydropower Stations under operation

There are sixteen hydropower stations under operation which are given here with a short introduction along with salient features.

1. Kaligandaki 'A' Hydropower Station

Introduction

Kaligandaki 'A' hydropower station is a peaking-run-of-the river type with an installed capacity of 144 MW. The power house was commissioned in the year 2002. The average (designed) annual generation of this power house is 842 KWH. The generation from this power station has contributed 23.00 percentage of the total energy in the INPS.

Salient Features:

1. Type	: Peak-Run-of-the-river
2. Installed capacity	: 14 MW
3. Turbine Generator set	: 3 NOS
4. Turbine:	
i) Number and Type	: 3NOS, Francis
ii) Output/Unit	: 48 MW
5. Generators:	
i) Numbers and Type	: 3 NOS, 3 Phase synchronous
ii) Rated Voltage	: 13.8 KV
6. Transmission Line	
Total Length	: 104.6 K.M
7. Project Inception Date	: August 16, 2002
8. Project Financed By	: ADB, FINNIDA and UNDP

2. Marsyangdi Hydroelectric power station

Marsyangdi hydropower station is a peaking-run-of-the-river type with an installed capacity of 69 MW. The power house was commissioned in the year 1989. Marsyangdi Hydropower Station generated 336.9 GWh of energy in this Fiscal year. The generation from this power station has contributed 13.9 % of the total energy in the INPS.

Salient features:

1. Type	: Peak-run-of-the-river
2. Installed capacity	: 69 MW
3. Turbine generator set	: 3 sets
4. Type of Turbine	: Francis
5. Capacity	: 30 MVA
6. Designed Average Annual Generation	: 462.5 GWH
7. Construction Cost	: 221.57 Million USD
8. Financed by	: HMG/N, IDA, KFW, KFED, SFD and ADB

3. Kulekhani-I Hydropower Station

Kulekhani-I is the only one reservoir type hydroelectric power station in Nepal. Its installed capacity is 1360 MW having two units each of 30 MW. The annual expected Energy generation capacity as primary energy is 165 GWH and 46 GHW as secondary energy. Generation from Kulekhani-2 contributed 7.19% in the INPS.

Salient features:

1. Type	: Reservoir
2. Installed capacity	: 60 MW

3. Turbine Type and Numbers	: Pelton, 2 Sets
4. Type of Generator	: Vertical shaft, synchronous
5. Capacity	: 35 MVA
6. Average Annual Generation	: 211 GWH
7. Construction Cost	: 117.84 Million USD
8. Financed by	: WB, Kuwait Fund, UNDP, OECF and OPEC fund.

4. Kulekhani-II Hydropower Station

The Kulekhani Hydropower Station with an installed capacity of 32 MW is cascade power station to Kulekhani-I along with a diversion of Mandu River to the specially built intake for Kulekhani-II. Besides this, when needed some water from Rapti River is also fed to the intake of KL-II by pumping. The operation of this power house is completely dependent on the operation of Kulekhani-I power station. It has generated 73.063 GWH of energy in fiscal year 061/62. The generation from Kulekhani-II contributed 3.02% of the total energy in this INPS.

Salient features:

1. Installed capacity	: 32 MW
2. Turbine generator set	: 2 sets
3. Type of Turbine	: Francis
4. Average Annual Generation	: 104.6 GWH
5. Commissioning Date	: Nov. 1986
6. Construction Cost	: NRs. 1,240 Million
7. Financed by	: HMG/N, OECF Japan.

5. Trishuli Hydropower Station

It is a peaking-run-of-the-river type, with an installed capacity of 24 MW. The power house was constructed in two stages, first with three units was commissioned in the year 2024 and the second stages with four units was commissioned in 2027. It was re-habilitated and up-grated in the year 2050. Trishuli Hydropower Station generated 122.233 GWH of energy in fiscal year 061/062. Generation from power house has contributed 5.17% of the total energy in INPS.

Salient features:

1. Type : peaking-Run-of-the River
2. Installed capacity : 24 MW (Peaking capacity 21 MW)
3. Turbine Type and Numbers : 7 units.
4. Type of Turbine : Horizontal Shaft
5. Project Inception : 1958
6. Project Financed by : Government of India and H.M.G. Of Nepal
7. Project cost including T/L : I.C 14 Corers

6. Gandak Hydropower Station

Gandak hydropower station is a canal drop scheme with an installed capacity of 15 MW. The average annual generation of this powerhouse is 106.38 GWH. Gandak hydropower station generated 21.596 GWH of energy in fiscal year 061/62. The generation from this power station has contributed 0.89% of the total energy in the INPS.

Salient features:

1. Designed Head : 6.09 M

2. Installed capacity : 15 MW

3. Turbine Generator Set : 3 NOS

4. Rated Voltage of Generator : 6.6 KV

5. Project Inception Date : 1964

6. Project Place in Service : April, 1979

7. Project Financed by : Nepal and India Govt.

8. Total Project Cost : NRS. 17 Corers

7. Modi Khola Hydropower Station

Modi Khola hydropower station is a peaking-run-of-the river with an installed capacity of 14.8 MW. The power house was commissioned in the year 2000. The average (designed) annual generation of this powerhouse is 92.5 GWH. Modi Khola hydropower station generated 44.20 GWH of energy in fiscal year 061/62. The generation from this power station has contributed 1.83% of the total energy in the INPS.

Salient features:

1. Type : peaking-run-of-the River

2. Rated net head : 66.9 meter

3. Type of Turbine and NOS : Vertical shaft Francis, 2 NOS

4. Rated Voltage : 6.6 KV

5. Average Annual Generation : 92.5 GWH

6. Commercial Operation : 9 Dec, 2000

7. Construction Cost : 30,000,000 USD

8. Financed by : HMG/N, NEA and EDCF (Korea)

8. Devighat Hydropower Station

Devighat hydropower station, with an installed capacity of 14.1 is situated in Kathmandu on the right bank of Trishuli hydropower station. The average (designed) annual generation of this power house is 114 GWH. Devighat hydropower station generated 85.615 GWH of energy in this fiscal year. The generation from this power station has contributed 3.54% of the total energy in the INDS.

Salient features:

1. Designed Head : 40 meter
2. Installed Capacity : 14.10 MW
3. Turbine Generator set : 3 NOS
4. Rated Voltage of Generator : 6.6 KV
5. Length of Canal : 4.50 Km
6. Project completion Date : Dec 1984.
7. Project Finance by : Indian Government
8. Total construction cost including

Transmission line : NRS 75 crores

9. Sunkoshi Hydropower Station

Sunkoshi hydropower station is located at 81 Km east from Kathmandu on the upper reach of Sunkoshi river in Sindhupalchowk District It has installed capacity of 10.05 MW (3 × 33.5 MW) and consists of three main parts: the head works area, the canal and the power house area. The power house is running at full load of 10.05 since placed in operation in January 1972. The hydropower station has generated

49.880 GWH in fiscal year 061/62. The generation from this power station has contributed 2.06% of total energy of INPS.

Salient features:

1. Type	: peaking-run-of-the River
2. Designed Head	: 30.5 meter
3. Average annual generation	: 70 GWH
4. Turbine generator set	: 3 NOS
5. Turbine output	: 3530 KW
6. Rated Voltage of generator	: Jan 1972
7. Project placed in service	: People's Republic of China and Nepal
8. Project Financed by	: WB, Kuwait Fund, UNDP, OECF and OPEC fund.
9. Project cost including transmission Line	: NRS 109.37 Million

10. Puwa Khola Hydropower Station

It is located at the right bank of Mai-Khola in Ilam municipality. Its installed capacity is 6.2 MW and consists of two units of horizontal axis pelton turbine. Puwa Khola hydropower station generated 29.896 GWH of energy in this fiscal year. The generation from this power station has contributed 1.24% of the total energy in the INPS.

Salient features:

1. Type	: Run of the river
2. Installed Capacity	: 6.2 MW
3. Turbine Type and NOS	: Horizontal Axis, 3 phases, Pelton, 2
4. Rated Voltage	: 6.6 KV

5. Commercial Operation : 4th April 2000

6. Construction Cost : 15.7 Million, US $

7. Designed Generation : 48 GWH

8. Financed by : HMG/Nepal and NEA.

11. Chatara Hydropower Station

It is a canal drop type with an installed capacity of 3.2 MW. The average (designed) annual generation of this power house is 6 GWH Chatara hydropower station generated 4.011 GWH of energy in this fiscal year. The generation from this power station has contributed 0.171 of the total energy in the INPS. This power house was handed over to NEA by Sunsari-Morang irrigation project in 15-12-2055.

Salient features:

1. Designed head : 5.38 meter

2. Installed capacity : 3.2 MW

3. Turbine generator set : 2 NOS

4. Power rating : 1627 KW

5. Rated Voltage : 11 KV

6. Date of Commission : July 1996

7. Project financed by : IDA

8. Project construction cost : NRS 16, 25, 85,000.00

12. Panauti Hydropower Station

Panauti Hydropower Station is the third hydropower station installed in Nepal. It is constructed on Roshi Khola, which lies at Khopasi of Kavre District located at 35 Km east of Kathmandu. The average (Designed) annual generation of this power house is 6.97 GWH. Panauti Hydropower Station has generated 3.772 GWH of energy in fiscal year

061/62. The generation from this power station has contributed 0.16% of the total energy in the INPS.

Salient features:

1. Type	: peaking-run-of-the River
2. Installed Capacity	: 2.4 MW
3. Length of the Canal	: 3.721 mm
4. Rated Voltage of generator	: 6.3 KV
5. Turbine Generator set	: 3 NOS
6. Turbine capacity	: 850 KW
7. Project completion date	: 2022 B.S.
8. Project Financed by	: USSR and Nepal Govt.
9. Project Construction cost	: NRS 2.7 corers

13. Seti Hydropower Station

Seti Hydropower Station is a run of river type with an installed capacity of 1.5MW. The powerhouse was commissioned in the year 1985 A.D. The average (designed) annual generation of this power house is 9.8 GWH. Seti hydropower station generated 9.31 GWH of energy in this fiscal has contributed 0.38% of the total energy in the INPS.

Salient features:

1. Designed Head	: 22.5 m
2. Installed Capacity	: 1.5 MW
3. N. of Generators	: 3 NOS
4. Length of the main canal	: 7.7 Km
5. Rated Capacity	: 543 KW
6. Project completion date	: July 1985

7. Project house commissioning: Nov 1985

9. Project Financed by : People's Republic of China and Nepal Government

14. Fewa Hydropower Station:

Fewa Hydropower Station is canal drop type with an installed capacity of 1.0 MW. The average (designed) annual generation of this power house is 2.2 GWH. Fewa hydropower station generated 1.464 GWH of energy in fiscal year 061/62. The generation from this power station has contributed 0.06% of the total energy in the INPS.

Salient features:

1. Installed Capacity : 1.0 MW
2. No. of Generators : 4 NOS
3. Transmission Voltage : 11 KV
4. Rated Capacity : 288 KW
5. Generation Voltage : 400 V
6. Project Commissioned date : 2025 B.S
7. Project Financed by : India and Nepal Government

15. Sundarijal Hydropower Station

Sundarijal Hydropower Station is the run-of-the river type with an installed capacity of 0.64 MW. The power house was commissioned in the year 1935 A.D. The average (designed) annual generation of this powerhouse is 5.77 GWh Sundarijal HPS has generated 4.231 GWh of energy in FY 061/62. Though its install capacity is 0.640 MW only, its contribution is 0.17 % of the total energy of INPS.

Salient features:

1. Installed Capacity : 640 KW

2. Manufactured by : English Electric Co-London
3. Rated Voltage : 3.3 KV
4. Project Inception date : 1982 B.S.
5. Project Completion date : 1991 B.S.
6. Project financed by : British Government

16. Pharping Hydropower Station

Pharping Hydropower Station is one of the oldest hydropower station of Asia and the first hydropower station in Nepal The construction of the power house was carried in the year B.S. 1964 (1907 AD) and was commissioned in the year B.S. 1968 (1911 AD)

Salient features:

1. Turbine : Pelton Turbine, 2 NOS.
2. Penstock : Riveted Steel Pipes of 20 Dia.
3. Reservoir : 200' dia and 18' deep
4. Conveyances system : Pipeline- 44" dia from satmule 10" and 9" dia from Shesh Naryan
5. Water pressure at Turbine : 288 Ib|/sa inch.

Other power plants i.e. under construction, IPP's under operation, Pipe line projects, multi fuel power plant, diesel power plants are not described here

ANNEX-XI

Electricity Related Act and Hydropower Development Policy 2001

The Electricity Act 1992 was introduced with the objective of promotion development of electricity through various activities, such as surveys, production and distribution of electricity and providing standard and safety measures. The next act is Nepal Electricity Act 1984. The act provides total authority to Nepal Electricity Authority (NEA) for handling all activities in electricity sector in Nepal. The NEA is given authority of management and supply of power by producing and distributing electricity in an efficient way. It can buy the electricity from individuals or from organization. It is also authorized to obtain loan from the national and International sources. One of the major duties of the NEA is to recommend the government to formulate short as well as long term policies regarding electricity supply in the country. Similarly the foreign Investment and Technology Act 1992 is a milestone in attracting foreign direct investment in Nepal.

In spite of the above mentioned acts, an opportune hydropower policy is foreseen as pre requisite for supply of hydropower energy at a reasonable price by developing hydropower, which has the pivotal role in the development to rural electrification supply of domestic energy, creation of employment and in the development of industrial enterprise. So based on the experiences gained in the course of implementing the principles followed by the hydropower development policy, 1992, emerging new concepts in the international market and their impacts, technological development, possibility of export of hydropower energy, possibility of foreign investment and commitment in environmental protection with a view to make it clear, transparent, practical and investment friendly; revision and improvement of the hydropower policy

has become imperative. So Hydropower development policy was approved by government t on 15 October 2001.

According to Hydropower development policy 2001, it shall be developed to achieve the following objectives.

- To generate electricity at low cost.
- To extend reliable and qualitative electric service throughout the kingdom of Nepal at a reasonable price.
- To tie-up electrification with the economic activities.
- To render support to the development of rural economy by extending the rural electrification.
- To develop hydropower as an exportable commodity.

To accomplish the aforementioned objectives, the policy has eight different strategies and twenty two different policies were introduced.

The different provisions vis-a-viz working policies which were mentioned to enforce the hydropower development policy are as follows.

- Environmental provisions;
- provision concerning water rights;
- provision for investment in generation, Transmission and Distribution;
- Provision of special investment for infrastructure development of rural electrification,
- Provision relating to Transfer of project
- Provision relating to power purchase,
- Provision relating to visa,
- Maximum utilization of local resources and means,

- Management of Investment Risks,
- Provision on Internal Electricity market,
- Provision on Export of Electricity.
- Provision on License;
- Provision relating to fees,
- Facilities relating to Tax and customs,
- Institutional provision,

ANNEX-XII

Priorities: Where and How to Focus

Governments and public power purchases can help to over come challenges/problems by:

- *Arranging up stream basin and sector studies, instituting water basis development and management strategies, and promoting realistic options assessments feasibility and preparation work, such as site investigations and surveys at selected project sits before engaging the private sector.*
- *Planning and managing hydropower investments from an integrated water resources management perspective that takes into account other uses, such as the farmers (dependent on down stream flows) and environment stream flow needs.*
- *Putting in place an appropriate regulatory and power purchase framework that helps to overcome the financing difficulties through measures including deferred taxation, tariff certainty, and valuation methodology recognizing system benefits.*
- *Providing incentives for acceptance of an appropriate proportion of risk in line with the principle that risk should be borne by the party best able to manage it.*
- *Acceptance of techniques for equalizing the power purchase prices, at lest over the duration of debt repayment, to lower this price in the initial years of the power purchase agreement;*
- *Arranging credit support for loans for project development;*
- *Providing local currency, equity or loans;*
- *Facilitating participation by, and consultation with, affected communities and mitigation of social impacts; and*

- *Devoting a proportion of net revenues of the project to improvement of the welfare of affected communities and the environment in the project area.*

Multilateral and bilateral institutions can help by:

- *Financing the upstream and preparation work within an integrated water resources management perspective.*
- *Assisting to develop appropriate regulating frameworks;*
- *Providing partial risk and partial credit guarantees to private developers;*
- *Financing public portions of multipurpose projects, government equity contributions government loans to the developer; and*
- *Ensuring that environmental and social impact assessments and mitigating plans are to the highest standards, enabling the materialization of planned benefits.*

Developers (whether public or private) can contribution by:

- *Preparing environmental and social impact assessments and mitigation plans to the highest international standards.*
- *Ensuring that project design incorporates measures that mitigate negative environmental and social effects and enhance positive impacts;*
- *In full consultation with affected communities, developing forward thinking resettlement plans, which treat resettlement as a development opportunities so that affected people as better off after the project than before and their ability to develop further is enhanced by the project; and*
- *Using environmental mitigation funds as a development opportunity.*

Source: WECS, International journal on hydropower and dams, volume 13, issue 2, 2006.

ANNEX-XIII

Hydroelectricity Projects to be Completed in Tenth Plan

S.N.	Project Name	Capacity (MW)
	Under Public Sector	
	Project with license to generate electricity	
1	Middle Marsyangdi	70
	b) The projects with feasibility completed	
2	Chamelia	30
3	Heldung	0.5
4	Gumgad	0.4
	Total	100.9
	Under a joint venture of private and public sector	
	a. Project with license to generate electricity.	
1	Chilime	20
	Total	20
	Under Private Sector	
	a) Project with license to generate electricity	
1	Upper Modi	14
2	Indrabati III	7.5
3	Mailung	5
4	Piluwa	3
	b) Project with electricity purchasing agreement	
5	Langtang	10
6.	Daram	5
7	Khudi	3.5

8	Sunkoshi Small	2.6
9	Chaku	1.5
10	Baramchi	1
11	Feme	1
	c) Project with feasibility study completed	
12	Kabeli I	30
13	Rahughat	27
14	Lower Modi	20
15	Madi I	20
16	Dodi	8.5
17	Hewa	5
18	Manhariv	5
19	Lower Indrawati	4.5
20	Trisuli	4
21	Belkhu	2.6
22	Vijayapur-1	2.5
23	Thupal	1.9
24	Ridi	1.8
25	Rigdi	1.5
26	Kahule	1.5
27	Sirsegad	1
28	Junrimba	1
29	Lower Piluwa	1
30	Gomagad	0.4
31	Khoranga	0.2
32	Tatopani	0.2
	Total	193.7
	Grand Total	314.6

Source: Tenth plan, NPC, HMG

In course of my thesis, I visited the different ministries, Institutions and Resource centers are mentioned here below. The sole purpose to mention the name and available address is, to make easy for forthcoming researcher in the hydropower sector. The places are as follows.

1. Water and Energy Commission Secretariat (WECS, Singha Durbar, Kathmandu, POB 1340 Kath, Tel +977-1-4227699, Fax +977-1-4227185.
2. Nepal Electricity Authority Durbar Marg, Kathmandu, Nepal. Ph: +977-1-4227725, Fax +977-1-4227035, 426673, E mail neama@mos.com.np, web: www.nea.org. np
3. Department of Electricity Development Anamnagar, Thapagaon, Kathmandu, Nepal.

   Tel +977-1-449-6800, Fax +9771448-0257

   Email: doed@pshdp.wlink.com.np.

   Website: www.doed.gov.np.
4. Practical Action (Formerly ITDG).

   Ph. +977-1-4446015
5. Government of Nepal, Ministry of Finance, Singha durbar Kathmandu,

   Website: www. mof.gov.np.
6. International centre for integrated mountain development (ICIMOD) POB: 3226

   Tel: 977-1-5525313

   Fax: 977-1-5524509/ 5536747

   Email: 1_icimod@icimo.org.

   Web: www.icimod.org.

7. Nepal Rastra Ban, Baluwatar, Kathmandu Nepal, Tel: 977-1-4419804, 4419805
   Website: www.nrb.org.np.
8. Central Library of Tribhuvan University
   T.U. Kirtipur, Tel. 977-1-4330834
   Email - TUCl @health net.org.np.
   Web - www.TUCl.org.np
9. Central Bureau of Statistics
   Ramshah Path, Thapathali, Kathmandu, Nepal
   Fx: 977-1-227720
   Tel: 4229406, 4245913, 4245946, 4245947
   Email: env@stat.wlink.com.np
   Stat@cbs.gov.np.
   P.O. Box No. 11031
   Website: www.cbs.gov.np
10. Independent Power Producers' Association, Nepal (IPPAN)
    Heritage Plaza II, Kamaladi, Kathmandu, Nepal,
    PO Box 20010
    Tel. +977-1-4240975
    Fax. +977-1-4240975
    E-mail: ippan@info.com.np,
    URL: www.ippan.org.np
11. Nepal Oil Corporation, Babar Mahal, Kathmandu
    PO Box 1440
    Tel. +977-1-263481, 263482
    Fax. +977-1-263499
12. Centre for Energy Studies,
    Pulchowok Engineering College, Pulchowok