HYDROELECTRICITY POWER POTENTIALITY AND ITS DEVELOPMENT IN NEPAL

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LETTER OF RECOMMENDATION

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APPROVAL LETTER

We certify that this dissertation entitled "HYDROELECTRICITY DEVELOPMENT IN NEPAL" submitted by Mr. Sahare Alam Khan to the Central Department of Economics, Faculty of Humanities and Social Sciences, Tribhuvan University, in partial fulfillment of the requirements for the Degree of MASTERS OF ARTS IN ECONOMICS has been found satisfactory in scope and quality. Therefore, we accept this as a part of the said degree.

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ABSTRACT

A number of benefits like that of minimization of the workloads and time of fetching firewood, motivates house to help in many works like that industries, official work, agricultural work and kitchen gardening and also marginalized community inclusive to the livelihood programmed for the betterment etc. are major impacts of hydroelectricity development in Nepal. Further, it also have economic impacts such as saving money for firewood, minimization of health services, women participation in economic works and slurry usefulness higher productivity of agricultural farms. The number of impacts goes on when environmentalists explain them. Present study reveals that the effect of hydropower is general in nature. It has made the work easier within the social construction of gender, but it has no effect to increase women participation in income generating activities outside the farm. After installation of hydropower plant women left to go to jungle for collecting firewood or they are saving money by not buying firewood anymore. Social activities of women are mostly religious, which are also parts of the social construction. Besides these observations the study found that hydropower in Nepal is not able to benefit Dalits and minorities as they are not included in the program significantly. The other weakness is that it is also not able to demonstrate the benefits of hydropower for lighting and thus, is limited to industrial, cooking and slurry use for technical, official, agricultural, kitchen gardening and farms. However, hydropower programmed in general, has positive effects to reduce the workload and improve health situation of our life.

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ABBREVIATION

BOOT - Built Own Operate and Transfer

CBS - Central Bureau of Statistic

DOED - Department of Electricity Development

EDC - Electricity Development Centre

EDF – Electricity Development Fund

EIA – Environmental Impact Assessment

FDI – Foreign Direct Investment

GDP-Gross Domestic Product

GJ – Giga Joule

GNP – Gross National Products

GON – Government of Nepal

GWH – Giga Watt Hour

HMG/N – His Majesty Government of Nepal

IEE – Initial Environmental Examination

IL and FS – International Leasing and Finance Service

INPS – Integrated Nepal Power System

INPPS – Independent Power Producers system

KM – Kilometer

KV - Kilovolt

KW – Kilowatt

MOF – Ministry of Finance

MWH – Megawatt Hour

MVA – Megavolt Ampere

NEA – Nepal Electricity Authority

NPC – National Planning Commission

NRB – Nepal Rasta Bank

PPA – Power Purchasing Agreement

UK – United Kingdom

UNDP – United Nations Development

USSR – Union of Soviet Socialist Republic

WECS – Water Energy Commission Secretarial

WRS – Water Resources Strategy

CHAPTER I
INTRODUCTION

1.1 Background:

Nepal is a country with rich biodiversity cultural heritage majestic Himalayas and immense water resources, still remains economically poor. It is a mountainous landlocked country, bordered by China in the north and India in the east, west and south. It has a total area 1,47,181 square KM. It is roughly rectangular in shape, with an average length from east to west 885 KM and a width from north to south varying 145 KM to 241 KM. The country is divided administratively into 5 developments regions and 75 districts. Currently there are 3,915 VDCs and 99 municipalities including one metropolitan and 4 sub-metropolitan cites. Ecologically, Nepal is divided into 3 regions called Mountain, Hill and Terai regions. Total population of Nepal is 2,64,94,504with annual growth rate 1.35 % (CBS:2011).

Hydropower is the major or the simple most only renewable energy sources of which is commercially viable on a large scale. It is evident from the fact the Nepal alone has hydropower potential of 83,000 Mega Watt (MW) out of which only 759 MW (Fiscal Year 2012/13) of electricity generated of the total electricity generated 705 MW has been connected to the nation grid, while for the rest, the stand alone micro-hydroelectricity centres have been supplying them at the local level (F/Y 2012/13).Different government and non-government organization are actively involved in the identification and feasibility study and implementation of hydro project in Nepal. Between the Fiscal year 2010/11 and 2011/12 , electricity generation licences for 52 large and small hydroelectricity projects with approximately 1761 MW installed capacity have been granted to NEA, its subsidiary companies and the private sector hydroelectricity companies. Fourteen MW of electricity promoted through the private sector is being supplied by connecting to the national transmission grid. By the same period, additional projects with installed capacity of 25 MW were in the processes of test transmission.

The Nepal main natural resource is its abundant hydropower potential. The distinct topography of Nepal with its unique high hills and more than 6,000 rivers and innumerable rivulets crisscrossing the country provides many opportunities for both large and small hydropower development (Warn hock 1989). According to estimates from Rural Energy Development Programme (2007), Nepal is rich in hydro-resources, with one of the highest per-capita hydropower potential in the world. The available water resources in Nepal of which 72,000 MW is connected in major rivers courses, while about 11,000 MW is connected in small rivers courses (Shah, 2008).

One hundred years have passed Nepal in 1911, started producing hydro-electricity from Pharping Power Station. The east while Bijulie Adda has found its continuity in various forms of

government agency and is presently the Nepal Electricity Authority (NEAs). In this way, Generation Operation and Maintenance Business can be called to passes the heritage of a hundred years of Operation and Maintenance of power station. The medium Power Plant Operation and Maintenance Department is responsible for Operation and Maintenance of medium and small power station with installed capacity of below 30 MW.

Topographically, Nepal is a mountainous country and climatically this country lies in monsoon region. These two factors have led to the occurrence of very reliable sources of rivers along with their tremendous volume. From several sources water such as spring, lakes, glacier, etc there are about 6,000 rivers in Nepal.

In the context of Nepal it can be more easily developed that the types of power. There is some technological problem, which however can be solved easily from technical assistance. But, hydroelectricity means not only development of energy resources but also protection of environment, economic development on one hand and solving soil erosion.

However, Nepal has made an attempt to top the water resources for developing hydroelectricity since long time ago. After the advent of democracy in 1951, diversified use of water gradually attempted. The country however was severally lacking in necessary infrastructure. So, Nepal had to depend upon foreign co-operation for hydropower development. During the subsequent decade of 1960's Nepal gradually diversified its international relation's and consequently water resources development co-operation also was diversified. Different hydel and irrigation projects were constructed with aid and loan from different countries and international donor agencies such as the World Bank, the Asian Development Bank etc. The diversification of international relation was positive towards widening the knowledge and increasing technical's known how and must so in deriving foreign aid and fund to develop the water resources.

The government of Nepal has recently formulated and adopted a fresh water resources policy. There is a number of proposed hydropower projects under consideration, national and bilateral debates are going on relating their priority and farming along with their management and cost benefits sharing. A part from this so far as the giants multipurpose projects are concerned. The environmental as well as seismic and other dangers, rehabilitation of displaced victims etc. Are also matters of immediate concern?

Feasibility and delayed studies are being carried out for the development of hydroelectricity. The work to identify other necessary projects that would be able to meet the demand for electricity is also going on. To address the existing seasonal imbalance of demand and supply in the national electricity system, reservoir-based projects are felt necessary. During F/Y 2011/12, the total number of consumer grew by 12.85% to reach 2.32 million of the total consumer,

domestic consumer accounted for 1.57%. The domestic and industrial consumer's contributed 44.05% and 36.95% to the total revenue respectively. Rest of the consumer accounted for 3.49% of the total consumers but contributed only 19% to the total revenue.

During the F/Y 2011/12, energy generation from NEA's hydropower plants registered and impressive growth of 11.09% over previous year figure of 2,122.08 Giga Watt Hour (GWH) to reach 2,357.43 GWH. The import of energy from India grew by 7.50% over previous year figure to reach 746.07 GWH. The power purchase from Integrated Planning Projects System (IPPS) stood at 1,073.57 GWH registering a marginal increment of 3.34% over previous year figure of 1038.84 GWH. During the year under review, the total electricity available in the system stood at 4178.63 GWH which is 8.30% higher than the previous year figure. Out of the total electricity available in the system consumption for, 3,074.10 GWH and system losses accounted for the rest. The special measures and programmed undertaken by NEA's helped reduce system losses from 28.55% to 26.43%.

The way forward Nepal Electricity Authority huge short fall to supply over demand cannot be removed out right and is bound to remain for the next 3-4 year. For the intervening period following measures among other will be pursued to restrict number of load shedding hours to 12-14 per day per consumer in the dry season. Demand side management such as promoting the use of energy efficient lamps and electrical appliances will be implemented etc. NEA's will improve the quality of its services through the use of new technologies to meet the challenges of new environment of utility business. In particular following measures will be pursued.

The allocation of budget according different plan periods, the simple efforts of financing on power to different begun prior to planning led by the government. But there was not specific budget and target for it. It begun with the introduction of the First plan, the feasibility study of power production through various rivers were commenced systematically. The need of manpower proper institutionalization of power sector etc for the generation, transmission and distribution were studied. For the overall development of power the finds well allocated in different plan.

A total of 179 projects in operation in the current F/Y 2011/12 including is NEA's study projects, 2 ready for implementation, 16 on-going projects, 43 projects under transmission line extension projects of 132 Kilo Voltage (KV) and other voltage categories, 106 distribution line projects, and 7 other projects. Preliminary study works have been completed on purposed Budhigandaki, Uttarganga, Nalsyngad, Tamor, Kaligandaki hydropower project in the first eight month of the current F/Y 2011/12. Likewise, license related works have been completed for Dudhkoshi, Nisthipanaha, Gudikhola and khadakkot hydropower projects.

From sector wise usages of electrical energy perspective, industry sector consumed 37.7%, household sector 42.54%, commercial sector 7.62%, non-commercial sector export 3.99% and miscellaneous sector consumed 8.14% electricity in F/Y 2010/11. In F/Y 2011/12, industry sector is estimated to consume 37.4%, household sector 42.8%, commerce sector 7.7% and miscellaneous sector 12.1%. The number of electricity consumers has been rising every year. Numbers of consumers that totalled 20, 53,259 by the end of the F/Y 2011/12 raise by 10.73% reaching to a total of 22,38,052 by FY 2012/13.

Concentration of power development in Nepal has given high priority before and after the concept of planned development. Capital, labour and energy are three factors that contribute to economic growth of the country. Capital can be found in the form of equipment, machinery and building that are necessary to produce goods and services. Labour is the work forces to participate in the production of goods and services. Energy is the power necessary to produce goods and services, and transport them their destination. These three components are used to produce a country's gross domestic product so, energy is the power that drives the country's economy.

Hydropower is one of the cleanest, renewable and environmentally binging sources of energy. Harnessing of water resources on large scale could provide significant contribution to the poverty reduction and employment generation. So, integrated water resources development plans are essential for the overall development of the country. The development of the hydropower does not only bring a social transformation of the local level but also create a resource pool. We have a lot of water resources and yet we are living in dark and we depend on fuel wood, animal dung and imported petroleum goods for our energy problem such as non-availability of market as well as difficult physical condition are cited on the reason.

1.2 Statement of the problem:

Nepal has the huge hydropower potential with very marginal utilization this is less developed countries. It is trying to raise the standard of living its people by developing different sectors such as agriculture, industry, trade, transport, communication etc. Most of Nepalese people deprived of electrical energy and use traditional sources of energy such as fuel wood, animal dung, agricultural waste, coal etc. it is the main cause of the deforestation to environmental degradation, natural calamities such as landslides, flood, soil erosion as well as ecological imbalance. So, the hydroelectricity is one of the sources of clean, renewable and environment friendly sources of energy.

Without electricity new factories, industries and daily activities like business expansion is not possible. Revenue to the state is generated from industrial production which requires electric energy. Nepal has a vast opportunity for energy production is not available most of the countries of the world. The generation of hydropower is environmentally friendly and

resources required are available in Nepal. The main challenge's is how to harness this vast potentiality.

But the problem of financing is acute in a poor and developing country like Nepal. It becomes much difficult when equity is poor (because of low saving) affordability is poor and willingness to pay is low. Sometimes this problem i.e.: financing, also aggregates the sect oral crowding out effect. Therefore, utilization of financial resources renders from domestic to foreign sectors and from government to private sectors in the form of grant, loan etc. In this regard NEA's is playing leading role as a public enterprises. Therefore, the study is justifiable on the ground that it study, the sources and mobilization of financial sources through NEA's on power sector. It is also asses' financial structure of NEA's.

A number of problems which slow down the hydro potential of the country are mentioned below.

1. Hydropower is a capital concentrated energy generating option, which requires huge amount of capital for mega project.

2. There is no clarity of export tax on power export when developing multipurpose project by the private sector and limited domestic market is one of the major hurdles for the development of mega project. This may be attributed to small size of the country and low level of industrialization. Nepal's electric cost is highest in the world due to difficult topography, lack of infrastructure, costly consultancy fees, and high cost of equipment and construction materials. So export of hydropower in neighbouring country is difficult.

3. Various type of risks are involved in the implementation of mega hydropower projects such as commercial, legal, political, natural calamities etc. Since there is no clear policy on what type of risks would be borne by the government.

4. In the present scenario the leakage of electricity is about 25 percent of which huge potential to illegal misuse and little proportion is technical reason. The effort towards minimize the leakage has not produce expected result.

Despite huge potential of hydropower, its development could not take momentum as aspired by the general mass of Nepalese people due to some key impediments. Financial constraints, high tariff, unstable socio-political situations, indefinite cross border poor infrastructure, geographical condition etc. are the main challenges in the speedy development of hydropower in Nepal.

1.3 Objective of the study:

The main objective of the study is to examine the status of the Hydropower Development in Nepalese economy at present. Besides following are the specific objectives:

1.) To describe the present situation of hydroelectricity in Nepal,
2.) To assess the plan wise hydroelectricity development in the Nepal.

1.4 Significant of the study:

Energy is necessary to produce goods and services, and transport them to other destination. In the industrial nations, most of the equipment, machinery manufacturing plants and office could not operate without an available supply of energy resources such as hydroelectricity. In fact, energy is such an important to manufacturing and production that its availability can have direct impact on GDP and the overall economic growth.

Nepal is a country with enormous water resources. It is estimated that the rivers flowing from Nepal contribute about 71 percent of the dry season flow and 41 percent of the total annual flow of the Ganga. The annual average run off with in the Nepalese territory is estimated at 174 billion cubic meters. Nepal's total hydropower potential in terms of estimated capacity and annual energy of identified 122 projects are respectively 43,000 MW and 180,000 GWh. Hydropower utilization is currently about more than one percent of the proven potential. The total installed hydroelectricity generation about 759 MW in 2013. Of this total generation 705 MW are hooked to national grid and remaining are in isolate system comprising 40 small/mini hydro plants, about 2,000 micro hydro and 5 large hydropower station of the country.

Through there is some of the research on the hydropower development in Nepal, they are of less significant at present due to their conventional method analysis. Moreover these studies could not focus at the present reality of huge electricity crises in Nepal. The sixteen hours per day load shedding that has badly affected the everyday life of people have also paralyzed the country's commercial sector with the industrial output falling by nearly 50%. Nepalese enterprises, business communities, water supply and other services sector and even hospitals have also been pushed to a state of frustration due to 112 hours load shedding in a week. This has happened due to increasing the demand of electricity and decreasing the supply of electricity due to decrease in the water level in winter season and government sector and private sector are not interested to construct the new hydro project for the increasing demand.

Nepal's water resources should be exploited in revolutionary manners. This holds the key to prosperity and poverty alleviation. All the rules, regulation, constrain and hurdles hampering hydropower development must be amended. Nepalese dream for a prosperous

future can achieve from the exploitation of water resources in the form of hydropower. Now it is the time to from huge potential of hydropower of our country into reality. The abundant water resources of Nepal hold the key for the overall socio-economic development of our nation. The escalating prices of oil, gas and coal in the international market have again emphasized the significance in developing hydroelectricity power.
The study will review the status of Hydroelectricity development in Nepal and will provide recommendation formulate policy for the future development of the hydroelectricity.

1.5 Limitation of the study:

1. Limitation of data and information:
   This study is mostly and mainly based on the secondary sources of data and information.
2. Limitation of the coverage:
   The coverage of this study is limited to analyze the financing trend of the government for power development in different plan and NEA's and the policy related with it.
3. So, some of the searching other department and library have been used to make the study more analytical.

1.6 Research Methodology:

1. Nature of Research Design:

This study is descriptive type of research because it is a fact finding investigation with adequate interpretation in the context of social research. It is more specific than exploratory study as it aims to identify the various socio _economic characteristics of the community.

2. Sources of Data Collection:

This study is absolutely based on secondary data most of the data and information related to hydropower and other energy have been collected from secondary sources. The secondary sources have included the previous studies carried out on the issue of hydropower, various institution, organization books, Nepal Electricity Authority (NEA's), Water and Energy Commission Secretariat (WECS), Central Bureau of Statistics (CBS), National Planning Commission (NPC), Ministry of Finance (MOF), Nepal Rasta Bank (NRB), Central Library of T.U. and few other journals relevant to the study area.

3. Methods of Analysis and Interpretation of Data:

The collected data from various relevant sources are processed according as the requirement of the chapter. The available data from various documents are collected, classified and tabulated to meet the needs of the study. Simple statistical tools like pie chart, bar diagram, line chart and graphs are used as required in analysis. Other different data presenting techniques statistical

tool with ratio, percentage are used for analysis. The qualitative data is analyzed widely as required and relevant.

1.7 Organization of the study:

The study is divided into six major chapters. The First Chapter consists of hydropower development in Nepal. The Second Chapter covers the review of related literature on hydropower development. The Third Chapter deals with the historical development of hydropower in Nepal under different Plan periods. In this chapter potentiality of hydropower in Nepal and its Present situation is analyzed. The Fourth Chapter deals with the present status of hydroelectricity in Nepal. The Fifth Chapter, i.e., Last Chapter presents summary, conclusion and recommendation.

CHAPTER II
REVIEW OF LITERATURE

The main purposes of review of literature is to find out what work have been done in the area of research problem under the study and what has not be done in the field of research study. Various studies have been conducted on the hydropower within and outside the country. There are so many researchers, the media and academician who made contribution to the literature of hydropower development and its problems and prospective. Some of the related studies have been discussed as follows:

2.1 Conceptual Review:

The conceptual review of the study includes the theoretical concept about hydropower development from the international perspective. Some of the reviews made under this heading are as follows:

Nexant SARI (2003), in the report "Regional Hydropower Resources: Summary and Analysis Selected SARI data" states that with 22.2%of the world's population and 3.85% of the global surface area, the SARI/energy region contribute a mere 1.98% of global GNP. The average GNP per capita of the region is US$ 440 which amounts to 9.0% coupled with inadequate supply, presents a challenge throughout the region. Electricity shortages have acted as a constraint on economic growth.

The findings of the report are as follows:

1. The commercial energy mix of the region was 47% coal, 33% petroleum, 12% natural gas, 7% hydropower, 1% nuclear power and 0.2% other sources in 1998. Significant variation in energy mix is observed in the region.

2. Utilities in the region are mostly operated by the public sector in a commercially unviable manner. Revenues from energy sales do not realize the cost of the delivery of services suffers as a result.

3. The estimated hydro-power potential of the SARI region some 98% of the potential lies in Bhutan, Nepal and India.

4. Only a modest amount of the abundant hydro-power in this region has been developed. Sri Lanka and Bangladesh have developed a substantial portion of their abundant hydro-power resources not only to meet domestic power requirements, but also cater to the demands of the power markets as the neighbouring countries.

5. The most important barrier is the lack of a deliberate policy the supports cooperation. Cooperation in hydro-power development is not a high- priority issues for the countries of the region. Insistence on the idea of self- sufficiency, low perceived benefits of the cooperation and absence of any established mechanism for cooperation can be considered the major factors responsible for the absence of a positive policy.

Based on the above findings, the recommendations given by the report are as follows:

a. The region is likely to benefit greatly if a regional power market were created, but the complexity of the task is considerable. A gradual, step by step approach is the most pragmatic one, reducing the parties' risks while building mutual trust and confidence.

b. The sharing of information and technology could be a first step. There is an ample reserve of knowledge and expertise in the region, and this expertise could be made available to those interested through seminars, training programs and so on.

c. The second step would be to promote cooperation in power supply, with common or unilateral sharing of spare capacity.

Tshering-etal(2004), mentions that the decision by the Royal Government to Exploit its water resources for production of electricity has changed the economic scenario for Bhutan. The rapid attitudinal variations with swift flowing rivers have made Bhutan a natural heaven for hydropower production.

The paper highlights the role and importance of hydropower for social and economic development of Bhutan and covers aspects related to planning and policy initiatives being pursued by the hydro-power sector to fulfil the national objectives:

Some of the major findings of this paper are as follows:

1. Bhutan has an estimated hydropower potential of 30,000 MW, so for 23,760 MW has been identified and assessed to be technically feasible, only 1.6% of the potential is harnessed so for.

2. Bhutan's electricity demand in the year 2003 was 105 MW, 664 GWH and 99.5% of the electricity was supplied from hydropower resources. About 40% of the Bhutanese population (in 40 towns and 822 villages) has electricity access.

3. The surplus generation from hydropower plants is exported to India and fetches a substantial amount of revenue that helps to meet the budget deficit. About 300 MW power and 70% of the total hydroelectric energy generation was exported to India in 2003.

4. Hydro powers provide safe, reliable, sufficient and affordable electricity for domestic consumption and industrial use.

5. The sustained techno-economic co-operation with India where Bhutan's export market lies is the key success factor for development of hydropower.

Based on the above findings the recommendations of this paper are as follows;

a. The sustainable development strategies incorporating the social and environment concerns of hydropower development will lead to successful implementation of hydropower projects.

b. Developments of legal and policy frameworks for restructuring and reforming the power sector.

Royal Swedish Academy of Sciences (2008), report states that hydropower is a key energy resource. It presently constitutes the most important sources of renewable electrical power generation. In the most recent world energy assessments with data for 2005, hydropower stands for around 87% of the total electricity generation from renewable energy sources. With regard to the total electricity generation and primary energy supply, it stands for about 16% and 2% respectively. He further stressed that hydropower is unique in providing a necessary development support for other renewable energy sources. The storage capacity of hydropower offers the operational flexibility needed for quickly responding to fluctuating electricity demands. This improves electricity grid stability and reliability as well as supports the deployment of intermittent renewable, such as wind and solar power.

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

2.2. National Context:

This heading includes the study of hydropower development in Nepal by various scholars based on the information of Nepal. Conclusions and recommendations prescribed by them are more useful in policy making and for accelerating the development of hydropower.

Adhikari Deepak (2006), focused on the exploitation of hydropower for the increasing demand of energy. He has argued that hydropower is a suitable source of energy with almost zero inputs costs. Its benefits are that it is non-polluting in the sense and it release heat or noxious gases. It has low operating and maintenance costs. Its technology oppresses reliable and flexible operation and hydropower stations have increased efficiencies along with life. He has focused that small hydropower has as and renewable sources of energy with negligible

environmental impacts micro-hydro system is becoming increasingly popular as in energy sources in rural Nepal. He has suggested that the major strategies of power sector have been appropriately identified as promoting private sector participation in power generation and distribution, integrating rural electrification with economic development programs and strengthening power infrastructure.

Dhital K.R. (2004), in his article "Hydropower Development in Nepal" states that Nepal is water rich country, but with little efforts towards harnessing water resources and developing hydropower. In recent years, economics growth rate is confined fairly below the normal target 4.3 percent during the tenth plan (2002-07), growth has been inadequate to make crucial impact on poverty. Unless water resources is efficiently utilized to the millennium developments goal set by Nepal (UNDP, 2003). The data are taken from the secondary sources. The data are present in tables and diagram and has been used analyzing information.

Some of the major findings of the article are as follows;

- Hydropower is exportable commodity. India is the potential market for the electricity that Nepal produces. India's willingness to pay for the Nepal's hydro-power is one of the key factors for sustainable hydro-power development.
- The primary challenge encountered by Nepal for hydropower development in the twenty first century is how to supply reliable, affordable and cheapest electricity to domestic population.
- The access to electricity is to be taken as the key indictors to the progress of living standard. It enhances the capabilities of the people to reduce poverty. Thus hydro-power development should consider as one of the most important fact of economic developments.

His recommendations indicate that the process of electrification should be demand oriented rather than project oriented.

Dhungel K. (2002), in his article "Trends and Patterns of Energy Consumption in Nepal" has explained that Energy is not only used to meet the basic needs of households such as cooking, heating, lighting but also in transportation, industries, agriculture, service and commercial sectors. Unavailability of adequate energy to fulfil the needs of these sectors will paralyze our economy. Nepal is rich in water resources and hydroelectricity is the only endogenous source of commercial energy. To meet the increasing demand for energy, Nepal has seen spending large amount of foreign currency to import fossil fuel which is one of the causes of adverse balance of payment. So, Nepal should generate substantial amount of hydroelectricity from its

abundant water resources and sell to other countries that can generate foreign currency in order to solve the acute problems of balance of payments.

Nepal is dominated by traditional sources of energy. It is accounted for 95, 94.9, 91.7, 86.4 percent of which fuel wood only contribute 84.5, 64.8, 81.9 and 77.2 percent in 1984/85, 1989/90, 1995/96 and 2000/01 respectively. The share of commercial energy consumption was 5, 5.1, 8.3 and 13.6 during these periods. The per capita energy consumption is very low revealing the low level of economic growth.

Dhungel K. (2009), in the article "Does Economic Growth in Nepal Cause Electricity Consumption" states that a primary objective of under developed countries is to reduced poverty. This objective is not meaningful unless it is tried to sustainable development to achieved desire level of economic growth. As the livelihood of the poor depends mainly on the natural resources, depletion in an unplanned manner will hit the livelihood of poor the hardest. Economic and social developments depend primarily on the use of energy. This implies that there is a strong and positive association between the growth rate of economy and growing energy consumption.

Excess use of energy, particularly fossil fuels, for accelerating the economic growth rate of developing countries results in the excessive emission of carbon dioxide (CO_2) into the atmosphere. Furthermore, the energy requirement of developing countries is not only fulfilled by fossil fuel, but also by biomass which is another major source of pollutants.

The article examine the casual relationship between the per-capita electricity consumption and the per-capita real GDP (natural logarithm) during the period 1980-2006 in Nepal using co-integrate and vector error correction model.

The major findings of this article are as follows;

- Nepal has two possible options to reduce the use of fossil and biomass fuel.

  (i)The development of immense water resources for generating electricity,

  (ii)The use of animal dung for generation biogas.

- There is a unidirectional causality from per-capita real GDP to per-capita electricity consumption.

- Estimate of electricity income and price elasticity from the time series data (1980-1999) have shown that the income elasticity of electricity was highly responsive. Its shows that

Nepal, for the long period of time does not have to arrange demand management. If further implies that more generation will create its own demand.

Based on the above findings the recommendations given by this article are as follows;

- The study also suggests that Nepal will need to put more effort into increasing electricity supply investment as a national strategy towards advanced development in the long-run.
- The electricity supply in Nepal is insufficient to meet the growing demand as reflected by the frequent load shedding a well designed conservation policy can play effective role in managing the energy supply sector.

Bhatt (2008), mentioned the confusion and problems of hydropower development in Nepal. He did research with descriptive analysis and tabular form. The author has described that although with bestowed with ample hydro resources, we are facing acute power shortage and load shedding has become unpleasant word for Nepalese consumer. This means there is something wrong in our thinking, planning, action and behaviour. He has highlighted that we are not good at planning of resources development as we do not have strategic plan for development of hydropower, neither we are good as a developer since most of those holding license are engaged in paper trading of licenses and nor good as consumer as our system loss is very high. Some of the problems highlighted by the author are given below:

- Electricity Act 2049 has no insight of electricity market model and industry structure.
- Ministry of Water Resources issues license of hydropower development where as Ministry of Forest and Soil Conservation has it stringent rules and provision for hydropower development that makes it almost impossible to develop hydropower.
- Still we do not have a realistic view on development to meet internal demand in future. The transmission system has the natural monopoly of the state. NEA neither responsible for managing transmission for all generation developer nor it is transmission planner.

Kafle (2005), in his article “Hydropower for Sustainable Development of Nepal” has explained that; Electricity is one the basic inputs for the acceleration of economic growth of the country but generation of hydropower for supplying electricity to fulfil even to the domestic demand is delaying resulting to the adverse impact in the national economy. The enormous hydro-power potential of Nepal is the main alternative sustainable source of energy that is environmentally friendly, socially responsible and economically viable. Development of hydropower contributes to the development of rural electrification meeting the domestic need, employment

generation, stemming deforestation and expanding dome sting agriculture production and development of industry as well as business, there by contributing to sustain poverty reduction. The availability of electricity in affordable cost can be utilized as a vehicle of industrial development and provide basis for competitive manufacturing industries, which in turn can lead to cheap manufactured export. In consideration the valuing of integrated approach to hydropower development projects, dam construction for the storage of water on river valley performs multiple functions including supply of water for residential use, industrial production and irrigation as well as flood control and habitat maintenance contributing to environment protection and economic growth.

WECS (2005), set the objective to the generate hydropower to meet national energy requirement and to allow for export of surplus energy. This plan has presented the quantitative data in tabular from with the help of simple statistical tool known percentage and ratio. It has taken target per-capita electricity consumption of 160 KWh by 2017 and 400 KWh by 2027. The estimated budget of overall plan is Rs.1, 28,938 million for water sector and Rs. 51,136 million is allocated in hydropower structure and non-structural development. Private sector investment is continuously increasing. But at present, they contribute to only about 21% of total installed capacity. Most of the government source is external (77%). The present resending of soft loan by government to NEA is a 10.25%. National water plan has presented the following action programs on hydroelectricity.

1. The focus of the hydroelectricity power program during the first five years on identifying and developing cost-effective small and medium hydropower projects that are capable to meeting domestic needs, including ground water pumping for irrigation at affordable prices.

2. In ten years substantial benefit will be realized by maximizing hydropower development for different markets including energy intensive industries, transport sector and power exports.

3. By the end of the 25 years, the country will have total hydropower capacity about 4000 MW excluding exports and more than 75% of all household will be provided with Integrated Nepal Power System (INPS) electricity.

WECS (2006), described sectoral energy consumption situation of Nepal, using statistical tools such as pie chart, bar diagram, flow chart, percentage and ratio. The sectoral energy consumption pattern for the year 2004/05 has been changed by marginally as compared to previous year. The residential account for the major share of energy consumption (90.28%) flowed by transport (3.78%), industry (3.48%), commercial (1.45%) and then the agriculture and others (1.01%). Some of major findings of this report are given below.

1. The residential sector consumed about Rs.331 Million Giga Joule (GJ) energy in FY 2004/05. The share of electricity consumption was 0.64%in FY2004/5.

2. The industrial sector consumed about Rs.2.5 Million G.J. energy in FY2004/05. The share of electricity in industrial energy consumption was 22%in FY 2004/05.

3. The commercial sector consumed about Rs.5.3 Million GJ energy in FY2004/05. The share of electricity in commercial sector was 7% in FY2004/05.

4. The transportation sector consumed about Rs. 13.8 Million GJ energy in FY2004/05. The share of electricity in transportation sector was 0.15% in FY 2004/05.

5. The agriculture sector consumed about Rs. 3 Million GJ energy in FY2004/05. The share of electricity in agriculture sector was 6% in FY2004/05.

Pandey (2009), he says about "Rural Entrepreneurship through Electricity" in Nepal hydro Budget Speech 2009-10 has found the some important conclusion described a follow, with a view to end load shedding forever and extend the services in the villages where the electricity has not yet reached, the construction of ongoing electricity projects will be expedited to accomplish on time. Emphasis has to be given to feasibility study of new project, extension and repair of transmission lines. On the basis of the objectives laid by Water Resources Strategy, 2002 and current evaluation of hydro electricity development, progress has to be formulating to develop at least 25,000 MW capacities within forth coming two decades for this necessary institution and policy has to be formulated. Nepal's has allocated RS.14 Billion 69 Million in the electricity sector.

National electricity crisis Reconciliation Work Plan with necessary amendments has to be carried out with high priority. In order to encourage private and foreign investment, appropriate policy has to be formulated for long-run energy development after making necessary review in the existing policies. An autonomous electricity regulatory commission has to be formed for the effective regulation of the production and transmission of electricity.

WECS (2010), Explained energy consuming sectors as per the economic sector of the country. They are residential, commercial, transport, industrial and agriculture sector. For energy accumulating, others have been included as energy consuming entity which does not fall in the above five sectors, are included in others like street light, temples, mosques, church etc. The total energy consumption in the same year was 401 million GJ. The sect oral energy consumption for the year 2008/09 has changed only marginally as compared to the previous years. However, the sect oral energy consumption for the year 2008/09 has increased by about 9% as compared to the 2004/05 years. In 2008/09 the residential accounts for the major share

of energy consumption (89.1%) followed by transport (5.2%), industry (3.3%), commercial (1.3%) and then the agriculture and others.

1. The residential sector consumed about Rs. 356.7 Million GJ energy in FY2008/09. The share of electricity consumption was 1% in FY 2008/09.

2. The industrial sector consumed about Rs. 13.4 Million GJ energy in FY2008/09. The share of electricity in industrial energy consumption was 23.2% in FY 2008/09.

3. The commercial sector consumed about Rs. 5.2 Million GJ energy in FY2008/09. The share of electricity in commercial sector was 11% in FY2008/09.

4. The transportation sector consumed about Rs. 20.8 Million GJ energy in FY2008/09. The share of electricity in transportation sector was 0.1% in FY2008/09.

5. The agriculture sector consumed about Rs. 3.6 Million GJ energy in FY2008/09. The share of electricity in agriculture sector was 4.8% in FY2008/09.

Nepal rich in water resources, Nepal has more than 6,000 rivers and rivulets with an overall annual run of 225 Billion cubic meters following to the south. The annual average run off with in the Nepalese territory is estimated at 174 Billion cubic meters. Nepal's total hydropower potential in terms of installed capacity and annual energy of identified 122 projects are 43,000 MW and 180,000 GWH respectively. Hydropower utilization is currently about 1.5 percent of the proven potential. The total installed hydroelectricity generation is about 759 MW in 2013. Out of this total generation of electricity, 705 MW are hooked to national grid and remaining are in isolates system comprising 40 small/mini hydro plants, about 2,000 micro hydro and about 12,000 peptic sets serving remote areas of the country (WECS,2006). Out of the total population, 48.5 percent was expected to have access to electricity services by the end of Tenth Year Plan. Prior to the Tenth Five Year Plan, electricity was available to 58 municipalities and 1,600 VDCs in the country. A total of 2,100 VDCs were expected to have access to electricity services at least partially.

Presently, the NEA system is a supply deficit one. This is being evident from load shedding being implemented for last several years. Even in, the Fiscal Year 2007/08 the peak power supply demand in wet season and dry season were 640 MW/ 542 MW and 720 MW/308 MW respectively, resulting into load shedding of above 98 hours a week (WECS,2010). In 2009 and 2010 load shedding per day was about 16 hours. According to the report of NEA, 2010 energy demand was 4367.13 GWH and supply energy was 3689.14GWH and rest 677.860 GWH was managed by load shedding. This kind of load shedding due to supply deficit is to continue till at least 2017/18. When among others, Upper Tamakoshi (456 MW) is expected to be commissioned. In the dry months shrinking of snow-fed river further increases power deficit.

CHAPTERE III
HISTORICAL REVIEW OF HYDROPOWER DEVELOPMENT IN NEPAL

3.1 Before Starting Five Year Plan:

The history of hydro-power development in Nepal is not old it's more than 100 years. Pharping Hydle power house is the first power house installed in Nepal which is one of the oldest hydropower in Asia. This station is installed in 1911 AD, during the Prime Minister Chandra Bahadur Samsher Rana's time to meet the energy requirement of the members of the ruling class. It's financed by British government. The installed capacity was 500 KW and 12 KW cable was installed to transmit 11 KW of purpose. This power house has been closed now and water from this reservoir is now used for water supply to Lalitpur municipality and adjoining areas. In order to meet the growing demand of electricity another power plant was established at Sundarijal at the time of Juddha Samsher Rana in 1936, the installed capacity of that power plant was 900 KW. Now it is working with the capacity of 640 KW. Morang Electricity Supply Company located at Letang is Morang district was the third power house established in the country with the capacity of 677 KW. It was the first project outside the Kathmandu valley and started distributing the electricity in 1939. Before 1956 utilization of water resources for electricity generation was negligible. Table 3.1 shows electricity installations that were in operation in country before the introduction of First Plan.

Table No.3.1 Electrical Installation before 1956 (First Five Year Plan)

S.N.	Name Of Plant	Power supply in KW	Agency	Cost
1.	Pharping Hydel Plant	5oo	Britain	0.713 million
2.	Sundarijal Hydel Plant	900	Britain	NRs. 3,67,984
3.	Morang hydroelectricity Company	677	_	_
4.	Birgunj electricity Company	255	_	_
	Total	2332		

Sources: NPC, GoN.

The table 3.1 shows the total production of electricity before the implementation of First Five Year plan. Out of the total 2,332 KW, the share of Pharping Hydro Plan, Sundarijal Hydro Plant, Morang Hydroelectricity Company and Birgunj Electricity Company, were 21.72%, 39.03% and 9.77% respectively.

Until 1955, there had been hardly any policy for the development of the country. There was no hydropower and energy development policy in Nepal. Some Rana rules had adopted ad-hoc policy in regard to hydropower development in the country. Hence, some hydropower projects took shape during Rana Regime, the notable on being the hydropower plants of Pharping and Sundarijal.

3.2 After Starting Five Year Planning:

Nepal has got specific direction on power development after planning economic since 1956. It was proposed to increase the generating capacity of hydropower in different plan periods.

(I) The First Five Year Plan (1956-1961)

The First Five Year Plan introduced a policy to study the feasibility of small and medium size of hydro project. When Rana rules collapsed in 1950, the process of national development started. It target to increase generation capacity of 20,000 KW at a cost of Rs. 80 Million (9 percent of the plan). In this plan, achievement to its target for power generation was 8.5 percent. Electricity was generated entirely from the diesel plants. Therefore, achievement in hydropower sector was totally failed. The power plants installed and commissioned during the first plan are listed in the Table No. 3.2.

Table No.3.2 the Power Plant Installed and commissioned During First Plan.

S.N.	Name of the project	Power Supply in KW	Donor Country	Cost (in Lakh)
1.	Trishuli Hydel Project	9,000	India	225
2.	Panauti Hydel Project	2,400	USSR	20
3.	Pokhara Hydel Project	500	India	40
4.	Thadokhola Hydel Project	400	UK	15
	Total	12,300		

Sources: First Plan, NPC, GON.

During this plan period an additional supply of 700 KW of power was added to the system mainly by Teku (500 KW) and Bhaktapur (200 KW) diesel power plant in Kathmandu valley.

Nepal made agreement for the first time with USSR and India to get aid for the construction of the most important hydroelectricity project like Panauti (Rosi Khola) and Trishuli respectively. Similarly, agreement was also made with India for the construction of hydroelectric project in Pokhara with the capacity of 500 KW.

Agreement was also done with UK for the construction of hydroelectric project in Chisapani with capacity of 400 KW. This was only the achievement of this plan period. Similarly, during this plan period Kathmandu - Hetauda – Birgunj transmission line and Karnali and Kali River's preliminary survey were completed.

(II) The Second Five Year Plan (1962-1965)

The plan put demand emphasis on the 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, Nepalgunj and Biratnagar etc were completed. The second plan (three year) had given second priority meet to the road construction conforming to its principle objective of creating the basis overhead for future plans. The target for the second plan was 22,000 KW of additional power generation both from hydropower and diesel. The monetary allocation of this was 91 million rupees (15 percent of the plan). In order to produce more power to meet the increasing requirement of industrial and agriculture development and effectively manage the distribution of power, separate organization under the name of Electricity Corporation was established in 1964, as government enterprises. This plan also did not specifically maintain about the energy policy of the government (Bhattrai, 2005).

Table No.3.3 Major Targeted Hydropower Project of the Second Plan

S.N.	Name of the project	Power Supply in KW	Location
1.	Trishuli Hydro Project	9,000	Trishuli
2.	Panauti Hydro Project	2,400	Panauti
3.	Pokhara Hydro Project	500	Pokhara
4.	Thadokhola Hydro Project	350	Chisapani
	Total	12,250	

Sources: HMG of Nepal, NPC and the Second Plan.

In the Second Plan Period Panauti Project with a capacity of 2400 KW, Patan Diesel Plant with a capacity of 1470 KW and Birgunj Diesel Plant with a capacity of 560 KW were brought into operation. In addition to this, construction on the Kathmandu –Birgunj transmission line was started and the Sunkosi and Karnali Project surveys were continued. Mainly achievement of the Second Plan was limited to Panauti Project having capacity of 2,400 KW.

(III) The Third Five Year Plan (1966-1970)

The Third Plan had given top priority to hydropower generation alone with development of transport and communication. It was proposed to increase the generated power by 60,000 KW and 260 million rupees (15 percent of plan) were allocated for this purpose. The policies were

formulated to improve the administration of depart of electricity corporation, with the objective of maintaining co-ordination in the activities of the these two organization and establishing Central Power Authority in order to prepare a long term master plan for the production and distribution of power completing the projects initiated in the first and second plan period (Bhattrai, 2005).

Table No. 3.4 Major Hydropower Projects Targeted on the Third Plan

S.N.	Name of the project	Power Supply in KW	Agency
1.	Trishuli Hydel Project	18,000	India
2.	Gandaki Hydel Project	10,000	India
3.	koshi Hydel Project	7,500	_
4.	One project from Marshyangdi or Kali or Kulekhani	18,000	ADB
	Total	53,500	

Sources: Third Plan, NPC, GON.

In the Third Five Year Plan, the total supply of power had been increased by 19,960 KW, primarily from Trishuli project (12,000 KW), from Pokhara hydro project (500 KW), from Hetauda diesel plant (4,470 KW) and from Patan and Biratnagar diesel pant (2,990 KW) respectively. Therefore, total achievement of electricity generation to its target was 55.44 percent. Out of the total capacity hydropower account for 62.62 percent and diesel plants accounted for 37.78 percent.

Table No. 3.5 Achievement of Third Plan

S.N.	Name of the project	Power Supply in KW
1.	Trishuli Hydel Project	12,000
2.	Pokhara Hydel Project	1,000
	Total	13,000

Sources: Fourth Plan, NPC, GON.

(IV) The Fourth Five Year Plan (1970-1975)

In the Fourth Five Year Plan, the government accorded second most priority on electricity development. A total of Rs. 225.3 million was allocated which accounted for 9 percent of total

budget to the development of electricity. It had set a target of generation a total of 40,300 KW from large hydro project, 500 KW from small micro plant and 4,000 KW from diesel plants (NPC, 1970). The table 3.7 shows the target for generation of hydropower in the plan period.

Table No. 3.6 Target of Fourth Plan

S.N.	Name of the project	Power Supply in KW	Agency	Cost in mil.
1.	Trishuli Hydel Project (additional)	9,000	World Bank	_
2.	Sunkoshi hudro project	10,000	JICKA	57.5
3.	Gandaki Hydel Project	10,000	India	_
4.	koshi Hydel Project	6,800	_	_
5.	Kulekhani hydro project	32,000	Japan &Nepal	245
6.	Micro hydro Plants (Including Dhankuta)	500	_	_
	Total	68,300		

Sources: Fourth Plan, NPC, GON.

The table 3.6 shows the target for generating 40,000 KW electric from different hydro plants and diesel plants.

The achievement of electricity generation was 26,040 KW during the Fourth Five Year Plan, which is shown in the table 3.7.

Table No.3.7 The Target and Achievement of Fourth Plan

S.N.	Name of the project	Target in KW	Achievement in KW
1.	Trishuli Hydro Project	9,000	9,000
2.	Sunkoshi hudro project	10,000	10,000
3.	Gandaki Hydro Project	10,000	Running
4.	koshi Hydel Project	6,800	6,800
5.	Kulekhani hydro project	32,000	Running
6.	Micro hydro Plants	500	240
	Total	68,300	26,040

Sources: Fifth Plan, NPC, GON.

Table 3.7 shows that Fourth Plan Planned to generate 40,300 KW hydroelectricity from different hydro projects namely Trishuli hydro project, Sunkoshi hydro projects, Gandak hydro projects, Koshi hydro projects Kulekhane hydro project and Micro hydro Plants (Dhankuta) under the capacity of 9,000 KW, 10,000 KW 6,800 KW, 32,000 KW, and 500KW respectively. Total hydroelectricity 26,040 KW was achieved in Fourth Plan from Trishuli Hydro Project (9,000 KW, Sunkosh hydro project (10,000 KW), Koshi hydro project (6,800 KW), Kulekhani hydro project (32,000 KW) and Micro hydro plants (240 KW). The achievement of the Fourth Plan in hydroelectricity was near 71.74% percent. Feasibility study of Kankai project and beginning of Devighat and Kulekhani hydro project were other achievement of the Fourth Plan. During the plan period 12 new districts were electrified and 152.2 KM transmission line was constructed.

(V) The Fifth Five Year Plan (1975-1980)

In the Fifth Plan policies were formulated to fulfil the short term and long term demand with in the country and to export excess power to India and expand village electrification to promote agriculture development, village industries and production activities. It also formulated a policy to fix the tariff on the basis of actual cost of projects, to limit the electricity services and activities in government sector and to handover the operation and distribution of electricity gradually to other electricity entities making them capable in business activities. Similarly, as in plans, no specific power policy was formulated for the development of other energy sector.

Table No. 3.8 Programme of Electricity Development in the Fifth Plan

S.N.	Name of the project	Position of the project	Target in KW
	Small hydel project		
1.	Jhurpa small hydel projct	Running	345
	Big and medium hydel project		
1.	Kankai hydel project	Running	32,000
2.	Devighat hydel project	Running	14,000
3.	Kulekhani hydel project	Running	60,000
4.	Shikharbas hydel project	New	2,400
5.	Sarada Babai hydel project	New	49,000
	Total		1,57,745

Sources: HMG of Nepal NPC and the Fifth Plan.

In this plan period, it was estimated that diesel plant of Biratnagar and Pokhara and Supplied 1500 KW and 500 KW electricity respectively. The small Hydel Project (3project) generating electricity of 445 KW to 545 KW in the Fifth plan period. The Jhurupa small hydel project situated in Surkhet district was to be constructed during the plan period, which was carried from Fourth Plan.

Table No. 3.9 Transmission Line in Fifth Plan

S.N.	Na Name of the project	Transmission line
1.	Hetauda- Gandak	132 KV(started in Fourth Plan)
2.	Gandak- Butwal	132 KV
3.	Bhairahwa- Pokhara	66 KV
4.	Butwal- Tansen	33 KV

Sources: Fifth Plan, NPC, GON.

For the distribution of electricity in the Fifth Plan the target was to develop transmission line in different parts of country were as shown in above.

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 MW. Due achievement was 16.22 MW from different hydel project and 2.492 MW form diesel plants. The field of transmission line only 182 KM was finished. In this plan period the achievement in electricity production was 31.75 percent of total target. Similarly, in transmission line 50.14 percent was achievement as that of target (NPC, 1980).

Table No. 3.10 Achievement of Fifth Plan

S.N.	Name of the project	Achievement in KW
1.	Large hydro project	15,000
2.	Small hydro project	1,220
	Total	16,220

Source: Sixth Plan, NPC, GON.

(VI) The Sixth Five Year Plan (1980-1985)

The Sixth Plan laid emphasis on the development of small hydel project in the mountain and remote area. In order to find out alternative sources of cheaper energy, research and survey activities were initiated. The plan also laid emphasis on narrow down of regional imbalance in power distribution. Private sectors were enough to invest in power sector including alternative energy sector. The development of multipurpose projects was expected to increases foreign exchange earnings by exporting surplus power to neighbouring countries, in addition to irrigation and other benefits (NPC, 1980). This plan had set a target to generate 1, 24,000 KW from large hydro projects and 5,829 KW from small hydro project. In this way, a total of 129,829 KW from hydropower and 15,000 KW from diesel plant was available and hence makes total power production of 144,829 KW (NPC, 1980). Total production of electricity during Sixth Five Year Plan was 75,217 KW, which is mentioned in the table 3.11.

Table No. 3.11 Target of Sixth Five Year Plan

S.N.	Name of the project	Power supply in KW	Donor Country
1.	Kulekhani (i) hydel project	60,000	Japan & Nepal
2.	Devighat hydel project	14,000	-
3.	Marsangdi hydel project	50,000	ADB & GoN
4.	Small hydel project	5,823	_
	Total	1,29,823	

Sources: Sixth Plan, NPC, GON.

Table No 3.12 Achievement of Hydropower Generation in Sixth Plan

S.N.	Name of the project	Production in KW
1.	Kulekhani (i) hydel project	60,000
2.	Devighat hydel project	14,000
3.	Small hydel project	1,217
	Total	75,217

Sources: Seventh Plan, NPC, GON.

In this plan period 10,674 KW of electricity was produced from diesel plants. The Sixth Plan achieved 57.89% of its target in hydropower generation. The Sixth Plan has conducted some survey and study about some new projects. In the field of transmission line achievement was nearly 90 percent.

(VII) The Seventh Five Year Plan (1985-1990)

The objectives of the power development of the Seventh Five Year Plan were basically same. Its objectives were also generate power from water resources of the country so as to meet the growing needs of various sectors of the economy, to develop small hydro power projects in rural areas and to conserve the long ever decreasing forest area as well as reduce the use of imported fuels. Policies were adopted to initiate 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.

During the Seventh plan period, construction of Kulekhani Hydro-electricity project, phase ii (32MW) Marsyangdi Hydro project (66MW) and Andhikhola hydro project (5.1 MW) were presently under construction and which were carried over from the Sixth Plan were to be

completed. The projects planned for completion during the Seventh Plan were sixteen whose estimated energy production was 3.549 MW (NPC, 1992). The power projects planned for completed during the Seventh Five year Plan period are presented in the table 3.13.

Table No. 3.13 Power Projects Planned in the Seventh Five Year Plan

S.N.	Name of the project	Power supply in KW	Agency
1.	Taplejung	125	Private (Shivani Hydropower Company)
2.	Khadbari	250	_
3.	Terahthum	100	Private (Reliable Hydropower Company)
4.	Bhojpur	260	Private (Eastern Hydropower)
5.	Namche	484	_
6.	Salleri	200	_
7.	Okhaldhunga	125	Private (Green Venture)
8.	Ramechap	75	Private (Garjang Upatyaka Hydropower)
9.	Manang	80	Private (Distribution Consumer Services West)
10.	Chame	50	Private
11.	Tatopani	1,000	ADB &GoN
12.	Chourjhari	150	Private
13.	Syarpudaha	200	Private (Distribution Consumer Services West)
14.	Bajura	200	Private (Distribution Consumer Services West)
15.	Bajhang	200	Private (Distribution Consumer Services West)
16.	Dharchula	50	Private (Distribution Consumer Services West)
	Total	3,549	

Sources: Seventh Plan, NPC, GON.

The table 3.13 shows the construction of hydropower plants of total of 3,549 capacities targeted to be completed during the Seventh Five Year Plan period. Important projects with a share in contribution to this capacity were 1,000 KW from Tatopani, 484 KW from Namche, 250 KW from Khadbari, 200 KW from Bajura Power projects.

The progress in the electricity sector and alternative sources of energy during the Seventh Five Year Plan (1985-1990) and the Interim Period (1991-1992) is given in table 4.15. The total production of hydropower during the Seventh Plan and Interim Period were 108.55 KW and 66.900 KW respectively.

Table No. 3.14 Progress during the Seventh Plan (1985-1990) and the Interim Period (1991-1992)

S.N.	Item	Seventh Plan	Interim Period
1.	Electricity Generation (KW)		
a.	Hydropower	103055	6,690
	Medium and large projects	101000	5,100
	Small projects	2055	1,590
b.	Fuel operated	-	26,000
2.	Transmission line (KM)	1,226	197
	132KV	723	-
	33KV (sub-grid)	503	197
3.	Alternative sources of energy		
	Small hydropower KW)	1,145	239

Sources: Eighth Plan, NPC, GON.

(VIII) The Eighth Five Year Plan (1992-1997)

In the Eight Plan, comprehensive policies for hydropower and energy development were formulated. Hydro- projects of different level and capacities were implemented to meet the medium and long term needs (NPC 1992). A policy was formulated to encourage the sale or joint venture of one or more private national investors as well as to encourage the joint venture with the government and a signee or more national or foreign investors. Like the previous plans, hydroelectricity was given high emphasis in the Eight Five Year Plan. The target of this plan was goes 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 (NPC 1992). The programmes in electricity sector include in the Eight Plan had been classified in following categories.

) Construction of New Hydroelectric Projects

All the construction work of Jhimruk hydro-electric project with an installed capacity of 12.5 MW under the construction in Pyuthan was to be completed, construction of the Kaligandaki

'A' hydroelectric project with an installed capacity of 144 MW was proposed to be started. In addition to this, works relating to the first phase of the Arun III hydroelectric project was to be installed in order to generate power from the Arun Rivver. 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 MW and 0.5 MW by refurbishing Trishuli-Devighat hydropower stations, completing the Jhimruk hydroelectric project and by various other small hydro electric projects.

) Strengthening of the Existing Hydropower Stations

The existing generating capacity of the Trishuli and Devighat hydropower station in Nuwakot district were to be increased as per the policy of increasing the existing generating capacity. The generating capacity of the Trishuli and Devighat hydropower stations were to be increased during this plan period by carrying out improvement and consolidation measures. These measures were to be incrased of about 12.2 MW of power generation capacity.

) Construction- Extension and Strengthening of Electric Transmission Lines

Construction of 42 km long Duhabi-Kataiya 132 KV transmission line had to be completed. Similarly, construction of 200 km long 132 KV transmission line between Banke (Kohalpur) and Kanchanpur (Mahendranagar) of the remaining portion of the central gried was be constructed during the Eighth Plan Period. In addition to this 132 KV and 66 KV transmission line passing through high electricity consumption areas especially of the central grid ie. Biratnagar-Kathmandu Valley and Hetauda- Bharatpur- Birgunj and Butwal- Bharatpur sections were to be strengthened.

In the process of development, construction and study of hydropower projects in the Eight Five Year Plan Period, medium projects such as Arun III (402 MW) and Kali Gandaki 'A' (144 MW) and small projects such as Puwa (6 MW), Chilime (10 MW) and Modi (14 MW) were initiated. Out of these, Arun III could not be implemented because the donor agencies with drawn from the project while arrangement was in the final stage (NPC 1992).

) Rural Electrification

Electrification from the Central Grid

Electrification work was to be undertaken in about 1200 villages in Illam, Jhapa, Sunsari, Morng, Dhanusa, Mahottari, Sarlahi, Siraha, Rauthat, Chitwan, Nawalparasi, Rupandehi, Kapilbastu, Kaski, Gulmi, Arghkhanchi, Dang, Banke, Bardia and surkhet districts having high population densities. This program was to be benefied about 9, 50,000 people of those areas.

J Electrification by Small Hydro- electric Project in Isolation

Small hydro-electric projects were to be constructed in order to meet the rural electricity demand in the Hills and Himalayan region. Electricity capacity under this programme was to be increased by 3,260 KW during the plan period from the continuing and proposed projects, construction of the Namche (600 KW), Achham (400 KW) and Tatopani Second Phase (1,000 KW) projects from the Seventh plan were to be completed. In addition to these, the Khotang (500 KW), Kalikot (600 KW) and Dolpa (160 KW) projects were to be constructed.

Table No. 3.15 Achievement in the Eighth Five Year Plan

Details	FY 1991/92	FY 1996/97	Increment in figure (%)
1. Total installed capacity			
a. Hydropower stations	2,38,563	2,52,418	13,855 (5.8%)
2. Length of Transmission (KM)			
132 KV single circuit	1178	1191	13 (1.09%)
132 KV double circuit	-	43	43
66 KV single circuit	64	179	115 (179.7%)
66 KV double circuit	153	158	5 (3.20%)
33 KV single circuit	1096	1349	253 (23.1%)

Sources: Ninth Plan, NPC, GON.

(IX) The Ninth Five Year Plan (1997-2002)

In the Ninth Plan enunciated long term policy with a view to raising the share of electricity in total energy consumption from about 1 percent to 3.5 percent in the next 20 years. The plan also laid emphasis on development of multipurpose project like Koshi 4,700 MW, Karnali 10,800 MW and mahakali 4,680 MW (about 22,000 MW) for domestic use as well as for export. It adopted the policy of controlling the power leakage. The major policies mentioned in the plan included institutional reforms to attraction private sector in power generation and indigenous talent and involvement line. The Ninth Plan had set the following objectives in the hydropower development.

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

2. To supply electricity at affordable price internally and to export electricity at competitive price by developing reliable and quality hydropower.
3. To maintain regional as well as rural-urban balance in power supply.
4. To develop hydropower with minimum adverse impact on environment.

In the Ninth Five Year Plan, the target was to increase hydropower to 546 MW from the existing 253 MW linked with central grid. Out of this, 4 projects (172 MW) were to be, implemented from public sector and 4 projects (121 MW) were to be implemented from private sector. The total capacity of thermal power stations was to increase 60 MW from the existing 47 MW. Transmission line was targeted to expand 3,926 KM from existing 2,902 KM. Similarly, 6,067 KM of distribution line was also targeted to add. A total of 8,28,000 people be benefited by electricity power in the end of the Ninth Five Year Plan. Feasibility studies started in the Eighth Plan were also been completed and feasibility studies of 12 other projects were to be started and completed in the Ninth Five Year Plan.

Power Generation and Supply:

From the various hydropower projects 295 MW additional electricity's was targeted to generate from large and medium projects and 660 KW from small hydel projects.

Table No. 3.16 Power Generation in Ninth Plan by Large, Medium and Small Hydel Projects;

S.N.	Name of the project	Capacity (MW)	Sector	Agency
1.	Indrawti III	5	Private	IPP /GoN
2.	Puwa khola	6	Private	NEA
3.	Modi khola	14	Private	NEA/ South Korea
4.	Chilime	20	Private	NEA/Company
5.	U.Bhotekoshi	36	Private	IPP / America
6.	Khimti I	60	Private	IPP / Norwegian
7.	Kali Gandaki 'A'	144	Public	NEA/ ADB/OECF
8.	Tanakpur	8	Public	-
9.	Kalikot	0.5	Public	-
10.	Dolpa	0.16	Public	-
	Total	293.66		

Sources: Ninth Plan, NPC, GON.

Target and Achievement of the Ninth Plan

Table No. 3.17 Physical Target of Electricity Development in the Ninth Plan

Details	Total	1997/98	1998/99	1999/2000	2000/01	2001/02
1 Electricity generation and supply system						
a.Large and medium hydro-power projects (MW)	293	-	6	104	183	-
b. Small hydropower projects (KW)	660	160	500	-	-	-
2 Construction and extension 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

Sources: Ninth Plan, NPC, GON.

Table No. 3.18 Target and Achievement of the Ninth Plan

S.N.	Area	Unit	Target	Achievement	Achievement%
1.	Hydropower installed capacity	MW	538	527.5	98.04
2.	Transmission line (132.66 and 33KV)	KM	3926	4324	110.13
3.	Capacity sub-station at higher level (132 and 66KV)	MVA	832	881	105.89
4.	Distribution line (11 KV and 400/230 Volt)	KM	6067	8400	138.45
5.	No of consumer	000	828	878	106.4
6.	Benefited people	%	20	40	200

Sources: Tenth Plan, NPC GON.

(X) The Tenth Five Year Plan (2002-2007)

The tenth plan emphasis on the construction of small, medium and large 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 sector and domestic and foreign investments. The plan also lays emphasis rural electrification, control of unauthorized leakage of electricity and private sector involvement in generation, transmission and distribution. In the power sectors, private sectors are given full freedom for the investment. As a result private sector joint venture companies have to construct some hydro projects under the Build Own Operate and Transfer (BOOT) system. Implementation of the concept would help

in economic development industrialization, flood control, environmental protection and in creating employment opportunities besides benefiting the downstream nation in profit sharing. To Tenth Plan had set the following objectives in hydropower sector to reduce the poverty of Nepalese people in sustainable manner.

1. To produce electricity at low cost by harnessing the existing water resources.
2. To expedite rural electrification so that it could contribute to the rural economy.
3. To develop hydroelectricity as an exportable item.

The quantitative target of the plan was as follows:

- Hydropower projects constructed to supply 842 MW electricity out of which 70 MW could be exported.
- Additional 10 percent people supplied electricity through national grid for which power supplied to 26,000 villages development communities (VDCs) through national grid and additional 5 percent people supplied power through alternative sources of energy.
- Per-capita electricity consumption rose to 100 kilo hour.

In the Tenth Plan period, the target was to increase 315 MW of hydropower by public on private sector. Of the total, population, 48.5 percent was expected to have access to electricity services by the end of the Tenth Plan. Prior to the Tenth Plan, electricity was available to 58 municipalities and 1600 VDCs in the country. Out of 315 MW, 101 MW was to be produced by public sector and 214 MW by private sector. In this plan period some projects were to be started for export hydropower and to supply the demanded electricity after the Tenth Plan Period. The projects which were to be started construction work were Arun III (402 MW), Upper Karnali (300 MW), Upper Tamakoshi (250 MW) and West Seti (750 MW). Transmission line was targeted to expand 430 km. Out of this 301 km transmission line was to be constructed by public sector and 129 km transmission line was targeted to construct by private sector. In the Tenth Plan the was to supply electricity of additional 1,000 VDCs and additional 7,05, 000 consumers were to be benefited.

The plan laid emphasis on the studies of reservoir projects during plan period. Survey and studies commissioned on various project with a total capacity of 13,376 MW of which 12,239 MW had planned to produce from the public sector and 1,137 MW from the private sector. Studies had been commissioned with bilateral co-operation on Pancheshwor Multipurpose Project (6,480 MW), Sunkoshi- Kamala diversion (1,300 MW) during the plan period.

From the various hydropower projects 101 MW additional electricity was targeted to generate from public sector and 214 MW from private sector as shown in below.

Physical target and achievement of electricity development during the Tenth Five year Plan Period is shown in the table 3.19.

Table No. 3.19 Physical Target and Achievement of Tenth Five Year Plan

S.N.	Areas	Unit	Target	Achievement	Percentage
1	Hydropower installed capacity	MW	315	40	12.69
2	Transmission line (132-66KV)	KM	430	47	10.93
3	Capacity sub-station at higher level (132-66KV)	MVA	426	332	77.93
4	Transmission line (11KV)	KM	865	123	14.21
5	Capacity Sub-station	MVA	101	112	110.89
6	Distribution line (11KV)	KM	14,197	8,371	58.96
7	Supply electricity in VDCs	Num	2,600	2,100	80.77
8	No of Consumers	000	706	417	59.06
9	Benefited people	%	10	8.5	85

Sources: three Year Interim Plan, NPC, GON.

(XI) The Three Year Interim Plan (2007-2010)

The main objective of hydro electricity in the Three Year Interim Plan is to create an environment conductive and foreign investment in the development of hydropower and to ensure reliable, quantity and easily accessible electricity services for majority of the people of the rural areas of the country, considering hydropower as an important base for the comprehensive economic development of the country. The Interim Plan has set the main objectives of the hydroelectricity sector are expand electricity to rural areas by providing quality services at a low cost, to adopt hydro-electricity as the foundation of overall economic development and develop it as on an export able item. The following main policies will be adopted to attain these objectives:

1. Domestic and foreign investment will be encouraged for development of hydroelectricity.

2. An electricity regulating agency will be strengthening for institutional improvement of electricity sector, and management of production, transmission and distribution.

3. Clear, simple and transport procedure will be adopted to increase the participation of private sector, community and local persons in production, consumption and export of hydroelectricity.

4. Rural electrification will be expanded with priority.

5. Policy will be adopted to provide electricity easily and at low cost to agriculture and other productive sectors.

6. The tendency to just obtain license for small hydroelectricity production and distribution, without carrying out production and distribution works will be discourage.

7. Domestic investment will be encouraged in hydroelectricity production to a certain capacity.

8. Water resources strategy as well as other provisions in national water plan will be gradually implemented.

9. Initiative will be taken to integrate micro and small hydro electricity with the national grid.

The qualitative Targets of the Three Year Interim Plan (2007-2010)

1. Hydropower projects will be constructed to supply additional 105 MW electricity's and the construction work will be started of additional 2,115 MW electricity.

2. Additional 10 percent of people will be supplied electricity through the national grid for which power will be supplied additional 500 VDCs.

3. Per-capita electricity consumption will be expanded to 100 kilowatt hour.

The programme in electricity sector include in the Three Year Interim Plan period have been classified in the following categories:

Õ **Electricity Production and Supply;**

Hydropower projects with a total capacity of 105 MW shall be developed under the public and private sectors within the plan period to meet the domestic electricity demand. For this, the public sector will contribute 85 MW and that the contribution of the private sector will be 20 MW. During the plan period, Middle Marsyangdi hydro-power plants of 70 MW and Kulekhani

III hydropower plant of 20 MW will make important contribution to the public sector. The private sector contributions of 20 MW will primarily from small and micro hydropower scheme. In line with the commitment made by the Finance Minister to develop generation capacity of 5,000 MW over 10 years, with in the three years plan period of hydropower plants of total of 2,115 MW capacities shall be initiated. Important project with generating capacity in contribution to this capacity will be 402 MW from Upper Tamakoshi'A' 60 MW from Upper Trishuli'A', 40 MW from Upper Tamakoshi'B' and 30 MW from Chameliya hydropower projects.

õ Electricity Transmission and Consolidation

Construction of a total of 174.5 km long transmission line of various kilovolts will be completed during the Three Year Interim Plan. Out of three cross border transmission line of 400 KV capacities for the purpose of export and import electricity between Nepal and India, Dhalkebar-Vittamod (30 km) transmission line will be constructed during the plan period other two transmission line Butwal- Sunauli (25 km) and Duhabi- Jogbani (15 km) will be started to construct. In addition to this Hetauda- Bardghat (220 km) transmission line will be commenced during the plan period. In the Three Year Interim Plan Period, construction of some new sub-station completed. For this 337 MVA of capacity transmission sub-station will be increased of different kilovolt.

õ Electricity ,Distribution, Expansion and electrification Programme

In order to cover large parts the rural areas, construction of transmission and distribution lines of 651 km of 33 KV capacities, 3,163 km of 11 KV capacity's, 5,978 km of 400/230 volts and construction of 33/11 KV distribution sub-station of a total of 113 MVA capacities shall be completed during the plan period. This will help electricity services to a 500 VDCs providing electricity to a total of 450,000 households. The national transmission grid will be expand to an additional Electrification Programmed, transmission and distribution lines of 130 km of 33 KV, 1,154 km of 11 KV and 2,345 km of 400/200 Volts shall be completed. This will help expand electricity services to an additional 135,000 households (NPC, 2007).

õ Special Effort for the Shortage of Supply of Electricity (Load Shedding)

In the Three Year Interim Plan Period load shedding will be completely wipe through the following programmes.

In the First Year FY 2007/08, 40 to 50 MW, electricity will be imported from India. This will reduce the time of load shedding. From selected three cross border transmission line,

Dhalkebar-Bhittamod transmission line will be started to construct in 2007/08 and completed in 2008/09. This will help to increase the business of electricity.

In the Second Year FY 2008/09, Middle Marsyangdi hydropower project will be completed and additional 70 MW, electricity will be connected in national grid which will be also decrease load shedding. After that importing electricity from India Load Shedding will be decrease.

The hydropower projects that will be constructed in the Interim Plan Period will be completed in FY 2010/11 and FY 2013/14 about 600 MW, electricity will be connected in national grid. After 2013/14 load shedding will completely wipe out through the internal production.

Table No.3.20 Hydropower Projects Proposed to be During Interim Plan Period

S. N.	Name of the project	Installed capacity (MW)	Completion year	Agency
1	Chameliya	30	2010/11	China
2	Upper Tamakoshi	309	2013/14	ADB/GoN
3	Upper Seti (Rservoir type)	122	2013/14	-
4	Upper Trishuli 'A'	60	2013/14	China
5	Upper trishuli 'B'	40	2013/14	China
6	Rahughat	27	2013/14	IVRCL, India
7	Kaweli 'A'	30	2013/14	Arun Kabeli Power
8	Mailung	5	Private Sector	-
9	Lower Indrawati	4.5	Private Sector	-
10	Upper Modi	14	Private Sector	NEA/ Korean Water Resources Corporation
11	Daram Khola	5	Private Sector	-
12	Lower Nyadi	4.5	Private Sector	-
13	Modi I	10	Private Sector	South Korea
14	Phawakhola	2.079	Private Sector	-
15	Arun III	102	Private Sector	NEA from Home Loan
16	Upper Karnali	300	Private Sector	-
17	West Seti	750	Private Sector	China/GoN
	Total	2,115.079		

Sources: Three Year Interim Plan, NPC, GON.

Table No. 3.21 Transmission Line to be Initiated Interim Plan Period

S.N.	Name of the project	Length (KM)
1	Kabeli Corridor 132 KV	129
2	Hetauda- Bardaghat220 KV	143
3	Middle Marsyangdi- Damauli 132 KV	43
4	Butwal- Kohalpur 132 Kv	208
5	Butwal- Sunauli 400 KV	25
6	Duhabi- Jogbani 400 KV	15
7	Upper Modi- Modi 132 KV	10
8	Modi- I Lekhinath 132 KV	7
9	Mailung- Grang 66 KV	3
	Total	583

Sources: Three Year Interim Plan, NPC, GON.

Table No. 3.22 Transmission Line to be completed in Interim Plan Period

S.N.	Name of the project	Length (KM)
1	Kulekhani-III Hetauda 132 KV	0.5
2	Thankot – Chapagaun 132 KV	27
3	Dhalkebar – Bhittamod 132 KV	30
4	Khimti – Dhalkebar 220 KV	75
5	Middle Masyangdi- Marsyangdi 132 KV	42
	Total	174.5

Sources: Three Year Interim Plan, NPC, GON.

(XII) Three Year Plan (2010-2013):

Despite the fact that various promotional and motivational measures have been adopted to involve the private sector and communities in the generation and distribution of hydropower under the Electricity Act (1992), and various policies and periodic plans, progress in hydropower has been far from satisfactory. By the end of the Three Year Plan in the FY 2012/13, the installed capacity of the power generation centres connected into the national grid was only 705 MW, out of which the NEA contributed 473 MW and the Private sector 232 MW. The national grid covered 59 districts. The Three Year Plan target for increasing capacity was 184 MW; the actual additional was only 21 MW. While progress in expanding capacity was discouraging, that in increasing distribution lines was satisfactory; nine hundred additional VDCs and 700,000 additional customers benefited from electricity. Nearly 50 percent per capita power consumption has reached 108 KWh. By 2011, nearly 67 percent of population had access to electricity.

The supply of power does not meet the demand for it, however, due to a host of problems such as the lack of transmission line in certain parts of the nation, the poor management of distribution, the fact that the nation's run of-river-system base-power-production approach means that plants do not run of at their installed capacities during the dry season, the inability of the private sector to generate power within the time from committed and the fact that not even the government sector operates any new huge capacity generation projects.

) Objective of the Plan

To increase the existing access to reliable and good quality electricity services by encouraging hydropower production.

) Strategies of the Plan

1. Increase the existing capacity for electricity production increasing public, private, community and cooperative investment through the creation of an investment friendly environment.
2. Expand and strength electricity transmission and distribution regimes.
3. Promote foreign investment in and assistance for the development of extensive and multipurpose hydropower projects that fulfil domestic needs and generate electricity to export.

)Operating Policies of the Plan

1. Project will be implemented through both private and government investment transmission lines will be constructed and power for domestic consumption generated.
2. Government and national private capital will be mobilised to construct and operate small and medium projects.
3. To increase private investment by Nepali citizens, power purchase rate will be reviewed and incentives and tax concessions on construction materials will be given to those projects which will be completed during the Three Year Plan Period.
4. The efficiency of the power generation, distribution and utilization system will be increased.
5. The private sector will be encouraged to construct transmission lines through public private partnership.

6. Electricity leakage will be controlled by adopting legal provisions and technical measures.
7. Action will be taken to construct underground and power-induced accidents.
8. Rural electrification will be expanded as called by policy.
9. Detailed reports on the proposed Pancheshwor and Saptakoshi hydropower projects will be prepared.
10. It will be mandatory for big hydropower projects to consider the effect of climate change.
11. The water sheds of big rivers will be projected.

Expected Outcomes of the Plan

By the end of Three Year Plan, completed hydropower projects will have added 668 MW of power generating capacity and projects with a total capacity of 584 MW will have been started. In addition, 400 km of new transmission lines will have been constructed; power leakage will have decreased to 21 percent. Per capita power consumption will have increased to 140 KWh, the proportion of the population using electricity from the national grid will have reached 65 percent and electricity will be available in 3,000 VDCs.

3.3 Hydroelectricity Power Potential in Nepal

Nepal is water rich country. The geographical constitution of Nepal with great variation of altitudes from high Himalayan to the low land of the Terai over a relatively narrow with combined with abundant snow melt and monsoon water after tremendous energy potential for generating hydropower. Nepal's theoretical hydropower potential has been estimated at about 83,000 MW and its technically and economically feasible potential of about 45,000 MW and 42,000 MW respectively. Table 3.23 shows that Summarizes the theoretical, technical and economical hydropower potential classified within the major river system in Nepal, feasible potential estimated by the Water and Energy Commission (WEC). The Karnali and Mahakali river system represent approximately 43 percent of Nepal theoretical hydropower potential and 55 percent of the technical/economical potential.

Table No. 3.23 Hydropower Potential in Nepal.

In Thousand MW

S.N.	River Basin	Theoretical Potential	Technical Potential	Economical Potential
1	Saptakoshi	22.35	11.40	10.860
2	Saptagandaki	20.65	6.66	5.270
3	Karnali and Mahakali	36.18	26.57	25.125
4	Southern Rivers	4.11	0.98	0.87
	Total Potential	83.29	45.61	42.13

Sources: WECS, 1992/93.

Table 3.23 shows that Nepal has 83.29 thousand MW of hydropower potential. Of this total potential, 50.5 % (42.133) thousand MW is economically viable. The highest potential possessed by Karnali and Mahakali rivers from theoretical, technical and economic perspectives. Southern rivers possess low potential because they don't flow from the Himalayan region like other majors rivers. There are many projects in number including large, medium and small in Technical and Economical viable sector respectively.

3.4 Nepal Electricity Regulatory Commission Bill 2064 (2007/08)

Nepal government has been submitted a bill on electricity regulatory body to the parliament (constituent Assembly) for facilitating electricity production, transmission, distribution, trading and management in a transparent way. Its other objectives are to balance supply and demand, to set electricity market and to protect consumer rights. But till now, no action is being taken to in acts the bill by the parliament yet. With the establishment of this regulatory body, electricity market is expected to develop in a competitive environment where stakeholder's rights are protected and electricity is made accessible, affordable and acceptable.

3.5 Ten Years Hydropower Development Plan 2009

Government of Nepal formed a task force under the convenor ship of Mr. Somnath Paudel in December 2008. The task given was to formulate programmes for developing 10,000 MW in 10 years to provide relief to the consumers, concerned industries and business against the ongoing energy crisis in the country. The task force has already submitted the draft report which is yet to be discussed among the concerned stakeholders and ratified by the government. Never the less, it has clearly pointed out the great importance of developing hydropower and the systematic way and means to materialize it in this country. It has also adequately presented the scary scenario of load shedding in the years to come and need of high level mechanism under the top leadership to resolve the crisis. GoN has again come up with the plan of development of 25,000 MW in 20 years in the plans and programmes of the government in July 2009 under the convenor ship of the secretary, WECS. There is huge potential of hydropower resources in the

country and if the government can facilitate the development of hydropower. On priority basis through private public partnership, Nepal can export the surplus power after meeting the domestic energy need of the consumers-households and industries in the country (WECS, 2009).

3.6 Physical Achievement in Hydro-Electricity Development

Nepal has travelled the 100 years journey of power development since the installation of Pharping Hydel plant in 1911 AD; it was one of the largest hydropower project in the South Asia during that time. Although, Nepal has completed the eleven development plan, but the power development in Nepal is still infant stage. Following table shows the physical achievement of hydro-electricity in Nepal.

Table No.3.24 Achievement in Hydro-Electricity Development in Different Plan Period

Plan	Total Planned Target (MW)	Total achievement (in MW)	Achievement (in %)	Share of hydropower (in %)
1st	20	0.75	3.75	-
2nd	22	7.50	34.09	73.33
3rd	36	19.96	55.44	100
4th	40.30	28.50	70.72	91.37
5th	58.85	18.71	31.79	86.75
6th	144.92	87.62	60.45	87.81
7th	106.63	103.06	96.65	99.90
8th	29.70	28.50	95.96	100
9th	306.66	137.66	44.89	90.56
10th	315	181.279	57.73	N.A*
Interim	105	77	73.36	-
	1184.06	690.54	58.0	-

Sources: Bhattrai (2005), Interim Plan and Statistical Pocket Book CBS (2009).

N.A* = Not Available

CHAPTER IV
PRESENT STATUS OF HYDROPOWER DEVELOPMENT5 IN NEPAL

4.1 Hydropower Potential of Nepal

In the global context 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 accessed as 10,000 TWH. About 48 percent of this total belongs to the developing countries (WECS, 2006). Out of the total hydropower potential 2,494 million KW, Nepal accounts for 3.34 percent (83.29 million KW). This is the highest among the SAARC nations. Regarding utilization, however, Nepal's performance is lowest among the SAARC countries. Only 0.75 percent of theoretical potential and 1.5 percent of economical potential is utilized. The rate of utilization is highest in Sri Lanka (84.75 percent) followed by India (33.16 percent) and Pakistan (24.07 percent) (Bhattrai, 2005).

Not only among many developing countries but also in the global scenario too, Nepal has dominance in water resources. The geography has blessed Nepal hydropower potential has been estimated at about 83,000 MW and its technically and economically feasible potential of about 45,000 MW and 42,000 MW respectively. The mountainous topography of the country provides the possibility of a series of high dams, which can hold huge quantities of water for multipurpose. This storage has the potential to augment dry season flow by about 5400 m^3 /sec (Bhatt 2008).

Table No. 4.1 Theoretical Hydropower Potential

River Basin	Potential in MW		Total MW
	Major river courses having catchments areas above 1000 km^2 (Major Rivers)	Major river courses having catchments areas above 1000 km^2 (Small Rivers)	
Saptakoshi	18750	3600	22,350
Saptagandaki	17950	2700	20,650
Karnali and Mahakali	32680	3500	36,180
Southern River	3070	1040	4,110
Country Total	72450	10840	83,290

Sources: Shrestha (1966).

Table No.4.2 Technical Hydropower Potential

River Basin	Number of project sites	Technical Potential Capacity in MW
Saptakoshi	53	11,400
Saptagandaki	18	6,660
Karnali	30	25,410
Mahakali	4	1,160
Southern Rivers	9	980
Country Total	114	45,610

Sources: Shrestha (1966).

Table No. 4.3 Economical Hydropower Potential

River Basin	Number of project sites	Economical Potential Capacity in MW
Saptakoshi	40	10,860
Saptagandaki	12	5,270
Karnali	7	24,000
Mahakali	2	1,125
Southern Rivers	5	878
Country Total	66	42,133

Sources: Shrestha (1966).

4.2 Import and Export of Electricity

Nepal has huge hydropower potential and domestic demand is very small as compared to its potential even to the foreseeable future. There is an agreement between Nepal and India to exchange electricity as per need. The exchange points are located various places in the Indo-Nepal border. Though there is a provision in the agreement to exchange to about 150n MW of electricity power between two countries, due to the lack of transmission facilities it is limited to below 100 MW. The table 5.2.1 shows the situation of import and export of hydroelectricity between Nepal and India from 2009 to 2013.

Table No 4.4 Import and Export of Hydroelectricity (In GWH)

Category	2009	2010	2011	2012	2013*
Export to India	46.38	75.07	31.10	4.12	3.72
Import from India	356.46	638.68	694.05	746.07	792.52
Net import/ export	310.08	563.61	664.61	741.95	788.8

Sources: Nepal Electricity Authority (2013).

*Provisional figures; subject to final audit.

The table 4.2.1 shows the quantity exchanged between the two countries from 2009 to 2013. The electricity exported to India in 2009 is about 141.23 GWH where as imported from India in 2009 is about 186.68 GWH. It presents that Nepal's net import from India is 45.44 GWH in 2009. The electricity imported from India in 2013 is about 792.52 GWH where as export to India is about 3.72 GWH. And it shows that Nepal's net import from India is 788.8 GWH in 2013.

4.3 Total Energy Available and Peak Demand

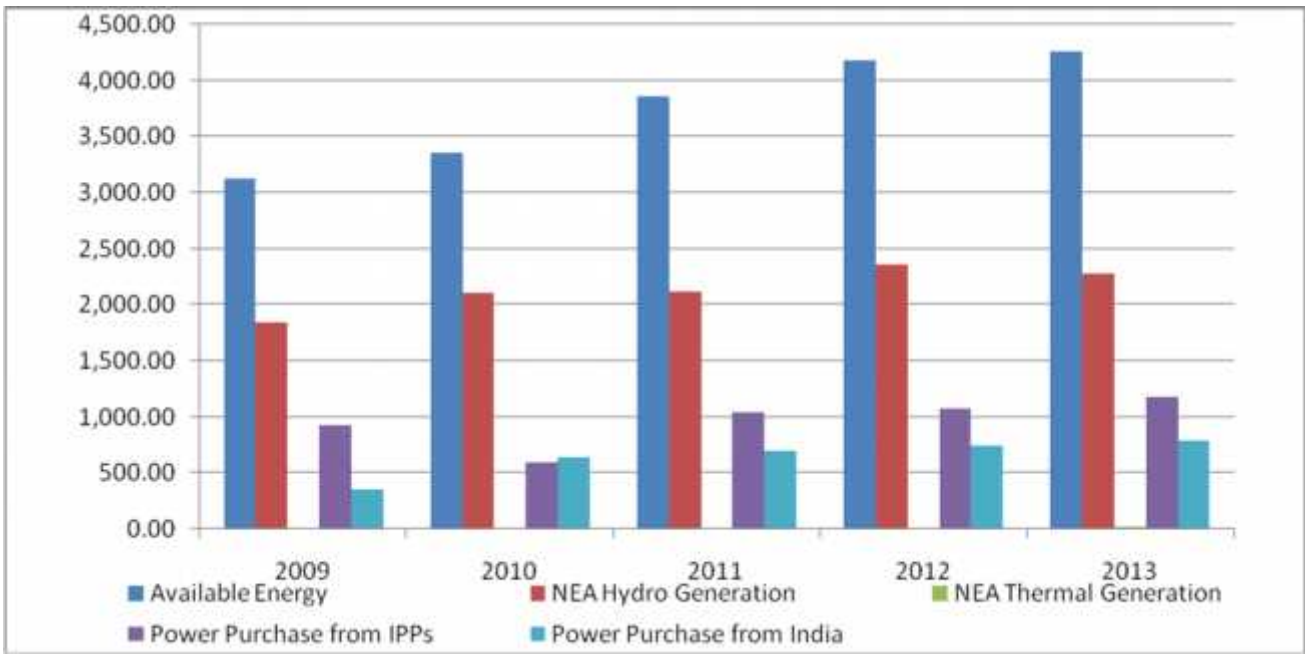
By the end of FY 2012/13, total installed capacity generated is found to be 759 MW from hydro resources. Out of the total installed capacity (NEA and IPP) generated 705 MW is connected nation grid and the remaining electricity generated by other micro hydropower is not connected with national grid. The available energy is less than the demand consequently it is creating the load shedding in the country. The situation of peak demand and available electricity has shown in the table 5.3.1

Table No. 4.5 Electricity Available and Peak Demand

Particulars	2009	2010	2011	2012	2013*
Peak demand (MW)	812.50	885.28	946.10	1,026.65	1,094.62
NEA Hydro Generation	1,839.53	2.108.65	2,122.08	2,357.43	2,273.14
NEA Thermal Generation	9.06	13.01	3.40	1.56	18.82
NEA Total Generation (GWH)	1,848.59	2,121.66	2,125.48	2,358.99	2,291.96
Power Purchase from India	356.46	638.68	694.05	746.07	792.52
Power Purchase from IPPS	925.74	591.43	1,038.84	1,o73.57	1,175.97
Power Purchase total	1,282.20	1,230.11	1,732.89	1,819.64	1,968.49
Available Energy (GWH)	3,130.79	3,351.77	3,858.37	4,178.63	4,260.45

Sources: NEA, 2013.

* Provisional figure, subject to final audit.
Note: Peak demand is for all areas covered by integrated system including supply to India.
Figure 4.1Total Energy Available and Peak Demand



The Table 4.3.1 and figure 4.3.1 shows the availability of total energy available and peak demand in different time period. The demand is for all areas covered by integrated system in including supply to India. The electricity peak demands are increasing every year. The peak demands were 812.50 in 2009 and it was 1,094.62 in 2013. Similarly, total available energy in 2009 was 3,130.79 and it was 4,260.45 in 2013.

4.4 Growth of Electricity Consumer

The number of customers receiving electricity service is growing every year. By the end of FY 2011/12, the number of customers had reached 20, 53,259 while by the end of mid –January in the current FY 2012/2013, the number of customers increased by 8.25 percent and reached 22, 88,052. The consumers of electricity are increasing day by day. But the production is not increased as number of consumers increased. As the result, we have facing Load Shedding problem. Table 5.4.1 shows situation number of consumers in different years according as the sectors involved consumers are divided in to various sectors such as domestic, commercial, non-commercial, water supply and transportation sector, irrigation, temple, street light, temporary supply, community wholesale consumer in our nation and bulk supply consumer outside country (India).

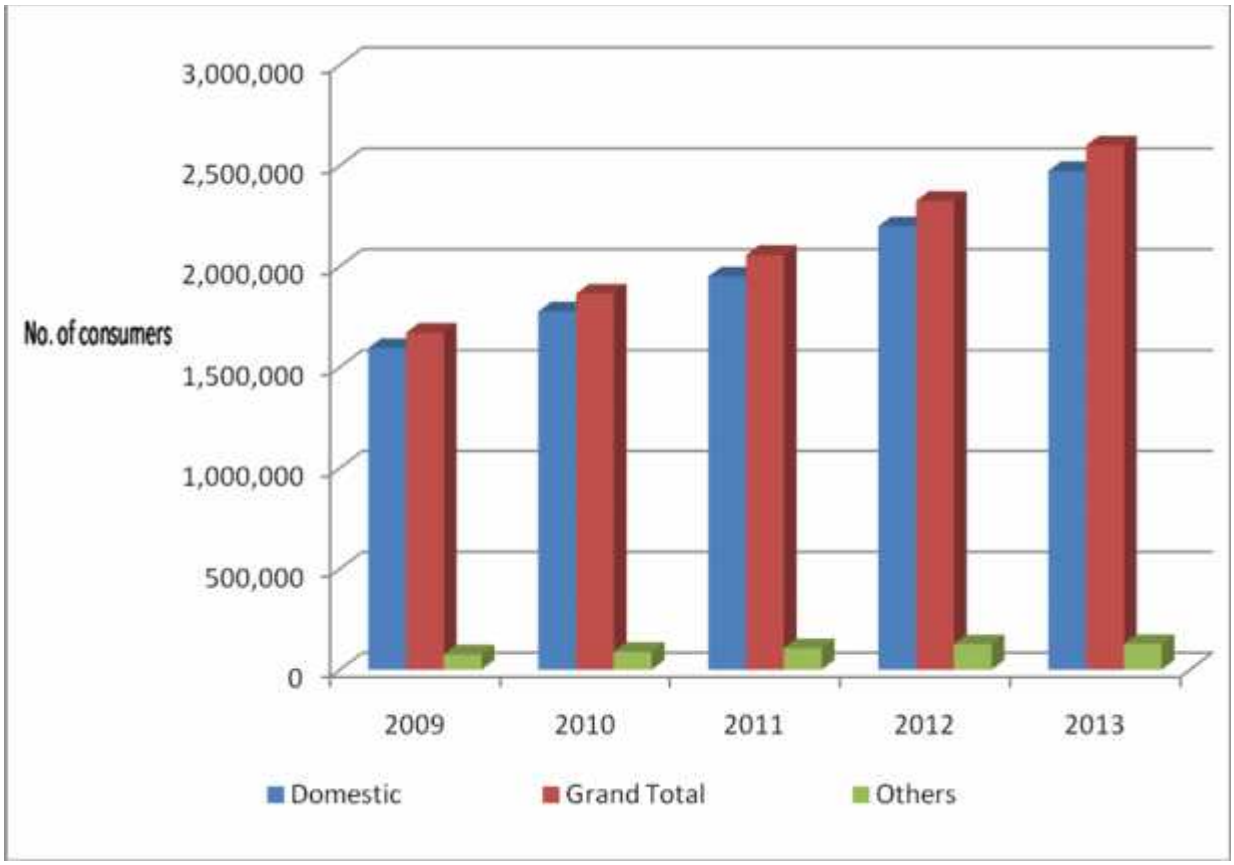
According to the given table we can say that domestic consumers are greater with respect to other sectors and its consumers are increasing continuously. In 2013 domestic sectors consumer are 2, 472,260 which is maximum up to till date. An electricity consumer in transport sector has lower and its value in 2013 is only 51. Consumers are fluctuating in different years in transport sector.

Table No. 4.6 Growth of Electricity Consumer

Particulars	2009	2010	2011	2012	2013*
Domestic	1,595,015	1,775,571	1,949,530	2,198,680	2,472,260
Non-commercial	10,518	10,952	12,520	14,055	15,179
Commercial	7,305	8,919	10,802	13,297	13,09
Industrial	28,559	29,410	33,030	36,409	37,498
Water supply	584	609	688	860	834
Irrigation	22,335	32,089	42,494	53,165	51,520
Street light	2,339	2,214	2,374	2,590	2,878
Temporary supply	403	522	634	619	768
Transport	42	41	42	44	51
Temple	2,911	2,941	3,181	3,529	1,207
Community Sales	594	795	995	1,161	1,207
Total (Internal Sales)	1,670,605	1,864,063	2,056,290	2,324,409	2,599,148
Bulk Supply (India)	5	4	2	5	4
Grand Total	1,670,610	1,864,067	2,056,292	2,324,414	2,599,152

Sources: NEA, 2013.

Figure No. 4.2 Growth of Electricity Consumer

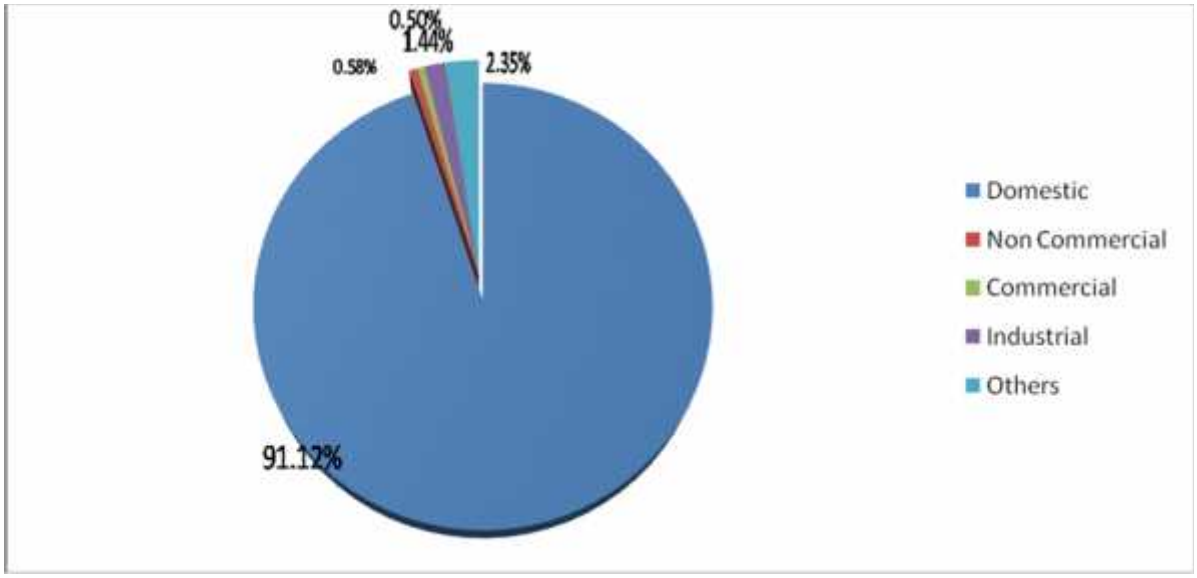


Sources: NEA, 2013.

The figure 4.2 shows the domestic consumers and grand total in different time period. The electricity domestic consumers are increasing every year. The electricity domestic consumers were 1,595,015 in 2009 and it was 2,472,260 in 2013. Similarly, grand total were 1,670,610 in 2009 and it was 2,599,152 in 2013.

Electricity Consumption Scenario

Figure No. 4.3 Electricity Consumption Scenario.



Sources: NEA, 2013.

Figure 4.3 shows the number of consumers of domestic which is very high, that is 91.12%. Similarly, large consumer is to 2.35% in industrial, 1.44% non commercial 0.58%, commercial 0.50% respectively.

4.5 Electricity Sales

Table 4.7 shows electricity sales for 2004 to 2013 more electricity sales are in domestic sector. A mainly electricity sales is in increasing pattern according as number of year increases.

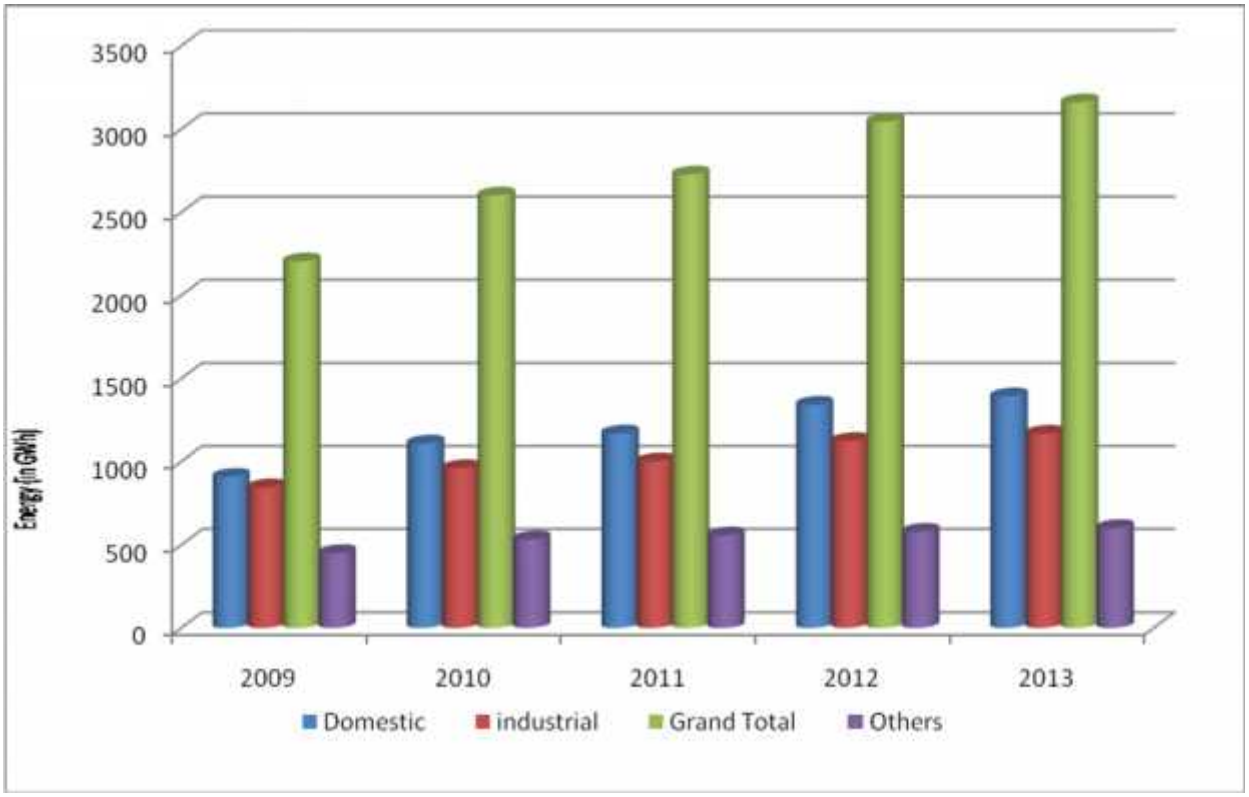
Table No. 4.7 Electricity Sales

Particulars	2009	2010	2011	2012	2013*
Domestic	908.67	1,108.87	1,169.87	1,342.67	1,392.44
Non-commercial	98.89	103.47	109.49	115.68	120.21
Commercial	146.29	187.12	204.03	240.74	250.17
Industrial	845.68	960.43	1,001.73	1,123.94	1,167.98
Water supply and Irrigation	48.14	55.98	82.80	64.59	67.12
Street light	67.51	65.58	67.21	72.06	74.86
Temporary supply	1.04	1.00	1.00	1.20	1.26
Transport	5.22	5.42	5.54	6.72	7.79
Temple	4.76	3.64	3.46	3.95	4.11
Community Sales	32.01	34.95	51.95	69.02	71.73
Total (Internal Sales)	2,158.21	2,526.46	2,696.52	3,040.57	3,157.67
Bulk Supply (India)	46.38	75.07	31.10	4.12	3.72
Grand Total	2,204.59	2,601.53	2,727.62	3,044.69	3,161.39

Sources: Nepal Electricity Authority, 2013.

*Provisional figures; Subject to final audit

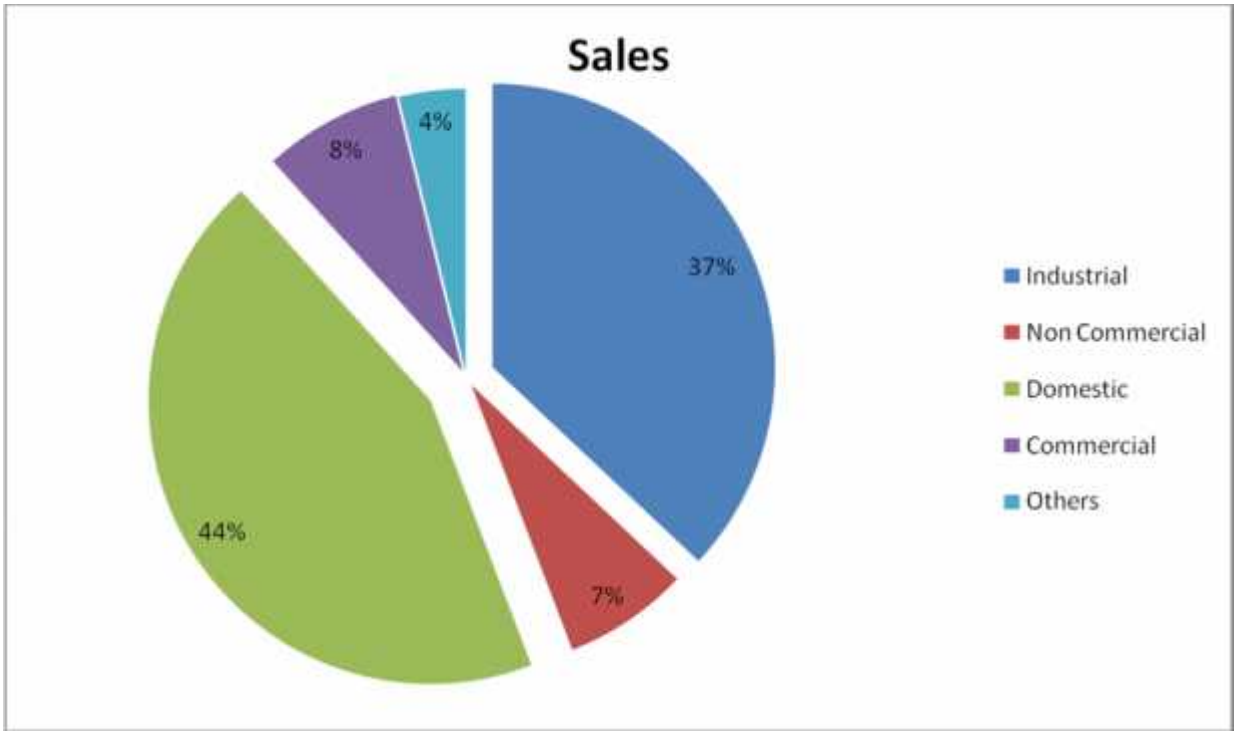
Figure No. 4.4 Electricity Sales (GWH)



Sources: NEA, 2013.

The figure 4.4 shows the domestic, industrial and grand total in different time period. The electricity sales in domestic and industrial are increasing every year. The domestic electricity sales were 908.67 in 2009 and it was 1,392.44 in 2013. And other in industrial sector were 845.68 in 2009 and it was 1,167.98 in 2013. Similarly, grand total were 2,204.59 in 2009 and it was 3,161.39 in 2013.

Figure No. 4.5 Electricity Sales scenario



Sources: NEA, 2013.

4.6 Revenue from Electricity

Table 5.8 shows the revenue from electricity from 2004 to 1013. Revenue figure shows more revenue from domestic sector than other sector.

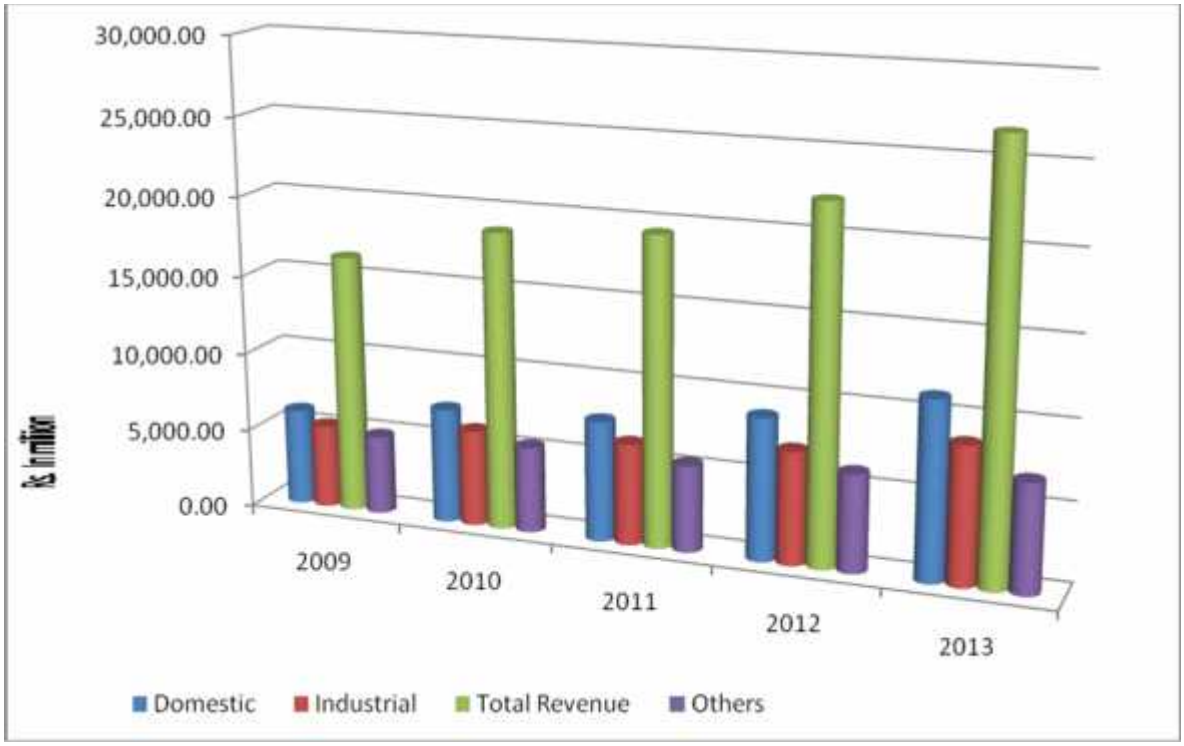
Table No. 4.8 Revenue from Electricity

Particulars	2009	2010	2011	2012	2013*
Domestic	6,100.65	7,252.06	7,602.34	8,967.77	11,217.38
Non-commercial	900.75	983.63	1,020.51	1,091.52	1,338.00
Commercial	1,384.67	1,719.35	1,910.28	2,259.52	2,666.84
Industrial	5,264.33	6,060.20	6,378.25	7,102.37	8,654.78
Water supply and Irrigation	215.62	353.14	250.60	294.82	330.81
Street light	445.96	333.90	433.42	464.22	504.53
Temporary supply	12.20	13.58	13.98	16.18	20.33
Transport	26.95	27.58	27.78	31.70	43.48
Temple	24.41	28.16	26.51	21.38	28.53
Community Sales	70.10	170.90	189.28	244.97	297.66
Total (Internal Sales)	14,445.64	16,942.50	17,547.35	20,494.43	25,102.34
Bulk Supply (India)	295.49	604.85	215.42	23.97	29.68
Gross Revenue	14,741.13	17,547.35	18,068.37	20,518.40	25,132.02
Net Income from Other services	1,601.66	1,188.27	1,382.94	1,695.42	1,609.20
Total Revenue	16,342.79	18,735.62	19,451.31	22,213.82	26,741.22

Sources: NEA, 2013.

Note: *Provisional figures final audit.

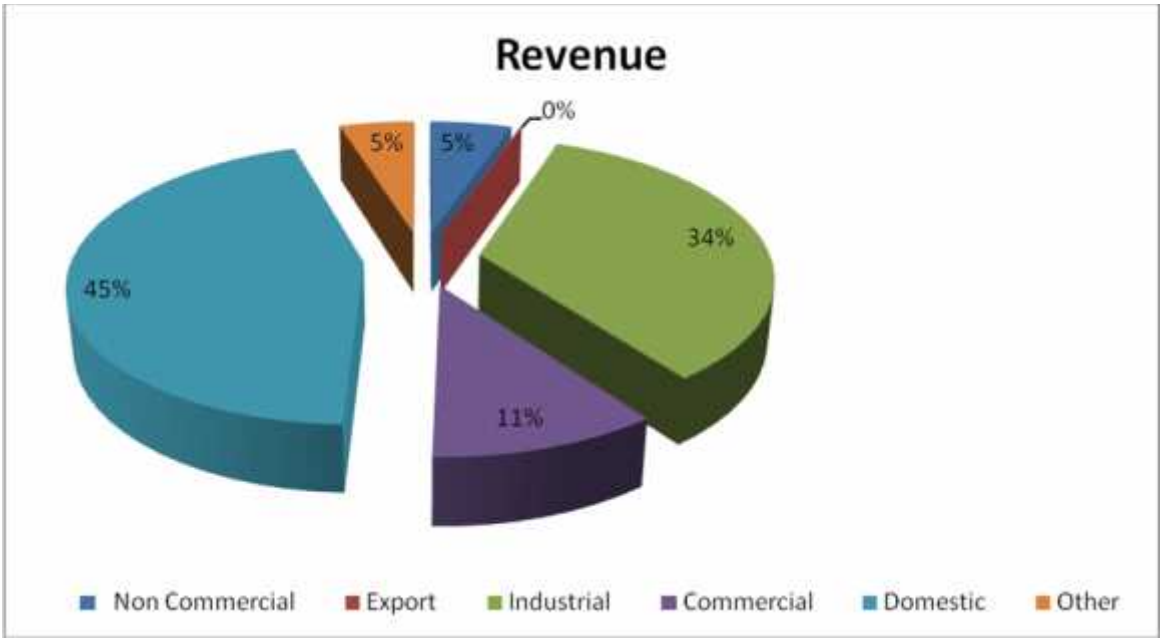
Figure No 4.6 Revenue from Electricity (in millions)



Sources: NEA, 2013.

The figure 4.6 shows the domestic, industrial and total revenue in different time period. The total revenue electricity is increasing from different sector in every year. The domestic revenue was 6,100.65 in 2009 and it was 11,217.38 in 2013. And the other in industrial sector are increasing were 5,264.33 in 2009 and it was 8,654.78 in 2013. Similarly, total electricity revenue was 16,342.079 in 2009 and it was 26,741.22 in 2013.

Figure No 4.7Revenue from Electricity Scenario



Sources: NEA, 2013.

) Tariff Rates

According to the tariff Table 5.9 given here, the domestic consumers of electricity are divided in different categories according to the use of electricity quantity used like 5 ampere, 15 ampere, 30 ampere, 60 ampere and three phase supply and charges (Demand Charge +Energy Charge) depends up on its use. NEA charged electricity according as the sector used, they are domestic, temple, street light, temporary supply, community wholesale consumer industrial, commercial, non-commercial, irrigation water supply and transportation. Other kind of Charges includes time of day tariff rates according as voltage system used (66 KV, 33 KV, 11 KV) and time.

Table No 4.9 Tariff Rates

1.	**DOMESTIC CONSUMERS**		
A	**Minimum Monthly Charge: METER CAPACITY**	**Minimum Charge (NRs)**	**Exempt KWh**
	Up to 5 Ampere	80.00	20
	15 Ampere	365.00	50
	30 Ampere	795.00	100
	60 Ampere	1765.00	200
	Three phase supply		
	Up to 10 KVA	4400.00	400
	Above 10 KVA to 25 KVA	6900.00	600
B	**Energy Charge**		
	Up to 20 units	Rs. 4.00 per unit	
	21-50 units	Rs. 7.30 per unit	
	51-150 units	Rs. 8.60 per unit	
	151-250 units	Rs. 9.50 per unit	
	Above 250 units	Rs. 11.00 per unit	
2.	**TEMPLES**		
	Energy Charge	Rs. 8.25 per unit	
3.	**STREET LIGHTS**		
A	With Energy Meter	Rs. 6.10 per unit	
B	Without Energy Meter	Rs. 2,255 KVA per month	
4.	**TEMPORARY SUPPLY**		
	Energy charge	Rs. 16.50 per unit	
5.	**COMMUNITY WHOLESALE CONSUMER**		
	Energy Charge	Rs. 3.50 per unit	
6.	**INDUSTRIAL**	**Monthly Demand Charge (Rs. /KVA)**	**Energy Charge (Rs. /unit)**
A	Low Voltage (400/220 volt)		
	(a)Rural and cottage	55.00	6.50
	(b)Small Industry	100.00	8.00
B	Medium Voltage (11 KV)	230.00	7.20
C	Medium Voltage (33 KV)	230.00	7.00
D	High Voltage (66 KV /Above)	220.00	6.25
7.	**COMMERCIAL**		
A	Low Voltage (400/220 V)	295.00	9.35
B	Medium Voltage (11 KV)	285.00	9.25
C	Medium Voltage (33 KV)	285.00	9.00
8.	**NON COMMERCIAL**		
A	Low Voltage (400/220 V)	195.00	10.00
B	Medium Voltage (11 KV)	220.00	9.60

C	Medium Voltage (33 KV)	220.00	9.50
9.	**IRRIGATION**		
A	Low Voltage (400/220 V)	-	3.60
B	Medium Voltage (11 KV)	50.00	4.10
C	Medium Voltage (33 KV)	50.00	4.00
10.	**WATER SUPPLY**		
A	Low Voltage (400/220 V)	140.00	4.30
B	Medium Voltage (11 KV)	200.00	5.20
C	Medium Voltage (33 KV)	200.00	5.00
11.	**TRANSPORTATION**		
A	Medium Voltage (11 KV)	230.00	5.30
B	Medium Voltage (33 KV)	230.00	5.30

Sources: NEA, 2013.

TIME OF DAY (TOD) TARIFF RATES

S.N.	Consumer Category and Supply Level	Monthly Demand Charge (Rs./KVA)	Energy Charge (Rs/unit)		
			Peak Time	Off Peak	Normal
			17:00-23:00	23:00-5:00	5:00-17:00
A	**High Voltage (66KVand Above**				
1.	Industrial	220.00	7.75	3.30	6.25
B	**Medium Voltage (33KV)**				
1.	Industrial	230.00	8.50	4.20	7.00
2.	Commercial	285.00	10.25	5.40	9.00
3.	Non-Commercial	220.00	11.00	5.60	10.00
4.	Irrigation	50.00	5.25	2.50	3.90
5.	Water Supply	200.00	6.10	2.90	4.90
6.	Transportation	230.00	6.35	3.10	5.20
7.	Street Light	70.00	7.00	2.80	3.50
C	**Medium Voltage (11KV)**				
1.	Industrial	230.00	8.75	4.30	7.10
2.	Commercial	285.00	10.50	5.50	9.25
3.	Non-Commercial	220.00	11.25	5.70	10.20
4.	Irrigation	50.00	5.30	2.80	3.95
5.	Water Supply	200.00	6.20	3.50	5.10
6.	Transportation	230.00	6.50	3.50	5.30
7.	Street Light	70.00	7.35	3.00	3.65

Sources: NEA, 2013.

N= Total number of consumers of a community group

Note:
If demand Meter of any consumer needs Kilowatts (KW), then KVA=KW/0.8.

a. 10% discount in total bill amount will be given to the Government of Nepal approved Industrial District.

b. 20% discount in total bill amount will be given to the Nepal Government Hospital's and Health Centres (except residential complex).

c. If new additional consumers applying for 11KV supply are to be supplied at 33 KV, they will be charged as per 11KV tariff structure.

4.9. The detail of electricity demand, consumption generation and other physical infrastructures based on results/ returns/ achievements of NEA operated programs are given Table 5.10 below. In the first eight month of fiscal year 2012/13, electricity generation of 40.4 MW has been added while no progress could be made in electricity transmission line extension despite continuous rise in demand and number of electricity consumers.

Table No. 4.10 Electricity demand, Consumption, Generation and Physical Infrastructures

Particulars	Fiscal Year			
	2009/10	2010/11	2011/12	2012/13*
Production (MW)	689.4	697.9	705.6	759
Transmission Line (km)	1,972.6	1,917.6	1,987.4	1,987.4
Customer Number	16,70,610	18,54,275	20,53,259	22,38,052
Distribution Line (km)	82,871.24	89,108.86	95,815.98	98,000
Available Energy (GWh)	3,130.77	3,389.27	3,858.37	4,205.22
High Demand (MW)	885	946.1	1,026	1,094

Sources: Economic Survey (2013), MOF.
*of the first eight months

4.10 Load Shedding in Nepal

The totalled installed capacity of the country is nearly 746 MW 2012 which is merely around one percent of the potential. At present, unfortunately, the country has been facing an acute

shortage of peak load during the dry seasons. Year 2012/13 witnessed new records of power and energy demand, generation and import. Annual Peak Demand was recorded 1,026.65 MW figure of previous year (NEA, 2013).

Nowadays we are suffering from hour Load Shedding in a week. It is affecting social life as well as economic life of the people. It effects the investors who have invested their property in the industries and after than the customers and the finally the economy as a whole. On the other hand it has also created the unemployment in the state as most of the industries are going to be close due to the load shedding of Nepal from which day by day large number of workers are being deprived form their job. Besides these, it has made life very miserable in the country as in this era of modern Science and Technology. This will finally effect the people of Nepal as their may arise the problems of starvation, shelter problem, and other facilities as the lands is limited and cannot give the support beyond its capacity. Although, the Eleventh Three Year Interim Plan focused on to remove the problem of Load Shedding.

CHAPTER V
SUMMARY, CONCLUSION AND RECOMMANDATION

5.1 Summary:

Hydroelectricity is most versatile source of energy and provides infrastructures for economic development of Nepal due to its advantage over other sources of energy. Though, Nepal has a long history (since 1911) of the development of hydropower, its development is still in infant stage. At the end of FY 2012/13* various hydropower projects generated 1094 MW of electricity of total hydropower generate, 759 MW is connected to the national grid while rest of the energy generated from small hydropower stations and not connected to the national grid have been providing electricity services at local levels. The Three Year Interim Plan play log on emphasis for effective generation, transmission and distribution of electricity and the business there to. The Plan intends to make a single door system effective in order to encourage domestic and foreign investment in the survey, studies other promotional activities for the hydropower development.

Energy is one of the basic and important infrastructures for the development of nation. Fuel wood, biomass hydroelectricity, coal, petroleum products and alternatives energies such as solar, wind etc are the most important type of energy consumed in Nepal. The use of traditional and non-commercial forms of energy such as fuel wood, agriculture residue and animal waste largely dominated the overall energy of Nepal. Nepal is the net importer of electricity, except the year 2003. In 2003, Nepal's net export to India is 42.73 GWh. We have no sufficient budget for investment in large- scale hydropower projects. Therefore, foreign aid is needed to conduct that large scale hydropower projects about 80 percent of power development is funded by external financing.

The numbers of customers availing services of NEA raced 2,238,052 in FY 2012/13, which an increases of 8.99 percent over that of previous year. Out of the total consumers 91.12 percent belongs to the domestic category accounting for 44.05 percent of total energy sales and 44.63 percent of total revenue earned in Fiscal Year 2012/13. Industrial consumers, through representing only 1.44 percent of the total consumers have significant contribution amounting to 36.95 percent of total energy and 34.44 percent of total revenue earned (NEA, 2013).

Hydropower projects are advantageous from many perspectives. It is renewable, multi-purpose fuel, no raw materials 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 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 sectors, 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.

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 conclusions:

- Nepal, a country with rich biodiversity, cultural heritage, majestic Himalayas and immense water. It's economically viable capacity is estimated to be 42,000 MW. The availability of electricity contributes significantly to the overall development of the country on one hand, and its consumption reflects the economic condition of the nation on the other. Therefore, it has become highly important to harness the abundant water resources to generate electricity for the development of the kingdom.

- Nepal has about one century long experience in hydroelectricity generation and its utilization. Hydropower development has been getting priorities in all Five Year Plan Period. But even after completion of Three Year Interim Plan, development of power in Nepal is still in infancy stage. The actual installed capacity of Nepal is only 759 MW up to FY 2012/13. Out of the total population, only 48% people have access to electricity services by the end of the Three Year Interim Plan. In 2013, the peak demand for electricity was 1094 MW, and energy available 4,260.45 GWh respectively which shows the situation of power deficit. There is great challenge in the bridging the gap between supply and demand of electricity. Therefore it can see that present status of hydropower development in Nepal is not satisfactory. The today's national interest should be given performance to mobilize domestic financial resources by encouraging private sector investment in hydropower project.

- The major constrains of hydropower development in Nepal are not only the financial and technology constrains but it faces the problem like local communities creates problem, poor infrastructure, insurgency, lack of skilled manpower, licensing difficulties, inadequacy of storage project, conservation and environmental problem. In Nepal policy deficiencies and slow making process in the electricity sector has resulted in the increased project cost and has reduced the involvement of private sector and

entrepreneur. In spite of its high possibility hydropower has no contribute enough in GDP of Nepal, neither has it generated huge amount of revenue in national economy. Thus, restricting and improvement at all policy level is required to overcome various hurdles and then only hydropower development will possible in Nepal.

The primary challenge encountered by Nepal for hydropower development in the 21st century is how to supply reliable, affordable and cheaper electricity to the domestic population. Rural electrification is essential for the economic prosperity and advancement. The access to electricity is to be taken as the key indicator to the progress of living standard. It enhances the capabilities of the people to reduce the poverty. Nepal is currently facing an acute power shortage which has negative impact in economic growth. This is the right time to move forward for the development of this sector by all involved stakeholders; viz, investor, financier, government, the local public, potential parties; e.g. This combined effort gives momentum for further developing the hydropower sector.

5.3 Recommendations:

The major recommendations are as follows:

- Being a low income country with a low electrification ratio limited financial resources in the public sector. Nepal needs to attract more domestic and foreign investment in hydropower development to meet demand.
- Concerned Authority should provide easy facilitation from national parks and wild life conservation department for the proposed project in the Buffer Zone and protected areas.
- Government and NEA should also be invested in the transmission line and attention should be given to Power Purchase Agreement (PPA). In the absence of PPA, only issuing license cannot produce electricity and also PPA procedure should be simplified.
- The benefit from the project should be distributed among the local people. So that they may be compensated and feel the project are their own property.
- Preference should be given to mobilize domestic financial resources by encouraging private sector investment in hydropower projects. Government should provide loan at confessional rate to encourage local people for the promotion of small and micro hydro projects.
- Hydropower development must be declared as first priority of Nepal. There should be forming of powerful high commission to determine and define the core and priority

agenda of the nation for its development and also should be eliminated the existing problems.

- To optimize hydropower development it is vital to pursue a basin-wise development policy. So that, the project infrastructures such as road and transmission line are shared by all projects within the basin. Such policy is absent in Nepal project development is undertaken hazard and isolated modes makes them expensive.

- It is complained that it is clumsy and time consuming to get the license for generation of electricity. It is also complicated and time consuming to make the IEE and EIA process. Therefore, it is necessary to reduce EIA and IEE approval procedure. There are many rules, laws and regulation which must be changed relaxed and simplicity so as to accelerate the development of this sector. The government policies must be consistent and should not be changed frequently.

- NEA should be given more authority and autonomy to work more efficiently. NEA should strength its financial condition and reduces electricity loss, which is 25 percent with efficient distribution system.

- There is need for national consensus among major political parties on the issues of water resources utilization. A clear national policy on hydropower.

- The existing legal as well as institutional problem hindering Foreign Direct Investment (FDI) in hydro power 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.

- The multi-purpose hydropower project should be developed to promote heavy industries, small and cottage industries and irrigation facilities of the nation in order to increase the employment level of country.

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

- Hydropower research and development should be given top priority.

- Government should promote the use of electric vehicles which have been recently introduced in Nepal by waiving customs duties on the imports of petrol and control environmental pollution.

- 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.

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ANNEX

Annex: 1

Target of Power Generation in Tenth Plan

S.N.	Name of the project	Capacity (MW)	Sector
1	Middle Marsyangdi	70	Public
2	Chameliya	30	Public
3	Heldung	0.5	Public
4	Gamgad	0.4	Public
	Total	**100.9**	
1	Chilime	20	Public+Private
	Total	**20**	
1	Upper Modi	14	Private
2	Indrawati III	7.5	Private
3	Mailing	5	Private
4	Piluwa	3	Private
5	Langtang	10	Private
6	Darm	5	Private
7	Khudi	3.5	Private
8	Sunkoshi Sano	2.6	Private
9	Chaku	1.5	Private
10	Baramchi	1	Private
11	Feme	1	Private
12	Kabeli 'A'	30	Private
13	Rahughat	27	Private
14	Lower Modi	20	Private
15	Modi I	20	Private
16	Dordi	8.5	Private
17	Hewa	5	Private
18	Manahari	5	Private
19	Lower Indrawati	4.5	Private
20	Trishuli	4	Private
21	Belkhu	2.6	Private
22	Bijaypur I	2.5	Private
23	Thupal	1.9	Private
24	Ridi	1.8	Private
25	Rigid	1.5	Private
26	Kahule	1.5	Private
27	Sirsegad	1	Private
28	Junrimba	1	Private
29	Lower Piluwa	1	Private
30	Golmagad	o.4	Private
31	Khoranga	0.2	Private
32	Tatopani	0.2	Private
	Total	**193.7**	
	Grand Total	**314.6**	

Sources: Tenth Plan, NPC, GON.

Annex: 2

Load Forecast

Fiscal year	Energy (GWh)	System peak load(MW)
2013-14	5,859.90	1,271.70
2014-15	6,403.80	1,387.20
2015-16	6,984.10	1,510.00
2016-17	7,603.70	1,640.80
2017-18	8,218.80	1,770.20
2018-19	8,870.20	1,906.90
2019-20	9,562.90	2,052.00
2020-21	10,300.10	2,206.00
2021-22	11,053.60	2,363.00
2022-23	11,929.10	2,545.40
2023-24	12,870.20	2,741.10
2024-25	13,882.40	2,951.10
2025-26	14,971.20	3,176.70
2026-27	16,142.70	3,418.90
2027-28	17,403.60	3,679.10

Sources: NEA, 2013.

EXISTING

Major Hydropower station

S.N.	Power Plants	Capacity (in KW)
1	Kaligandaki A	144,000
2	Middle Marsyangdi	70,000
3	Marsyangdi	69,000
4	Trishuli	24,000
5	Sunkoshi	10,050
6	Gandak	15,000
7	Kulekhani I	60,000
8	Devighat	14,100
9	Kulekahni II	32,000
10	Puwa Khola	6,200
11	Modi Khola	14,800
	Sub Total	459,150

Sources: NEA, 2013.

ANNEX: 3

Power Project

Small Hydropower Station

S.N.	Power Plants	Capacity (in KW)
1	Sundarijal	640
2	Panauti	2,400
3	Fewa	1,000
4	Seti (Pokhara)	1,500
5	Tatopani	2,000
6	Chatara	3,200
7	Tinau	1,024
8	Pharping***	500
9	Jomsom**	240
10	Baglung***	200
11	Khandbari**	250
12	Phidim**	240
13	Surnaiyagad	200
14	Doti***	200
15	Ramechhap	150
16	Terahthum**	100
17	gamgad	400
	Sub Total	473,394

Small Hydropower Plants (Isolated)

S.N.	Power Plants	Capacity (in KW)
1	Dhankuta***	240
2	Jhurpa (Shurkhet)***	345
3	Gorkhe (Ilam)***	64
4	Jumla**	200
5	Dhading***	32
6	Syngja***	80
7	Helambu	50
8	Darchula**	3000
9	Chame**	45
10	Taplejung**	125
11	Manang**	80
12	Chaurjhari(Rukum)**	150
13	Syaprudha (Rukum)**	200
14	Bhojpur**	250
15	Bajura**	200
16	Bajhang**	200

17	Arughat (Gorkha)	150
18	Okhaldhunga	125
19	Rupalghad (Dadeldhura)	100
20	Accham	400
21	Dolpa	200
22	Kalokot	500
23	Heldung (Humla)	500
	Sub Total	4,536

Sources: NEA, 2013.

Note:

** Leased to Private Sector

***Not in Normal Operation

ANNEX: 4

Under Construction

S.N.	Power Plants	Capacity (in KW)
1	Upper Tamakoshi Hydropower Project	456,000
2	Tanahu Hydropower Project	140,000
3	Chameliya HEP	30,000
4	Kulekhani III	14,000
5	Upper Trishuli 3 'A' HEP	60,000
6	Rahughat HEP	32,000
	Total	732,000

Sources: NEA, 2013.

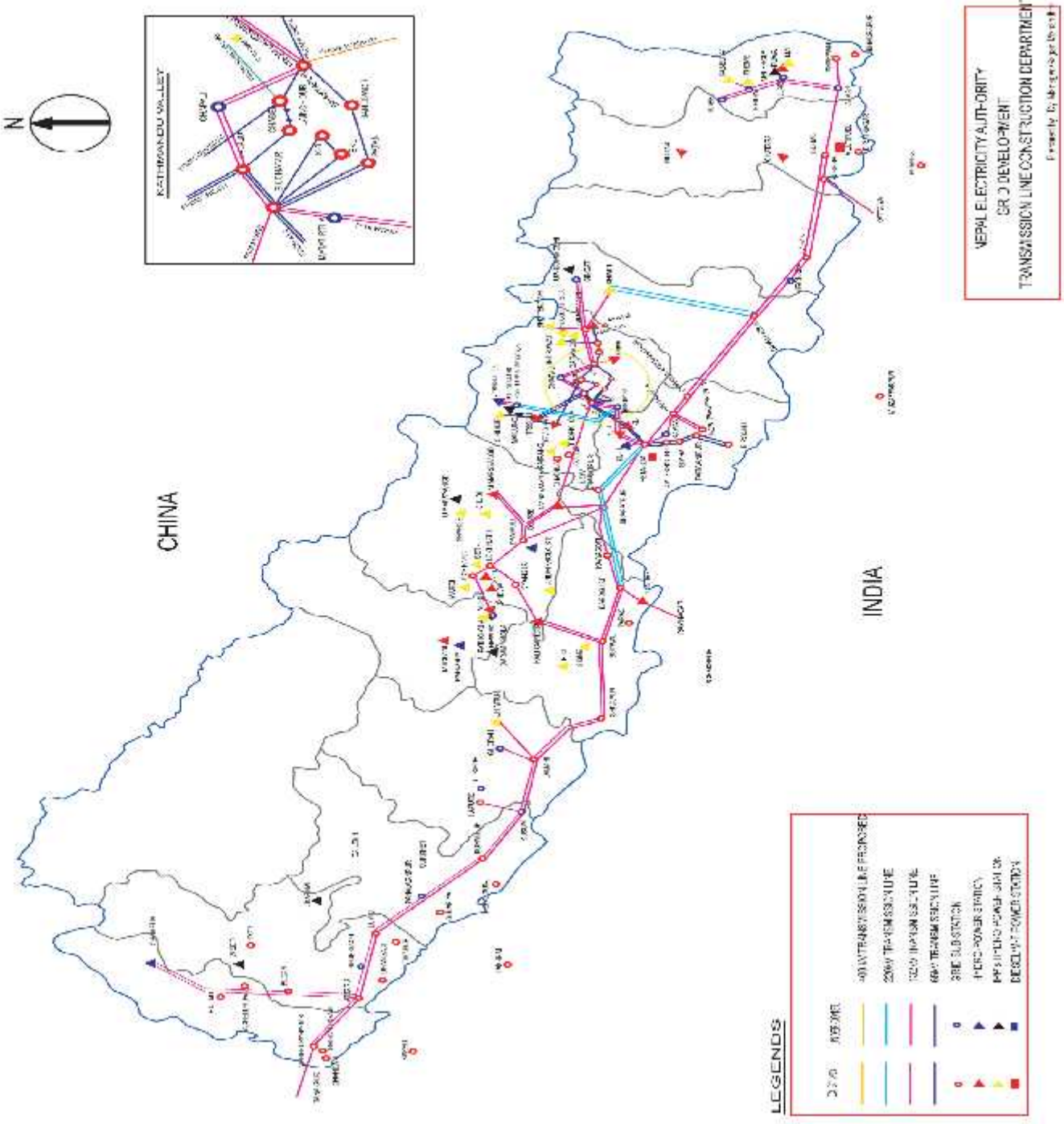
Power Development in Nepal under Private IPP Projects Connected to INPS

S.N.	Power Plants	Capacity (in KW)
1	Upper Trishuli 3'B'	40,000
2	Upper Arun HEP	335,000
3	Upper Modi 'A' HEP	47,000
4	Dudh Koshi Storage HEP	640,000
5	Tamor Storage HEP	530,000
6	Uttar Ganga Storage HEP	300,000
	Total	1,892,000

Sources: NEA, 2013.

ANNEX: 5

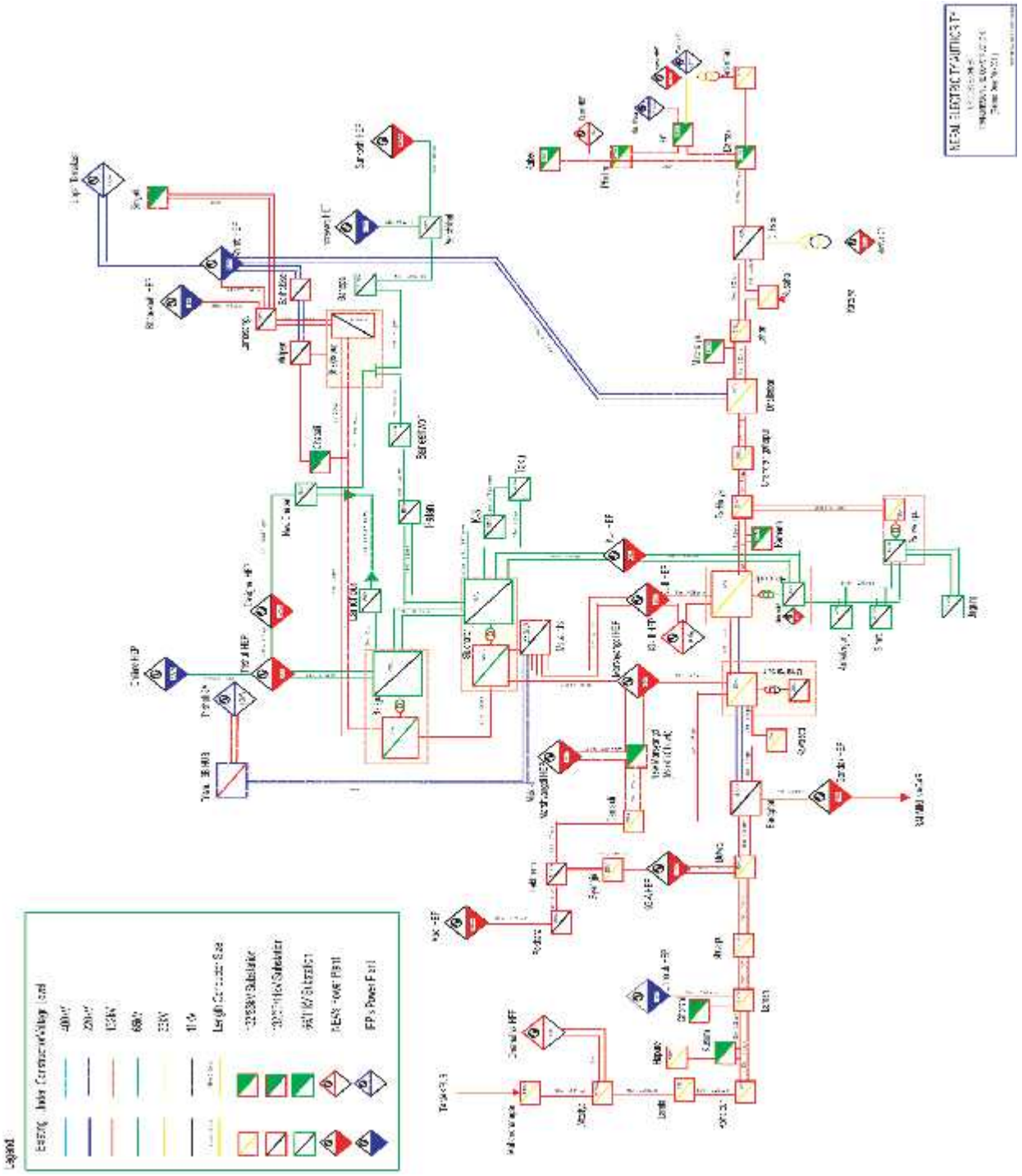
POWER DEVELOPMENT MAP OF NEPAL



Sources: NEA, 2012.

ANNEX: 6

INTEGRATED NEPAL POWER SYSTEM



Sources: NEA, 2012.