CONTRIBUTION OF HYDRO ELECTRICITY TO THE ECONOMIC DEVELOPMENT OF NEPAL

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LETTER OF RECOMMENDATION

This thesis entitled "Contribution of Hydro Electricity to the Economic Development of Nepal" has been prepared by Keshab Prasad Rimal under my supervision. I hereby recommend this thesis for examination by the thesis committee as a partial fulfillment of the requirement for the Degree of Masters of Arts in Economics.

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LETTER OF APPROVAL

We certify that the thesis entitled "Contribution of Hydro Electricity to the Economic Development of Nepal" submitted by Mr. Keshab Prasad Rimal to the Central Department of Economics, Faculty of Humanities and Social Sciences, Tribhuvan University, Kirtipur 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 dissertation as a part of the said thesis.

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Keshab Prasad Rim**al**

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ABSTRACT

Hydroelectricity is white-Gold of Nepal to sustain its economy. Nepal has over 6,300 rivers and rivulets and thousands of hills and valleys. The perennial nature of Nepali rivers and the steep gradient of the country's topography provide ideal conditions for the development of some of the world's largest hydroelectric projects. It has been estimated potentiality of 83 000 MW of which 42000 MW is economically Feasible. If we could block the water in these valleys, we can conserve the rainwater and it can be a huge assets. Hydropower could be the engine of growth for Nepal as it would offer opportunity to create employment, alleviate poverty and provide basic services including good governance. The development of this sector can be a potent contributor for transforming villages, cities and societies in Nepal into prosperous and inclusive economic zones.

The research method is descriptive depending on collected and informative data from secondary source. The analysis and presented data allocation evokes the motto of this research on the Topic of "Contribution of Hydro-Electricity to the Economic Development of Nepal"

The main objective of this study is to analyze the Contribution of Hydropower to the Economic Development of Nepal and how it contributes in Nepal's economy. Specifically current generation, transmission distribution and usage of electricity in Nepal have been taken on account. Requirement of energy in India also has been checked out. On another aspect the contribution of electricity on national economy of Nepal also has been analyzed. Analytical and descriptive approach has been adopted for the purpose of this research. Analytical approach has been utilized to analyze the relationship between energy availability and gross domestic product. Descriptive approach has been used mainly for conceptualization of the research objectives and research problem of the study.

The collected data have been edited, classified and tabulated in appropriate form. Processing of data has been done by the programme like Microsoft excel. Co-relation analysis between variables has been carried out to analyze the data and as statistical tool F-test has been carried out to test significance of relationship.

The domestic use of hydroelectricity is more beneficial as it ultimately assists to increase GDP. As it is concern to export is not suggestible until cheaper electricity generation technology comes to practice. On the another hand the study shows as

much as 5% of total Indian energy demand may be fulfilled even if Nepal produced all her economically feasible generation capacity. And, Nepal is currently using almost all imported technology to generate electricity. In this case the study shows the necessity of monetary benefit than economic one.

From the study, it is found that infrastructural and institute barriers for power trade between India and Nepal are gradually clearing out. A significant progress has been attained since it has been initiated in the history. On the same provision some Indian organizations and other agencies either domestic or international are constructing hydropower plants in Nepal, in the context of private public partnership.

Ii is concluded that primarily domestic use of energy is beneficial for Nepal to increase her GDP rate which is more crucial points to develop to the country. Nepal can export very little units of energy in compare to Indian demand. There is almost no legal barrier to export energy compare with Indian Demand. However, some technological barrier such as capacity of transmission lines exists.

ACRONYMS/ABREVIATION

ADB	Asian Development Bank
BIMSTEC	Bay of Bengal Initiative for Multi-Sectored Technical and Economic Cooperation
CBIP	Central Board of Irrigation and Power
CBS	Central Bureau of Statistics
CII	Confederation of Indian Industry
CNI	Confederation of Nepalese Industries
CRs.	Company Rupees.
ft.	Feet
GJ	Giga Joule
GW	Giga Watts
HMG	His Majesty's Government, Nepal
HPP	Hydropower Plant
I.C.	Indian Currency
INPS	Interconnected Power System of Nepal
IPPAN	Independent Power Producers' Association Nepal
IPPs	Independent Power Producers
IPPS	independent power producers System
KOE	Kilo Oil Equivalent
KW	Kilo Watts
KWh	Kilowatt Hour
lb.	Pounds
LPG	Liquid Petroleum Gas
MW	Mega Watts
NA	Not Available
NEA	Nepal Electricity Authority
NEA	Nepal Electricity Authority
NEC	Nepal Electricity Corporation
NOC	Nepal Oil Corporation
NORAD	Norwegian Agency for Development Cooperation

NPC	National Planning Commission
NRs.	Nepalese Rupees
PDF	Power Development Fund
PPA	Power Purchase Agreement
PPAS	Power purchase agreements
PTC	Power Trade Corporation
PTC	Power Trade Corporation
R&D	Research and Development
RoR	Run-of-River
sq.	Square
UNDP	United Nations Development Program
US$	United States Dollar
V.	Volts
WB	World Bank
WECs	Water and Energy Commission

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

1.1 General Background

Nepal is a small and landlocked country in South Asia. It is bordered by the People's Republic of China to the north and by India to the south, east and west. The Himalaya mountain range runs across Nepal's northern and western parts, and eight of the world's ten highest mountains, including the highest, Mount Everest, lie within its borders. Until 2006, Nepal was a kingdom. On December 28, 2007, the Interim Parliament passed a bill and declared Nepal to be a Federal Democratic Republic. It is a mountainous country consisting of 17%. Terai, 68% Hill and 15% Himalaya out of total area 1, 47,181 sq km. Agriculture is the main stay of Nepalese economy. Water is an important natural resource of Nepal which represents a source of potential wealth. Commercially exploitable hydropower generating potential is estimated to be about 44,000 MW from 66 hydropower project sites. Except for some lignite deposits, Nepal has no known oil, gas or coal deposits. All commercial fossil fuels (mainly oil and coal) are either imported from India or from international markets routed through India. Fuel imports absorb over one-fourth of Nepal's foreign exchange Earnings. Despite the hydro potential, hydro electricity accounts for only 1 percent of total energy supplies. The bulk of Nepal's energy supplies come from traditional sources, mainly from fuel wood, agriculture waste and dung production by livestock. Fossil fuels, like petroleum and Coal, account for the remaining eight percent.Agriculture sector witnessed a dismal performance in spite of a top priority accorded to it in almost all the plans. The distinct topography of Nepal with its high hills and more than 6000 rivers and innumerable rivulets crossing the country provides vast opportunities for the development of hydropower. Nepal is estimated to have theoretical hydro power potential of 83000 MW of which 42000 MW is economically feasible (Warnock, 1989).

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

In the history of last one hundred years of the country's electricity generation, an average electricity generation stands at a mere 6.44 Mega Watt per year, whereas according to traditional estimation of Nepal Electricity Authority (NEA), demand for consumption has been increasing by10-12 percent every year, according to the experts. Nepal has 600 MW of installed capacity in its Integrated Nepal Power System (INPS). The power system is dominated by the hydropower which contributes about 90 % of the system and the balance is met by multi fuel plant.

The hydropower developments in Nepal begin with the development of 500 KW Pharping power plants in 1911. The most recent significant power plant commissioned is the 144-MW Kali Gandaki "A" Hydroelectric Plant. Until 1990, hydropower development was under the domain of government utility, Nepal Electricity Authority (NEA) only. However, with the enactment of new Hydropower Development Policy 1992, the sector was opened to the private sector also. There are number of projects already built by the private developers. Private power producers contribute 148 MW of power to the 'Integrated Nepal Power System'.

In the world today, the highest producers of hydropower are China, Canada, Brazil, United States, Russia, Norway and India. Among the various countries, China ranks first in the production of hydropower with about 197 GW of installed capacity, as it has abundant water resources, and a geography that provides many opportunities to produce low-cost energy.

Though, Nepal has abundant water resources, it hasn't been harnessed properly .At the end of FY 2010/11, a total of 635.500 MW (which is only 0.76 percent compared to total capacity) hydropower was generated from various projects of the country (Economic survey, 2010).

Despite huge amount of benefits by exporting electricity Nepal had been able to very mean amount of it to do so in the past(2002) but now is importing about more than 135-140 MW from India. Since, the projections have expected not to exceed the demand by 11000 MW by 2030. The surplus may be exported to India by year 2018.

In the last 10 years from 2000 to 2010 only 127 km transmission line had been constructed that is insufficient in case all the hydro projects that are in pipeline completes on time. There are some 3,200 MW capacities PPA in pipeline, report by NEA, adding that the budget for the next fiscal year is going to address marketing of surplus electricity, apart from provisions of bulk sale of electricity.

Industrial sector is projected to consume 37.4 per cent, household 42.8 per cent, trading sector 7.7 per cent, and miscellaneous sector 12.1 per cent of electricity in current fiscal year, whereas, number of electricity consumers, in first six months of 2010-11, stood at 1.95 million an increase by 9.02 percent from last fiscal's 1.79 million. *(Source:THT)*

The World Bank (WB) has approved a $99 million package for the Nepal-India Electricity Transmission and Trade Project (NIETTP) to help Nepal mitigate the ongoing energy crisis.

The project will provide Nepal at least 100 MW of additional electricity to supplement its current electricity generation capacity of 698 MW and help minimize power outages. The country's peak electricity demand is 885 MW.

The project will see the establishment of a cross-border transmission having 1000 MW capacity, stated a WB press statement issued on 2014. The Bank's assistance package comprises a credit of $84 million and a grant of $15 million. The credit carries a 0.75% service charge, 10-year grace period and a maturity of 40 years.

Nepal had declared a 'national energy crisis' in December 2008 and approved an Electricity Crisis Management Action Plan that is currently under implementation with the WB support. The Action Plan includes development of the Dhalkebar-Muzaffarpur transmission link, a key component of NIETTP and the first major cross-border transmission line between India and Nepal.

In 2009, WB decided to provide a loan to Nepal for the construction of 400 KV Cross-Border Electricity Transmission lines, but the project has been stalled for the last three years due to financial constraint. Of the total cost for the 45 km transmission line project, Nepal has to bear Rs 2, 263 million for the construction of the line on its side and India should invest Rs 2, 352 million for the line on its side. The Indian

government, through soft loans, has provided Rs 13.2 million to Nepal for the construction of the line on the Nepali side.

In mid 2006, IL&FS, Power Trading Corporation of India and NEA had decided to construct the cross-border transmission line by the end of December 2011 by establishing a separate joint venture company.

In an effort to contain the increasing power shortage, the Nepal Electricity Authority (NEA) brought diesel plants based in Duhabi of Sunari and Hetauda into operation on 2013.NEA, however, said the government's financial support would determine how long it would continue to operate the expensive power generators. As generating power from diesel plants is more expensive than from hydropower projects, the financially weak NEA had long been resisting operation of the diesel plants.

The Duhabi-based plant generated 12MW electricity during its four-hour operation. NEA officials have said in the first phase (from December 11 to December 25 2013), the Hetauda plant will produce 10MW for eight hours a day and the Biratnagar plant will generate 15MW for six hours a day. And in the second phase (from December 26 to January 92013-14), the Hetauda plant will run 16 hours a day, while the Duhabi based plant run 10 hours a day. The Duhabi-based plant has 39MW capacity, while Hetauda plant's capacity is 14.4 MW.
Operation of the plants will cost "Rs 28 million" to NEA just for the above mentioned period, said an NEA source, adding the authority has asked the Energy Ministry to request the Ministry of Finance for the required budget."Once the government allocates the required funds, we will fix the operation schedule for the plants after January 9- 2014."

The plants were recently repaired under the financial assistance from the World Bank. The multi-fuel plant at Duhabi consists of six units each with 6.5MW capacity. The plant is expected to generate around 36MW electricity. The NEA source, however, said the plant has not been completely repaired, adding: "Necessary spare parts have recently been imported and they will be soon installed." .The NEA source said operation of the plants costs Rs 2.80 billion annually Rs 28-30 per unit of electricity.

Meanwhile, a team of NEA officials had left for India to negotiate for the import of additional 150MW electricity. The country has been importing 80MW power from the

southern neighbor currently. Under its Load Shedding Reduction Action Plan, the Energy Ministry had recommended measures, including operation of local diesel plants, import of additional energy from India and setting up another 80MW diesel plant. The government is planning on granting permission to Nepal Oil Corporation (NOC) to operate a separate liquefied petroleum gas (LPG) bottling plant.

Currently, there are 42 LPG bottling plants in operation across the country, according to the NOC. Similarly, nearly a dozen bottling plants have further acquired a license to operate bottling plants. Similarly, the ministry has also directed NOC to submit a separate report on expanding the capacity of its storage facilities.

The increase in storage capacity over the years in line with the growth in demand is quite satisfactory. The present storage capacity of 71,558 kiloliters (kl), however, is sufficient for only 15 days of national sales based on the projected sales for 2009.

The ministry also directed NOC to submit the progress report on the construction of the much-hyped pipeline project from Indian Oil Corporation's depot at Raxaul to Nepal Oil Corporation's depot at Amlekhgunj.

Electricity production from hydroelectric sources (% of total) in Nepal was last measured at 99.58 in 2009, according to the World Bank. Sources of electricity refer to the inputs used to generate electricity. Hydropower refers to electricity produced by hydroelectric power plants. This page has the latest values, historical data, forecasts, charts, statistics, an economic calendar and news for Electricity production from hydroelectric sources (% of total) in Nepal.

NEA report (2012) Indicated that the Power shortage of Nepal is one of a major problem. 20hrs of load shedding was recorded in Nepal. It's been almost a decade that the country is suffering a heavy power shortage problem. The rate of growth of electricity is near to 10% as by the NEA report. Total installed capacity of electric power in Nepal is around 748 MW as of 2013. But maximum demand is about 1026.6 MW. There is a total gap of more than300MW in general. Major crisis is in the spring and winter seasons where production of Hydropower plant even fall to the more minimum level up to500MW because most of plant are run off river type. Still it shows of 50% percent of power is shortage in the maximum peak demand in drought seasons.

Lets imagine that the whole project will be complete by year 2021 then data shows that in 2021 maximum demand will be rise of about 1000 MW, which again installed capacity will be less then demand capacity. So it is not easy to say that Nepal load-shedding problem will be completely end by the 2021 but I am pretty sure that if mega project will not come to exist and new more project will not be added then load shedding will remains as it is for one more decade.

The Power shortage of Nepal is one of a major problem. Twenty Hours of load shedding was recorded in Nepal. It's been almost a decade that the country is suffering a heavy power shortage problem. The rate of growth of electricity is near to 10% as by the NEA report in july2012.Total installed capacity of electric power in Nepal is around 748 MW as of 2013. But maximum demand is about 1026.6 MW (2012 NEA report). There is a total gap of more than 300MW in general. Major crisis is in the spring and winter seasons where production of Hydropower plant even fall to the more minimum level upto500MW because most of plant are run off river type. Still it shows of 50% percent of power is shortage in the maximum peak demand in drought seasons. Lets imagine that the whole project will be complete by year 2021 then data shows that in 2021 maximum demand will be rise of about 1000 MW, which again installed capacity will be less then demand capacity. So it is not easy to say that Nepal load-shedding problem will be completely end by the 2021 but I am pretty sure that if mega project will not come to exist and new more project will not be added then load shedding will remains as it is for one more decade. The Nepal Electricity Authority (NEA**)** signed power purchase agreements (PPAs) for a combined 361.55-MW electricity with 16 independent power producers (IPPs) in the first nine months of the current fiscal year.

These two extracted paragraph shows the bright future of energy sector, like in India, provided it is handled in an organized manner. The state-owned power utility had signed PPAs for 261-MW electricity with 11 IPPs during the same period last year.

Of the 16 projects that signed the agreement this year, 13 are below 25-MW capacity. Rashugadhi Hydro Power Project (RHPP) is the largest with 111-MW capacity, followed by Middle Bhotekoshi (102 MW). Chilime Hydropower Company Limited (CHCL) has signed the agreement for a combined 255.5 MW for Middle Bhotekoshi, Rashuwagadhi and Sanjen projects.

The authority is also preparing to sign PPAs for another 57 MW electricity 30 MW Khani Khola Hydro Project and 27-MW Dorji Khola Hydro Project. In June 2011, NEA had increased the PPA rate by 20 percent for projects having less than 25-MW capacity. As per the new rate, hydropower developers will get Rs 8.40 per unit during summer and Rs 4.80 per unit during rainy season. Earlier, the rate was Rs 7 per unit during summer and Rs 4 per unit during rainy season.

Thus the Recent Operational Performance of NEA (Annual Report 2014) Shows that the annual peak power demand of the Integrated Nepal Power System (INPS) in fiscal year 2013/14 is estimated to be 1,201 MW, with 410 MW power estimated to have been shed. Out of the 791 MW of power actually supplied, 436.4 MW was contributed by NEA hydro, 22 MW by NEA thermal, 216.4 MW by IPP hydro and the rest 116.2 MW was import. Compared to the preceding fiscal year's figure of 1,094.6 MW, the annual peak power demand of the INPS registered a growth rate of 9.7 %.

Energy demand of INPS in fiscal year 2013/14 is estimated at 5,909.96 GWh, out of which only 4,631.51 GWh (78.4%) could be supplied. The rest 1,278.45 GWh (21.6%) was resorted to load shedding. Of the total supplied energy volume, 3,559.28 GWh (76.8%) was contributed by domestic generation and 1,072.23 GWh (23.2%) by import from India. Domestic supply included 1,258.94 GWh (35.4%) from IPPs and the rest 2,300.34 GWh (64.6%) was from NEA owned power stations with a share of 2,290.78 GWh from hydro and 9.56 GWh from thermal.

In fiscal year 2013/14, we succeeded in restricting the load shedding hours to a maximum 12 hours per day. This was possible due to sound operation of the power system, to ensure filling up of the Kulekhani reservoir at the onset of the dry season, and also comparatively a wet monsoon. Record generation from Kali Gandaki 'A' and Middle Marsyangdi hydropower plants since their commissioning and highest generation from Marsyangdi hydropower plant in the last 15 years also played a role.

Total energy sales including sales to India was 3,447.58 GWh in fiscal year 2013/14. This is a growth by 9.1 % in the sales figure of fiscal year 2012/13. Sales to India however declined to 3.32 GWh from 3.6 GWh in fiscal year 2012/13. Decrease in NEA's system loss in fiscal year 2013/14 is also encouraging. NEA's system loss

decreased by 0.32 percentage point from the audited loss figure of 25.11% in fiscal year 2012/13 to 24.79 % (provisional) in fiscal year 2013/14. This, we believe, is the result of our continued efforts and measures taken on curbing electricity theft. We are committed in continuing to intensify our efforts to bring down the system loss to an acceptable level. For this, support from the political parties, civil society and the general public will also be solicited.

The total number of consumers including community and bulk buyer (India) consumer categories at the end of fiscal year 2013/14 reached 2.71 million. Out of the total number of consumers of 2.71 million, the domestic consumer category alone accounted for 2.56 million (94.37%).The other good news is that the Upper Tamakoshi is going to join in to the main streams till 2073 March (Source: Kantipur News).Thus the possibilities of Hydropower shows the bright future of Nepal in the power sector. These are major projects:-

Table No. 1.1: **Major Hydro Projects in Nepal**

Sy.Nr.	Name of the Projects	Installed capacity	Project Started time	Project ending time
1	Upper Tamakoshi Project	456 MW	May 18 2011	5 years (upto 2015 Extended)
2	Kulekhani III Hydro Project	14 MW	April27, 2008	2014
3	Chameliya Hydro Electric Project	30 MW	2007	2013 (Extend to March 2015)
4	Rahughat Hydro Electric Project	32MW	2010/11	2016
5	Upper Trishuli3A Hydro Electric Project	60MW	1st Jun 2011	35 Months (Not completed)
6	West Seti Hydro project	750 MW	-	-
	Total Under Construction	1342 MW		

Source: NEA Report 2013.

1.2 Statement of the Problem

Nepal's domestic electricity supply system is small. Current, total installed electric power generating capacity is dominated by hydropower, which constitutes 88 percent of installed capacity. The balance is composed of thermal installations using multi

fuels and diesel plants. Hydropower facilities are mostly run-of-river and account for 71 percent of total installed capacity. Despite high level of susceptibility of run-of-river to high rates of spillage they (albeit with sufficient poundage to be used for daily peaking) represent the least-cost development plan of the Nepal Electricity Authority (NEA) system. NEA hydro generation capacity is about 407 MW. Currently, only one the 92 MW Kulekhani has seasonal storage capacity.

The story of power position in Nepal is that of highest potential and lowest consumption. The main load centre is the central zone, which includes the Kathmandu Valley. The main transmission line is 132 kilovolts (kV) and runs for approximately 1200 kilometres parallel to the Indian border from east of Nepal (Anarmani)to west of Nepal (Mahendranagar) major sub-stations are located in Hetauda, Syuchatar and Balaju.

During 1990s Nepal introduced far reaching policy changes in opening up the power sector to domestic and foreign private sectors and to boost export of power. Nepal enactment of Hydropower Development Policy 1992, Electricity Act, 1992 and Electricity Regulations, 1993 which marked the noticeable entry of Independent Power Producers (IPPs) in Nepal's Power Sector through non-recourse financing. Further, the NEA act was amended in 1992 to "enable the NEA to function autonomously". Since then NEAs status has been replaced from that of a sole monopoly player to that of a licensee with the responsibility of buying the privately generated power, hence promoting Independent Power Producers.

It is really ironic that a large majority of Nepalese people are bound to live in darkness although the country is endowed with immense hydropower resources. The issue of exporting hydroelectricity has always been in top priority of leaders to enhance income per capita like Bhutan. Nepalese economically exploitable hydropower potential of 43,000 MW remains virtually unexplored. A large proportion of people still use traditional type of energy. Among various sources of energy, hydroelectric energy is cheaper and perennial because most of the Nepalese rivers flow from the high Himalayas and with high current flow. Only a small portion of total population, mostly in urban areas, has access to electricity, while a vast majority of rural people are deprived of access to electricity. This shows the urgency of exploiting hydropower potentiality not only for enabling people to use hydropower

for meeting energy needs, but also for increasing power supply to industrial use. Effective development as hydropower is hindered by the lack of development finance, scarcity of local expertise and presence of difficult geology and inaccessible terrain at site where projects are located.

In the other hand electrical energy once produced can't be easily stored in huge quantity. Some expensive storage systems may require for the purpose. The system is called "Grid energy storage". Which let store electrical energy in other types of energy like static energy in reservoir, chemical energy in batteries or kinetic energy in flywheels etc.

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

The Geography of Nepal is very critical. Due to the unusual landmarks and geographical coverage with plane, mountainous and hilly region. Sustainable development is a bigger challenge technically and theoretically. But ,Nature gives us the tremendous support for the hydropower .

The Power shortage of Nepal is one of a major problem. 20hrs of load shedding was recorded in Nepal. It's been almost a decade that the country is suffering a heavy power shortage problem. The rate of growth of electricity is near to 10% as by the NEA report in July 2012 .Total installed capacity of electric power in Nepal is around 748 MW as of 2013. But maximum demand is about 1026.6 MW (2012 NEA report). There is a total gap of more than 300MW in general. Major crisis is in the spring and winter seasons where production of Hydropower plant even fall to the more minimum level up to 500MW because most of plant are run off river type. Still it shows of 50% percent of power is shortage in the maximum peak demand in drought seasons.

How we can decrease this much of gap? Well big Hydropower is a time consuming project and it will take more than 4yrs for the completion, in the case of Nepal. Lets imagine that the whole project will be complete by year 2021 then data shows that in 2021 maximum demand will be rise of about 1000 MW, which again

installed capacity will be less then demand capacity. So it is not easy to say that Nepal load-shedding problem will be completely end by the 2021, but I am pretty sure that if mega project will not come to exist and new more project will not be added then load shedding will remains as it is for one more decade.

During excess production and renders the same energy when the demand exceeds the production? Lack of this system wasting a lot of energy. A number of problems on research which is insufficient to give the information about the development of hydropower and its way to promote. Thus following points are right be relevant problems of research:

i. What is the Trend and development of Hydro-electricity in Nepal?
ii. What is the role of hydroelectricity to the development of economy?
iii. Is there any potentiality of Hydroelectricity in Nepal?

1.3 Objectives of the Study

This study has investigated the problems and trend of Hydroelectricity in Nepal besides its current status which will benefit future researchers. This may also be helpful to the planners and policy makers and investors directly or indirectly associated with hydroelectric energy sector in Nepal may be expected to benefit. This study also assessed the hydropower policies of government on Nepal. The finding of the study may be the one step to go upstairs to the management of Hydro development of Nepal.General objective of the study is to evaluate the socio-economic impact of hydropower development and its contribution to the nation. Besides this, the study has following major objectives:

i. To analyze the trends and development of Hydro-electricity in Nepal.
ii. To analyze the contribution of hydropower to the economic development of Nepal.
iii. To analyze potentiality of hydroelectricity of Nepal.

1.4 Significance of the Study

The electricity of Nepal is called the (White Gold), Nepal can easily grow in the way of wealthiest as some of the oil and mineral rich countries of the Middle East and Africa. In the present global scenario where the oil price is remaining higher and future provides an uncertainty outlook with respect to oil, optimum utilization of the

abundant endowment, Hydropower would reduce Nepal's import cost substantially contribute in the improving the relative competitiveness of the economy both on a regional and global basis and fulfill the desire of double digit sustainable growth in the coming decades.

In this context, this study has investigated the problems and potentials of Hydropower in Nepal besides its current status which will benefit future researchers. This may also be helpful to the planners and policy makers and investors directly or indirectly associated with hydroelectric energy sector in Nepal may be expected to benefit. This study also assessed the hydropower policies of government on Nepal. The finding of the study may be the one step to go upstairs to the management of Hydro development of Nepal.

1.5 Limitations of the Study

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

1.6 Organization of the Study

This study entitled "Contribution of Hydro-Electricity to the Economic Development of Nepal "has been organized in five chapters.

The First chapter is consisting of introduction about Hydropower and Major issues to investigate along with the objective significance, limitation and organization of the study have been presented in this chapter.

The second chapter consists of review of many researches and conceptual framework about meaning, history, development and progress in Nepal. Empirical studies so far undertaken in this area have also been reviewed in order to explore the research gap.

The third chapter is specially included about Research Methodology to analysis historical development of hydroelectricity before plan period and during various plan periods.

This fourth chapter consists of allocation of various data of different plan period depending on statistic. The chapter is originally analytical and main body of this research and this part presents the Trend, contribution and potentiality of hydropower in different plans and its contribution in national economy. The description consists of status of energy import and export scenarios, ideas of expertise and legal provisions. In this chapter the contribution of energy in national economy has been analyzed using variables and statistic tools and forecast for its possibilities.

The fifth chapter evokes Summary, Conclusion and Recommendations of whole body of the research. Major findings summary, conclusion with self views and recommendations have been presented in this chapter.

CHAPTER II

LITERATURE REVIEW

2.1 General Introduction

There are many researches, Surveys, Articles and books on Hydropower development, its problem, possibilities and prospects in Nepal. Similarly, there are various conclusions of different researchers on trend and role of Hydroelectricity in economic growth and development. In order to find out what articles have been written or researched, available literature in the area of hydropower development in Nepal is reviewed. The review includes major books, articles and reports on the subject of hydropower development plan in Nepal, Indian consumption trend especially in northern region of India for the purpose of forecasting their demand, Legal provision of both countries on the subject of import/export of electricity and infrastructures developed and under development to facilitate import/export activities including its potentiality and possibilities.

For exporting electricity there are some constrains which don't exist in other goods this is because of unlike other products electricity can't be stored in warehouses can't be transported in vehicles etc. still there are some similarities like other goods for instant to export there must be availability and demand of goods, The cost must be competitive in international market and the legal provision must be favourable.

2.2 Review of International Studies

Ministry of Power of India (2011-12) has forecasted the long term demand of electrical energy requirement in India as for the year 2016-2017 and 2021-2022 1392 TWH and 1914 TWH (Tera Watt Hours) respectively. To meet above energy demand, the corresponding generating installed capacity should be about 300 GW and 410 GW (Giga Watts) respectively. Leaving other region aside only Northern Region of India has been forecasted a requirement of peak load of 66583 MW and 89913 MW respectively for these years. This report also insisted that annual growth of electricity peak load demand in India is about 10%.

Ministry of Power of India (2007) has projected to require installed capacity by year 2031-32 is 962 GW and 1207 GW for economic growth rate of 8% and 9% respectively. New Hydro policy of India 2008 has stated the total hydroelectricity potentiality of India is 150000 MW, and its plan to utilize all potentiality by year 2030 making share of 12.4% to 16.67% to total required installed capacity.

Central Electric Authority India (2011) shows overall shortage of electricity over all five regions. However the acuteness of this shortage is deferent by both energy and peak load. In northern region energy deficit is 30436 million units (MU) 10.9% of total energy demand and peak load deficit is 4860 MW 11.9% of peak load demand. In western region energy deficit is 31520 MU 11% of total energy demand and peak load deficit is 4641 MW 10.9% of peak load demand. In southern region energy deficit is 26210 MU 10.5% of total energy demand and peak load deficit is 5388 MW 14.5% of peak load demand. In eastern region energy deficit is 8167 MU 7.7% of total energy demand and peak load deficit is 1986 MW 11.6% of peak load demand. In north-eastern region energy deficit is 34 MU 0.3% of total energy demand and peak load deficit is 130 MW 5.9% of peak load demand. Which make all India energy deficit of 96367 MU 10.3% of all India energy demand and peak load deficit of 17517 MW 12.9% of all India peak load demand.

Nepal India Cooperation on Hydropower (NICOH) 2006 prepared by Independent Power Producers' Association Nepal (IPPAN) and Confederation of Indian Industry (CII) has pointed out 12 existing points along Nepal-India border for power exchange. Most of these points' power exchange are at 33 kV voltage level and are used for import of power to Nepal from Bihar and Utter Pradesh grid on radial mode and 3 interconnections are at 132 kV level.

i. Gandak powerhouse (Nepal) to Ram Nagar (India): this line is used for power export from Nepal to India in Bihar.
ii. Duhabi (Nepal) to Kataiya (India): this line is used for power import to Nepal from Bihar grid, whenever Nepal needs more power in eastern region.
iii. Mahendra Nagar (Nepal) to Tanakpur (India): this line is constructed for Nepal's use of power under Tanakpur agreement.

All these lines are also on radial mode and isolated from Nepal's grid during operation. However among these three lines only Duhabi-Kataiya link is being use for power exchange. This fact is also confirmed by Dhungel and Pun, 2009, in the book The Nepal India Water Relationship Challenges.

India's Electricity Act (2003) has introduced significant changes in the Electricity Industry by moving from a single-buyer market to a multiple-buyer and multiple seller system. The Act provides all countries in South Asia with an example of the type of reforms necessary for establishing an open, competitive market for power trading. The Act provides a base whereby licensed power traders will utilize market forces to expand the opportunities for trading and exchanging power by harnessing hydropower and natural gas resources located in Nepal, Bangladesh and Bhutan.

However, India has engaged Power Trade Corporation (PTC) for power exchange from Nepal and Bhutan also. That's why any organization intended to export from Nepal need first to have power purchase agreement (PPA) with PTC. PTC can do PPA within the limit of bilateral agreement between two countries and Electricity Act of India.

The ten year taskforce report has indicated to need to develop high electricity consuming industries like chemical fertilizer, cement factories and electric vehicles like electric railways, trolley buses, cable cars etc.

It had also show the compulsion for imposing load shedding up to 2013 but even in wet season in case of dry season load shedding may still be imposed up to 2019 in case of low level of economic growth, 2016 in case of medium economic growth, and 2019 in case of high economic growth.

JICA (1974-75) stated on power sector "Master Plan", that the power market in India is large and growing at an annual rate of more that 10 percent, which may be mainly consumed by northern and eastern regional of India alone. As the report further state that Nepal has a lot possibility in hydropower, if this power can be produced in Nepal at a competitive cost compared to India, Nepal will have access to huge Indian market along the border areas. It cites the example of Bhutan which has become richer than Nepal by selling Hydro-electricity to India from "Chukha" hydro project.

Regional Energy Trade in South Asia (2008) Myanmar has unexploited hydro potential of about 39,000 MW and is developing about 10,000 MW of new capacity through joint ventures with Thai and Chinese businessmen and utilities mainly for export of power to Thailand. Indian and Myanmar governments have a history of cooperation is designing and building hydropower projects in Myanmar and are again collaborating in the design and formulation of Tamanti multipurpose project located near the Indian border, initially with a power component of 1,200 MW, essentially for export to India. This is likely to be developed as a joint venture between Myanmar and Indian power entities.

2.3 Review of National Studies

Ministry of energy (2010) has projected to produce 2057 MW by year 2014 of which 1867 MW will be for internal use and 170 MW will be for export purpose. By 2019 the same report has projected to produce 14480 MW of which 9960 MW will be for internal use and 4500 MW will be for export purpose. This report also suggested important reforms in national grid and need of technical development in general. Not only that but it also indicated the importance of export of produced electricity since there are not that much demand of electricity in Nepal.

Hydropower development policy (2001) has divided hydropower projects as "Internal use" and "Export oriented". For export oriented projects royalty will be levied as type of project Run of the River (ROR) or Storage. For ROR project Annual capacity royalty is Rs. 400 per KW of installed capacity and Energy Royalty is 7.5% of total revenue energy sold. This royalty will be levied after commencement of commercial production for the period of 15 years. After 15 years annual capacity royalty will be Rs. 1800 per KW and Energy royalty will be 12% of energy sold. For storage projects the royalty will be Rs. 500 per KW and 10% of energy sold for 15 year and Rs. 2000 per KW and 15% of energy sold after 15 years of commercial operation.

Sixth power exchange committee (Nepal-India 2001) meeting government of India had agreed in principle to increase the quantum of power exchange between the two countries from 50 MW to 150 MW. During recent visit of Prime Minister Dr.Baburam Bhattarai to India, India has agreed in principle to 200 MW.

Pun (2008) reflects the idea that even after exporting huge amount of electricity Paraguay couldn't be benefited she remains still one of the poorest country among south America. Bhutan after exporting electricity is increasing her per capita income only because she has small size population. Thus Nepal shouldn't be overjoyed even if she could be able to export electricity.

Thus Hydropower is both for and against of export. This is, however, not only case of Nepal. Even in Bangladesh, Regional Cooperation in Energy Sector (2002), they have feared that what to do after finish of their natural gas reserve? Though they have heavy natural gas reserve, they have fear of run out of it.

Nepal has 40,000 MW of hydropower potential. If Bangladesh could buy power from Nepal and perhaps Bangladesh can sell gas to India. In Bangladesh we have a fear that the country may run out of gas in the next 12-30 years if it is misused. And that's why issue of gas export became very important. Does Nepal have similar concerns about the future of its energy potential? If they sell to India or Bangladesh then what will b*e* rest for them? A study could be done to look into this particular area. This also indicated that energy cost is cheap in Bhutan. So necessarily Bhutan can sell it cheaper.

Bangladesh signed a 35-year power transmission agreement with India on 26 July 2010 aiming to import 250 megawatt electricity from the neighbour, starting from late 2012. However, the agreement keeps the provision for Bangladesh to export power to India in the future as the transmission system will have an increment in the capacity to exchange 500 MW of power soon after the system is launched. "The Hindu", "The Economic Times"

Adhikari (2013) expressed in his economic review on the subject "Hydropower Development in Nepal" about potentiality of Nepal is huge and the sustainable hydropower development. He expresses the key to make Nepal's economic growth scenario brighter, gaining deep inroads into the national goal and priority of poverty reduction. Hydropower has a number of benefits:

(a) It is a continuously renewable electrical energy source;

(b) It is non-polluting, i.e., no heat or noxious gases are released;

(c) It has no fuel cost and, with low operating and maintenance cost, is essentially inflation-proof;

(d) Hydropower technology is a proven technology that offers reliable and flexible operation,

(e) Hydropower stations have a long life and many existing stations have been in operation for more than half a century and are still operating efficiently;

(f) Hydropower station efficiencies of over 90 percent have been achieved making it the most efficient of the energy conversion technologies. Hydropower offers a means of responding within seconds to changes in load demand.

Fortunately, Nepal is rich in hydro-resources, with one of the highest per capita Hydropower potentials in the world. However, at present, the total hydropower generation has been 556.8 MW, merely 0.7 percent of the potential, with connection to 40 percent of the people. It is notable to mention that, by the end of the Tenth Plan (2002-07), 55 Percent of the population will have connection to the electricity. Use of environment friendly technologies and implementation of sound legal and institutional issues are critical to improve the reach of the population to the hydropower. Putting into place a favorable environment for increasing investments in cost-effective projects would definitely contribute to make this target a reality.The Acts and regulations should be made to support the environment as well as the hydropower development efforts so that the environment and development go together, especially when it comes to the most important natural resource development endeavors of the nation. The major strategies of the power sector have been appropriately identified as promoting private sector participation in power generation and distribution, unbundling the activities of the NEA as well as improving its financial viability, integrating rural electrification with rural economic development programs, and strengthening power infrastructure. In the present global scenario where the oil prices are remaining higher and future provides an uncertain outlook with respect to oil, optimal utilization of the abundant natural endowment, viz., hydropower, would reduce Nepal's import cost substantially, contribute in improving the relative competitiveness of the economy both on a regional and global basis, and fulfill the desire of double-digit sustainable growth in the coming decades.

And again Nepal's per capita electricity consumption is extremely low in compare to highest consumer that is Iceland. One needs to remember that most of the prosperous countries consume electricity above 10,000 kWh per capita (Iceland consumed 31,147.292 kWh per capita in 2006, the highest in the world) and for Nepalese consumers to use 10,000 kWh per capita the installed capacity necessary will have to be in the order of 61,000 MW, which is a lot more than even the economic potential of Nepal (43,000 MW). Given this, it is disingenuous to say that Nepal has excess capacity. Therefore, the policy and strategy adopted by the government based on the assumption that Nepal has excess hydropower potential, the only use of which is exporting it to a neighbouring country, is at the root of all the problems.Thus there are two types of conflicting ideas one to export for electricity and another exactly opposite.

Paudyal & Shrestha (2010)in their research express investing in expensive and with highly economical costing storage projects it is reasonable to make a deal with India about power exchange. Nepal and India's power systems and demands availability are complementary. In wet season, there is very high potential of hydropower generation in Nepal due to high flow in the rivers but demand is low. In dry season the potential of generation is low but demand is high. In India the situation is reverse. This gives us an opportunity to export power to India in wet season and import about equal energy (thermal generated) from India. For this no haggling of price is required. It is a brilliant strategy. For this Nepal should negotiate with India. There are environmental and social issues. The project will have short life of about 50 years due to reservoir filled up with sediments. Hence, only the most important storage projects should be undertaken. There should be appropriate mix of ROR, storage, and seasonal export/import from India.

Bista & Joshi (2011) have mentioned that energy is important for economic development. The pace of economic development cannot be accelerated without hydropower development. The development of productive sector of an economy depends on development of the energy sector in the hilly and mountainous area, almost all the households are found to have consumed traditional sources of energy for cooking, heating, Lighting and other necessary activities. Traditional energy Sources cannot be sustainable to fulfil energy requirement. The hydro Power project

has delivered about the changes in socio-economic, Cultural and other aspects of people living in the project located area.

Regmi (2012) analyzed the condition of Nepalese energy system on present condition. He concludes that there should be need of proper utilization of natural resources like water to achieve the goal of development. Increase the energy power is not only by the formation of new hydro Projects but also maintaining and optimizing the existing hydropower plants, cause become panacea to control the web of problem and has been grossly over looked for the reasons. Projects are Selected by planning procedure which is deliberated designed to produce a 'no option' situation in decision making It is too late to understand the government that sector is not capable to develop sufficient hydro energy projects to fulfil the demand . So public sector must play crucial role in the sector of hydropower.

Dhakal (2013) pointed on his topic "Climate Change Impacts on Reservoir based Hydropower Generation in Nepal**"** has mention in his research about potentiality and prospects of hydropower that as suggested by study, domestic use may be more beneficial than trying to vague export to neighbourhoods. However, there is almost none legal barrier exist. The export can't be denied but before that Nepal needs to be able to generate huge amount of energy and construct transmission lines as potential requirement of India which is for now and by means of hydroelectricity seems unattainable.

Adhikari (2014) expressed her words in her research on the topic of "Socio Economic Impact of Micro Hydropower Project, that there should be political consensus in the framework of hydropower development so that no further delay in development is caused by political disagreement. The legal and political environment should be compatible and consensus about political and economic reality. The result of all these endeavours should be reflected in the sustained, uninterrupted and adequate supply of power at competitive as well as favourable price to the consumer. In this world the electricity is life leaving part of human being. Which contribute to raise the standard of living for all Nepalese as a consequence of their participation in any one of combination of activities related to generation, transmission, distribution and productive use of power. Only this will make the hydropower sector the vehicle for socio-economic transformation on Nepal.

Malla (2008) pointed out energy purchased from Nepal will help India significantly reducing CO2 emission. Thus, in his view, for India importing electricity from Nepal is not only beneficial on the economic ground but also for environment.

WECS (2010) advised to use electricity for cooking as it is cheaper than Liquid Petroleum Gas (LPG). According to report the cost of household cooking stands RS. 794 LPG versus RS. 788 electricity. Thus it is rational to use electricity than subsidized LPG.

World Bank (2010) stated the power shortage may increase the poverty rate and decrease the economy. Whole economy depends on how much power is utilizes by that country. A shortage of power may increase in the cost of the product which directly affected to the consumer. This is main issue why the immediate attention is needed. The import of fossil fuel from India which growth rate is 11.61% (2010 World Bank). The Indo Nepal trade loss contain the 60% only in bio-fuel Assume if we increase the production in energy and the less dependency in fossil fuel and in India there is a Profit and profit. The Hydropower is a clean energy and unfriendly Nepal can make carbon trade and it will be next income source for Nepal government.

The various questions unanswered, misunderstood or undisclosed during past on the hydro energy has been tried to clarify. Training and human resource development is given due importance by the ministry of new and renewable energy. Towards this, apart from regular training programmes, a real time digital simulator (tds) for shp plants has been established at alternate hydro energy centre (ahec), it roorkee, and India with the aim of providing efficient initial and advanced training to operators and engineering staff of different types of shp plants. Training conditions have been created very close to real operating conditions. This will meet the large requirement of trained personnel for operation and maintenance of shp plants, reduce o&m costs, reduce damage to plant, increase plant life and reduce training time. The hydraulic part, the generator, the transformers as well as auxiliary electricity systems are taken care in the simulation. Present and future operators are taking the benefits of such training and are being utilized by national and international personnel.

The Above discussed literatures are related to various aspects of hydropower development in Nepal. The entire researcher is relating to give right and fact information, fact relevant to present study. They are the well guide liner to me and invaluable director for the researcher to make this study more analytical and effective.

CHAPTERIII

RESEARCH METHODOLOGY

3.1 Research Design

The research method is descriptive. This is just a macro study. On macro study all data are taken from secondary source. Micro study is ignored on this research. The methodology is briefly described as bellow.

The objectives of this research are to find out Trends and potentiality of Hydro-Electricity Development in Nepal. To find out benefit from electricity in Nepal, consumption and production pattern of electricity and its trends of development will be analyzed based on different plan Period. Using Tables and graphs as it need.

The Role of Hydroelectricity to the Development of Economy is another finding of this research. The electricity of Nepal is white gold. From the development and production of Electricity in a huge amount, Nepal can get more benefit to develop GDP and its economy. This is analyzed depending on its development trends and GDP growth.

Economical potentiality, Trends of export and import of electricity the cost of it and expected price in neighbour countries market has checked out seeing on its trends and collected information.

Data and information to meet the objectives of this study were collected from secondary sources. These included documents, newspapers, economic journals, magazines, books, unpublished dissertations, government publications, and Views of authorised Person etc.

3.2 Data and Information

This study is absolutely based on secondary data. Which is collected from various governmental and non-Governmental organizations. Most of the data and information related to hydropower and other energy were collected from secondary sources.

The data were collected from various publications of Nepal Electricity Authority (NEA) Journal, Water and Energy commission secretariat (WECS), Department of Electricity Development (DOED), Central Bureau of Statistics (CBS), National planning commission (NPC) Ministry of Finance (MOF), Nepal Rastra Bank (NRB), Central Library of T.U., Central Electricity Authority (CEA), Ministry of Power India and other news and authorized person and Few other resource centre and institutions as well as their websites relevant to hydropower.

3.3 Method of Analysis

To achieve its objective, at first the collected data are presented and analyst on the topic of "Trend and Potentiality of Hydro-Electricity Development in Nepal". To find out Contribution and Potentiality of Hydro-Electricity, collected information is specifically analyzed. The yearly progress and promotion of hydroelectricity is analyzed through collected data and information which found on different Plan period.

The potentiality of Hydroelectricity will be analyzed based on collected information. This is found on Different tables and graphs. Present status of Hydroelectricity of Nepal, Per-capita consumption, Growth of Consumer, sales scenario demand and supply of electricity in different sector also analyzed.

This study has been carried out through descriptive and analytical research design and based on secondary data. Tabulation, Graphs, trend lines and charts have been used as the tools of analysis, Trend lines and charts clearly show the hydropower development in various prospective.

3.4 Analysis and Presentation of Data

To support its objectives the Quantitative data are presented in tabular form, Graphs and Figures. Different Statistical tools ratio percentage data in tabular form. Other data presenting techniques like pie-chart, bar diagram are used required. The qualitative data are analyzed widely as required and relevance. The Descriptive model is used to make explanation of the various consumption and investment variables. The data obtained from survey, plan, documents and other secondary sources are merged each other to have the required results in MS Excel.

CHAPTER IV

TREND AND POTENTIALITY OF HYDRO-ELECTRICITY DEVELOPMENT IN NEPAL

4.1 Trends and Development of Hydroelectricity

The history of hydro-power development is not an old in Nepal. It's more than 100 years. Pharping Hydro power house is the first power house installed in Nepal which is one of the oldest hydropower in Asia in 1911 AD, during the time of Chandra Samsher Rana, the then Prime Minister. The installed capacity was 500 KW and 12 KW cable was installed to transmit 11 KW of purpose. From that time the trend of Hydropower was start to generate. Which is described as different time as a different plan period like as below.

4.1.1 Development and Physical Achievement of Hydroelectricity

At the time of establishment of Pharping Hydro Plant, it was supposed to be the largest one in the South - East Asia. But after the completion of the tenth plans, the development of power in Nepal is still in infant stage. Since the installation of Pharping Hydro Plant in 1911 A.D Nepal has traveled 103 years in the journey of power development. Table 4.32has shown the physical achievement in hydro-electricity development in different plan period.

Table No 4.1:Target and Achievement in Power Generation in Different Plan Period

Plan Period Year	Target in MW	Achievement MW	Achievement facts (in %)	Share of Hydropower (In %)	Resource Allocation (Rs in Millions)
Before planning	-	0.24	-		-
First plan (1956-61)	20	0.75	3.75	73.33	30
Second Plan (1962-65)	22	7.5	34.09	100	91
Third plan (1965-1970)	36	19.96	55.44	91.37	260

Fourth Plan (1970-75)	40.30	28.50	70.72	86.75	255
Fifth plan (1975-1980)	58.85	18.71	31.79	87.81	230
Sixth plan (1980-85)	144.92	87.62	60.45	99.90	3800
Seventh plan (1985-90)	106.63	103.06	98.65	100	4757.100
Eight plan(1992-97)	29.70	28.50	95.96	90.56	32034
Ninth plan(1997-2002)	306.66	137.66	44.89	N.A.	23385
Tenth plan (2002-07)	315	181.279	57.73		
Three years Interim Plan (2007-10)	67.20	64.04			
	1251.31	754.58	58.0		

Source: 1st plan to Three years Interim plan and Statistical pocket books CBS 2009)
N.A. =Not available.

The table shows the achievement was lowest is first plan (3.75 percent). The rate of achievement was highest in the seventh and eighth plan (around 96). But the achievement was lower in the Ninth and Tenth plan. The rate of achievement increased significantly in the subsequent plans, although the performance varied from plan to plan.

4.1.2 Initial Period (Before Plan 2013)

The sustainable source of energy with almost zero input cost has been recognized as a Hydropower. Its benefits are that it is non-polluting energy in the sense that it releases no heat or noxious gases, it has low operating and maintenance cost, its technology offers reliable and flexible operation, and hydropower stations have increased efficiencies along with long life. Nepal's huge potential in hydropower is still untapped. Though Nepal has not yet been able to tap even one percent of its potential electricity capacity and more than 60 percent of Nepalese are still deprived of electricity.

In Nepal, the history of hydro-power development is not an old, it's more than 100 years. Pharping Hydro 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 time of Chandra Samsher Rana, the then Prime Minister. The energy requirement of the members of the ruling class which is financed by British government. The installed capacity was 500 KW and 12 KW cable was installed to transmit 11 KW of purpose. Unfortunately, this power house has been closed now and water from this reservoir is used for water supply to Lalitpur municipality and adjoining areas. The major strategies of the power sector have been appropriately identified as promoting private sector participation in power generation and distribution, integrating rural electrification with rural economic development programs, and strengthening power infrastructure. The immense role of the power sector in contributing to the generation of broad-based, sustainable and high level of economic growth as well as improving the relative competitiveness of the economy both on a regional and global basis makes it imperative that the programs and activities on power sector development as visualized in the plans and policies be given the utmost urgency, priority and focus.

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 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 4.1 shows electricity installations that were in operation in country, before the First Plan. Hydropower is derived from generators turned by the force of falling water. Most other electric energy is obtained from generators driven by steam produced either by a nuclear reactor or by burning fossil fuel namely coal, gas and oil. In the initial stage, hydropower plants played a vital role in world, yet hydropower plants are estimated to provide only about 2 percent of the world energy requirement (Encyclopaedia Britannica, 4,328-338)

Table No. 4.2: Electrical Installation before 1956 (First Five Year Plan)

S.N.	Plant Name	Supply of Power in KW	Agency	Cost
1	Pharping Hydel Plant	500	Britain	0.713 million
2	Sundarijal Hydel Plant	900	Britain	NRs. 367984
3	Morang hydroelectricity Company	677	---	---
4	Birgunj electricity Company	255	---	---
	Total	2332		

Source: NCP, GOV, Source: Acharya (1983).

The table 4.2 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 adhoc 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. Since the installation of pharping Hydro plant in 1911 AD, Nepal has travelled the 100 years journey of power development; it was one of the largest hydropower projects 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.

4.1.3 Major Hydro Projects Installed in Different Plan Period with Capacity

The major hydro electric project installed after plan period, since 1956 and their installed capacity are presented in the table 4.3 below:

Table No.4.3: Major Hydro projects installed din different plan period and installed capacity

Plan	Hydro Project installed	Installed capacity MW	Installed year
First plan	-	-	-
Second plan	Panauti	2.4	1965
Third plan	Trisuli	21	1967
	Pokhara	1	1967
Fourth plan	Sunkoshi	10	1972
Fifth plan	Gandaki	15	1979
Sixth plan	Kulekhani-I	60	1982
	Devghat	14	1983
	PokharaSeti	1.5	1985
Seventh plan	Kulekhani-II	32	1986
	Marsyangdi	69	1989
Interim plan	Adhikhola	5.1	1991
Eighth plan	Jhimruk	12.3	1995
Ninth plan	Puwakhola	6.2	2000
	Khimtikhola	60	2000
	Modi	14.8	2001
	Kaligandaki-A	144	2001
	Bhotekosi	36	2002
Tenth Plan	Arun Third	402	2002-2007
	Upper Karnali, Upper	300	2002-2007
	Tamakoshi,	250	2002-2007
	West Seti	750	2002-2007
Interim Plan 2007-2010	Kulekhani III	20	2007-2010
	Middle-Marshyangdi	70	2007-2010
	Upper Tamakoshi 'A'	402	2007-2010
	Upper Trishuli 'A'	60	2007-2010
	Chameliya	30	2007-2010

Source: 1st plan to Three years Interim plan and Statistical pocket books CBS 2009)

4.1.4 Hydro Power Development after Plan Period

Since 1956 Nepal has got specific direction on power development after planned economic development. It was proposed to increase the generating capacity of hydro-power in different plan period as below.

4.1.4.1 Hydro Electricity Generation in Different Plan Period

Nepal has got specific direction on power development after planned economic development since 1956. It was proposed to increase the generating capacity of hydro-power in different plan period. Following table 4.4 evokes the target of total plan periods power generation and achievement in different plan period.

1. Beginning of Five Year Plan: (1956-1961)

Nepal has got specific direction on power development after planning since 1956. It was proposed to increase the generating capacity of hydropower in different plan periods. The beginning of First Five Year Plan introduced a policy to study the feasibility of small and medium size of hydro project. When Rana rules finished in 1950, the process of national development was begin. Its target was to increase generation capacity of 20,000 KW at a cost of Rs. 80 Million (9% 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. 4.4.

Table No. 4.4: The Power Plant Installed and commissioned During First Plan.

S.N.	Project name	Power Supply in KW	Donor Countries	Cost (in Lakh)
1	Trishuli Hydel Project	9000	India	225
2	Panauti Hydel Project	2400	USSR	20
3	PokharaHydel Project	500	India	40
4	Thadokhola Hydel Project	400	UK	15
	Total	12300		

Source: First Plan, NPC, GOV.

During the Beginning of first plan period an additional supply of 700 KW of power was added in the main stream by Teku (500 KW) and Bhaktapur (200 KW) diesel power plant in Kathmandu valley. Nepal joined for the first time with USSR and India to get aid for the construction of the most important hydroelectricity project like Panauti (Rosikhola) and Trishuli respectively. Similarly, agreement was also made with India for the construction of hydroelectric project in Pokhara with the capacity of 500 KW.

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

2. The Second Plan (1962-1965)

With the motto of establishment and expansion of transmission lines and diesel plants on temporary basis to meet the demand, plants in some big towns like Kathmandu, Birgunj, Hetauda, Nepalgunj and Biratnagar etc were completed in the second three year plan. The second plan had given second priority to meet to the road construction, confronting, its principle objectives of creating the overhead basis for future plans. 22,000 KW of additional power generation both from hydropower and diesel was the target for the second plan. The monetary allocation of this was 91 million rupees (15%) of the plan. 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. Specifically maintain about the energy policy of the government also did not meet in this plan (Bhattrai, 2005).

Table No. 4.5: Major Targeted Hydropower Project of the Second Plan

SN	Project name	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

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

With a capacity of 2400 KW Panauti Project was opined in Second Plan Period, Patan Diesel Plant With a capacity of 1470 KW and Birgunj Diesel Plant with a capacity of 560 KW was 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 having capacity of 2,400 KW achievement was limited to Panauti project.

3. The Third Plan (1966-1970)

The top priority to hydropower generation along with development of transport and communication had given for the Third Plan. It was proposed to increase the generated power by 60,000 KW and 260 million rupees (15 % 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.4.6: Major Targeted on the Third Plan

S.N	Project Name	Power Supply in KW	Aided by
1	Trishuli Hydro Project	18,000	India
2	Gandaki Hydro Project	10,000	India
3	Koshi Hydro project	7,500	
4	One project from Marshyangdi or Kali or Kulekhani	18,000	ADB
	Total	53,500	

Source: Third Plan, NPC, GON

The Third Five Year Plan period shows the total supply of power had been increased by 19,960 KW, primarily from Trisha project (12,000 KW), from Hetauda diesel plant (4,470 KW) and from Patan and Biratnagar diesel pant (2,990 KV1), respectively, From Pokhara Hydro project (500 KW). 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 31.78 percent.

Table No. 4.7: Achievement of Third Plan

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

Source: Fourth Plan, NPC, GON.

4. The Fourth Plan (1970-1975)

The Fourth Year Plan shows the government 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 4.7 shows the target for generation of hydropower in the plan period.

Table No. 4.8: Targeted of Fourth Plan

S.N	Project Name	Supply of Power in KW	Aided by	Cost in mil.
1	Trishuli Hydro Project (additional)	9,000	World Bank	
2	Sunkoshi Hydro Project	10,000	JICKA	57.5
3	Gandaki Hydro Project	10,000	India	
4	Koshi Hydro Project	6,800		
5	Kulekahni Hydro Project	32,000	Japan & Nepal	245
6	Micro Hydro Plants (Including Dhankuta)	500		
	Total	68,300		

Sources:Fourth Plan, NPC, GON

The above table 4.8 shows the target for generating 40,000 KW electric from different hydro plant and diesel plants.

The achievement of electricity generation was 26,040 KW during the Fourth Five Plan, Which is shown in the table 4.9

Table No. 4.9: Target and Achievement of Fourth Plan

S.N	Project Names	Target in KW	Achieved in KW
1	Trishuli Hydro Project	9,000	9,000
2	Sunkoshi Hydro Project	10,000	10,000
3	Ganadaki Hydro Project	10,000	Running
4	Koshi Hydro project	6,800	6,800
5	Kulekhani Hydro project	32,000	Running
6	Micro Hydro Project	500	240
	Total	68,300	26,040

Source: Fifth Plan, NPC, GON

From the record, above table 4.9 shows that Fourth Plan Planned to generate 40,300 KW hydroelectricity from different hydro projects namely Trishuli hydro project, Sunkoshi hydro projects, Gandaki hydro projects, Koshi hydro projects Kulekhani 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 'Trisholi Hydro Project (9,000 KW; Sunkosh hydro project (10,000 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.

5. The Fifth Plan (1975-1980)

Policies were formulated to fulfill the short term and long term demand within the country and to export excess power to India and expand village electrification to promote agriculture development, village industries and production activities were promoted in the Fifth Plan period. Similarly, as in plans, no specific power policy was formulated for the development of other energy sector. 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.

It was estimated that diesel plant of Biratnagar and Pokhara were Supplied 1500 KW and 500 KW Electricity respectively in this plan. The small Hydel Project (3projects) 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.4.10: Transmission Line in Fifth Plan.

SN	Projects names	Transmission line
1	Hetauda - Gandaki	132 KV (Started in Fourth Plane)
2	Gandaki - Butwal	132 KV
3	Bhairahwa - Pokhara	66 KV
4	Butwal - Tansen	33 KV

Sources: Fifth Plan, NPC, GON

In the Fifth Plan the target was to develop transmission line in different parts of country were as shown in above for the distribution of electricity. Total achievement of electricity was just 18.712 MW. Due achievement was 16.27 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 just 50.14 percent was achieved as that of target (NPC, 1980). Target of electricity generation and construction of Transmission line was high, but achievement was very low in both of this plan

Table No.4.11: **Achievement of Fifth Plan**

SN	Projects Names	Achieved KW
1	Large hydro project	15,000
2	Small hydro project	1,220
	Total	16,220

Sources: Sixth Plan, NPC, GON.

6. The Sixth Plan (1980-1935)

The development of small hydro project in the mountain and remote area were emphasis in the Sixth Plan. In order to find out alternative sources of cheaper energy, research and survey activities were initiated. Private sectors were enough to invest in power sector including alternative_ energy sector. The plan also laid emphasis on narrow down of regional imbalance in power distribution. The development of multipurpose projects was expected to increases foreign exchange earnings by exporting surplus power to neighboring 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, 1130). Total production of electricity during Sixth Five Year Plan was /5,217 KW, which is mentioned in the table 4.12.

Table No.4.12: Target of Sixth plan

SN	Projects Names	Supply of Power in KW	Aided by
1	Kulekhani (i) hydro project	60,000	Japan & Nepal
2	Devighat hydro project	14,000	-
3	Marsangdi hydro project	50,000	ADB&GON
4	Small hydro project	5,823	-
	Total	1,29,823	

Sources: Sixth Plan, NPC, GON

Table No.4.13: Achievement of Hydropower Generation in Sixth Plan.

SN	Project Name	Produced in KW
1	Kulekhani (i) hydro project	60,000
2	Devighat hydro project	14,000
3	Small hydro project	1,217
	Total	75,217

Sources: Seventh Plan, NPC, GON.

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. In. this plan period 10,674 KW of electricity was produced from diesel plants.

7. The Seventh Plan (1985-1990)

The Seventh Five Year Plan's objectives 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. From economic point of view 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.

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 During the Seventh plan period. 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 4.14.

Table No.4.14: Projects Planned in the Seventh Plan.

SN	Project Name	Supply of in KW	Agencies
1	Taplejung	125	Private(Shivani Hydropower Company0
2	Khadbari	250	
3	Terahthum	100	Private (Reliable Hydropower Company)
4	Bhojpur	260	Private(Eastern Hyropower)
5	Namche	484	
6	Salleri	200	
7	Okhaldhunga	125	Private (Green Venture)
8	Ramechhap	75	Private (Garjang Upatyaka Hydropower)
9	Manang	80	Private (Distribution Consumer Services west)

10	Chame	50	Private
11	Tatopani	1,000	ADB&GON
12	Chourhari	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, GVN.

The table 4.14 shows targeted to be completed the construction of hydropower plants of total of 3,549 capacities, during the seventh five Year Plan periods, important projects with 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 total production of hydropower during the Seventh Plan and Interim plan Period was 108.55 KW and 66.900 KW respectively. The progress in the electricity sector and alternative sources of energy during the seventh five Year Plan (1985-1990) and the Interim Period (19914992) is given in table 4.15.

Table No.4.15: Progress during the Seventh Plan (1985-1990) and the Interim Period (1991-1992).

SN	Position	Seventh Plan	Interim Period
1	Electricity Generation (KW)		
2	Hydropower	103055	6,690
3	Medium and Large Projects	101000	5,100
4	Small Projects	2055	1,590
5	Fuel Operated		26,000
6	Transmission line (KW)	1,226	197
7	132 KW	723	
8	33KV (Sub-grid)	503	197
9	Alternative sources of energy		
10	Small hydropower KW	1,145	239

Sources: Eighth Plan, NPC, GON

8. The Eighth Plan (1992-1997)

The Eight Plan period comprehensively shows the progress and the policies for hydropower and energy development was formulated. 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. Hydro - projects of different level and capacities were implemented to meet the medium and long term needs (NPC 1992).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.

i. New Hydro Projects Construction

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. A total of 79.7 MIN- 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. In addition to this, works relating to the first phase of the Arun Ill hydroelectric project was to be installed in order to generate power from the Arun River.

ii. Existing Hydropower Stations Strengthening Program

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. 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. These measures were to be increased of about 172 MW of power generation capacity.

iii. Promotion of Electric Transmission Line (Construction-Extension and Strengthening)

Construction of 200 km long 132 KV transmission line between Banke (Kohalpur) and Kanchanpur (Mahendranagar) of the remaining portion of the central grid was be constructed during the Eighth Plan Period. Construction of 42 km long Duhabi-Kataiya 132 KV transmission line had to be completed. Similarly, 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 Bultwal- Bharatpur sections were to be strengthened. The development, construction and study of hydropower projects in the Eighth Five Year Plan Period, medium projects suchas Arun III (402 MW) and Kali Gandaki 'A' (144 MW) and small projects such as Puwakhola (6 MW), Chilime (10 MW) and Mod (14 MW) were initiated. Out of these, Arun lit could not be implemented because the donor agencies with drawn from the project while arrangement was in the final stage (NPC 1992).

iv. Rural Electrification

a. Electrification from the Central Grid

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

b. Small Hydro- electric Project Electrification in Isolation

In order to meet the rural electricity demand in the Hills and Himalayan region Small hydro-electric projects were to be constructed. During the plan period from the continuing and proposed projects Electricity capacity under this programme was to be increased by 3,260 KW, 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 (500KW), Kalikot (600 KW) and Dolpa (160KW) projects were to be constructed.

Table No.4.16: Achievement in the Eighth Plan.

Particular	FY 1991/92	FY 1996/97	Increment in (%)
Total Installed Capacity			
1.Hydropower stations	2,38,563	2,52,418	13,855 (5.8%)
2.Length of Transmission(KW)			
132 KV single circuit	1178	1191	13(1.09%)
132 KV double circuit		43	43
66KV single circuit	64	179	115 (179.75%)
66 KV double circuit	153	158	5(3.20%)
	1096	1349	253(23.1%)

Sources: Ninth Plan, NPC, GON.

9. The Ninth Plan (1997-2002)

The long term policy with a view to raising the share of electricity in total energy consumption from about 1 percent to 35 percent in the next 20 years was promoted in the Ninth Plan period. The plan also laid to emphasis on development of multipurpose project like Koshi 4,700 MIA', 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 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.

i. To develop hydropower with minimum adverse impact on environment.
ii. To supply electricity at affordable price internally and to export electricity at competitive price by developing reliable and quality hydropower.
iii. To develop hydropower in a least way so as to meet the energy demand from agriculture, industry; transportation, domestic commercial and other sectors.
iv. To maintain regional as well as rural-urban balance in power supply.

The target was to increase hydropower to 546 MW from the existing 253 MW linked with central grid in the Ninth Five Year Plan. Out of this, 4 projects (121 MW) were to be implemented from private sector and similarly, 4 projects (172 MW) were to be implemented from public sector too. The total capacity of thermal power stations was to increase 60 MW from the existing 47 MW. Transmission line was targeted to expand 3,976 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 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.

a. Power Generation and Supply

Additional electricity was targeted to generate 295 MW from various hydro projects, from large and medium projects and 660 KW from small hydro projects.

Table No.4.17: Power Generation in Ninth Plan (Large, Medium and Small Hydro Project)

SN	Project Name	Capacity (MW)	Investor	Agencies
1	Indrawati III	5	Private	IPP/GON
2	PuwaKhola	6	Private	NEA
3	ModiKhola	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	015	Public	
	Total	293.66		

Sources: Ninth Plan, NPC, GON.

In this ninth plan period small, medium and large hydropower was promoted together. Kaligandaki 'A' 144 MW, Upper Bhotekoshi 36 MW and Khimti 'I' 60 MW are the

major and large generation of this plan period. Other small Hydro projects like Indrawati III, PuwakholaTanakpur Dolpa etc were promoted on ninth plan.

b. Target and Achievement of Ninth Plan.

The following tables 4.18 and 4.19 show the target and achievements of Ninth Plan:

Table No.4.18: Physical Target of Electricity Development in the Ninth Plan.

Details	Total	1997/98	1998/99	1999/2000	2000/2001	2001/2002
Electricity generation & supply system						
a. Large & medium hydro -power project (MW)	293		6	104	183	
b. Small hydropower project (KW)	660	160	500			
2. Construction & extension transmission line (KM)	1024			286	267	471
3. Rural electrification (KM)	6067	1220	597	1620	1650	980
4. Survey, feasibility study & detailed engineering design no.	31	7	5	8	7	4

Sources: Ninth Plan, NPC, GON.

In the Ninth Plan Period More projects are generated by Private and public sector. The large, medium and small hydro projects are constructed gradually. Construction and extension of transmission line, rural electrification and more surveys are promoted on this plan period and the achievements also grabbed**.** The plan was conducted from 1997 to 2002 smoothly, which is demonstrated on table 4.18 and 4.19 respectively.

Table No.4.19: Target and Achievement of the Ninth Plan

S.N	Area covered by	Unit	Target	Achievement	Achievement%
1	Hydropower installed	MW	538	527.5	98.04
2	Transmission line (132.66 & 33 KV)	KW	3926	4324	110.13
3	Capacity sub-station at higher level (132 and 66 KV)	MVA	832	881	105.89
4	Distribution line (11KV 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.

10. Tenth Plan (2002-2007)

The tenth plan was shown about emphasizing on the construction of small, medium and large reservoir type of hydro projects. Involving to private and public sector and domestic and foreign investments. The ten plans intend to promote integrated development of water resources (large as well as export oriented projects). 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.

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:

1. Hydropower projects constructed to supply 842 MW electricity out of which 70 MW could be exported.
2. 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.
3. Per-capita electricity consumption rose to 10-3 kilo hour.

The target was to increase 315 MW of hydropower by public on private sector. By the end of the Tenth Plan, of the total, population, 48.5 percent was expected to have access to electricity services. 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 3rd (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 there was to supply electricity of additional 1,000 VDCs and additional 7, 05,000 consumers were to be benefited.

The plan 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 cooperation 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 4.20

Table No.4.20: Physical Target and Achievement of Tenth Five Year Plan.

S.N	Areas covered	In Unit	Target	Achievement	Percentage
1	Hydropower installed capacity	MW	315	40	12.69
2	Transmission line (132-66 KV)	KM	430	47	1.93
3	Capacity sub-station higher level(132-66 kV)	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 (11 KV)	KM	14,197	8,371	58.96
7	Supply electricity in VDC's	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.

11. Three Year interim Plan (2007-2010)

Objective of hydroelectricity in the tenth 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. Rural electrification will be expanded with priority.
2. Policy will be adopted to provide electricity easily and at low cost to agriculture and other productive sectors.
3. The tendency to just obtain license for metal hydroelectricity production and distribution, without carrying out production and distribution works will be discourage.
4. Initiative will be taken to integrate micro and small hydroelectricity with the national grid.

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

Water resources strategy as well as other provisions in national water plan will be gradually implemented. Domestic and foreign investment still; be encouraged for development of hydroelectricity. Clear, simple and transport procedure in be adopted to increase the participation of private sector, community and local persons in production, consumption and export of hydroelectricity.

Domestic investment will be encouraged in hydroelectricity production to a certain capacity. An electricity regulating agency will be strengthening for institutional improvement of electricity sector, and management of production, transmission and distribution.

ii. The Targets of the Three year Interim Plan (2007-2010)

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. Additional 10 percent of people will be supplied electricity through the national grid for which power will be supplied additional 500 VOCs. 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:-

iii. Production and Supply of Hydro Energy

With a total capacity of 105 MW hydropower project 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, Kulekhani III hydropower plant of 20 MW and Middle Marsyangdi hydro-power plants of 70 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 till 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 and 30 MW from Chameliya hydropower projects.

iv. Electricity Transmission and Consolidation

Construction of a total of 174.S 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 IN 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.

v. Distribution, Expansion and electrification Program

Construction of transmission and distribution lines of 651 km of 33 KV capacities in order to cover large parts the rural areas,, 3,163 km of 11 KV capacities, 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 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 he completed. This will help expand electricity services to an additional 135,009 households (NPC, 2007).

vi. Effort for the Shortage of Supply of Electricity (Load Shedding)

Load shedding will be completely wiped through the following programmes in the Three Year Interim Plan Period. 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-Shittamadi transmission line will be started to construct in 2007/08 and completed in 2003/09. 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 decreased load shedding. Importing electricity from India too it help to decrease Load Shedding.

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 its hope that load shedding will completely wipe out through the internal production.

Table No.4.21: Hydropower Projects proposed to be during interim plan period.

SN	Project Name	Installed Capacity (MW)	Year to Completion	Aided by
1	Chameliya	30	2010/11	China
2	Upper Tamakoshi	309	2013/14	ADB/GON
3	Upper Seti(Reservoir type)	1222	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	213/14	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	DaramKhola	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 HomeLoan
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.4.22: Transmission line to be initiated interim plan period.

S.N	Projects Names	Length (KM)
1	Kabeli Corridor 132 KV	129
2	Hetauda - Bardaghat 220 KV	143
3	Middle Marsyangdi - Damauli 132 KV	43
4	Butwal - Kohalpur 132 KV	208
5	Butwal- Sunauli 400 KV	25
6	Dhabi - Jogbani 400 KV	15
7	Upper Modi - Modi 132 KV	10
8	Modi - I Lekhinath 132 KB	7
9	Mailung - Grang 66 KV	3
	Total	583

Sources: Three Year Interim Plan, NPC, GON

Table No.4.23: Transmission Line to be completed in Interim Period

S. N	Projects Names	Length (KM)
1	Kulekhani III - Hetauda132 KV	0.5
2	Thankot - Chapagaun 132 KV	27
3	Dhalkebar - Bhittamod132 KV	30
4	Khimti - Dhalkebar 132 KV	75
5	Middle Masyangdi - Marsyandi 132 KV	42
	Total	174.5

Sources: Three Year Interim Plan, NPC, GON.

12. Power Development in Three Year Plan (2010-2013)

i. Target and Objectives of Three Plan:

During this plan period 184 MW of hydroelectricity will be added so at the end of plan period total electricity production will be 877.7 MW. And 67% of people will have access to electricity.

Targets of Eleventh Plan: The targets of this sector will be as follows:

ii. Operating Policies of the Plan

Project will be implemented through both private and government investment transmission lines- will be constructed and power for domestic consumption generated. Government and national private capita will be mobilized to construct and operate small and medium projects. To increase private investment by Nepali citizens, power purchase rate will he review and incentives and tax concessions on construction materials will be given to those projects which will be completed during the Three Year Plan Period.

The efficiency of the power generation, distribution and utilization system will be increased. The private sector will be encouraged to construct transmission lines through public private partnership. Electricity leakage will be controlled by adopting legal provisions and technical measures.

To facilitate 65 percent of people and 735000 households by the supply of electricity. Hydroelectricity projects will be constructed to generate 184 MW electricity and the construction of 1743 mw capacity of new plants will be started.

Electricity will be supplied to 1200 more VDCs through national grid and by which 13 percent will be come under electrical facility. Per capita electricity consumption will be raised to 100 from 86 kilowatt-hours. Add 400 Kilometre of transmission lines.

iii. 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 KW, the proportion of the population using electricity from the national grid will have reached 65 percent and electricity will be available in 3,000 VOCs.

iv. Objectives of Three Year Plan

The following objectives have been set for the electricity sector for overall development and reduce poverty in reliable and sustainable manner in the eleventh plan. 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 centers connected into the national grid was only 705 MW, out of which the ILA 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.

a. Programmes of Power Sector in the Three Year Plan

The public sector will produce 44 megawatt and the private sector 140 megawatt. To reduce current imbalance between demand and supply of electricity processes will be started for construction of reservoir projects in there Year Plan like as below.

i. Production and Supply of Electricity:

A total of 184 mw electricity will be generated and supplied from both the public and private sector during the eleventh plan to meet the domestic demand. The public sector will produce 44 megawatt and the private sector 140 megawatt. To reduce current imbalance between demand and supply of electricity processes will be started for construction of reservoir projects like Budigandaki (600 mw), Upper Seti (128 mw). Under Nepal Electricity Authority and its subsidiary Company Upper Trisuli A (60 mw), Rahughat (32 mw), Upper Tamakosi (456 mw), Upper Trisuli B (40 mw), Sangen (42.5 mw), Upper Sanghen (14.6 mw), Rasuagadi (100 mw) and middle Bhotekosi (102 mw) will be developed as well.

It shall be required to begin construction of some hydropower projects during the tenth plan in order to export and meet the demand of power after the completion of the tenth plan. Construction of hydropower projects with a total capacity of 1,938 mw will be begun during the tenth plan. Arun with 402 MW, upper Karnali with 300 mw and upper Tamakoshi (Rolwaling) with 250 megawatt capacity are among the major projects.

The construction of western Seti hydropower project of 750 mw capacity will also be commenced during the tenth plan. This apart, construction of a reservoir hydropower project suitable to the existing electricity system will be started during the plan period.

ii. Transmission and Consolidation

Construction of a total of 404 km long transmission lines of various kilovolts will be completed during the eleventh plan in order to transmit power form the hydroelectricity projects to the completed during the plan period to electricity consumption centre for export purpose. Three cross boarder transmission lines will be constructed.Of the total, 404 km transmission line will be constructed such as Butwal-Mahendranagar at 132 kv level (200 km), 147 km Hetauda-Bharatpur-Berdaghat (220 kv), 75 km Khimti - Dhalkebar at 220 kv level, 72 km Kaveli corridor at 220 kv level, 56 km Dumre - Damauli - Marsyangdi 132 kv, and 40 km Singati - Lamosangu at 132 kv level. Again additional transmission lines will be commenced during the plan period including one of three cross border line.

Besides constructing new transmission lines, some new substations will also be built and the capacity of some existing substations will be enhanced. Upgrade of a total of 377 MVA capacity substations of various kilovolts will be completed during the eleventh plan.

iii. Distribution, Extensions and Electrification of Electricity

Special emphasis will be given on expanding electricity to the rural areas in the eleventh plan considering the unavailability of the facility. During the plan period, 1625 km distribution lines of 33 kv, 3000 km lines of 11 kv, and 7500 km lines of 400/230 volts will be constructed for this purpose. That will facilitate electric supply to additional 750,000 households from 1600 VDCs.

iv. Studies being commissioned with Bilateral

Cooperation on Pancheshwor multi-purpose project (6,480 mw), Sunkoshi-Kamala Diversion (1,300 mw) and Saptakoshi multi-purpose project (3,400 mw) will be continued during this plan period. Other studies on water resources and power development and on promoting the private sector in the development of electricity will continue during the eleventh plan as well.

v. Nepal Electricity Regulatory Commission Bill 2064 (2007/08)

The government of Nepal 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 row, 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 stakeholders' rights are protected and electricity is made accessible, affordable and acceptable.

vi. Ten Years Hydropower Development Plan 2009

Government of Nepal formed a task force under the convener 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 dearly 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. GOV 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 20091 under the convenorship 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)

4.2 Contribution of Hydroelectricity to the Economic Development of Nepal

It is a known fact that hydroelectricity has a great potential to contribute a large proportion to Nepal's GDP. But because of the low level of development of hydropower, it's contribution to GDP is very low. It can be seen from the data presented in Table 4.24 the contribution of hydropower to GDP hasn't increased in recent years compared with a decade ago, but it is not even 1.2 percent.

Table No. 4.24: Contribution of Electricity in Gross Domestic Product by ISIC Division 2010/11

In Percentage

Year	Contribution of Electricity
2000/01	1.82
2001/02	2.06
2002/03	2.42
2003/04	2.31
2004/05	2.26
2005/06	2.09
2006/07	2.13
2007/08	1.95
2008/09	1.56
2009/10	1.36
2010/11R	1.19
2011/12P	1.13

Source: National Accounts of Nepal, 2012, CBS R Revised Estimate/P Preliminary

In twelve years from 2000 to 2011, its contribution has not increased from 1.82 to 2.13 in year 2006 then started decreasing. According to preliminary study it is expected to stand to only 1.13 in year 2011/2012.

Table No. 4.25: Trends of Growth Rates in Nepalese economy 2011/12

Year	Energy Available (gwh)	Growth Rate Manufacturing Sector	Growth Rate Electric Sector	GDP Growth Rate
2001	1701.45	-5.32	11.37	0.46
2002	1868.42	0.04	19.04	3.45
2003	2066.45	2.15	4.07	5.13
2004	2261.13	2.62	3.97	3.34
2005	2380.89	2	4.01	4
2006	2642.75	2.55	13	3.12
2007	2780.92	-0.87	1.06	5.86
2008	3185.95	-1.04R	-0.91R	4.09
2009	3130.77	2.65P	0.55	3.69

Sources: Economic Survey, Nepal Energy Sector Scenario. R=Revised, P=Pr

Above table shows the data about energy available and GDP growth in Manufacturing industries and Energy industries itself. However, Hao-Yen Yang (Energy Economics 22, 2000, pp 309-317) found by using updated data for the period of 1954-1997 for Taiwan and a variety of econometric techniques designed to detect the direction of causality between energy consumption and GDP. As a secondary contribution, they investigate the causal relationship between GDP and the aggregate as well as several disaggregate categories of energy consumption, including coal, oil, natural gas, and electricity. Applying Granger's technique, they found bi-directional causality between total energy consumption and GDP. They found further that different directions of cause exist between GDP and various kinds of energy consumption.

Table No. 4.26: GDP and Energy Availability in Nepal 2009/10

Year	GDP(In millions of NRs)	Energy Available(GWH)
2001	69762.59	1868.4
2002	72193.42	2066.3
2003	76758.17	2261.1
2004	83768.23	2381.5
2005	91408.8	2642.8
2006	101397.73	2780.9
2007	112630.04	3051.8
2008	126460.61	3180.7
2009	150569.08	3130.7
2010	176141.54	3537.4

Sources: Economic Survey, Nepal Energy Sector Scenario

The calculated value of F is approximately 54.821 which is highly greater than the tabulated value. The tabulated value of F at 5% level of significance for (1, 8) degrees of freedom is 5.32. Therefore the regression line Gross domestic product on Energy availability is highly significant. Moreover there exists relationship between GDP and Energy availability.

Table No. 4.27: The Power Demand Projection 2007/08 In million NRs

Year	*Energy(GWH)	GDP(projected as equ.(ii)	GDP growth rate
2009/10	4018.4	187710	
2010/11	4430.7	213040.7	13.49
2011/12	4851.3	238880.68	12.13
2012/13	5349.6	269494.24	12.82
2013/14	5859.9	300845.03	11.63
2014/15	6403.8	334260.07	11.11
2015/16	6984.1	369911.38	10.67
2016/17	7603.7	407977.13	10.29
2017/18	8218.8	445766.41	9.26
2018/19	8870.2	485785.82	8.98
2019/20	9562.9	528342.54	8.76

Source: NEA (2009)

On above 4.27table 1st column stands for economic years, 2nd column shows NEA's projection for energy demand, 3rd column is for projection on Gross Domestic Product derived from regression line (equation ii) and 4th column is for calculated growth rate on reference of projected GDP.

4.2.1. Contribution in Consumption Pattern by Sector

The residential, industrial, commercial, transport and agriculture sectors are the major sectors consuming electricity in Nepal. Sectored hydro energy consumption pattern from 2004/05 to 2010/11 is presented in table 4.28, figure 4.1 and 4.2.

Table No.4.28 Electricity Consumption Pattern by Sector (000 GJ)

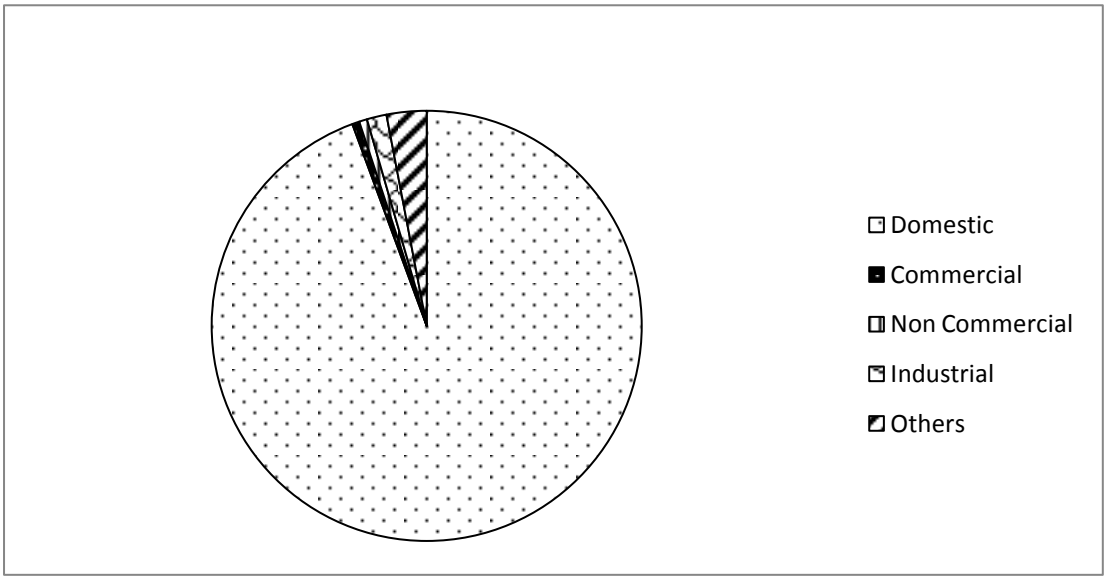
S. N.	Consumption Sector	Percent
1	Domestic	94.94
2	Industrial	1.57
3	Commercial	0.51
4	Non-Commercial	0.59
5	Others	2.39
6	Total	100

Source: Energy synopsis 2010, NEA 2012

The status of consumption pattern of hydroelectricity by sector in Nepal is no more positive which is shown on table 4.28.Because, more power is used on domestic sector which is 94.94 percent of total production. But in commercial and Industrial sectors are using little power which is just 0.51 percent and 1.57 percent. It shows that Nepal has still in deprived condition in using Hydroelectricity.

The Figure 4.1 shows the condition of uses of electricity in Nepal in different sector. This figure is supported by table 4.28.The current situation of sector wise use of electricity is demonstrated by this figure. These trends of electricity using show that, still Nepal is depriving to promote its economy through Hydroelectricity.

Figure No. 4.1: No. of Consumers as of 16 July, 2014



Source: Source: NEA report 2014. *5 million GJ*

The table 4.29 presents the consumption pattern by fuel types on Electricity of Nepal. Figure 4.2.Such energy is achieved more by the fuel wood and petroleum sector. It the electricity just 2.2 percent consumed. This situation shows that still Nepal is in poor condition of using Hydroelectricity and the people are in traditional condition of using energy.

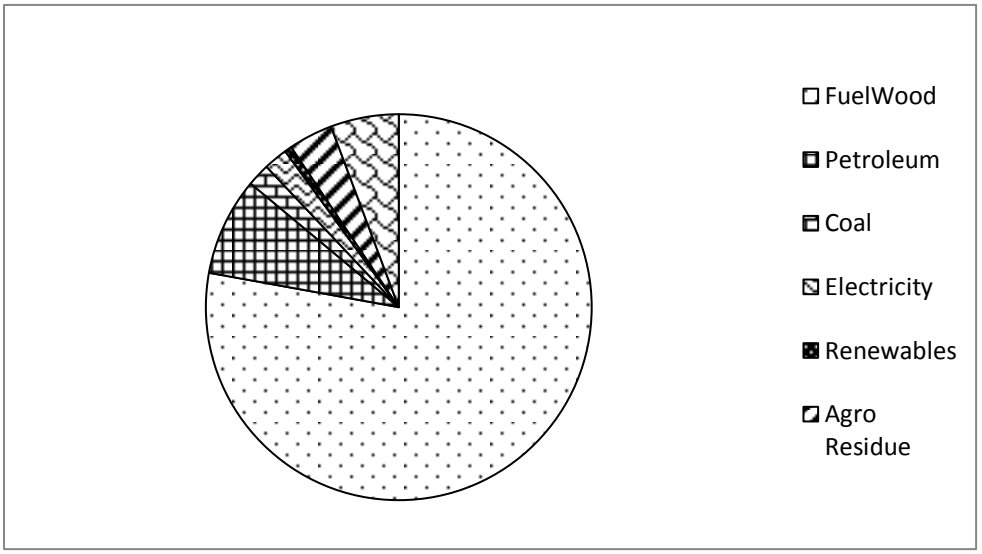
Table No. 4.29: Total Energy Consumption by Fuel Type (000MillionGJ)

S.N.	Consumption	Percent
1	Fuel Wood	77.70
2	Petroleum	8.20
3	Coal	1.9
4	Electricity	2.2
5	Renewable	0.6
6	Agro Residual	3.70
7	Animal Dung	5.70
	Total	100

Source: WECS Energy Sector Synopsis Report 2010,

Figure 4.2.Such energy is achieved more by the fuel wood and petroleum sector. It the electricity just 2.2 percent consumed. This situation shows that still Nepal is in poor condition of using Hydroelectricity and the people are in traditional condition of using energy.

Figure No.4.2: Total Energy Consumption by Fuel types



Source:WECS Energy Sector Synopsis Report 2010,Total Consumption 401MillionGJ

4.2.2 Energy and Economy

Capital, labour and energy are three primary factors that contribute to and influence economic growth in any country in the world. Capital is the equipment, machinery,

manufacturing plants and office buildings that are necessary to produce goods and services. Labour is the viability of the workforce to participate in the production of goods and services. Energy is the power necessary to produce goods and services and transport to their destinations. These three components are used to produce a country's gross domestic product (GDP), the total of all output produced in the country. Without these three inputs to production, business and industry would not be able to transform raw materials into goods and services. Energy is the power that derives the country's economy. In the industrialized nations, most of the equipment, machinery, manufacturing plants and office building could not operate without an available supply of energy resources such as oil, natural gas, coal or electricity. In fact energy is such an important component to manufacturing and production that its availability can have a direct impact on GDP and the overall economic health. (WECS, 2010)

4.2.3 Contribution in Revenue from Electricity

Government revenue in Nepal is divided into two categories: tax revenue and non-tax revenue. Revenue received from electricity is categorized under non tax revenue. The contribution made by electricity in non-tax revenue. Following figure shows the Revenue from electricity under 2005 to 2014.Table 4.30 and Figure 4.3 show the revenue from electricity from 2004-2014*, where more revenue from domestic sector than other sector. The revenue from electricity is increasing continuously.

Table No.4.30: Total Revenue From Sectors (NRs. In millions)

Particular	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014*
Domestic	4987.3	5405.2	6021.4	6297.7	6100.7	7252.2	7602.4	8967.8	11248	12108
Non-Commercial	862.37	881.73	940.20	982.08	900.75	983.63	1020.5	1091.5	1355.2	1475.2
Commercial	1012.7	1081.3	1288.2	1399.5	1384.7	1719.4	1910.3	2259.5	2994	3342.4
Industrial	4799.8	4978.7	5300.9	5544.8	5264.3	6060.2	6378.3	7102.4	8885.2	9774.2
Water Supply and Irrigation	171.57	197.96	214.18	204.67	215.62	353.14	250.60	294.82	389.34	397.93
Street Light	354.10	422.35	454.85	467.31	445.96	333.90	433.42	464.22	582.69	656.45

Temporary Supply	5.06	11.18	17.36	10.51	12.20	13.58	13.98	16.18	24.48	27.85
Transport	30.72	29.78	31.65	33.70	26.95	27.58	27.78	31.70	39.53	43.47
Temple	29.17	24.42	26.03	26.38	24.41	28.16	26.51	21.38	23.66	25.84
Community Sales	24.03	23.94	53.70	64.22	70.10	170.90	189.28	244.94	301.38	331.67
Total (internal sales)	12276	13056	14348	15031	14446	16943	17853	20495	25843	28183
Bulk Supply (India)	609.5	579.33	428.93	361.14	295.49	604.85	215.42	23.97	32.22	29.83
Gross Revenue	12886	13636	14777	15392	14741.1	17547.4	18068.4	20518.4	25875.5	28212.4
Net Income from other Service	336.7	336.09	689.08	684.18	1601.66	1188.27	1382.94	1695.42	1868.37	1596.84
Total Revenue	13223	13972	15466	15976.2	16343	18736	19451.3	22213.82	27743.82	29809.19

*Note: - *Provisional figures*

Table No.4.31: Revenue from Electricity

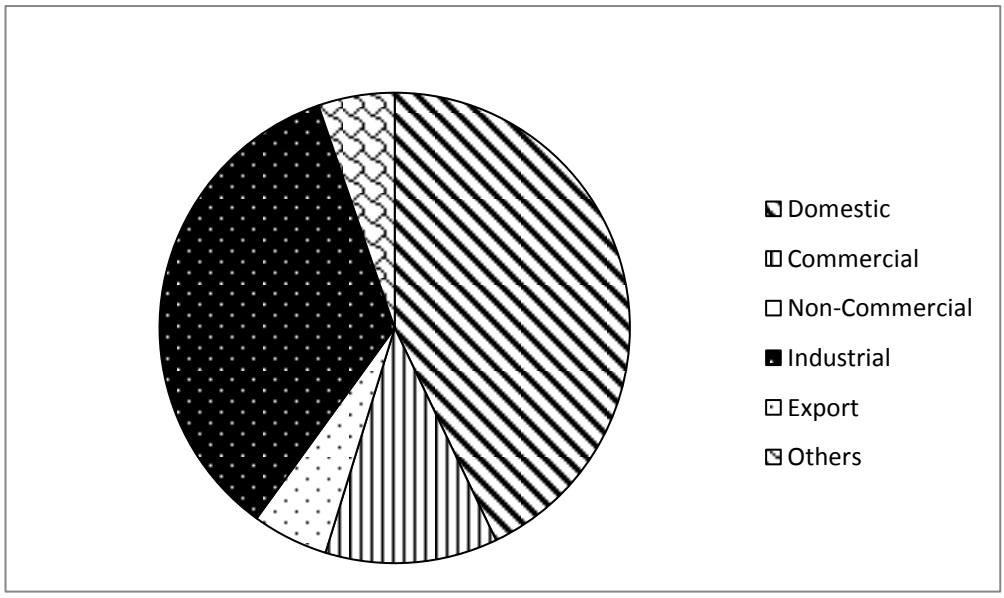
S.N.	**Revenue**	Percent
1	Domestic	42.92
2	Non-Commercial	5.22
3	Commercial	11.84
4	Industrial	34.65
5	Export	0.11
6	Others	5.26
	Total	100

Source: NEA Report 2013

The Above Table 4.31 shows the incoming revenue from Hydroelectricity. The table is explanation of figure is represents equally each other. This table shows incoming

revenue by different sector in the fiscal year 2013/14.Nepal has been achieving more revenue from domestic sector which 42.92.Because in Nepal domestic sector is using huge amount of electricity than other sector. The revenue from Export is in critical situation which just 0.11 percent. It shows that the export condition is meaningless comparing with other sector. Commercial and industrial sectors are paying little more than other sector except domestic sector, which is 11.84 and 34.64 percent. But it is also not satisfactory. Thus Nepal has to generate more power to achieve more revenue by exporting to neighbor countries.

FigureNo. 4.3: Revenue (FY 2013/14



Source: NEA Report 2013

Figure 4.3 show the incoming revenue from Hydroelectricity. The table is explanation of figure is represents equally each other. These figure and table show has showed incoming revenue by different sector in the fiscal year 2013/14.Nepal has been achieving more revenue from domestic sector which 42.92.Because in Nepal domestic sector is using huge amount of electricity than other sector. The revenue from Export is in critical situation which just 0.11 percent. It shows that the export condition is meaningless comparing with other sector. Commercial and industrial sectors are paying little more than other sector except domestic sector, which is 11.84 and 34.64 percent. But it is also not satisfactory. Thus Nepal has to generate more power to achieve more revenue by exporting to neighbor countries.

4.3 Potentiality of Hydroelectricity in Nepal

Despite being tremendously rich in water resources with its theoretical potential of 83,280 MW and techno-economically feasible potential of 45092 MW, Nepal's exploitation of hydropower has been limited to 613.557 MW (installed capacity in NBA including private and others. Although the domestic market at present is limited and if industrial and transportation development is to remain at present level, the present electricity demand forecast in business as usual scenario predicts a peak demand of 1750 MW by the year2020. Recent studies have shown that for Nepal to bring its population above poverty level by 2027 AD with annual GDP growth of 8 percent will require the generation of 22000MW.

4.3.1 Present Status of Hydroelectricity

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. Nepal is wealthy country in the source of water. 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. The Karnali and Mahakali river system represent approximately 43 percent of Nepal theoretical hydropower potential and 55 percent of the technical/economical potential. Table 4.31 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 theoretical, technical and economical potentiality of main river system has been estimated 83.28, 45.61 and 42.133 million KW respectively. Following table 4.31 has presented potentiality of Major River.

Table No. 4.32: Potentiality of Major River

S.N.	River Basin	Theoretical Potential	Technical Potential	Economic Potential
1	Saptakoshi	22.35	11.40	10.860
2	SaptaGandaki	20.65	6.66	5.270
3	Karnali and Mahakali	36.17	26.57	25.125
4	Southern Rivers	4.11	0.98	.878
	Total	83.29	45.61	42.133

Source: Energy Synopsis Report WECS, (1997/98)

The table 4.32 shows that Nepal has 83.29 million kilowatts of hydroelectricity potential on which 5.5 percent (42.133 million kilowatts) is economically viable. The highest potential is possessed by Karnali and Mahakali rivers from theoretical, technical and economic perspective. Southern rivers possess low potential because they do not flow from the Himalayan region.

4.3.2. Per-capita Consumption Potentiality of Electricity

Generally, per capita electricity consumption is used to measure living standard of people of a country. Consumption of electricity is an indicator of economic development of a country. Lower level of consumption of electricity as commercial energy indicates lower level economic development of the country and vice- versa. Nepal's per capita electricity consumption is one of the lowest in the world. Recent study shows that 14 percent of the total population has access to electricity and most of the electricity facility is concentrated in urban areas. The per capita electricity consumption of Nepal was 47 KWH in 1998, the Lowest among selected developing Asian countries (Bhutan 600 KWH, Bangladesh 81 KWH, Myanmar 60 KWH, Pakistan 237 KWH, China 934 KWH, Maldives 220 KWH and India 443 KWH (Dhungel, 2004).

The UN data base has indicated 142nd energy consumption position of Nepal in the world. The UN data base has shown the situation of per capita energy consumption for 1980 to 2012. It is presented in the above table. It has shown the situation of highest per capita energy consumption 86.0 KOE in 2004-2012 compare to other

year's Import and Export of Electricity. The countries exchange electricity as per the need. The agreement between Nepal and India indicates both the exchange points are located at various places in the border line. Though there is a provision in the agreement to exchange to about 150 MW of electrical power between the two neighbors, but due to lack of transmission facility, it is limited below 100 MW. The per-capita energy consumption in different year have shown in following table 4.33 and trends of growth of consumer rate in figure 4.4

Table No.4.33: Exchange of Electricity between Nepal and India

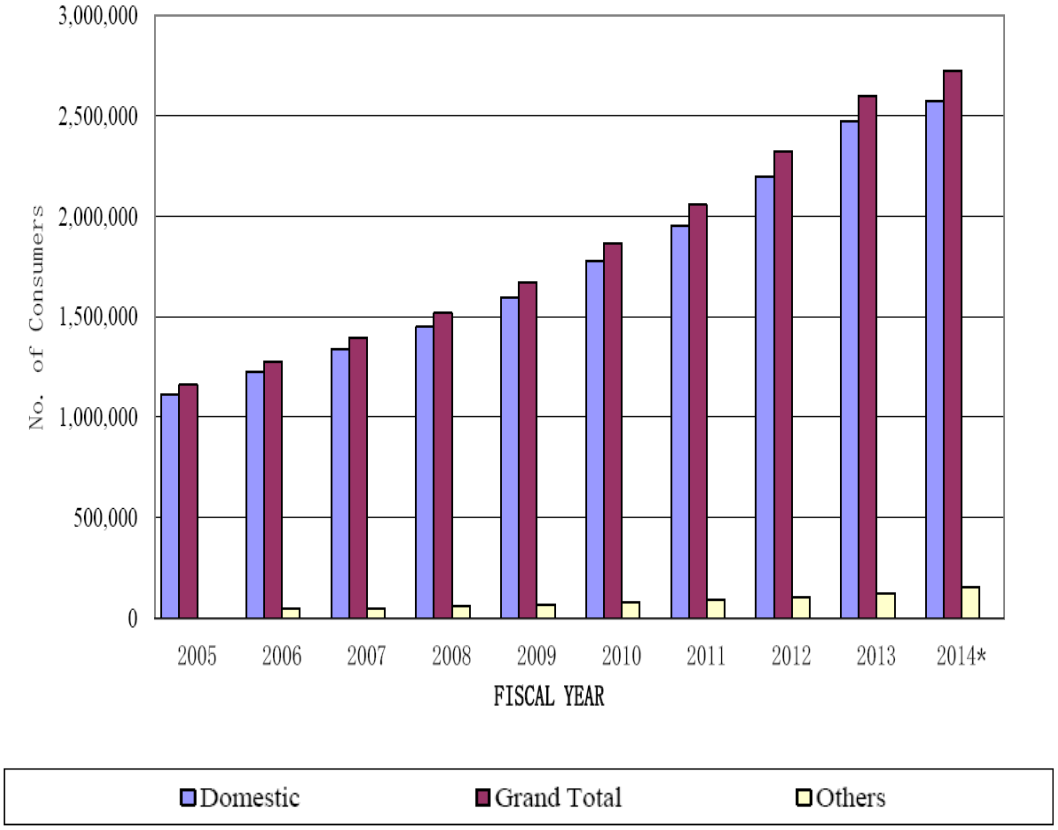
Category	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Export to India	64.16	95.0	126.00	133.86	192.25	141.24	110.70	96.55	76.87	61.50
Import from India	232.39	232.20	226.54	238.29	149.88	186.68	241.39	266.23	328.83	412.41
Net Import/ Export	168.23	137.20	100.54	104.43	42.37	45.44	130.69	169.68	251.96	350.91

Source: NEA Report 2012/13, Note: Provisional figure

The electricity imported from India along the points of exchange for the year 2008* is about 412 GWH whereas export to India is about 61 GWH. The table 4.33 shows the quantity exchanged between the two countries since 2004. It can be seen that except for the year 2003, Nepal is the net importer of electricity.

Figure 4.4 shows the Growth of consumer scenario. The table allocated that increasing of consumer is higher per year. But the generating hydroelectricity cannot fulfill the desire of consumer. According report 2012/13 the demand of hydroelectricity is 1026.47MW but the supply is just 748 MW. It shows that more than 300 MW is still unfulfilled desire of consumer.

Figure No.4.4: Growth of Consumer



4.3.3 Electricity Import and Export Scenario

Trade between Nepal-India exist since the birth of these neighbouring countries. However the matter of trading power came to existence only after intense industrialization. Transfer of power between two countries was in form of power exchange since decades. That is now becoming commercial or taking place as power trade. In this matter it is better to put in front some views of expertise.SB Pun analyses the three-and-a-half decades of Indo-Nepal power exchange that has resulted in Nepal importing more power from India than exporting to her. He points out that, despite India's concurrence 'in principle' to upgrade the quantum of power exchange, she insists on long-term commercial arrangements for the construction of Indo-Nepal high voltage transmission lines. He goes on to explain why Nepal's electricity tariff is the highest in the region, why private sector entry has not been able to mitigate this high tariff, and how Nepal, in its times of power deficit is forced to trade power with India at rates near its average selling price. He explains some of the 'missed' Indo-

Nepal power trading opportunities like Karnali/Chisapani and Arun-III, despite international backing. He believes that long-term Indo-Nepal power trading firmly hinges on Indo-Nepal water sharing. India's near double digit GDP growth rate will only mean a greater demand not only for energy but for freshwater as well. Unfortunately, while Nepal has been mesmerized by electricity exports, India wants to solve her water scarcity and flood problems through Nepal's default. Pun believes that, if a sizable quantum of Indo-Nepal power trading occurs in future, then India must banish her old 'concessional, goodwill gesture, in principle, subject to etc., etc.' psyche. Pun points out that Indo-Nepal power trading can be win-win affair for both countries, provided there is transparency and mutual trust, equity and play, bereft of any hidden agenda.

The agreement between Nepal and India indicates both the countries exchange electricity as per the need. The exchange points are located at various places in the border line. Though there is a provision in the agreement to exchange to about 150 mw of electric power between the two neighbours, but due to lack of transmission facility, it is limited below 100 mw.

The research shows increasing trend of import of Electricity from India. The export exceeding import could be possible only once during fiscal year 2004/13.

Table No.4.34: **Exchange of Electricity between Nepal and India**

Category	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Export to India	64.16	95.0	126	133.9	192.3	141.2	110.7	96.55	76.87	61.50
Import from India	232.4	232.2	226.5	238.3	140	186.7	241.4	266.2	328.8	412.4
Net Import/ Export	168.2	137.2	100.5	104.4	42.4	45.44	130.7	169.7	252	350.9

Source: NEA, 212/13, Note: Provisional figure

The electricity imported from India along the points of exchange for the year 2008* is about 412 GWH whereas export to India is about 61 GWH. The table 4.34 shows the quantity exchanged between the two countries since 2004. It can be seen that except for the year 2003, Nepal is the net importer of electricity. But at this moment Nepal has requested to the Indian government to increase the importing quantity from the 220 to 240 MW. Similarly Nepal has been importing 205-220 MW electricity from India, and then it will be 235 to 240 MW after increasing. In the previous year Nepal has been imported 193 MW electricity from India. The power will import from the Katia-Kusaha terminal line.

4.3.4 Electricity Sales Scenario

Following the figure shows the situation of electricity sales from 2005-2014*. The figure 4.35 shows the electricity sales from 2005-2014. Where, more electricity is sold to domestic sectors compared to other sectors. Electricity sales are increasing continuously for different sectors. Table 4.35 and figure 4.5 show Total Energy Sales Situation in Nepal.

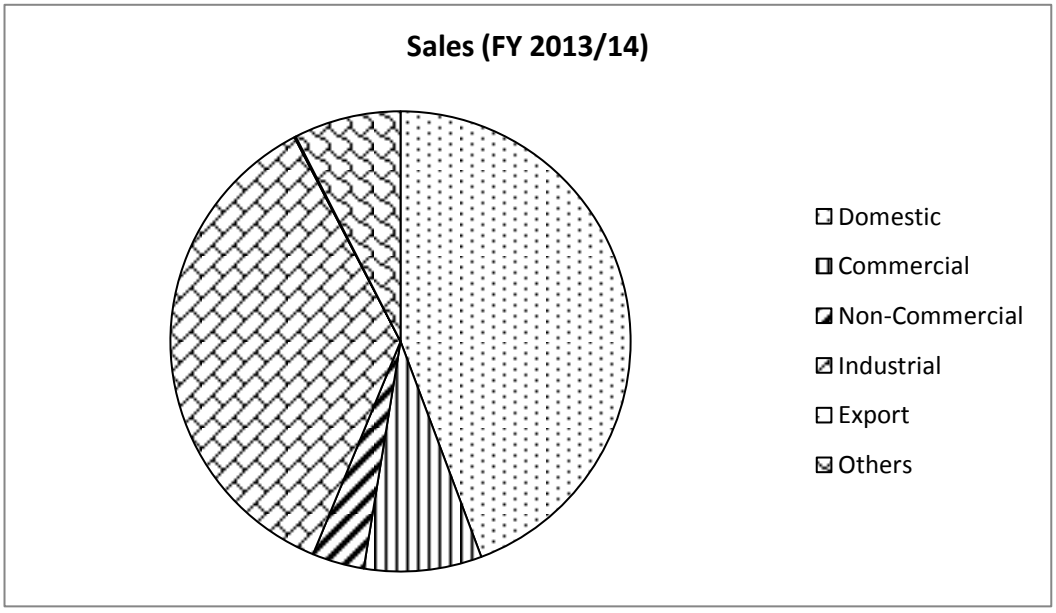
TableNo.4.35: Electricity Sales from 2005-2014* (In GWH)

Particular	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014*
Domestic	758.2	805.72	893.27	931.32	908.67	1108.9	1169.3	1342.7	1401.6	1526.84
Non-Commercial	100.5	95.29	100.52	109.93	98.89	103.47	109.49	115.68	115.21	125.87
Commercial	109.3	120.30	141.69	154.38	146.29	187.12	204.03	240.74	256.82	285.16
Industrial	764	785.55	849.13	901.09	845.68	960.43	1001.7	1123.9	1141.1	1246.7
Water Supply and Irrigation	49.98	45.50	47.96	46.86	48.14	55.98	82.80	64.59	72.55	79.25
Street Light	54.86	63.24	66.90	70.26	67.51	65.58	67.21	72.06	76.24	83.31

Temporary Supply	0.39	0.87	1.26	0.70	1.04	1.00	1.00	1.20	1.47	1.61
Transport	5.80	5.65	6.31	5.88	5.22	5.42	5.54	6.72	6.26	6.85
Temple	4.58	4.77	4.78	5.12	4.76	3.64	3.64	3.95	4.11	4.49
Community Sales	6.03	9.18	15.51	24.65	32.01	34.95	51.95	69.02	77.04	84.18
Total internal sales	1,854	1,936.1	2,127.3	2,250.2	2,158.2	2,526.5	2,696.5	3,040.6	3,152.4	3,444.3
Bulk Supply (India)	110.7	96.55	76.87	61.10	46.38	75.07	31.10	4.12	3.60	3.32
Grand Total	1964	2032.62	2204.20	2310.32	2204.59	2601.53	2727.62	3044.69	3156.01	3447.58

*Source: Energy synopsis 2010, NEA report 2014, Note: - *Provisional Figure.*

Figure No.: 4.5: Electricity Sales 2014



Source: Based on Annex

Figure 4.5 is Total Electricity Sales scenario till 2013/14.The sales condition shows more electricity is sold to Domestic sector because more users are on this sector

which is 44.29 percent. Sales of electricity in Commercial Industrial sectors are 8.27 and 36.16 percent respectively. The sales scenario of export is very poor is just 0.10 percent. The export of electricity should more because we have unlimited market in neighbour countries. If Nepal has generate more power it can be sustain its economy by exporting to neighbours countries.

Table No.4.36: Electricity Sales (FY 2013/14)

Sy. No.	Sales	Percent
1	Domestic	44.29
2	Non-Commercial	3.65
3	Commercial	8.27
4	Industrial	36.16
5	Export	0.10
6	Others	7.53
	Total	100

Source: Based on Annex-II

Table 4.37 is Total Electricity Sales scenario till 2013/14.The Percent of sales demonstrated .The sales condition shows more electricity is sold to Domestic sector because more users are on this sector which is 44.29 percent. Sales of electricity in Commercial Industrial sectors are 8.27 and 36.16 percent respectively. The sales scenario of export is very poor is just 0.10 percent. The export of electricity should more because we have unlimited market in neighbour countries. If Nepal has generate more power it can be sustain its economy by exporting to neighbours countries.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

Nepal is a mountainous, landlocked country wedged between two growing economic powers India and China. Agriculture sector is the main stay of life but this sector witnessed dismal performance in spite of a top priority in different periodical plans. Nepal, one of the poorest countries in the world has a lot of possibilities in hydropower sector by which the nation can overcome her poverty. Hydropower is known as white gold. Nepal is called the second richest country of the world; however, it is not true.

Though Nepal has large potential of hydropower development nearer to the power demand centers in the Northern India, past five decades of cooperation between Nepal and India could not provide desired results. Project implementation in the past, like Koshi and Gandak Projects were mainly for irrigation and flood mitigation and hydropower generation was a byproduct without much importance.

The Koshi and Gandaki Projects included small hydropower component of big projects which proved to be problematic because of silt and other technical Problems from the very beginning and could not provide envisaged benefits. Trishuli and Devighat Hydroelectric Projects built subsequently with India's cooperation in Nepal proved to be extremely helpful in improving the quality of power supply and expanding rural electrification in Nepal. Power Exchange Agreement in border area between Nepal and India, signed in early 1970s, has proved to be beneficial for both countries. Study of Mega projects like Karnali, Pancheswor (Chisapani) and Koshi, Upper Tamakoshi, Trishuli3Aetc (presently under study) could not be finalized in spite of many bilateral meetings and agreements; Mega hydroelectric Projects are multipurpose having high capital cost and multiple benefits besides hydropower. Environmental and social issues are much more complicated having impact on large area with big population. These projects need extensive cooperation from public including NGOs. It is important to build favorable public opinion for development as

benefits accrued on both sides. Under the literature review, the view of various experts on the matter has been illustrated. However, some views contradict mutually. Two taskforce report to mitigate current power crisis also have been presented. The concept of south Asian grid which came to existence a decade ago but couldn't be materialized till date. For the purpose various expertise were brought together.

Current situation of transmission lines to transmit electrical energy to neighborhoods found inadequate. Nepal is required to go long in technology development to get real benefit from energy export.

5.2 Conclusion

As suggested by study, domestic use may be more beneficial than trying to vague export to neighbourhoods. However, there is almost none legal barrier exist. The export can't be denied but before that Nepal needs to be able to generate huge amount of energy and construct transmission lines as potential requirement of India which is for now and by means of hydroelectricity seems unattainable.

The study clearly shows that currently Nepal doesn't have neither energy for sale nor transmission lines. In this context, her requirement should be primarily to cope her generation with domestic demand and think about export provided she has enough resources for cheaper energy generation. By one or other means she must seek and acquire competency in hydropower development.

The role of conventional energy is more significant in the rural areas where around 85 percent of the population resides. Conventional energy plays an important role in the energy sector of Nepal. The fuel-wood supply is constrained because of environmental considerations and depleting forest resources. In contrast, the country's enormous hydropower potential is virtually untapped to meet its energy needs, creating a unique situation of a chronic imbalance between energy consumption and energy resource endowment. Large increase in population resulting in the big loss of per-capita land and the poor state of the development of other types of renewable energy has left Nepal no space except to rely on hydropower geological condition. High cost of project development together with initially expensive power purchase agreement with IPPs, transmission and distribution losses, non-payments or payments in arrears from the public sector consumers and wastage of surplus power contribute

to high electricity tariffs, thereby making adverse impact on industrial use and export purposes.

Despite the introduction of some demand management measures to even them out, these imbalances are still very evident. According to demand supply projections concluded under Water Resources Strategy 2002, such imbalances are expected to persist in the years ahead and this presents an unique opportunity as well as challenge for evening-out the power imbalances on a long-term basis.

Financing and cost considerations provide major challenges in the process of materializing the hydropower potential of Nepal. It is estimated that the government developed medium-sized hydropower cost an average of US$ 2,800/KW while private generators have been able to produce at US $ 1,000/KW. In this context, making the government-developed hydropower at a cheaper rate comparable to that of the private sector becomes an important challenge. To meet the existing gap in the supply of hydropower, new and cheap hydropower generation must come on national grid very fast.

Producing hydropower in sufficient quantity and quality constitutes another challenge. Regional balance in production and distribution capacity needs to be maintained for both socio-political and techno-economic reasons. The people of Nepal from east to west must feel that they are part of the overall national development process, and this will occur if important symbols of development such as hydropower are available to them. Large-scale export potential should not be entertained without first achieving a strong domestic base because once Nepal's needs are adequately met from hydropower development efforts within Nepal, it will be in a more comfortable bargaining position then if it is in a situation where her internal demands have to be met, especially in border towns, with the generosity of the Bihar and the Uttar Pradesh Electricity Boards. So, there is a need for seriously pushing forward a strong hydropower development program that matches Nepal's own power demand growth. State monopoly with no contractual accountability to supply the consumer’s power of reliable quantity and quality needs to be discouraged at all costs.

Hence, the challenge facing Nepal is to generate sufficient financial resources to develop its hydropower in an environmentally sustainable and socially acceptable

manner to meet the needs of its people. This calls for least cost approach that makes power affordable to domestic consumers and competitiveness in the export markets of the neighboring countries in the medium-term. In this context, it is interesting to observe that the hydropower development policy 2001 and the Tenth Plan has attempted to address these issues by way of power sector reform focusing on promotion of private investment, creation of competition through institutional restructuring and establishment of an independent regulatory authority though the reform is progressing very slowly.

5.3 Recommendations

Quality product, price competitiveness and production reliability. That means a producer must be able to produce quality product at competitive price and whenever and how much of quantity a potential buyer demands. In absence of any one factor bargaining power of buyer goes high or he seeks an alternative. Observing all collected data from secondary sources. My recommendations are on following points to prove its objectives.

i. In Nepal production of hydroelectricity is always tough affair. Like in Paraguay as Nepal also requires to import, unbalancing foreign trade, high quantity of construction as well as maintenance materials and manpower from foreign country for the purpose of establishment and run a hydroelectric project. Without her own resources, obviously, that is an ailing obstacle on development of hydroelectricity in Nepal.

ii. The story of power position in Nepal is that of highest potential and lowest consumption. The electricity demand in Nepal is increasing by about 10 per cent every year and close to 40 per cent of the Nepali population has access to electricity through grid and off-grid systems. The main load centre is the central zone which includes the Kathmandu Valley. Nepal owns a number of hydropower plants with a total installed capacity of around 650 MW which includes several small and medium hydropower plants owned by Independent Power Procedures (IPP). A significant amount of energy is also supplied by thermal (Diesel) and solar photovoltaic power plants besides the micro hydro plants in hilly areas.

iv. There is a huge power demand-supply imbalance which is evident from load shedding implemented over the last several years. At present, Nepal Electricity Authority (NEA) is supply deficit. While the peak power demand in wet season is more or less met by the supply, the deficit during the dry season is very high resulting in power outage for as much as 16 hours a day in the capital itself. According to a forecast, the power misery due to supply-deficit is likely to continue till at least 2016-117, when, among others, Upper Tamakoshi (456 MW) is expected to be commissioned.

v. Nepal's economically feasible generation capacity is 42 GW and currently generating less than 1 GW. Even if Nepal by any means in future becomes able to generate all her economically feasible hydroelectricity she will not be able to play a significant role on India's energy scenario. But her prospective investment in energy sector must gain a positive result. In such a case investment on hydroelectricity may only endanger her economic requirements. NEA is currently buying electricity from private entrepreneurs at the price of NRs 6 per unit. In this condition Nepal's production is neither competitive nor reliable in quantity.

Recent developments indicate that our focus will be on reducing load shedding in the next five years or so on. My observation is that energy crisis will continue in the next five years if the efficiency remained same. The energy sector does not hold out a very bright future and will have many problems but Nepal can certainly make some valuable progress in attaining energy independence. The experts and authorities against depending on a single energy source such as hydropower and instead asks them to work for an appropriate energy-mix. We must determine our total energy-mix scenario over the next five, 10 or 20 years.

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