Research on

Nepal India Cooperation on Hydropower (NICOH)

By:
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FOREWORD

The need of co-operation in the hydroelectric sector between Nepal and India has been emphasized by various stakeholders for the last almost five decades. However, there is very little progress to show on ground so far. Lack of co-ordination between government agencies on both sides, lack of pace and direction in the co-operation dialogue, complexities arising due to power-water nexus, absence of private participation in the process and non-availability of physical infrastructure have been some of the conspicuous factors for the tardy progress, which is a matter of serious concern.

To study and analyse these factors along with some of the other less apparent factors and to evolve an implementable roadmap of hydroelectricity co-operation between the two countries, Independent Power Producers of Nepal (IPPAN) and Confederation of Indian Industry (CII) undertook this study titled Nepal-India Co-operation on Hydroelectricity (NICOH) under USAID sponsored SARI/E Small Grants Scheme, jointly managed by Winrock International and Institute of International Education.

The South Asia Regional Initiative for Energy Cooperation and Development (SARI/Energy) promotes sustainable economic prosperity by fostering mutually beneficial energy linkages among the nations of South Asia. SARI/Energy has built a network of stakeholders and potential investors that appreciate the economic, policy, financial, contractual and investment advantages and requirements for increased energy cooperation in South Asia. Based on feedback from these regional stakeholders, the SARI/Energy program is supporting the design and implementation of specific cooperation opportunities and disseminates lessons learned from other successful energy initiatives, such as the Southern African Power Pool and the Rural Electrification Board in Bangladesh.

This Report is a single volume divided into several sections, sub-sections covering different aspects of hydroelectric co-operation between the two countries. It is hoped that the Study findings will be useful to all stakeholders – in India and in Nepal – in making decisions on future policies, strategies and work plan for furthering electricity co-operation and trade.

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ACRONYMS

B/C ratio	–	Benefit-cost ratio
CDM	–	Clean Development Mechanism
CII	–	Confederation of Indian Industry
d/s	–	downstream
DoED	–	Department of Electricity Development
GHG	–	Green House Gas
GWh	–	Gigawatt hours (10^9 watt hours)
Hz	–	Hertz
IC	–	Indian Currency
INPS	–	Integrated Nepal Power System
IPP	–	Independent Power Producer
IPPAN	–	Independent Power Producers' Association, Nepal
IRR	–	Internal Rate of Return
kV	–	Kilovolts (1000 volts)
kW	–	Kilowatts (1000 watts)
LRWL	–	Lowest regulated water level
Masl	–	Meters above sea level
Mill	–	Million
MOWR	–	Ministry of Water Resources
MW	–	Megawatts (10^6 watts)
NEA	–	Nepal Electricity Authority
NHPC	–	National Hydro Power Corporation, India
NPV	–	Net Present Value
NRs.	–	Rupees, (Nepal's currency, 1 USD ≈ 71 Rs.)
O&M	–	Operation and maintenance
PROR	–	Peaking run of the river
PTC	–	Power Trading Corporation
RFP	–	Request for Proposal
ROR	–	Run of the River
Rpm	–	Revolutions per minute
SARI/E	–	South Asian Regional Initiative for Energy
USAID	–	United States Agency for International Development
USc	–	United States cents (1USD= 100 cents)
USD	–	United States Dollars

EXECUTIVE SUMMARY

This study – Nepal India Cooperation on Hydropower (NICOH) – has looked into the historical background on hydropower development and power exchange, current status of cooperation, and hindrances and impediments in development cooperation in this sector. It has come up with specific recommendations to develop hydropower for mutual benefit.

The major issues highlighted in this study are:

1. Nepal has huge potential for hydropower development and the present status of development is approximately 600 MW, which is less than 2% of its economically feasible potential of 42000 MW

2. The cooperation history dates back to the 1950s with the Kataiya Powerhouse in the Koshi Canal and subsequently Trishuli, Devighat and Fewa Hydro projects were built in Nepal with the assistance of India in the 1970s and 80s.

3. There are transmission interconnections in the border areas for mutual exchange of power in the deficit areas on either side. Both the countries in principle have agreed to increase the quantum of power exchange from 50 MW to 150 MW. Seasonally-available power from Nepal upto this limit can be exchanged under this agreement until the time when the surplus power is below this limit.

4. Chisapani Multipurpose Project and Integrated Mahakali Treaty were mutual-interest projects and were undertaken for implementation in the past, but these have not moved ahead due to problems in implementation. Currently, the feasibility study of theKoshi High Dam Multi purpose project is being jointly conducted.

5. His Majesty's Government of Nepal has given priority for private sector investment in the electricity sector, and the National Plan has also identified export of power along with the expansion of grid within the country as priority items. But what has been lacking is the requirement for implementing the polices, e.g. the Single-Window Policy. Moreover, additional polices need to be enacted, e.g. wheeling policy, grid codes etc so that the private sector can have open, non-discriminatory access to the grid and the power markets.

6. The Power Trade Agreement between Nepal and India has opened the possibility to develop projects from private and public sector as well.

7. Many treaties have been signed on power and water sharing between Nepal and India but little has progressed in the implementation level. This is primarily attributed to a lack of confidence on both sides. Power sharing and cooperation has always been shadowed by the water issues.

8. India has 7% and 12 % of energy and peak load shortage. Therefore, both the countries can be benefited with development and cooperation of hydropower in Nepal. The new Electricity Act of India 2003 has opened the power market to all with the introduction of Availability Based Tariff. It has opened the possibility for

power trading from Nepal as well. The transmission interconnections between the two countries need to be strengthened for actual power trading to happen.

9. Bilateral cooperation in the power sector will also balance the power system in both countries with the complementarities of different generation systems of the two countries since Nepal has hydro-dominated power system whereas India has thermal. The different patterns of seasonal demand and supply in either country favors cooperation.

10. Medium-size hydroelectric projects in Nepal for committed exports can also be started. Financing of the project could be mobilized jointly by involving private sectors of both the countries, and both governments should encourage these efforts with proper facilities, securities and incentives to the developers.

11. Private-public partnership should be encouraged from both the countries. Private sector's involvement will speed up the development of the projects.

1. INTRODUCTION

This research 'Nepal India Cooperation on Hydropower (NICOH)' was jointly conducted by Independent Power Producers' Association, Nepal (IPPAN) and Confederation of Indian Industry (CII) under the Small Grants Program, Round-2 of Winrock International.

This study has covered widely on the historical background in power trade between the two countries and joint development of hydropower projects, the current situation, and has identified the impediments in increasing cooperation in this sector. It has come up with certain recommendations for future steps for cooperation.

1.1. Nepal's Perspective

Nepal's vast water resources have been appropriately termed by experts as nature's bounteous gift to the country. In fact, 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 in Nepal. Current estimates are that Nepal has a theoretical potential of 83,000 MW of hydropower, out of which 42,000 MW is economically feasible. However, the present situation is that Nepal has developed only approximately 600 MW of hydropower. Therefore, more than 98% of feasible generation has not been realized yet. Besides, the multipurpose, secondary and tertiary benefits have not been realized from the development of its rivers.

Nepal's electricity generation is dominated by hydropower, though in the entire scenario of energy use of the country, electricity is a tiny fraction, only 1% energy need is fulfilled by electricity. The bulk of the energy need is dominated by fuel wood (68%), agricultural waste (15%), animal dung (8%) and imported fossil fuel (8%). The other fact is that only about 40% of Nepal's population has access to electricity. With this scenario and having immense potential of hydropower development, it is important for Nepal to increase its energy dependency on electricity with hydropower development. This will help to reduce the deforestation, reduce the import of fossil fuel and reduce Green-House-Gas (GHG) emissions. Not only this, it will help to achieve the millennium development goals while conserving environment, increasing literacy, improving health of children and women with better source of energy.

Nepal's overall development depends on the optimum utilization of its water resources, through which India can also be benefited. Harnessing water resources of Nepal can benefit both countries in many ways. India can also help Nepal to develop the projects in terms of technology and finance, and in turn India can be benefited by importing energy from the Nepali hydro projects. The advent of power trading on a real-time basis will help energy security in the two countries, provide better quality and more reliable power to India, improve the balance of payments situation for Nepal, which currently is heavily in favor of India. Besides, Nepal is still a net importer of electricity from India.

Most of the power plants in Nepal are run-of-river type with energy available in excess of the in-country demand during the monsoon season and deficit during the dry season. This imbalance has clearly shown the need for storage projects, and hence, cooperation between the two neighbouring countries is essential for the best use of the hydro resource

for mutual benefit. The energy linkages between Nepal's hydropower and Indian thermal power can benefit both countries in terms of reducing seasonal imbalance of hydropower generation in Nepal and reducing the use of fossil fuels for power generation in India; this will open the possibility of benefiting to both countries with the carbon credits under the Clean Development Mechanism (CDM). Thus, the complementarities of the demand and generation patterns and energy resources need to be properly utilized for maximum benefit to all stakeholders with minimum adverse environmental impacts.

1.2. India's Perspective

India ranks sixth in the world in total energy consumption and needs to accelerate the development of the sector to meet its growth aspirations. Higher growth trajectories of India's development hinges on accelerated development of energy resources. This entails a comprehensive and balanced growth of the energy sub-sectors be it coal, hydropower, oil and gas, renewables, nuclear etc.

Although India is rich in coal and abundantly endowed with renewable energy in the form of solar, wind, hydroelectricity and bio-energy its hydrocarbon reserve is really small (0.4 per cent of world's reserve). India is a net importer of energy with more than 25 per cent of primary energy needs being met through imports. The country also imports near about 70% of the oil it consumes.

Coal and oil accounts for 52 per cent and 33 per cent respectively for the energy production of India and the balance is covered by natural gas, hydro and nuclear.

The distribution of primary commercial energy resources in India is quite skewed, 70 per cent of the total hydroelectric potential is located in the Northern and North-Eastern regions where as the Eastern region accounts for nearly 70 per cent of the total coal reserves in the country. The Southern region, which has only 6 per cent of the total coal reserves and 10 per cent of the total hydroelectric potential, has most of the lignite deposits occurring in the country.

Energy is the prime mover of economic growth and is vital to the sustenance of a modern, rapidly growing economy like India. India's growth aspiration of 8% per annum is coupled with rapidly changing lifestyle is likely to increase the energy demand exponentially.

The primary energy requirement was around 455 Million Metric Ton of Oil Equivalent (MMTOE) in 2001-02 and is projected to be 556.2 MMTOE and 722.3 MMTOE in the terminal years of the Tenth (2002-07) and Eleventh (2007-12) Five Year Plans respectively.

Power sector needs special attention to propel economic growth. Despite significant growth in terms of technological sophistication and capacity addition, the sector has been suffering from financial sickness and supply constraints. Energy and peak load shortages were 8.8 and 12.2 per cent respectively in the year 2003-04. Per capita electricity consumption in India is also much lower than the international standards.

India is planning to add about 12,000 MW power generating capacity from renewables by the end of 11th Plan, almost half of it will come from wind, 3500 MW from biomass and 2000 MW from small hydro. Proper policy initiatives can enhance the share of renewables to 20 per cent of the total supply of power against the targeted 10 per cent by

2012. Renewables are capable of meeting the energy needs of rural areas in an economically efficient manner besides addressing India's energy security concerns.

1.3. Objectives and Purpose of Research

The objective of the research was to explore the areas of cooperation between India and Nepal for hydropower development in Nepal in order that both countries can benefit from energy trade utilizing the complementarities of the generation systems of both countries. The study has looked in to the historical background, current situation, impediments and future perspective for energy trade and hydropower development in Nepal. The main objective was to determine the barriers to energy trade between the two countries.

The purpose of the study was also to highlight multiple benefits that can be accrued from the cross boarder power trading. Multiple gains can be visualized on the following sectors and sub sectors namely enhancing industrial production, financial gains, increasing revenue, increasing the GDP, security on foreign currency, socioeconomic benefits from rural electrification which can help to farmers, poverty alleviation, rural asset building, impact on health, education, impact on demographic nature, empowerment of women, creating employment through power project development and tourism sector development.

The aim of this research was to help to achieve above objectives and to arrive at the desired outcome at the policy and decision making level in both countries.

1.4. Limitations of Study

Information and document collection and review was to be the primary basis for this research. However, since cooperation in this sector historically has been at inter-governmental level, most of the documents of the inter-governmental meetings are classified and are not available for public review. Therefore, the Study Team had to channel its efforts for collecting information by meeting with former members of these teams in Nepal and in India. Therefore, the views and thesis of this research are based on the available information and on the basis of the experience of the Study Team.

2. HISTORICAL BACKGROUND

2.1. Introduction

The history of cooperation in the hydropower sector between the two countries began with the Koshi and Gandak Projects in the late 1950s. Kataiya power house of capacity 6.8 MW was built by India for Nepal on the Koshi Canal at that time. Trishuli, Devighat and Phewa Hydropower Projects were built subsequently in Nepal with the support of India. Power exchange between Nepal and India began in 1971 with limited low-capacity exchange at various locations along the boarder. Currently, there are 14 power exchange points along Nepal India boarder.

2.2. Current Status

Some major hydropower projects are being considered in Nepal for joint development and/or for electricity exports to India. In this context, a joint review team of Nepal and India was formed in 1988 for the development of the 10,800 MW Karnali Chisapani Multipurpose Project. Similarly, the Mahakali Pancheswar Project is in the stage of finalizing of the DPR. Arun III Hydroelectric Project was also planned for partial exports to the Indian market. Upper Karnali Hydroelectric Project is now being considered for joint development by Nepal Electricity Authority and NHPC of India. Similarly, SMEC has been putting substantial efforts to develop the 750-MW West Seti Project for dedicated export to India. It has already initialed a power purchase agreement with PTC, and is in the process of financial closure. It is expected that financial closure will happen by the first quarter of 2006, and construction will start immediately afterwards.

In terms of power trading and power exchange between the two countries, at present, the 132 kV Butwal-Sonauli-Anandanagar transmission line has been identified to be constructed on priority. It has been understood that PTC and Power grid India has already made an agreement for construction on the Indian side, but PTC is looking for a long term commitment from the Nepal Electricity Authority for supply of power. Assessment of the power available currently in the NEA grid shows that NEA should be able to export power during certain periods of the year to India through this interconnection.

2.3. History of Cooperation

Historical background of Nepal India co-operation in the field of hydropower development can be categorized in following different types of projects:

1. **Multipurpose project in border area like**
    a. Koshi Project;
    b. Gandak Project;
2. **Development of hydroelectric project in Nepal under grant - aid program for internal use in Nepal like**
    a. Trishuli Hydroelectric Project;

b. Devighat Hydroelectric Project;

c. Fewatal Small Hydroelectric Project.

3. **Border power exchange and power transmission line link**

4. **Joint technical study for mega projects like**

   a. Chisapani (Karnali) Multipurpose Project;

   b. Pancheshwar Multipurpose Project, including Tanakpur Project;

   c. Koshi High Dam Multipurpose Project.

5. **Electric Power Trade Agreement**

6. **Project Development by the private sector and under public-private partnership**

   a. West Seti Hydroelectric Project;

   b. Upper Karnali Hydroelectric Project.

2.3.1. Koshi Project

Nepal–India co-operation in the field of hydropower development started with the signing of Koshi Agreement on 25th April 1954. This Agreement was amended on 19th December 1966. Main purpose of development of Koshi project on Nepal–India border was flood protection and irrigation. Power generation was a very small component of the project. Head available from irrigation canal drop was used for power development. The agreement said that up to 50 percent of total hydroelectric power generated by any power house situated within 10 mile radius from the barrage site and constructed by India will be available for use of Nepal. Transmission line from power house in India up to Nepal – India border was to be built by India. The tariff rates for electricity to be supplied to Nepal were to be fixed by mutual agreement.

Pursuant to the provision of the agreement a hydroelectric power plant of 6800 kW installed capacity was built at Kataiya (India) on the irrigation canal drop. From the beginning this power plant faced technical problem due to low head and heavy silt in the river water. The power plant could not run on full capacity and supplying electricity to Nepal was irregular. Even after heavy maintenance the power plant became inoperative after few years of operation. In this situation it was agreed to continue electricity supply to Nepal from India grid at Kataiya power house. This was first time power import from India to Nepal started from a project built in India Nepal border area at tariff rate I.C. Rs. 0.10 per unit.

2.3.2. Gandak Project

Gandak Agreement between Nepal and India was signed on 4th December 1959 to construct a barrage, canal head regulator and other appurtenant structure and taking out canal systems for purpose of irrigation and development of power for Nepal and India. This project was also planned for irrigation and flood protection purposes, and electric power development was to utilize this canal drop. Unlike Koshi barrage which is on the Nepal – India border, this barrage was built inside Nepalese territory near border area.

Regarding power development it was agreed to construct one hydroelectric powerhouse by India with as installed capacity of 15,000 kW in Nepal territory on the main western canal and transmission line from the powerhouse in Nepal to Indian border in Bihar to connect supply of power in Bihar grid.

India was to supply power to Nepal at powerhouse and /or at any point in the Bihar grid up to Raxaul. The charges for supply of power were to be based on the actual cost of production on terms and conditions mutually agreed. Transmission line inside Nepal was to be built by Nepalese side.

The ownership and management of powerhouse was to be transferred to Nepal, on one year notice to India after the full load of 10,000 kW at 60 percent load factor had been developed in Nepal from this power house. But on completion at the powerhouse only up 50 percent of installed power i.e. up to 7500 kW could be generated due to some technical problem.

To utilize the power from this powerhouse and meet the requirement of 60 percent load factor, a132 kV transmission line from powerhouse to Hetauda (Nepal) was constructed by Nepal and this power was connected to Nepalese power grid. On completion of this transmission line 60 percent load factor criteria was met and the power house was handed over to Nepal. Nepal continued the supply of power to local nearby areas of power house in India through Powerhouse (Nepal) – Ram Nagar (India) transmission line and Raxaul area. This became the first export of power from Nepal to Indian local power market. Tariff rate for this supply of electricity was mutually agreed at 10:14 ratio with Koshi project.

2.3.3. Hydroelectric Projects on Grant-aid basis in Nepal

Following the Koshi Agreement, some hydroelectric projects were built in Nepal with Indian cooperation under grant-aid basis. These are as follows:

2.3.4. Trishuli Hydroelectric Project

This project is located in mid hill near Kathmandu on Trishuli River. This project was designed, constructed and financed by India on grant aid basis to Nepal. Construction of this project started in early 1960's and first phase of 9000 kW was completed in 1966 second phase of 12000 kW was completed in 1970, total installed capacity being 21000 kW. On completion, this project was handed over to Nepalese side for operation of the power plant. This project also included construction of a 66 kV transmission line from power plant to Kathmandu.

2.3.5. Fewa Dam Hydroelectric Project

Overflow of water from Fewa Lake in Pokhara valley was controlled by small dam and head developed was used to develop 1000 kW small hydro project, to supply electricity to Pokhara valley. This project was financed and built under Indian grant aid program in 1970's.

2.3.6. Devighat Hydroelectric Project

Tailrace water of Trishuli hydroelectric project was utilized to develop 14,100 kW Devighat Hydropower Project. This project was designed, financed and constructed by India on grant aid basis. On completion, management of project was handed over to Nepalese side in early eighty's. After completion of this project, no other electricity generation project has been built under India – Nepal co-operation in Nepal up to date (say last twenty years).

During early 1970's, an understanding between Nepal and India was reached to supply power (electricity) to border towns of Nepal from Indian grid in UP and Bihar. These Nepalese towns are scattered from east to west in Nepal along Nepal – India (Bihar – UP) border. About 10 townships were supplied in the beginning and power quantum was fixed at 5000 kW. The power supply voltage from Bihar and UP grid was 11 kV and 33 kV. This was the first time that the import of power from India to Nepal started. Tariff rates for these supply was fixed on the mutual agreement without taking in to consideration of all commercial aspects. Power exchange at Gandak and Raxaul were also brought under this understanding and power tariff rate for export and import were kept same. Under this understanding, Nepal was exporting power at Gandak and Raxaul, while importing at ten points from east to west including Koshi project site. In totality Nepal has been net importer of power from Indian grid except year 2003. Later on, quantum of exchange of power was increased to 50,000 kW on request of Nepal. Presently exchange quantum has been increased to 150,000 kW.

The meeting of India–Nepal delegates on power exchange in 1988 agreed on power exchange tariffs for 33 kV voltage level at Koshi at 0.60 IC Rs per unit energy with 8.5% of annual escalation. A ratio of 10:14 with Koshi power to other exchange point was maintained.

The power exchanged between Nepal and India in recent years is as follows:

Table 2-1: NEA Power Export Import Scenario

Nepal Electricity Authority (NEA) Export - Import scenario (1993-2004)

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
NEA Export (in million units)	46	51	40	87	100	67	64	95	126	134	186	139	1135
NEA Import (in million units)	82	103	114	73	154	210	232	232	227	238	150	186	2001
Koshi Tariffs (In I.C. Rs.)	0.89	0.97	1.05	1.19	1.29	1.40	1.52	1.65	1.79	1.95	2.11	2.29	-
Power exchange Tariff (In I.C. Rs.)	1.25	1.36	1.47	1.67	1.81	1.97	2.13	2.31	2.51	2.72	2.95	3.21	-

(Note: The Koshi and other points power exchange (PE) tariffs are at 33 kV supply level with a surcharge at 7.5 % for 11kv supply and discount 7.5% for 132 kV supply for the power exchange points.)

2.3.7. Power transmission link

There are 12 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 UP power grid. At present three interconnections are at 132 kV level.

Gandak powerhouse (Nepal) to Ram Nager (India) – 132 kV line: This line is used for power export from Nepal to India in Bihar.

Duhabi (Nepal) – Bhantabari (Border) – Kataiya (India) – 132 kV line: This line is used for power import to Nepal from Bihar grid, when ever Nepal needs more power in eastern region.

Mahendra Nagar (Nepal)– Tanakpur (India) 132 kV line: This line was recently constructed for Nepal's use of power under Tanakpur agreement.

All three lines are on radial mode and operation is isolated from Nepal power system.

In January 2001 at the sixth power exchange committee (Nepal – India) 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. Three 132kv transmission links were identified for interconnection.

- Butwal (Nepal) – Ananda Nagar (U.P.) – 31km in Nepal, and 45 km in UP
- Birgung (Nepal) – Motihari (Bihar) – 25 km in Nepal and 45 km in Bihar
- Dhalkebar (Nepal) – Sitamarhi (Bihar) – 23 km in Nepal and 40 km in Bihar

Regarding the construction of these lines Indian side stated in that meeting "it would be desirable that all aspects including commercial arrangements be finalized and settled between the two sides expeditiously."

In the mean time Nepal has proceeded with the construction of Butwal – Anand Nagar line in Nepalese territory. Response from Indian side is still awaited.

2.3.8. Joint Technical Studies for Mega Projects

Nepal and India have conducted joint technical studies for some mega projects as described in this section.

2.3.9. Chisapani (Karnali) Multipurpose projects

A joint group of expert committee (Nepal-India) was formed to supervise and guide the feasibility study of Chisapani (Karnali) multipurpose project. Nepal received financing from World Bank under technical assistant program to conduct the feasibility study of the project. The joint group of expert started functioning right from the selection of consultant for the study. An international consultant was selected for the study. The committee used to meet time to time to review the field investigation work. Design parameters were also discussed and reviewed in the joint committee. Different reports submitted by the consultant used to get reviewed by the committee and comments were made available for finalization of the different reports. Difference of opinion surfaced for

the finalization of parameters for benefits calculation from the project. Height of dam and size of powerhouse also seemed concern for India.

Final feasibility report of 10,800 MW installed capacity powerhouse with multipurpose use of was completed by the consultant but benefit from multiple use of regulated water could not be finalized in the joint group of expert committee. This issue could not be addressed at secretary level meeting of the two governments also. And the completed feasibility report of the project has been lying without any further action.

2.3.10. Pancheshwar High Dam Multipurpose project

The Mahakali River flows along the border of Nepal – India and enters in to Indian territory to join Ghaghra (Karnali). First water use for irrigation purposes of Mahakali River started with the construction of Sarda Barrage in 1920's by India. Before the construction of barrage, left bank of Mahakali River was in Nepalese territory. An agreement was signed which included land swapping, so that both banks of Mahakali River at barrage construction point become in Indian Territory. Some water for irrigation was provided to Nepal under the agreement.

During 1960's a high dam project was identified by India near place called Pancheshwar in Mahakali River. This dam was envisaged for multipurpose use of water resources e.g. power generation, Irrigation and flood control.

Nepal – India joint group of expert was formed in 1978 to finalize the parameters of Pancheshwar Multipurpose project. After several joint meetings it was agreed to carry out field investigation in the respective territory by the respective government and on completion of field investigation parameters of the project could be finalized jointly. Nepal received financing assistant from World Bank and started field investigation work by an International Consultant, in its territory e.g. left bank of Mahakali River. India also carried out field investigation work itself in its territory e.g. Right bank of Mahakali River. Even after completion of the field investigations on both sides, the finalization of joint report could not proceed further. Main reason for this seemed lack of agreement on principle of benefit calculations and location of re- regulating dam downstream of Pancheshwar project.

2.3.11. Joint Commission

In June 1987 a Nepal–India Joint Commission was established to strengthen understanding and to promote co-operation for mutual benefit in the field of Economic, Trade, Transit, Industry and Multiple use of water resources. The communiqué stated, "The joint commission shall discuss mutually agreed agenda and refer its agreed recommendations to the contracting parties (Nepal – India) for action which shall facilitate and promote cooperation for mutual benefit between them in the field enumerated." The respective delegation was to be led by their minister for foreign affairs of each country.

Subsequently, India started building of a barrage at Tanakpur up stream of Sarda Barrage to divert water from Mahakali River to generate electricity and Irrigation is Indian Territory. Left afflux bund of this barrage was to be connected to Nepalese territory and few sectors of Nepalese land were also to be submersed.

An understanding was reached between two countries is December 1991 to complete the construction of Tanakpur Barrage by connecting left afflux bund to Nepalese Territory. Nepal was to get some additional water for irrigation and 10 million units of electricity free of cost. Some controversy arose in Nepal regarding this understanding.

Regarding Pancheshwar, it was agreed to prepare a detailed project report (DPR) jointly by both countries by October 1992. The financing of the DPR was to be provided by India. The basis for project financing and sharing of cost and benefits was to be subject to mutual agreement.

A Treaty between Nepal and India concerning the integrated development of the Mahakali River including Sarda Barrage, Tanakpur Barrage and Pancheshwar Project was signed on 12th February 1996. Some of the major provisions of the Treaty include:-

- Equal partnership in regard to waters of Mahakali River and its utilizations;
- In lieu of eastern afflux bund of Tanakpur barrage built in Nepal, a supply of 28.35 m^3/s of water in wet season and 8.50 m^3/s in dry season in addition to water available from Sarda Barrage and 70 million kilowatt hour (kWh) of energy on continuous basis will be available to Nepal free of cost, from the date of entry in to force of the Treaty;
- Further at the time of development of any storage upstream, Nepal shall have additional water and half of the increment energy at additional investment cost at Tanakpur;
- Equal capacity of power plants on both banks of the river at Pancheshwar and total energy generated shall be shared equally;
- The cost of project shall be borne by the parties in proportion to the benefits accruing to them. Both the parties shall jointly endeavour to mobilize the finance required for implementation of the project;
- A portion of Nepal's share of energy shall be sold to India at mutually agreed price;
- Both the countries have equal entitlement in utilization of the waters of the Mahakali River without prejudice to their respective existing consumption uses on completion of Pancheshwar Project;
- Pancheshwar Project to be designed to produce the maximum total net benefit. All benefits accruing to both the parties with development of the project from power, irrigation, flood control should be assessed;
- Understanding reached on Sarda Barrage and Tanakpur Barrage is also incorporated in this Treaty;
- Formation of Mahakali River commission for recommendation and co-ordination of different aspects of the Treaty.

Further, it was agreed that Detailed Project Report shall be jointly finalized within six months from the date of the entry in to force of the treaty. While assessing the benefits

from the project during preparation of DPR, power benefits shall be assessed on the basis of saving in costs to the beneficiaries as compared with the relevant alternatives available. Irrigation benefits shall be assessed on the basis of incremental and additional benefits due to argumentation of river flow and flood control benefit shall be assessed on the basis of the value of work saved and damages avoided.

DPR of Pancheshwar project was to be completed within six month of the effective date of the treaty. In spite of joint work by technical groups from both sides and several meetings at higher level, DPR of the project is yet to be finalized. Main concerns from both sides seem location of re-regulating dam down stream of high dam and methods of calculation of different benefits accruing from the project.

2.4. Understanding reached on some Projects

2.4.1. Prime Minister Level - In December 1991

2.4.2. Budhi Gandaki Project

A 600 MW high dam project site is located in the central part of Nepal on Budhi Gandaki River, a tributary of Trishuli River. Pre feasibility study was done by Nepal Electricity Authority in early 1980's. It was agreed to from joint team of experts between Nepal and India to conduct field work leading to preparation of DPR by 1994.

No progress has been seen on this project.

2.4.3. Sapta Koshi High Dam Multipurpose Project

This project is located is the eastern region of Nepal on Sapta Koshi river, near Barah Chhetra temple, upstream of off take of Chatara Canal. It was agreed to from a joint committee of experts for study and investigation to finalize the parameters of the project.

At present, a joint team is carrying out field investigations, but this activity was started only in 2004.

2.4.4. October 1992 – Prime Minister Level

Following up on the understanding reached and decision taken in December 1991, on bilateral cooperation in this sector, both sides have agreed on time frame for investigations, preparation of project reports on Karnali, Pancheshwar, Sapta Koshi, Budhi Gandaki, Kamala and Bagamati projects and also on installation of flood forecasting and warning system, the construction of flood protection embankments and on power exchange.

It was further agreed to explore the possibility of private sector participation in setting up of hydro projects.

2.5. Power Trade Agreement between Nepal and India

A Power Trade Agreement between Nepal and India was signed in February 1996. The preamble says that both the countries have adopted the policy of economic liberalization

with the intention to promote participation of private sector also in the development of their respective countries. The major provisions of the agreement include:

- Any party, in Nepal or India, may enter in to an agreement for power trade between Nepal and India, Irrespective of such parties being governmental, semi governmental or private enterprise.

- The parties entering in to such an agreement for power trade, may determine, the terms and conditions of such an agreement including the quantum and parameters of supply, the points of delivery and price of supply of electrical power to be traded between them.

- The parties entering in to such an agreement for power trade shall be afforded all necessary assistance by respective governments, in accordance with the laws and regulations of respective countries, for conduct of surveys including field investigations and for construction, installation, operations and maintenance of facilities required for generation and transmission of power in the territories of both the countries, required for such power trading.

- The agreement shall remain valid for a period of fifty years from the date of its entry in to force and is validity shall be extended by mutual consent.

2.6. Project Development by Private and Public Sector for Dedicated Export

2.6.1. West Seti High Dam (Storage reservoir)

West Seti River is a tributary of Karnali River, located in the far western Region of Nepal. Feasibility study of the hydroelectric project was carried out by NEA with technical assistance from French Government. The Project consists of a high dam creating seasonal reservoir, a headrace tunnel with underground powerhouse of installed capacity of 360 MW. After opening the power sector for private investment by HMGN, Snowy Mountain Engineering Corporation (SMEC) of Australia carried out further study of the project and came out with an installed capacity of 750 MW project. SMEC is promoting the project for power sale to India. It is learnt that an understanding with India has been reached for the power purchase from this project. This is the first project which is trying to export power to India on a commercial basis from private sector in Nepal.

2.6.2. Upper Karnali Hydroelectric Project

This is a daily pondage run of river project located upstream of proposed Chisapani high dam. Feasibility study of this project was carried out with the financial support of World Bank under technical assistance program. The feasibility was carried out together with the study of Chisapani (Karnali) Multipurpose Project. The study indicates the installed capacity to be 300 MW. Recently an understanding has been reached between Nepal and India to develop this project. National Hydro Power Corporation of India (a govt. owned company) and Nepal Electricity Authority (an undertaking of HMGN) are to participate jointly for the development of the project. Institutional model, project financing and power purchase modes are not clearly defined yet. It is learnt that NHPC

has now optimized the size of the plant to 480 MW, keeping in view the on-peak, off-peak and seasonal tariffs available in the Indian market.

2.7. Summary of Historical Cooperation till Date

In summary, the Nepal-India Treaties and Agreements on water resources development are summarized as follows:

Nepal – India Treaties and Agreement on Water Resources Development

1. Exchange of letter pertaining to the arrangement for construction of Sarada Barrage on Mahakali (Sarada) River: Aug 23, 1920
2. Amended Agreement between HMG/N and GOI concerning the Koshi Project Original: April 25, 1954 and Amended: December 19, 1966.
3. Agreement between HMG/N and GOI on Gandak Irrigation and power project: Dec 4, 1959 and April 30, 1964. (With amendments)
4. Joint communiqué on the visit of Indian P.M. Morarji Desai to Nepal Dec 11, 1977
5. The setting up of Nepal - India joint commission: June 20, 1987
6. Minutes of Understanding on the visit of Nepalese P.M. G.P.Koirala to India: Dec 6, 1991
7. Joint communiqué on the visit of Indian P.M. P.V. Narshimbha Rao to Nepal: Oct 19-21, 1992
8. Treaty between HMG/N and GOI concerning the Integrated Development of the Mahakali River, including Sarda Barrage, Tanakpur Barrage and Pancheshwar Project: Feb 17, 1996
9. The Electric Power Trade Agreement – Feb 17, 1996.

Similarly, the historical background of cooperation in the field of Hydropower development between Nepal and India can be summarized as:

- The Koshi and Gandak 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 1970's, has proved to be beneficial for both countries.

- The Mega projects e.g. Karnali (Chisapani), Pancheshwar and Koshi high dam projects have remained the subject of discussion between two countries for last 30 years, without much progress.

- Some encouraging steps, however recently have been taken, and it is hoped that positive out come will emerge in the following projects.

    - Power Trading Agreement between two countries allows private sector to participate in the field of power generation and trading.

    - Private sector participation like in West Seti high dam hydroelectric project and public sector joint venture project like Upper Karnali Hydroelectric Project.

3. COUNTRY SCENARIO

3.1. Hydropower in Nepal

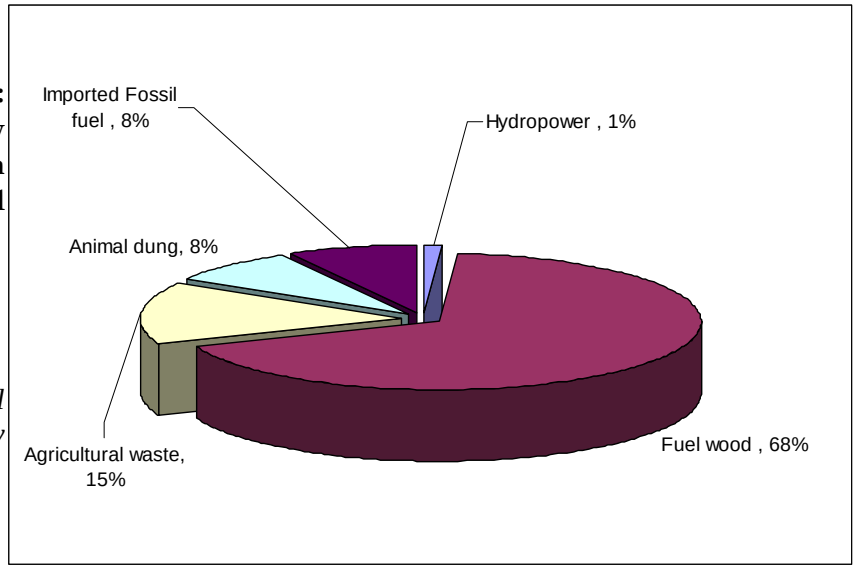
Nepal has a huge hydropower potential. In fact, the perennial nature of Nepali rivers and the steep gradient of the country's topography provide ideal conditions for the development of some of the world's largest hydroelectric projects in Nepal. Current estimates are that Nepal has approximately 40,000 MW of economically feasible hydropower potential. However, the present situation is that Nepal has developed only approximately 600 MW of hydropower. Therefore, bulk of the economically feasible generation has not been realized yet. Besides, the multipurpose, secondary and tertiary benefits have not been realized from the development of its rivers.

Although bestowed with tremendous hydropower resources, only about 40% of Nepal's population has access to electricity. Most of the power plants in Nepal are run-of-river type with energy available in excess of the in-country demand during the monsoon season and deficit during the dry season.

Nepal's electricity generation is dominated by hydropower, though in the entire scenario of energy use of the country, the electricity is a tiny fraction, only 1% energy need is fulfilled by electricity. The bulk of the energy need is dominated by fuel wood (68%), agricultural waste (15%), animal dung (8%) and imported fossil fuel (8%). The other fact is that only about 40% of Nepal's population has access to electricity. With this scenario and having immense potential of hydropower development, it is important for Nepal to increase its energy dependency on electricity with hydropower development. This contributes to deforestation, soil erosion and depletion, and increased flooding downstream in the Ganges plain. Shortage of wood also pushes farmers to burn animal dung, which is needed for agriculture. Not only this, the development of hydropower will help to achieve the millennium development goals with protecting environment, increasing literacy, improving health of children and women with better energy. Growing environmental degradation adds a sense of urgency for developing this sector at an accelerated pace.

Figure 3-1: Energy Consumption in Nepal

Source: Nepal Electricity Authority



The electricity demand in Nepal is increasing by about 7-9% per year. About 40 % of population in Nepal has access to electricity through the grid and off grid system. Nepal's Tenth Five Year Plan (2002– 2007) aims to extend the electrification within country and export to India for mutual benefit. The new Hydropower Policy 2001 seeks to promote private sector investment in the sector of hydropower development and aims to expand the electrification within the country and export.

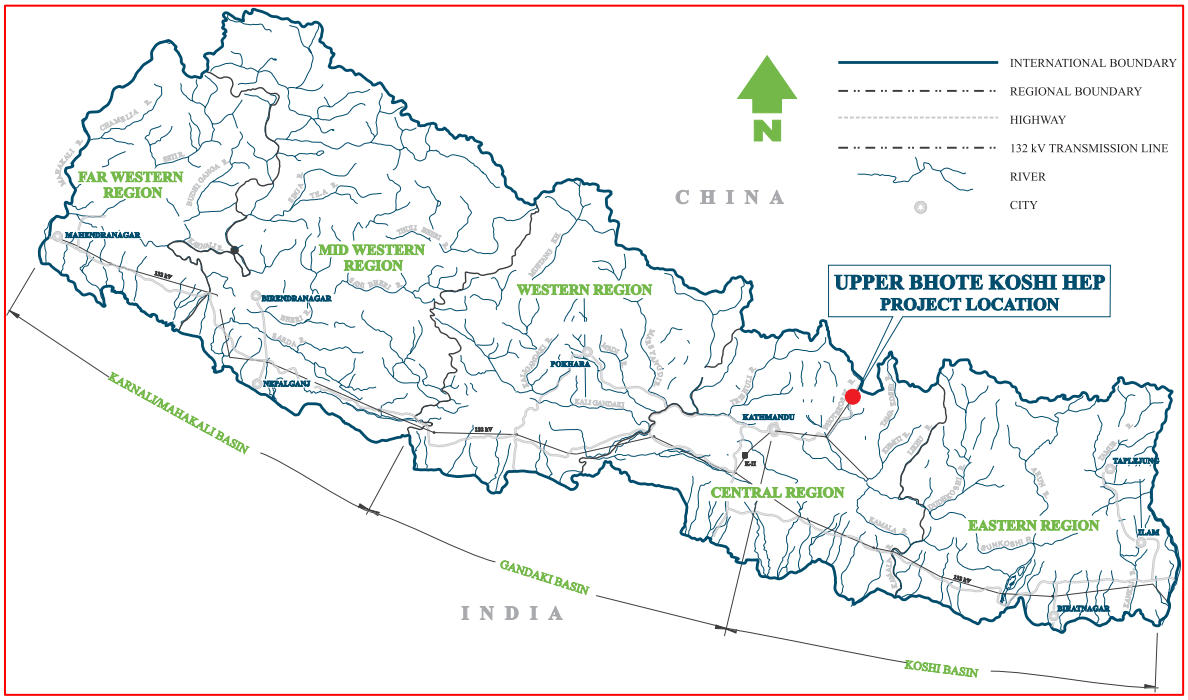


Figure: 3-2: River Network of Nepal

Source: Nepal Electricity Authority

The hydropower system in Nepal is dominated by run-of-river projects. There is only one seasonal storage project in the system. There is shortage of power during winter and spill during wet season. The load factor is quite low as the majority of the consumption is dominated by household use. This imbalance has clearly shown the need for storage projects, and hence, cooperation between the two neighboring countries is essential for the best use of the hydro resource for mutual benefit.

The system loss is one of the major issues to be addressed to improve the power system which accounts to be 25 % including technical and non-technical losses like pilferage.

3.1.1. Status of Power Generation and Transmission

Nepal has 600 MW 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. Hydropower development in Nepal began with the development of 500 kW Pharping power plant in 1911. The most recent significant power plant commissioned is the 144-MW Kali Gandaki "A" Hydroelectric Plant

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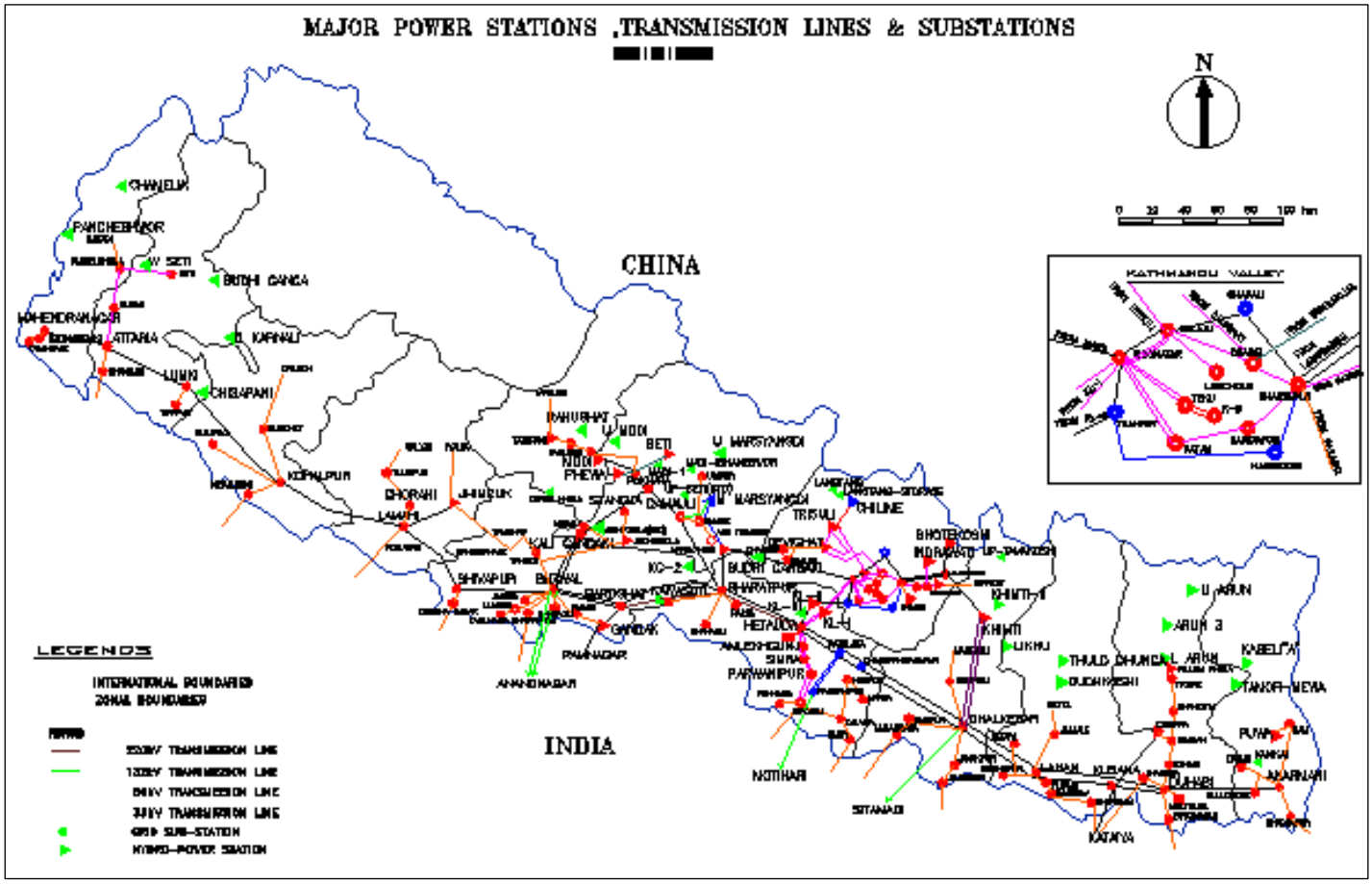


Figure: 3-3: Transmission Network in Nepal

Source: Nepal Electricity Authority

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 140 MW of power to the 'Integrated Nepal Power System'.

The major hydropower plants with their capacity are listed in the table as follows:

Table3-1: Power Plants in Operation

S.N.	Power Plant	Capacity (MW)	Annual Energy (GWh)	Owned by	Operation Date	Type
1	Trishuli	24	292	NEA	1970	ROR
2	Sunkoshi	10	66	NEA	1973	ROR
3	Gandak	15	53	NEA	1979	ROR
4	Kulekhani I	60	164	NEA		STO
5	Devighat	14	13	NEA		ROR
6	Kulekhani II	32	96	NEA		STO
7	Marshyangdi	69	519	NEA		PROR
8	Puwa	6	41	NEA		ROR
9	Modi	15	87	NEA		ROR
10	Kaligandaki	144	791	NEA		PROR
11	Andhikhola	5	38	BPC		ROR
12	Jhimruk	12	81	BPC		ROR
13	Khimti	60	353	HPL		ROR
14	Bhotekoshi	36	246	BKPC		ROR
15	Indrawati	7.5	51	NHPC		ROR
16	Syange	.2	1.2	SHC		ROR
17	Chilime	20	101	CHC		PROR
18	Piluwa	3	18	AVHC		ROR
19	Small hydro	12.5	26	NEA		ROR
20	Small hydro (Isolated)	6.4		NEA		ROR
21	Microhydro	14.5				
	Total	566.1				

There are a few hydro plants under construction by NEA and private developers as listed in the Table below:

Table 3-2: Power Plants under construction

S.N.	Power Plant	Capacity (MW)	Owned by	Remarks
1	Middle Marshyangdi	70	NEA	
2	Sunkoshi	2.6	Sanima Hydropower Co.	
3	Gamgad	0.4	NEA	
4	Heldung	0.5	NEA	
5	Chaku Khola	1.5	Alliance Power	
6	Rairang	0.5	Rairang HPD	
7	Upper Modi	14	GITEC	
8	Khudi	3.5	KHL	
9	Mailung	5	MPC	

3.1.2. Potential for Development

There are about six thousand big and small rivers in three major river basins namely Koshi, Gandaki and Karnali including some southern rivers, and two border rivers,

Mechi and Mahakali in Nepal. The basin wise potential for power generation is in the table below:

Table 3-3: Basin-wise Hydropower potential

River Basin	Capacity on small river courses	Capacity on Major River Courses	Gross Total (GW)	Economic potential (GW)
Sapta Koshi	3.6	18.75	22.35	10.86
Sapta Gandaki	2.7	17.95	20.65	5.27
Karnali and Mahakali	3.5	32.68	36.18	25.1
Southern Rivers	1.04	3.07	4.11	.88
Total	**10.84**	**72.45**	**83.29**	**42.14**

There are many projects which have been identified for development. Some of those identified promising projects for development are in the following table:

Table 3-4: Identified potential Hydropower Projects

S.N.	Project	Capacity (MW)	Type	Remarks
1	West Seti	750	Storage	
2	Arun III	402	PROR	
3	Budhi Gandaki	600	Storage	
4	Kali Gandaki II	660	Storage	
5	Lower Arun	308	PROR	
6	Upper Arun	335	PROR	
7	Karnali Chisapani	10800	Storage	
8	Upper Karnali	300	PROR	
9	Chamelia	30	ROR	
10	Pancheswor	6480	Storage	
11	Thulodhunga	25	ROR	
12	Tamor/ Mewa	100	PROR	
13	Dudh Koshi	300	Storage	
14	Budhi Ganga	20	ROR	
15	Rahughat Khola	27	ROR	
16	Likhu 4	51	PROR	
17	Kabeli A	30	ROR	
18	Upper Marshyangdi A	121	PROR	
19	Kulekhani III	45	Storage	Cascade of Kulekhani-I and II
20	Andhikhola (Storage)	180	Storage	
21	Khimti II	27	ROR	

S.N.	Project	Capacity (MW)	Type	Remarks
22	Upper Modi A	42	ROR	
23	Langtang Khola (Storage)	218	Storage	
24	Madi Ishaneswor (Storage)	86	Storage	
25	Upper Seti (Storage)	122	Storage	
26	Kankai (Storage)	60	Storage	
27	Upper Tamakoshi	309	PROR	

3.1.3. Project Features

Budhi Gandaki

Location:	Central/Western part of Nepal
Type:	Storage
Installed Capacity:	600 MW
Average Annual Energy:	2495 GWh
Net Rated Head:	185 m
Design flow:	430 m^3/Sec
Dam height:	225 m
Power House type:	Underground
Access road length:	2.5 km
Transmission length:	65 km (220 kV)
Level of Study:	Pre-feasibility

In terms of project size, location, access and proximity, this could be an ideal project for development in cooperation in the short term.

Arun-3

Location:	Eastern part of Nepal
Type:	Pondage, ROR
Installed Capacity:	402 MW (6 X 67 MW)
Average Annual Energy	2891 GWh
Firm Energy	1558 GWh
Net Rated Head:	304 m
Design flow:	320 m3/s
Dam height:	68 m
Power House type:	Underground
Power tunnel length and dia:	11.5 km/ 8.4 m
Transmission length	432 km (220 kV double circuit)
Status:	Detailed Design study

Upper Arun

Location:	Eastern part of Nepal
Type:	Pondage, ROR
Installed Capacity:	335 MW (4 X 83.75 MW)

Average Annual Energy:	2050 GWh
Net Rated Head:	492 m
Design flow:	78 m3/s
Dam height:	37 m
Power House type:	Underground
Power tunnel length and dia:	8 km/ 5.5 m
Access road length:	45 km from Arun 3 dam site
Transmission length:	200 km (220 kV)
Status:	Feasibility study (1991)

Lower Arun

Location:	Eastern part of Nepal
Type:	Daily Pondage, ROR
Installed Capacity:	308 MW (4 X 77 MW)
Average Annual Energy	2276 GWh
Firm Energy	1436 GWh
Net Rated Head:	212 m
Design flow:	172 m3/s
Power House type:	Underground
Power tunnel length and dia:	15 km/ 8.4 m
Status:	Pre-feasibility study

Proposed Koshi Zone Highway through Arun Valley Highway, if constructed early will make these projects very economical. Being run of the river projects, the environmental and socio-economical impacts will be minimal. The proximity of these projects to the Purnia, Bihar of India makes these projects attractive for export as well.

Dudh Koshi

Location:	Eastern part of Nepal
Type:	Storage
Installed Capacity:	300 MW (5 X 60 MW)
Average Annual Energy:	1806 GWh
Net Rated Head:	249 m
Design flow:	136 m3/s
Dam height:	180 m
Live Storage:	442 mill cubic meter
Power House type:	Underground
Access road length:	43 km
Transmission length:	228 km (220 kV)
Status:	Feasibility study (1998)

Upper Tamakoshi

Location:	Eastern part of Nepal
Type:	PROR
Installed Capacity:	309 MW
Average Annual Energy:	3470 GWh
Net Rated Head:	820 m
Design flow:	44 m3/Sec
Dam height:	177 m

Power House type:	Surface
Access road length:	61 km
Transmission length:	47 km (220 kV)
Status:	Feasibility study (2005)

Upper Karnali

Location:	Mid/ Far Western part of Nepal
Type:	PROR
Installed Capacity:	300 MW
Average Annual Energy:	1915 GWh
Net Rated Head:	141m
Design flow:	236m3/Sec
Dam height:	27 m
Power House type:	Surface
Access road length:	22 km
Transmission length:	215 km (220 kV)
Status:	Feasibility study (1998)

This project is being considered by Nepal Electricity Authority and National Hydro Power Corporation, India for joint development at an increased capacity of 480 MW to incorporate the demand situation in India.

Kali Gandaki-2

Location:	Western Region
Type:	Storage
Installed Capacity:	660 MW (6X 110)
Net Rated Head:	128 m
Design flow:	585m3/Sec
Dam height:	177 m
Power House type:	Surface
Access road length:	20 km
Transmission length:	40 km (220 kV)
Status:	Pre-feasibility study (1985)

Karnali Chisapani

Location:	Mid Western
Type:	Storage
Installed Capacity:	10800 MW (18 X 600 MW)
Average Annual Energy:	20842 GWh
Live Storage:	16.2 bill cubic m
Design flow:	44 m3/Sec
Dam height:	270 m
Dam type:	Rockfill with inclined core
Tunnel length and dia:	276m / 12 m
Power House type:	Underground
Access road length:	2.5 km
Transmission length:	300 km (765 kV)
Status:	Feasibility study (1984)

3.1.4. Institutional and Statutory Provisions

Water resources development has been a national priority of all of the development plans in Nepal. The Tenth Five Year Plan (2002-2007) and the National Water Resources Strategy, 2002, (NWRS 2002) have emphasized on the need of developing sustainable hydropower as a strategy for poverty alleviation in the country. The hydropower generation capacity is to be increased from the present capacity of about 600 MW to a target of 842 MW (with 70 MW of export) by 2007. The target for the year 2017 is 2,230 MW with 400 MW of export. A long term goal of exporting about 22,000 MW of electricity by implementing large hydropower projects like Karnali, Pancheshor and Sapta Gandaki have also been proposed (NWRS, 2002).

Nepal's 10th five year plan (2002 to 2007) aims to accelerate hydropower development in the country; to extend electrification within Nepal; and, to generate significant electricity to export to India. The plan has the following specific target, strategy, policy and work plans for the export of power to India:

- Initiatives will be taken to export 22,000 Megawatt electricity generated from the development of hydropower projects.
- Electricity will be generated through bilateral and regional cooperation and in keeping with the abundance of production capacity; export of electricity will be encouraged.
- In order to increase electricity exchange between Nepal and India, inter connection transmission facilities will be strengthened.

Hydropower development in the past was mainly within the domain of the government. The private sector is now considered an important partner in hydropower development. However, despite having a huge hydropower potential and the power market, there remains a lot to be done in terms of meeting the national as well as the regional demand for energy. There is a need of an enabling environment in terms of appropriate policies, acts and regulations to facilitate hydropower development. Similarly, an appropriate institutional framework is required to make hydropower development investor friendly while protecting the interests of all stakeholders including the consumers. In the past, hydropower projects were mainly funded by government sources supported heavily by grants and soft loans from donor countries and international lending agencies. Such sources of funding are now either unavailable or at least not enough to meet the substantial financial requirements in the sector. In the case of Nepal, the financial capability of the local economy is limited. This gap in financial resources needs to be met by the resources mobilized from the domestic capital markets or through foreign investments.

His Majesty's Government (HMG/N) promulgated the first Hydropower Development Policy in 1992 to support and encourage the participation of the private sector in the development of hydropower in Nepal. There have been several hydropower projects developed by the private sector since then in line with this policy. Based on the experience of this policy, and emerging principles and situational analysis of the hydropower sector, a new Hydropower Development Policy was promulgated by HMG/N in 2001. The new policy hopes "to overcome the shortcomings and weaknesses that have

emerged in the course of involvement and participation of the private sector in the water resource (hydropower) sector". National Water Resources Strategy (NWRS), approved by the government in 2002 also supports private sector participation in hydropower development.

In line with the Hydropower Development Policy 1992 (HDP 1992), the Electricity Act 1992 (EA 1992) was enacted to enhance the development of hydropower for domestic consumption as well as for export through the mobilization of domestic and foreign investments. In addition, HMG/N also promulgated the Foreign Investment and One Window Policy, 1992 and the Industrial Policy, 1992 and enacted the Foreign Investment and Technology Transfer Act, 1992 (FITTA 1992) and the Industrial Enterprises Act, 1992 (IEA 1992) to establish transparent legal framework that encourages the participation of the foreign and domestic investors in the industrial sector. Beside these, there are also a host of other regulatory policies and legislations that have a direct or indirect impact on the development of the hydropower sector. Some of these acts and regulations now need to be amended in line with the Hydropower Development Policy, 2001 (HDP 2001).

Recently, HMGN has embarked upon drafting the Electricity Ordinance and the Nepal Electricity Regulatory Commission Ordinance based on the policy statements of HDP 2001. These draft Ordinances seek to provide the legal and regulatory framework for expansion of electrification in the country, provide the necessary directives for power sector reforms, encourage private sector investment and power exports.

The Ministry of Water Resources (MoWR) is responsible for all activities in the field of water resources including hydropower, irrigation, flood control and water-ways development in Nepal.

Department of Electricity Development (DoED), under the Ministry of Water Resources is responsible for regulating the hydropower sector and promoting the private sector participation in the hydropower generation, transmission and distribution. The licence for any hydropower project is to be issued from the Ministry of Water Resources through the DoED. One window policy has been adopted for the proliferation of hydropower development in the country where DoED is assumed to the single window for the developers; still it has not been fully functional as anticipated.

Water and Energy Commission Secretariat (WECS) is the policy advisory body and responsible for the formulation of short and long term water and energy policies including regional and national energy analysis, balance the growth in power, energy and irrigation sector etc.

NEA is an undertaking of HMGN and is deemed to be an autonomous, commercial public utility. It is responsible to generate, transmit and distribute adequate, reliable and affordable power by planning, constructing, operating and maintaining all generation, transmission and distribution facilities in Nepal. The major portion of the transmission and distribution system is owned by NEA. It has own power plants and also buys power from the private producers for distribution.

Environmental study for any hydropower project is mandatory in Nepal. Ministry of Population and Environment (MoPE), now changed to Ministry of Environment, Science and Technology (MoEST) in coordination with DoED examines and approves the environmental studies for the power projects.

3.1.5. Project Implementation Approach

There have been different models of hydropower project development in Nepal. NEA has developed many projects mainly through the grants and loan from the bilateral donor agencies and multi national financial institutions on the basis of its own developed 'Least Cost Generation Expansion Plan (LCGEP)'. Recently the private sector has come up. Most of the projects are built on 'Build Own Operate and Transfer' (BOOT) system for a maximum of 50 years license period. The government has promulgated a liberal economic policy to attract the investment in the hydropower sector. There are possibilities of private public partnership for project development. Foreign investment is very important especially in the development of bigger projects of bilateral and or regional interest.

3.2. Power Situation in India

There is energy and peak load shortage in India of 7% and 12% respectively and in the future demand supply mismatch is likely to increase, if precautionary measures are not taken.

Indian energy sector has been structurally handled by five different ministries and power, for example, is a concurrent subject of both center and states. Although reforms in the energy sector are underway, the paces of reform are different in the sub-sectors viz. power, coal, oil, gas and renewables. There are other issues like low per capita energy consumption, high-energy intensity, energy subsidy and realization of user charges.

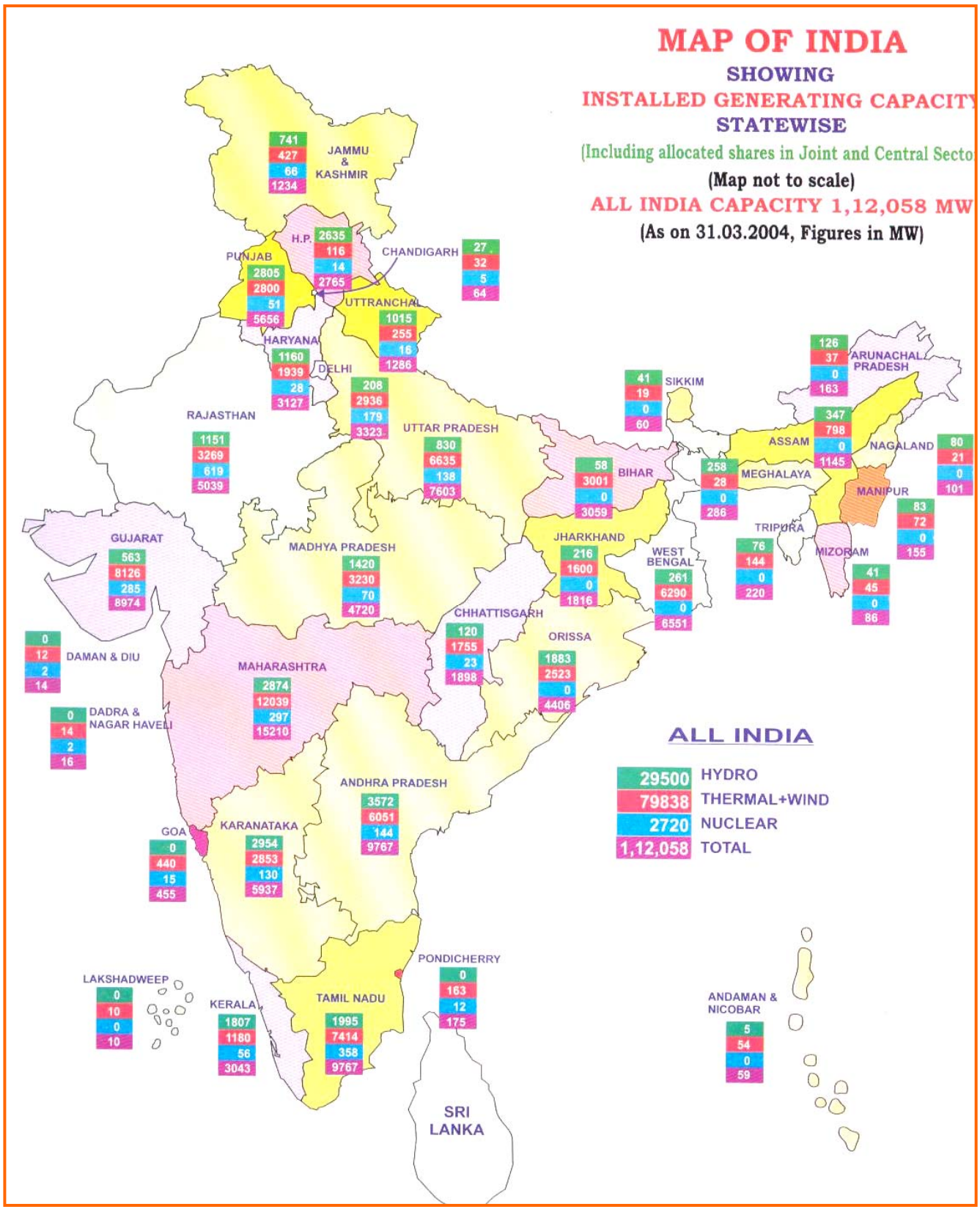


Figure: 3-4: Map of India: Installed Generating Capacity, State wise

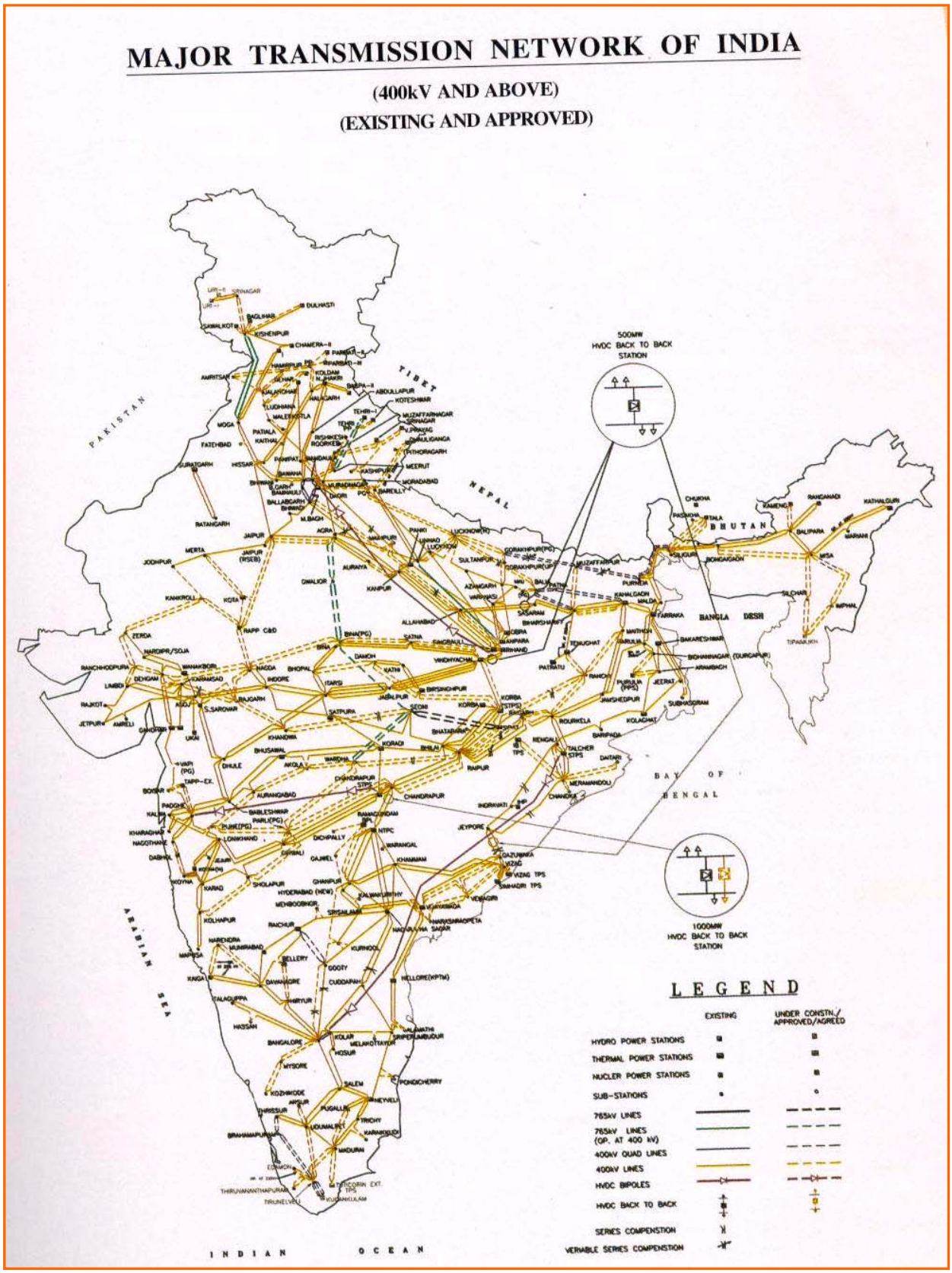


Figure: 3-5: Transmission Network in India (Source: MOP, Annual Report 2003-04)

The primary energy requirement is estimated to be 455 Million Metric Ton of Oil Equivalent (MMTOE) in 2001-02 and is projected to be 556.2 MMTOE and 722.3 MMTOE in the terminal years of the Tenth (2006-07) and Eleventh (2011-12) Five Year Plans respectively. However due to an anticipated decline of the energy intensity,

the actual demand may be 5 – 10 percent below the estimated figures. The recommended fuel mix for the Tenth and Eleventh Plan Period is given in the table below.

Table 3-5: Recommended Fuel Mix for India

S. N.	Primary Fuel	2001-02	2006-07		2011-12	
		(anticipated)	W.G.	S.C.	W.G.	S.C.
1	Coal & Lignite	36.1	35.9	36.0	38.4	36.0
2	Oil	23.4	26.1	23.5	25.7	23.0
3	Gas	7.2	7.4	7.0	7.7	7.5
4	Hydro Power	1.7	2.3	3.0	2.6	3.5
5	Nuclear Power	0.9	1.1	1.5	1.9	2.5
6	Wind Power	0.1	0.1	0.1	0.1	0.1
7	Traditional Fuels	30.6	27.1	28.9	23.6	27.4
		100.0	100.0	100.0	100.0	100.0

Source: Planning Commission (W.G. – Working Group S.C. – Steering Committee)

Power sector needs special attention to propel the economic growth. Despite significant growth in terms of technological sophistication and capacity addition, the sector has been suffering from financial sickness and supply constraints. Energy and peak load shortages were 8.8 and 12.2 per cent respectively in the year 2003-04. Per capita electricity consumption in India is also much lower than the international standards. The elasticity of electricity consumption with respect to Gross Domestic Product (GDP) during the Eighth Plan Period (1992-97) works out to 0.97. As GDP growth accelerates to an ambitious 8-10 per cent, the shortage of power will become more severe. Under such circumstances, imaginative repositioning of the power sector, which considers all the supply as well as demand side options is the need of the hour to double the existing capacity by 2012 to meet the higher growth trajectory, which would accomplish the targeted mission of "Power for All' by 2012.

Being a tropical country, India is abundantly endowed with renewable energy sources in the form of solar, wind, biomass and small hydro. The importance of increasing use of renewable energy sources in the transition to a sustainable energy base was recognized in the mid 1970's. Significant thrust has been given to the development of renewable energy (RE) sources and the activities cover all major renewable energy sources, such as bio, solar and wind energy, small hydro power and other new emerging technologies.

The sustained efforts and initiatives taken by the government at the central and the state level in India for the promotion of renewable energy technologies have resulted in significant growth of the renewable energy based power installed capacity. Currently, renewable energy sources accounts for around 3,700 MW (3.5%) of total installed capacity in the country. Active participation of private players has been a major contributory factor to enable such an impressive growth. Around 90% of the required investment has come from private sector. Solar energy has been increasingly used for water heating in homes, institutional buildings and industrial & commercial establishments. Wind energy production has rapidly grown and has established itself as a source of firm power. Biomasses, cogeneration, energy from waste and new technologies

such as fuelcell and hydrogen have also made significant strides. Table 2 provides status of different RETs achievements in India against their potential.

Table 3-6: Renewable Energy Potential & Achievement

Source/Technologies	Unit	Approximate Potential	Status (As on March 2004)
Power from Renewables:			
Wind	MW	45,000	2,483
Small Hydro (up to 25 MW)	MW	15,000	1603
Biomass/ Bagasse based co-generation	MW	19,500	613
Solar PV Power	MW/Sq. Km.	20	151 MW*
Solar cookers	(No.)	5,15,000	
Energy Recovered from Wastes:			
Urban & Industrial	MW	1,700	41.50
Waste Energy for Rural Area:			
Biogas Plants	Nos.	12 Million	3.65 Million
Improved Chulha	Nos.	120 Million	33.9 Million

[Source: Ministry of Non-conventional Energy Sources (MNES)]

India is planning to add about 12,000 MW power generating capacity from renewables by the end of 11th Plan, almost half of it will come from wind, 3500 from biomass and 2000 MW from small hydro. Proper policy initiatives can enhance the share of renewables to 20 per cent of the total supply of power against the targeted 10 per cent by 2012. Renewables are capable of meeting the energy needs of rural areas in an economically efficient manner besides addressing India's energy security concerns.

4. IMPEDIMENTS TO COOPERATION

Nepal's geography is well-suited to hydropower; the topography varies from the Himalayan Mountains in the north to the plains in the south which are barely above sea level in short reach of 100 to 150 km. The rainfall is heavily skewed towards the monsoon months of June-September which brings risks as well as opportunities for hydropower development. Hydropower project development in a mountainous country like Nepal is complex as it engulfs many areas of human lives and environment.

Some of the major areas of concern in the development of hydropower resources of Nepal are:

Natural constraints: Although Nepal's topographical features are favorable for various forms of hydropower development, the fragile geological features and inadequate hydrological data introduce some degree of uncertainty and risks.

High sediment load in rivers in Nepal is a natural phenomenon, aggravated by man-made interventions. Young geology combined with glacial silt introduces huge quantities of sediment into the rivers, posing serious challenges to the various uses of the river water, including hydropower. However, well planned dams with proper management of sediment can control flood and regulation.

Lack of Infrastructure: Due to remoteness of hydropower project sites, lack of adequate access, transport facilities, transmission grid for power evacuation and other infrastructures, the cost of hydropower development is likely to be higher in certain sites in Nepal.

Transmission interconnections: The transmission interconnection is a bottleneck for export. There is a lacking of policy, regulatory mechanism for the third party access to the grid.

Lack of Funds: Hydropower projects are capital intensive in nature. Nepal does not have adequate financial resources to finance the development of these projects, and hence, in the past has had to seek international donors and multilateral funding agencies. In recent times, the private sector has become increasingly active in project development, which is an encouraging sign. The highly-talked about potential of 42,000 MW of installed capacity will require at least a 100 billion US Dollars to develop. Neither the government nor the donor agencies are going to put up such large amounts for hydropower development, when there are other competing social requirements, e.g. health and the education sector. There are no short-cuts and these hydropower projects will have to be developed in a fully commercial manner. Inadequate internal financial resources including mechanisms for its mobilizations on account of a capital market which is still in its initial stage of development.

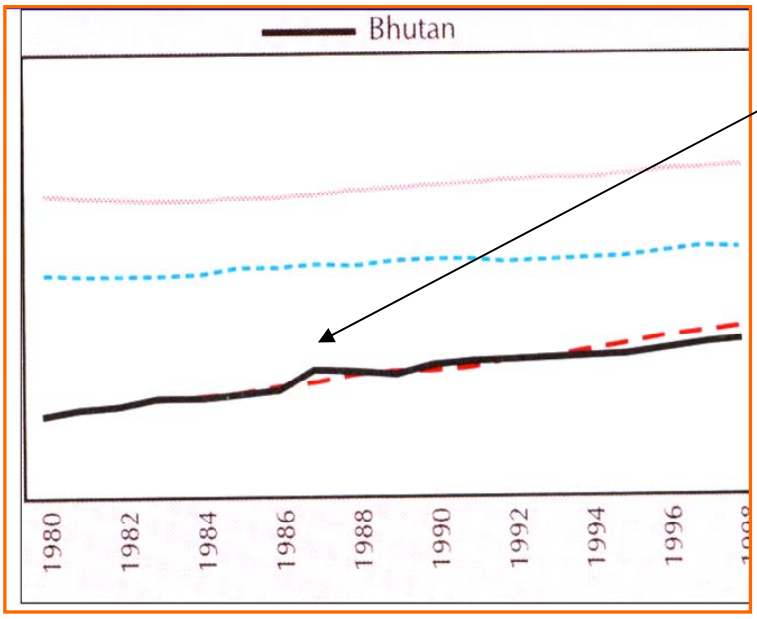
Market: The expansion of electricity grid within Nepal and the growing energy demand of India are the major markets for Nepal's hydropower. With the limitations of the economic feasibility of grid expansion within Nepal, the possibility of power exports need to be pursued aggressively from all quarters.

Political will: In the past, the interest of cooperation has been focused on the selection of mega projects where there is no strong political commitment. The major issues are:

- Complicated detailed technical and environmental studies;
- Lack of transparency in calculating cost and benefit calculations;
- Lack of institutional support to lead the implementation;
- Lack of financial resources to implementation;
- Power market not guaranteed.

The issue of lack of political will can be addressed to a great extent, if hydropower projects in Nepal are visualized not only as commercial projects but also as enablers of regional prosperity and stability.

The poverty and unemployment in Nepal is one of the main reasons for growing insurgency and militancy in the country and has aggravated security concerns in the region. Development of hydropower projects in Nepal can help solve the root problems of the insurgency by providing impetus to the macro-economic growth of these areas and can be a great enabler of regional stability. India can support the development of hydropower projects in Nepal in line with the desire of all countries of the region to promote prosperity and security in the region. As a precedence, India supported mega hydropower projects in Bhutan (Chukha Project) that helped Bhutan simply doubling its per capita GDP (as shown in the figure below).



Cost of generation: Generally the cost of production of hydro-electricity in Nepal is influenced by the followings:

- Lack of adequate infrastructure to access hydropower sites;
- Geological condition;

- Limited capability of needed construction materials production in the country;
- Multilateral financing, generally high cost of capital;
- Employment of International contractors and consultants;
- Currency risk.

Institutional arrangements: There are many institutions related to water resources and hydropower development in Nepal but there is no dedicated institution which is fully responsible to implement the project. DoED has been the principal organization in the development of hydropower in Nepal. The entire transmission grid in Nepal is owned by NEA and there is no wheeling policy and grid code. There is no regulatory commission in the power sector in place in Nepal. NEA has been the nodal agency to negotiate the power trade with India. There are unclear and overlapping roles and responsibilities of existing institutions. Only government bodies are involved in the negotiations.

Statutory Provisions: The HDP 2001 of Nepal evokes to pursue a strategy of bilateral or regional cooperation in the hydropower development sector taking into consideration the feasibility of hydropower in Nepal and the demands of electricity in the neighboring countries in view of the fact that development of hydropower in Nepal supports not only the domestic but also the regional economy. The 10th Five Yeas plan of Nepal has inked to take initiatives for the export 22,000 Megawatt electricity generated from the development of hydropower projects. 70 MW is aimed to be exported with the total generation of 842 MW within this plan period.

Still the new Electricity Act and Electricity Regulation have to be enacted in accordance with the new HDP 2001. There is no regulatory commission in place yet. Wheeling Policy and Grid Code for the third party access to the third party has not been formulated yet in Nepal. Acts and regulations are not developed to adequately assist policies along with inconsistencies and conflicts in various acts/policies/regulations. Besides the above, the following are barriers to development of hydropower projects in Nepal:

- Difficulty in selling electricity to third parties;
- Lack of independent regulatory mechanism;
- Lack of well-defined "power export policy";
- Shortcomings in the compliance of acts and regulations.

Water sharing issues: Often hydropower generation is intermingled with other aspects of water use or benefit which has been hindering to make cooperation on hydropower to large extent. The issue of downstream water use, benefit with regulated water, flood control are connected with bigger multipurpose projects.

The Koshi and Gandak projects primarily for flood mitigation and irrigation purpose were located at the boarder area in Nepal included small hydropower component. Since the projects were located at far downstream of Nepal, major benefits of flood mitigation and irrigation were for the downstream country.

Other examples of water sharing is the 'Mahakali Integrated Treaty 1996' for the integrated development of Mahakali River including the Sarada Barrage, Tanakpur Barrage and Pancheswor Project. A brief review of the status of the Pancheswar Project is as follows:

Pancheshwor Multipurpose Project:

Pancheshwor Multipurpose project is part of the Mahakali Integrated Development Treaty (1996) which includes Sarada Barrage (Sarada Agreement 1920) and Tanakpur Barrage as well.

The DPR of the Pancheshwor project was agreed to be prepared within six months of the agreement made but it has not yet been prepared in almost 10 years time. The major points of differences stands of two countries are on the following:

- Cost share by power component, and Cost share by Irrigation and flood control component

Points to be sorted out before DPR finalization

- Re regulating site selection
- Prior use of water

"Nepal and India have not left anything in the water resources sector on which they have not agreed to cooperate" Dr. DN Dhungel, 2001.

In this vein, resolution of the Mahakali Integrated Project could set one example in the cooperation of Hydropower and the water sharing between Nepal and India.

Karnali Chisapani Project:

The feasibility study of 10,800 MW Karnali Chisapani Project was carried out by Nepal in 1984 with the financial support from World Bank and technical supervision was jointly done by Nepal and India.

The major issues of concerns to develop this project are:

- Sharing of cost on different component of the project
- Conflict on benefit calculation of energy, irrigation, flood control etc

5. MODES OF COOPERATION

Nepal has huge hydropower potential and the domestic demand is very small compared to its potential even to the foreseeable future. Therefore its potential can be harnessed for the mutual benefit between Nepal and India. Nepal has given ample emphasis in its plan and priorities for the cooperation of hydropower development which can be seen from its Tenth Five Year Plan (2002 – 2007). The plan has the following specific target, strategy, policy and work plans for the export of power to India:

- Initiatives will be taken to export 22,000 Megawatt electricity generated from the development of hydropower projects.
- Electricity will be generated through bilateral and regional cooperation and in keeping with the abundance of production capacity; export of electricity will be encouraged.
- In order to increase electricity exchange between Nepal and India, high voltage interconnection transmission facilities need to be strengthened.

The Electricity Act 2003 of India has opened the possibilities of different modes of power trade for anyone, which has already brought many power traders in Indian energy market.

Nepal and India both have agreed for bilateral power trading. According to the Power Trade Agreement, both the countries will provide all facilities to the private sector for participation in power projects development.

As stated earlier, the objective of this study was to outline viable modes for increasing co-operation in the field of hydropower development and its utilization. The existing potential and needs provide immense opportunities, however, the progress is not so significant so far in this respect.

The reason perhaps is that exploitation of natural resource such as water engulfs several aspects. The water resource has several uses both with positive and negative impacts accruing direct benefit and having at the same time social and environmental affect in one hand and alternative sources for energy are available and look cost effective on the other hand for the moment.

To be prudent, the co-operating partners approach needs to consider the efficient and sustainable use of the resource, without taking undeterred position to maximize benefit to one side alone rather than cooperate in the areas of maximizing benefit to either side.

5.1. Existing Institutional Arrangements

The existing institutional arrangements between Nepal and India on hydropower development are as follows:

1. **Coordination Committee for Koshi Project:**

Minister of Water Resources HMG/N heads the committee and Secretary of the Committee is the Administrator of the Koshi Project.

2. **Coordination Committee on Gandak Project:**

   Minister of Water Resources HMG/N heads the Committee and the Chief Administrator of the Project is the Secretary.

3. **Committee on Karnali: 1977**

   It is co-chaired by the Secretaries of water Resources of the both countries.

4. **Karnali Co-ordination Committee – 1977**

   It is Technical Committee of the Karnali Committed represented by experts of both countries.

5. **Joint Group of Expert (Nepal – India) on Pancheshwar Multipurpose Project – 1977**

   It is co-chaired by chief of Pancheshwar Project, Nepal and representative Central Water Commission (CWC) India.

6. **Nepal – India Joint Commission – 1987**

   Headed by foreign ministers of both countries

7. **Joint Team of Experts on Sapta Koshi High Dam and Sunkoshi Kamala Diversion Project: - Dec 1991.**

   The Committee is headed by Executive Director of WECS from Nepal and Chairman Central Water Commission (CWC) India.

8. **Power Exchange Committee – 1992**

   The Committee is headed by Managing Director Nepal Electricity Authority (NEA) and Member (Planning) Central Electricity Authority (CEA) India

9. **Joint Committee on Water Resources – Aug, 2000.**

   The Committee is headed by Secretaries of both countries.

(Source: Ministry of Water Resources HMG/N)

5.2. Categories of Power Exchange

5.2.1. Power (including free share) from the projects as per treaty

There is an existing power exchange agreement between Nepal and India in the boarder areas for up to 150 MW. There could be an arrangement to trade seasonally-available power for certain periods of the year from Nepal to the border areas for up to 150 MW. This range of exchange can evacuate the surplus power available in Nepal and can fulfill the demand in the boarder areas of India.

5.2.2. Seasonally-available power on as and when available subject to technical feasibility

India has entered into the open market and the PTC has been entertaining different types of power purchase agreements, dedicated power supply with long term Power Purchase Agreement, merchant plants selling on the spot market or any other power can be sold in the market in the market price.

Dedicated power plants will have its own transmission line while there is a need to have high voltage interconnection for trading on market in India and Nepal. West Seti of 750 MW is one example, which has been planned for dedicated power to India.

There has been always government to government approach in water and power sharing issues between two countries in the past. Mega projects have been always the primary interest and there has been a problem in getting consensus in cost and benefit sharing issues where multiple benefits are there. It is strongly recommended to start from the private sector where more business approach will be taken up. It will be further beneficial if a joint venture of Nepalese and Indian investors could be made for the project development for export to India. This will reduce many risks and ease the process and open up for better cooperation. This type of cooperation should be started for short term projects with purely commercial venture.

5.3. Implementation Approach

Co-operation in the field of hydropower encompass many issues such as regulatory regimes, matters relating to financing and decision making procedures etc. Further more review of project proposed for implementation vis-à-vis access to market, labour force and construction materials are also involved. As such either party need to deal with on any specific or sets of issues as they arise.

This study also attempts to select example projects for implementation in harmony with respective development policies and intend to proceed by stages with development programs

The intended plan for implementation involves;

- Categorizing identified projects for short term, medium term and long term implementation.
- Selecting doable feasible projects for implementation.
- Opening up access to transmission line for wheeling power produced by private sector.
- Setting up an institution to pool the power and trade it within the country and with India.
- Advocating private sector participation in policy and planning meetings in power development activities.
- Promoting private financing for developing hydropower projects.

Table 5-1: List of Potential Hydropower Projects for Development

S.N.	Projects	Capacity MW
1	West Seti	750
2	Arun 3	402
3	Burhi Gandaki	600
4	Kali Gandaki No.2	660
5	Lower Arun	308
6	Upper Arun	335
7	Karnali Chisapani	10,800
8	Upper Karnali	300
9	Chamelia	30
10	Pancheswar	6480
11	Likhu-4	51
12	Kabeli "A"	30
13	Upper Marsyangdi A	121
14	Kulekhani 3	45
15	Andhi Khola Storage	180
16	Langtang Khola Storage	218
17	Madi Ishaneswar	86
18	Upper Seti Storage	122
19	Kankai Storage	60
20	Upper Tama Kosi	250
21	Tamar Mewa	100
22	Dudh Kosi Storage	300

From the lists mentioned above the projects are categorized for short, medium and long term implementation. The schedule for implementation for short, medium and long term is assumed to be 5, 10 and 15 years. For short terms implementation program, preference is given for mainly to run-of-river projects with or with daily peaking and others with no significant adverse impacts.

5.3.1. Short Term

The short term projects are defined as the projects which can be implemented immediately and be ready within five years in cooperation. These projects will be worthwhile in building up confidence on both sides which has been eroded due to much priority given on the multi-dimensional multi-purpose projects in the past and due to the atmosphere of suspicions and lack of political will and commitment. There are always different arguments being raised, often difficult to reach consensus, without any real implementation of such multi purpose projects.

The identified projects categorized under the short term projects are:

- Burhi Gandaki 600 MW PRoR

- Arun III 402 MW RoR
- Upper Marsyangdi 121 MW RoR
- Upper Karnali 300 MW PRoR *(now 480 MW)*
- West Seti 750 MW Storage

These are the projects of which the major studies have already been completed and therefore will not require much time to initiate. It is essential to recognize that there are no major water rights associated with these projects; they are doable medium-size projects which can go a long way in building confidence between the two countries.

Transmission Interconnection (220 kV-400 kV)

Under the short term projects, fall the transmission interconnection linkages. The following are some of the identified lines to connect between Nepal and India. This interconnection is important to be in place to let the trade happen. The surplus power in Nepal, especially during the wet season can be traded and even the private power producers can optimally use their power plant so that the excess energy can be sold across the southern boarder.

Some of the identified interconnection lines are

- Butwal –Sonauli – Ananda Nagar - 220 kV
- Nepalgunj – Baharaich –Lucknow - 220 kV
- Dhangadhi – Bareilly - 220 kV
- Kakervitta –Siligurhi - 220kV

Instead of making the interconnection as 132 kV transmission line as proposed, it will be prudent to upgrade the transmission to 220 kV double-circuit looking into the future prospects of power exchange and power trade.

5.3.2. Medium Term

Under the medium term projects will be the projects which will take longer time that the short term projects due to the study stage of the project itself or need to developed after the identified short term projects due to the its location.

Some of the projects categorized under the medium term projects are:

- Upper Arun 335 MW
- Langtan Khola 212 MW
- Upper Karnali Storage 4180 MW
- Sapta Gandaki 225 MW

5.3.3. Long Term

Long term projects are the projects with longer duration of implementation due to many reasons. The projects which have multiple dimensions, i.e. not only the hydropower, it may have the purpose of irrigation, flood control, navigation. This may need much intense study, much financial resources, multi dimensional benefit sharing etc. These are the projects which should be taken up after the confidence building in cooperation for larger benefit. These sorts of projects should not be in the front line, as is the present case, which may take much longer time with a single project to arrive at the mutually agreeable solution.

Some of the projects identified for long term category are;

- Sapta Kosi 4700 MW
- Karnali Chisapani 10,800 MW
- Pancheswar 6,480 MW
- Other potential mega projects to be identified in course of time.

These projects should be taken up once sufficient confidence is built between the two countries involving economic, environmental, social interaction and political will.

5.4. Institutional Models for Project Development

There are mainly three models in terms of institutions involvement for the project development

- Government to Government
- Government and Private (Public Private Partnership)
- Private to Private

There has been government to government cooperation in developing projects in the past and now the process has been stagnated mainly due to the multi purpose projects in sharing costs and benefits. There is a need to develop projects fully in commercial basis either government level or private sector. There is a possibility of developing a project for a private developer, national or foreign or in partnership in Nepal and supply power to India.

5.5. Financial and Technical Cooperation

5.5.1. Financial Cooperation

India has comparatively more developed capital markets than other South Asian Countries. Power Projects in Nepal driven by private sector can take advantage of India Capital Market in securing equity, debt and other financial services (insurance and other risk management etc) for their hydropower projects.

Besides there is also a possibility of bilateral financial assistance by Indian government embarked to hydropower development in Nepal. Support by Indian government to the Kingdom of Bhutan for the Chuka Project, helped to enhance the Bhutanese economy significantly.

5.5.2. Technical Cooperation

In absolute numbers, the size of Indian hydroelectricity sector is quite significant. There are several successful public private companies functioning in this sector. Most of the hydro projects in Nepal are run-of-the river type projects. For better and uniform utilization of hydropower, Nepal also needs to develop few storage projects. Indian side can certainly help in this regard so that cost can be kept to its minimum.

- Import of hydroelectricity by India;
- Export of thermal based electricity by India in the lean season;
- Dedicated hydropower plants in Nepal to export to India to take advantage of CDM and emission trading opportunities.

6. CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

In conclusion, it can be said that Nepal and India both have considerable benefits to reap through the sound and sustainable development of hydropower in Nepal and with the setting up of high-capacity transmission interconnections in selected corridors. Power trading activities can thus, provide the right impetus for accelerated economic growth of the two countries.

It is thus essential that certain confidence-building measures be taken up and a sound legal and regulatory framework be setup to develop projects and conduct power trading activities between the two countries. The major observations are:

- 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 by product 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 (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;
- Power exchange between Nepal and India falls under three categories:
    - Power from Indian assisted projects like Koshi, Gandak, Tanakpur, etc. under separate agreements. This exchange can continue as stipulated in respective agreements.

- Border-area power exchange: This exchange is very useful and can be continued till demands are met by alternate sources by either country.

- Committed export Projects in Nepal: Medium size hydroelectric projects can also be started. Financing of the project could be mobilized jointly by involving private sectors of both the countries and the governments should encourage with proper facilities to the developers. A separate project can be launched – West Seti hydroelectric type of model could be one example.

- Up till now only governmental institutions of both the countries have been working for cooperation in hydropower development with limited achievement so far. Nepal and India both have agreed in principle, for the participation of private sector in the field of hydropower development and power trading. If implemented confidently, this is a very positive step and may prove to be a major milestone for the future hydropower development in Nepal and trading of power between two countries.

- Some encouraging steps, however recently have been taken, and it is hoped that positive out come will emerge in the following projects.

  - Power Trading Agreement between two countries allowing private sector in the field of power generation and trading.

  - Private sector participation like, West Seti High Dam hydroelectric project and public sector joint venture project like Upper Karnali Hydroelectric Project.

6.2. Recommendations

The following measures and recommendations, therefore, need to be recognized and undertaken at the earliest:

- Past experiences show that even within a country consumptive use of water sharing create sensitive problems. It is important to create environment of trust between two countries step by step to proceed in this direction. Sharing of project cost in proportion of accruing benefits is the subject of prime concern. It requires a high level of trust in each and transparency in the calculation of cost and benefits based on fair and agreed principles. Past experiences explain that before launching such mega projects, some medium size projects should be started where environmental and social issues are low, electricity generation portion is high and consumptive use of water has low impact. Budhi Gandaki Hydroelectric Project could be a good case to take up in this context.

- An independent regulator is needed for generation, transmission and distribution of electricity. This encompasses greater importance when power is to be traded across the international boundary.

- An independent power transmission grid organization is required to wheel the surplus power from independent power producer.

- Sound regulatory and policy reforms are very important for Nepal to attract investment;
- Nepal should strengthen its transmission network within the country and also the interconnections with India.
- Presently quantum of exchange is agreed at 150 MW. Seasonally-available power from Nepal upto this limit can be exchanged under this agreement till the time when the surplus power is below this limit.
- Hydropower development in Nepal should take advantage of well developed capital markets, the technical capacity and power markets of India.
- Focus should be on investment rather than studies and meetings only;
- Low risk, quick yield less-controversial projects should be started to build confidence in the beginning.
- Private sector should be an important stakeholder in the entire process;
- Start with immediately doable projects, like ROR or PROR projects of ranging 100 MW to 500 MW.
- Private sector should also be included in the Joint Water Resources Committee from both the countries
- Run of river projects are most suitable to start with for confidence building measure. Some storage projects can also be initiated where other uses of water are not of much concern.
- Public awareness regarding power project development and power trading is important to eradicate suspicion and generally negative notions regarding power trading.
- Some institutional and legal reforms may be required in Nepal to facilitate future power trade with India.
- There is a need of an independent power trading agency including private sector in Nepal for power trading.
- The governments on either country should facilitate the private sector for project development and cooperation.
- Governments on both sides should view hydropower projects in Nepal as enabler of regional stability and prosperity.
- Dedicated hydropower plants in Nepal to export to India can utilize the CDM opportunities.
- To expedite the process, IPPAN from Nepal and CII from India can play a key role to facilitate for the project development and private sector mobilization on

respective countries. The government in both countries should encourage the private parties through trade agreements, and they can also be involved as equity partners with private parties in project development.

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