TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

PULCHOWK CAMPUS

THESIS NO: 072/MSP/701

"Future Energy Mix of Nepalese grid and its effect on Power System"

By

Bharat Lamichhane

A THESIS

SUBMITTED TO THE DEPARTMENT OF ELECTRICAL ENGINEERING

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE

DEGREE OF MASTER OF SCIENCE IN POWER SYSTEM ENGINEERING

DEPARTMENT OF ELECTRICAL ENGINEERING

LALITPUR, NEPAL

June, 2023

COPYRIGHT

TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

PULCHOWK CAMPUS, PULCHOWK

DEPARTMENT OF ELECTRICAL ENGINEERING

The undersigned certify that they had read, and recommended to the Institute of Engineering for acceptance, a thesis report entitled **"Future Energy mix of Nepalese grid and its effect on Power System"** submitted by **Bharat Lamichhane** in partial fulfillment of the requirements for the degree of Master of Science in Power System Engineering.

Associate Prof. Dr. Netra Prasad Gyawali
Supervisor
Chief executive Officer
Rastriya Prasaran Grid Company Limited

Prof. Dr. Bhupendra Bimal Chhetri
External Examiner
School of Engineering, Kathmandu University

Asst. Prof. Yubraj Adhikari
Head of Department
Department of Electrical Engineering

Asso. Prof. Dr. Basant Gautam
Programme Co Ordinator
Msc in Power System Engineering

Date: June, 2023

ABSTRACT

Energy mix refers to the combination of different sources in to the grid to increase the power system reliability. In Nepal most of electricity is from hydro power plant. There are other alternative sources of energy to produce an electricity but hydro is much more available resources to produce electricity. There are different types of schemes of hydro power plants which can be operated to meet base load, intermittent load and peak load.

In current situation, there is some deficit of energy. So country is importing energy from India via different points. The generation pattern of hydro power plant is highly dependent in natural phenomenon of rain and hence the flow of water in river. In wet season the generation from run off river hydro power plants is high but in dry season the generation is low. Due to this there is large unbalance may arise in the system. The energy surplus deficit analysis will give an overview of future energy situation in advance which will be very helpful for energy planner to take necessary decision. Energy surplus analysis for fiscal year 2087/088 and for fiscal year 2092/093 under three scenario viz: under 4.5 % with only half of all generation license issued RoR/ PRoR projects in operation within fiscal year 2087/088 and half of generation license applied projects(RoR/PRoR) comes in operation till fiscal year 2092/093 (Scenario 1); under 4.5 % Economic growth rate with all generation license issued projects in operation within fiscal year 2087/088 and all generation license issued and generation license applied projects comes in operation till fiscal year 2092/093 (scenario 2) and under 7.2 % Economic growth with all generation license issued projects in operation within fiscal year 2087/088 and all generation license issued and generation license applied projects comes in operation till fiscal year 2092/093. Energy surplus and deficit situation with need of storage capacity during the planned year under all three scenario is summarize in table below.

	For Fiscal Year 2087/088			For Fiscal Year 2092/093		
	Energy Surplus (GWh)	Energy Deficit (GWh)	Additional storage capacity requirement (Mw)	Energy Surplus (GWh)	Energy Deficit (GWh)	Additional storage capacity requirement (Mw)
Scenario 1	7,441	880	1,305	11,040	1,340	2,158
Scenario 2	20,374	-	-	3,335	-	-

Scenario 3	15,537	47	893	29,055	-	1,560

The proper selection of RoR, PRoR and storage power plant is very much essential for sustainable development of power system. Increase in storage type project will help in increasing the dry energy as well has contribution on peak load management. Introduction of storage projects reduces the energy surplus in wet season and supports to supply peak demand. So, introduction of storage project is very essential for self-sustainability and energy security. About 1305 MW storage project will be sufficient for fiscal year 2087/088 to manage the demand for every situation, whereas for fiscal year 2092/093 it will be required about 2158 MW storage project. Operation of these storage projects will results decrease in energy spill during wet season and increase in dry energy during peak hours. Annually huge amount can be earned by the country from energy trading if there is no restriction by transmission facilities. Out of five zones there will have excess capacity available in four zones (except zone 2) in F/Y 2087/088. So international electricity transmission lines from Anarmani, Dhalkebar, Butwal and Dododhara has to be completed in time for possible trading in future. Thus, the information about the availability of hydro power projects in different location for different year with possible energy generation and possible energy situation will also be helpful to manage generation expansion planning, on prioritization of the projects, trading and energy banking policy making and negotiations of energy trading, energy market planning, etc.

ACKNOWLEDGEMENT

I would like to thank my supervisor, Associate Professor Dr. Netra Prasad Gyawali for his guidance throughout the period of this work. His valuable support, understanding and expertise have been very important in completing this work. It was a great honor for me to pursue my thesis under his supervision.

I would like to thank Professor Dr. Nava Raj Karki, Department of Electrical Engineering for all of his support and guidance throughout my time.

My special thanks go to Er. Dinesh Kumar Ghimire, Secretary, Ministry of Energy, Water Resources and Irrigation for his help during the period of study.

I would also like to thank head of Department, Msc. Programme Coordinator and rest of faculty members of Department of Electrical Engineering, for their valuable input and for taking the time to review my thesis.

I would like to express my sincere gratitude and appreciation to Er. Subash Thapaliya and Er. Bijay Puri for providing the relevant documents and his help in the work.

My thanks are also extended to the Department of Electrical Engineering, Pulchowk Campus, Pulchowk for a nice atmosphere, kind treatment and support.

Last but not least, I would like to express my deepest appreciation to my parents and my family for their never-ending love and constant support.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS, SYMBOLS AND ABBREVIATIONS

AC	Alternating Current
BAU	Business as usual
CA	Connection Agreement
DoED	Department of Electricity Development
GDP	Gross domestic product
GWh	Giga watt Hour
HPP	Hydro power Project
INPS	Integrated National Power System
KV	Kilo Volt
KW	Kilo Watt
KWh	Kilo watt-hour
MW	Mega Watt
MWh	Mega watt-hour
MoEWRI	Ministry of Energy, Water Resources and Irrigation
NEA	Nepal Electricity Authority
PPA	Power Purchase Agreement
RoR	Run of river
PRoR	Peaking Run of river
RPGCL	Rastriya Prasaran Grid Company Limited
WECS	Water and Energy Commission Secretariat

CHAPTER 1 INTRODUCTION

1.1 Background

Nepal is a landlocked developing country with large potential of hydropower development. There are many perennial rivers and streams flowing from north to south. These rivers and stream have high potential of hydro power theoretically about 83,000MW. But technically about 43,000 MW can be produced within the country. Today, the major source of energy in Nepal is hydroelectricity. More than 95% of energy in INPS is from hydropower plant. Hydro power plants in Nepal are of basically of three categories; Run of River (RoR), Peaking Run of river (PRoR) and Storage. Run of river type hydro power plant do not have any storage facility. They produce the power as per the availability of water in the river. Peaking run of river hydro power plant have some small area for daily water storage ranging from 1 hr. to 6 hr. Storage power plant have facility to store large water in reservoir.

The flow of water in river depends on the natural phenomenon of rainfall. So, the quantity of water in river will be high in rainy season and decreases to about one third in dry season. Therefore, the generating capacity of hydropower plants in Nepal changes with the season. In the wet season, the power as well as the energy generation from RoR and PRoR is high and in the dry season the power as well as the energy generation is low. So, energy generation in Nepal is not uniform throughout the year.

Besides the water resources for power generation, solar power is another alternative source which is freely available throughout the year. The average global solar radiation in Nepal varies from 3.6 – 6.2 KWh/m^2day, sun shines for about 300 days in a year and average insolation intensity is about 4.7 KWh/ m^2day. Based on these the total energy generation potential of country is about 83,000 GWh per day [1]. About 47,628 MW from solar and 1686 MW from wind energy can be harnessed in Nepal [2]. As compare to the hydro power, the contribution of solar in national grid is very small and government priority on solar power generation is also less as compare to hydro power. Installed capacity about 47,200 MW hydro power projects except Pancheshwor, Karnali chisapani, Saptakoshi High dam, are identified by private sector and government entities out of which some are under construction, some are ready for construction and some are under study. After Electricity Act, 2049 and Electricity regulation, 2050; the private participation in the development of

hydro power started. The over view of hydro power commencement in different fiscal year is shown in Figure 1-1.

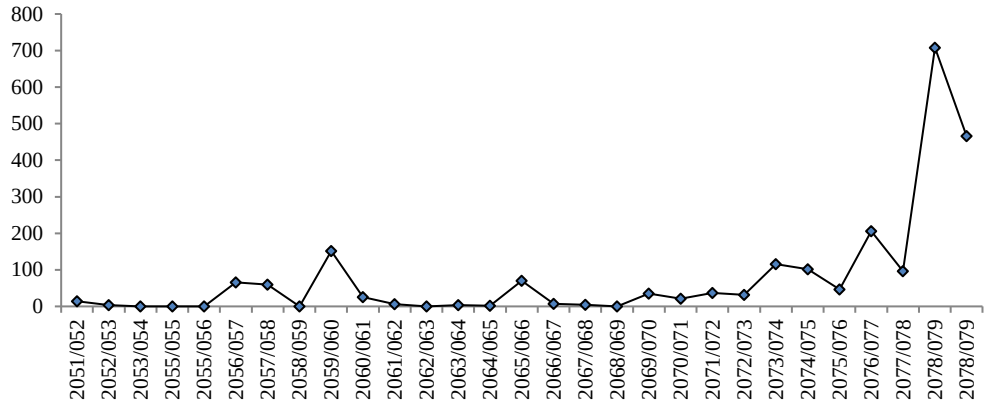


Figure 1-1 Yearly addition of hydropower plants

As Nepal is the developing country, the GDP of the country is low. The use of the electricity is very less. Mostly, people use electricity for lighting purpose. Nowadays electricity in cooking, cooling, heating and ventilation application also increasing. There are some limited numbers of industries that consumes large amount of electricity. The application of electricity in transportation sector is very less but it is increasing in electrical vehicle such as scooter, car and buses. People uses electricity for water pumping purpose in agricultural sector. There is higher electricity demand in summer season as compare to winter season.

1.2 Problem Statement

The major source of electricity in INPS is hydro and most of the hydropower plants are of run of river (RoR) type. The energy generation from hydropower plant mainly depends on the natural phenomenon of rain and hence water availability in the river. Generation of energy will be high during wet and falls to one third in dry season. So, power system of Nepal is expecting surplus energy in wet season and deficit energy dry season. Lack of projection of monthly energy surplus and deficit in future with possible demand and generation variation is resulting into no idea about monthly quantitative energy for trading. Proper planning of storage project to accommodate all the demand and generation in future should be study in advance to tackle any abnormalities in future INPS as well as to make dialogue with other countries on energy trading. Studying future energy generation in advance will help on proper planning of hydropower projects in the country. This

necessitates precise analysis of future energy mix in Nepalese grid under different scenario and its effect on power system to balance generation and demand with maximizing utilization of natural resources with less curtailment in operating projects.

1.3 Objective and Scope

The main objective of this study is to identify the possible energy sources mix in future and need of storage project in the country for secure power supply. In order to achieve the main objective, the following scope are set.

- To compare the different foretaste report with present demand to predict possible future demand scenario.
- Determine the plant capacity factor of different types of projects.
- Determine monthly expected energy generation for fiscal year 2087/088 (2030AD) and fiscal year 2092/093 (2035 AD) considering 4.5% economic growth rate and 7.2% economic growth rate when all estimated projects come into operation i.e., 100% generation.
- Determine monthly expected energy generation for fiscal year 2087/088 (2030AD) and fiscal year 2092/093 (2035 AD) under 4.5% economic growth rate considering only half of RoR/PRoR projects under consideration comes in operation i.e., 50% generation scenario.
- Recommend monthly energy surplus or deficit for projected fiscal year in each scenario considered.
- Determine the possible monetary benefit from energy trading in projected fiscal year.
- Determine the capacity availability in different international interconnection points for projected year.

1.4 Outline of the Thesis

This thesis is organized into five chapters:

Chapter 2 gives the overview of literature on the different types of power plants its nature and characteristics. Also, it gives the overview of literature on the different types load forecast study as well as energy trading studies and plan and policies of government of Nepal.

Chapter 3 presents the methodology used for future energy scenario study with storage capacity assessment and its implication on Nepalese energy sector.

Chapter 4 describes the analysis and output of the study. The outputs are analyzed and discussed in this chapter.

Chapter 5 summarizes the thesis main points and contributions, and proposes future directions for research.

Finally, the thesis ends with list of papers referred for this study.

CHAPTER 2 LITERATURE REVIEW

Most of the sources of electricity in Nepalese power system is hydro. Hydro power plant utilizes the moving water in the river and streams. There are different types of hydro power plants based on the capacity of water storing facilities. They are run of river (RoR), peaking run of river (PRoR) and storage. Different hydro power plants have different nature in generation pattern. The capacity factor of run of river and storage type hydro power plant is different. The capacity factor of a hydro power is a measure of its efficiency and indicates the percentage of time that the plants operate at maximum capacity over a given time period. Plant capacity factor is defined as the actual energy generated divided by the maximum possible energy that the plant might have generated during a given period. The capacity factor depicts the extent of the use of the power plant. Plant capacity factor is given by

$$\text{Plant Capacity factor} = \frac{\text{Units generated in a given period}}{\text{Rated Capacity in KW} * \text{number of hours in given period}} \quad (2.1)$$

2.1 Government plan and policies on Energy Sector

Government of Nepal in 2075 BS has aim of being self-dependent in energy sector by utilization of internal resources by producing 15,000 MW in upcoming ten years. Generation mixes of about 30-35 percentage of storage and pump storage projects, 25- 30 percentage of PRoR and 30 – 35 percentage of RoR is considered for PPA purpose to get the target of 15,000 MW in upcoming ten years. About 5-10 percentage of alternative sources are considered to connect in the national power system [3]. Also, the 15th periodic plan of Nepal has goal of ensuring energy security through intensifying hydropower generation. The installed capacity of hydropower will be reached to 5,000MW with all local levels and 100 percent of the population will have access to electricity with per capita consumption of 700 KW per hour [4]. The government have target to generate 15,000 MW of installed capacity and increase per capita electricity consumption to 1500 KWh in 2030 AD [5].

Resources of electricity generation in India are not sufficient so that demand can be meet by importing the energy from neighboring countries like Nepal, Bhutan, Myanmar, etc. Nepal will have potential of energy export to India after 2020 AD if there is not limitation

on cross boarder transmission line. India imports electricity from Nepal even when its own hydro potential of 145 GW is fully utilized [6].

2.2 Energy Mix in generation

Energy mix refers to the combination of different energy sources used for electricity generation. The energy mix is essential for achieving energy security, reducing environmental impact, mitigating climate change, fostering Economic growth and promoting equitable energy access. A diversified and sustainable energy mix is crucial for a resilient. Low carbon and inclusive energy system that meets the present and future energy need of society. There were several studies on energy mix with the objective of reducing the cost of generation and environmental effects. The long-term energy mix optimization study was carried out for Polish power system using load duration curve. The model was developed which optimized the energy mix in long term perspective (2020-2050) with annual step. The energy mix optimization model eMix was used to minimize the total cost of power units' construction and operation. The cost was divided into fixed cost and variable cost. This developed a long-term energy mix optimization methodology with the application of the residual load duration curve approach [7].

The optimum renewable generation mix of hydro, wind and photo voltaic for integration in to the Portuguese power system was carried out using multi objective formulation. The analysis for different scenarios considering renewable generation and demand data were carried out using the active set algorithm of fmincon MATLAB function. Constraint multi objective optimization model was applied to the Portuguese power system to derived the optimum mix of hydro, wind and PV renewable sources.

The vision of Bangladesh is to become high-income nation by the year 2014. The demand was forecasted to 60GW by 2041. The generation sector of Bangladesh is largely depended on natural gases however it is predicted that natural gas will be depleted by the year 2028. Considering the Economic value and the environmental value of the energy, energy mix of Bangladesh was estimated. The estimate suggests that the use of 25% coal, 25% natural gas and 35% renewable will ensure the best energy mixed of Bangladesh. For the estimation per unit cost of electricity for each fuel type was calculated. Per unit cost of electricity generation was minimum when share of natural gas is maximum but as the reserve of natural gas is limited, the energy mix of 25% coal, 25% natural gas and 35% renewable was selected [8].

The future power generation mix of Nepal was analyzed for different economic growth scenario i.e., 4.5%, 7.2% and 9.2 % up to 2040AD and after that 5 % and 4% for 2045 and 2050 respectively. The objective function was to minimize the net present value of total power system costs over entire planning horizon (i.e., 2015 to 2050 AD). The IBM CPLEX optimization studio was employed to identify an optimal power generation mix in each scenario. The optimal technology mix was further investigated by creating a 100 % renewable and hydro for generation. The result shows that RoR types hydro can serve as a base load power plant with PRoR operating to meet fluctuating hourly demand, denying the requirement of storage technologies in almost all scenarios. In zero emission scenario, the capacity of storage hydro is increased which will substitute the power from coal-based plant. This will reduce the dependency on imported fuels or electricity [9].

2.3 Transmission System Planning of Nepal

Nepal electricity authority (NEA) is an entity in Nepal who is responsible for transmission and distribution of electricity in Nepal. It is a single buyer and distributer of electricity in Nepal. It has separate system planning department which does the scenario analysis of demand and generation and based on it they plan for the power system expansion. Every year NEA publish an annual report which provides the technical as well as financial and organizational performance information. In annual report 2021-2022, NEA has published transmission line network of Nepal including completed transmission lines, under construction transmission line and planned construction line. The transmission line voltage ranges from 66 KV to 400 KV. This also includes the proposed international transmission lines [10]. Power development map of Nepal published by NEA is attached in annex 4.

In 2018, Rastriya Prasaran grid company Limited (RPGCL) has prepared a Transmission system development plan of Nepal. The plan of transmission line is for the year of 2040 AD. The study was carried out dividing the whole country in to five zones. Zone 1 includes 14 districts namely, Humla, Mugu, Jumla, Darchula, Bajhang, Bajura, Kalikot, Baitadi, Doti, Achham, Kanchanpur, Kailali, and Surkhet. Zone 2 includes 11 districts namely Dolpa, Jajarkot, Rukum, Dailekh, Surkhet, Salyan, Rolpa, Pyuthan, Dang, Banke and Bardiya. Similarly zone 3 consists of 17 districts namely, Mustang, Myagdi, Kaski, Manang, Lamjung, Baglung, Gulmi, Arghakhachi, Kapilvastu, Rupandehi, Palpa, Syangja, Tanahun, Nawalparasi, Chitwan, Gorkha and Parbat. Zone 4 consists of 18 districts namely Rasuwa, Dhading, Nuwakot, Sindhupalchowk, Dolakha, Kathmandu, Bhaktapur, Lalitpur,

Kavrepalanchowk, Ramechhap, Makawanpur, Sindhuli, Parsa, Bara, Rautahat, Sarlahi, Mahottari and Dhanusha. Similarly zone 5 consists of 16 districts namely Solukhumbu, Sankhuwasabha, Taplejung, Okhaldhunga, Khotang, Bhojpur, Tehrathum, Panchthar, Dhankuta, Udaypur, Ilam, Siraha, Saptari, Sunsari, Morang and Jhapa. This plan has proposed different possible corridor of transmission line of voltage level upto 400 KV. Various north south and east west transmission line corridor were identified to evacuate the power from generation area to load area [11]. The transmission system development map is attached in annex 5.

The 10th meeting of energy secretarial level Nepal- India joint steering committee, JSC in India have agreed to increase the capacity of Dhalkebar – Muzaffarpur 400 KV transmission line from 600 MW to 800 MW and exchange electricity about 70 MW to 80 MW from Tanakpur - Mahendranagar 132 KV transmission line. Also, meeting has agreed to do study of possible alternatives on export up to 200 MW electricity to India and complete second international New Butwal – Gorakhpur 400 KV transmission line by 2025 AD. There is a plan to construct Inaruwa – Purniya 400 KV transmission line and New Lamahi (Dododhara) – Bareli 400 KV transmission line by 2027/028 and 2028/029 respectively. Also, there were many dialogues between Nepal, India and Bangladesh on trading of electricity with Bangladesh via India [12].

2.4 Demand forecast

In Electricity demand forecast Report (2015-2040) [13], three scenarios of Economic development have been taken into account. These three scenarios are

i) Business as usual (BAU): 4.5% economic Growth rate ii) Reference: 7.2% economic Growth rate and iii) High Growth Rate: 9.2% economic Growth rate

Extra Analysis has been done with various policy intervention such as 10% of cooking with electricity and 75% of water heating with electricity in urban area by 2020, metro in cities by 2025, etc. at 7.2% and 9.2% economic growth rate.

The planning period of 25 years (from 2015-2040) has been taken into consideration. This report used Model for Analysis of Energy Demand (MAED) prepared by IAEA to evaluate future energy demand based on a set of consistent assumptions on medium to long-term socio-Economic, technological and demographic development in a country. The electricity demand from 2015 to 2040 at different time step was estimated as present in Table 2-1.

Table 2-1 Demand Forecast by WECS

Year	Final Electricity Demand (GWh)					Growth Rate of Final Electricity Demand (% p.a.)				
	BAU	Reference Scenario	High Scenario	Policy Intervention @ 7.2%	Policy Intervention @ 9.2%	BAU	Reference Scenario	High Scenario	Policy Intervention @ 7.2%	Policy Intervention @ 9.2%
2015	3866.3639	3866.363904	3866.36	3866.36	3866.36					
2020	7600.75872	8110.66	8522.97	14870.92	15304.29	14.5	15.10	17.13	30.92	31.67
2025	12998.2503	14863.67	16545.84	22431.68	24265.05	11.3	12.19	14.19	8.57	9.66
2030	20073.8344	24956.79	29864.09	35334.66	41264.82	9.1	10.25	12.54	9.51	11.20
2035	29744.6919	40709.77	52983.16	51771.84	65657.50	8.2	9.64	12.15	7.94	9.73
2040	43016.6893	66096.60	94851.06	81958.97	115294.44	7.7	9.50	12.35	9.62	11.92

Based on the power system Master Plan for Nepal, Load forecast Report 1997 by Norconsult under ADB's technical assistance program, System planning department of Nepal electricity authority has prepared the Load forecast Report, 2014/15 which covers internal load growth of Nepal from the period of F/Y 2014/15 to F/Y 2033/34.

Based on the estimated economic growth of F/Y 2015/16 and the population of Population census 2011, the economic growth rate and population projection was done as 1.98 % on 2014/15, 4.59 % for F/Y 2015/16 to 2017/18, 5.08 % for F/Y 2018/19 to 2022/23, 5.5 % for 2023/24 to 2027/28 and 6.07 % for 2028/29 to 2033/34 per annum for the base case of the forecasting period. From F/Y 2014/15 to 2020/21, 4 % growth was assumed to meet the electrification ratio of 80% in F/Y 2020/21. After that the rate was consider to meet the electrification ratio of 90 % in F/Y 2033/34. The income elasticity of 1.4, price elasticity of -0.4 and inflation of 7% has been taken for the whole planning period. GDP growth rate for industrial, commercial and other sector sector was taken separately during the study. Different model for domestic sector, industrial, commercial and other sector and irrigation sector were developed during forecast. Load forecast report, July 2015 by NEA system planning development was prepared on an unconstrained basis with respect to NEA's ability to provide the energy required. The demand model in this forecast includes the demand mode for domestic sector, industrial, commercial and other sectors and irrigation sector. Forecast at two cases are presented, one is base case and another is optimistic case [14]. The energy forecast at base case is as in Table 2-2.

Table 2-2 Demand Forecast by NEA under base case

Fiscal Years	Domestic Energy (GWh)	Industrial Energy (GWh)	Commercial Energy (GWh)	Irrigation Energy (GWh)	Other Loads (GWh)	Internal Consumption	Nepal Energy Demand
2013/14	2,138.90	1,618.65	369.09	50.92	334.88	3.5	4,515.91
2014/15	2,249.01	1,801.89	380.51	70.78	357.02	3.7	4,862.87
2015/16	2,500.28	2,008.59	411.43	91.63	391.04	3.8	5,406.80
2016/17	2,772.01	2,192.02	444.86	113.52	428.30	4.0	5,954.73
2017/18	3,065.69	2,543.88	481.00	136.51	469.11	4.2	6,700.41
2018/19	3,409.20	2,847.56	520.83	160.64	514.54	4.4	7,457.21
2019/20	3,787.29	3,159.67	563.96	185.98	564.36	4.7	8,265.93
2020/21	4,198.76	3,307.32	610.66	212.59	619.02	4.9	8,953.24
2021/22	4,634.33	3,464.54	661.23	240.53	678.96	5.1	9,684.74
2022/23	5,082.17	3,631.95	715.99	269.87	744.71	5.4	10,450.09
2023/24	5,582.84	3,812.51	776.49	300.68	818.08	5.7	11,296.26
2024/25	6,107.47	4,004.93	842.10	333.02	898.68	5.9	12,192.15
2025/26	6,652.43	4,209.97	913.26	366.98	987.22	6.2	13,136.11
2026/27	7,219.30	4,428.48	990.43	402.64	1,084.48	6.6	14,131.89
2027/28	7,809.79	4,661.33	1,074.12	440.08	1,191.32	6.9	15,183.53
2028/29	8,502.10	4,912.64	1,166.56	479.40	1,310.55	7.2	16,378.48
2029/30	9,266.99	5,180.65	1,266.96	520.68	1,441.71	7.6	17,684.57
2030/31	10,097.43	5,466.49	1,375.99	564.02	1,585.99	8.0	19,097.89
2031/32	10,999.00	5,771.32	1,494.41	609.53	1,744.72	8.4	20,627.35
2032/33	11,977.76	6,096.42	1,623.02	657.32	1,919.33	8.8	22,282.64
2033/34	13,040.26	6,443.14	1,762.69	707.50	2,111.42	9.2	24,074.23

Other energy demand analysis was done by various institution such as by Investment Board Nepal (IBN), Asian development bank and Japan international cooperation agency (JICA). National Planning commission and IBN have jointly conducted energy demand analysis for year 2030 AD. This study has used MAED policy tool considering the following assumption:

Base year is 2014 AD and population growth was taken as 1.35 % p.a. GDP was taken as 5 % and by 2030 AD agriculture and irrigation will be powered by electricity exclusively and fossil fuel and transportation partially. 52 % of total cooking energy for urban household and 45 % of total household cooking energy in rural will be from electricity. The energy demand for base case scenario for different year were forecasted as in Table 2-3.

Table 2-3 Energy Demand forecast by IBN

Year (AD)	Energy Demand (Gwyr)
2014	0.707
2020	1.493
2025	2.462
2030	3.817

2.5 Studies on international trading of electricity in India

South Asia Regional Initiative for Energy Integration (SARI/EI) has carried out an analytical study on Economic benefits from Nepal – India electricity trade in 2017 AD. The primary objective of the study was to improve energy co- operation between Nepal and India by strengthening policy and decision makes and other stakeholders with necessary information on the scope and benefits of cross border electricity transmission (CBET) to strategic its promotion and implementation. The physical power system of Nepal and India were modelled separately using energy system modelling software TIMES. To access the potential gain from increased cross border electricity transmission, three scenarios were developed namely; Base, Accelerated Power Trade (APT) and Delayed Capacity Addition (DCA). The study results that Nepal's hydropower potential could be a source of large Economically feasible electricity export to India starting from the year 2025. Former the development of trade infrastructure takes place, the better would for Nepal to import and export electricity. Without emphasis on electricity trade in the base scenario a number of storage type hydropower projects are required to meet domestic demand. With trade in APT exploitation of hydropower potential is through ROR plants which are the cheapest and easiest to construct [15].

As resources of electricity generation in India are not sufficient. The potential of electricity imports to meet future electricity requirements in India from neighboring countries was analyzed based on the electricity generation, consumption and future generation potential data. Electricity generation demand of India and its neighboring countries by 2050 was projected to identity the possibilities of CBET with its neighboring countries. The neighboring countries on the analysis was Nepal, Bhutan, Bangladesh, Myanmar, China, Afghanistan, Pakistan, Maldives, Sri Lanka. The potential of hydro, wind and solar in India is estimated to be 150 GW, 65 GW and 100 GW respectively which is not sufficient to meet future requirement [6].

Nepal is selling electricity in Indian power exchange (IEX) in day a head market during energy surplus period specially in wet seasons. Annual energy export to India during F/Y 2077/078 was about 44 GWh where as in F/Y 2078/079 it was about 493 GWh. Average power purchase rate in F/Y 2077/078 was NRs. 6.75 per KWh which is decreased to NRs. 6.13 per KWh in F/Y 2078/079. In 2077/078, about 2806 GWh energy was imported but in F/Y 2078.079 it was only 1543 GWh [10]. The price of electricity in day a head market

varies with time of day. The price will be high during peak time and low during off peak time. The annual weighted market clearing price of IEX is shown in Figure 2-3 [16].

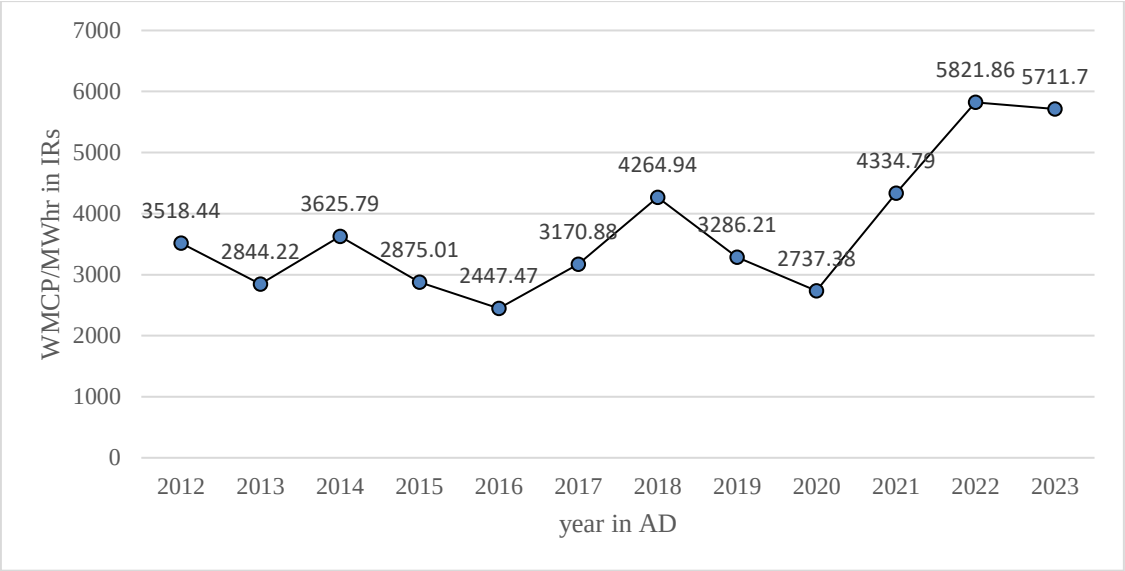


Figure 2-1 Weighted average Market Clearing price (MCP) of IEX

2.6 Load Pattern of the country and load distribution

Integrated National Power System of Nepal is dominated by hydro generation as the source of generation. More than 95 % of energy comes from hydro power within the country. The load in the system is domestic load, industrial load, commercial load, agricultural load, transportation and some others. Mainly the system load is domestic load. About 92.51 % of total population on Nepal has access to electricity. The total energy consumption in F/Y 2021/022 was about 8,823 GWh which is an increase by 21.28 % over the corresponding in F/Y 2020/021. Some year before the peak demand in the system was in dry season but in F/Y 2021/022, peak demand was shifted to wet season, in Asar. Annual national peak demand in F/Y 2021/022 was about 1,748 MW with annual national energy demand of 10,686.17 MWh. The annual load factor was about 65 %. Variation of demand and monthly load factor is attached in annex 6 [10]. The load distribution throughout the country in not uniform. Mostly zone 4 have large load concentration than other. About 47 percentage of total national load is in zone 4. About 25 percentage loads distributed in zone 3, about 14 percentage loads distributed in zone 5, about 9 percentage in zone 1, and about 5 percentage load is distributed in zone 2. The detail is attached in annex 6.

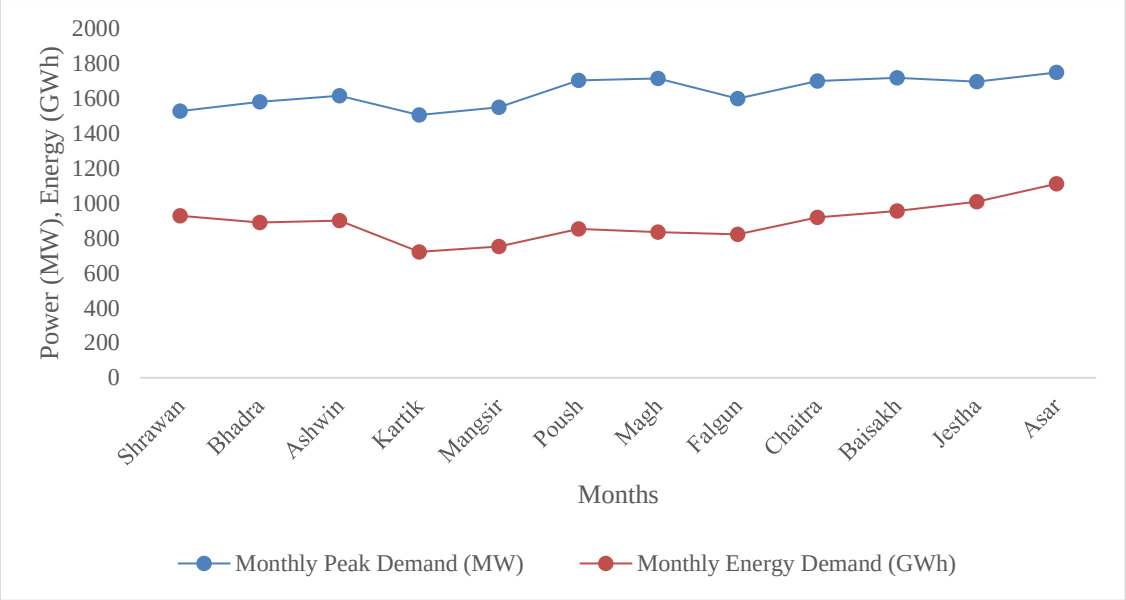


Figure 2-2 Monthly national peak demand and monthly energy demand in F/Y 2021/022

In order to get more precise value of plant capacity factor, weighted average plant capacity factor is used. The weighted average of all monthly average plant capacity factor can be determine using equation 2.2 [17]

$$\text{WAMCF} = \frac{\text{AMCF1}*\text{C1}+\text{AMCF2}*\text{C2}+\cdots+\text{AMCFn}*\text{Cn}}{\text{C1}+\text{C2}+\cdots+\text{Cn}} \quad (2.2)$$

Where,
WAMCF = weightage average monthly capacity factor
AMCF1 = average monthly capacity factor of plant 1
AMCF2 = average monthly capacity factor of plant 2
AMCFn = average monthly capacity factor of plant n
C1 = Plant installed capacity of plant 1
C2 = Plant installed capacity of plant 2
Cn = Plant installed capacity of plant n

For the year 2078/079, there was capacity and energy surplus during some months of wet seasons. During months of Asar, Bhadra, Ashwin, Kartik, and Mangsir energy was traded in Indian market while in rest of the months, energy was buying from India. Similarly, except from Jestha, Asar and Kartik, domestic generation capacity was not sufficient to meet monthly peak demand. The energy and capacity surplus and deficit during different months of fiscal year 2078/079 is shown in figure 2-3 and figure 2-4 respectively.

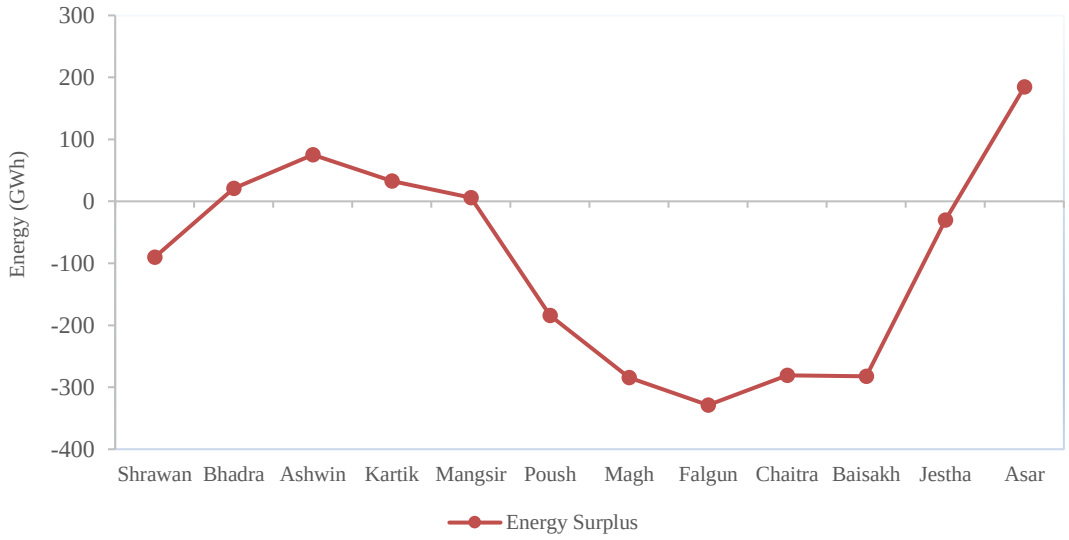


Figure 2-3 Energy surplus/deficit during fiscal year 2078/079

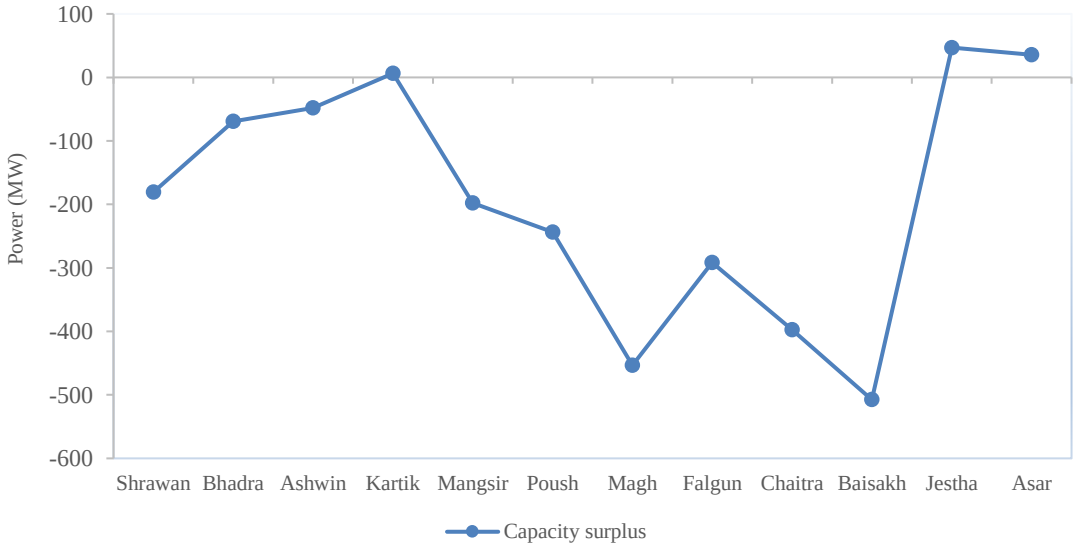


Figure 2-4 Capacity surplus/Deficit during fiscal year 2078/079

CHAPTER 3 METHODOLOGY

3.1 General

The outline of this work begins form literature review, existing practices and study of available materials in relevance to this topic. From literature review it can be comprehended that there is necessity of analyzing the types of hydro generation mix in the power system.

The beginning step of methodology involves the collection of literature related to the load forecast of Nepal; generation pattern of RoR, PRoR and storage power plants and monthly load and energy demand variation. In overall the methods that has been applied for completion of thesis are as follow.

1. Identification of problem due to generation pattern of different possible energy source mix on future power system of Nepal and identification of different possible consumption scenario to determine the importance and need of storage projects in the power system.

2. Data collection:

   a) Collection of monthly energy generation data of different hydropower projects under operation in Nepal.

   b) Collection of information of operating projects, under construction projects (i.e., generation license issued projects) and ready for construction (i.e., application for generation license) projects from Department of Electricity Development (DoED).

   c) Collection of load distribution data all over the Nepal and different transmission line information from Nepal Electricity Authorities.

   d) Collection of data related to energy exchange rate in Day-a-head market of IEX from IEX.

   e) Comparison of different forecast with actual demand.

3. Calculation of monthly plant capacity factor of individual hydropower projects by performing mathematical analysis in MS excel based on their past energy generation data.

4. Calculation of capacity factor of solar projects based on their estimated energy generation presented in study reports.

5. Estimation of generation pattern (capacity of ROR, PRoR and storage projects for different month taking estimated power output of different RoR, PRoR and storage projects in Nepal.

6. Verification of calculated generation with actual generation of year 2076, fiscal year 2077/078 and fiscal year 2078/079 to check reliability of the data.

7. Calculation of expected energy generation in fiscal year 2087/088 (2030 AD) and fiscal year 2092/093 (2035 AD).

8. Calculation of surplus or deficit energy for every month of the projected year and capacity to meet monthly peak demand.

9. Calculation of benefit from energy trading.

10. Calculation of storage capacity requirement and energy scenario with and without storage.

11. Conclusion and recommendation

The overall methodology can be better explained by flow chart presented below.

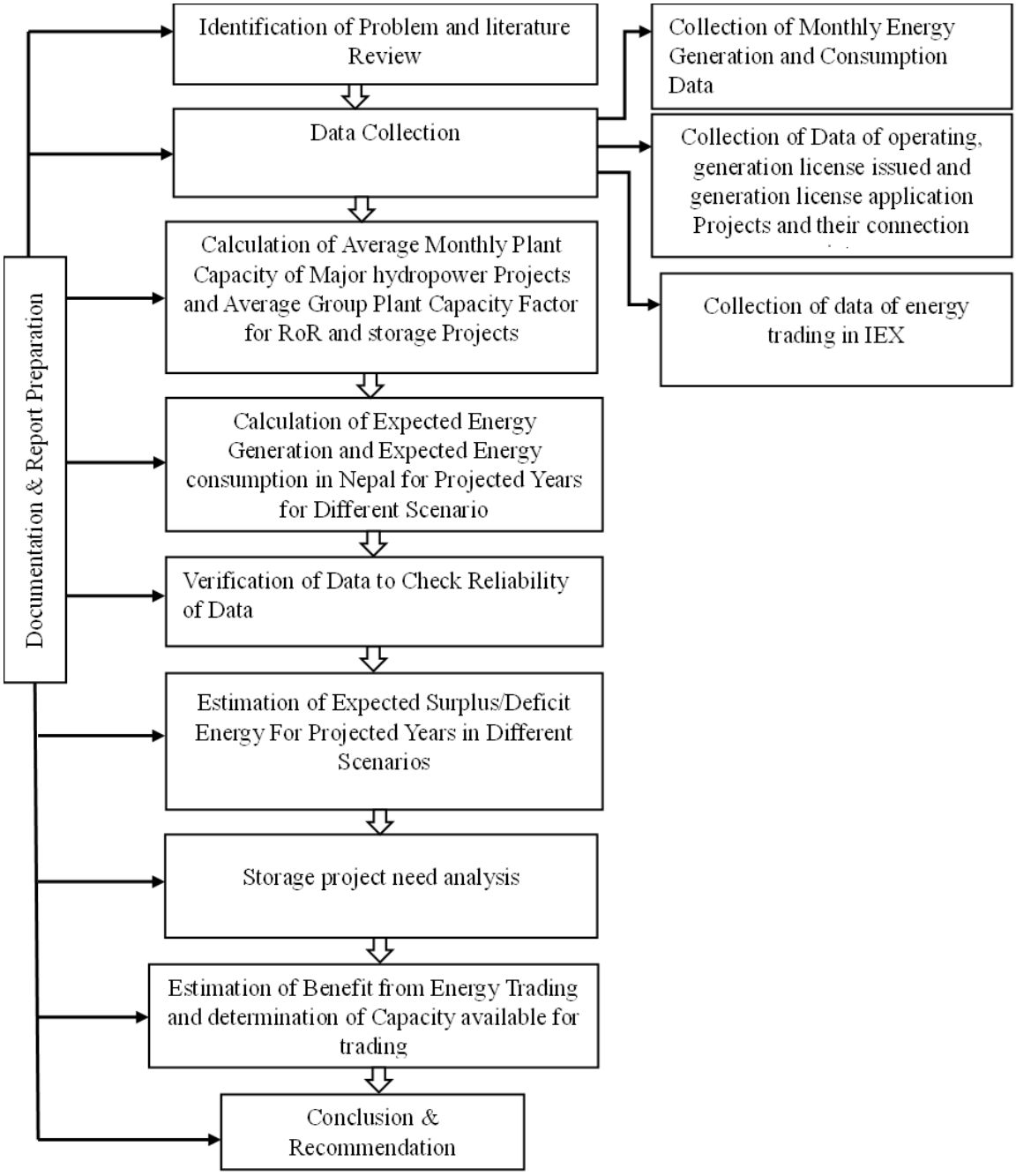


Figure 3-1 Flow diagram of methodology

3.2 Data requirements and data collection

3.2.1 Energy generation data

Collection of monthly energy generation of different operating hydro projects owned by Nepal Electricity Authority (NEA) and independent power producers (IPPs) was done. The monthly energy generation of IPP operated RoR hydro power plant and NEA owned and operated RoR, PRoR and storage was collected from DoED and NEA.

Similarly, the operating modality and capacity of different planned and under study storage projects are collected from different literatures and from DoED.

3.2.2 Power plant information data

Collection of information of planned power projects in Nepal and their current Status are taken from Department of Electricity Development, Ministry of Energy, water Resources and Irrigation. Information about the stages of power plants and their connection points were collected.

3.2.3 Demand forecast data

There are many load forecast reports published by different agencies. Electricity Demand forecast report (2014-2040), published by Water and Energy commission secretariat (WECS) and Demand forecast report published by Nepal Electricity Authority were considered for analysis of different demand scenario. Demand distribution all over the country was taken from annual report 2020/021 published by Nepal Electricity Authority. Similarly past peak loads and energy demand was taken from annual report published by Nepal Electricity Authority. Energy for the planned year was taken from Electricity Demand forecast report (2014-2040) under 4.5 % economic growth and 7.2% economic growth rate and annual energy under such situations were considered as the annual energy demand for projected year.

3.3 Calculation of average capacity factor

Mathematical analysis in MS Excel was performed to calculate the monthly plant capacity factor of individual operating hydropower projects based on their monthly energy production data and assigning this capacity factor to upcoming hydro power project.

Monthly plant capacity factor is determined using following relation:

$$\text{Monthly Plant Capacity factor} = \frac{\text{Monthly energy generation}}{\text{Installed Capacity} * \text{Number of days in that month}} \quad (3.1)$$

After calculation of monthly plant capacity factor of different IPP and NEA owned power project, average monthly capacity factor was calculated with averaging the monthly capacity factor of individual power plant and this average monthly capacity factor was used to determine the future energy production of that power plant.

In order to get more reliable data of future energy generation form planned power projects, weighted average of all monthly average plant capacity factor was determined using the formula

$$\text{WAMCF} = \frac{\text{AMCF1}*\text{C1}+\text{AMCF2}*\text{C2}+\cdots+\text{AMCFn}*\text{Cn}}{\text{C1}+\text{C2}+\cdots+\text{Cn}} \quad (3.2)$$

Where,

WAMCF = weightage average monthly capacity factor
AMCF1 = average monthly capacity factor of plant 1
AMCF2 = average monthly capacity factor of plant 2
AMCFn = average monthly capacity factor of plant n
C1 = Plant installed capacity of plant 1
C2 = Plant installed capacity of plant 2
Cn = Plant installed capacity of plant n

For solar power project, Average capacity factor was determined by taking design generation data of five projects; Duhabi solar (1.5 MW), Banke Solar (10 MW), Chandranighapur Solar (4 MW), Dhalkebar Solar (1 MW), and Kalikhola Solar (3 MW). Similarly capacity variation of RoR projects is taken with reference to contract energy and power table during power purchase agreement with NEA of eleven projects (Mathillo Sardi Khola Hydropower Project, Mathillo Piluwa khola 1 Hydropower Project, Luja Khola Hydropower Project, Aayu molun Hydropower Project, Middle Tamor Hydropower Project, Kunwan Khola Hydropower Project, Langtang Khola Hydropower Project, Jogmai Khla Hydropower Project, Mewa Khola Hydropower Project, Super hewa Hydropower Project and Solu Hydropower Project) around the country and for storage projects capacity variation of Kulekhani I and Kulekhani II was taken as reference. For new upcoming storage, capacity from their feasibility study was taken. In case of PRoR project capacity variation was taken from the past data of PRoR project and from consultation with PRoR project operators.

Once WACF was determined then expected energy generation of different power plant in future using weighted average monthly capacity factor was done using equation 3.3.

$$\text{Monthly Energy generation} = \text{WACF} * \text{Installed capacity} * \text{Number of days a month} \quad (3.3)$$

MS Excel was used to perform all the mathematical analyses.

3.4 Validation of monthly energy generation

As the energy generation of power plant till 2076/077 was used in calculation of average monthly capacity factor and weighted average monthly capacity factor, these values were used to calculate the energy generation for year 2076, F/Y 2077/078 and F/Y 2078/079. These calculated data are compared with actual energy generation in that year and percentage variation in monthly energy generation was calculated. Percentage variation in monthly energy (PVME) generation was calculated using the formula

$$\text{PVME} = \frac{(\text{Estimated energy} - \text{Actual Energy})}{\text{Actual Energy}} * 100 \qquad (3.4)$$

3.5 Analysis of different load forecaste

Actual energy demand over for year 2015 AD and 2020 AD are compared with the estimated demand by two forecast reports. This provides the information on reliability of the demand forecast. For this, two energy demand forecast report was taken. One was Demand forecast report published by WECS in January, 2017 which considers different scenario to predict future energy demand till 2040 AD. Another one is load forecast report published by System Planning Department, NEA on July, 2015 which forecast the demand till 2033/34.

3.6 Calculation of future energy Generation

Energy generation from RoR/PRoR and storage power plant was calculated by considering the calculated average weighted capacity factor. Based on the weighted average plant capacity factor which was determined using historical energy generation data of different operating power plants, possible energy generation from the RoR/ProR projects were calculated. Since there is only Kulekhani I, kulekhani II and kulekhani III are the operating storage projects and they have same operating modality. So, taking the reference of plant factor of kulekhani I and Kulekhani II, future possible energy from Kulekhani I, Kulekhani II and Kulekhani III HPP was calculated.

But in the cases of new storage projects that were assumed to come in operation during the analysis period, the monthly designed generation data were taken into consideration. The monthly energy and capacity of Budi Gandaki hydro power plant, Nalgad storage hydro power plant and Tamor storage hydro power plant is taken as attached in annex 10.

For RoR and PRoR projects, the expected energy generation was calculate using equation 3.3.

3.7 Energy and capacity surplus / Deficit Analysis

Expected energy demand of projected year was taken from Electricity Demand forecast report (2014-2040) and this annual energy is distributed into different month of planned year on the basis of monthly energy requirement percentile in fiscal year 2078/079. On the basis of this monthly energy demand and monthly load factor as calculated for year fiscal year 2078/079, peak demand for every month in the planned year was calculated. The monthly load factor was calculated using equation 3.5.

$$\text{Monthly Load factor} = \frac{\text{Monthly energy demand}}{\text{Monthly peak demand} * 24 * \text{number of days in that months}} \quad (3.5)$$

Total generation was estimated using WACF for RoR, PRoR and existing storage projects, whereas designed value of monthly energy and capacity were taken for planned storage projects. The energy surplus or deficit was calculated as

$$\text{Energy Surplus (or Deficit)} = \text{Total energy generation} - \text{Total energy demand} \quad (3.6)$$

Also, for capacity estimation, the possible capacity during the different months was calculated for RoR, PRoR and Storage projects. The difference between expected capacity during particular month and the peak demand of that month explains the deficit of surplus of capacity.

$$\text{Capacity surplus (or Deficit)} = \text{Estimated total capacity} - \text{monthly peak demand} \quad (3.7)$$

For energy surplus or deficit analysis and capacity surplus or deficit analysis, three scenario was considered. These three scenarios are:

i. Scenario 1: Economic growth rate will be 4.5 % and only half of the estimated RoR and PRoR projects that are not started commercial operation are assumed to come in the planned year (50% scenario).
ii. Scenario 2: Economic growth rate will be 4.5 % and all of the estimated RoR and PRoR projects that are not started commercial operation are assumed to come in the planned year (100% scenario).

iii. Scenario 3: Economic growth rate will be 7.2 % and all of the estimated RoR and PRoR projects that are not started commercial operation are assumed to come in the planned year (100% scenario).

The demand as well as energy surplus/ deficit analysis was done for the fiscal year 2087/088 (2030 AD) and F/Y 2092/093 (2035 AD) considering above three scenarios. Also, the energy surplus/ deficit analysis of PPA and Connection agreement concluded projects was analyzed for the fiscal year 2087/088. The mathematical analysis and calculations were carried out using MS Excel.

3.8 Calculation of possible trading capacity at different international trading points

The transmission plan of Nepal has divided the whole country in to different five zones for analysis purpose. Different generation hub and load points are identified in that report. The connection points of different hydro power projects were identified and possible capacity at different generation hub for fiscal year 2087/088 (2030 AD) were calculated. Also based on the distribution of load around the country as in F/Y 2078/079, the possible load in different load points for year fiscal year 2087/088 (2030 AD) were calculated. Once the possible generation and possible load within different zones were determined, the possible trading capacity and points in each zone was determined as

$$\text{Estimated trading capacity} = \text{Estimated generation capacity} - \text{Estimated domestic demand} \quad (3.8)$$

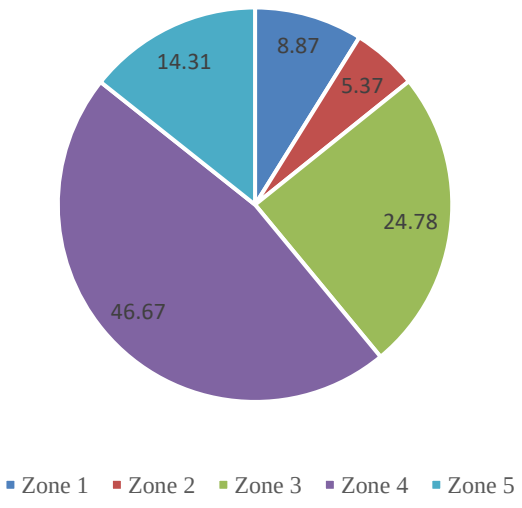


Figure 3-2 Percentage distribution of Loads among different zones

3.9 Benefit from electricity trading

Weekly weighted market clearing price of IEX, day a head market, was used for the benefit calculation from electricity trading. Weekly weighted market clearing price of day a head market for year 2021 AD is converted in to Nepali calendar date. Assuming that Nepal will sale energy at the rate 20 % below weekly weighted market clearing price and buy energy at the rate 20 % above weekly weighted market clearing price, annual benefit in NRs was calculated for different scenarios. MS Excel was used for calculation of energy trading benefits. The trading rate considered is attached in annex 9. Gross revenue from energy trading was calculated as

$$\text{Gross revenue} = (\text{Surplus energy} * \text{ selling rate}) - (\text{Energy deficit} * \text{ buying rate}) \quad (3.9)$$

3.10 Comparative study on Effect of Storage projects

Budi Gandaki HPP (1,200 MW), Nalgad storage HPP (417 MW) and Tamor storage HPP (726 MW) were taken as possible storage project that may come in operation to meet domestic demand during F/Y 2087/088 and F/Y 2092/093 under different situation. The energy situation with addition of storage to meet capacity deficit was analyzed. Also, the effect of storage with equivalent RoR and PRoR was compared in term of energy generation and peak power management contribution. While analyzing the effectiveness of storage with equivalent installed capacity RoR/PRoR, total annual energy, total dry energy, total wet energy, operating hours and capacity, contribution to peak load were used to compared.

CHAPTER 4 REUSLT AND DISSCUSSION

4.1 General overview of results

This section presents the results obtained from the analysis. The results of comparison between various load forecasts at different scenario with actual demand scenario, capacity factor for RoR/PRoR projects, storage projects and solar power projects. Energy surplus and deficit analysis, storage capacity requirement analysis, benefit from energy trading and possible available capacity at different international trading point are presented in detail. The result of energy surplus and deficit during twelve months are determined considering different conditions as follows.

i) All projects having generation license comes into operation till fiscal year 2087/088 (2030 AD) and economic growth of country will be 4.5%.

ii) Only half of projects having generation license comes into operation till fiscal year 2087/088 (2030 AD) and economic growth of country will be 4.5%.

iii) All projects having generation license comes into operation till fiscal year 2087/088 (2030 AD) and economic growth of country will be 7.2 %.

iv) All projects having generation license and applied for generation license (except storage) comes into operation till fiscal year 2092/093 (2035 AD) and economic growth of country will be 4.5%.

v) Only half of projects having generation license and applied for generation license (except storage) comes into operation till fiscal year 2092/093 (2035 AD) and economic growth of country will be 4.5%.

vi) All projects having generation license and applied for generation licence (except storage) comes into operation till fiscal year 2092/093 (2035 AD) and economic growth of country will be 7.2 %.

Based on these cases, storage capacity needed for different scenario was determined. All the mathematical calculation was performed in MS excel and comparison between generation and demand was made to find storage capacity. The value of storage project in INPS was calculated with comparing the energy and capacity scenario with equivalent RoR and PRoR projects to justify the need of storage projects in future.

Based on the energy exchange rate of IEX, day a head market during 2021 AD, benefit that can achieve by country through energy trading was calculated for the different cases and

possible capacity available for different zones are determined based on the information from connection agreement of various projects, data base of DoED and transmission system development plan of Nepal. The detail on the results obtained by the study is presented in the following sections.

4.2 Load forecast analysis

Different load forecast from Water and Energy commission Secretariat (WECS) and Nepal Electricity Authority were compared with the actual past data. The energy consumption during year 2015 AD 2020 AD were compared with the forecasted data and it was found that the load forecast from the WECS under 4.5 % economic growth rate was found to be closer with actual annual energy demand than load forecast by Nepal Electricity authority. Comparison of different load forecast is shown in figure 4-1.

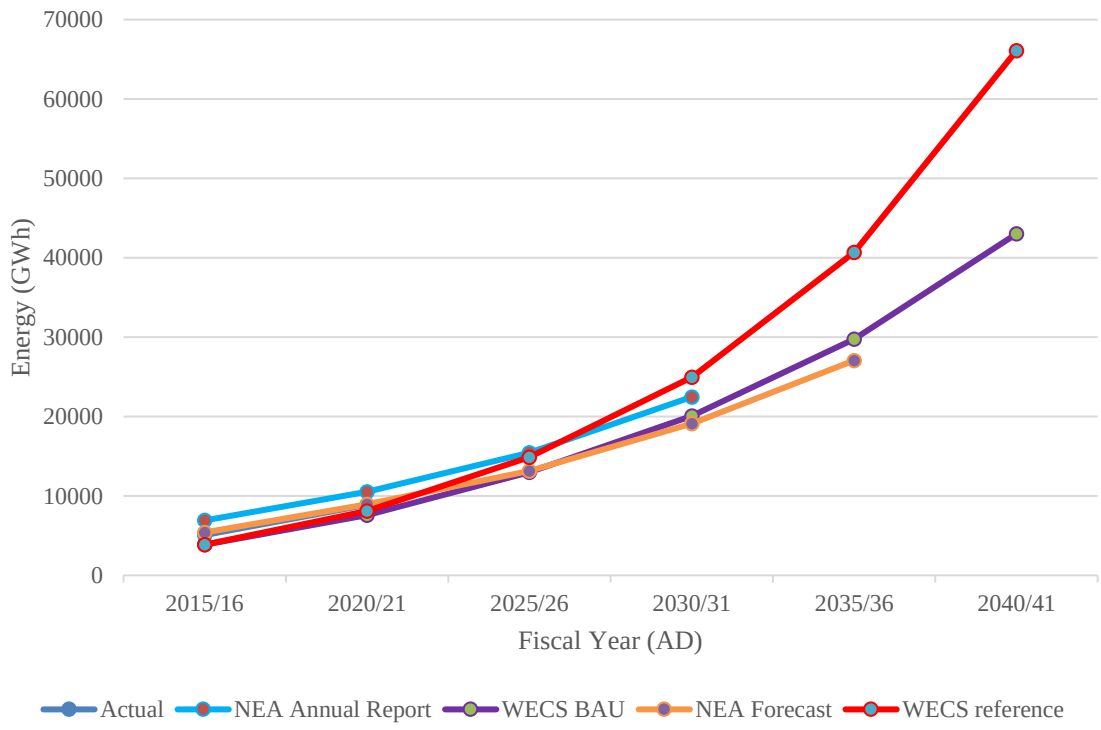


Figure 4-1 Comparison of different load forecast

Also, energy forecast by NEA is based on the its system expansion and distribution planning, it may have some restriction on the expansion of future demand. So, the energy forecast by WECS under 4.5 % economic growth rate and 7.2 % economic growth rate was considered for analysis purpose which was found to be more relevant for the study.

4.3 Capacity factor of Power plants

For the determination of monthly capacity factor of RoR power plants, the monthly energy generation data of 13 projects as shown in table 4.1 were taken and weighted average plant capacity factor was determined. The weighted average plant capacity factor is present in table 4.2.

Table 4-1 IPP's Power Plant under consideration

SN	Name of Project	Capacity (MW)
1	Khimti 1	60
2	Indrawati HPP	7.5
3	Bijaypur 1 HPP	4.5
4	Sanima Mai HPP	22
5	Upper Bhotekoshi HPP	45
6	Upper Marshyangdi HPP	50
7	Upper Madi HPP	25
8	Piluwa Khola HPP	3.2
9	Khudi HPP	4
10	Mardi HPP	4.8
11	Lower Modi HPP	10.2
12	Sipring HPP	10
13	Naugadgadh HPP	8.5

Table 4-2 WACF for IPP RoR/ PRoR hydropower projects

Months	Shrawan	Bhadra	Ashwin	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Asar
WACF	0.79486	0.81015	0.85653	0.82313	0.66306	0.49575	0.40918	0.36395	0.39183	0.46267	0.65166	0.78657

For the analysis period, it is assumed that there will be only four storage projects that will be in operation. Out of four, three will be Kulekhani I hydro power plant (60 MW), Kulekhani II hydro power plant (32 MW), and Kulekhane III hydro power plant (14 MW) and fourth power plant will be Tanahun Seti hydro power plant (140 MW). Average Capacity factor of storage power plant was calculated using past ten years monthly energy data of Kulekhani I and Kulekhani II hydro power plant which is found as in table 4.4. Estimated energy for Tanahun Seti hydro power plant is taken from the designed monthly energy generation table. Similarly estimated capacity and monthly energy for Budi Gandaki HPP, Nalgad Storage HPP and Tamor storage HPP was taken from their designed value.

Table 4-3 Estimated Energy from Tanahun seti Hydro power plant

SN	Months	Estimated Energy (GWhr)
1	Baisakh	29.601
2	Jestha	31.461
3	Asar	69.978
4	Shrawan	103.333
5	Bhadra	102.48
6	Ashwin	68.050
7	Kartik	34.170
8	Mangsir	31.190
9	Poush	30.352
10	Magh	27.921
11	Falgun	28.630
12	Chaitra	29.128

Table 4-4 Plant capacity factor of storage project (Kulekhani I, II and III)

Months	Shrawan	Bhadra	Ashwin	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Asar
WACF	0.10057	0.05309	0.05912	0.06099	0.08333	0.16089	0.22025	0.28245	0.35801	0.34369	0.17486	0.11180

General monthly generation pattern for storage, PRoR and RoR project is shown in figure 4-2. Based on this curve capacity analysis was carried out.

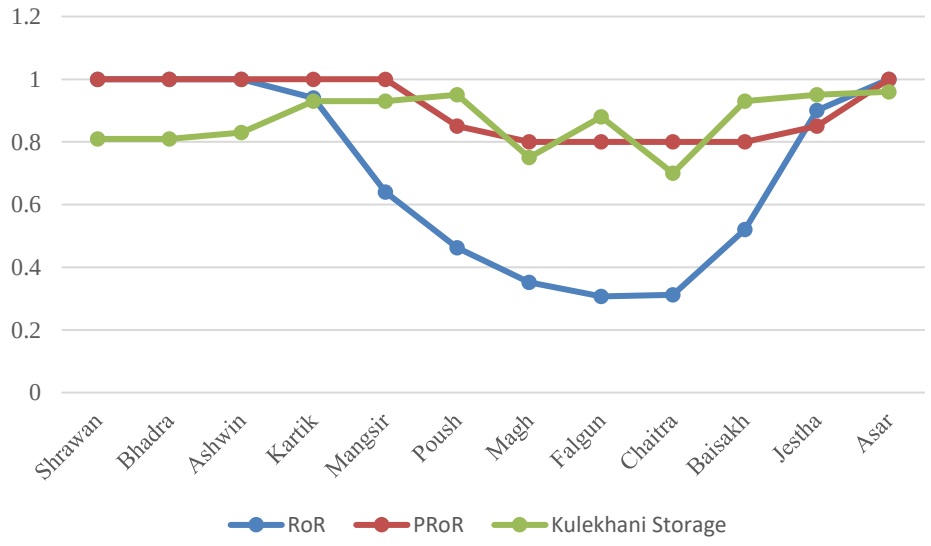


Figure 4-2 Generation pattern of different types of hydro power plants

Considering the plant capacity factor as determined above; the monthly energy generation of the plants was calculated. Energy generation from estimated hydro power projects and solar power projects were calculated for projected year.

4.4 Verification of results

The calculated weighted average capacity factor is used to calculate the energy generation for year 2076, F/Y 2077/078 and F/Y 2078/079 to validate it. The absolute value of percentage variation is shown in table 4-5.

Table 4-5 Absolute value of percentage variation of monthly energy

Months	Percentage variation in monthly energy generation (PVME)			
	Year 2076	F/Y 2077/078	F/Y 2078 /079	Average
Shrawan	7.90	14.28	2.42	8.21
Bhadra	0.30	10.89	4.92	1.89
Ashwin	14.34	6.00	8.60	5.65
Kartik	10.35	3.43	20.45	11.41
Mangsir	0.86	0.48	2.22	1.19
Poush	0.03	1.01	9.03	2.66
Magh	6.43	5.08	10.15	7.23
Falgun	3.22	10.28	5.82	0.41
Chaitra	2.16	12.64	15.27	1.60
Baisakh	15.94	15.18	4.63	1.80
Jestha	0.94	3.65	1.65	0.98
Asar	14.16	16.46	8.76	7.29

4.5 Energy surplus/Deficit analysis

In order to get the overview on the situation of energy demand and supply condition in future different analysis was carried out. The possible projects that may come into operation in 2030 AD (F/Y 2087/088) and 2035 AD (F/Y 2092/2093) were taken from the information of construction license issued by MOEWRI and DoED which is attached in annex 1. The generation pattern and capacity factor were taken as calculated in previous section. The overall generation, transmission and distribution loss was considered to be about 25 %. The monthly energy demand and monthly peak demand for fiscal year 2087/088 and fiscal year 2092/093 were calculated with reference to monthly energy demand, monthly peak demand and monthly load factor for fiscal year 2078/079. Monthly

energy and monthly peak demand for planned fiscal year was found as presented in table 4-6.

Table 4-6 Monthly energy and peak power demand

Months	For fiscal year 2087/088				For fiscal year 2092/093				Monthly Load factor
	Under 4.5 % economic growth		Under 7.2 % economic growth		Under 4.5 % economic growth		Under 7.2 % economic growth		
	Energy (GWh)	Peak Demand (MW)	Energy (GWh)	Peak Demand (MW)	Energy (GWh)	Peak Demand (MW)	Energy (GWh)	Peak Demand (MW)	
Shrawan	1742.26	2869.38	2166.09	3567.38	2581.62	4251.74	3533.31	5819.10	0.816
Bhadra	1670.22	2967.92	2076.52	3689.90	2474.88	4397.76	3387.21	6018.95	0.756
Ashwin	1689.23	3033.48	2100.16	3771.41	2503.04	4494.90	3425.77	6151.90	0.748
Kartik	1354.71	2825.96	1684.26	3513.41	2007.36	4187.41	2747.36	5731.06	0.666
Mangsir	1410.60	2909.88	1753.74	3617.73	2090.17	4311.75	2860.69	5901.23	0.696
Poush	1599.99	3197.66	1989.20	3975.52	2370.80	4738.18	3244.77	6484.86	0.695
Magh	1564.91	3219.56	1945.60	4002.76	2318.83	4770.64	3173.65	6529.28	0.698
Falgun	1543.69	3002.94	1919.21	3733.43	2287.38	4449.64	3130.60	6089.96	0.714
Chaitra	1724.57	3190.17	2144.09	3966.21	2555.40	4727.07	3497.43	6469.66	0.751
Baisakh	1794.56	3224.99	2231.10	4009.51	2659.11	4778.68	3639.37	6540.29	0.748
Jestha	1893.52	3185.79	2354.14	3960.76	2805.75	4720.59	3840.06	6460.79	0.799
Asar	2085.58	3282.72	2592.91	4081.27	3090.33	4864.22	4229.55	6657.36	0.827

4.5.1 Expected Energy and Capacity for fiscal year 2087/088 under different Scenario

The energy situation for F/Y 2087/088 was carried out with the assumption that all the projects that has generation license issued by DoED and MOEWRI will be in operation which is 100 % available situation (Scenario 2). Also, if Economic growth rate is as usual and remain low at 4.5 %, another condition also considered that only half of generation

license issued projects will come in operation till F/Y 2087/088 (Scenario 1). For economic growth rate of 4.5 %, the total annual energy requirement will be 20,074 GWh. This total annual energy requirement is distributed month wise as reference to the monthly energy demand of fiscal year 2078/079. The monthly load factor of fiscal year 2078/079 was used to calculate the monthly peak demand for each month of fiscal year 2087/088. It is seen that generation will more than demand in every month of the year for 100 % generation scenario i.e when 9,855.2 MW of hydro power project and 157.74 MW of solar power project comes in operation. Under this condition, about 20,374.197 GWh energy will be surplus annually and capacity surplus will vary from 105 MW to 4506.91 MW at monthly peak time.

Similarly, it is assumed that if the Economic growth rate is low as condition is as usual, all projects considered may not come in operation till fiscal year 2087/088. Assuming only half of project obtaining generation license i.e only 6,509 MW hydro and 157.74 MW of solar power projects comes in operation, there will be energy deficit in four months (Magh, Falgun, Chaitra and Baisakh) and power deficit to meet monthly peak demand for five months (Poush, Magh, Falgun, Chaitra and Baisakh). So, additional storage hydro power of capacity about 1,305 MW will be appropriate to fulfill the gap between demand and supply.

Table 4-7 Estimated Demand and Generation for F/Y 2087/088 under 4.5 % economic growth rate

Months	Energy Demand (GWh)	Energy from P/RoR (GWh)		Energy from Storage (GWh)	Energy Generation from solar (GWh)	Total Energy Generation after loss (GWh)		Surplus / Deficit Energy (GWh)	
		100 % generation	50 % generation			100 % generation	50 % generation	100 % generation	50 % generation
Shrawan	1742.26	5682.61	3703.98	111.26	16.77	4362.18	2878.21	2619.92	1,135.95
Bhadra	1670.22	5791.94	3775.24	106.81	17.07	4441.14	2928.61	2770.91	1,258.40
Ashwin	1689.23	6123.50	3991.36	72.71	17.68	4664.84	3065.74	2975.61	1,376.51
Kartik	1354.71	5694.94	3712.01	38.82	17.72	4318.04	2830.85	2963.33	1,476.14
Mangsir	1410.59	4434.51	2890.46	37.33	16.53	3370.42	2212.38	1959.83	801.79
Poush	1599.98	3429.88	2235.63	42.63	16.04	2620.43	1724.74	1020.44	124.76
Magh	1564.91	2736.61	1783.75	44.17	16.19	2101.78	1387.13	536.86	(177.78)

Falgun	1543.68	2518.01	1641.26	50.18	20.07	1946.22	1288.66	402.53	(255.02)
Chaitra	1724.56	2710.91	1767.00	56.45	22.01	2097.54	1389.60	372.97	(334.96)
Baisakh	1794.55	3307.76	2156.03	56.70	22.60	2545.96	1682.16	751.40	(112.40)
Jestha	1893.51	5540.86	3036.67	45.25	20.49	3548.55	2331.93	1655.04	438.42
Asar	2085.57	6903.75	3783.61	79.08	17.98	4430.88	2915.00	2345.30	829.43

Table 4-8 Monthly peak demand and Capacity for F/Y 2087/088 under 4.5 % Economic growth rate

Months	Peak Demand (MW)	Capacity P/RoR (MW)		Storage Capacity (MW)	Total Generation after loss (MW)		Surplus / Deficit Capacity (MW)	
		100 % generation	50 % generation		100 % generation	50 % generation	100 % generation	50 % generation
Shrawan	2869.37	9609.18	6263.36	225.86	7,376.28	4,866.92	4,506.91	1,997.54
Bhadra	2967.92	9609.18	6263.36	225.86	7,376.28	4,866.92	4,408.36	1,899.00
Ashwin	3033.48	9609.18	6263.36	227.98	7,377.87	4,868.51	4,344.39	1,835.03
Kartik	2825.96	9178.01	5983.57	238.58	7,062.45	4,666.61	4,236.48	1,840.65
Mangsir	2909.87	7022.16	4584.58	238.58	5,445.56	3,617.37	2,535.69	707.49
Poush	3197.66	5379.57	3514.50	240.7	4,215.21	2,816.40	1,017.55	(381.26)
Magh	3219.56	4467.95	2921.53	219.5	3,515.59	2,355.78	296.02	(863.79)
Falgun	3002.93	4144.57	2711.68	233.28	3,283.39	2,208.72	280.45	(794.21)
Chaitra	3190.16	4180.50	2735.00	214.2	3,296.03	2,211.90	105.86	(978.26)
Baisakh	3224.99	5675.22	3704.97	238.58	4,435.35	2,957.66	1,210.36	(267.33)
Jestha	3185.78	8527.11	5557.02	240.7	6,575.86	4,348.29	3,390.07	1,162.51
Asar	3282.71	9609.18	6263.36	241.76	7,388.21	4,878.84	4,105.49	1,596.13

Similarly for economic growth rate of 7.2 %, the total annual energy requirement will be 24,957 GWh. Considering all PRoR and RoR projects having generation license and only 246 MW of storage project will come in operation (Scenario 3) till F/Y 2087/088, except for the month of Chaitra, there will be energy surplus in every other month and the annual energy surplus will about 15,491.027 GWh. But there will be capacity deficit to meet peak

demand of Magh, Falgun and Chaitra. The monthly generation and demand details is presented in annex 7. Monthly Energy and capacity surplus under three scenario is shown in figure 4-3 and figure 4-4 respectively.

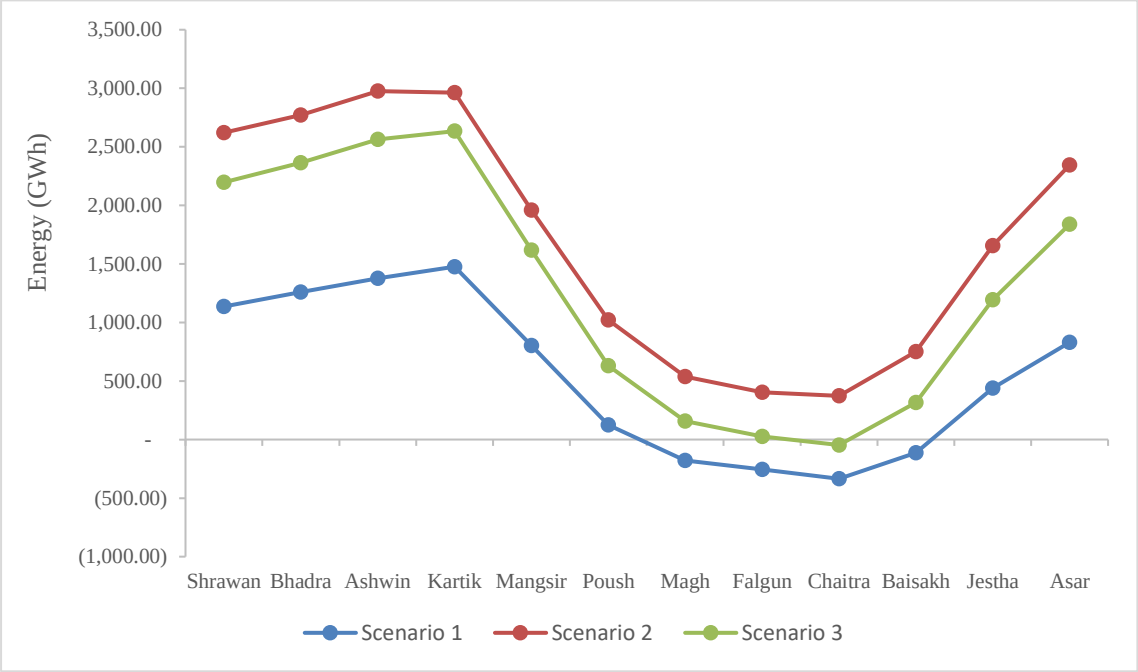


Figure 4-3 Energy surplus/deficit during F/Y 2087/088 for different scenario

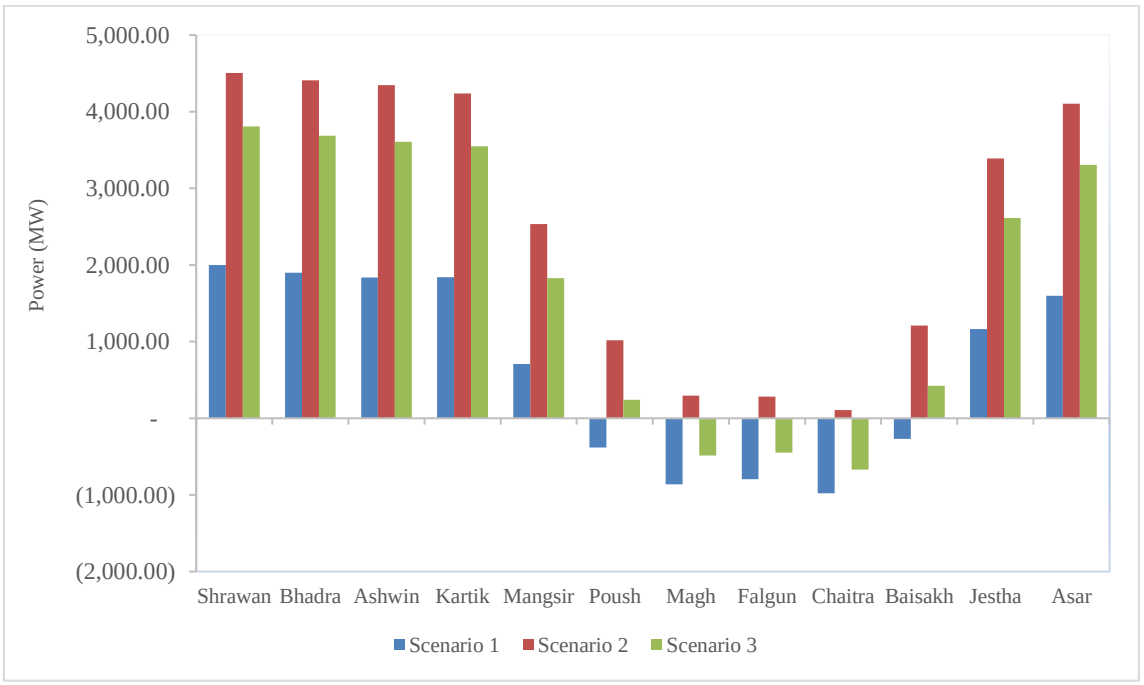


Figure 4-4 Capacity surplus/deficit during F/Y 2087/088 for different scenario

4.5.2 Expected Energy and Capacity for fiscal year 2092/093 under different Scenario

The energy situation for F/Y 2092/093 was carried out with the assumption that all the projects that has generation license issued by DoED and MOEWRI and the projects applying for construction license will be in operation which is 100 % available situation (Scenario 2). Also, if Economic growth rate is as usual and remain low, it is considered that only half of generation license issued projects and the projects applying for construction license (except storage projects) will come in operation till 2092/093 (Scenario 1). For economic growth rate of 4.5 %, the total annual energy requirement will be 29,745 GWh. This total annual energy requirement is distributed month wise as reference to the monthly energy demand of fiscal year 2078/079. The monthly load factor of fiscal year 2078/079 was used to calculate the monthly peak demand for each month of fiscal year 2092/093. It was seen that generation will more than demand in every month of the year for 100 % generation scenario i.e., when 16,951 MW of hydro power project and 157.74 MW of solar power project comes in operation. Under this condition, about 64,875 GWh energy will be surplus annually and there will be minimum of 3,441MW capacity surplus at monthly peak time.

Similarly, it is assumed that if the economic growth rate is low as condition is as usual, all estimated projects may not come in operation till fiscal year 2092/093. Assuming only half of project obtaining generation license issued projects and the projects applying for construction license (except storage projects) i.e., only 9,607 MW hydro and 157.74 MW of solar power projects comes in operation, there will be energy deficit in four months (Magh, Falgun, Chaitra, Baisakh) and capacity deficit in five months (Poush, Magh, Falgun, Chaitra, Baisakh) to meet monthly peak demand. The annual energy surplus will about 9,701.41 GWh. The maximum capacity deficit was found to be 1,618 MW. So, additional storage hydro power of capacity about 2,158 MW will be appropriate to fulfill the gap between demand and supply.

Under 7.2 % economic growth rate when all the projects that has generation license issued by DoED and MOEWRI and the projects applying for construction license will be in operation which is 100 % available situation (Scenario 3), there will be about 29,055 GWh energy surplus annually. But in the month of Magh, Falgun and Chaitra, the total capacity will be inadequate to meet monthly peak demand. The details of monthly energy generation

by RoR/PRoR and storage as well as solar and capacity variation during different months are attached in annex. Energy and capacity surplus under three scenarios for fiscal year 2092/093 is shown in figure 4-5 and figure 4-6 respectively.

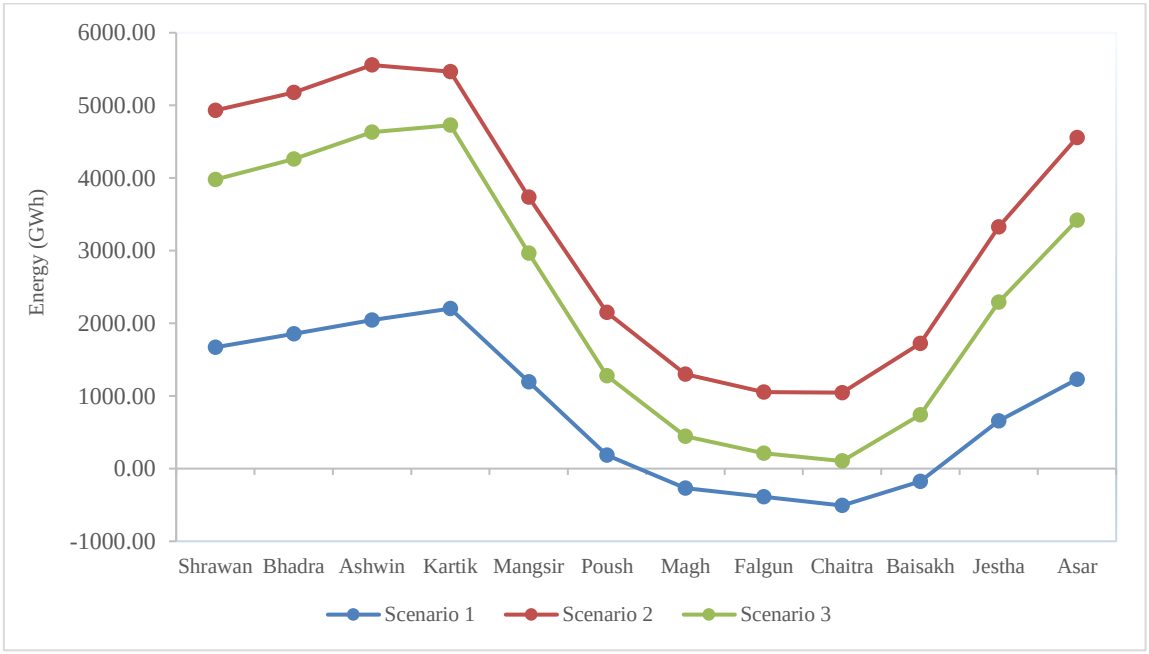


Figure 4-5 Energy Surplus/ deficit during F/Y 2092/093 for different scenario

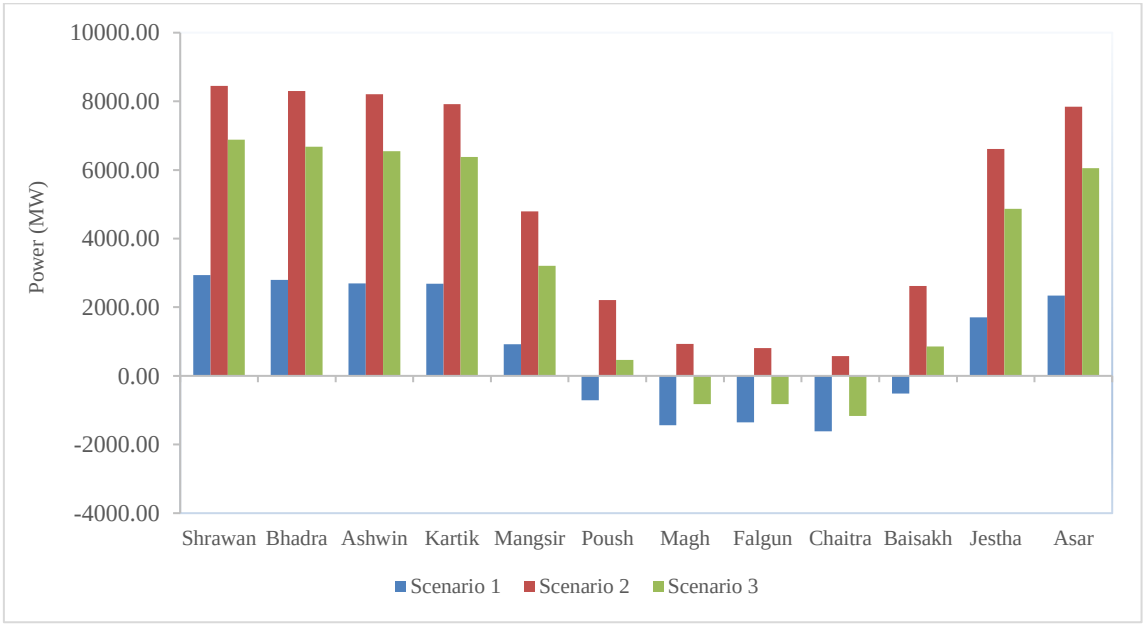


Figure 4-6 Capacity surplus/deficit during F/Y 2092/093 for different scenario

Similarly, the generation and demand scenario for fiscal year (F/Y) 2087/088 under 7.2 % economic growth rate when the PPA and CA concluded projects within government set quota (RoR: 5250 MW, PRoR: 4294 MW) and Storage of installed capacity 244 MW comes in operation, there will be nominal amount of energy deficit in the month of Falgun and Chaitra but in total about 15,000 GWh energy will be surplus annually. The capacity will be almost sufficient to meet the peak demand of driest month. The energy detail is attached in annex 7.

4.6 Benefit from Energy Trading

Taking weighted market clearing price of 2021 AD of IEX day a head market and assuming that Nepal will sale electricity at 20 % less and buy electricity at 20 % more than the weighted market clearing price during the year. The result for F/Y 2087/088 and F/Y 2092/093 is shown in Table 4-9.

Table 4-9 Revenue generation from energy trading under different situation for F/Y 2087/088 and F/Y 2092/093

For F/Y 2087/088 (2030 AD)				For F/Y 2092/093 (2035 AD)		
Income (in NRs Billion)				Income (in NRs Billion)		
Months	Scenario 1	Scenario 2	Scenario 3	Scenario 1	Scenario 2	Scenario 3
Shrawan	7.59	17.51	14.68	11.18	32.94	26.58
Bhadra	10.09	22.22	18.97	14.89	41.51	34.20
Ashwin	7.61	16.45	14.18	11.31	30.71	25.61
Kartik	8.44	16.94	15.05	12.59	31.24	27.01
Mangsir	5.12	12.51	10.32	7.63	23.85	18.94
Poush	0.75	6.11	3.78	1.11	12.87	7.64
Magh	(1.38)	2.77	0.81	(2.08)	6.71	2.30
Falgun	(2.48)	2.61	0.17	(3.77)	6.83	1.37
Chaitra	(6.14)	4.56	(0.85)	(9.31)	12.78	1.27
Baisakh	(2.11)	9.41	3.94	(3.29)	21.55	9.28
Jestha	3.83	14.45	10.43	5.72	29.03	20.00
Asar	5.68	16.06	12.58	8.42	31.20	23.40
Total	**37.00**	**141.58**	**104.05**	**54.38**	**281.23**	**197.59**

In overall, Nepal can earn about NRs.37 billion annually if only half of RoR and PRoR projects having generation license issued comes into operation till F/Y 2087/088. Similarly, if all projects having generation license comes into operation till F/Y 2087/088, we can earn NRs.141.58 billion under 4.5 % economic growth and NRs.104.05 billion under 7.2 % economic growth rate. Similarly, NRs 104.05 billion can earn from energy trading if only half of RoR and PRoR projects having generation license issued and application for generation license comes into operation till fiscal year 2092/093 under 4.5 % economic

growth rate. If all expected projects come in operation till fiscal year 2092/093, then we can earn about 281.23 billion under 4.5 % economic growth rate and about 197.59 billion under 7.2 % growth rate.

4.7 Effect of Storage on Monthly Energy and Peak Demand

If Budi Gandaki Storage project (1200MW) comes into operation to meet the maximum monthly demand of driest month (Chaitra) in F/Y 2087/088 under 4.5 % economic growth rate (when only half of RoR and PRoR projects having generation license issued comes in operation), there will be only small amount of power (i. e. about 183 MW) will be deficit to meet monthly peak demand in the month of Chaitra and about 84 GWh energy will be deficit in that month.

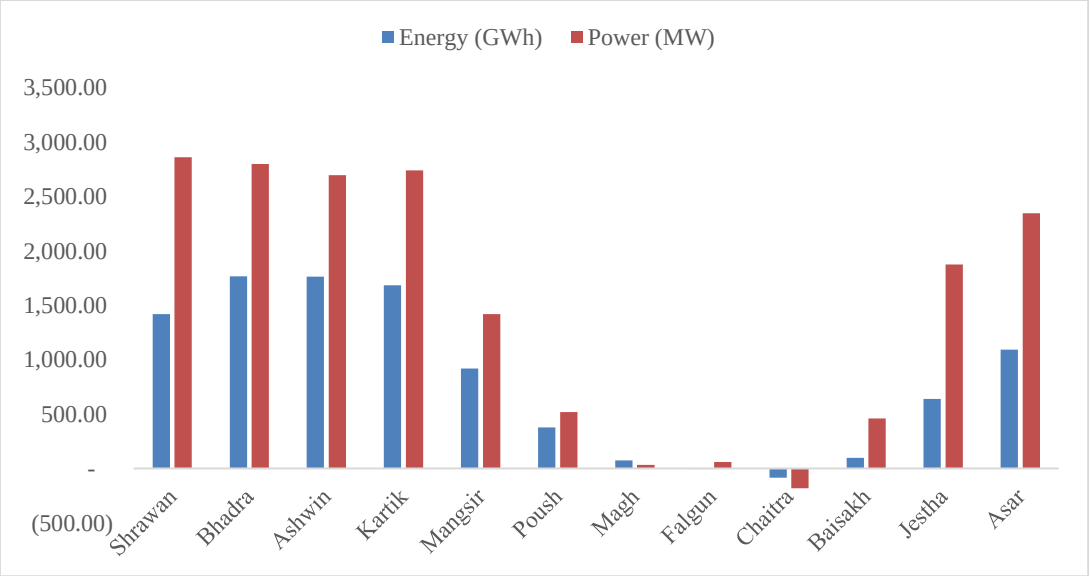


Figure 4-7 Power and energy Surplus/Deficit with Budi Gandaki HPP under BAU for F/Y 2087/088 when only half of the estimated RoR/ PRoR comes into operation

Nepal can earn annually NRs.65.24 billion by trading electricity in the foreign market with the construction of Budi Gandaki Hydropower project. Comparison between energy and power with and without Budi Gandaki Hydropower project in presented in figure 4-8.

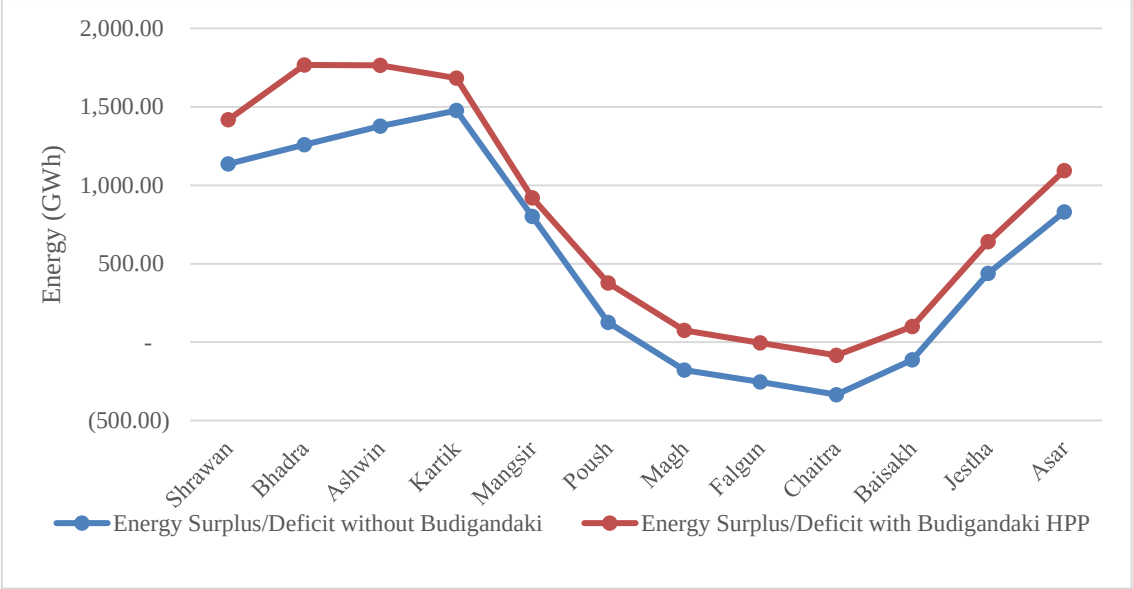


Figure 4-8 Comparison of Energy surplus/deficit with and without Budi Gandaki HPP for scenario 1

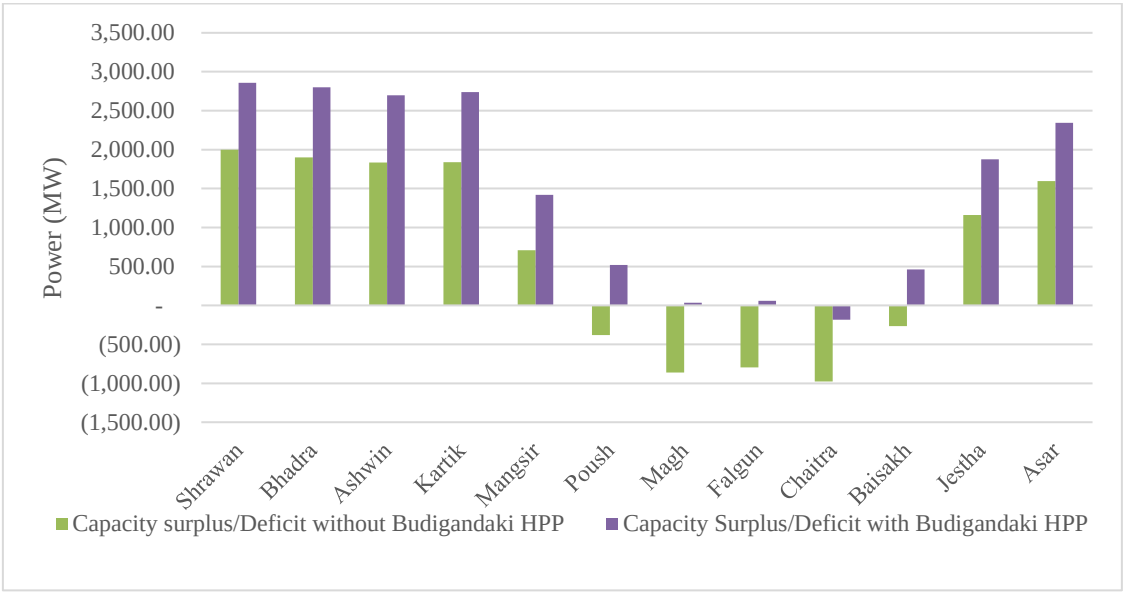


Figure 4-9 Comparison of Surplus/deficit in capacity with and without Budi Gandaki HPP for scenario 1

The addition of Budi Gandaki HPP will aids contribution in total wet energy too. But if we compare the scenario by adding 800 MW RoR types hydro power and 400 MW PRoR types hydro power in place of 1200 MW Budi Gandaki HPP, the result shows that addition of RoR and PRoR in place of Storage will give more wet energy as compare to storage but decreases the capacity during dry season which will create challenge on peak power management as well as energy management during dry months, especially in the month of Falgun and Chaitra. So, for energy security and energy balance storage will be more beneficial as compare to RoR.

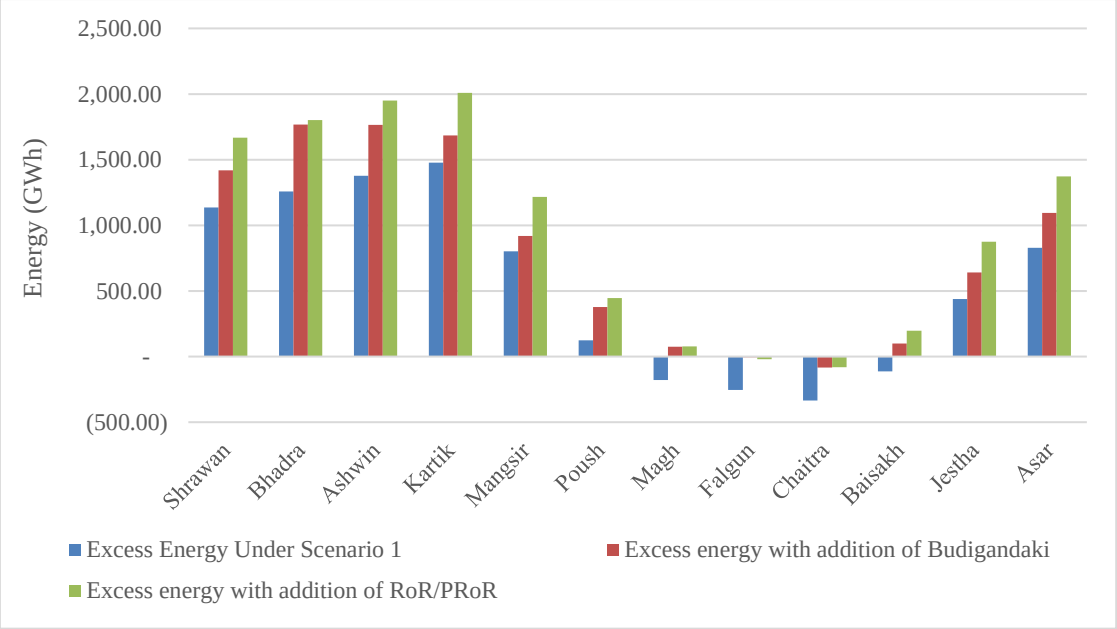


Figure 4-10 Energy for Scenario 1, with addition of Storage project and addition of RoR/PRoR in place of storage for F/Y 2087/088

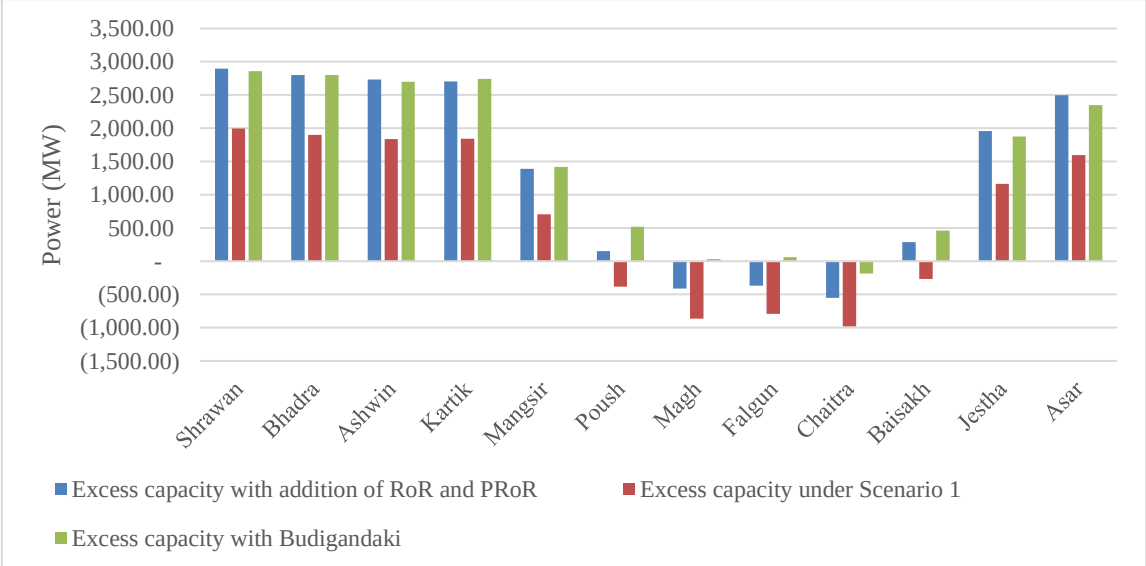


Figure 4-11 Capacity under Scenario 1, with additional Storage and with RoR/PRoR in place of storage for F/Y 2087/088

As there is deficit of maximum about 1,618 MW power during peak in the month of Chaitra for F/Y 2092/093 when only half of RoR/PRoR projects comes into operation under business as usual. This requires about 2,158 MW of storage project. If Tamor storage (726 MW), Budi Gandaki storage HPP (1,200 MW), and Nalgad storage HPP (417 MW) are selected to compensate the demand supply gap, then it will be sufficient to meet demand at every month with spill of energy during wet season. Demand and supply scenario under this condition shows that in total about 16,545.95 GWh annual energy will be available for

trading. This will make possible to earn about Nrs. 98 billion annually by trading in Indian market.

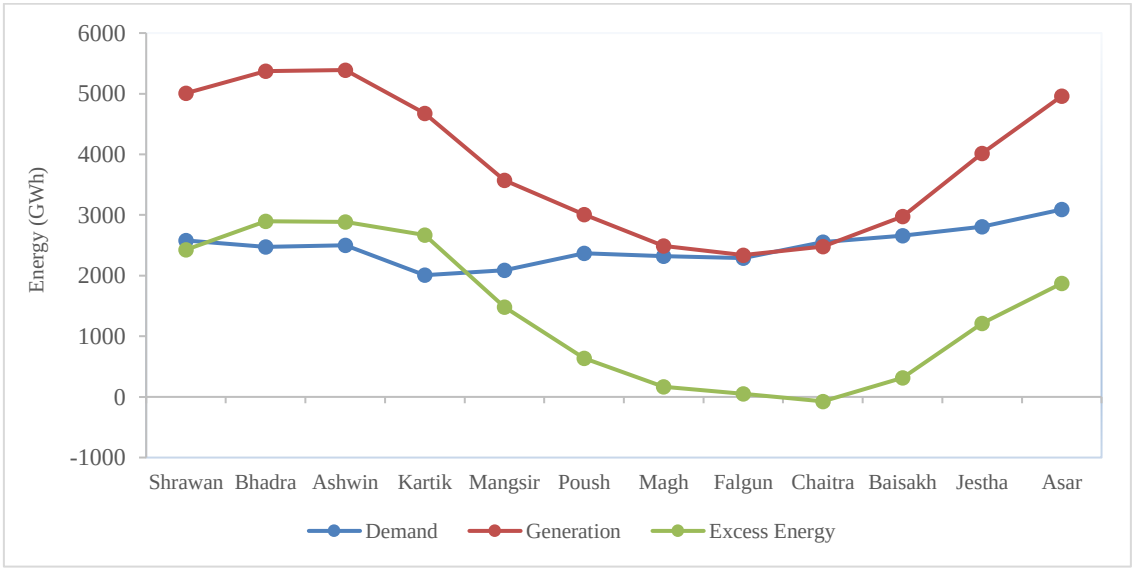


Figure 4-12 Energy scenario for F/Y 2092/093 under Scenario 1 with storage

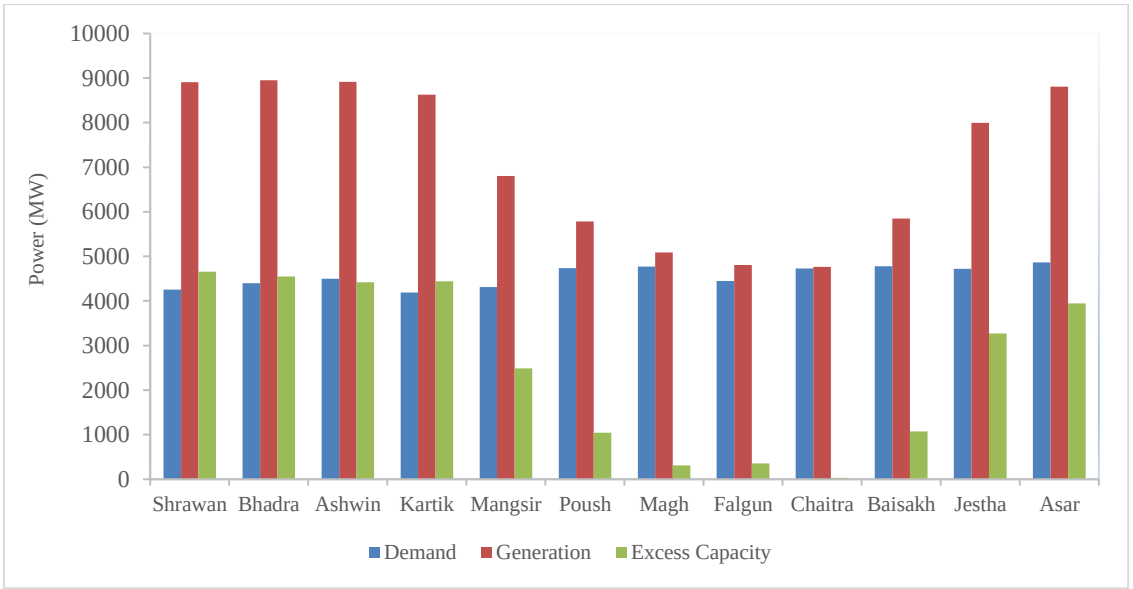


Figure 4-13 Capacity for F/Y 2092/093 under Scenario 1 with storage

A comparison was done with addition of storage and addition of RoR and PRoR projects in place of storage for F/Y 2092/093 under 4.5 % Economic growth, when only half of estimated RoR and PRoR comes in operation. During analysis with addition of 1290 MW RoR type hydro power and 1053 MW PRoR type hydro power project was considered. It was found that again there will be more excess energy with addition of RoR and PRoR projects but it does require more capacity to fulfill monthly peak demand.

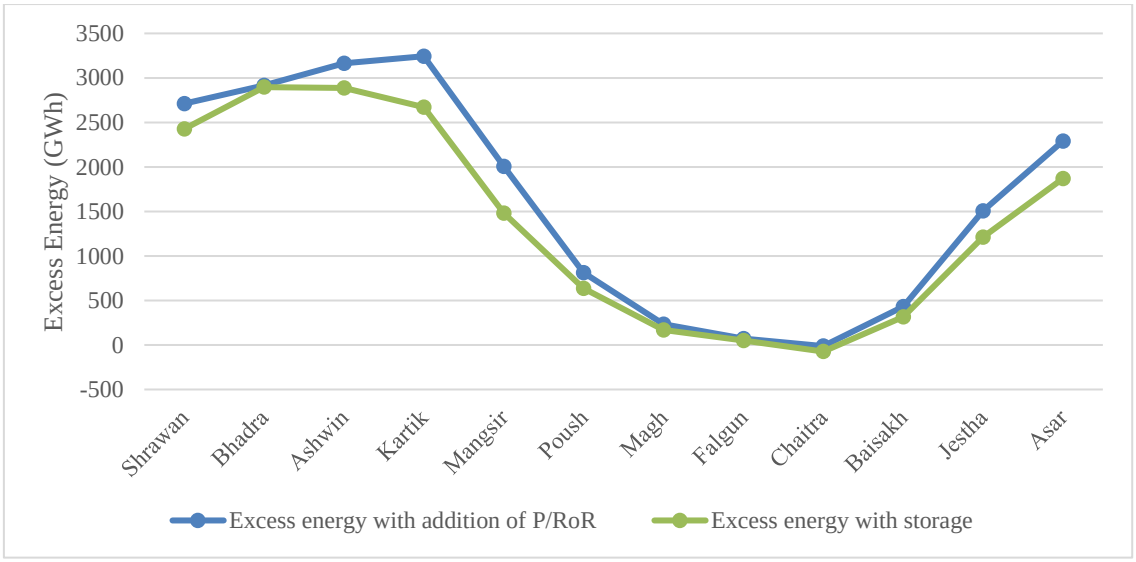


Figure 4-14 Comparison of excess energy with storage and P/RoR in place of storage under scenario 1 for F/Y 2092/093

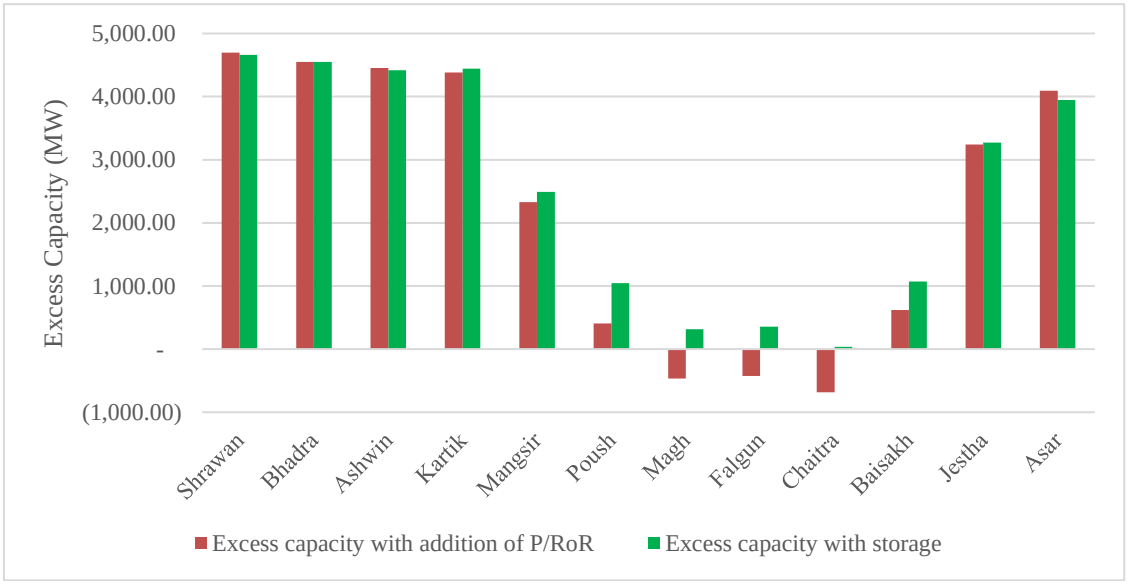


Figure 4-15 Comparison of excess capacity with storage and P/RoR in place of storage under BAU (Scenario 1) for F/Y 2092/093

It was found from the analysis that the difference in energy with storage and with PRoR/RoR during dry season seem not much difference but the time of operating storage with full capacity have significant role in demand management. The selected storage projects can run from 6 hr to 9 hr daily during peak hour with full capacity during dry season. This enables storage projects more attractive than P/RoR projects.

4.8 Generation distribution and Available capacity for trading

Taking the load distribution across the country in F/Y 2078/079 as reference for the possible load in F/Y 2087/088 (2030 AD) under 7.2 percentage economic growth and 4.5 percentage economic growth rate, the available capacity at southern possible power trading point will be as presented in table 4-10 and table 4-11 respectively.

Table 4-10 Total Generation and demand in different zones for 7.2 % economic growth rate for F/Y 2087/088

Zone	Estimated Load (MW) for F/Y 2087/088 under Reference case	Estimated generation capacity (Mw)	Excess Capacity available (MW)	Available point in Southern part of Nepal
1	362.1367925	883.965	544.2229144	Dododhara
2	219.2075472	61.845	-143.806651	
3	1011.366352	2328.948	1380.125011	Butwal
4	1904.982704	2565.414	525.8035382	Dhalkebar
5	584.3066038	1542.9	994.7271871	Anarmani

Table 4-11 Total Demand and Generation in different zone for 4.5 % economic growth rate for F/Y 2087/088

Zone	Estimated Load for F/Y 2087/088 under BAU	Estimated generation capacity (MW)	Excess capacity available (MW)	Available point in Southern part of Nepal
1	291.2530842	883.965	610.7231414	Dododhara
2	176.3004354	61.845	-103.5529349	
3	813.4041485	2328.948	1565.845141	Butwal
4	1532.106374	2565.414	925.0315536	Dhalkebar
5	469.9359579	1542.9	1102.025099	Anarmani

In similar way the possible excess capacity for fiscal year 2092/093 was calculated individually for different five zones and found to be more excess in all five zones. All five zones have potential to sale energy in foreign market through identified international interconnection points. The detail is attached in annex 8.

CHAPTER 5 CONCLUSION

Being rich in clean and freely available source of water resources, the government has kept focus on development of hydro power as a primary source of electricity. So, in future, it is seen that the source of electricity will be hydro only (except some solar power). Hydropower plants are connected in INPS and operating commercially. The hydro power plants with installed capacity 8,631 MW (6846 MW RoR, 1645 MW PRoR and 140 MW storage) are in different phase of construction. Out of these about 3300 MW project have significant physical progress. Hydro power plants with total installed capacity of 7,771 MW (5259 MW RoR, 937 MW PRoR, 1575 Storage) are ready to go for construction and hence are in the stage of application of generation license. The generation pattern of RoR, PRoR and storage projects are different throughout the year. Energy generation and surplus / deficit analysis in different scenario was carried out with mathematical analysis in MS Excel for fiscal year 2087/088 (2030AD) and fiscal year 2092/093 (2035 AD). The conclusion drawn from the analysis are illustrated case wise as follow.

A) Under 4.5% Growth rate

i) Energy surplus deficit for F/Y 2087/88 under 100% generation (Scenario 2)

There will be surplus energy in each month for f/y 2087/088. The energy demand during f/y 2087/088 will be 20073.83 GW with peak demand 3282.71 MW and annual generation will be 40,448 GWh. So, in total 20374 GWh energy will surplus during the year. The operation of hydropower projects with installed capacity 9855.186MW and 157.74MW solar during the year will results sufficient capacity to meet the peak demand throughout the year. So, on additional storage needed and can be export energy throughout the year.

ii) Energy surplus/deficit for f/y 2087/088 under 50% generation (Scenario 1)

Operation of 6,510 MW hydro and 157 MW solar project results capacity as well as energy deficit in some months of dry season. There will be about 880 GWh of energy deficit in months of Falgun & Chaitra. But during the months of Magh Falgun & Chaitra the generated capacity will not sufficient to meet the monthly peak demand. So additional project needs to be plan. Operating Budi Gandaki HPP (1200MW) will be nearly sufficient to meet peak demand during dry season. But still there will be about 183MW capacity deficit during Chaitra. With Budi Gandaki HPP, Nepal can earn Nrs. 64.25 billion per year by trading electricity. Additional of RoR/PRoR in place of storage will results energy

deficit as well as capacity deficit during month of Falgun & Chaitra. So, storage project is the only alternative to have self-sustain to meet domestic demand.

iii) Energy surplus deficit for F/Y 2092/93 under 100% generation (Scenario 2)

There will be surplus energy in each month for F/Y 2092/093. The energy demand during f/y 2092/093 will be 29,745 GW with peak demand 4,864 MW and annual generation will be about 69,764 GWh. So, in total 40,020 GWh energy will surplus during the year. The operation of hydropower projects with installed capacity 16,951 MW and 157.74MW solar during the year will results sufficient capacity to meet the peak demand throughout the year. So, no additional projects need to meet the demand but there will be a challenge to manage surplus energy throughout the year.

iv) Energy surplus deficit for F/Y 2092/93 under 50% generation (Scenario 1)

Operation of 7,293 MW RoR, 2,068.63 MW PRoR and 246 MW storage types hydro and 173 MW solar project results maximum capacity deficit deficit of 1,618 MW in the month of Chaitra with energy deficit during months of Magh, falgun, Chaitra and Baisakh. The total energy deficit during dry months will be about 1,340 GWh but there will be energy surplus during other months. About 11,040 GWh energy will be surplus during other months. In total 9,701 GWh will be net energy surplus annually. In order to meet peak demand, it will require about 2,158 MW of storage project. Operation of Budigandaki HPP, Tamor storage and Nalgad HPP will be sufficient to meet the demand throughout the year but again huge amount of energy will be surplus. Annually about 16,545 GWh energy will be available for trading. In place of storage projects, if equal capacity RoR/PRoR are assume to be come in operation then this will not be feasible to meet peak demand during Magh, Falgun and Chaitra. So, it is not advisable to plan additional RoR projects.

B. Under 9.2 % Growth rate

i) Energy surplus deficit for F/Y 2087/088 under 100% generation (Scenario 3)

Operation of 7,186 MW RoR, 2,423 MW PRoR and 246 MW storage storage will not sufficient to meet peak demand of Magh, Falgun and Chaitra. About 670 MW of peak demand will be unserved during peak hours but in total about 15,491 GWh of energy will be available for trading which can earn about Nrs.104 billion annually.

ii) Energy surplus deficit for F/Y 2092/093 under 100% generation (Scenario 3)

In this situation about 1170 MW will be insufficient to meet monthly peak demand by the operation of 13,345 MW RoR, 3360 MW PRoR and 246 MW storage projects. Annually about 29,055 GWh energy will be available for trading which can have opportunities to earn about Nrs. 104 billion annually.

For 7.2 % economic growth situation, zone 1, zone 3, zone 4, and zone 5 will have potential to export energy through Dododhara, Butwal, Dhalkebar and Anarmani respectively during fiscal year 2087/088. During fiscal year 2092/093, the demand of all zone will be less than supply in this zone and there will be large potential available to export through these above-mentioned international transmission line provided that there is no transmission line problem within the country. So, the proposed international transmission line needs to be completed within fiscal year 2087/088 to eliminate energy spill by trading it to the India.

The energy requirement during the months of dry seasons can be increased by increasing the number of RoR or PRoR projects but this will create a huge energy spill during wet season. The lack of internal power market and solid decision and assurance of energy trading in India may cause spill of energy which consequently causes the huge losses in the investment of hydropower. Run of river projects being not able to store water are suitable for base load and storage projects having capacity to operate more than 6 hours during dry season will be very appropriate projects in the management of peak load.

So, planner and policy maker need to think about the possible energy spill situation with more run of river projects. Operation of storage projects will helps reducing energy spill during wet and in energy management throughout the year. To cope with these challenges, government need to focus on construction storage projects in place of runoff river projects and should create an environment of energy trading with timely completion of proposed transmissions line by Transmission line master plan of Nepal.

5.1 Recommendations

1. This study considered past energy generation data to calculate capacity factor of RoR and PRoR hydro power projects and assumed that there is no any limitation on power flow due to transmission line constraint. So further study on transmission line congestion and stability of network for the planned year can be done for possible energy trading scenario.

2. This study is carried out on monthly energy basis. So, this daily energy management issues may not be suitably addressed by this research. So, a study can be done with taking generation and demand on daily basis.
3. This study shows the scenario and possibilities of energy trading but do not explain the modality of energy trading and energy management.

REFERENCES

[1] Water and Energy Comission Secretariat, "Energy Sector Synopsis Report Nepal," Government of Nepal, Kathmandu, 2010.

[2] D. Neupane, S. Kafle , K. R. Karki, H. Dae and P. Pradhan , "Solar Wind Energy Potential Assessment at Provincal Level in Nepal: Geospatial and Economic analysis," *Renewable Energy*, vol. 181, pp. 278-291, 2022.

[3] Ministry of Energy, Water resources and Irrigation, "Currebt Status and Future plan of Ministry of Energy, Water Resources and Irrigation," MoEWRI, Kathmandu, 2075.

[4] National Planning Commisson Nepal, "The Fiftenth plan (Fiscal Year 2019/20-2023/24)," Government of Nepal, Kathmandu, 2020.

[5] National Planning Comission, "National Review of Sustanable Development Goals," Government of Nepal, Kathmandu, 2020.

[6] U. K. Shukla and s. Sharma, "The potential of electricity imports to meet future electricity requirements in India," *The Electricity Journal*, vol. 30, no. 3, pp. 71-84, 2017.

[7] W. Lyzwa and M. Wierzbowski, "Load Duration Curve in the Long-term Energy Mix Optimization," *IEEE*, 2016.

[8] N. K. Das, J. Chakrabartty, A. S. Gupta and M. M.A., "Present energy scenario and future energy mix of Bangaladesh," *Energy Strategy Reviews*, vol. 32, p. 100576, 2020.

[9] K. Gyanwali, K. Ryoichi and F. Yasumasa, "Representing hydropower in the dynamic power sector model and assessing clean energy deployment in the power generation mix of Nepal," *Energy*, vol. 202, p. 117795, 2020.

[10] Nepal Electricity Authority, "Nepal Electricity Authority, A year in review - Fiscal Year 2021/2022," Nepal Electricity Authority, Kathmandu, 2022.

[11] MInistry of Energy Water Resource and Irrigation, "Transmission System Developmnet Plan of Nepal," Government of Nepal, Kathmandu, 2018.

[12] Ministry of Energy, Water Resources and Irrigation, "www.moewri.gov.np," MoEWRI, 30 5 2023. [Online]. Available: http://moewri.gov.np/storage/listies/May2023/press-release-2080-02-021.pdf. [Accessed 30 5 2023].

[13] Water and Energy Commission Secretariat, "Energy Demand Forecaste Report 2015-2040," Government of Nepal, Kathmandu, 2017.

[14] NEA, "Load Forcast Report," NEA, Kathmandu, 2017.

[15] South Asian Regional Initiative for Energy Integration , "Econimic Benifit from Nepal - India Electricity Trade," South Asian Regional Initiative for Energy Integration, Kathmandu, 2027.

[16] Indian Energy Exchange, "iexindia.com," Indian Energy Exchange Limited, 30 12 2022. [Online]. Available: http://www.iexindia.com/marketdata/market_snapshot.aspx. [Accessed 1 5 2023].

[17] B. Puri, *Scenarion Analysis of Integrated Nepal Power System for Energy Banking Between Nepal & India*, Kathmandu: Insitute of Engineering, 2021.

[18] Nepal Electricity Authority, "nea.org.np," NEA, 01 01 2022. [Online]. Available: http://www.nea.org.np/annual_report. [Accessed 1 5 2022].

ANNEXES

Annex 1: List of Hydro power and solar projects

Hydro Power Projects under operation

S No	Project	Capacity (MW)	River	Promoter	VDC/District
1	Khimti -I	60	Khimti Khola	Himal Power Limited	Sahure, Hawa (Dolakha) Betali (Ramechhap)
2	Seti	1.5	Seti Khola	Nepal Electricity Authority	(Kaski)
3	Marsyangdi	69	Marsyangdi	Nepal Electricity Authority	(Tanahu)
4	Kulekhani-I	60	Kulekhani	Nepal Electricity Authority	(Makawanpur)
5	Trishuli	24	Trishuli	Nepal Electricity Authority	(Nuwakot)
6	Gandak	15	Narayani	Nepal Electricity Authority	(Nawalparasi)
7	Panauti	2.4	Roshi	Nepal Electricity Authority	(Kabhrepalanchok)
8	Tatopani	2	Tatopani	Nepal Electricity Authority	(Myagdi)
9	Kulekhani-II	32	Kulekhani	Nepal Electricity Authority	(Makawanpur)
10	Devighat	14.1	Trishuli	Nepal Electricity Authority	(Nuwakot)
11	Sun Koshi	10.05	Sun Koshi	Nepal Electricity Authority	(Sindhupalchok)
12	Tinau	1.024	Tinau	Nepal Electricity Authority	(Palpa)
13	Andhi Khola	9.4	Andhi Khola	Butwal Power Company	(Syangja)
14	Jhimruk Khola	12.5	Jhimruk	Butwal Power Company	(Pyuthan)
15	Puwa	6.2	Puwa	Nepal Electricity Authority	Ilam N.P. (Ilam)
16	Modi Khola	14.8	Modi Khola	Nepal Electricity Authority	(Parbat)
17	Kali Gandaki A	144	Kali Gandaki	Nepal Electricity Authority	Shreekrishna Gandaki (Syangja)
18	Upper Bhotekoshi	45	Bhote Koshi	Bhotekoshi Power Company	(Sindhupalchok)
19	Chilime	22	Chilime	Chilime Hydropower Company Limited	Chilime (Rasuwa)
20	Indrawati -III	7.5	Indrawati Khola	National Hydropower Company Pvt. Ltd.	Jyamire, Langarche (Sindhupalchok)
21	Madhya Marsyangdi	70	Marsyangdi	Nepal Electricity Authority	(Lamjung)
22	Piluwa Khola	3	Piluwa Khola	Arun Valley Hydropower Development Company Pvt. Ltd.	(Sankhuwasabha)
23	Sunkoshi Small	2.6	Sun Koshi	Sanima Hydripower Pvt.Ltd	(Sindhupalchok)
24	Mailung Khola	5	Mailung Khola	Mailun Khola Hydropower Company Pvt. Ltd	(Rasuwa)
25	Chaku Khola	3	Chaku	Alliance Power Nepal P.Ltd	Fulpingkatti, Tatopani (Sindhupalchok)
26	Khudi Khola	4	Khudi	Khudi hydropower limited	Ghanpokhara, Khudi, Simpani (Lamjung)
27	Thoppal Khola	1.65	Thoppal	Thoppal Khola Hydropower Company	(Dhading)
28	Chameliya Khola	30	Chameliya Khola	Nepal Electricity Authority	Latinath, Seri, Sikhar (Darchula)

Hydro Power Projects under operation

S No	Project	Capacity (MW)	River	Promoter	VDC/District
29	Mardi Khola	4.8	Mardi	Gandaki Hydropower Development Co. P. Ltd	(Kaski)
30	Ridi Khola	2.4	Ridi	Ridi Hydropower Development Co P Ltd	(Palpa)
31	Mai Khola	4.5	Mai Khola	Himal Dolkha Hydropower Co Ltd	(Ilam)
32	Kule Khani Third	14	Kulekhani	Nepal Electricity Authority	Bhaise (Makawanpur)
33	Hewa khola	4.455	Hewa Khola	Barun Hydropower Development Co. Pvt. Ltd	Jaljala, Siddhapokhari (Sankhuwasabha)
34	Lower Chaku Khola	1.8	Chaku	Laughing Buddha Power Nepal Pvt. Ltd	(Sindhupalchok)
35	Sipring Khola	10	Sipring	Synergy Power Development P Ltd	Khare, Gauri Sankar (Dolakha)
36	Lower Modi -1	10	Modi Khola	United Modi Hydropower Pvt. Ltd., 1st Floor Heritage Plaza 2; Kamaladi, Kathmandu Metropolitan - 31	(Parbat)
37	Bhairab Kund Khola	3	Bhairab Kund	Bhairabkund Hydropower Pvt. Ltd.	Tatopani (Sindhupalchok)
38	Siuri Khola	5	Siuri	Nyadi Group Pvt Ltd	(Lamjung)
39	Ankhu Khola - 1	7	Ankhu Khola	Ankhu Jalvidut Co. Pvt. Ltd	(Dhading)
40	Baramchi Khola HPP	4.2	Baramchi	Unique Hydel Pvt Ltd	Baramchi, Hagam (Sindhupalchok)
41	Bijayapur-1	4.5	Bijayapur	Bhagawati Hydropower Development Company	(Kaski)
42	Upper Madi	25	Madi Khola	Madi Power Pvt Ltd.,	Namarjung, Thumakodada, Sildujure (Kaski)
43	Upper Mai Hydropower Project (Panchakanya Mai Hydropwer limi	12	Mai Khola	Mai Valley Hydropower P Ltd.	Mabu, Maimajhuwa (Ilam)
44	Mai	22	Mai Khola	Sanima Mai Hydropower Limited	(Ilam)
45	Lower Modi Khola	20	Modi Khola	Modi Energy Pvt . Ltd	, Durlung, Deurali, Ramja, Tilahar (Parbat)
46	Phawa khola Hydropower Project	5	Phawa Khola	Shiwani Hydropower Company	Dummrise, Chaksibote, Thechambu (Taplejung)
47	Charnawati Khola Hydroelectric Project	3.52	Charnawati	Nepal Hydro Developer Pvt Ltd	Mati (Dolakha)
48	Upper Tamakoshi HPP	456	Tama Koshi	Upper Tamakoshi Hydropower Limited	Bulung, Gauri Sankar, Khare, Lamabagar, Sunakhani, Sundrawati (Dolakha)
49	Upper Trishuli 3A	60	Trishuli	Nepal Electricity Authority	Dandagoun, Laharepouwa, Thulogoun, Ramche (Rasuwa)

Hydro Power Projects under operation

S No	Project	Capacity (MW)	River	Promoter	VDC/District
50	Jiri Khola SHP	2.4	Jiri Khola	Bojini Company (P.) Ltd	(Dolakha)
51	Pikhuwa Khola	5	Pikhuwa	Eastern Hydropower P Ltd	Kota, Bokhim, Bhojpur (Bhojpur)
52	Middle Chaku Khola	1.8	Chaku	Laughing Budha Power Nepal	(Sindhupalchok)
53	Radhi Small	4.4	Radhi	Radhi Bidyut Co. Ltd	(Lamjung)
54	Mristi Khola	42	Mristi	Mountain Energy Nepal Limited	, Dana, Narchyang (Myagdi)
55	Tadi Khola (thaprek)	5	Tadi Khola	Aadi Shakti Bidhut Bikash Co. P. Ltd	(Nuwakot)
56	Upper Chaku A	22.2	Chaku	Shiva Sri Hydropower Pvt. Ltd	Marbin, Fulpingkatti (Sindhupalchok)
57	Likhu-4	52.4	Likhu Khola	Green Ventures Pvt. Ltd	Ragani, Pokli (Okhaldhunga) Saibu, Bijulikot, Naga Daha, Tilpung (Ramechhap)
58	Upper Marsyangdi A	50	Marsyangdi	Sinohydro-Sagarmatha Power Company Pvt Ltd	Bhulbhule, Bahundada, Khudi (Lamjung)
59	Thapa Khola	11.2	Thapa Khola	Mount Kailash Energy Co. Ltd	(Mustang)
60	Daraundi A	6	Daraundi	Daraundi Kalika Hydro	(Gorkha)
61	Jhyari Khola	2	Jhyari Khola	Electrocom and Research Centre, 9851003846	Pipaldanda, Sanusiruwari, Kunchok, Bhotsipa (Sindhupalchok)
62	Lower Khare	11	Khare	Universal Power Company P. Ltd	Bulung, Chankhu, Khare, Suriti (Dolakha)
63	Nau Gad Khola	8.5	Naugad	Api Power Company Pvt. Ltd	(Darchula)
64	Upper Hugdi	5	Hugdi	Ruru Jalbidyut Pariyojana Pvt. Ltd	(Gulmi)
65	Midim Khola	3	Midim Khola	Union Hydropower P.Ltd	Karapu (Lamjung)
66	Mai Cascade	7	Mai Khola	Sanima Mai Hydropower Limited	(Ilam)
67	Hewa Khola A	14.9	Hewa Khola	Panchthar Power Company Pvt. Ltd.	Bharapa, Nangeen, Yanganam (Panchthar)
68	Upper Khimti	12	Khimti Khola	Himalaya Urja Bikas Co. Pvt. Ltd.	Chuchure (Ramechhap)
69	Namarjun Madi	12	Madi Khola	Himalayan Hydropower Pvt.Ltd	Namarjung, Sildujure (Kaski)
70	Sabha Khola	3.3	Sabha Khola	Dibyaswari Hydropower P Ltd	Dhupu (Sankhuwasabha)
71	Nyadi Khola	30	Nyadi	Nyadi Hydropower Limited	Bahundada, Bhulbhule (Lamjung)
72	Tungun - Thosne Khola	4.36	Tugun	Khani Khola Hydropower Company Ltd	(Lalitpur)
73	Khani Khola	2	Khani Khola	Khani Khola Hydropower Company Ltd	(Lalitpur)
74	Lower Tadi	4.993	Tadi Khola	Buddha Bhumi Nepal Hydropower Co. Pvt. ltd.	Balkumari, Samundratar,

Hydro Power Projects under operation

S No	Project	Capacity (MW)	River	Promoter	VDC/District
					Sundaradevi, Thaprek (Nuwakot)
75	Jogmai Khola	7.6	Jogmai Khola	Sanvi Energy Pvt. Ltd.	, Namsaling, Naya Bazar, Panchakanya, Phikal Bazar (Ilam)
76	Daram Khola-A	2.5	Daram	Sayapatri Hydropower Pvt. Ltd.	(Baglung)
77	Upper Puwa-1	3	Puwa	Joshi Hydropower Co. P. Ltd	(Ilam)
78	Sardi Khola	4	Sardi	Mandakini Hydropower Pvt. Ltd.	(Kaski)
79	Upper Mai -C	6.1	Mai Khola	Mai Valley Hydropower P.L.,	, Mabu, Sulubung (Ilam)
80	Kabeli B - 1	25	Kabeli Khola	Arun Kabeli Power Limited.	Nagi, Tharpu (Panchthar)
81	Lower Hewa	22.1	Hewa Khola	Mountain Hydro Nepal (P.) Ltd	Bharapa, Nangeen, Phidim (Panchthar)
82	Mai Cascade HPP	8	Mai Khola	Himal Dolkha Hydropower Company Pvt Ltd	Goduk, Chisapani, Ilam N.P., Soyak (Ilam)
83	Chhandi Khola	2	Chhandi	Chhyandi Hydropower Co. P. Ltd	(Lamjung)
84	Puwa Khola-1	4	Puwa	Puwa Khola - 1 Hydropower Pvt. Ltd	Shantidanda, Barbote, Ilam N.P. (Ilam)
85	Rudi A	8.8	Rudi Khola	Bindhabasini Hydropower Developmwnt Company Pvt.Ltd	Mijuredada (Kaski) Bhoje, Pasagaun (Lamjung)
86	Ghalemdi Khola	5	Ghalemdi	Ghalemdi Hydro Limited	Narchyang (Myagdi)
87	Kapadigad	3.33	Kapadigad	Salmanidevi Hydropower Pvt Ltd	, Barchhen (Doti)
88	Madkyu Khola	13	Madkyu	Silkes Hydropower Pvt.Ltd	(Kaski)
89	Chake Khola	2.83	Chake Khola	Garjang Upatyaka HP Company Limited	Chuchure (Ramechhap)
90	Solu Hydropower Project	23.5	Solu Khola	Upper Solu Hydroelectric Company Pvt Ltd	Gora Khami, Garma, Salleri (Solukhumbu)
91	Dwari Khola SHP	3.75	Dwari	Bhugol Energy Development Company Pvt Ltd	
92	Bagmati Nadi	22	Bagmati	Mandu Hydropower Pvt. Ltd.	Kogate, Ipa Panchakanya, Sisneri Mahadevsthan (Makawanpur)
93	Molun Khola SHP	7	Molun	Molun Hydropower Co. Pvt. Ltd	Baraneshwor, Prapchan, Harkapur (Okhaldhunga)
94	Upper Khimti II	7	Khimti Khola	Himalaya Urja Bikash Company Limited	Chuchure (Ramechhap)
95	Upper Hewa HPP	8.5	Hewa Khola	Upper Hewa Khola Hydropower Company Pvt Ltd	Jaljala, Siddhapokhari (Sankhuwasabha)
96	Suri Khola	7	Suri	Suri Khola Hydropower Pvt Ltd	, Chankhu (Dolakha)
97	Ghatte Khola	5	Ghatte Khola	Mankamana Engineering HP	Marbu (Dolakha)

Hydro Power Projects under operation

S No	Project	Capacity (MW)	River	Promoter	VDC/District
98	Iwa Khola	9.9	Iwa Khola	Rairang Hydropower Development Co Ltd	Sawalakhu (Taplejung)
99	Theule Khola HPP	1.5	Theule	Barahi Hydropower Pvt Ltd	Kusmi, Binamare, Sarkuwa (Baglung)
100	Likhu Khola 'A'	51	Likhu Khola	Numbur Himalaya Hydropower Ltd	Chaulakharka(Waula), Goli (Solukhumbu)
101	Singati Khola hydropower project	25	Singati	Singati Hydro Energy Pvt. Ltd.	Babare, Laduk, Lamidada (Dolakha)
102	Lower Likhu	28.1	Likhu Khola	Swaita Ganga Hydropower and Construction Pvt. Ltd.	Tarkerabari, Yasam, Gamanamatar (Okhaldhunga) Bijulikot, Gothgau (Ramechhap)
103	Taksar Pikhuwa	8	Pikhuwa	Taksar Pikhuwa Khola Hydropower Pvt. Ltd.	Kota, Mane Bhanjyang, Taksar, Dalgaun (Bhojpur)
104	Bijaypur Khola-2 HPP	4.5	Bijaypur	Civil hydropower company	Lekhnath (Kaski)
105	Upper Khorunga HPP	7.5	Khoranga Khola	Terhathum Power Company Pvt. Ltd.	Morahang, Shree Jung, Oyabjung, Pouthak (Terhathum)
106	Upper Naugad Gad Hydropower Project	8	Naugad	Api Power Company Ltd.	Dhuligada, Sikhar (Darchula)
107	Upper Mardi Hydropower Project	7	Mardi	United Idimardi and R.B. Hydropower Pvt Ltd	Lwangghale (Kaski)
108	Rawa Khola	3	Rawa Khola	Rawa Energy Development Pvt Ltd	Sungdel, Diplung (Khotang)
109	Super Mai Hydropower Project	7.8	Mai Khola	Supermai Hydropower Pvt.Ltd.	Barbote, Soyang, Sumbek (Ilam)
110	Upper Syange Khola SHP	2.4	Syange	Upper Syange Hydropower Pvt. Ltd.	Taghring (Lamjung)
111	Rudi Khola-B Hydropower Project	6.6	Rudi Khola	Bindhyabasini Hydropower Development Co. Pvt Ltd	Mijuredada (Kaski) Pasagaun (Lamjung)
112	Padam Khola SHP	4.8	Padam Khola	Dolti Power Company P. Ltd	Kalika (Dailekh)
113	Sapsup Khola Small Hydro Electric Project	7.151	Sapsup Khola	Three Star Hydro Power Pvt.Ltd.	Batase, Chhorambu, Rajapani (Khotang)
114	Richet Khola SHP	5	Richet	Richet Jalbidhyut Company Pvt. Ltd.	Manbu, Kashigaun (Gorkha)
115	Super Mai-A HPP	9.6	Mai Khola	Sagarmatha Jalbidhyut Company P.Ltd.	Sumbek, Sulubung, Pyang (Ilam)
116	Mai Beni HPP	9.51	Mai Khola	Samling Power company Pvt.Ltd	Namsaling, Soyang, Goduk (Ilam)
117	Upper Chhyandi Small HPP	4	Chhyangdi	Chhyandi Hysropower LTD	Bansar, Faleni (Lamjung)
118	Super Mai Khola Cascade HPP	3	Mai Khola	Mai Khola Hydropower Pvt.Ltd.	Soyang, Barbote (Ilam)
119	Lower Jogmai Khola HPP	6.2	Jogmai Khola	Asian Hydropower Pvt. Ltd	Namsaling, Goduk, Panchakanya (Ilam)
120	Kabeli B1 Cascade HPP	9.94	Kabeli Khola	Arun Valley Hydropower Development Company Ltd.	Ambarpur, Nagi (Panchthar)

Hydro Power Projects under operation					
S No	**Project**	**Capacity (MW)**	**River**	**Promoter**	**VDC/District**
121	Chepe Khola Small HEP	8.63	Chepe Khola	Aashutosh Investment Pvt. Ltd.	Kharibot (Gorkha) Dudhpokhari (Lamjung)
122	Sunigad HEP	11.05	Suni Gad	Omega EnergyDeveloper Pvt. Ltd	Sunikot (Bajhang)

List of projects with generation license issued by MoEWRI/DoED					
S No	**Project**	**Capacity (MW)**	**River**	**Promoter**	**VDC/District**
1	Khani Khola - 1	40	Khani Khola	Green Life Energy Pvt.Ltd, Sirin Bhawan, Lalitpur-1, Kupakdole	Khare, Marbu (Dolakha)
2	Dordi Khola	27	Dordi	Himalaya Power Partner Pvt. Ltd	Archalbot, Chiti, Dhodeni, Nauthar, Shree Banjyang, Udipur (Lamjung)
3	Rahughat	40	Rahughat	Raghu Ganga Hydropower Limited	Jhin (Myagdi)
4	Tadi Khola	5	Tadi Khola	Hiraratna hydropower Pvt. Ltd	, Rautbesi, Samundratar, Shikharbesi (Nuwakot)
5	Jumdi Khola Small	1.75	Jumdi	Jumdi Hydropower Pvt. Ltd.,	Bharse, Hasara, Juhang (Gulmi)
6	Sanjen	42.5	Sanjen	Sanjen Jalvidyut Co.	Chilime (Rasuwa)
7	Upper Mailung - A	6.42	Mailung Khola	Energy Engineering Pvt. Ltd	, Gatlang, Haku (Rasuwa)
8	Upper Sanjen	14.8	Sanjen	Sanjen Jalvidhyut Co	Chilime (Rasuwa)
9	Kabeli-A	37.6	Kabeli Khola	Kabeli Energy Limited	Ambarpur, Panchami (Panchthar) Thechambu (Taplejung)
10	Rasuwagadhi	111	Bhote koshi	Rasuwagadhi H P	Thuman, Timure (Rasuwa)
11	Upper Mailun Khola	14.3	Mailung Khola	Upper Mailung Khola Hydropower Limited.	, Gatlang, Haku, Dandagoun (Rasuwa)
12	Junbeshi	5.2	Junbeshi	Dobhan Hydropower Pvt.Ltd.	Beni (Solukhumbu)
13	Dordi-1	12	Dordi	Dordi Khola Jalvidyut Company Limited	Chiti, Bansar, Dhodeni, Faleni (Lamjung)
14	Khorunga Khola	4.8	Khoranga Khola	Reliable Hydropower Company. P. Ltd	Ambung, Oyabjung (Terhathum)
15	Gelun Khola HPP	3.2	Gelun	Gelun Khola Hydropower Company Pvt Ltd	Baramchi, Hagam, Jalbire (Sindhupalchok)
16	Khani Khola (Dolakha)	30	Khani Khola	Sasha Engineering Hydropower P. Ltd	Marbu, Khare (Dolakha)
17	Middle Modi	18	Modi Khola	Middle Modi Hydropower Limited	, Deupurkot, Tilahar (Parbat)
18	Middle Midim	3.1	Midim Khola	Madhya Midim Jalvidhyut Company Pvt. Ltd.	, Gilung, Karapu, Maling, Nalma (Lamjung)
19	Upper Trishuli 3B	37	Trishuli	Nepal Electricity Authority	Manakamana (Nuwakot)
20	Parajuli Khola-1	2.15	Parajuli Khola	Rara Hydropower Development Co.	Awal Parajul (Dailekh)
21	Lohare Khola	4.2	Lohore Khola	Lohare Khola Hydropower Co. P. L.,	Baluwatar, Nomule, Salleri, Toli (Dailekh)
22	Salankhu Khola	2.5	Salankhu	Salankhu Khola Hydropower P. Ltd.	Kaule, Manakamana, Tupche, Fikuri (Nuwakot)
23	Madhya Bhotekoshi	102	Bhote koshi	Madhya Bhotekoshi Jalbidyut Company Ltd.	Maneswor, Marbin, Listi (Sindhupalchok)
24	Rawa Khola HPP	6.5	Rawa Khola	Dudhkoshi Power Company Pvt Ltd	Hauchour, Jalapa, Dumekoldada (Khotang)
25	Down Piluwa	10.3	Piluwa Khola	River Falls Hydropower Development P. Ltd.	Baneswor, Ankhibhui, Mamling (Sankhuwasabha)

List of projects with generation license issued by MoEWRI/DoED					
S No	**Project**	**Capacity (MW)**	**River**	**Promoter**	**VDC/District**
26	Super Dordi Kha Hydropower Project	49.6	Dordi	Peoples Hydropower Company Pvt.Ltd.	Dhodeni, Faleni (Lamjung)
27	Lower Solu Hydropower Project	82	Solu Khola	Solu Hydropower Pvt Ltd	Garma, Tingla (Solukhumbu)
28	Upper Myagdi	20	Myagdi Khola	Hydro Empire P Ltd	Marang, Mudi, Muna (Myagdi)
29	Rupse Khola	4	Rupse Khola	Research & Development Group	Dana (Myagdi)
30	Upper Dordi A HEP	25	Dordi	Liberty Energy Hydropower Pvt. Ltd.	Dhodeni, Faleni (Lamjung)
31	Khare Hydropower Project	24.1	Khare	Constorium Power Developers Pvt Ltd	Chankhu, Khare, Marbu (Dolakha)
32	Maya Khola Hydropower Project	14.9	Maya	Maya Khola Hydropower Company pvt Ltd	Mamling, Madi Rambeni, Baneswor (Sankhuwasabha)
33	Solu Khola (Dudha Koshi)	86	Solu Khola	Sahas Urja Limited	Kagel, Tingla, Panchan, Newa Beddhari, Salyan (Solukhumbu)
34	Sabha Khola A	8.3	Sabha Khola	Deepsabha Hydropower Pvt. Ltd.	Dhupu, Syabun (Sankhuwasabha)
35	Badigad HPP	6.6	Badigad	Water and Energy Nepal Pvt Ltd	Burtiwang, Bhinggithe, Rajkut (Baglung)
36	Durbang Myagdi Khola	25	Myagdi Khola	Dhaulagiri Kalika Hydropower P Ltd	, Arman, Babiyachaur, Devisthan, Darwang, Niskot (Myagdi)
37	Balephi A	10.6	Balephi	Moonlight Hydropower Company Ltd.	Baramchi, Golche, Pangtang (Sindhupalchok)
38	Upper Modi A	42	Modi Khola	Nepal Electricity Authority	Lumle, Ghandruk (Kaski)
39	Rukum gad	5	Rukum Gad	Rapti Hydro and General Construction Pvt. Ltd.	Kanda, Sobha (Rukum)
40	Ghar Khola	14	Ghar	Myagdi Hydropower Ltd.	, Shikha (Myagdi)
41	Tanchhahara SHP	2.4	Tangchhahara	Tanchhar Hydro Pvt. Ltd.	Kowang, Lete (Mustang)
42	Langtang Khola Small Hydropower Project	20	Langtang	Multi Energy Development Pvt. Ltd.	Syafru (Rasuwa)
43	Siddhi Khola	10	Siddhi Khola	Lumbini Builders P. Ltd	Samalpung, Jirmale (Ilam)
44	Upper Tadi	11	Tadi Khola	Surya Kund Hydro Electric Pvt. Ltd.	Rautbesi (Nuwakot)
45	Likhu -1	77	Likhu Khola	Pan Himay Energy Ltd	Gumdel (Ramechhap)
46	Likhu -2	55	Likhu Khola	Global Hydropower Associate Ltd	Gumdel (Ramechhap) Chaulakharka(Waula) (Solukhumbu)
47	Ruru Banchu - 1	16	Rurubanchu Khola	Mount Nilgiri Hydropower Company Pvt Ltd	Chilkhaya, Odanku (Kalikot)
48	Upper Piluwa Khola-2 SHP	4.72	Piluwa Khola	Menchhiyam Hydropower P Ltd.	Mawadin, Siddhakali (Sankhuwasabha)
49	Kalanga	15.33	Kalanga Gad	Kalanga Hydropower P Ltd	, Sunkuda, Khiratadi, Banjh (Bajhang)
50	Upper Kalangad	38.46	Kalanga Gad	Sani Gad Hydro pvt. Ltd	Dahabagar, Khiratadi (Bajhang)
51	Sanigad	10.7	Sani Gad	Bungal Hydro P Ltd	Kaphalaseri, Pipalkot (Bajhang)
52	ChulepuKhola Hydropower Project	8.52	Chulepu, Dhunde Khola	Chandeswari Mahadev Khola Micro Hydro Com.P.Ltd.	Bhujee, Guptesqor, Pritee (Ramechhap)
53	Chauri Khola	5	Chauri	Chauri Hydropower P Ltd	Goswara (Ramechhap)
54	Tanahu HEP	140	Seti Khola	Tanahu Hydropower Limited	Damauli, Kahu Sivapur (Tanahu)

List of projects with generation license issued by MoEWRI/DoED					
S No	**Project**	**Capacity (MW)**	**River**	**Promoter**	**VDC/District**
55	Daraundi-1	10	Daraundi	Diamond Hydropower Pvt. Ltd	Takumajhlakuribot, Takukot, Masel, Jaubari, Gakhu, Shreenathkot (Gorkha)
56	Sanjen Khola	78	Sanjen	Sala Sungi P Ltd	Chilime (Rasuwa)
57	Phalakhu Khola HPP	5	Phalankhu Khola	Rasuwa Hydropower Company Pvt Ltd	Bhorle, Saramthali (Rasuwa)
58	Phalakhu Khola HPP	14.7	Phalankhu Khola	Betrawati Hydroelectric Co. Ltd	Saramthali, Yarsa (Rasuwa)
59	Upper Balephi A	36	Balephi	Balephi Hydropower Ltd.	Golche, Pangtang, Dhumthang (Sindhupalchok)
60	Liping Khola	16.26	Liping	Him River Power Pvt. Ltd	Tatopani (Sindhupalchok)
61	Lower Khorunga	5.5	Khoranga Khola	IDS Energy Pvt. Ltd	Jaljale, Tamfula (Terhathum)
62	Upper Solu Khola HPP	18	Solu Khola	Beni Hydropower Project	Beni, Salleri (Solukhumbu)
63	Makari gad	10	Makari gad	Makarigad Hydropower Pvt. Ltd	, Guljar, Khandeswori (Darchula)
64	Yambaling Khola	7.271	Yambling	Yamling Hydropower Pvt Ltd	Gumba, Golche (Sindhupalchok)
65	Sano Milti Khola SHP	3	Milti	Sano Milti Khola Hydropower P.Ltd.	Dandakharka, Melung (Dolakha) Phulasi (Ramechhap)
66	Rahughat Mangale	37	Rahughat	Tundi Power Company P.Ltd.	Pakhapani, Chimkhola, Kuinemangale (Myagdi)
67	Upper Nyasim Khola	43	Nyasem Khola	Sindhujwala Hydropower P. Ltd	Gumba (Sindhupalchok)
68	Ruru Banchu Khola- 2	12	Rurubanchu Khola	Ruru hydroelectric Co Pvt. Ltd	Gela, Chilkhaya (Kalikot)
69	Khimti II	48.8	Khimti Khola	Peoples Hydro sahakari Sastha Limited	Chyama (Dolakha) Betali, Rasanalu (Ramechhap)
70	Upper Lapche Khola	52	Lapche	Energy Venture Pvt. Ltd.	Lamabagar (Dolakha)
71	Daram Khola HEP	7.3	Daram	Daram Khola Hydro Energy Limited	Malm, Righa, Kandebas (Baglung) Arlangkot (Gulmi)
72	Ankhu Khola	42.9	Ankhu Khola	Ankhu Hydropower Pvt. Ltd	Darkha, Gumdi, Jharlang, Ree (Dhading)
73	Upper Chirkuwa Khola	4.7	Chirkhuwa	Chirkhuwa Hydropower Company Pvt td	Nepaledada, Mulpani, Khartimchcha (Bhojpur)
74	Sabha Khola-B HPP	15.1	Sabha Khola	Arbit Energy P Ltd	Sabha Pokhari (Sankhuwasabha)
75	Middle Tara Khola SHP	1.7	Tara Khola	Pahadi Hydropower Company Pvt. Ltd.	Tara (Baglung)
76	Balephi	23.52	Balephi	Balephi Jalbidhut Company Ltd	Baramchi, Golche, Selang (Sindhupalchok)
77	Super Madi	44	Madi Khola	Himal Hydro and General Construction Ltd.	, Namarjung, Parche, Saimrang, Kalika (Kaski)
78	Upper Chauri Khola	6	Chauri	Himalayan Water Resources & Energy Development Co. P. Ltd	(Kabhrepalanchok)
79	Tamakoshi V	87	Tama Koshi	Tamakoshi hydropower Company Ltd.	Lamabagar, Orang, Bulung, Laduk, Gauri Sankar (Dolakha)
80	Lower Chirkhuwa	4.06	Chirkhuwa	Chirkhuwa Hydropowerr Pvt. Ltd.	Mulpani, Nepaledada (Bhojpur)
81	Middle Tamor	54	Tamor	Sanima Middle Tamor Hydropower Ltd	Hangdeva, Khokling, Phurumbu, Sawadin (Taplejung)
82	Lankhuwa Khola	5	Lankhuwa	Sabhapokhri Hydropower Pvt Ltd	Dhupu (Sankhuwasabha)

List of projects with generation license issued by MoEWRI/DoED					
S No	**Project**	**Capacity (MW)**	**River**	**Promoter**	**VDC/District**
83	Mewa Khola Hydropower project	50	Mewa Khola	United Mewa Khola Hydropower Pvt Ltd	Khamlung, Khokling, Lingtep, Liwang, Thukima (Taplejung)
84	Nilgiri Khola	38	Nilgiri	Nilgiri Khola Hydropower Company Pvt. Ltd.	, Narchyang (Myagdi)
85	Buku-Kapati Hydropower Project	5	Buku	Him Star Urja Company Ltd.	Bhussinga, Rawadolu (Okhaldhunga) Goli (Solukhumbu)
86	Super Nyadi Hydropower Project	40.27	Nyadi	Siuri Nyadi Power Ltd	Bahundada, Bhulbhule (Lamjung)
87	Seti Khola HPP	3.5	Seti Khola	Parbat Paiyu Khola Hydropower Company	Shivalaya (Parbat)
88	Marsyangdi Besi	50	Marsyangdi	Divyajyoti Hydropower Pvt. Ltd.	Besisahar, Chandisthan, Bhulbhule, Gaunsahar, Bajhakhet, Hiletaxar (Lamjung)
89	Upper Trishuli-1	216	Trishuli	Nepal Water & Energy Development Co. P. Ltd	Dhunche, Haku (Rasuwa)
90	Istul Khola HPP	1.506	Istul	Amar Jyoti Hydropower Pvt Ltd	Aarupokhari (Gorkha)
91	Lapche Khola	160	Lapche	Nasa Hydropower Company P Ltd	Lamabagar (Dolakha)
92	Kasuwa Khola HPP	45	Kasuwa	Kasuwa Hydropower Ltd	Makalu, Pathibhara (Sankhuwasabha)
93	Saptang Khola HPP	2.5	Saptang	Saptang Hydropower Pvt Ltd	Bungtang (Nuwakot)
94	Buku Khola	6	Buku	Apolo Hydropower Pvt.Ltd	Bhussinga, Rawadolu (Okhaldhunga) Goli (Solukhumbu)
95	Nyam Nyam	6	Nyam Nyam Khola	Nyam Nyam HydroPower Company Pvt.Ltd.	Dandagoun (Rasuwa)
96	Super Trishuli	100	Trishuli	Blue Energy Pvt. Ltd.	
97	Lower Irkhuwa Khola	14.15	Irkhuwa Khola	Lower Irkhuwa Hydropower Company Ltd.	Kulunga, Nepaledada (Bhojpur)
98	Rele Khola	6	Rele Khola	Hym Consult	Narchyang (Myagdi)
99	Irkhuwa Khola-B HPP	15.524	Irkhuwa Khola	Barah Multi Power Pvt Ltd	Kudak Kaule, Chaukidada, Nepaledada (Bhojpur)
100	Rasuwa Bhotekoshi	120	Bhote koshi	Langtang Bhotekosi Hydropower Company Pvt. Ltd	Thuman, Briddhim, Goljung (Rasuwa)
101	Upper Gaddi Gad	1.55	Gaddi Gad	Shaileshwari Power Nepal	Gaihragau, Kadamadaun, Sanagau (Doti)
102	Upper Modi HPP cascade project	18.2	Modi Khola	Nepal Electricity Authority	Dangsing, Ghandruk, Lumle (Kaski)
103	Taman Khola	4.85	Taman	Taman Khola Hydro Pvt. Ltd.	Burtiwang (Baglung)
104	Arun 3	900	Arun	Satluj Jal Vidyut Nigam Limited	Diding, Num, Makalu, Matsya Pokhari, Mangtewa, Pathibhara (Sankhuwasabha)
105	Middle Daram Khola-A HPP	3	Daram	Dhaulagiri Cem Engineering Pvt Ltd	Heel, Argal, Amarbhumi (Baglung)
106	Middle Daram Khola-B HPP	4.5	Daram	Milestone Hydropower Pvt. Ltd.	Amarbhumi, Harichaur, Heel (Baglung)
107	Upper Khudi	26	Khudi	Super Khudi Hydropower Co.Pvt. Ltd.	Ghanpokhara, Khudi (Lamjung)
108	Upper Tamor	285	Tamor	Tamor Sanima Energy P. Ltd	Phurumbu, Linkhim, Lelep, Tapethok (Taplejung)
109	Hewa A Small HEP	5	Hewa Khola	Habitat Power Company Pvt. Ltd	Ekteen, Yanganam, Memeng, Sidin (Panchthar)
110	Tila-1 Hydropower Project	440	Tila	S C Power Company P Ltd	Dahafatgaun, Gela, Manma, Mugraha, Pakha, Sukitaya (Kalikot)

List of projects with generation license issued by MoEWRI/DoED					
S No	**Project**	**Capacity (MW)**	**River**	**Promoter**	**VDC/District**
111	Tila-2 Hydropower Project	420	Tila	S C Power Company Pvt Ltd	Pakha (Kalikot)
112	Upper Phawa HPP	5.8	Phawa Khola	Unitech Hydropower Company Pvt.ltd.	Sikaicha, Tiringe (Taplejung)
113	Super Aankhu Khola Hydropower Project	25.4	Ankhu Khola	Gorakshya Hydropower Pvt.Ltd	Lapa, Sirtung (Dhading)
114	Puwa II hydropower Project	4.96	Puwa	Peoples' Power Ltd	Sakhejung, Maipokhari, Barbote (Ilam)
115	Nilgiri Khola-II cascade Project	62	Nilgiri	Nilgirikhola Hydropower Company Limited	Narchyang (Myagdi)
116	Lower Manang Marsyangdi	140	Marsyangdi	Butawal Power Company	, Tachi Bagarchhap, Dharapani, Thoche (Manang)
117	Manang Marsyangdi	282	Marsyangdi	Manang Marsyangdi Hydropower Company Pvt.Ltd.	Chame, Tachi Bagarchhap (Manang)
118	Badigad (Kolti)	4.5	Badigad	Pioneer Hydro Pvt.Ltd	Kolti, Kotila (Bajura)
119	Garchyang Khola	6.6	Garchyang	Citizen Hydropower Company Pvt. Ltd.	Namarjung (Kaski)
120	Upper Marsyangdi 1	138	Marsyangdi	Upper Marsyangdi Hydropower Company Pvt. Ltd.	Taghring, Khudi, Ghermu, Bahundada (Lamjung)
121	Upper Lohore SHP	4	Lohore Khola	Upper Lohore Khola Hydropower Company. Pvt. Ltd	Baluwatar (Dailekh)
122	Chameliya (Chhetigad)	85	Chameliya Khola	Grid Nepal Co. Pvt. Ltd.,	Ghusa, Guljar, Khandeswori, Sitaula (Darchula)
123	Upper Piluwa Hills Small HP Project	4.99	Piluwa, Tupuwa & Chhange Khola	Milke Jaljale Hydropower Pvt.Ltd.	Nundhaki, Siddhakali (Sankhuwasabha)
124	Kaligandki Gorge	164	Kali Gandaki	Kaligandaki Hydropower P. Ltd, Charkhal, Dillibazar, Karhmandu	Dana, Narchyang, Dana (Myagdi)
125	Nyadi-Phidi HPP	21.4	Nyadi, Phidi	North Summit Hydro Pvt.ltd.	Bahundada, Bhulbhule (Lamjung)
126	Upper Rahughat	48.5	Rahughat	Tudi Power Company Pvt.Ltd	Chimkhola, Dagnam, Jhin, Pakhapani (Myagdi)
127	Super Hewa HPP	5	Hewa Khola	Super Hewa Power Com. Pvt.Ltd.	Jaljala, Siddhapokhari (Sankhuwasabha)
128	Middle Kaligandaki	53.539	Kali Gandaki	Hydro Support Pvt. Ltd.	Tatopani, Dana, Narchyang (Myagdi)
129	Tadi Khola Cascade	3	Tadi Khola	Hira Ratna Hydropower Company Pvt. Ltd	Samundratar (Nuwakot)
130	Bajra Madi Hydropower Project	24.8	Madi Khola	Bajra Energy Ventures Pvt. Ltd.	Kalika, Thumakodanda (Kaski)
131	Upper Richet Khola SHP	2	Richet	Upper Richet Hydropower Pvt. Ltd.	Kashigaun, Manbu (Gorkha)
132	Jhyaku Khola HPP	5.243	Jhyaku	Ganesh Hydro power Com.Pvt.Ltd	Jhyaku, Jugu (Dolakha)
133	Upper Trishui-2 HPP	102	Trishuli	Hydrochina Corporation	Haku (Rasuwa)
134	Tinau Khola HPP	3.44	Tinau	Nama Buddha Hydropower Pvt Ltd	Koldada (Palpa)
135	Likhu Khola HPP	30	Likhu Khola	P K Hydropower Pvt. Ltd.	Rawadolu, Khijichandeshwari (Okhaldhunga) Pritee, Kubukasthali (Ramechhap) Goli (Solukhumbu)
136	Upper Suri Khola HPP	7	Hulak, Kolung	Makar Jitumaya Hudropower Pvt.Ltd.	Chankhu (Dolakha)

List of projects with generation license issued by MoEWRI/DoED					
S No	**Project**	**Capacity (MW)**	**River**	**Promoter**	**VDC/District**
137	Upper Midim Khola SHP	7.5	Midim Khola	Bhujung Hydro Power Ltd.,	Bhujung (Lamjung)
138	Upper Chameliya HP	40	Chameliya Khola	Api Power Co. Ltd	Tapoban, Latinath, Guljar, Sitaula (Darchula)
139	Chisang Khola - A Small HEP	1.8	Chisang	Chisang Hydro Pvt Ltd	Warangi (Morang)
140	Lower Hewa Khola-A HPP	7.3	Hewa Khola	Panch Khapan Hydropower P.Ltd.	Bana, Baneswor, Chainpur, Jaljala (Sankhuwasabha)
141	Sagu Khola HEP	20	Sangu Khola	Him Parbat Hydropower Pvt. Ltd.	Alampu, Chilankha, Khupachagu (Dolakha)
142	Dudhkunda Khola HEP	12	Solu Khola	Mount Everest Power Development P.Ltd.	Beni, Takasindu (Solukhumbu)
143	Upper Ankhu Khola	38	Ankhu Khola	Dhading Ankhu Khola Hydro Pvt. Ltd.	Jharlang, Lapa, Sirtung (Dhading)
144	Upper Machha Khola HEP	4.55	Machha Khola	Bikash Hydropower Company Pvt. Ltd.	Gumda, Laprak (Gorkha)
145	Bhim Khola Small HEP	4.96	Bhim Khola	Shikhar Power Development Pvt.Ltd.	Gwalichaur, Bhinggithe, Ranasinkiteni (Baglung)
146	Jogmai Cascade	5.2	Jogmai Khola	Sanvi Energy Pvt. Ltd.	Namsaling (Ilam)
147	Sangu Khola HPP	5	Sangu (Sorun) Khola	Kalinchowk Hydropower Pvt. Ltd.	Kalingchok, Khupachagu (Dolakha)
148	Middle Mewa HPP	49	Mewa Khola	Mewa Developers LTd	Liwang, Sanwa, Nalbu, Papung, Thukima (Taplejung)
149	Nupche Likhu HEP	57.5	Nupche , Likhu	Vision Energy and Power Pvt. Ltd.	Gumdel (Ramechhap)
150	Upper Myagdi-I HEP	53.5	Myagdi Khola	Upper Myagdi Hydropower Pvt. Ltd	Bima, Marang, Takam, Muna, Mudi (Myagdi)
151	Sagu khola 1 HPP	5.5	Sagu	Him Parbat Hydropower Pvt. Ltd	Alampu, Chilankha (Dolakha)
152	Phedi Khola (Thumlung) Small HPP	3.52	Phedi khola (Thumlung)	Phedi khola Hydropower Company Pvt. Ltd.	Dobhane (Bhojpur)
153	Thulo Khola Hydropower Project	21.3	Thulo Khola	Samyukta Urja Pvt. Ltd	Kuinemangale (Myagdi)
154	Chepe Khola HEP	7	Chepe Khola	Champawati Hydro Power P.Ltd	Thalajung, Kerabari (Gorkha)
155	Upper Irkhuwa HPP	14.5	Irkhuwa, Phedi	Aarati Power Company Ltd.	Dobhane, Khatamma, Kudak Kaule (Bhojpur)
156	Isuwa Khola Hydropower Project	97.2	Isuwa Khola	KBNR Isuwa Power Ltd.	Makalu (Sankhuwasabha)
157	Upper Maiwa HPP	17.85	Maiwa	Kang Hydropower Company Pvt. Ltd	Thinglabu, Phakumba, Sanghu, Dhungesaghu (Taplejung)
158	Madme Khola HPP	24	Madme Khola	Madme Khola Hydropower P.Ltd.	Namarjung (Kaski)
159	Lower Balephi	20	Balephi	Sajha Power Development	Batase, Kubhinde, Fulpingkot, Fupingdandagau (Sindhupalchok)
160	Madya Super Daraundi HPP	10	Daraundi	Barpak Daraundi Hydropower Company Pvt. Ltd.	Ghyalchok (Gorkha)
161	Rauje Khola HPP	4.99	Rauje Khola	Hydro Connection Pvt Ltd	Takasindu (Solukhumbu)
162	Bhotekoshi 5 HEP	62	Bhotekoshi	Kalika Energy Ltd.	Ramche, Tekanpur, Gati, Barhabise, Maneswor, Mankha (Sindhupalchok)
163	Seti Khola HPP	25	Seti Khola	Vision Lumbini Urja Company Limited.	Ghachok, Machhapuchchhre,

List of projects with generation license issued by MoEWRI/DoED					
S No	**Project**	**Capacity (MW)**	**River**	**Promoter**	**VDC/District**
					Purachaur, Sardikhola (Kaski)
164	Karuwa Seti HEP	32	Seti	Jhyamolongma Hydropower Development Company Pvt. Ltd.	Machhapuchchhre, Sardikhola (Kaski)
165	Upper Piluwa 3 HPP	4.95	Piluwa Khola	Mabilung Energy.Ltd	Mawadin, Siddhakali (Sankhuwasabha)
166	Hidi Khola HEP	6.82	Hidi Khola	White Lotus Power Pvt.ltd.	Bhulbhule, Bahundada (Lamjung)
167	Mid Solu Khola HEP	9.5	Solu Khola	Mid Solu Hydropower company Pvt Ltd	Gora Khami, Salleri (Solukhumbu)
168	Middle Tadi HPP	5.5	Tadi Khola	Dupcheshwor Mahadev Hydro Company Pvt. Ltd.	Rautbesi, Shikharbesi, Dhyangphedi (Nuwakot)
169	Pegu Khola Small Hydropower Project	4.35	Pegu	BiguHydropower Venture	Bigu (Dolakha)
170	Jurimba Khola Small Hydropower Project	7.63	Jurimba	Jurimba Hydropower Company Pvt. Ltd	Listi, Tatopani (Sindhupalchok)
171	Landruk Modi HEP	86.59	Modi	Annapurna Bidhyut Bikas Company Pvt. Ltd	
172	Sunigad	11.05	Suni Gad	Omega Energy Developer Pvt. Ltd	
173	Mid Rawa Khola HEP	2.5	Rawa Khola, Sung Khola	Halesi Urja Pvt. Ltd. , Anamnagar, Kathmandu, Tel: 5538632, 9851088040	Baksila, Rakha Bangdel (Khotang)
174	Dudhkoshi-2 (Jaleswar) HPP	70	Dudh Koshi	Dudhkoshi Hydropower Nepal Pvt Ltd	Deusa, Kagel, Jubu, Lokhim, Mukali, Necha Batase (Solukhumbu)
175	Mudi Khola Hydropower Project	14.7	Mudi Khola	Everest Energy and Infrastructure Fund Pvt. Ltd.	Mudi (Myagdi)
176	Lower Mid Rawa Khola HEP	4	Rawa	Lower Mid Rawa Khola Hydropower ProjectPvt. Ltd	Rakha Bangdel, Sapteswor (Khotang)
177	Menchet Khola HPP	7	Menchet Khola	Ruby Valley Hydropower Com.Ltd.	Sirtung, Tipling (Dhading)
178	Tamor Mewa	128	Tamor & Mewa	Spark Hydroelectric Co. Ltd.	Khokling, Phungling (Taplejung)
179	Midim 1 HEP	13.424	Midim Khola	Mount Rasuwa Hydropower Pvt. Ltd.	Bhujung, Bhoje, Maling, Uttarkanya (Lamjung)
180	Lower Tara Khola HPP	3.5	Tara Khola	Pahadi Hydropower company Pvt Ltd	Tara (Baglung)
181	Myagdi Khola Hydropower Project	57.3	Myagdi Khola	Hydro Village Pvt. Ltd.	Mudi (Myagdi)
182	Upper Bhurundi Khola SHP	3.75	Bhurundi Khola	Ambe Hydropower Pvt. Ltd,	Dangsing (Kaski)
183	Nyasim HEP	35	Nyasem Khola	Sita Hydropower Company Pvt. Ltd.	Gumba (Sindhupalchok)
184	Upper Ingwa Khola	9.7	Ingwa	Ingwa Hydopower Ltd.,	(Taplejung)
185	Upper Daraudi Hydropower Project	9.2	Daraudi	Green Gorkha Energy Limited	Ghyalchok, Simjung, Saurpani (Gorkha)
186	Langdi Khola Small HEP	3.26	Langdi	Ujyalo Nepal Hydro Pvt. Ltd.	Hanspur (Gorkha) Ilampokhari, Bichaur (Lamjung)
187	Setikhola HEP	22	Seti Khola	Setikhola Hydropower Pvt.Ltd.	Bharatpokhari, Lekhnath (Kaski)
188	Mewa khola HEP	23	Mewa Khola	Union Mewa hydro ltd	Papung (Taplejung)

List of projects with generation license issued by MoEWRI/DoED					
S No	**Project**	**Capacity (MW)**	**River**	**Promoter**	**VDC/District**
189	Bagar Khola HEP	5.5	Bagar Khola	Mona Hydropower Limited	Chimkhola (Myagdi)
190	Dudhpokhari Chepe HEP	8.836	Chepe Khola	Dudhpokhari Chepe Hydropower Pvt. Ltd	Kharibot (Gorkha)
191	Super Chepe HEP	9.05	Chepe Khola	Ridge Line Energy Pvt. Ltd	Kharibot (Gorkha) Dudhpokhari (Lamjung)
192	Jum Khola HEP	56	Jum	Sanima Jum Hydropower Pvt. Ltd	Lamabagar (Dolakha)
193	Upper Daraudi B Small HEP	8.3	Daraudi	Kalika Construction Pvt.Ltd.	Ghyalchok, Warpak (Gorkha)
194	Upper Daraudi-C HEP	9.82	Daraudi	Kalika Construction Pvt Ltd	Ghyalchok, Warpak (Gorkha)
195	Upper Balephi	46	Balephi	Upper Balephi Hydropower Limited (Previously, Samjhana Acharya)	Golche, Gumba (Sindhupalchok)
196	Ilep Tatopani Khola HEP	25	Tatopani(Ilep) Khola	Jalshakti Hydro companu Pvt Ltd	Lapa, Sirtung (Dhading)
197	Super Melamchi HEP	23.6	Melamchi	Milarepa Energy Pvt Ltd	Melamche (Sindhupalchok)
198	Upper Piluwa-1 HEP	7.7	Piluwa	Menchhiyam Hydropower P Ltd.	Madi Rambeni, Siddhakali (Sankhuwasabha)
199	Super Kabeli Khola A HEP	13.5	Kabeli Khola, Amji Khola	Snow River Ltd	Yamfudin (Taplejung)
200	Super Kabeli Khola Cascade HEP	12	Kabeli Khola	Hilton Hydro Energy Pvt. Ltd.	Khewang, Mamangkhe, Yamfudin (Taplejung)
201	Kabeli-3 HEP	21.93	Kabeli	Kabeli Hydropower Company Ltd	Khewang, Mehele, Paidang, Mamangkhe, Tellok (Taplejung)
202	Bhalaudi Khola HEP	2.645	Bhalaudi	Bhalaudi Khola Hydropower Pvt. Ltd.	Machhapuchchhre (Kaski)
203	Isuwa Khola PRoR Cascade HEP	37.7	Isuwa Khola	Isuwa Energy Pvt. Ltd	Makalu (Sankhuwasabha)
204	Arun Khola 2 HEP	2	Arun Khola	Himalayan Engineering and Energy Pvt. Ltd.	Humsekot, Rakachuli (Nawalparasi)
205	Sona Khola HEP	9	Sona Khola, Khahare Khola	Himali Hydro Fund Pvt. Ltd.	Papung (Taplejung)
206	Mathillo Kabeli HEP	28.1	Kabeli Khola	Peace Energy Company Pvt. Ltd.	Limbudin, Ambegudin, Mehele, Tellok, Sinam, Sawalakhu (Taplejung)
207	Super Lower Bagmati HEP	41.86	Bagmati	Super Bagmati Hydropower Pvt. Ltd	Milche, Salamechakla(Taldhunga), Saldhara (Kavrepalanchok) Gimdi, Thuladurlung (Lalitpur) Faparbari, Betini (Makawanpur)
208	Middle Hongu Khola B HEP	22.9	Hongu Khola	Gaurishankar Power Development Pvt. Ltd	Sautang, Gudel, Bung, Chheskam (Solukhumbu)
209	Upper Seti HEP	20	Seti Khola, Sadhu Khola	Upper Seti Hydro Pvt.Ltd.	Machhapuchchhre (Kaski)
210	Upper Deumai Khola Small HEP	8.3	Deumai	Water Energy Solution Pvt Ltd	Ektappa, Mangalbare, Ghuseni (Ilam)
211	Sepli Khola HEP	5	Sepli Khola	Sepli Hydropower Development Pvt. Ltd.	Patle, Jantarkhani, Ragadeep (Okhaldhunga)
212	Tamor Khola-5 HEP	37.5	Tamor	River Side Hydro Energy Pvt. Ltd	Lelep, Tapethok (Taplejung)
213	Kunban Khola HEP	20	Kunban	Sushmit Energy Pvt. Ltd.	Mudi (Myagdi)
214	Himchuli Dordi HEP	57	Dordi	Peoples Hydropower Company Pvt. Ltd	Dhodeni, Faleni (Lamjung)

List of projects with generation license issued by MoEWRI/DoED

S No	Project	Capacity (MW)	River	Promoter	VDC/District
215	Mathillo Thulo Khola A HEP	15	Thulo Khola	Thulo Khola Hydropower Pvt. Ltd	Kuinemangale (Myagdi)
216	Upper Sagu HEP	10	Khartal, Kothali(Sagu)	Aalampu Jalbidhyut Bikash Company Pvt. Ltd	Alampu, Bigu (Dolakha)
217	Tiplyang Kaligandaki HEP	58	Kali Gandaki	Tiplyang Kaligandaki Hydropower Pvt. Ltd	Tatopani, Dowa, Histan Mandali, Shikha (Myagdi)
218	Madhya Hongu Khola -A HPP	22	Hongu Khola	Apex Makalu Hydropower Limited	Gudel (Solukhumbu)
219	Chino Khola HEP	7.9	Chino	Butwal Power Company	Tachi Bagarchhap, Dharapani (Manang)
220	Ghunsa Khola HEP	77.5	Ghunsa Khola	Remit Hydro Ltd	Lelep (Taplejung)
221	Simbuwa Khola HEP	70.3	Simbuwa Khola	Simbuwa Remit Hydro Ltd	Tapethok (Taplejung)
222	Dudh khola HEP	65	Dudh Khola	Sita Hydropower Company Pvt.Ltd.	Dharapani, Tachi Bagarchhap, Thoche (Manang)
223	Jaldigad	21	Jaldi Gad	Shangrila Hydropower Pvt. Ltd.	Syalakhadi (Rukum)
224	Middle Trishuli Ganga nadi	15.625	Trishuli	Perfect Energy Developmnet Pvt. Ltd, KTM,	Gerkhu, Manakamana, Tupche (Nuwakot)
225	Upper Madi 0 HEP	43	Madi	Annapurna Power Company Pvt. Ltd	Parche, Namarjung (Kaski)
226	Middle Mailung (cascade) HEP	13	Mailung Khola	Mathillo Mailung Khola Jalbidhyut Ltd	Dandagoun, Haku (Rasuwa)
227	Aayu Malun Khola HEP	21	Malun	Puwa Khola 1 Hydropower Limited	Prapchan, Ragadeep, Shreechaur (Okhaldhunga)
228	Upper Kabeli-2 HEP	15	Kabeli Khola	Arun Valley Hydropower Development Company Limited	Sawalakhu, Sinam, Thumbedin (Taplejung)
229	Palun khola 1 HEP	30	Palun Khola	Trust Energy Pvt. Ltd.	Papung (Taplejung)
230	Palun Khola Small HEP	21	Palun Khola	Palun Khola Hydropower Pvt. Ltd.	Papung (Taplejung)
231	Syarpu HEP	3.3	Dharne	Syarpu Power Company Limited	Bapsekot, Syalaphakha (Rukum)
232	Bhotekoshi 1 HEP	40	Bhotekoshi	Shailung Power Company Limited	Fulpingkot, Tatopani, Listi (Sindhupalchok)
233	Luja Khola HEP	24.8	Luja Khola	Silk Power Pvt.Ltd.	Takasindu (Solukhumbu)

List of projects applied for Generation License

S No	Project	Capacity (MW)	River	Promoter	VDC/District
1	Upper Marsyangdi -2	600	Marsyangdi	Himtal Hydropower Company Pvt. Ltd	Ghermu, Taghring (Lamjung) (Manang)
2	Budhi Gandaki Ka	130	Budhi Gandaki	Naulo Nepal Hydroelectric Pvt. Ltd.	(Gorkha)
3	Elun Khola	0.485	Elun Khola	Ilun Hydropower Company Pvt. Ltd	Khijifalate, Patle, Shreechaur (Okhaldhunga)
4	Lower Barun Khola HPP	132	Barun Khola	Ampik Energy Pvt Ltd	Hatiya (Sankhuwasabha)
5	Uttarganga Storage Hydropower Project	828	Uttar Ganga	Nepal Electricity Authority	Bowang, Boharagaun, Nisi, Adhikarichaur (Baglung)
6	Budhi Gandaki HEP	341	Budhi Gandaki	Times Enery Pvt. Ltd	Kerauja, Sirdibas, Uiya (Gorkha)
7	Adhikhola Storage HEP	180	Adhikhola	Nepal Electricity Authority	Hungi (Palpa) Waling, (Syangja)
8	Super Sabha Khola Small HEP	4.1	Sabha Khola	Sankhuwasabha Power Development Pvt.Ltd	Bahrabise Bazar, Sabha Pokhari (Sankhuwasabha)

List of projects applied for Generation License					
S No	**Project**	**Capacity (MW)**	**River**	**Promoter**	**VDC/District**
9	Dudhkoshi-6 HEP	171	Dudh Koshi	Sagarmatha Hydropower Pvt. Ltd.	Chaurikharka (Solukhumbu)
10	Irkhuwa Khola Ka HEP	15	Irkhuwa Khola	Estern Hydropower Pvt.Ltd.	Khatamma, Dummana (Bhojpur)
11	Dordi Dudh Khola Small HEP	20.8	Dordi	Goma Ganesh Hydropower Pvt. Ltd.	Dhodeni, Faleni (Lamjung)
12	Jhimruk Aglung HEP	1.5	Jhimruk	Aglung Hydropower Company P.Ltd.	Aaglung (Gulmi) Akhra, Puja, Rajbara (Pyuthan)
13	Upper Mailung B HEP	17	Mailung Khola	Sanima Hydropower Ltd	Dandagoun, Haku (Rasuwa)
14	Tawa Khola HEP	9.96	Tawa Khola, Yamkha Khola, Siwa	M.A energy venture pvt.ltd.	Surunkhim, Khewang (Taplejung)
15	Akhu Khola-2 HEP	20	Akhu Khola	Ganesh Himal Hydropower Pvt. Ltd.	Gumdi, Darkha, Marpak, Satyadevi (Dhading)
16	Lower Kalanga Gad HEP	8	Kalanga Gad	Bagthala Hydro Pvt.ltd.	Khiratadi, Rayal, Sunkuda (Bajhang)
17	Badigad Khola HEP	24.6	Badigad	Liberty Energy Co. Ltd.	Burtiwang, Rajkut, Durling, Bhinggithe (Baglung) Neta (Gulmi)
18	Lantang Khola Reservoir HEP	310	Langtang	Yeti \world Investment Pvt. Ltd.	Syafru, Briddhim, Timure, Langtang (Rasuwa)
19	Upper Pikhuwa Khola HEP	4.9	Pikhuwa	Sumnima Hydropower Company Pvt. Ltd.	Chhinamukh, Gupteshwor, Timma (Bhojpur)
20	Super Tamor HEP	166	Tamor	Cristal Power Development Pvt ltd	Lelep, Olangchung (Taplejung)
21	Dudhkoshi-9 HEP	166	Dudhkoshi	Urja Developers Pvt.Ltd.	Chaurikharka (Solukhumbu)
22	Betan Karnali HEP	439	Karnali	Betan Karnali Sanchayakarta Hydropower Company Ltd	Dhungachalna, Turmakhad (Achham) Sugarkhal (Kailali) Betan, Bidyapur, Bijaura, Chapre, Guthu (Surkhet)
23	Lower Nyadi HEP	12.6	Nyadi	Hub Power Pvt. Ltd	Bahundada, Bhulbhule (Lamjung)
24	Sani Bheri HEP	44.52	Sani Bheri	Expert Hydro Investment Pvt. Ltd	Rangsi (Rukum)
25	Kisedi Khola Small HEP	4.1	Kisedi Khola	Ana Multipurpose Company Pvt.Ltd.	Shree Banjyang, Nauthar, Pachok, Gauda (Lamjung)
26	Syano Khola HEP	4.75	Syano Khola	Karnali Jalashrot Limited	Kuinemangale (Myagdi)
27	Machhe Khola HEP	16	Machha Khola	Water Energy Development Pvt. Ltd.	Lapu, Gumda, Uiya (Gorkha)
28	Hongu Khola HEP	28.9	Hongu Khola	Union Hydropower Ltd	Chheskam (Solukhumbu)
29	Darkhola Small HEP	6.5	Dar Khola	Darkhola Hydropower Pvt. Ltd.,	Muna (Myagdi)
30	Tatopani khola HEP	19	Tatopani(Ilep) Khola	Hanuman Hydropower Pvt. Ltd	Lapa, Sirtung (Dhading)
31	Upper Sardi HEP	2.9	Sardi, kutmi	Mandakini Hydropower Ltd	Sardikhola (Kaski)
32	Lower Bhim Khola HEP	6.05	Bhim Khola	Shikhar Power Development Pvt. Ltd.	Bhinggithe (Baglung)
33	Super Ghalemdi HEP	9.14	Ghalemdi	Super Ghalemdi Hydropower Pvt. Ltd.	Narchyang (Myagdi)
34	Sinkos Khola HEP	3.45	Sinkos Khola	Simkos Hydropower P.Ltd.	Mudi (Myagdi)
35	Ghunsa-Tamor HEP	43	Tamor	Nepal Hydro Venture Pvt.Ltd.	Lelep (Taplejung)
36	Upper Seti-1 HEP	13	Seti Khola	Shrestha Energy Solution Pvt. Ltd	Purachaur (Kaski)
37	Brahmayani HEP	36.52	Balefi Khola	Bhramayani Hydropower Company Pvt. Ltd.	Gumba, Golche (Sindhupalchok)

List of projects applied for Generation License					
S No	**Project**	**Capacity (MW)**	**River**	**Promoter**	**VDC/District**
38	Malta Bagmati Small HEP	8.85	Bagmati	Bagmati Water Energy Pvt. Ltd.	Malta, Pyutar (Lalitpur)
39	Upper Tamor A HEP	72	Tamor	Union Hydropower Limited	Olangchung (Taplejung)
40	Phukot Karnali HEP	480	Karnali	Vidhyut Utpadan Company Limited	Manma, Mehal Mudi, Mumrakot, Sipkhana, Siuna, Phukot, Nanikot, Ramanakot, Badalkot, Pakha, Raku, Dahafatgaun (Kalikot)
41	Chainpur Seti HEP	210	Seti Khola	Nepal Electricity Authority	Dhamena, Melbisauni, Kanda (Bajhang)
42	Upper Dudh Khola HPP	30.4	Dudh Khola	Carbonless Energy Fund Pvt. Ltd.	Thoche (Manang)
43	Kimathanka Arun HEP	454	Arun	Vidhyut Utpadan Company Limited	Keemathnka, Chepuwa (Sankhuwasabha)
44	Chyandi Khola HEP	4.2	Chyandi Khola	Chyadi Khola Hydropower Company Pvt. Ltd.	Kharibot (Gorkha) Dudhpokhari (Lamjung)
45	Hongu Khola I HEP	30	Hongu Khola	IB Energy Pvt ltd	Gudel, Sautang (Solukhumbu)
46	Lower Thulo Khola HEP	4.75	Thulo Khola	Chitwan Energy Limited	Chimkhola, Kuinemangale (Myagdi)
47	Kalinchok Small HEP	3	Budhekhani khola, Shikhaarjun K	Himalayan Energy Pvt. Ltd.	Khupachagu, Kalingchok (Dolakha)
48	Jagdulla HEP	106	Bheri	Jagdulla HydropowerCompany Limited	Narku, Kaigaun (Dolpa) Bhagawati Tol (Jajarkot)
49	Chhomron Khola Small HEP	4.894	Chhomron Khola	Ghandruk Hydro Private Limited	Ghandruk (Kaski)
50	Kalika Kaligandaki HEP	38.16	Kali Gandaki	Maulakalika Hydropower Company Pvt. Ltd	Gaidakot, Mukundapur, Ratnapur (Nawalparasi) Kota (Tanahu)
51	Upper Mewa Khola -A HEP	31.92	Mewa Khola	Surya Holding Company Pvt.Ltd.	Papung, Sanwa (Taplejung)
52	Pikhuwa Pashupati HEP	4.1	Pikhuwa	Sumnima Hydropower Company Pvt. Ltd.	Annapurna, Chhinamukh, Gupteshwor (Bhojpur)
53	Chujung Khola HEP	48	Chujung	Sangrila Urja Pvt. Ltd	Chepuwa (Sankhuwasabha)
54	Mistri Khola-2 HEP	12	Mistri	Mountain Energy Nepal Ltd	Dana, Shikha, Narchyang (Myagdi)
55	Upper Bhurundi Khola- A Small HEP	4.5	Bhurundi	Niko Energy Pvt. Ltd.	Dangsing (Kaski)
56	Upper Nyasem A HEP	21	Nyasem Khola	Sindhu Jwala Hydropower Pvt. Ltd.	Gumba (Sindhupalchok)
57	Khimti Ghwang Khola HEP	9	Khimti khola and Ghwan Khola	Nilganga Hydropower Company Pvt. Ltd	Syama (Dolakha)
58	Thuligad Khola Small PRoR HEP	17	Thuli Gad	Om Power Company Pvt.Ltd.	Barchhen (Doti) Nigali (Kailali)
59	Rolwaling Khola HEP	22	Rolwaling	Upper Tamakoshi Hydropower Company Limited	Lamabagar (Dolakha)
60	Upper Mudi HEP	12.73	Mudi & Ghurma	Fresh Water Energy Pvt. Ltd.	Mudi (Myagdi)
61	Nar Khola HEP	58.9	Nar Khola, Soti Khola	Nar Khola Hydro Energy Pvt. Ltd	Tachi Bagarchhap, Chame (Manang)
62	Budhi Gandaki Prok Khola HEP	81	Budhi Gandaki	Chilime Hydropower Company Limited	Bihi, Lho, Prok (Gorkha)
63	Seti Nadi-3 HEP	65	Seti Khola	Chilime Hydropower Company Limited	Sunikot, Luyanta, Kotdewal, Hemantabada, Chainpur, Bhatekhola,

List of projects applied for Generation License					
S No	**Project**	**Capacity (MW)**	**River**	**Promoter**	**VDC/District**
					Rithapata, Subeda (Bajhang)
64	Upper Junbesi HEP	4.7	Junbeshi	Gurkhas Himalayan Hydro Pvt. Ltd.	Salleri (Solukhumbu)
65	Upper Sunigad HEP	11.05	Suni Gad	Omega EnergyDeveloper Pvt. Ltd	Dilichaur (Bajhang)
66	Miwaje Khola HEP	4.95	Miwaje	Ma Durga Kali HYdropower Company Pvt. Ltd	Machhapuchchhre (Kaski)
67	Suti Khola HEP	21	Suti	Nilganga Hydropower Company Pvt. Ltd	Thoche (Manang)
68	Budum HEP	14.5	Budum	Arun Valley Hydropower Development Company Pvt. Ltd.	Bung, Gudel (Solukhumbu)
69	Syalque Khola Small HEP	4.8	Syalque khola, Danque Khola	Alliance Energy Solutions Pvt Ltd	Chame (Manang)
70	Siwakhola HEP	9.3	Siwa Khola	Mewa Developers Pvt. Ltd	Nalbu, Papung (Taplejung)
71	Rawa Khola HEP	5.4	Rawa	Halesi Hydropower Pvt. Ltd.	Magpa, Jalapa, Sapteswor, Rakha Bangdel (Khotang)
72	Sabha Khola C HEP (Cascade)	6.3	Sabha	Orbit Energy Private Limited	Sabha Pokhari, Bahrabise Bazar (Sankhuwasabha)
73	Lower Khani-B HEP	6.2	Khani	Koplang Energy Hydropower Pvt.Ltd.	Marbu (Dolakha)
74	Super Iwa Khola HEP	4.795	Iwa Khola	Kanchanjunga Hydro Energy Pvt. Ltd	Sadewa (Taplejung)
75	Middle Chameliya HEP	35	Chameliya Khola	Darchula Power Pvt. Ltd	Rauleswor, Kotpetara (Baitadi) Latinath, Khandeswori (Darchula)
76	Tamakoshi 3 HEP	650	Tama Koshi	TBI Holding Co. Ltd.	Melung (Dolakha) Manthali (Ramechhap)
77	Upper Brahmayeni HEP	15.15	Nyamya Masal	Integrated Hydro Fund Nepal Pvt. Ltd	Gumba, Golche (Sindhupalchok)
78	Lodo Khola Sana HEP	1.6	Lodo	Liberty Energy Co. Ltd.	Dhodeni, Faleni (Lamjung)
79	Budhi Gandaki Nadi HEP	91.15	Budhi Gandaki	Surya Energy Pvt.Ltd,	Sirdibas, Chunchet (Gorkha)
80	Nimrung Khola HEP	9.8	Nimrung	Kiran Power Company Pvt. Ltd.	Uiya (Gorkha)
81	Begnas- Rupa Storage HEP	150	Begnas - Rupa	Nepal Electricity Authority	Lekhnath, Rupakot (Kaski)
82	Dana Khola HEP	49.95	Dana Khola	Lalupate Hydropower Company Pvt. Ltd.	Dharapani, Thoche (Manang)
83	Super Inkhu Khola HEP	24.41	Inkhu	Dordi Khola Jalvidyut Company Limited	Baku, Bung (Solukhumbu)
84	Upper Inkhu Khola HEP	24.22	Inkhu	Universal Power Company P. Ltd	Baku, Bung, Mabe(Pawai) (Solukhumbu)
85	Shyam Khola HEP	7.25	Shyam Khola	Shyam Khola Energy Development Pvt. Ltd	Keemalung, Khartimchcha (Bhojpur)
86	Super Machha Khola HEP	4.6	Machha Khola	Budhigandaki Hydropower Pvt. Ltd	Laprak (Gorkha)
87	Mugu Karnali HEP	159.62	Mugu Karnali	Butwal Power Company Limited	Jima, Natharpu, Shree Nagar (Mugu)
88	Gasali Khola Small HEP	4.5	Gasali	Himshila Power Company Pvt Ltd	Jharlang, Darkha (Dhading)
89	Sani Bheri 3 HEP	49.59	Sani Bheri	Sani Bheri Hydropower Company Pvt. Ltd	Pipal, Pokhara, Sobha, Syalaphakha (Rukum)

List of projects applied for Generation License					
S No	**Project**	**Capacity (MW)**	**River**	**Promoter**	**VDC/District**
90	Nalsyau Gad Storage HEP	417	Nalsyau	Nalgad Hydropower Company Limited	Ramidanda, Sakala, Khagenakot, Lahai, Dandagaun (Jajarkot)
91	Tallo Indrawati HEP	4.5	Indrawati	National Hydropower Company Limited	Melamche (Sindhupalchok)
92	Apsuwa I HEP	23	Apsuwa	Ram Janaki Hydropower Pvt. Ltd	Makalu, Yafu (Sankhuwasabha)
93	Myagdi Khola A HEP	30	Myagdi	Dordi Khola Jalvidyut Company Limited	Mudi (Myagdi)
94	Devdhunga Chaku Khola HEP	3.56	Chaku and Devdhunga	Devdhunga Malika Hydropower Pvt. Ltd	Marbin, Fulpingkot (Sindhupalchok)
95	Super Seti HEP	24	Seti Khola and Batase Khola	S N Energy Pvt. Ltd	Machhapuchchhre (Kaski)

Summery:

Types	Operating Projects (MW)	Generation License issued project (MW)	Generation application (MW)	Total (MW)
RoR	1240.443	6845.713	5258.941	13345.097
PRoR	777.1	1645.93	937.133	3360.163
Storage	106	140	1575	1821
Total	2123.543	8631.643	7771.074	18,526.26
Solar	24.18	133.56	15	172.74

*These data are based on database of DoED accessed on Kartik 2079.

Annex 2: Capacity factor calculation

Name of Project: Khimti 1 HPP

Capacity (MW): 50

Monthly energy generation in MWh

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	40432.04	43297.56	41627.19	39013.91	33352.08	25444.85	19338.77	16665.05	15104.44	18961.81	20027.61	41142.62
067/68	42176.65	41976.9	41876.03	38440.77	46866.59	26674.53	19950.6	18442.63	16050.54	21207.69	28973.34	43459.51
068/69	43116.86	41948.73	40880.08	40590.61	37241.85	27244.41	12800.25	17397.68	17603.91	16725.39	21357.01	40246.39
069/70	43341.93	42666.02	41099.02	42250.73	31463.22	23135.37	18884.2	17797.94	16154.87	18780.07	38149.84	43036.63
070/71	43126.63	42217.63	42478.02	42348.83	40213.18	29252.43	20633.25	18989.3	16999.19	16095.84	22284.83	42958.47
071/72	43160.72	56450.66	43787.52	42874.86	36354.27	28192.39	21089.32	20315.27	19393.21	24339.4	42123.28	42161.09
072/73	42384.27	42835.29	37909.54	40754.33	31247.9	24697.97	20305.58	17948.7	15339.55	23439.4	25690.44	42962.41
073/74	44149.92	43645.23	41826.62	43209.27	40455.18	29426.31	23152.66	17989.91	21483.41	19801.59	30482.53	39944.28
074/75	35367.63	37161.53	50657.73	42300.62	33717.62	24029.69	20065.43	17805.14	16658.17	18585.7	31374.5	44105.7
075/76	40784.3	43535.97	43493.39	41286.06	30468.76	23605.83	19727.66	17795.99	18422.91	24628.21	26886.28	41860.62

Capacity factor

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	0.90573566	0.96992742	0.9325087	0.90309977	0.79866092	0.58900116	0.46309315	0.38576505	0.34963981	0.42477173	0.4486472	0.892852
067/68	0.94481743	0.94034274	0.9380831	0.88983264	1.12228424	0.61746597	0.47774425	0.42691273	0.37154028	0.47508266	0.6490444	0.94313173
068/69	0.96587948	0.93971169	0.9157724	0.93959745	0.89180675	0.63065764	0.3065194	0.40272407	0.40749792	0.37467272	0.4784276	0.87340256
069/70	0.97092137	0.95578002	0.920677	0.97802616	0.7534296	0.53554097	0.45220785	0.41198935	0.37395532	0.42070049	0.8546111	0.93395464
070/71	0.96609834	0.94573544	0.9515685	0.98029699	0.96295929	0.67713958	0.49409124	0.43956713	0.39349977	0.36056989	0.4992121	0.93225846
071/72	0.96686201	1.26457572	0.9809032	0.99247361	0.87055244	0.65260162	0.50501245	0.47026088	0.4489169	0.54523746	0.9436219	0.91495421
072/73	0.94946841	0.95957191	0.849228	0.94338727	0.74827347	0.57171227	0.48624473	0.41547917	0.35508218	0.52507616	0.5755027	0.93234397
073/74	0.98902151	0.97771573	0.9369763	1.00021458	0.96875431	0.68116458	0.55442193	0.4164331	0.49730116	0.44358401	0.6828524	0.86684635
074/75	0.79228562	0.83247155	1.1348058	0.97918102	0.80741427	0.55624282	0.48049401	0.41215602	0.38560579	0.41634633	0.7028338	0.95715495
075/76	0.91362679	0.97526815	0.9743143	0.95569583	0.7296159	0.54643125	0.47240565	0.41194421	0.42645625	0.55170721	0.6022912	0.90843359
Total	9.36471662	9.76110036	9.5348374	9.56180532	8.6537512	6.05795787	4.69223467	4.19323171	4.00949537	4.53774866	6.4370444	9.15533247

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
ACF	0.93647166	0.97611004	0.9534837	0.95618053	0.86537512	0.60579579	0.46922347	0.41932317	0.40094954	0.45377487	0.6437044	0.91553325

Name of Project: Indrawati III HPP

Capacity (MW): 7.5

Monthly energy generation in MWh

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	4186.37	4354.51	4682.73	4167.26	3861.5	2790.12	2121.18	1757.25	1707.5	1966.21	2342.54	4760.74
067/68	5008.35	4581.6	3230.11	4371.29	3797.421	2932	2279.84	1871.78	1548.24	1832.94	2997.977	4498.7
068/69	4037.15	4578.12	4140.63	4845.175	3580.88	3066.32	1284.76	1827.69	2016.49	2017.57	1582.38	4586.2
069/70	4686.461	4405.25	4086.797	4352.09	4111.38	2620.63	1759.48	2048.75	1855.93	2400.71	3324.35	4070.55
070/71	4428.81	4295.76	4282.42	3847.47	3579.68	2961.356	1723.58	1920.32	1460.84	1639.307	2136.1	2490.665
071/72	4279.01	2284.68	4577.3	4172.02	3661.31	2991.03	1977.06	1701.73	2195.65	2121.01	3635.02	3339.47
072/73	3576.94	4100.09	3797.31	3720.47	2979.75	2637.28	2118.46	1897.77	1655.57	2246.05	1909.42	2315.98
073/74	2868.97	3813.4	3227.85	4014.208	3862.65	2835.47	2102.76	1822.6	1428.63	2011.55	2003.963	2525.22
074/75	2304.56	3151.28	3054.2	2132.46	2247.14	2058.03	1769.53	1564.08	1004.9	1481.74	2246.44	3293.02
075/76	4141.15	3763.3	4082.05	3463.34	3493.31	2363.43	1950.87	1485.73	1842.72	2056.52	2216.12	3190.08

Capacity Factor

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	0.75024552	0.78037814	0.83919892	0.77171481	0.73975096	0.51668889	0.40635632	0.32541667	0.3162037	0.35236738	0.41981004	0.82651736
067/68	0.89755376	0.82107527	0.57887276	0.80949815	0.72747529	0.54296296	0.43675096	0.34662593	0.28671111	0.32848387	0.53727186	0.78102431
068/69	0.72350358	0.82045161	0.74204839	0.89725463	0.68599234	0.56783704	0.24612261	0.33846111	0.37342407	0.36157168	0.28358065	0.79621528
069/70	0.83986756	0.78947133	0.7324009	0.80594259	0.78762069	0.48530185	0.33706513	0.37939815	0.34369074	0.43023477	0.59576165	0.70669271
070/71	0.79369355	0.76984946	0.76745878	0.71249444	0.68576245	0.54839926	0.33018774	0.35561481	0.27052593	0.29378262	0.38281362	0.43240712
071/72	0.76684767	0.40944086	0.82030466	0.7725963	0.70140038	0.55389444	0.37874713	0.31513519	0.40660185	0.38010932	0.65143728	0.5797691
072/73	0.64102867	0.73478315	0.68052151	0.68897593	0.57083333	0.48838519	0.40583525	0.35143889	0.30658704	0.40251792	0.34218996	0.40207986
073/74	0.51415233	0.68340502	0.57846774	0.74337185	0.73997126	0.52508704	0.40282759	0.33751852	0.26456111	0.36049283	0.35913315	0.43840625
074/75	0.41300358	0.56474552	0.54734767	0.3949	0.43048659	0.38111667	0.33899042	0.28964444	0.18609259	0.2655448	0.40258781	0.57170486
075/76	0.74214158	0.67442652	0.73155018	0.64135926	0.66921648	0.43767222	0.37372989	0.27513519	0.34124444	0.36855197	0.39715412	0.55383333
Total	7.08203781	7.04802688	7.01817151	7.23810796	6.73850977	5.04734556	3.65661303	3.31438889	3.09564259	3.54365717	4.37174014	6.08865017

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
ACF	0.70820378	0.70480269	0.70181715	0.7238108	0.67385098	0.50473456	0.3656613	0.33143889	0.30956426	0.35436572	0.43717401	0.60886502

Name of Project: Bijaypur Khola 1 HPP

Capacity (MW): 4.5

Monthly energy generation in MWh

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67												
067/68												
068/69												
069/70			2587.29	2703.753	2505.79	2354.614	2177.76	2094.56	1766.068	1458.95	1700.96	3100.93
070/71	3255.25	3126.53	2364.26	3206.337	2554.141	2508.55	2230.2	1995.791	1574.06	1528.536	1273.32	2292.39
071/72	2951.72	3064.54	2877.82	2109.79	955.55	403.77	0	166.82	1193.6	658.27	972.79	2113.34
072/73	3064.57	3274.28	2974.03	2606.51	2156.25	2292.62	2122.68	1949.92	1601.85	1728.16	1376.78	2661.88
073/74	2256.64	1588.96	1830.88	1874.43	1496.89	1464.57	1322.66	1139.755	1278.39	198.52	0	1553.03
074/75	2643.74	1986.76	2437.08	1815.83	1381.568	699.695	1097.27	1684.52	1135.5	128.82	73.44	525.65
075/76	1808.04	2569.23	2625.1	2158.67	1725.36	1729.95	1079.55	564.48	234.26	123.52	0	1194.7

Capacity Factor

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	0	0	0	0	0	0	0	0	0	0	0	0
067/68	0	0	0	0	0	0	0	0	0	0	0	0
068/69	0	0	0	0	0	0	0	0	0	0	0	0
069/70	0	0	0.77278674	0.83449167	0.80006066	0.7267327	0.69532567	0.64646914	0.54508272	0.43576762	0.50805257	0.89725984
070/71	0.9722969	0.93385006	0.70617085	0.98961019	0.8154984	0.7742438	0.71206897	0.61598488	0.48582099	0.45655197	0.38032258	0.66330729
071/72	0.88816368	0.91533453	0.85956392	0.65116975	0.30509259	0.1246204	0	0.05148765	0.36839506	0.19661589	0.29055854	0.61149884
072/73	0.9153435	0.97798088	0.88830048	0.8044784	0.68845785	0.7075988	0.67773946	0.60182716	0.49439815	0.51617682	0.41122461	0.77021991
073/74	0.6740263	0.47459976	0.54685783	0.57852778	0.47793423	0.4520278	0.42230524	0.35177623	0.39456481	0.0592951	0	0.44937211
074/75	0.7896476	0.59341697	0.72792115	0.56044136	0.44111367	0.2159552	0.35034163	0.51991358	0.35046296	0.0384767	0.02193548	0.1520978
075/76	0.5400358	0.76739247	0.78408005	0.66625617	0.55088123	0.5339352	0.34468391	0.17422222	0.07230247	0.03689367	0	0.34568866
Total	4.7729869	4.66257467	5.285681	5.08497531	4.07903863	3.5351139	3.20246488	2.96168086	2.71102716	1.73977778	1.61209379	3.88944444

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
ACF	0.7954978	0.77709578	0.75509729	0.72642504	0.5827198	0.5050163	0.53374415	0.42309727	0.38728959	0.24853968	0.32241876	0.55563492

Name of Project: Sanima mai HPP

Capacity (MW): 22

Monthly energy generation in MWh

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67												
067/68												
068/69												
069/70												
070/71												
071/72										3110.01	4324.19	2251.89
072/73	2690.21	2187.95	5851.96	10891.88	6323.52	4897.62	3956.32	3073.33	2425.1	3293.08	6902.33	14489.22
073/74	16434.92	16424.29	15099.31	15889.12	9349.65	5687.24	3998.53	3319.988	4069.2	3442.08	6761.21	14393.61
074/75	13394.01	9942.109	14507.04	12028.21	6353.56	4674.72	3081.89	2843.59	2911.03	5886.363	11786.99	14419.88
075/76	16433.62	15132.87	15332.07	9563.178	5140.77	4248.89	2688.288	3691.276	3573.127	5393.249	5961.831	9375.214

Capacity Factor

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	0	0	0	0	0	0	0	0	0	0	0	0
067/68	0	0	0	0	0	0	0	0	0	0	0	0
068/69	0	0	0	0	0	0	0	0	0	0	0	0
069/70	0	0	0	0	0	0	0	0	0	0	0	0
070/71	0	0	0	0	0	0	0	0	0	0.1900055	0.2641856	0.13327947
071/72	0.16435789	0.13367241	0.3575244	0.68761869	0.41297806	0.30919318	0.25838036	0.19402336	0.15309975	0.20119013	0.42166966	0.85755327
072/73	1.00408847	1.00343903	0.9224896	1.00310101	0.61060933	0.35904293	0.26113702	0.2095952	0.25689394	0.21029326	0.4130749	0.85189453
073/74	0.81830462	0.60741135	0.886305	0.75935669	0.41493992	0.29512121	0.20127286	0.17951957	0.18377715	0.35962628	0.720124	0.85344934
074/75	1.00400904	0.92453996	0.93671	0.60373598	0.33573472	0.26823801	0.1755674	0.2330351	0.2255762	0.32949957	0.364237	0.55487772
075/76	0	0	0	0	0	0	0	0	0	0	0	0
Total	2.99076002	2.66906274	3.1030291	3.05381237	1.77426202	1.23159533	0.89635763	0.81617323	0.81934703	1.29061474	2.1833181	3.25105433

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
ACF	0.74769	0.66726569	0.7757573	0.76345309	0.4435655	0.30789883	0.22408941	0.20404331	0.20483676	0.32265368	0.5458295	0.81276358

Name of project: Upper Bhotekoshi HPP

Capacity (MW): 45

Monthly energy generation in MWh

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	26983.41	26224.99	25190.22	19519.39	16230.96	13732.12	10879.2	8188.382	10316.91	13175.71	13551.79	26941.44
067/68	26359.86	26066.79	25890.57	23756.27	16658.66	12477.82	11475.61	11188.27	10709.91	13639	21484.31	24208.47
068/69	26936.97	24300.64	25158.38	26644.91	19140.02	14455.58	7463.878	12528.36	9245.92	14532.48	23840	27123.11
069/70	29251.87	29976.13	28044.7	23697.83	17028.95	12778.64	10630.51	11596.43	12348.53	18188.78	29566.12	31240.52
070/71	33478.89	32674.05	32834.27	31150.93	20270.15	15451.68	12615.68	11901.11	13115.94	15768.69	25480.12	31858.07
071/72	16633.94	0	0	0	0	0	9567.57	12848.72	15099.67	6570.84	0	0
072/73												
073/74												
074/75												
075/76					5237.34	15246.39	13717.58	13383.38	14251.42			

Capacity Factor

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	0.80595609	0.78330317	0.75239606	0.60245031	0.51822989	0.42383086	0.34735632	0.2527278	0.31842315	0.39353973	0.4047727	0.77955556
067/68	0.78733154	0.77857796	0.77331452	0.73321821	0.5318857	0.3851179	0.36639879	0.345317	0.33055278	0.40737754	0.64170579	0.70047656
068/69	0.804569	0.72582557	0.75144504	0.82237377	0.61111175	0.44615988	0.23831028	0.3866778	0.2853679	0.43406452	0.71206691	0.78481221
069/70	0.87371177	0.89534438	0.83765532	0.73141451	0.54370849	0.39440247	0.33941603	0.3579145	0.38112747	0.543273	0.88309797	0.90395023
070/71	0.99996685	0.97592742	0.98071296	0.96144846	0.64719508	0.4769037	0.40279949	0.3673182	0.40481296	0.47098835	0.76105496	0.92181916
071/72	0.49683214	0	0	0	0	0	0.30547797	0.3965654	0.4660392	0.19626165	0	0
072/73	0	0	0	0	0	0	0	0	0	0	0	0
073/74	0	0	0	0	0	0	0	0	0	0	0	0
074/75	0	0	0	0	0	0	0	0	0	0	0	0
075/76	0	0	0	0	0.16722031	0.47056759	0.43798148	0.4130673	0.43985864	0	0	0
Total	4.76836738	4.15897849	4.09552389	3.85090525	3.01935121	2.59698241	2.43774036	2.519588	2.62611821	2.44550478	3.40269833	4.09061372

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
ACF	0.7947279	0.8317957	0.81910478	0.77018105	0.5032252	0.4328304	0.34824862	0.3599411	0.37516887	0.40758413	0.68053967	0.81812274

Name of Project: Upper Marshyangdi A HPP

Capacity (MW): 50

Monthly energy generation in MWh

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
073/74							19575.3	17349.53	26280.19	34167.5	35178.88	33401
074/75	35310.79	35520.2	35688.36	35626.44	32479.23	26308.02	24973.22	18998.42	20793.71	23142.47	35712.1	35363.26
075/76	34908.41	35143.83	35532.52	34329.53	32805.36	23851.97	20356.84	18269.73	17608.55	30966.83	34977.25	34997.38

Capacity Factor

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	0	0	0	0	0	0	0.56250862	0.48193139	0.73000528	0.91848118	0.94566882	0.86981771
067/68	0.94921478	0.9548441	0.9593645	0.9896233	0.9333112	0.7307783	0.71762126	0.52773389	0.57760306	0.62210941	0.96000269	0.92091823
068/69	0.93839812	0.9447266	0.9551753	0.9535981	0.9426828	0.6625547	0.58496667	0.5074925	0.48912639	0.83244167	0.94024866	0.9113901
	1.887613	1.899571	1.91454	1.943221	1.875994	1.393333	1.865097	1.517158	1.796735	2.373032	2.84592	2.702126

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
ACF	0.94380645	0.9497853	0.9572699	0.9716107	0.937997	0.6966665	0.62169885	0.50571926	0.59891157	0.79101075	0.94864005	0.90070868

Name of Project: Upper Madi HPP

Capacity (MW): 25

Monthly energy generation in MWh

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
073/74							6012.92	5732.38	7078.82	9518.52	11194.4	9277.18
074/75	4213.97	11418.82	17779.66	13754.5	8239.888	7181.956	5634.74	5108.02	7737.36	5411.71	10707.86	16628.2
075/76	16020.43	10876.65	17948	11355.61	7209.8	5479.7	5318.48	5629.03	7275.7	7166.52	12918	9018

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	0	0	0	0	0	0	0.34557011	0.31846556	0.39326778	0.51174839	0.60184946	0.48318646
067/68	0.22655575	0.61399151	0.95558957	0.76441389	0.47355568	0.39899976	0.32383563	0.28377889	0.42985333	0.29095215	0.5756914	0.86605208
068/69	0.86133134	0.58447661	0.96499462	0.63008672	0.41443563	0.30444278	0.30565977	0.31272389	0.40420556	0.38529677	0.69451613	0.4696875
Total	1.087871	1.198681	1.920842	1.395006	0.887913	0.703425	0.975066	0.914968	1.227327	1.187997	1.872057	1.818926

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
ACF	0.5439355	0.5993406	0.960421	0.6975031	0.4439566	0.3517127	0.3250 2184	0.3049 8944	0.4091 0889	0.3959 991	0.6240 19	0.6063 0868

Name of project: Piluwa Khola HPP

Capacity (MW): 3.2

Monthly energy generation in MWh

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	1914.851	1837.046	1995.542	1983.12	1538.29	1034.78	884.914	714.466	637.01			
067/68	2113.51	209.674	2107.917	2052.355	6382.17375	1313.554	1051.436	853.728	744.503	816.25	1505	1857.656
068/69	2088.119	2019.073	2024.324	2050.784	1754.019	1404.141	1019.94	810.375	816.25	896	1651	205.6
069/70	1989	1899	2065	2041	1605	1140	930	870	687	745	1243	111
070/71	417	1917	2031	2043	1779	1158	947	885	689	996	1065	2122
071/72	1893	2032	2033	2031	1582	1172	861	865	708	548	1133	1162
072/73	1876	1856	2133	1969.5	1533	1189.5	939	762	617	847	963	1991.2609
073/74	1914.851	1086	0	1217	1736.3	142.025	1020	797	773	963	1576	997
074/75	906	1041	1041	797	1075	1090	936	802	634	923	1070	2055.908
075/76	502	1101	1917	1849	1293	1055	885	803	792			

Caapacity Factor

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	0.80428889	0.7716087	0.83818128	0.86072917	0.69068337	0.44912326	0.3973213	0.3100981	0.27648003	0	0	0
067/68	0.88773101	0.08806872	0.8853818	0.89077908	2.86555933	0.57011892	0.4720887	0.3705417	0.32313498	0.34284694	0.6321405	0.7558822
068/69	0.87706611	0.84806494	0.8502705	0.89009722	0.78754445	0.6094362	0.4579472	0.3517253	0.35427517	0.37634409	0.6934644	0.0836589
069/70	0.83543347	0.79763105	0.86735551	0.88585069	0.72063578	0.49479167	0.4175647	0.3776042	0.29817708	0.31292003	0.5220934	0.045166
070/71	0.17515121	0.80519153	0.8530746	0.88671875	0.79876078	0.50260417	0.4251976	0.3841146	0.29904514	0.41834677	0.4473286	0.863444
071/72	0.79511089	0.85349462	0.85391465	0.88151042	0.71030891	0.50868056	0.3865841	0.375434	0.30729167	0.23017473	0.4758905	0.472819
072/73	0.78797043	0.77956989	0.89591734	0.85481771	0.68830819	0.51627604	0.4216056	0.3307292	0.26779514	0.35576277	0.4044859	0.8102461
073/74	0.80428889	0.45614919	0	0.52821181	0.77958872	0.0616428	0.4579741	0.3459201	0.33550347	0.40448589	0.6619624	0.4056803
074/75	0.38054435	0.43724798	0.43724798	0.34592014	0.48266882	0.47309028	0.4202586	0.3480903	0.27517361	0.38768481	0.4494288	0.8365511
075/76	0.21085349	0.4624496	0.80519153	0.80251736	0.58054957	0.45789931	0.3973599	0.3485243	0.34375	0	0	0
Total	6.55843876	6.29947623	7.2865352	7.82715234	9.10460792	4.64366319	4.2539018	3.5427817	3.08062263	2.82856603	4.2867944	4.2734476

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
ACF	0.65584388	0.62994762	0.80961502	0.78271523	0.91046079	0.46436632	0.4253902	0.3542782	0.30806263	0.35357075	0.5358493	0.534181

Name of Project: Khudi HPP

Capacity (MW): 4

Monthly energy generation in MWh

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	1825.99	2105.06	1485.5	2595.81	1940.73	1245.21	1258.85	1099.62	1010.54	1273.92	1442.3	1655.45
067/68	2269.62	2559.72	2556.64	2615.54	2065.93	1639.06	1184.69	1031.25	1089.48	1522.35	1558.74	2033.94
068/69	2535.35	2335.83	2335.89	2216.92	1145.59	1375.07	1133.91	1189.28	1341.36	1467.82	1854.69	1565.41
069/70	2652.13	2533.59	2646.59	2623.49	1498.95	1426.279	1268.921	1274.07	1256.62	1294.08	1383.82	2442.18
070/71	2612.81	2612.62	2601.46	2577.08	2155.24	1660.18	1358.38	1256.85	1071.05	1899.59	2193.21	2456.64
071/72	2659.89	2044.26	2189.37	2486.84	2242.4	1848.83	1408.75	1428.64	1487.96	1246.23	1591.37	2367.8
072/73	2033.45	2122.51	2782.13	2722.33	1921.15	1437.24	1065.51	195.64	659.93	1700.6883	0	0
073/74	1752.08937	2259.7007	2330.2998	2732.25833	2224.04733	1473.80207	1229.19235	1187.1494	1461.15086	1116.26531	2094.35031	1896.6985
074/75	1451.91066	2630.74	2715.5	2552.11375	1643.94954	1487.5739	1106.82851	927.4605	1164.60925	1426.59841	2395.98386	2762.023
075/76	2829.40478	2129.0503	2669	2551	1630.23807	1189.43	1051.42	1107.32	1426.90314			

Capacity Factor

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	0.61357191	0.7073454	0.49915995	0.90132292	0.69710129	0.43236458	0.45217313	0.3818125	0.35088194	0.42806452	0.48464382	0.53888346
067/68	0.76264113	0.860121	0.85908602	0.90817361	0.74207256	0.56911806	0.4255352	0.3580729	0.37829167	0.51154234	0.52377016	0.66208984
068/69	0.85193212	0.7848891	0.78490927	0.76976389	0.41149066	0.47745486	0.40729526	0.4129444	0.46575	0.49321909	0.62321573	0.50957357
069/70	0.89117272	0.8513407	0.88931116	0.91093403	0.53841595	0.49523576	0.45579059	0.4423854	0.43632639	0.43483871	0.46499328	0.79498047
070/71	0.87796035	0.8778965	0.87414651	0.89481944	0.7741523	0.57645139	0.48792385	0.4364063	0.37189236	0.63830309	0.73696573	0.7996875
071/72	0.89378024	0.6869153	0.7356754	0.86348611	0.80545977	0.64195486	0.50601652	0.4960556	0.51665278	0.41876008	0.53473454	0.77076823
072/73	0.68328293	0.713209	0.93485551	0.94525347	0.69006825	0.49904167	0.38272629	0.0679306	0.22914236	0.57146784	0	0
073/74	0.58873971	0.759308	0.78303085	0.94870081	0.79886758	0.51173683	0.44152024	0.4122047	0.50734405	0.37508915	0.70374674	0.61741488
074/75	0.48787321	0.8839852	0.9124664	0.88615061	0.59049912	0.51651872	0.39756771	0.3220349	0.40437821	0.47936775	0.8051021	0.89909603
075/76	0.95074085	0.7154067	0.8968414	0.88576389	0.58557402	0.41299653	0.37766523	0.3844861	0.49545248	0	0	0
Total	7.601695 16	7.840417	8.169482 46	8.914368 78	6.633701 49	5.132887 325	4.334214 03	3.714333 33	4.156111 224	4.350652 56	4.877172 1	5.592493 98

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
ACF	0.76016952	0.7840417	0.81694825	0.89143688	0.66337015	0.51328733	0.4334214	0.3714333	0.41561122	0.48340584	0.60964651	0.69906175

Name of Project: Mardi Khola HPP

Capacity (MW): 4.8

Monthly energy generation in MWh

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67										948.4151	1202.18261	1543.266
067/68	1569.87259	1772.5955	1367.0078	1700.3184	1822.4159	1593.5112	1067.3179	1100.719	1016.9973	1153.85792	1709.90435	1740.4174
068/69	1650.68174	1709.6044	2177.0201	2104.6511	1811.2955	1561.6031	1298.4818	1160.6749	1210.5824	1236.19	1774.98	2557.121
069/70	1613.135	1976.899	2118.266	2216.4	2103.465	1458.73	1241.78	1093.5	1089.35	1065.72	1341.12	2162.92
070/71	1648.84	207.99	1510	2836.71	2573.43	1883.43	1372.71	1251.72	1083.4953	1570.93	2035.17	2505.87
071/72	2787.73	2891.67	2772.54	2822.41	2253.64	1945.21	1451.59	1431.02	1498.51	968.1981	1522.18405	2746.5227
072/73	2793.4323	2699.785	2992.291	2847.705	2123.5094	1649.8676	1281.9061	1071.8634	1356.3579	1283.91155	1555.9051	2288.9536
073/74	2882.5529	2819.6948	2808.2826	2903.7635	2400.0774	1702.192	1334.8895	1129.0297	1256.1306	1410.06705	1599.69185	2326.3705
074/75	2684.07525	2818.7971	2987.7366	2706.1262	2103.9605	1539.4123	1164.7467	1014.4297	1089.6646	1420.01815	1802.2951	2395.9422
075/76	2432.8052	2961.9707	2959.8697	2663.963	2077.7362	1526.0805	1294.1205	1299.9651	1204.8089			

Caapacity Factor

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	0	0	0	0	0	0	0	0	0	0.26557322	0.33663268	0.4186377
067/68	0.43959246	0.4963585	0.3827867	0.4919903	0.5455028	0.4610854	0.3194797	0.3184951	0.2942701	0.3231009	0.47880386	0.4721184
068/69	0.46222047	0.4787199	0.6096047	0.6089847	0.5421742	0.4518527	0.3886739	0.3358434	0.3502843	0.34615535	0.49702621	0.6936635
069/70	0.45170671	0.5535671	0.5931524	0.6413194	0.6296291	0.4220862	0.3717014	0.3164063	0.3152054	0.2984207	0.37553763	0.5867296
070/71	0.46170475	0.0582409	0.4228271	0.8208073	0.7703035	0.544974	0.4108926	0.3621875	0.3135114	0.43988855	0.56988407	0.6797607
071/72	0.78061436	0.8097194	0.7763609	0.8166696	0.6745809	0.5628501	0.4345037	0.4140683	0.4335966	0.27111282	0.42623881	0.745042
072/73	0.78221111	0.7559882	0.8378951	0.8239887	0.635629	0.4773922	0.3837123	0.3101456	0.3924647	0.35951824	0.43568131	0.6209184
073/74	0.80716647	0.7895651	0.7863694	0.8402093	0.718414	0.4925324	0.3995718	0.3266868	0.3634637	0.39484404	0.44794239	0.6310684
074/75	0.75158917	0.7893137	0.8366198	0.7830226	0.6297774	0.4454318	0.348643	0.2935271	0.3152965	0.39763053	0.50467493	0.6499409
075/76	0.68122905	0.8294049	0.8288166	0.7708226	0.6219277	0.4415742	0.3873684	0.3761473	0.3486137	0	0	0
Total	5.61803455	5.5608777	6.0744326	6.5978145	5.7679387	4.2997791	3.4445469	3.0535074	3.1267063	3.09624436	4.07242189	5.4978796

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
ACF	0.62422606	0.6178753	0.674937	0.7330905	0.6408821	0.4777532	0.3827274	0.3392786	0.3474118	0.34402715	0.45249132	0.6108755

Name of Project: Lower Modi 1 HPP

Capacity (MW): 10.2

Monthly energy generation in MWh

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67												
067/68												
068/69												
069/70									2199.08	3333.06	5592.06	5523.17
070/71	6011.79	6612.194	6949.794	6180.86	3830.13	2755.756	2069.911	1683.516	1613.94	2903.82	4840.77	5585.34
071/72	5489.54	3738	6646.71	6338.82	4231.14	3082.71	2330.62	2221.73	1232.44	2600.4	5373.42	3872.78
072/73	1735.88	0	0	0	242.02	2156.22	2149.57	1824.54	1285.23	2685.4	3498.6	3943.98
073/74	4708.18	4536.37	3517.03	4942.32	4341.98	2988.7	1427.17	1392.796	1321.42	2812.52	1882.76	3920.34
074/75	2851.18	2847.12	3213.78	3889.79	2261.21	1927.92	1640.3	1257.5	1218.21	1725.2	2987.9	4215.1
075/76	4881.36	5407.76	5231.94	3025.52	2638.87	2358.68	1854.48	1205.88	1440.165	2737.44	3282.14	4084.81

Caapacity Factor

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	0	0	0	0	0	0	0	0	0	0	0	0
067/68	0	0	0	0	0	0	0	0	0	0	0	0
068/69	0	0	0	0	0	0	0	0	0	0	0	0
069/70	0	0	0	0	0	0	0	0	0.299439	0.4392078	0.7368833	0.7050615
070/71	0.79219244	0.87130956	0.9157962	0.8416204	0.53951572	0.3752391	0.2915696	0.2292369	0.2197631	0.3826455	0.6378835	0.7129979
071/72	0.72337392	0.49256799	0.8758578	0.8631291	0.59600237	0.419759	0.3282933	0.3025231	0.1678159	0.3426629	0.7080724	0.4943806
072/73	0.22874236	0	0	0	0.03409117	0.2936029	0.3027905	0.2484395	0.1750041	0.3538636	0.4610215	0.5034697
073/74	0.62041166	0.59777172	0.4634501	0.6729739	0.61161539	0.4069581	0.2010325	0.1896509	0.1799319	0.3706146	0.2480972	0.5004519
074/75	0.37570894	0.37517394	0.4234899	0.5296555	0.31851617	0.2625163	0.2310542	0.1712282	0.1658783	0.227335	0.393725	0.5380796
075/76	0.64323213	0.71259751	0.6894292	0.4119717	0.37171371	0.321171	0.2612238	0.1641993	0.1961009	0.3607211	0.4324979	0.5214474
Total	3.38366145	3.04942073	3.3680231	3.3193505	2.47145453	2.0792465	1.6159639	1.3052781	1.4039331	2.4770504	3.6181807	3.9758885

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
ACF	0.56394357	0.60988415	0.6736046	0.6638701	0.41190909	0.3465411	0.2693273	0.2175463	0.2339889	0.4128417	0.6030301	0.6626481

Name of Project: Sipring Khola HPP

Capacity (MW): 10

Monthly energy generation in MWh

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67												
067/68												
068/69												
069/70												
070/71	3491.952	2645.695	2593.351	3228.337	2480.424	1338.332	890.615	672.17	350.55	476.022	1663.476	6260.869
071/72	3882.775	6708.81	5880.81	4179.21	1952.458	1103.86	875.06	795.5	1323.53	785.61	0	0
072/73	0	9.07	0	0	0	0	0	0	0	688.42	1321.21	3852.09
073/74	4158.67	3805.81	1707.42	4278.648	2560.23	1338.09	1115.59	840.867	1292.29	1074.07	2681.95	5128.85
074/75	6332.92	4184.529	4634.92	3449.12	480.958	0	0	641.44	775.07	782.138	2670.252	5068.416
075/76	4099.19	5518.87	4764.32	2582.871	1460.57	1073.18	347.967	513.907	551.17	1245.58	1831.177	3745.225

Caapacity Factor

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	0	0	0	0	0	0	0	0	0	0	0	0
067/68	0	0	0	0	0	0	0	0	0	0	0	0
068/69	0	0	0	0	0	0	0	0	0	0	0	0
069/70	0	0	0	0	0	0	0	0	0	0	0	0
070/71	0.46934839	0.35560417	0.3485687	0.4483801	0.3563828	0.18587944	0.12796193	0.0933569	0.0486875	0.0639815	0.22358548	0.8152173
071/72	0.52187836	0.90172177	0.7904315	0.5804458	0.2805256	0.15331389	0.12572701	0.1104861	0.18382361	0.1055927	0	0
072/73	0	0.00121909	0	0	0	0	0	0	0	0.0925296	0.17758199	0.5015742
073/74	0.55896102	0.5115336	0.2294919	0.5942567	0.3678491	0.18584583	0.16028592	0.1167871	0.17948472	0.1443642	0.36047715	0.667819
074/75	0.85119892	0.56243669	0.6229731	0.4790444	0.0691032	0	0	0.0890889	0.10764861	0.1051261	0.35890484	0.65995
075/76	0.5509664	0.7417836	0.6403656	0.3587321	0.209852	0.14905278	0.04999526	0.071376	0.07655139	0.1674167	0.24612594	0.4876595
Total	2.95235309	3.07429892	2.6318308	2.4608592	1.2837126	0.67409194	0.46397011	0.481095	0.59619583	0.6790108	1.3666754	3.1322201

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
ACF	0.59047062	0.51238315	0.5263662	0.4921718	0.2567425	0.16852299	0.11599253	0.096219	0.11923917	0.1131685	0.27333508	0.626444

Name of Project: Naugadgad HPP

Capacity (MW): 8.5

Monthly energy generation in MWh

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67												
067/68												
068/69												
069/70												
070/71												
071/72												
072/73		2832.1	3342.01	3125.65	2056.13	1950.69	1400.57	1299.2	1112.33	914.41	1499.06	3370.06
073/74	3439.79	3542.38	4017.67	3757.82	2436	2202.89	1815.78	1471.23	1431.84	1173.84	1157.86	1622.69
074/75	3318.67	3721.66	2598.93	2989.59	2389.41	2140.45	1529.92	1368.25	1205.74	2132.89	1249.4	1896.06
075/76	3457.62	4633.72	5675.43	4034.47	2771.8152	2148.273	1574.6606	1973.1033	2644.5			

Caapacity Factor

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
066/67	0	0	0	0	0	0	0	0	0	0	0	0
067/68	0	0	0	0	0	0	0	0	0	0	0	0
068/69	0	0	0	0	0	0	0	0	0	0	0	0
069/70	0	0	0	0	0	0	0	0	0	0	0	0
070/71	0	0	0	0	0	0	0	0	0	0	0	0
071/72	0	0	0	0	0	0	0	0	0	0	0	0
072/73	0	0.44783365	0.5284646	0.5107271	0.3475541	0.3187402	0.2367427	0.2122876	0.1817533	0.14459361	0.237043	0.5162469
073/74	0.5439 2631	0.5601 4864	0.635 3052	0.614 0229	0.411 7647	0.359 9493	0.306 927	0.240 3971	0.233 9608	0.1856 167	0.183 0898	0.248 5738
074/75	0.5247 7388	0.5884 9779	0.410 963	0.488 4951	0.403 8895	0.349 7467	0.258 6072	0.223 5703	0.197 0163	0.3372 6913	0.197 5648	0.290 4504
075/76	0.5467 4573	0.7327 198	0.897 4431	0.659 2271	0.468 5286	0.351 025	0.266 1698	0.322 4025	0.432 1078	0	0	0
Total	1.6154 4592	2.3291 9987	2.472 1758	2.272 4722	1.631 7368	1.379 4613	1.068 4467	0.998 6574	1.044 8382	0.6674 7944	0.617 6977	1.055 2711

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
ACF	0.5384 8197	0.5822 9997	0.618 044	0.568 1181	0.407 9342	0.344 8653	0.267 1117	0.249 6644	0.261 2096	0.2224 9315	0.205 8992	0.351 757

Weighted Average capacity factor for RoR and PRoR projects

FY/MONTH	Shrawan	Bhadra	Ashoj	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
WACF	0.7948 5632	0.8101 491	0.8565 255	0.8231 332	0.6630 565	0.495 747	0.409 183	0.3639 474	0.3918 296	0.4626 741	0.6516 554	0.7865 706

Annex 3: Validation of data

For 2076 BS

Days	31	31	31	30	29	30	29	30	30	31	31	32
Months	Shrawan	Bhadra	Ashwin	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Asar
Calculated Energy												
P/RoR	0.7948563	0.810149145	0.856525502	0.82313317	0.663056516	0.49574698	0.409182956	0.3639474	0.3918296	0.4626741	0.6516554	0.7865706
Storage	0.1005707	0.054968881	0.059119872	0.0609899	0.083328023	0.160888986	0.220255317	0.2824542	0.3580074	0.3436953	0.174857	0.1118024
NEA	240.02297	244.6409448	258.645225	240.543615	187.3057107	144.871783	115.5893993	106.35608	114.50408	139.71381	196.78055	245.18288
Storage	6.883866	3.762551	4.046637	4.039971	5.33566	10.657344	14.103251	18.709766	23.71441	23.525253	11.968615	7.899507
IPP	326.70111	332.9867564	352.0483237	327.409781	254.9463709	197.188518	157.3315505	144.76385	155.8543	190.16787	267.8428	333.7244
Total	**573.60794**	**581.3902112**	**614.7401858**	**571.993367**	**447.5877416**	**352.717645**	**287.0242008**	**269.82969**	**294.07279**	**353.40694**	**476.59197**	**586.8068**
Kapadigag	1.9692724	2.007160711	2.122059061	1.9735441	1.536752826	1.188600296	0.948355154	0.8726002	0.9394506	0	0.3124818	2.0116071
Pikhuwa	2.9568655	3.013754821	3.186274867	2.96327943	2.307436676	1.784688913	1.423956688	1.3102105	1.4105865	0	0.3127946	3.020431
Lower Hewa	4.2159179	13.32079631	14.08333491	13.0976951	10.1987011	7.88832597	6.293888559	5.7911304	6.2347925			
Upper Trishuli 3A		20.99906585	38.2352984	35.5593531	27.68924011	21.4162696	17.08748025	15.722526	16.927038			
Iwa Khola			2.238615051	5.86729327	4.568724619	3.53368448	2.819434241	2.5942168	2.7929613			
Upper mardi			1.582859127	4.1485912	3.230411347	2.49856479	1.993539363	1.8342947	1.9748212			
Kulekhani III				0.6147782	0.811948261	1.62176974	2.146146891	2.8471383	3.6087146			
Upper Naugadgad				2.686770668	3.691898682	2.85550261	2.2783307	2.0963368	2.2569385			
Kabeli B1				3.45715933	11.53718338	8.923444566	7.119783438	6.5510525	7.0529327			
Padam Khola						1.256422115	1.36699842	1.2578021	1.3541631			
Ghalemdi								1.0918421	1.4105865			
Rudi Khola B								1.4412316	1.8619742			
Upper Khorunga								0.8516368	2.1158798			
Total	**582.75**	**620.7309889**	**676.1886272**	**642.361767**	**513.1602076**	**405.684921**	**330.5021145**	**314.09171**	**344.01363**	**353.40694**	**477.21725**	**591.83883**
Actual Generation												
NEA	264.28	274.2	248.69	256.63	232.39	184.27	164.04	152.86	172.78	237.33	264.59	259.27
IPP	318.06	328.98	333.02	306.17	247.46	198.33	170.34	162.14	165.69	152.15	185.95	239.5
Storage	50.46	15.65	9.67	19.29	28.9	22.95	18.86	9.56	13.15	30.97	22.21	19.62
Total	**632.8**	**618.83**	**591.38**	**582.09**	**508.75**	**405.55**	**353.24**	**324.56**	**351.62**	**420.45**	**472.75**	**518.39**
PVME	7.90	-0.307	-14.34	-10.35	-0.866	-0.033	6.43	3.22	2.16	15.94	-0.94	-14.1

For fiscal year 2077/078

Days	31	31	31	30	29	30	29	30	30	31	31	32
Months	Shrawan	Bhadra	Ashwin	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Asar
Calculated Energy												
P/RoR	0.794856	0.810149	0.856526	0.823133	0.663057	0.495747	0.409183	0.363947	0.39183	0.462674	0.651655	0.786571
Storage	0.100571	0.054969	0.05912	0.06099	0.083328	0.16089	0.220253	0.282454	0.358007	0.343695	0.174857	0.111802
NEA	281.4522	286.8673	303.2888	282.0627	219.6357	169.8774	135.5407	124.7137	134.2681	163.8292	230.7459	287.5027
Storage	6.883866	3.76251	4.046637	4.039971	5.33566	10.65734	14.10325	18.70977	23.71441	23.52525	11.96862	7.899507
IPP	331.6273	338.0077	357.3567	332.3466	258.7906	200.1618	159.7039	146.9467	158.2043	193.0353	271.8815	338.7564
Addition in F/Y 2077/078												
Addition in fiscal year 2077/078	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0
			6.166984	8.889838	6.92231	5.354067	4.27187	3.930632	4.23176	5.163443	7.272474	9.061293
				11.15378	27.04316	20.91656	16.68877	15.35567	16.53207	20.17185	28.41113	35.39945
					0	0	0	0	0	0	0	0
							0	0	0	0	0	0
							0	0	0	0	0	0
								0.777392	2.680114	3.27018	4.6059	5.738819
										0	0	0
										3.764316	3.878653	4.83269
										7.745164	10.90871	13.59194
												22.99303
Total	619.9633	628.6374	670.859	638.4929	517.7274	406.9672	330.3085	310.4338	339.6308	420.5047	569.6729	725.7759
Actual Generation												
IPP	397.48	404.6	409.25	358.01	268.92	198.8	166.6	139.78	142.14	170.22	300.43	352.04
NEA	271.08	265.04	280.59	237.39	228.78	174.74	153.6	134.92	137.05	183.39	226.89	221.65
Storage	54.76	35.88	23.84	21.87	17.54	29.34	27.8	6.78	22.31	11.47	22.24	49.47
Total	723.32	705.52	713.68	617.27	515.24	402.88	348	281.48	301.5	365.08	549.56	623.16
PVME	14.29	10.90	6.00	-3.44	-0.48	-1.01	5.08	-10.29	-12.65	-15.18	-3.66	-16.47

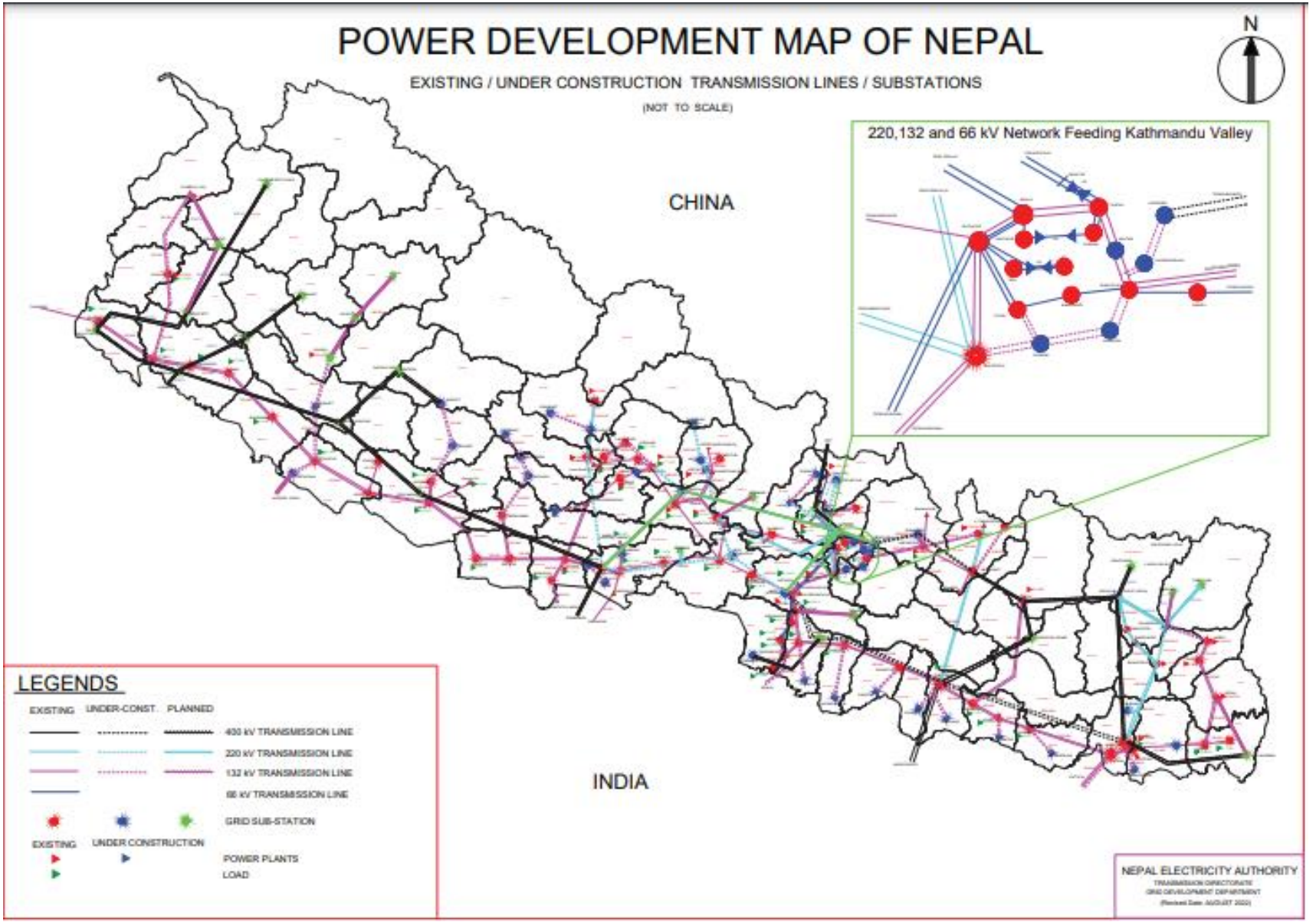
Fiscal Year 2078/079												
Days	31	31	31	30	29	30	29	30	30	31	31	32
Months	Shrawan	Bhadra	Ashwin	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Asar
Calculated Energy												
P/RoR	0.794856	0.810149	0.856526	0.823133	0.663057	0.495747	0.409183	0.363947	0.39183	0.462674	0.651655	0.786571
Storage	0.100571	0.054969	0.05912	0.06099	0.083328	0.16089	0.220253	0.282454	0.358007	0.343695	0.174857	0.111802
NEA	281.4522	286.8673	303.2888	282.0627	219.6357	169.8774	135.5407	124.7137	134.2681	163.8292	230.7459	287.5027
Storage	7.931411	4.335066	4.66243	4.654749	6.147608	12.27911	16.2494	21.5569	27.32312	27.10518	13.78993	9.101606
IPP	481.7591	491.0281	519.1366	482.8042	375.9484	290.7776	232.0038	213.4713	229.8255	280.4249	394.9657	492.1158
Addition in fiscal year 2078/079												
Additional Projects during fiscal year 2078/079	6.905712	17.47978	18.48039	17.18702	13.38313	10.3512	8.258949	7.599221	8.181402	9.982656	14.06012	17.5185
		274.8544	290.5883	270.2511	210.4382	162.7636	129.8648	119.4912	128.6455	156.9687	221.0832	275.4633
			13.04954	17.48928	13.61849	10.53324	8.404192	7.732862	8.325282	10.15821	14.30738	17.82658
				11.15378	27.04316	20.91656	16.68877	15.35567	16.53207	20.17185	28.41113	35.39945
					0.318267	1.427751	1.139165	1.048168	1.128469	1.376918	1.939326	2.416345
						3.736544	5.168963	4.756064	5.120429	6.247766	8.799694	10.96416
							0.942758	6.28901	6.770815	8.261508	11.63596	14.49807
								0.314451	0.677082	0.826151	1.163596	1.449807
									3.500888	8.06633	11.36106	14.15555
										2.342982	17.93877	22.35119
												5.889841
Total	816.8805	954.9402	1058.218	907.8217	773.8547	607.4094	492.7668	464.3073	540.0931	642.0236	961.4265	1206.653
Actual Generation												
IPP	409.15	402.1	442.06	426.54	350.17	312.38	228.71	207.79	223.7	264.53	392.98	554.82
NEA Sub	126.92	225	218.22	109.55	137.72	101.76	102.6	91.49	131.85	139.43	262.11	404.05
NEA	262.78	270.94	297.65	213.14	255.53	230.07	189.64	175.24	236.37	240.98	289.29	305.93
Storage	38.31	12.11	16.4	4.46	13.59	23.53	27.54	18.49	45.56	28.29	33.24	29.82
Total	837.16	910.15	974.33	753.69	757.01	667.74	548.49	493.01	637.48	673.23	977.62	1294.62
PVME	2.422	-4.92	-8.60	-20.45	-2.22	9.035	10.159	5.821	15.276	4.635	1.656	6.794

Annex 4: Power Development map of Nepal

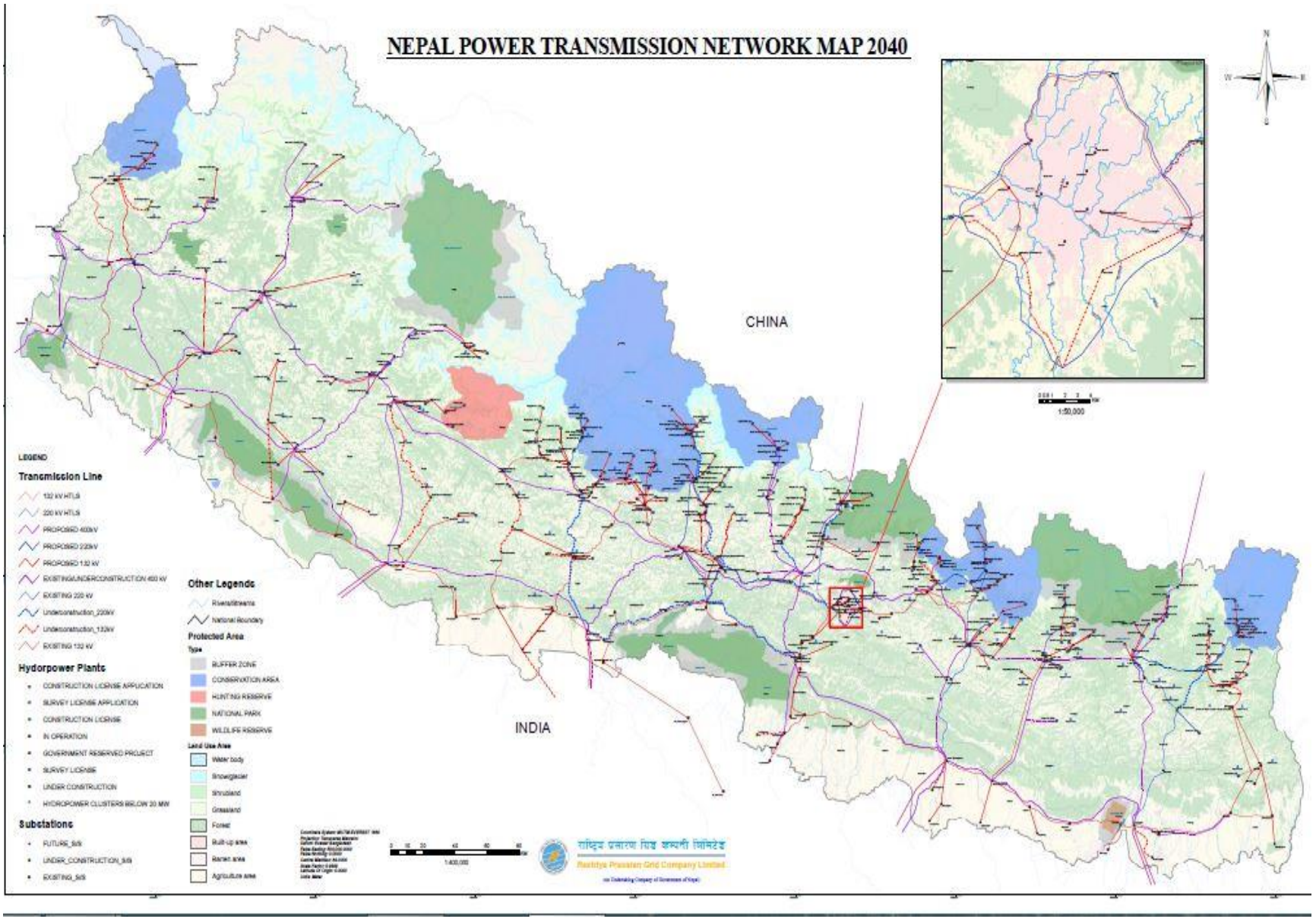
POWER DEVELOPMENT MAP OF NEPAL

EXISTING / UNDER CONSTRUCTION TRANSMISSION LINES / SUBSTATIONS

(NOT TO SCALE)



Annex 5: Transmission system development plan of Nepal


NEPAL POWER TRANSMISSION NETWORK MAP 2040
CHINA
INDIA
LEGEND
Transmission Line
132 kV HTLS
220 kV HTLS
PROPOSED 400kV
PROPOSED 220kV
PROPOSED 132 kV
EXISTING/UNDERCONSTRUCTION 400 kV
EXISTING 220 kV
Underconstruction_220kV
Underconstruction_132kV
EXISTING 132 kV
Hydorpower Plants
CONSTRUCTION LICENSE APPLICATION
SURVEY LICENSE APPLICATION
CONSTRUCTION LICENSE
IN OPERATION
GOVERNMENT RESERVED PROJECT
SURVEY LICENSE
UNDER CONSTRUCTION
HYDROPOWER CLUSTERS BELOW 20 MW
Substations
FUTURE_SS
UNDER_CONSTRUCTION_SS
EXISTING_SS
Other Legends
Rivers/Streams
National Boundary
Protected Area
Type
BUFFER ZONE
CONSERVATION AREA
HUNTING RESERVE
NATIONAL PARK
WILDLIFE RESERVE
Land Use Area
Water body
Snow/glacier
Shrubland
Grassland
Forest
Built-up area
Barren area
Agriculture area
1:400,000
1:50,000
राष्ट्रिय प्रसारण गिड कम्पनी लिमिटेड
Rashtriya Prasaran Grid Company Limited

Annex 6: Load distribution within country in F/Y 2021/022

Zone	Substation	Load (MW)
1	Syaule +Balanch	11.6
1	Mahendranagar	21.6
1	Attariya	27
1	Pahalmanpur	1.9
1	Lumki	15.3
1	Bhurigaun	2.9
1	Kohalpur	66.4
2	Ghorahi	28.2
2	Lamahi	55.8
2	Jhimrukh	4.8
3	Shivapur	23
3	Mainhiya	50
3	Butwal	75
3	Modi	10
3	Syangja	17.8
3	Kudahar	39.1
3	Lekhnath	11.7
3	Damauli	25.8
3	Markichowk	2.9
3	Bardaghat	13.4
3	Hongsi cement (Bardaghat)	60
3	Kawasoti	17.2
3	Bharatpur	56.6
4	Malekhu	20
3	Purbi Chitwan	7.2
4	Hetauda	80
4	Trishuli	11.5
4	Devighat	6.7
4	Kulikhani III	10.8
4	Amlekhgunj	2
4	Simara	95.8
4	Birgunj	37.1
4	Pathlaiya	10
4	Chapur	47.8
4	Siuchatar	125
4	Matatirtha	13.7
4	Bhaktapur	90.3
4	Balaju	78.2
4	Chapali	60.8
4	Lamosangu	14.4
4	Dhalkebar	60.5

Zone	Substation	Load (MW)
4	Mirchaiya	7.1
5	Lahan	28.8
5	Rupani	20
5	Duhabi	126.9
5	Damak	23.9
5	Anarmani	37.1

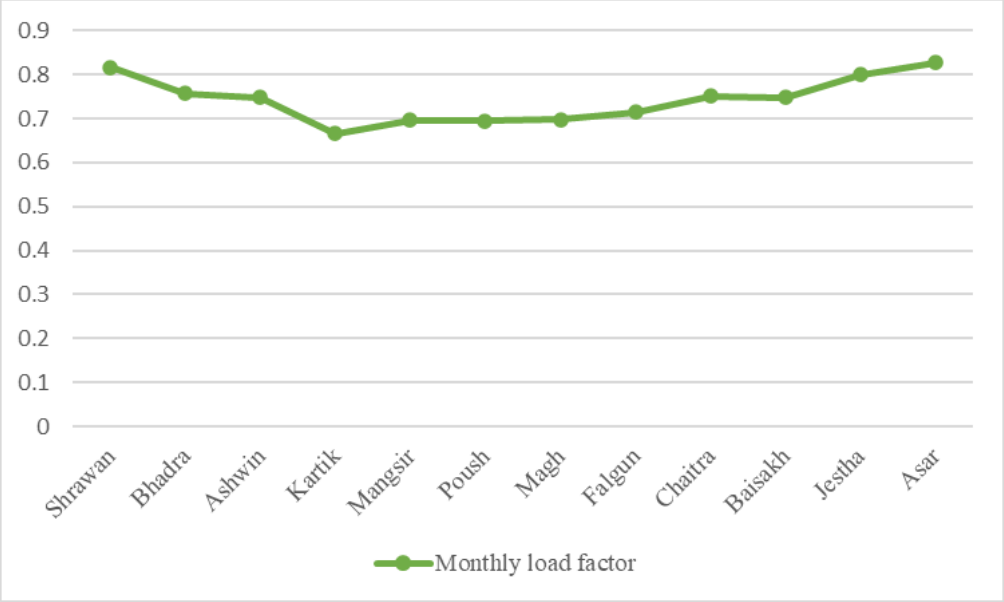


Figure: Monthly load factor of fiscal year 2078/079

Annex 7: Energy and capacity surplus and deficit analysis

Table: Estimated Demand and Generation for F/Y 2087/088 under BAU

Months	Energy Demand (GWh)	Peak Demand (MW)	Energy from P/RoR (GWh)	Energy from Storage (GWh)	Energy Generation from solar (GWh)	Total Energy Generation (after 25% loss) (GWh)
Shrawan	1742.2623	2869.3753	5682.61	111.26	16.77	4362.186
Bhadra	1670.2222	2967.9209	5791.94	106.81	17.07	4441.141
Ashwin	1689.2325	3033.4802	6123.50	72.71	17.68	4664.846
Kartik	1354.7109	2825.9634	5694.94	38.82	17.72	4318.045
Mangsir	1410.596	2909.8755	4434.51	37.33	16.53	3370.427
Poush	1599.9854	3197.6603	3429.88	42.63	16.04	2620.432
Magh	1564.914	3219.5635	2736.61	44.17	16.19	2101.780
Falgun	1543.687	3002.9359	2518.01	50.18	20.07	1946.224
Chaitra	1724.5669	3190.1651	2710.91	56.45	22.01	2097.541
Baisakh	1794.5594	3224.9923	3307.76	56.70	22.60	2545.960
Jestha	1893.5183	3185.7882	5540.863	45.25	20.49	3548.559
Asar	2085.5752	3282.7183	6903.755	79.08	17.98	4430.880

Table: Energy and Capacity surplus/Deficit for F/Y 2087/088 under BAU

Months	RoR (MW)	PRoR (MW)	Storage (MW)	Total (MW)	Total (MW) (after 25% loss)	Energy Surplus (GWh)	Capacity surplus (MW)
Shrawan	7186.156	2423.03	225.86	9,855.19	7,376.28	2619.924057	4,506.91
Bhadra	7186.156	2423.03	225.86	9,855.19	7,376.28	2770.919575	4,408.36
Ashwin	7186.156	2423.03	227.98	9,855.19	7,377.87	2975.613983	4,344.39
Kartik	6754.98664	2423.03	238.58	9,702.56	7,062.45	2963.334382	4,236.48
Mangsir	4599.13984	2423.03	238.58	8,334.35	5,445.56	1959.831978	2,535.69
Poush	3320.004072	2059.5755	240.7	6,540.85	4,215.21	1020.44668	1,017.55
Magh	2529.526912	1938.424	219.5	5,679.82	3,515.59	536.8666616	296.02

Falgun	2206.149892	1938.424	233.28	5,293.18	3,283.39	402.5377307	280.45
Chaitra	2242.080672	1938.424	214.2	5,531.49	3,296.03	372.9745613	105.86
Baisakh	3736.80112	1938.424	238.58	6,137.02	4,435.35	751.4015336	1,210.36
Jestha	6467.5404	2059.5755	240.7	7,873.44	6,575.86	1655.040753	3,390.07
Asar	7186.156	2423.03	241.76	9,855.19	7,388.21	2345.305143	4,105.49

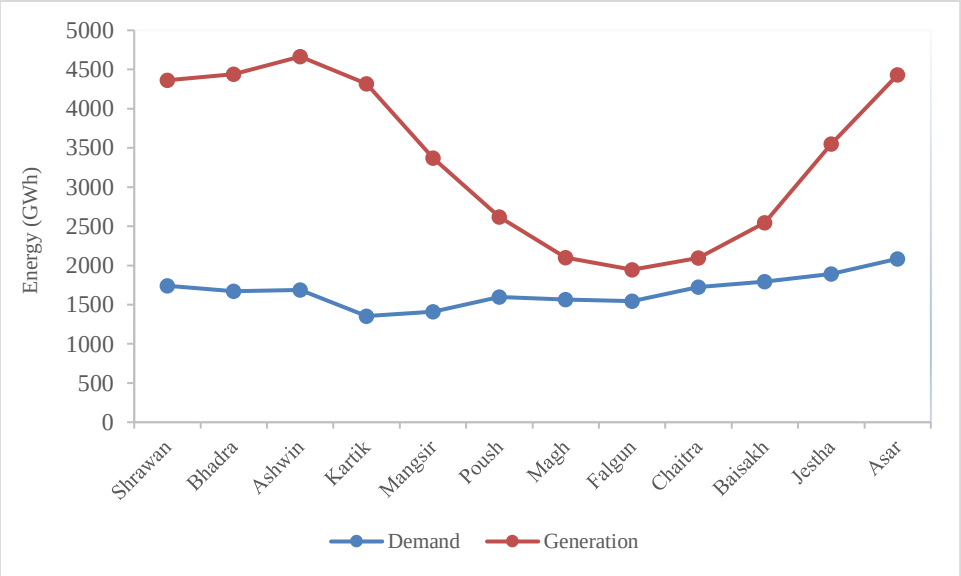


Figure: Energy Demand and Generation for F/Y 2087/088 under BAU

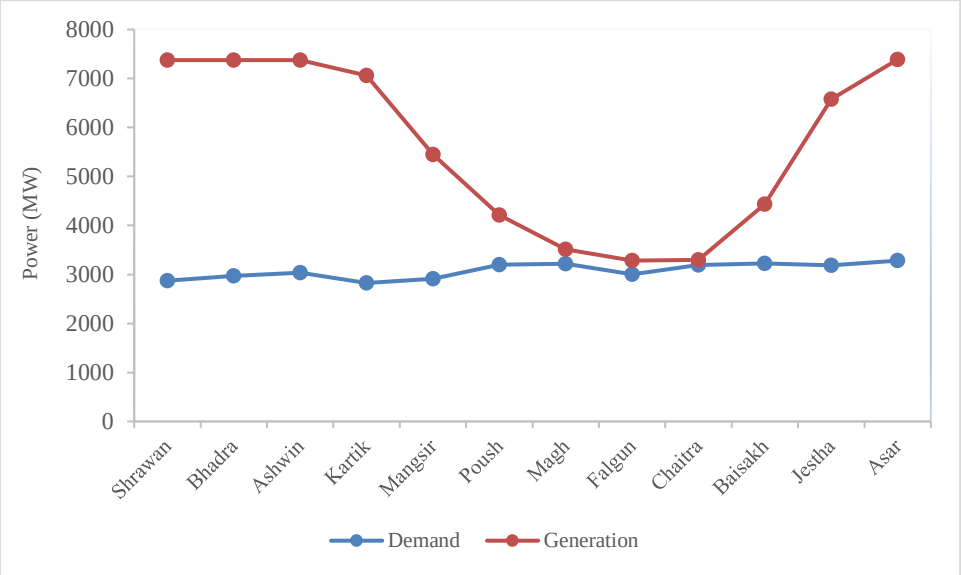


Figure: Monthly Peak power demand and generation for F/Y 2087/088 under 4.5 % economic growth rate

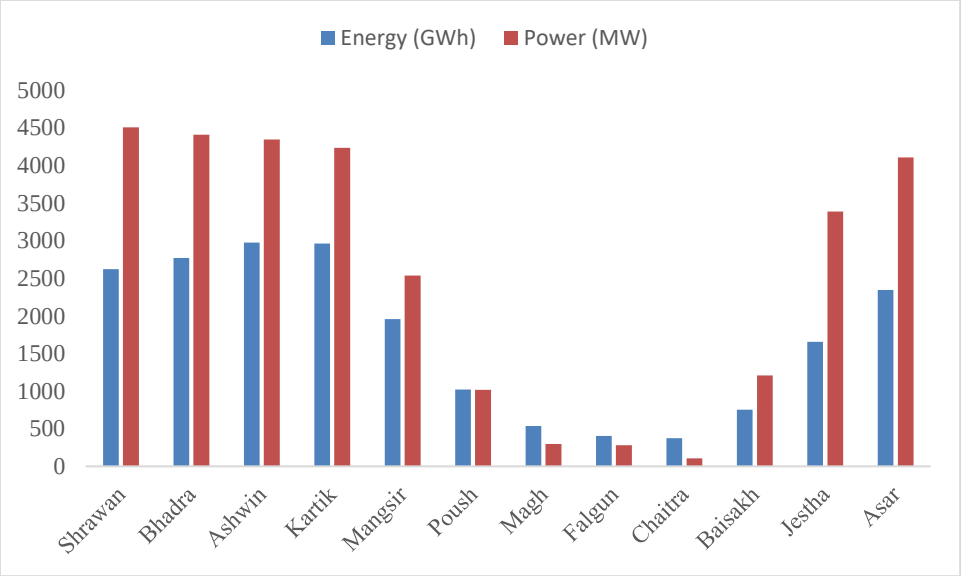


Figure: Power and Energy Surplus/Deficit for F/Y 2087/088 under 4.5 % economic growth rate

Table: Estimated Demand and Generation for F/Y 2087/088 under 7.2 % economic growth rate

Months	Energy Demand (GWh)	Peak Demand (MW)	Energy from P/RoR(GWh)	Energy from Storage (GWh)	Energy Generation from solar (GWh)	Total Energy Generation (after 25% loss) (GWh)
Shrawan	2166.0859	3567.3809	5682.614	111.2647	16.77716573	4362.186
Bhadra	2076.5212	3689.8988	5791.946	106.8151	17.07083514	4441.142
Ashwin	2100.156	3771.4061	6123.502	72.71246	17.68594227	4664.846
Kartik	1684.2586	3513.4086	5694.941	38.82543	17.72074214	4318.045
Mangsir	1753.7383	3617.7333	4434.518	37.33833	16.53599947	3370.428
Poush	1989.1987	3975.5247	3429.882	42.63162	16.0468902	2620.432
Magh	1945.5957	4002.7561	2736.613	44.17044	16.19311518	2101.781
Falgun	1919.2051	3733.4317	2518.011	50.1878	20.07544846	1946.225
Chaitra	2144.0859	3966.2062	2710.918	56.4516	22.01447955	2097.541
Baisakh	2231.1049	4009.5055	3307.765	56.70717	22.60652023	2545.961

Jestha	2354.1365	3960.7646	4658.837	45.25167	20.49239168	3548.559
Asar	2592.9132	4081.274	5804.777	79.0802	17.98762609	4430.88

Table: Energy and capacity surplus/Deficit for F/Y 2087/088 under 7.2 % economic growth rate

Months	RoR (MW)	PRoR (MW)	Storage (MW)	Total (MW)	Total (after 25% loss) (MW)	Energy Surplus (GWh)	Capacity surplus (MW)
Shrawan	7186.156	2423.03	225.86	9,835.05	7,376.28	2196.100	3,808.90
Bhadra	7186.156	2423.03	225.86	9,835.05	7,376.28	2364.620	3,686.39
Ashwin	7186.156	2423.03	227.98	9,837.17	7,377.87	2564.690	3,606.47
Kartik	6754.987	2423.03	238.58	9,416.60	7,062.45	2633.787	3,549.04
Mangsir	4599.14	2423.03	238.58	7,260.75	5,445.56	1616.690	1,827.83
Poush	3320.004	2059.576	240.7	5,620.28	4,215.21	631.233	239.68
Magh	2529.527	1938.424	219.5	4,687.45	3,515.59	156.185	(487.17)
Falgun	2206.15	1938.424	233.28	4,377.85	3,283.39	27.020	(450.04)
Chaitra	2242.081	1938.424	214.2	4,394.70	3,296.03	-46.544	(670.18)
Baisakh	3736.801	1938.424	238.58	5,913.81	4,435.35	314.856	425.85
Jestha	6467.54	2059.576	240.7	8,767.82	6,575.86	1194.423	2,615.10
Asar	7186.156	2423.03	241.76	9,850.95	7,388.21	1837.967	3,306.94

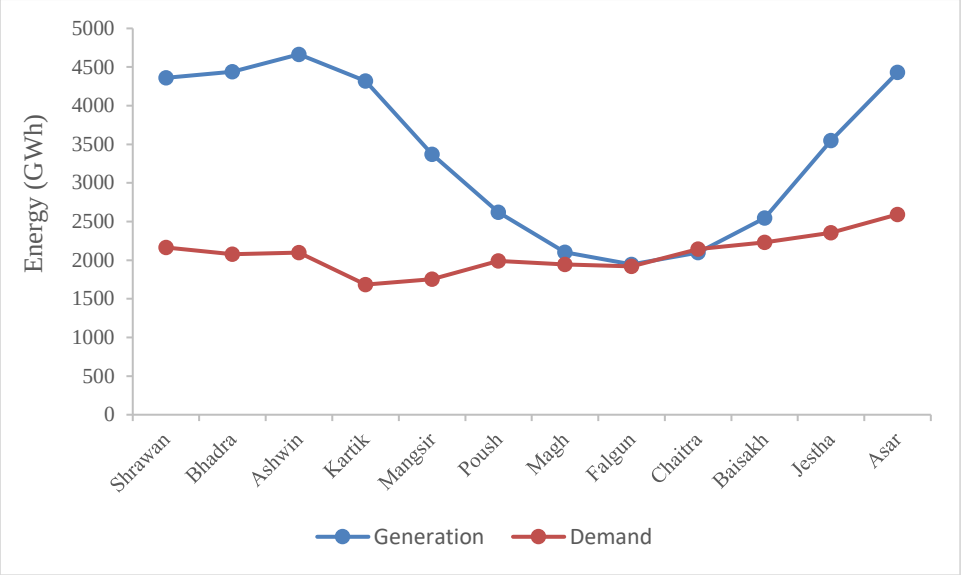


Figure: Energy Demand Generation for F/Y 2087/088 under 7.2 % economic growth rate

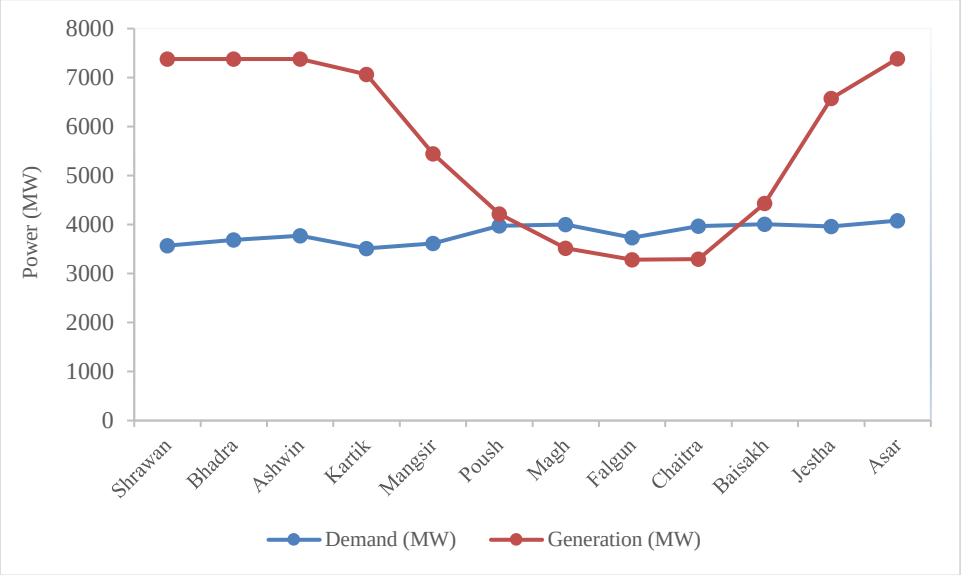


Figure: Monthly peak power demand and Generation for F/Y 2087/088 under 7.2 % economic growth rate

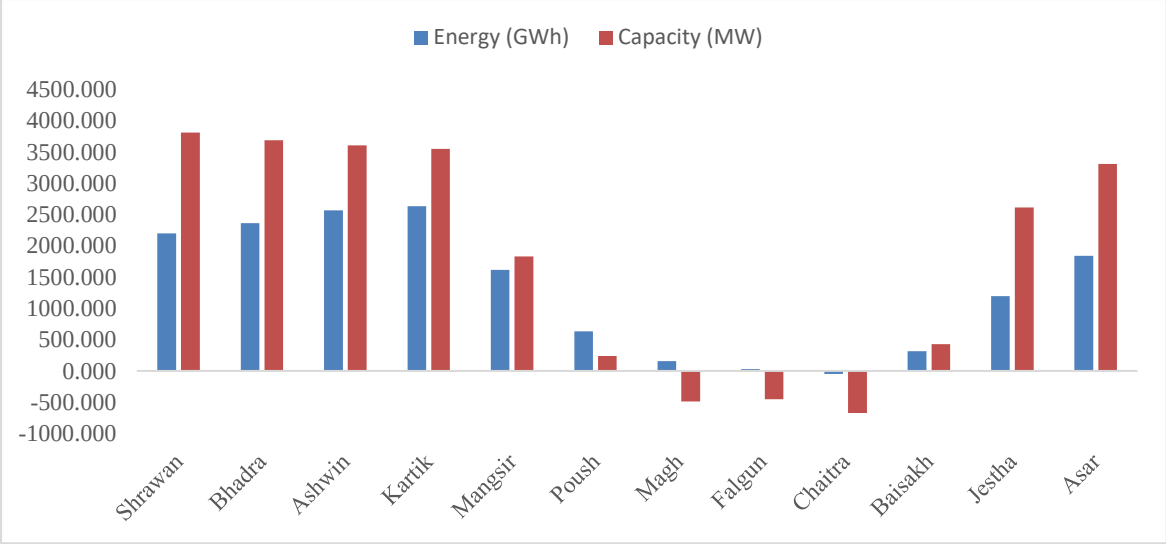


Figure: Power and Energy Surplus/Deficit for F/Y 2087/88 under 7.2 % economic growth rate

Table: Estimated demand and generation for F/Y 2092/093 under 4.5 % economic growth rate

Months	Energy Demand (GWh)	Peak Demand (MW)	Energy from P/RoR (GWh)	Energy from Storage (GWh)	Energy Generation from solar (GWh)	Total Energy Generation (after 25% loss) (GWh)
Shrawan	2581.6225	4251.7386	9879.041	136.2557	18.372	7511.102
Bhadra	2474.876	4397.76	10069.11	74.47316	18.694	7650.639
Ashwin	2503.0448	4494.9035	10645.51	80.09702	19.367	8058.035
Kartik	2007.3626	4187.4124	9900.471	79.96508	19.405	7473.878
Mangsir	2090.1712	4311.7504	7709.266	105.6113	18.108	5828.062
Poush	2370.8017	4738.1797	5962.739	210.9459	17.572	4521.601
Magh	2318.8341	4770.635	4757.513	279.1524	17.732	3618.996
Falgun	2287.3808	4449.6441	4377.481	370.3313	21.984	3342.736
Chaitra	2555.4021	4727.0736	4712.843	469.3907	24.108	3601.079
Baisakh	2659.1146	4778.6793	5750.444	465.6466	24.756	4380.119
Jestha	2805.7483	4720.5881	8099.238	236.9005	22.441	6130.809
Asar	3090.3314	4864.2157	10091.42	156.3587	19.698	7647.571

Table: Energy and capacity surplus/Deficit for F/Y 2092/093 under BAU

Months	RoR (MW)	PRoR (MW)	Storage (MW)	Total (MW)	Total (after 25% loss)	Energy Surplus(GWh)	Capacity surplus (MW)
Shrawan	13345.097	3360.163	225.86	16,931.12	12,698.34	4929.48	8446.60
Bhadra	13345.097	3360.163	225.86	16,931.12	12,698.34	5175.76	8300.58
Ashwin	13345.097	3360.163	227.98	16,933.24	12,699.93	5554.99	8205.03
Kartik	12544.39118	3360.163	238.58	16,143.13	12,107.35	5466.52	7919.94
Mangsir	8540.86208	3360.163	238.58	12,139.61	9,104.70	3737.89	4792.95
Poush	6165.434814	2856.13855	240.7	9,262.27	6,946.71	2150.80	2208.53
Magh	4697.474144	2688.1304	219.5	7,605.10	5,703.83	1300.16	933.19
Falgun	4096.944779	2688.1304	233.28	7,018.36	5,263.77	1055.36	814.12
Chaitra	4163.670264	2688.1304	214.2	7,066.00	5,299.50	1045.68	572.43
Baisakh	6939.45044	2688.1304	238.58	9,866.16	7,399.62	1721.00	2620.94
Jestha	12010.5873	2856.13855	240.7	15,107.43	11,330.57	3325.06	6609.98
Asar	13345.097	3360.163	241.76	16,947.02	12,710.27	4557.24	7846.05

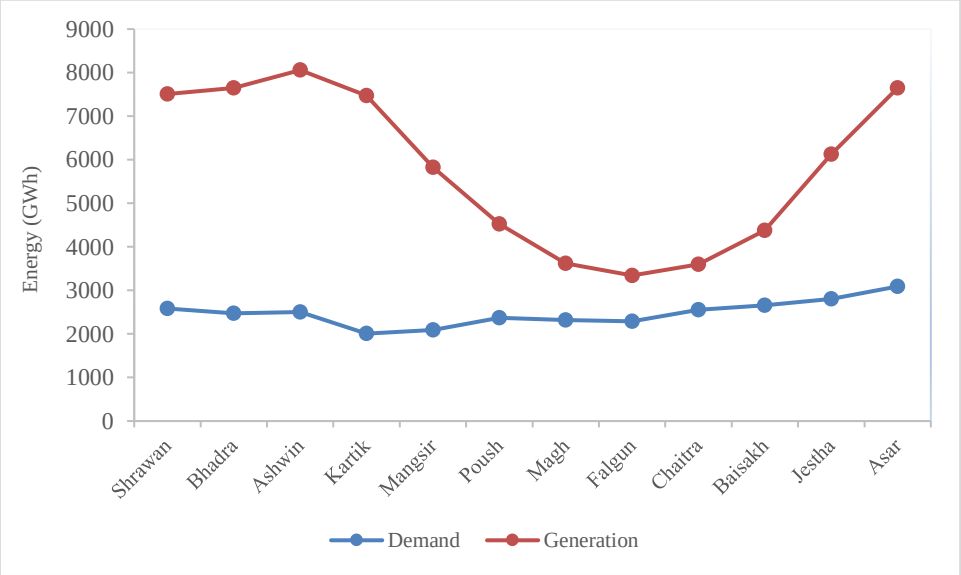


Figure: Energy Demand and Generation for F/Y 2092/093 under BAU

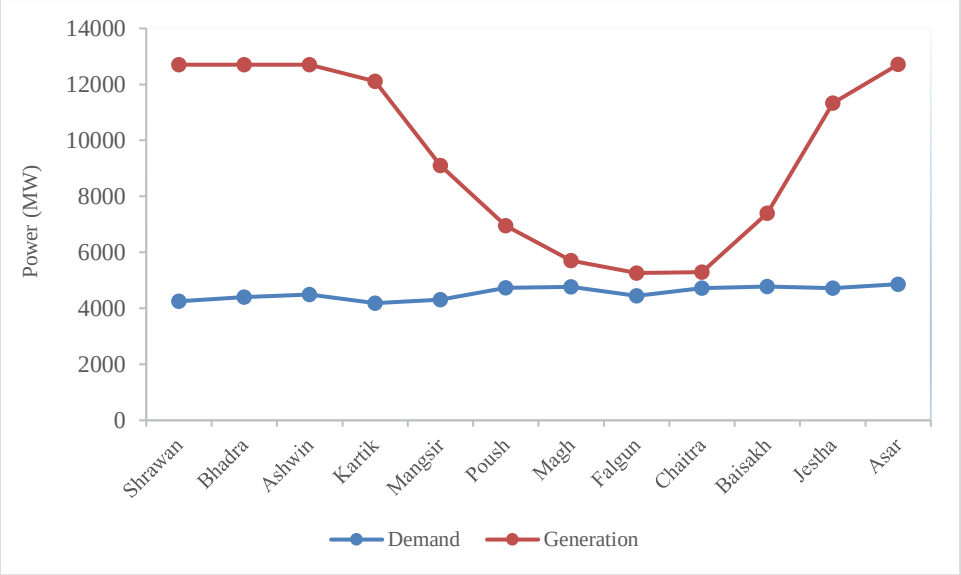


Figure: Monthly peak power demand and Generation for F/Y 2092/093 under BAU

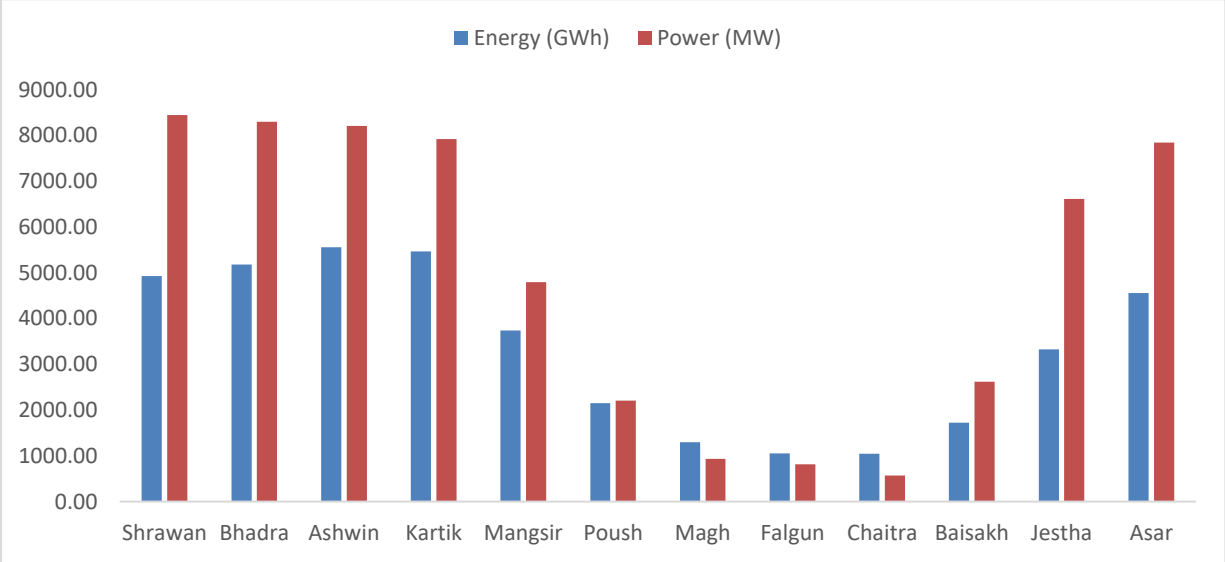


Figure: Power and Energy Surplus/Deficit for F/Y 2092/093 under BAU

Table: Estimated demand and Generation for F/Y 2092/093 under 7.2 % economic growth rate

Months	Energy Demand (GWh)	Peak Demand (MW)	Energy from P/RoR(GWh)	Energy from Storage (GWh)	Energy Generation from solar (GWh)	Total Energy Generation (after 25% loss) (GWh)
Shrawan	3533.31	5819.09	9879.041	136.255	18.372	7511.102

Bhadra	3387.21	6018.94	10069.111	74.473	18.694	7650.639
Ashwin	3425.76	6151.90	10645.510	80.097	19.367	8058.034
Kartik	2747.35	5731.05	9900.470	79.965	19.405	7473.877
Mangsir	2860.69	5901.23	7709.265	105.611	18.108	5828.061
Poush	3244.77	6484.8618	5962.739	210.945	17.572	4521.600
Magh	3173.64	6529.281	4757.513	279.152	17.732	3618.995
Falgun	3130.60	6089.960	4377.481	370.331	21.984	3342.736
Chaitra	3497.42	6469.661	4712.842	469.390	24.107	3601.078
Baisakh	3639.37	6540.291	5750.443	465.646	24.756	4380.119
Jestha	3840.05	6460.785	8099.238	236.900	22.441	6130.808
Asar	4229.55	6657.359	10091.417	156.358	19.698	7647.571

Table: Energy and Capacity Surplus / Deficit for F/Y 2092/093 under 7.2 % economic growth rate

Months	RoR (MW)	PRoR (MW)	Storage (MW)	Total (MW)	Total (after 25% loss) (MW)	Energy Surplus (GWh)	Capacity surplus (MW)
Shrawan	13345.097	3360.163	225.86	16,931.12	12,698.34	3977.79	6,879.24
Bhadra	13345.097	3360.163	225.86	16,931.12	12,698.34	4263.43	6,679.39
Ashwin	13345.097	3360.163	227.98	16,933.24	12,699.93	4632.27	6,548.03
Kartik	12544.39118	3360.163	238.58	16,143.13	12,107.35	4726.52	6,376.29
Mangsir	8540.86208	3360.163	238.58	12,139.61	9,104.70	2967.37	3,203.47
Poush	6165.434814	2856.13855	240.7	9,262.27	6,946.71	1276.83	461.84
Magh	4697.474144	2688.1304	219.5	7,605.10	5,703.83	445.35	(825.45)
Falgun	4096.944779	2688.1304	233.28	7,018.36	5,263.77	212.14	(826.19)
Chaitra	4163.670264	2688.1304	214.2	7,066.00	5,299.50	103.65	(1,170.16)
Baisakh	6939.45044	2688.1304	238.58	9,866.16	7,399.62	740.75	859.33
Jestha	12010.5873	2856.13855	240.7	15,107.43	11,330.57	2290.75	4,869.78

Asar	13345.097	3360.163	241.76	16,947.02	12,710.27	3418.02	6,052.91

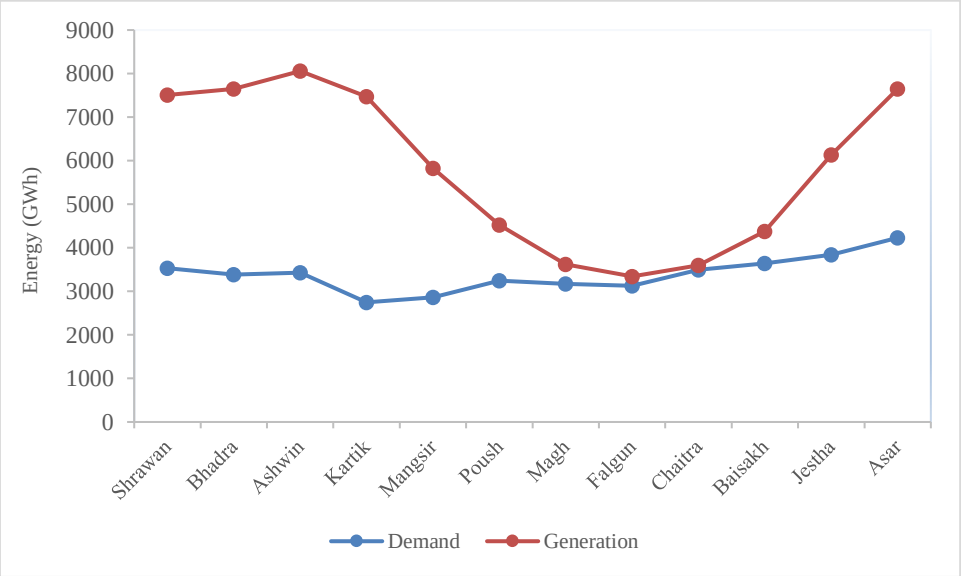


Figure: Energy Demand and Generation for F/Y 2092/093 under 7.2 % economic growth rate

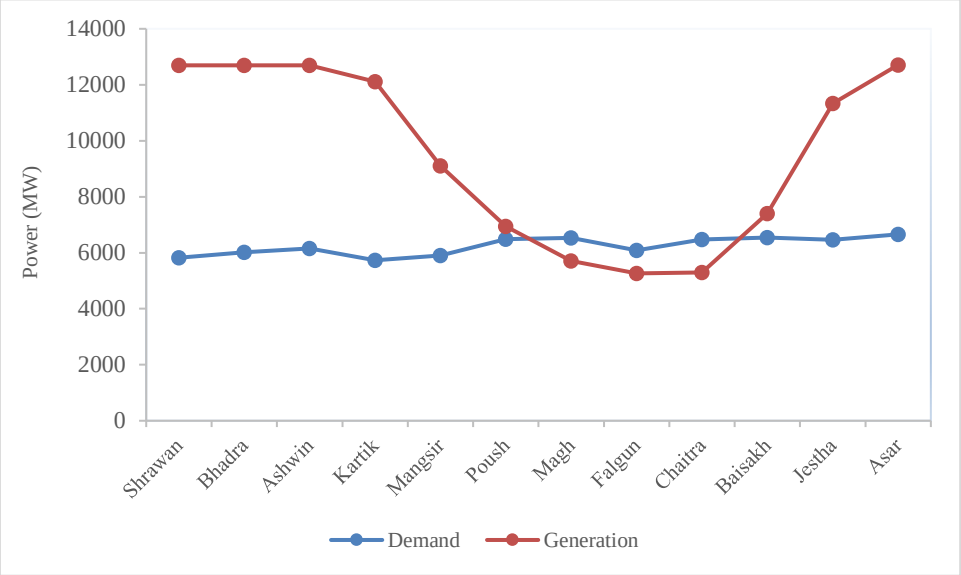


Figure: Monthly peak power demand and Generation for F/Y 2092/093 under 7.2 % economic growth rate

Table: Estimated demand and Generation for F/Y 2087/088 considering CA completed projects

Months	Energy Demand (GWh)	Peak Demand (MW)	Energy from P/RoR(GWh)	Energy from Storage (GWh)	Energy Generation from solar (GWh)	Total Energy Generation (after 25% loss) (GWh)
Shrawan	2166.0859	3567.3809	5644.06	111.26	16.77717	4333.27
Bhadra	2076.5212	3689.8988	5752.66	106.82	17.07084	4411.67
Ashwin	2100.156	3771.4061	6081.96	72.71	17.68594	4633.69
Kartik	1684.2586	3513.4086	5656.31	38.83	17.72074	4289.07
Mangsir	1753.7383	3617.7333	4404.44	37.34	16.536	3347.87
Poush	1989.1987	3975.5247	3406.61	42.63	16.04689	2602.98
Magh	1945.5957	4002.7561	2718.05	44.17	16.19312	2087.86
Falgun	1919.2051	3733.4317	2500.93	50.19	20.07545	1933.41
Chaitra	2144.0859	3966.2062	2692.53	56.45	22.01448	2083.75
Baisakh	2231.1049	4009.5055	3285.33	56.71	22.60652	2529.13
Jestha	2354.1365	3960.7646	4627.23	45.25	20.49239	3524.86
Asar	2592.9132	4081.274	5765.40	79.08	17.98763	4401.35

Table: Energy and Capacity Surplus/ Deficit for F/Y 2087/088 Considering CA complected projects

Months	RoR (MW)	PRoR (MW)	Storage (MW)	Total (MW)	Total (after 20% loss) (MW)	Energy Surplus (GWh)	Capacity surplus (MW)
Shrawan	5250	4294	225.86	9,769.86	7,327.40	2,150.41	3,760.01
Bhadra	5250	4294	225.86	9,769.86	7,327.40	2,318.08	3,637.50
Ashwin	5250	4294	227.98	9,771.98	7,328.99	2,515.85	3,557.58
Kartik	4935	4294	238.58	9,467.58	7,100.69	2,587.09	3,587.28
Mangsir	3360	4294	238.58	7,892.58	5,919.44	1,577.59	2,301.70

Poush	2425.5	3649.9	240.7	6,316.10	4,737.08	597.74	761.55
Magh	1848	3435.2	219.5	5,502.70	4,127.03	126.07	124.27
Falgun	1611.75	3435.2	233.28	5,280.23	3,960.17	(5.87)	226.74
Chaitra	1638	3435.2	214.2	5,287.40	3,965.55	(82.35)	(0.66)
Baisakh	2730	3435.2	238.58	6,403.78	4,802.84	275.42	793.33
Jestha	4725	3649.9	240.7	8,615.60	6,461.70	1,150.23	2,500.94
Asar	5250	4294	241.76	9,785.76	7,339.32	1,790.45	3,258.05

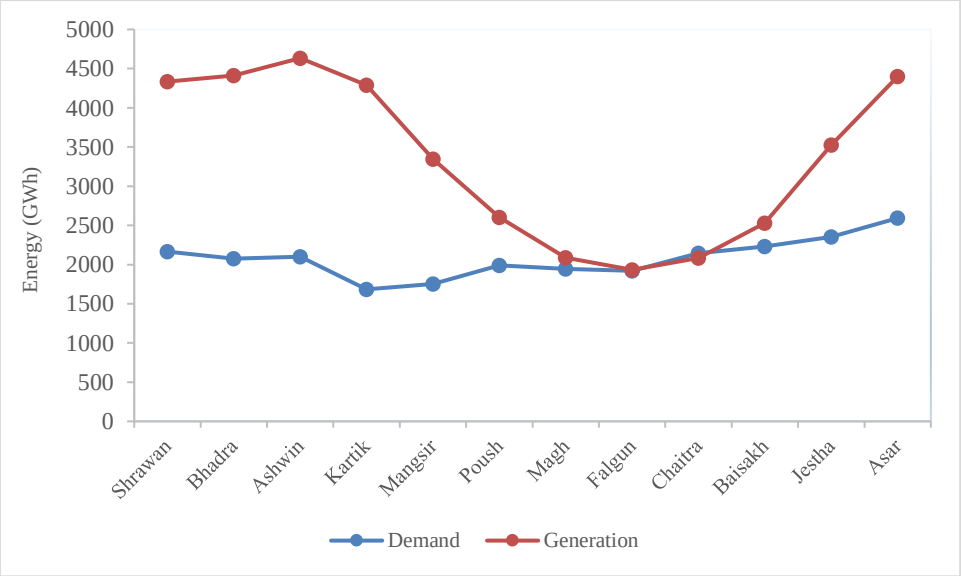


Figure: Energy Demand and Generation for F/Y 2087/088 considering CA completed projects

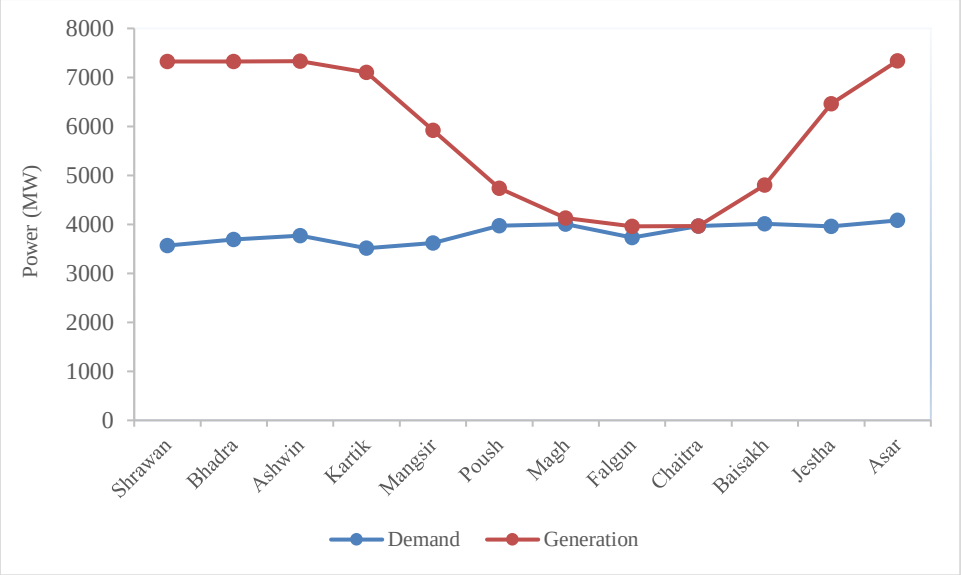


Figure: Monthly peak power demand and Generation for F/Y 2087/088 considering CA completed projects

Table: Estimated demand and Generation for F/Y 2087/088 under BAU when only half of estimated projects comes in operation

Months	Energy Demand (GWh)	Peak Demand (MW)	Energy from P/RoR (GWh)	Energy from Storage (GWh)	Energy Generation from solar (GWh)	Total Energy Generation (after 25% loss) (GWh)
Shrawan	1742.2623	2869.3753	3703.985288	111.2647442	16.777	2878.21469
Bhadra	1670.2222	2967.9209	3775.248991	106.8150659	17.0708	2928.618878
Ashwin	1689.2325	3033.4802	3991.360177	72.71245531	17.685	3065.740417
Kartik	1354.7109	2825.9634	3712.019834	38.8254281	17.720	2830.854689
Mangsir	1410.596	2909.8755	2890.463393	37.33832768	16.535	2212.38729
Poush	1599.9854	3197.6603	2235.631711	42.63161896	16.046	1724.744388
Magh	1564.914	3219.5635	1783.751953	44.17043899	16.193	1387.134909
Falgun	1543.687	3002.9359	1641.265198	50.18780238	20.075	1288.665199
Chaitra	1724.5669	3190.1651	1767.003526	56.45160469	22.014	1389.605828
Baisakh	1794.5594	3224.9923	2156.034917	56.70716843	22.606	1682.163084
Jestha	1893.5183	3185.7882	3036.677161	45.2516676	20.492	2331.939013

Asar	2085.5752	3282.7183	3783.612095	79.08019675	17.987	2915.006845

Table: Energy and Capacity Surplus/ Deficit for F/Y 2087/088 under BAU when only half of estimated projects comes in operation

Months	RoR (MW)	PRoR (MW)	Storage (MW)	Total (MW)	Total (after 25% loss) (MW)	Energy Surplus (GWh)	Capacity surplus (MW)
Shrawan	4663.2995	1600.065	225.86	6,489.22	4,866.92	1,135.95	1,997.54
Bhadra	4663.2995	1600.065	225.86	6,489.22	4,866.92	1,258.40	1,899.00
Ashwin	4663.2995	1600.065	227.98	6,491.34	4,868.51	1,376.51	1,835.03
Kartik	4383.50153	1600.065	238.58	6,222.15	4,666.61	1,476.14	1,840.65
Mangsir	2984.51168	1600.065	238.58	4,823.16	3,617.37	801.79	707.49
Poush	2154.444369	1360.05525	240.7	3,755.20	2,816.40	124.76	(381.26)
Magh	1641.481424	1280.052	219.5	3,141.03	2,355.78	(177.78)	(863.79)
Falgun	1431.632947	1280.052	233.28	2,944.96	2,208.72	(255.02)	(794.21)
Chaitra	1454.949444	1280.052	214.2	2,949.20	2,211.90	(334.96)	(978.26)
Baisakh	2424.91574	1280.052	238.58	3,943.55	2,957.66	(112.40)	(267.33)
Jestha	4196.96955	1360.05525	240.7	5,797.72	4,348.29	438.42	1,162.51
Asar	4663.2995	1600.065	241.76	6,505.12	4,878.84	829.43	1,596.13

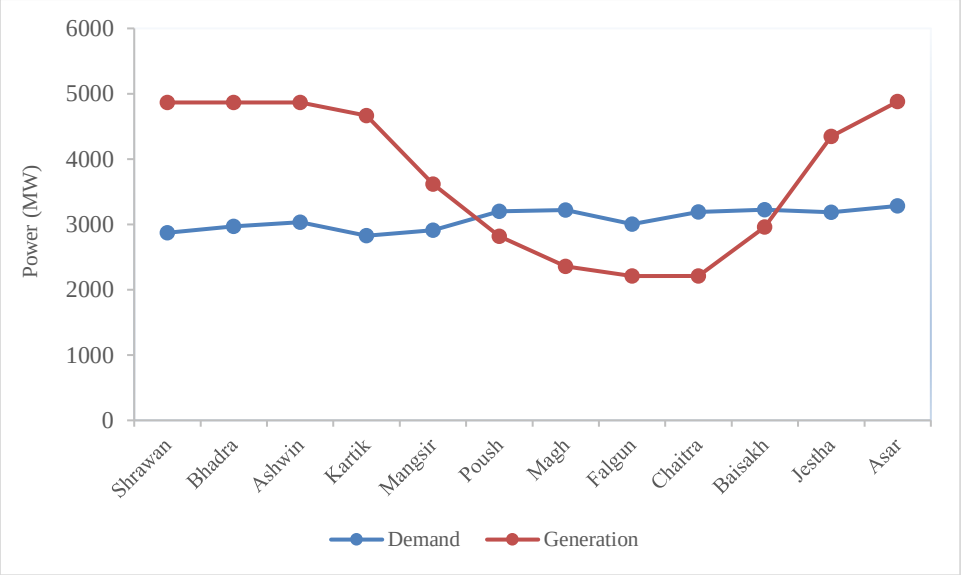


Figure: Mothly peak power demand and generation for F/Y 2087/088 under BAU when only half of estimated projects comes in operation

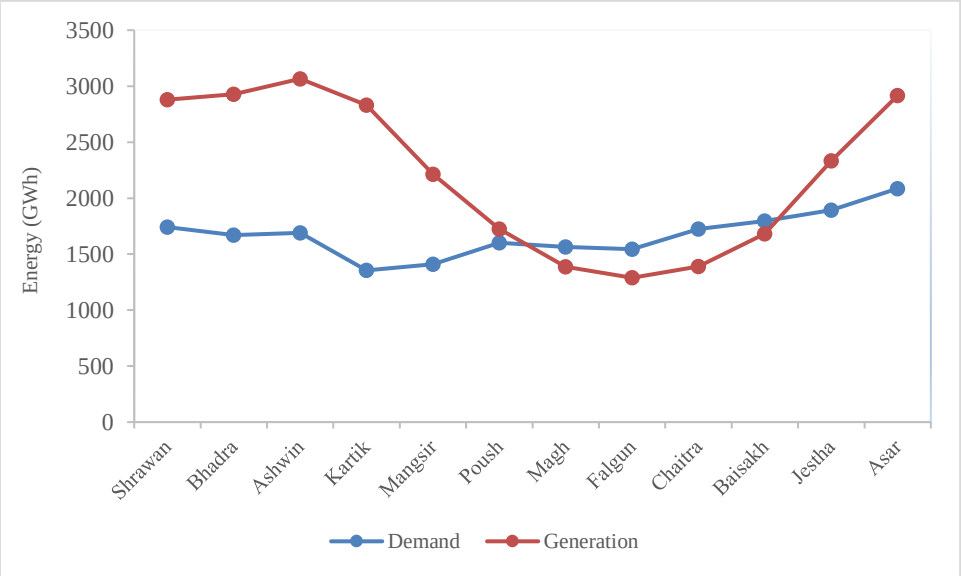


Figure: Energy demand and Generation for F/Y 2087/088 under BAU when only half of estimated projects comes in operation

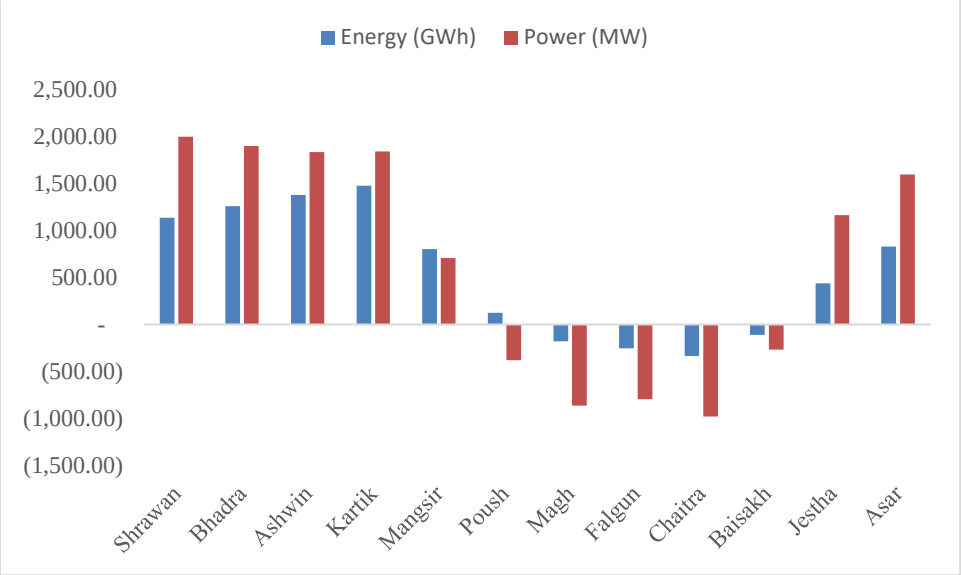


Figure: Power and Energy surplus / Deficit for F/Y 2087/088 under BAU when only half of estimated projects comes in operation

Table: Estimated demand and Generation for F/Y 2092/93 under BAU when only half of estimated projects comes in operation

Months	Energy Demand (GWh)	Peak Demand (MW)	Energy from P/RoR (GWh)	Energy from Storage (GWh)	Energy Generation from solar (GWh)	Total Energy Generation (after 25% loss) (GWh)
Shrawan	2581.6225	4251.7386	5,536.08	111.2647442	18.373	4253.882
Bhadra	2474.876	4397.76	5,642.59	106.8150659	18.694	4330.75079
Ashwin	2503.0448	4494.9035	5,965.60	72.71245531	19.368	4548.101844
Kartik	2007.3626	4187.4124	5,548.09	38.8254281	19.406	4209.592207
Mangsir	2090.1712	4311.7504	4,320.17	37.33832768	18.108	3286.23838
Poush	2370.8017	4738.1797	3,341.44	42.63161896	17.573	2555.625283
Magh	2318.8341	4770.635	2,666.05	44.17043899	17.733	2050.39534
Falgun	2287.3808	4449.6441	2,453.08	50.18780238	21.984	1899.436332
Chaitra	2555.4021	4727.0736	2,641.01	56.45160469	24.108	2047.206647
Baisakh	2659.1146	4778.6793	3,222.47	56.70716843	24.756	2484.139638
Jestha	2805.7483	4720.5881	4,538.70	45.2516676	22.441	3460.407425

Asar	3090.3314	4864.2157	5,655.09	79.08019675	19.698	4320.328408

Table: Energy and Capacity Surplus/ Deficit for F/Y 2092/093 under BAU when only half of estimated projects comes in operation

Months	RoR (MW)	PRoR (MW)	Storage (MW)	Total (MW)	Total (after 25% loss)	Energy Surplus(GWh)	Capacity surplus (MW)
Shrawan	7,292.77	2,068.63	225.86	9,587.26	7,190.45	1672.26	2938.71
Bhadra	7,292.77	2,068.63	225.86	9,587.26	7,190.45	1855.87	2792.69
Ashwin	7,292.77	2,068.63	227.98	9,589.38	7,192.04	2045.06	2697.13
Kartik	6,855.20	2,068.63	238.58	9,162.42	6,871.81	2202.23	2684.40
Mangsir	4,667.37	2,068.63	238.58	6,974.58	5,230.94	1196.07	919.19
Poush	3,369.26	1,758.34	240.7	5,368.30	4,026.22	184.82	-711.96
Magh	2,567.06	1,654.91	219.5	4,441.46	3,331.10	-268.44	-1439.54
Falgun	2,238.88	1,654.91	233.28	4,127.07	3,095.30	-387.94	-1354.34
Chaitra	2,275.34	1,654.91	214.2	4,144.45	3,108.34	-508.20	-1618.74
Baisakh	3,792.24	1,654.91	238.58	5,685.73	4,264.29	-174.97	-514.39
Jestha	6,563.49	1,758.34	240.7	8,562.53	6,421.90	654.66	1701.31
Asar	7,292.77	2,068.63	241.76	9,603.16	7,202.37	1230.00	2338.16

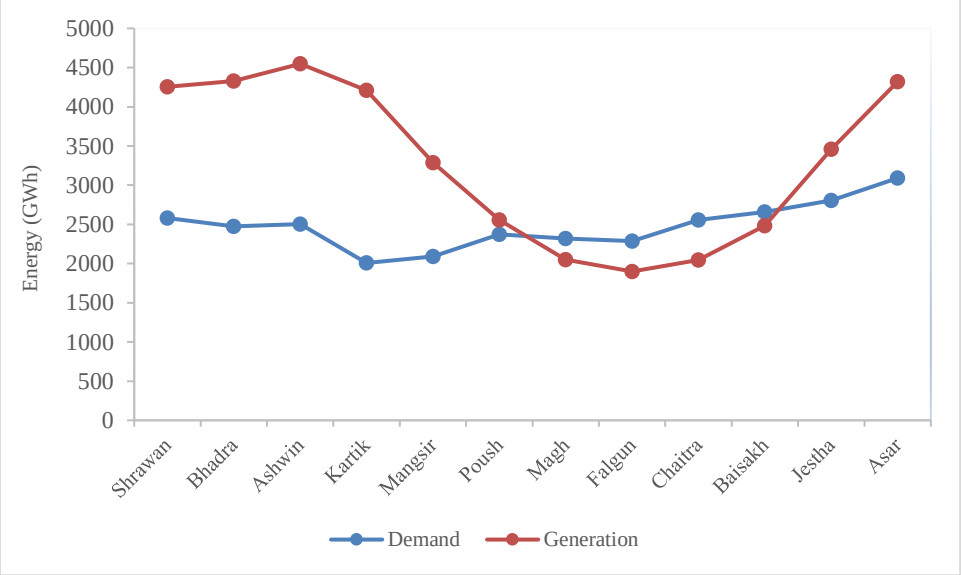


Figure: Energy demand and Generation for F/Y 2092/093 under BAU when only half of estimated projects comes in operation

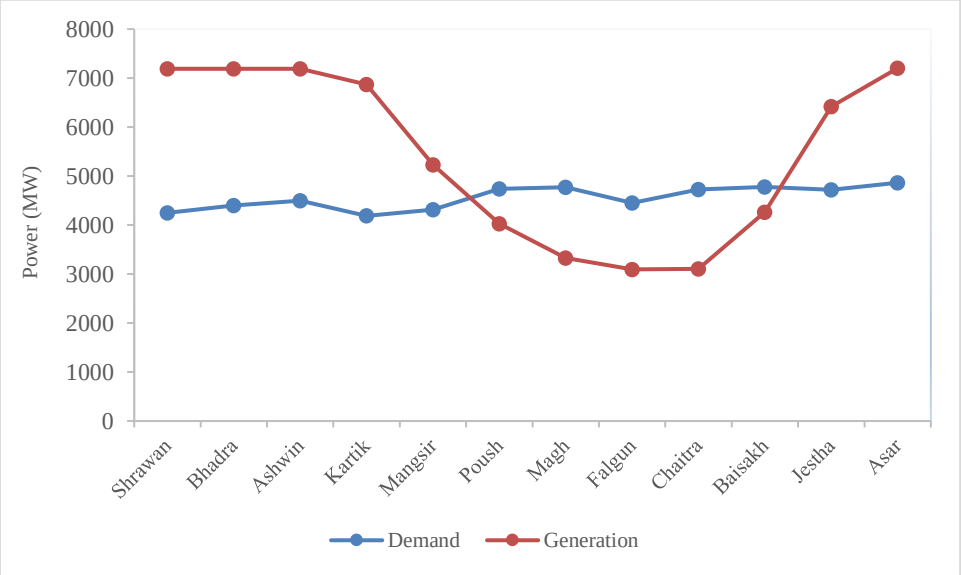


Figure: Monthly peak power demand and generation for F/Y 2092/093 under BAU when only half of estimated projects comes in operation

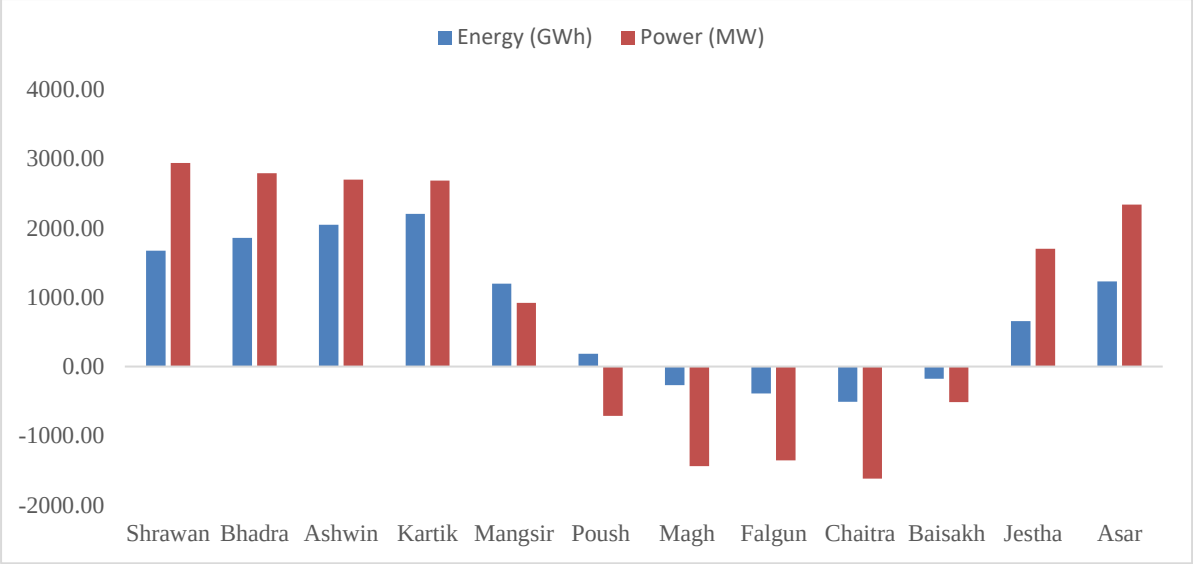


Figure: Power and energy Surplus/ Deficit for F/Y 2092/093 under BAU when only half of estimated projects comes in operation

Annex 8: Available capacity at different zone for F/Y 2092/093

Demand and Generation for fiscal year 2092/093 under scenario 2

Zone	Estimated Load for 2035 AD (MW)	Estimated generation capacity (MW)	Supply/demand gap (MW)	Available point in South for trading
1	291.2282438	1952.4675	1661.239256	Dododhara
2	176.2853991	236.04	59.75460087	
3	813.334775	3082.4535	2269.118725	Butwal
4	1531.975704	4004.8365	2472.860796	Dhalkebar
5	469.8958781	2273.31375	1803.417872	Anarmani

Demand and Generation for fiscal year 2092/093 under scenario 3

Zone	Estimated Load for 2035 AD (MW)	Estimated generation capacity (MW)	Supply/demand gap (MW)	Available point in South for trading
1	362.1367925	1952.4675	1590.331	Dododhara
2	219.2075472	236.04	16.832	
3	1011.366352	3082.4535	2071.087	Butwal
4	1904.982704	4004.8365	2099.854	Dhalkebar
5	584.3066038	2273.31375	1689.007	Anarmani

Annex 9: Energy Trading rate

Weeks	Months	Weighted MCP (Rs/MWh)	Buying Rate (20% above MCP (Rs/MWh))	Selling Rate (20% below MCP (Rs/MWh))
1	Baisakh	11189.22	13427.064	8951.376
2	Baisakh	11993.09	14391.708	9594.472
3	Baisakh	10444.88	12533.856	8355.904
4	Baisakh	5506.32	6607.584	4405.056
5	Jestha	5945.23	7134.276	4756.184
6	Jestha	5490.11	6588.132	4392.088
7	Jestha	7401.23	8881.476	5920.984
8	Jestha	7484.92	8981.904	5987.936
9	Jestha	7779.75	9335.7	6223.8
10	Asar	5033.35	6040.02	4026.68
11	Asar	5496.14	6595.368	4396.912
12	Asar	5778.68	6934.416	4622.944
13	Asar	5086.13	6103.356	4068.904
14	Shrawan	5657.01	6788.412	4525.608
15	Shrawan	5938.12	7125.744	4750.496
16	Shrawan	5962.45	7154.94	4769.96
17	Shrawan	3734.06	4480.872	2987.248
18	Shrawan	4812.86	5775.432	3850.288
19	Bhadra	5790.39	6948.468	4632.312
20	Bhadra	7521.21	9025.452	6016.968
21	Bhadra	7453.72	8944.464	5962.976
22	Bhadra	4298.96	5158.752	3439.168
23	Ashwin	4503.07	5403.684	3602.456
24	Ashwin	5163.76	6196.512	4131.008
25	Ashwin	3754.55	4505.46	3003.64
26	Ashwin	3844.23	4613.076	3075.384
27	Ashwin	4329.12	5194.944	3463.296
28	Kartik	3697.22	4436.664	2957.776
29	Kartik	4731.09	5677.308	3784.872
30	Kartik	4692.2	5630.64	3753.76
31	Kartik	4740.26	5688.312	3792.208
32	Mangsir	5017.6	6021.12	4014.08
33	Mangsir	4898.35	5878.02	3918.68
34	Mangsir	5076.38	6091.656	4061.104
35	Mangsir	4949.33	5939.196	3959.464
36	Poush	6073.69	7288.428	4858.952
37	Poush	5853.1	7023.72	4682.48
38	Poush	3526.18	4231.416	2820.944
39	Poush	3243.54	3892.248	2594.832
40	Magh	3774.83	4529.796	3019.864
41	Magh	3818.31	4581.972	3054.648
42	Magh	4515.26	5418.312	3612.208
43	Magh	4026.78	4832.136	3221.424
44	Falgun	4413.83	5296.596	3531.064

45	Falgun	5355.46	6426.552	4284.368
46	Falgun	4243.56	5092.272	3394.848
47	Falgun	6217.35	7460.82	4973.88
48	Chaitra	7271.67	8726.004	5817.336
49	Chaitra	12683.09	15219.708	10146.472
50	Chaitra	10244.58	12293.496	8195.664
51	Chaitra	7849.52	9419.424	6279.616
52	Chaitra	9682.88	11619.456	7746.304

Annex 10: Monthly Capacity and Energy from storage Project

Projects	**Budi Gandaki HPP**		**Nalgad Storage HPP**		**Tamor Storage HPP**	
Months	Power (MW)	Energy (GWh)	Power (MW)	Energy (GWh)	Power (MW)	Energy (GWh)
Shrawan	1150	376	417.00	92.79	726.00	535.74
Bhadra	1200	678	417.00	178.15	726.00	531.35
Ashwin	1150	517	417.00	150.19	726.00	455.86
Kartik	1200	277	417.00	77.09	726.00	270.13
Mangsir	950	157	417.00	82.77	726.00	141.94
Poush	1200	337	417.00	118.27	726.00	148.70
Magh	1195	337	417.00	109.31	726.00	137.82
Falgun	1140	334	417.00	112.09	726.00	140.28
Chaitra	1060	334	417.00	113.52	726.00	131.86
Baisakh	970	281	417.00	114.67	726.00	258.76
Jestha	950	269	417.00	63.60	726.00	409.50
Asar	1000	352	417.00	19.30	726.00	483.67

Annex 11: Plagiarism Test report

Energy mix of Nepalese grid and its effect on power system (Final Thesis for plagiarism test 1).pdf

ORIGINALITY REPORT

10%
SIMILARITY INDEX

PRIMARY SOURCES

1	www.nea.org.np Internet	173 words —	1%
2	irade.org Internet	154 words —	1%
3	www.moen.gov.np Internet	150 words —	1%
4	www.researchgate.net Internet	106 words —	1%
5	Khem Gyanwali, Ryoichi Komiyama, Yasumasa Fujii. "Representing hydropower in the dynamic power sector model and assessing clean energy deployment in the power generation mix of Nepal", Energy, 2020 Crossref	75 words —	1%
6	Wojciech Lyzwa, Michal Wierzbowski. "Load duration curve in the long-term energy mix optimization", 2016 13th International Conference on the European Energy Market (EEM), 2016 Crossref	54 words —	< 1%
7	Jorge Sousa, Ana Martins. "Optimal renewable generation mix of hydro, wind and photovoltaic for integration into the Portuguese power system", 2013 10th	48 words —	< 1%

International Conference on the European Energy Market (EEM), 2013
Crossref

8 Umesh Kumar Shukla, Seema Sharma. "The potential of electricity imports to meet future electricity requirements in India", The Electricity Journal, 2017 — 41 words — < 1%
Crossref

9 Khem Gyanwali, Aadya Bhattarai, Tri Ratna Bajracharya, Ryoichi Komiyama, Yasumasa Fujii. "Assessing green energy growth in Nepal with a hydropower-hydrogen integrated power grid model", International Journal of Hydrogen Energy, 2022 — 35 words — < 1%
Crossref

10 file.scirp.org — 35 words — < 1%
Internet

11 engineeringnotesonline.com — 30 words — < 1%
Internet

12 N.K. Das, J. Chakrabartty, Mrinmoy Dey, A.K. Sen Gupta, M.A. Matin. "Present energy scenario and future energy mix of Bangladesh", Energy Strategy Reviews, 2020 — 27 words — < 1%
Crossref

13 www.undp.org — 20 words — < 1%
Internet

14 Naito, Y.. "Evaluating replacement project of nuclear power plants under uncertainty", Energy Policy, 201003 — 18 words — < 1%
Crossref

15 openknowledge.worldbank.org — 18 words — < 1%
Internet

16	www.erb.org.zm Internet	17 words — < 1%
17	www.unido.org Internet	17 words — < 1%
18	Ceylan, H.. "Estimating energy demand of Turkey based on economic indicators using genetic algorithm approach", Energy Conversion and Management, 200409 Crossref	16 words — < 1%
19	mdpi-res.com Internet	16 words — < 1%
20	www.theses.fr Internet	16 words — < 1%
21	www-wds.worldbank.org Internet	15 words — < 1%
22	Ramchandra Bhandari, Surendra Pandit. "Electricity as a Cooking Means in Nepal—A Modelling Tool Approach", Sustainability, 2018 Crossref	14 words — < 1%
23	jultika.oulu.fi Internet	13 words — < 1%
24	pubs.usgs.gov Internet	13 words — < 1%
25	researchrepository.murdoch.edu.au Internet	13 words — < 1%

26	Corinna Maria Grottola, Paola Giudicianni, Fernando Stanzione, Raffaele Ragucci. "Influence of Pyrolysis Temperature on Biochar Produced from Lignin–Rich Biorefinery Residue", ChemEngineering, 2022 Crossref	12 words —	< 1%
27	Durga Prasad Sangroula, Hari Shankar Shrestha, Pawan Kumar Bhattarai. "Hydropower Development in Nepal: Opportunities and Challenges", Elsevier BV, 2022 Crossref	12 words —	< 1%
28	cmuir.cmu.ac.th Internet	11 words —	< 1%
29	urjanews.com Internet	11 words —	< 1%
30	Deependra Neupane, Sagar Kafle, Kaji Ram Karki, Dae Hyun Kim, Prajal Pradhan. "Solar and wind energy potential assessment at provincial level in Nepal: Geospatial and economic analysis", Renewable Energy, 2021 Crossref	10 words —	< 1%
31	Jeevan Kutu, Sher Bahadur Gurung, Narendra Raj Khanal, Hridaya Lal Koirala et al. "Socio-economic Impact and Adapting Strategies of Inter Basin Transfer by Kulekhani Hydro-electricity Project Nepal", NUTA Journal, 2022 Crossref	10 words —	< 1%
32	jctjournal.com Internet	10 words —	< 1%
33	Khem Gyanwali, Padam Adhikari, Sonu Khanal, Nawraj Bhattarai, Tri Ratna Bajracharya, Ryoichi Komiyama, Yasumasa Fujii. "Integrating glacio-hydrological and power grid models to assess the climate-resiliency of high	9 words —	< 1%

mountain hydropower in Nepal", Renewable and Sustainable Energy Reviews, 2023
Crossref

34	fdocuments.us Internet	9 words — < 1%
35	web.nepalnews.com.np Internet	9 words — < 1%
36	www.atlantaga.gov Internet	9 words — < 1%
37	www.mdpi.com Internet	9 words — < 1%
38	Anthony Oliver, Madhu Khanna. "Demand for biomass to meet renewable energy targets in the United States: implications for land use", GCB Bioenergy, 2017 Crossref	8 words — < 1%
39	Ratna Sansar Shrestha, Stephen Biggs, Scott Justice, Amanda Manandhar Gurung. "A Power Paradox: Growth of the Hydro Sector in Nepal", Hydro Nepal: Journal of Water, Energy and Environment, 2018 Crossref	8 words — < 1%
40	jndmeerut.org Internet	8 words — < 1%
41	link.springer.com Internet	8 words — < 1%
42	mediatum.ub.tum.de Internet	8 words — < 1%
43	rd.springer.com Internet	8 words — < 1%

44	uwspace.uwaterloo.ca Internet	8 words — < 1%
45	vbn.aau.dk Internet	8 words — < 1%
46	Khem Gyanwali, Ryoichi Komiyama, Yasumasa Fujii, Tri Ratna Bajracharya. "A review of energy sector in the BBIN sub-region", International Journal of Sustainable Energy, 2020 Crossref	7 words — < 1%
47	Maneesha Naresh, Shashwati Ray, Anirban Guha. "Optimum installed capacity of Coal Based Powei Plants cogitating Environment and Economic Aspects", 2020 First International Conference on Power, Control and Computing Technologies (ICPC2T), 2020 Crossref	7 words — < 1%
48	S.N. Upadhyay, M.R. Tuladhar. "Nepal's power system and privatization", Energy for Sustainable Development, 1997 Crossref	6 words — < 1%

EXCLUDE QUOTES	ON	EXCLUDE SOURCES	OFF
EXCLUDE BIBLIOGRAPHY	ON	EXCLUDE MATCHES	< 6 WORDS