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Assessment on Nepal Power Market & Opportunity for Cross Border Power Trade

by

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A THESIS

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The undersigned certify that they have read, and recommended to the Institute of Engineering for acceptance, a thesis entitled **"Assessment on Nepal Power Market and Opportunity for Cross Border Power Trade"** submitted by Mr. Basanta Raj Raut in partial fulfillment of the requirements for the degree of Master of Science in Energy System Planning and Management.

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ABSTRACT

This thesis presents the exportable energy projections for the decade from FY 2022/23 to FY 2032/33 of Federal Democratic Republic Nepal using numerous indicators. Also, the thesis has presented the current power demand and hydropower generation scenarios along with the electricity export/ import history with the neighboring country India. Also, the present status of hydropower developments in the country has been highlighted in the report. The existing transmission line infrastructure for cross border power trade has also been highlighted in the study along with future plans of the transmission infrastructures. The recent power trade developments with neighboring countries India & Bangladesh along with BIMSTEC region has been detailed in the study.

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LIST OF ABBREBIATIONS

BAU	Business as Usual
BBIN	Bangladesh Bhutan India Nepal
BIMSTEC	Bay of Bengal Initiative for Multi-Sectoral Technical & Economic Cooperation
CERC	Centre of Electricity Regulatory Commission
DoED	Department of Electricity Development
FY	Fiscal Year
GDP	Gross Domestic Product
GoB	Government of Bangladesh
GoI	Government of India
GoN	Government of Nepal
GW	Giga Watt
GWh	Giga Watt-hour
IEX	Indian Energy Exchange
INPS	Integrated Nepal Power System
IoE	Institute of Engineering
IPP	Independent Power Producers
kWh	kilowatt hour
MAED	Model for Energy Demand Analysis
MoU	Memorandum of Understanding
NEA	Nepal Electricity Authority
SAARC	South Asian Association for Regional Cooperation
WECS	Water and Energy Commission Secretariat

CHAPTER ONE: INTRODUCTION

1.1 Background

Nepal has endowed high potential of renewable water resources, possessing about 2.27% of the world's fresh water resources. Most of the rivers flowing from Nepal Himalayas covers 818,500 ha land area equivalent to 5%, out of the total surface area of the country. In total, Nepal possesses 6000 rivers including rivulets and tributaries in totaling of about 45,000 km in length and covering an area of 395,000 ha (48%) and offering dimensional uses including hydropower development. There are 33 rivers having their drainage areas exceeding 1000 km^2 and all the rivers in Nepal comprise the total drainage area of about 194,471 km^2 and the rest in China and India. The annual average discharge of the Nepalese rivers is about 7124 m^3/s including the total basin area and about 5479 m^3/s excluding the area outside of Nepal.

Nepal's technical potential for hydropower has been estimated to be 83 gigawatts (GW). Usually, all the technically potential water resources will not be developed due to other constraints. Hence, about 42 GW is considered economically viable. (Shrestha, 1966)

The gross hydropower potential of Nepal is estimated as 72,544 MW. Similarly, the Techno economical Hydropower potential is estimated as 32,680 MW. (WECS, Assessment of Hydropower Potential of Nepal, 2019)

The total installed generation capacity of Nepal is only 2,684 megawatts (MW) against a peak electricity demand of 2,000 MW in fiscal year 2021–2022.

The load demand exceeding the generation is fulfilled by importing electricity from India (maximum import 846.74 MW, 2078/01/14). (NEA, 2020/21)

In terms of the recent progress in hydropower developments, Nepal is moving towards harnessing hydropower potential of the country. 25 GW capacity hydropower power projects are in various stages of development. 8 GW capacity hydropower projects construction license has already been issued by the government. Among 8 GW, 2.016 GW is already generated. The projects in advanced stage that could be constructed in recent future is around 6 GW.

Table 1.1 Power Projects at various stages of Development, DoED 2022

S.No	Description	Capacity in MW	Remarks
A	Power Plants in Operation		
	< 1 MW projects, 17 nos.	13.232	
	> 1 MW projects, 113 nos.	2,003.612	
	Total Projects in Operation, 130 projects	2,016.844	
B	Power Projects possessing Construction license		
	< 1 MW projects, 24 projects	18.638	
	> 1 MW projects, 220 projects	7,067.532	
	Project under IBN, 1 project	900.000	
	Total projects possessing construction license, 245 projects	7,985.170	
C	Power Projects possessing Survey License		
	< 1 MW projects, 10 projects	10.740	
	> 1 MW projects, 191 projects	14,468.534	
	Projects under IBN, 2 projects	1,100.000	
	Total Projects possessing Survey license, 203 projects	15,578.274	
D	GoN ongoing projects, 2 projects	68.000	
	Total Projects at various stages of development, 575 projects	**25,648.288**	

Source: (DoED, 2022)

1.2 Power Trading present scenario of Hydropower projects in Nepal

Nepal's energy sector, is a vertically integrated, state-owned utility responsible for electricity generation, transmission, and distribution. NEA is the sole off-taker of generation from other parties, including private sector-owned generation.

NEA conducts power purchase agreements with the Independent Power Producers (IPP's) for the purchase & sale of electricity generated from the private owned companies.

As of FY 2022/23, PPA signed having the combined installed capacity of 8,557.27 MW. Among total 8.5 GW power trade agreements, 2.7 GW projects are in operation & 3.5 GW power projects PPA completed projects could be constructed. (NEA, 2020/21)

1.3 Overview on Nepal Cross Border Power Trading Market

Cross border power trading possibilities are evident in various neighboring countries like India, China, Bangladesh & other regional cooperation like SAARC & BIMSTEC.

In recent years, India & Nepal have already started power trading between two countries. India had contributed significantly to end the load shedding in Nepal INPS. In hand, from 2021 A.D, Nepal has also started to export energy to India market which itself is a good sign towards cooperation on cross border power trade.

1.4 Research Objectives

1.1.1 Main Objective

To review the current & future power market of Nepal & analyze the opportunity on cross border trade with neighboring country India, Bangladesh & BIMSTEC states.

1.1.2 Specific Objectives

- To study on current & future power generation scenario of Nepal.
- To formulate Energy Export Table.
- To study on future cross border power trade possibilities with neighboring countries India, Bangladesh & BIMSTEC region states.

1.5 Scope of the work

This thesis focuses on the assessment of Nepal power market and opportunity to cross border power trade with neighboring countries India & Bangladesh & in BIMSTEC

regional states including the formulations of export energy table for upcoming decade. The scope can be summarized as;

i. Formulate export energy table for a decade, 2021 – 2032.
ii. Overview of current Nepal power market
iii. Projection of the hydropower generation in upcoming decade
iv. Infrastructural review & needs for cross border power trade
v. Advice the effective policy/ infrastructural & institutional reforms, law formations for cross border power trade

1.6 Assumptions and Limitations

The major assumptions and limitations of the study are enlisted as:

i. The power trading & generation are assumed to be solely dependent on hydropower projects. Various other alternative energy sources contribution to INPS is assumed to be negligible & non effective to results & conclusions of the study.
ii. Projection of Decade Electricity Generation is based on the data sources of DoED & NEA and considering the construction history & completion pattern i.e timeline generally consumed during construction of hydropower projects infrastructure in Nepal.
iii. Overall Plant Use Factor of Nepal Hydropower plants is calculated by referring to the historical generation data of NEA power plants.
iv. All surplus power shall be exported to neighboring countries without any limitations.
v. In Base case, NEA load forecast for demand & generation projection as per current progress is considered in study to project the exportable energy.
vi. In Business-as-Usual case, WECS load forecast BAU scenario for demand & generation projection as per current progress is considered in study to project the exportable energy.
vii. In Reference Scenario 1 case, WECS load forecast BAU scenario for demand & generation projection considering GoN White paper – 2075 projects & assumed that Projects whose PPA & Connection agreement signed all projects shall be completed.

viii. In Reference Scenario 2 case, WECS load forecast Ref. Scenario for demand & generation projection considering GoN White paper – 2075 projects & assumed that Projects whose PPA & Connection agreement signed all projects shall be completed.

CHAPTER TWO: LITERATURE REVIEW

Nepal power sector have been the topic of discussion for the past 10-15 years now. And, there are numerous reports and papers published in that time frame advising the possible causes and solutions towards management of excess & shortage of power supply. Every sector of economy i.e., Commercial, Industrial, etc. have been deeply affected by the current energy situations resulting in the slow-paced economic development of the nation.

The various reports published by WECS in different stages of time such as Nepal's Energy Vision 2050 and National Survey of Energy Consumption and Supply in Nepal provides ample information's for the development of the future power sector scenarios & projections.

The report Electricity Demand Forecast Report 2017 prepared by WECS describes about the current status & forecast of electricity demand up to 2040 A.D.

Nepal Electricity Authority System Planning Department has also conducted power demand forecast of Nepal INPS which is also utilized further for fulfilling the objectives of the study.

Nepal's energy sector, is a vertically integrated, state-owned utility responsible for electricity generation, transmission, and distribution. NEA is the sole off-taker of generation from other parties, including private sector-owned generation.

NEA conducts power purchase agreements with the Independent Power Producers (IPP's) for the purchase & sale of electricity generated from the private owned companies.

2.1 Electricity Demand Forecast by WECS

The trend in power sector growth is expected to continue along with rapid urbanization and a growing number of energy-intensive industries & expansion of grid networks along the country.

WECS has published an "Electricity Demand Forecast Report" of Nepal INPS in January 2015 from forecast method utilizing MAED. (WECS, Electricity Demand Forecast Report (2015-2040), 2017) forecasting electricity demand of the country up to 2040 A.D.

Below table demonstrates the power demand of the country up to 2040 A.D at various scenarios as of report by WECS in 2017.

Table 2.1 Power Demand Forecast, WECS, 2015-2040

Year	**BAU 4.5 %**	**Reference Scenario 7.2%**	**High Scenario 9.2%**	**@ 7.2% growth with policy intervention**	**@ 9.2% growth with policy intervention**
2015	1721	1721	1721	1721	1721
2020	3384	3611	3794	6621	6814
2025	5787	6617	7366	9987	10803
2030	8937	11111	13296	15731	18371
2035	13242	18124	23588	23049	29231
2040	19151	29427	42228	36489	51330

Note: Installed capacity has been calculated considering the following parameters Capacity factor: 50%

Regular outage and unexpected outage: 20%

T&D loss: 25% Additional Power requirement to support the peak demand: 30%

Assumptions made for the Policy Intervention Scenario:

• 75% of the water heating in urban household will be done by electricity by 2020

• 100% of the cooking in urban household will be done by electricity by 2020

• At least 7% of the cooking in rural household will be done by electricity by 2020

• 100% electrification by 2020

• 18 % of the total passenger Kilometers demand will be fulfilled by electric car and 7% by electric metro in city by 2025

Source: (WECS, Electricity Demand Forcast Report [2015-2040], 2017)

Similarly forecast of energy demand & per capita electricity demand up to 2040 at various scenarios as of report by WECS in 2017 is tabulated below:

Table 2.2 Energy Forecast, WECS, 2015-2040

Year	Final Electricity Demand (GWh)				
	BAU	**Reference Scenario**	**High Scenario**	**Policy Intervention @ 7.2 %**	**Policy Intervention @ 9.2 %**
2015	3,866.36	3,866.64	3,866.36	3,866.36	3,866.36
2020	7,600.76	8,110.66	8,522.97	14,870.92	15,304.29
2025	12,998.25	14,863.67	16,545.84	22,431.68	24,265.05
2030	20,073.83	24,956.79	29,864.09	35,334.66	41,264.82
2035	29,744.69	40,709.77	52,983.16	51,771.84	65,657.50
2040	43,016.69	66,096.60	94,851.06	81,958.97	115,294.44

Table 2.3 per capita Electricity Demand forecast, WECS, 2015-2040

Year	Final per capita Electricity Demand (kWh)				
	BAU	**Reference Scenario**	**High Scenario**	**Policy Intervention @ 7.2 %**	**Policy Intervention @ 9.2 %**
2015	138.00	138.08	138.08	138.00	138.00
2020	271.00	291.00	304.00	531.00	547.00
2025	464.00	531.00	591.00	801.00	867.00
2030	716.00	891.00	1,067.00	1,261.00	1,474.00
2035	1,062.00	1,454.00	1,892.00	1,848.00	2,345.00
2040	1,536.00	2,361.00	3,388.00	2,927.00	4,118.00

2.2 Load Forecast by NEA

NEA System Planning Department has conducted a study & published a “Load Forecast Report” in 2015. (NEA, Load Forecast Report, 2015). The electricity need in Nepal is

projected to rise by 8.1 percent per annum over the study period, from 5,988.98 GWh in fiscal year 2013/14 to 28,329.85 GWh in fiscal year 2033/34 with the inclusion of excess energy evacuating to India. Nepal electricity peak demand is expected to escalate from 1201 megawatt in fiscal year 2013/14 to 5785.3 megawatt in fiscal year 2033/34.

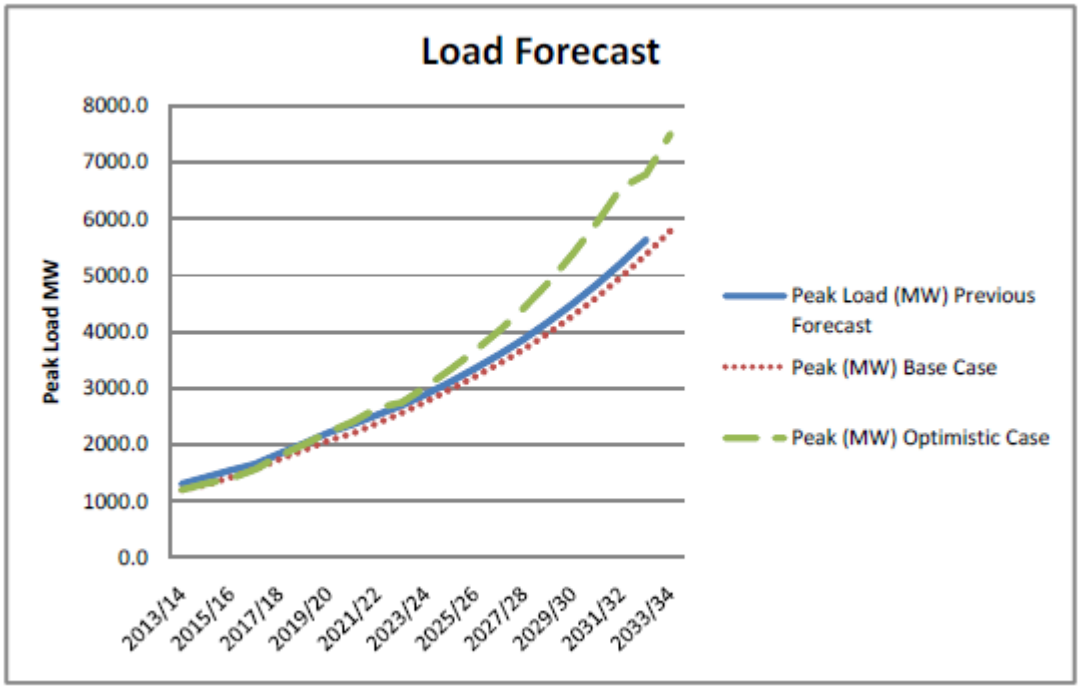


Figure 2.1 NEA load forecast, 2013/14 - FY 2033/34

2.3 Electricity Demand & Generation review of last decade, 2012 - 2021

The actual demand & generation in INPS of last decade, 2012 - 2021 is plotted as of data of NEA Annual Report, 2021. 455 MW load was added in the INPS at an average annual increment of 45.50 MW & the % yearly increment of load varied from 4.26 – 9.68. (NEA, Annual Report, 2020/21, 2021)

From the generation – demand review, it is seen that the generation of INPS was suffering to fulfill the demand in initial stages of the study decade & in later stages of the study decade, the gap between generation & demand is found decreasing. In year 2021 A.D, the generation & demand are matching each other.

The trend of generation & demand is clearly indicating that in upcoming years the generation could exceed the demand & the excess energy would be available for export in wet seasons to neighboring countries or to regional states.

Table 2.4 NEA load forecast, 2013/14 - 2034/35

Fiscal Year	Peak Demand Previous Forecast MW	Peak Demand Base Case MW	Peak Demand Optimistic Case MW	Energy Demand Base Case GWh	Energy Demand Optimistic Case GWh
2013/14	1303.9	1201	1201	4519.32	4577.13
2014/15	1426.4	1286.1	1310.6	4866.37	5023.01
2015/16	1542.6	1422.8	1400.5	5410.41	5395.67
2016/17	1653.7	1559.7	1561.5	5958.45	6044.47
2017/18	1837.1	1742.2	1800.6	6704.24	6928.91
2018/19	2018.8	1903.3	2003.5	7461.15	7853.78
2019/20	2208.7	2071.5	2220.3	8269.99	8863.75
2020/21	2361	2203.8	2408.6	8957.43	9790.12
2021/22	2523	2378.9	2652.6	9689.05	10803.76
2022/23	2695.4	2562.1	2744.7	10454.53	11199.47
2023/24	2888.1	2764.5	3024.9	11300.84	12365.29
2024/25	3109	2978.3	3330.1	12196.86	13637.83
2025/26	3345.5	3203	3661.6	13140.96	15022.61
2026/27	3597.6	3439.5	4022	14136.88	16531.39
2027/28	3866.4	3688.7	4414.5	15188.68	18177.18
2028/29	4168.8	3971.7	4866.7	16383.78	20075.57
2029/30	4493.2	4280.7	5371.2	17690.03	22196.66
2030/31	4841.4	4614.4	5930.4	19103.52	24551.69

Fiscal Year	Peak Demand Previous Forecast MW	Peak Demand Base Case MW	Peak Demand Optimistic Case MW	Energy Demand Base Case GWh	Energy Demand Optimistic Case GWh
2031/32	5216.4	4974.9	6550.3	20633.15	27166.72
2032/33	5621.8	5364.5	6779.9	22288.6	28169.68
2033/34		5785.3	7491.8	24080.37	31183.29

2.4 Government Plan & Policies in Power Sector

Government have formulated various plans & policies in power sector for meeting the country power demand, generation & to support in country's economic growth.

Some of the plans & policies are highlighted here:

- Energy Crisis Resolution and Power Development Decade Concept Paper, 2072
- White Paper, 2075
- SDC, Status & Roadmap: 2016-2030, NPC, GoN

As per Energy Crisis Resolution & Power Development Decade Paper, 2072, projects that would complete within 2082/83 are as follows:

Table 2.5 Decade Generation Plan, GoN

S.No	Description	Installed MW	Remarks
1	Projects that had obtained Generation license & Projects to be developed by GoN	2,587	
2	Proposed Reservoir type Projects	5,373	
3	Proposed PRoR type Projects	1,975	
	Total MW	9,935 MW	

GoN has already taken a strategic direction to reach 3 GW by 2021, 5 GW by 2023 & 15 GW by 2028, including 5,000 MW for export through a White paper-2075 developed by the Ministry of Energy, Water Resources and Irrigation (MoEWRI) on May 2018. Likewise, GoN has taken to expand access to electricity and clean cooking to 100 per cent of the population by 2023 and increase per capita consumption of electricity to 1,500 kWh by 2028 through this White Paper.

Sustainable Development Goal, Status & Roadmap: 2016-2030, NPC, GoN has also ensured 15,000 MW electricity generation upto 2030 & per capita energy consumption to 1500 kWh

Table 2.6 White paper - 2075 Generation Targets FY 2084/85

FY	Capacity (MW)					Total Capacity by FY	Cumulated Total Capacity by FY	Energy (GWh)					Total Energy by FY (GWh)	Cumulated Total Energy by FY (GWh)
	NEA	NEA Subsidiary & other company	IPP	Export Oriented	Solar and Other RES			NEA	NEA Subsidiary / Other companies	IPP	Export Oriented	Solar and Other RES		
Till date	505.38	22.1	489.06		3.29	1,019.82	1,019.82	2,493.22	132.92	2,839.81		4.6	5,470.56	5,470.56
2074/75			94.8			94.8	1,114.62			535.56		-	535.56	6,006.12
2075/76	74	470.8	190.65		25	760.45	1,875.07	340.85	2,363.69	1,053.82		20	3,778.36	9,784.48
2076/77		153.5	399.48		100	652.98	2,528.05		855.74	2,250.46		140.16	3,246.36	13,030.84
2077/78		139	741.29		100	980.29	3,508.34		834.89	4,212.96		140.16	5,188.01	18,218.85
2078/79			486.94		100	586.94	4,095.28			2,794.40		140.16	2,934.56	21,153.41
2079/80		365.2	337.59	900	100	1,702.79	5,798.07		1,578.66	1,935.54	850	140.16	4,504.36	25,657.77
2080/81			531.14		100	631.14	6,429.21			3,310.42		140.16	3,450.58	29,108.35
2081/82		150	200	900	100	1,350.00	7,779.21		-	1,051.20	480	140.16	1,671.36	30,779.71
2082/83		2,685.00	200		100	2,985.00	10,764.21		15,022.00	1,051.20		140.16	16,213.36	46,993.07
2083/84		5,804.00	200		100	6,104.00	16,868.21		21,091.18	1,051.20		140.16	22,282.54	69,275.61
2084/85		1,610.00	200		100	1,910.00	18,778.21		6,600.00	1,051.20		140.16	7,791.36	77,066.97
Total	579.38	11,399.60	4,070.95	1,800.00	928.29	18,778.21		2,834.07	41,879.08	22,086.57	1,330.00	1,145.88	77,066.97	

2.5 Electricity Import/ Export review with neighboring country India

The net gap between export & import of energy from India is 2773 .41 GWh in FY 2020/21. Nepal imported 2805.79 gigawatt & exported 32.38 gigawatt to India in fiscal year 2020/21. (NEA, Annual Report, 2020/21, 2021).

From Baisakh 2078, NEA started to import power from Day ahead Market of the Indian Energy Exchange open market. Till date, Government of India has issued an approval for import of total capacity of 452 MW from selected hydropower projects of Nepal on Day ahead Market (DAM) in Indian Energy Exchange open market. Other many hydropower projects of Nepal are in the pipeline towards obtaining approval from India for export in Indian DAM Market.

Table 2.7 List of approved projects to trade in IEX

S.N	Promoter	Power Plant	Installed Capacity (MW)
1	Nepal Electricity Authority	Trishuli	23.28
2	Nepal Electricity Authority	Devighat	14.55
3	Nepal Electricity Authority	Marsyangdi	67.00
4	Nepal Electricity Authority	Kaligandaki A	140.00
5	Nepal Electricity Authority	Middle Marsyangdi	68.00
6	Green Ventures Ltd.	Likhu-IV	51.00
7	Chilime Hydro Company Ltd.	Chilime	21.44
8	Upper Solu Hydroelectric Co. Pvt. Ltd	Solu Khola	22.80
9	Arun Kabeli Power Ltd.	Kabeli B1	24.25
10	Modi Energy. Ltd.	Lower Modi	19.40
		Total MW	**451.71**

Nepal's all excess energy is expected to be resolved by utilizing these open energy markets in India.

Till date, 10 projects of Nepal have total installed capacity of 452 MW has obtained the approval from GoI for cross border power trade in Indian Energy Exchange open market.

Also, many projects are awaiting for approval from GoI for obtaining the approval for power trade in Indian market. NEA is the focal agency from Nepal to propose India for granting approval to the projects for power trade in India.\

Currently, NEA has made a proposal to India for obtaining an approval of 22 projects with a combined installed capacity of 1047 megawatt.

Table 2.8 List of projects in pipeline to trade in IEX

S. N	**Promoter**	**Power Plant**	**Installed Capacity (MW)**
1	Himalayan Power Partner Pvt. Ltd.	Dordi River	26.19
2	Sahas Urja Ltd.	Solu Dudhkoshi	83.42
3	Shiva Shree Hydropower (P.) Ltd.	Upper Chaku A	21.53
4	Super Madi Hydropower Ltd.	Super Madi	42.68
5	Robust Energy Ltd.	Mistri Khola	40.74
6	Numbur Himalaya Hydropower Pvt. Ltd.	Likhu A HEP	23.47
7	United Modi Hydro power Pvt. Ltd.	Lower Modi 1	9.70
8	Sanima Mai Hydropower Ltd.	Mai Khola	21.34
9	Panchthar Power Company (P) Limited	Hewa Khola A	14.45
10	Mountain Hydro Nepal (P) Limited	Tallo Hewa Khola	21.44
11	Kalanga Hydro Pvt. Ltd.	Kalangagad	14.87

S. N	Promoter	Power Plant	Installed Capacity (MW)
12	Sanigad Hydro Pvt. Ltd.	Upper Kalangagad	37.31
13	Makari Gad Hydropower Pvt. Ltd.	Makari Gad HEP	9.70
14	Api Power Company Limited	Upper Chameliya HEP	38.80
15	Balephi Hydropower Ltd.	Upper Balephi A	34.92
16	Liberty Hydropower Pvt. Ltd.	Upper Dordi A	24.25
17	Swet-Ganga Hydropower & Construction Limited	Lower Likhu HEP	27.26
18	Peoples' Hydropower Company Pvt. Ltd.	Super Dordi 'Kha'	52.38
19	Global Hydropower Associate (P) Limited	Likhu HEP -2	50.89
20	Nepal Electricity Authority	Chameliya	29.10
21	Bhotekoshi Power Company Ltd.	Upper Bhotekoshi	43.65
22	Upper Tamakoshi Hydropower Limited	Upper Tamakoshi HEP	442.32
		Total MW	**1047.05**

2.6 Per capita energy consumption of south Asian sub region & south Asian countries

South Asia population is nearly one quarter of the world's population. But the per capita annual power consumption is the second lowest which is marginally above the Sub-Saharan Africa in comparison to any global regions and sub regions.

Bhutan per capita power consumption is the highest around 3,219 kwh. among the per capita power in South Asia which is just 838 kWh. India's per capita energy

consumption is around 1,010 kWh while Bangladesh 404 kWh and Pakistan 471 kWh have less than half of India's per capita consumption. The Afghanistan annual per capita power consumption is around 134 kilowatt hours. South Asian nations per capita power consumption is presented graphically in above figure. South Asia's average per capita power consumption is 3.6 times lower than that of the global energy consumption average (3,044 kwh) & 3.1 times lower than people's republic of China (2,600 kwh). (Firoz Alam, South Asia's power generation and crossborder, 2019)

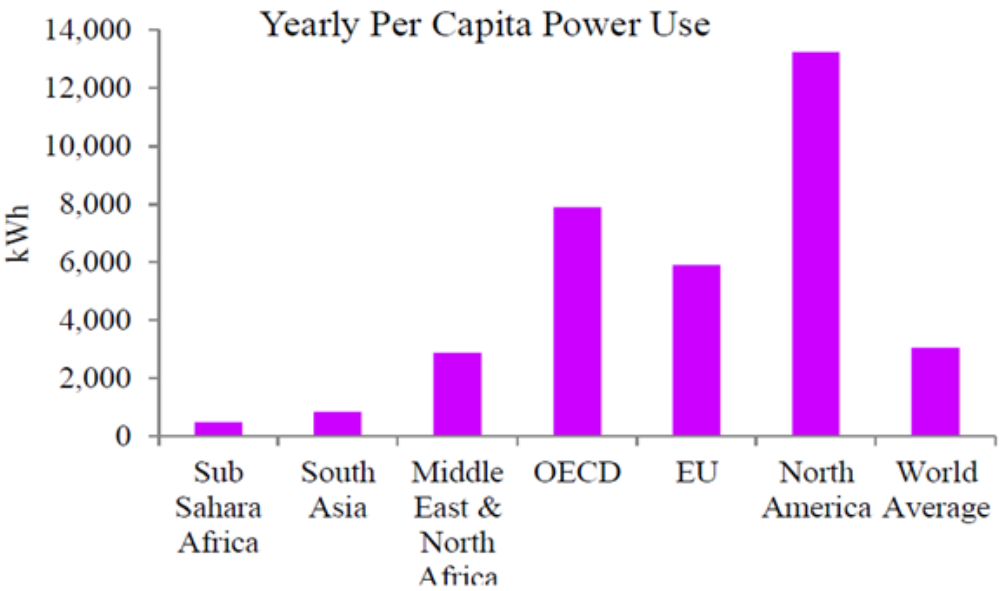


Figure 2.2 per Capita Energy consumption of South Asia sub region & south Asian countries

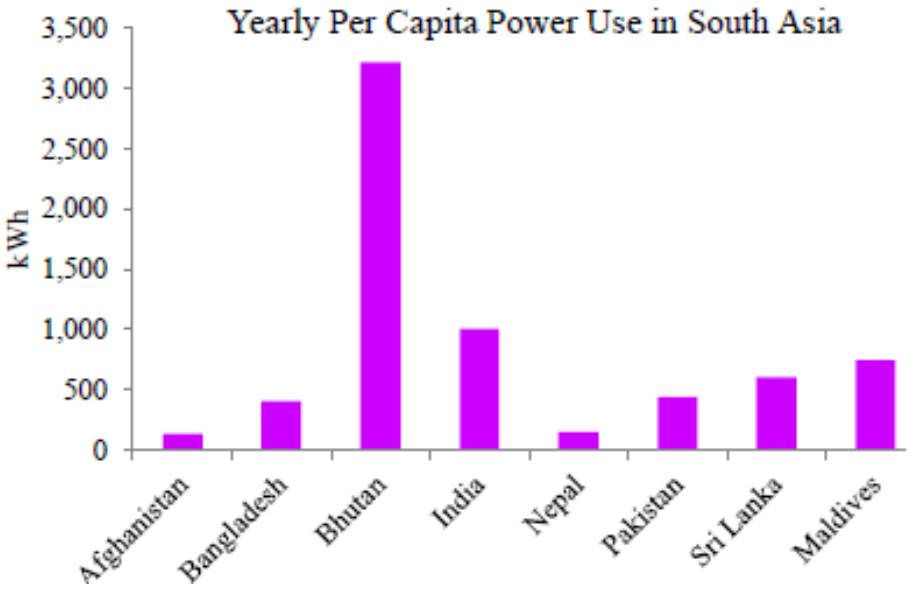


Figure 2.3 per capita energy consumption in South Asian Countries

2.7 BIMSTEC region energy resource potential

BIMSTEC countries are rich with natural resources possessing 65 billion tonnes of coal, 6.4 billion barrels of crude oil, 87 trillion cubic feet of natural gas, 243 million tonnes of Bio-mass & 390 gigawatt of hydroelectricity potential. (SARI/EI, 2017).

Table 2.9 Energy Resource Potential of BIMSTEC

Resource	Coal (million tonnes)	Oil (million barrels)	Gas Reserves (TCF)	Bio-mass (MT)	Hydro Potential (GW)
Bangladesh	3,300	12	8	^	^
Bhutan	2	-	-	27	30
India	60,600	5,749	53	139	150
Myanmar	466	459	17	38	108
Nepal	-	-	-	27	83
Sri Lanka	-	150	-	12	2
Thailand	1,239	405	8	-	17
BIMSTEC Total	**65,607**	**6,775**	**86**	**243**	**390**

^ *Value less than 0.5*

Source: BP Statistical Review, 2016; IRADe Presentation, September 2016; Myanmar Energy Master Plan 2015

2.8 Cross Border Power trade practice by BIMSTEC countries

Among BIMSTEC countries, Bhutan cross border power trade has the highest percentage in regards to their total production. India & Bhutan has strong tie up in electricity cross border power trade. Nepal is also trading excess energy with India in wet season & importing in dry season to match the demand & supply of electricity. Another country in BIMSTEC Bangladesh also trades especially imports over 7% of its electricity from India. Myanmar & India are also engaged in cross border power trade through bilateral trade arrangement by Myanmar importing 3 MW of power.

BIMSTEC member countries are also involved in power trading with their neighboring countries. As Thailand is scarce to electric power, it imports electricity from Malaysia & Laos. Thailand imports around 8% of its generation capacity. Srilanka is also in discussion with India for electricity imports in future to meet its domestic demand. (SARI/EI, 2017).

2.9 BIMSTEC Power Demand Projections

BIMSTEC region power demand is projected to escalate at an annual rate of 6.5% in periods from 2015-2030 an increment from 175 gigawatt to 482 gigawatt in 2030. (SARI/EI, 2017)

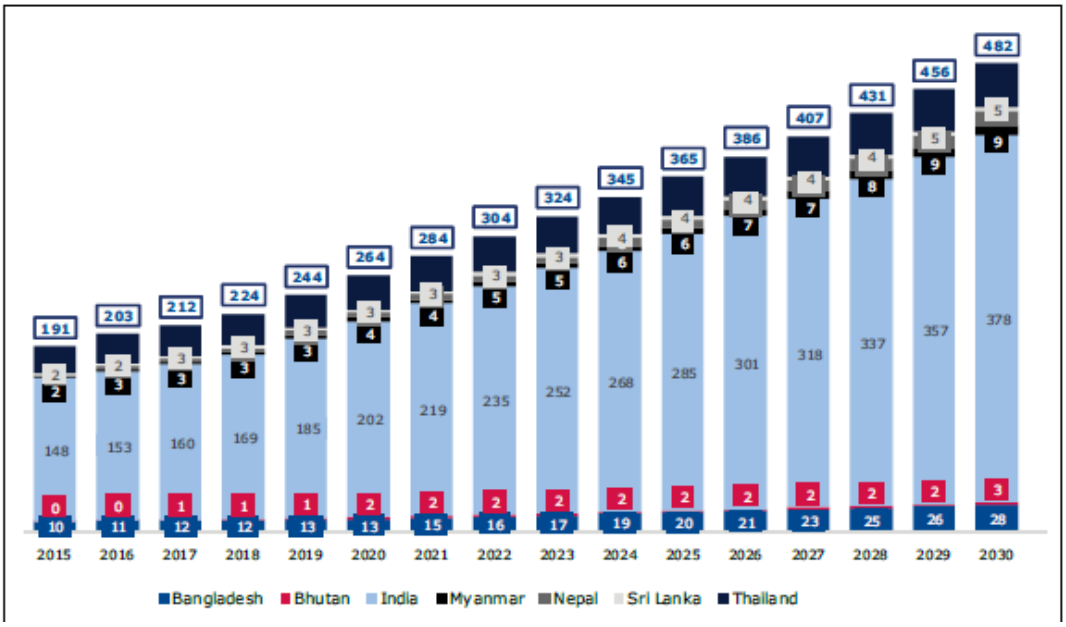


Figure 2.4 Power demand of BIMSTEC countries

2.10 Bangladesh Bhutan India & Nepal (BBIN) sub region Initiative

South Asia is among the most venerable regions in terms of energy security & environmental changes with equally at-risk zone for its lack of integration and regional co-operation. Frequent & significant political tensions, and hostility between the two larger member countries of South Asian Association for Regional co-operation (SAARC) have been a major restriction in the realization of common regional energy projects. (Khem Gyanwali, 2020). To promote economic growth, commerce, and connectivity among the four nations, Bangladesh, Bhutan, India, Nepal (BBIN) sub-regional initiative was introduced. The significant portion of the South Asian population is concentrated at the eastern part formed by these four countries and is home to about 20% of the world's population. (Khem Gyanwali, 2020)

This sub-region, also known as South Asia Growth Quadrangle shares similar socio-economic characteristics where a large proportion of the population is still living below the poverty line. (Khem Gyanwali, 2020).

2.11 Bilateral & Regional developments in cross border power trade

2.11.1 Nepal – India Power Trade Developments:

Oct. 21, 2014 Nepal & India signed an agreement on Electric Power Trade, Cross Border Transmission Interconnection and Grid Connectivity to work on power trade between two countries with a validity for 25 years. (GoN & GoI, Agreement on Electric

Power Trade, Cross-Border Transmission Interconnection and Grid Connectivity, 2014)

2.11.2 Nepal – Bangladesh Power Trade Developments:

Aug. 10, 2018 Nepal & Bangladesh signed an Memorandum of Understanding on mutual cooperation in Power Sector for trading of power between two countries having mutually agreed upon price & procedure. (GoN & GoB, Cooperation on the field of Power Sector, 2018)

2.11.3 BIMSTEC Power Trade Developments:

1st meeting of BIMSTEC at Bangkok, Thailand dated July 31, 2004 agreed on mutual cooperation between member countries for cooperation on energy sector.

2nd meeting of BIMSTEC at New Delhi, India dated Nov. 13, 2008 noted the progress in establishing BIMSTEC Energy Center in India.

4th meeting of BIMSTEC at Kathmandu, Nepal dated Aug. 30, 2018 committed to providing reliable & affordable power supply in the BIMSTEC region.

On 22 January 2011, BIMSTEC member states signed the MoA for the establishment of the BIMSTEC Energy Centre (BEC) in Bengaluru, India. Currently, the member States are in line to develop & implement a guideline to govern the structure, functioning, financing and reporting of all BIMSTEC centers/entities including BIMSTEC Energy Centre. (BIMSTEC, 2021)

The MoU for establishment of the BIMSTEC Grid Interconnection was signed on 31 August 2018 at the 4th Summit organized in Nepal. The MoU has entered into force on 07 April2019. (BIMSTEC, 2021)

The Joint Ministerial Statement adopted at the Second BIMSTEC Energy Ministerial Meeting (2 BEMM) held in Bangkok, Thailand on 05 March 2010decided to commence a BIMSTEC Grid Interconnection Master Plan Study. Currently, the Secretariat is in contact with the development partners including the Asian Development Bank (ADB) to undertake this Study. (BIMSTEC, 2021)

2.11.4 SAARC Framework Agreement for Energy Cooperation (Electricity)

The SAARC (South Asian Association for Regional Cooperation) Member States, comprising Afghanistan, Bangladesh, Bhutan, India, the Maldives, Nepal, Pakistan and

Sri Lanka recognizing the importance of electricity in promoting economic growth & improving the quality of life & member states have duly signed an agreement on "SAARC Framework Agreement for Energy Cooperation (Electricity)" on Nov. 27, 2014.

The objective of the framework agreement "Member States may enable cross-border trade of electricity on voluntary basis subject to laws, rules and regulations of the respective Member States and based on bilateral/trilateral/mutual agreements between the concerned states". (SAARC, 2014)

2.12 Indian Energy Exchange (IEX)

Indian Energy Exchange limited is an electronic system based for power trading exchange which was established in June 27 2008 A.D. It is under the direct regulation by Central Electricity Regulatory Commission (CERC). It is a platform to trade electricity by enabling an efficient discovery of per unit price of electricity. Currently there are over 4,000 participants from India's of all 29 states, 1,000 private generators and more than 3,500 open access consumers are utilizing the IEX open market to manage their power demand & supply. IEX is one of the two operational Power Exchange market of India. (Firoz Alam, South Asia's power generation and crossborder, 2019).

Through IEX, participants trade electricity on 15-minute block basis, a day prior to the delivery of electricity. Both supplier & receiver submit their bid electronically & participate in the bid call session. The Market Clearing Price (MCP) is determined on the basis of demand and supply pattern and same for both selected buyers. The Day-Ahead-Market (DAM) is a physical power trading market for deliveries for any/some/all 15-minute time blocks in 24 hours of next day starting from midnight. The prices and quantum of electricity to be traded are determined through a double-sided closed auction bidding process. The operations are carried out as per the prevailing rules & regulations issued by the Central Transmission Utility and Open Access in Inter-State Transmission Regulations 2008 and the laws, rules and business rules of the Exchange. (Firoz Alam, South Asia's power generation and crossborder, 2019)

Nepal has been assigned B2 zone in Indian Energy Exchange. Through IEX, Nepal can utilize the IEX gateway for cross border power trade in India where Nepal could bid in

automated electronic power trading exchange established by IEX. (Firoz Alam, South Asia's power generation and crossborder, 2019)

NEA started to trade electricity by participating in Day Ahead Market through IEX. Nepal is the 1st country to trade in this open market. The volume of energy can be procured on day ahead basis, which enables to equalize the system efficiently in balancing the supply and demand. NEA load Dispatch Center is managing to bid daily on Day ahead market of IEX. (NEA, Annual Report, 2020/21)

2.13 Existing/ Under construction Cross border Transmission line

Nepal is trading power by existing cross border transmission line with India through 400 kV, 132 kV, 33 kV & 11 kV high voltage.

Following interconnection points are in use for exchange of power between India & Nepal.

Table 2.10 Existing Cross Border Transmission line with India

Existing Nepal-India Inter-connections Links	**Voltage (kV)**	**Power Capability (MW)**
Kataiya – Kusaha	132	140
Kataiya – Rajbiraj	33	8
Sursand-Jaleshwor	33	12
Raxaul-Birgunj	33	12
Ramnagar-Gandak	132	40
Jaynagar-Siraha	33	7
Nanpara-Nepalgunj	33	12
Tanakpur-Mahendranagar	132	70
Dhalkebar-Mujaffarpur	400	1250
Kataiya – Kusaha II	132	160
Raxaul-Parwanipur	132	80
Total		**1791**

2.14 Planned & Proposed cross border Transmission line with India & China

Various cross border transmission lines are under planning to proceed forward in construction of it. 2nd cross border transmission line from New Butwal to Gorakhpur was finalized as a part of it. Also, two more 400 kV cross border transmission lines namely; New Duhabi-Purnia and Lumki-Bareilli are also under study. (NEA, Annual Report, 2020/21).

Table 2.11 Under construction/ Planned Cross Border Transmission line with India

Time-frame	**India – Nepal Cross Border Transmission line (Under Construction/Planned)**	**Transmission Capability (MVA)**
2023	Dhalkebar – Sitamarhi 400kV D/c TL by SAPDC for Arun 3	2500
2025-26	New Butwal – Gorakhpur 400kV D/c (Quad) line by Jv of NEA and PGCIL, India	2500
2026-27	Inaruwa – Purnea (New) 400kV D/c (Quad) line	2500
2027-28	Lumki (Dododhara) – Bareilly 400kV D/c (Quad) line	2500
Total		10,000

Rastriya Prasaran Grid company ltd., GoN owned company has conducted a study on Transmission line development & prepared a report "Transmission System Development Plan of Nepal" on July 2018. (RPGCL, 2018).

According to the study by the RPGCL, following are the cross-border transmission line interconnections with India & China.

Cross Border Transmission line with India (Source: (RPGCL, 2018))

1 Dododhara- Barelly	400kV	Quad Moose
2 Attariya-Bareli	400kV	Quad Moose
3 Phulbari- Lukhnow	400kV	Quad Moose
4 New Butwal - Gorakhpur	400kV	Quad Moose
5 New Dhalkebar- Muzzafarpur	400kV	Quad Moose
6 Inaruwa-Purniya	400kV	Quad Moose
Cross Border Interconnection with China (Source: (RPGCL, 2018))		
1 Kimanthanka - Latse	400kV	Quad Moose
2 Chilime Hub- Kerung	400kV	Quad Moose

2.15 Institutional setups for electricity & cross border power trade

Ministry of Energy, Water Resources & Irrigation: The Ministry of Energy, Water Resources, and Irrigation, along with its subordinate bodies, is responsible for the development of policies, laws, standards, and regulations concerning sustainable development, conservation, utilization, and allocation of energy, water resources, and irrigation. Furthermore, it is tasked with studying, researching, and advancing technology pertaining to energy, water resources, and irrigation. The formation of the Ministry has brought together the former Ministry of Energy and Ministry of Irrigation, as well as their respective subordinate entities, including the Alternative Energy Promotion Center and the Water and Meteorology Department.

The primary focus areas of the Ministry encompass sustainable development, preservation, utilization, and equitable distribution of water resources. Additionally, the Ministry engages in research, technological advancements, and knowledge enhancement relating to water resources, energy, irrigation, underground water resources, alternative energy promotion, and water and meteorology. (MoEWRI, 2022)

Power Transmission Company Nepal Ltd. (PTCN): This is a subsidiary company of Nepal Electricity Authority and established with an aim to develop high voltage cross border transmission between Nepal & India to trade the power within the countries. 1st

cross border transmission line Dhalkebar and Muzaffarpur Nepal portion was executed by PTCN. (NEA, Annual Report, 2020/21).

Nepal Power Trading Company Limited (NPTC): NPTC has been established to carry out power trading in and out of the country. Business Plan for its operation was approved and license issue pertaining to power trading is under consideration. This company will come into operation after fulfilling all the legal compliances. (NEA, Annual Report, 2020/21).

Rastriya Prasaran Grid Company Ltd. (RPGCL): Rastriya Prasaran Grid Co Ltd (RPGCL) was established by the Government of Nepal on 12 July 2015 to transmit and evacuate the power for the development and operation of the hydropower sector. (RPGCL, https://www.rpgcl.com/pages/about-us, 2022).

Nepal Electricity Authority (NEA): Nepal Electricity Authority (NEA) was formed on Bhadra 01, 2042 under the Nepal Electricity Authority Act. 1984, acting under the Department of Electricity of Ministry of Water Resources, Nepal Electricity Corporation and related Development Boards. (NEA, https://nea.org.np/aboutus, 2022).

The main objective of NEA is to generate, transmit and distribute adequate, reliable and affordable power by planning, constructing, operating and maintaining all generation, transmission and distribution system in Nepal's power sector both interconnected and isolated. (NEA, https://nea.org.np/aboutus, 2022).

Electricity Regulatory Commission (ERC): The aim of the Electricity Regulation Commission is to maintain a balance between electricity demand and supply by simplifying, regularizing, organizing, and ensuring transparency in electricity production, transmission, distribution, and trading. The commission's role also includes regulating electricity tariffs, safeguarding the rights and interests of electricity consumers, promoting a competitive electricity market, and delivering reliable, accessible, and high-quality electricity services.

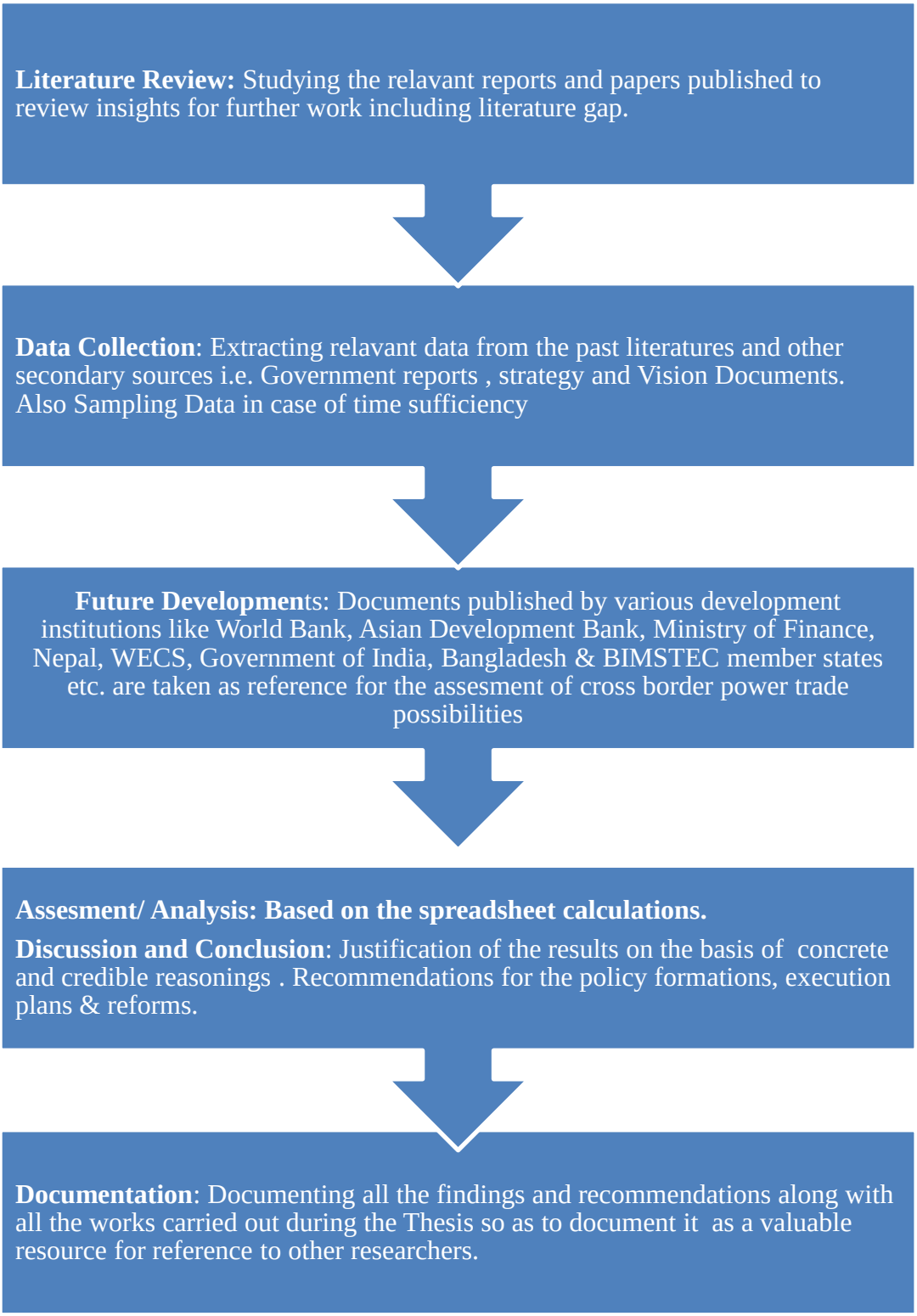
Recognizing the necessity for an independent regulatory body to ensure safety, this commission was established under the Electricity Regulation Commission Act of 2074 and the Electricity Regulation Commission Regulations of 2075, as

per the decision of the Government of Nepal, Council of Ministers dated 2076/01/23. The commission's responsibilities encompass technical management in accordance with prevailing laws and regulations, tariff determination, and the regulation of electricity purchase and sale. Additionally, the commission is tasked with maintaining competition, safeguarding consumer interests, enhancing organizational capacity, providing policy recommendations, conducting investigations and inspections, and facilitating dispute resolution.

The commission is also entrusted with offering essential advice to the Government of Nepal concerning the formulation and implementation of regulatory tools based on needs and priorities. It makes decisions regarding pre-approval, consent, and actions in accordance with existing laws, based on applications received from stakeholders. The commission is committed to establishing reliable and effective arrangements for electricity production, transmission, distribution, and trading. (ERC, 2022)

CHAPTER THREE: METHODOLOGY

3.1 Methodological Flowchart



3.1.1 Literature Review

There are various papers and reports published in different point of time by many national and international level organizations, committees, institutions researchers and students. The assumptions made by different stakeholders need to be properly studied and the methodologies used for carrying out the research need to be analyzed properly so that the learning's from those papers and reports can be used for the basis of scenario development. Moreover, the knowledge of the parameters that needs to be studied and compared can also be found useful in drawing conclusions.

3.1.2 Data Collection

The different types of data required for the research need to be collected from various types of sources i.e., Primary sources and secondary sources. However, the main source would be the secondary sources which include papers of researchers, vision documents, reports, plans of various national level organizations such as Ministry of Energy, Water Resource & Irrigation, Water & Energy Commission Secretariat (WECS), Nepal Electricity Authority, etc. The types and nature of the data would be mostly related with the Energy generation status, consumption trends depending on the sectors, targets set by the governments and its departments etc.

The types of data utilized were presented below:

- The Hydropower potential of Nepal
- Hydro Projects under various stages of development
- Power supply/ demand situations & projections
- Power Import/ Export situations & projections

3.1.3 Future Developments

Various documents and reports published by various development institutions like World Bank, ADB, Ministry of Finance, Nepal, Water and Energy Commission Secretariat (WECS), Nepal Electricity Authority, Ministry of Energy & etc. are taken as reference for the making different power sector future development scenarios.

3.1.4 Documentation

In order for knowhow on the present informations on the Nepal power market & BIMSTEC energy situtions of the the neighboring countries & BIMSTEC region states, the reports from related stakeholders were utilized for the study purposes. Since, most

the the data available in internet and in the publications, reports from the Government agencies, data of Nepal as a whole is generally presented, its difficult to get the data & informations at the level of disaggregation from the government offices itself as required for this specific study purpose. However, the data obtained from the annual reports publications of NEA & WECS & BIMSTEC Energy Outlook 2030, Dec. 2017 were really supportive.

CHAPTER FOUR: RESULT AND DISCUSSION

4.1 Actual Power Generation & Demand review of last decade, 2012-2021

The power demand projected by Energy Demand Forecast Report [2015-2040], WECS, 2017 & the Actual Demand (NEA, Annual Report, 2020/21) in INPS need to be compared for further planning/ review & execution to fulfill the domestic energy demand & in utilizing the excess production by cross border power trade with neighboring countries & with regional cooperation.

The Generation-Demand curve plotted as of data of NEA Annual Report, 2021, in a decade time, 455 MW load was added in the INPS at an average annual increment of 45.50 MW.

Similarly, the generation of INPS was suffering to fulfill the demand & now in year 2021 A.D, it is matching with the demand in Year 2021. The trend of generation & demand is a clear indication that in upcoming years the generation shall exceed the demand & there would be excess energy available for export in wet seasons to neighboring countries or to regional states.

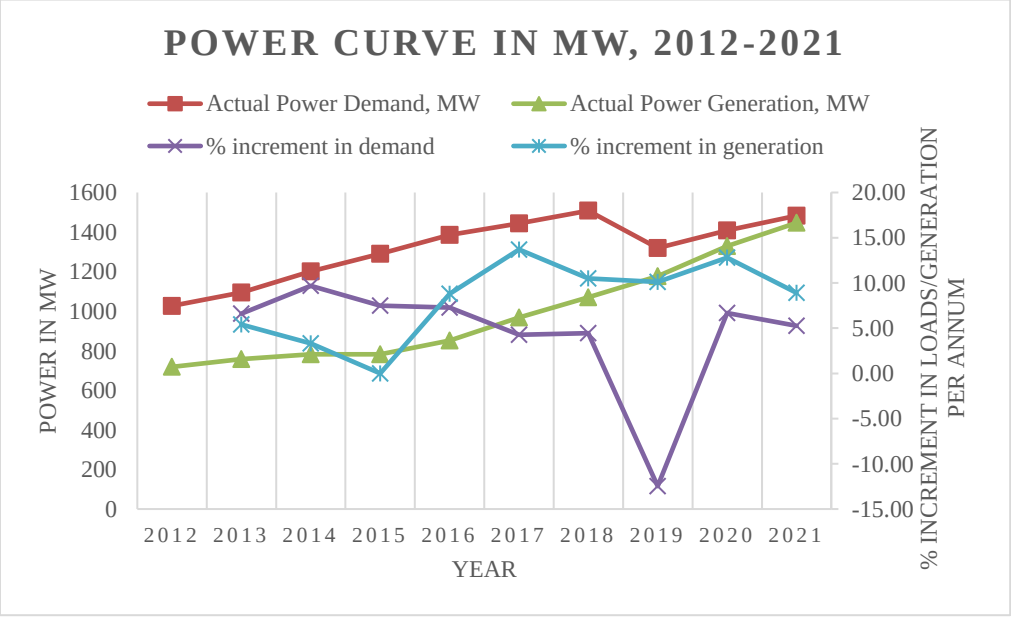


Figure 4.1 Power Actual Demand & Generation, 2012 - 2021

4.2 Import/ Export review with neighboring country India

The energy gap between export & import with neighboring country India is around 2773 GWh in year 2019 & in 2021. From the data, it seems still there is huge gap

between import & export of energy. The export opportunity is still far behind under these circumstances. With addition of Nepal largest hydropower project, Upper Tamakoshi, 456 MW & other IPP's project that are almost ready for commissioning, the import/ export gap would be drastically minimized. Also, recently Nepal certain projects with total capacity 452 MW has been accepted by Indian government to trade the energy in Indian Energy Exchange Market. Also, a number of projects has been applied for the approval from GoI to get traded in IEX which would definitely minimize energy trade gap with neighboring country India in coming years.

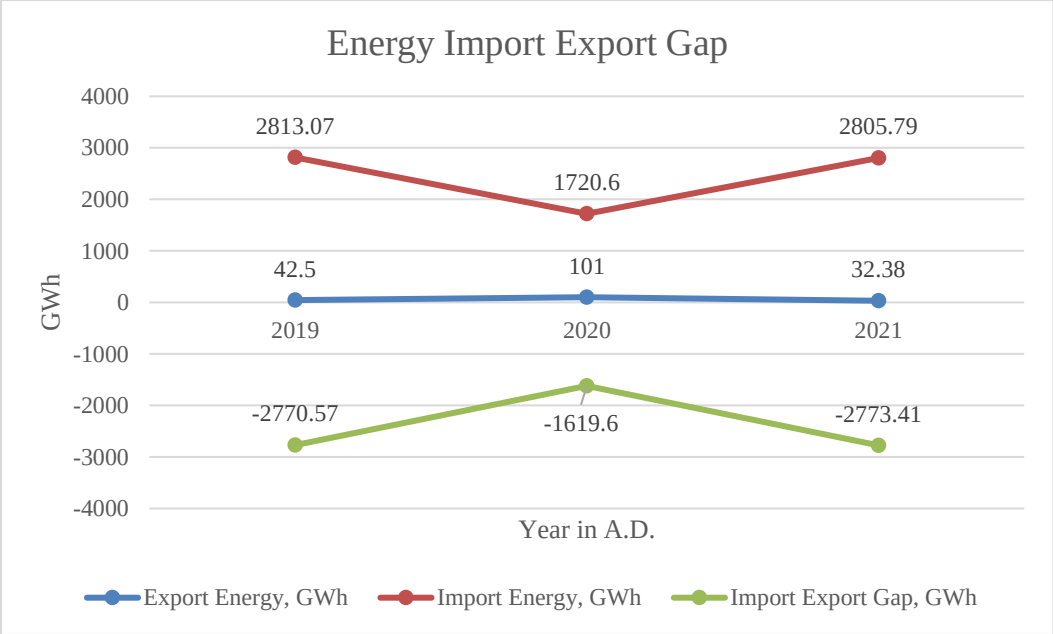


Figure 4.2 Actual Import Export Review

4.3 Plant Factor of Large & Medium Hydropower Plants of NEA

The various FS annual generation data of large & medium hydropower plants were collected & the total generation of every plant was found out. The plant factor of NEA large and medium power plants was calculated based on the available data.

Plant factor was calculated using following mathematical formula.

$$Plant\ Factor = \frac{Actual\ \ Generation\ in\ GWh}{Plant\ Installed\ Capacity\ in\ GW * 365 * 24}$$

The plant factor of NEA large & medium power plants was found to be 0.55. Plant factor of 0.55 is considered for overall power plants of Nepal INPS.

Table 4.1 Plant Factor of NEA Power Plants

Name of Plant	Installed Capacity, MW	Actual Generation (GWh)												
		Total	Shrawan	Bhadra	Aswin	Kartik	Mangsir	Poush	Magh	Falgun	Chaitra	Baisakh	Jestha	Ashad
Kaligandaki	144	755.63	78.05	80.69	74.64	71.60	67.17	51.13	42.03	39.30	44.09	56.71	74.42	75.79
Marsyandi	69	416.31	41.34	40.62	37.01	38.71	37.43	30.01	24.89	23.14	25.42	33.74	42.46	41.54
Middle Marsyandi	70	426.04	47.22	46.72	44.88	42.69	33.90	26.19	19.23	20.41	23.26	31.69	44.86	45.00
Upper Trusuli	60	362.28	16.66	21.03	35.15	35.04	40.93	36.79	31.30	27.37	27.06	30.46	32.65	27.84
Kulekhain I	60	133.80	10.28	9.74	8.78	7.01	8.80	13.98	16.18	15.06	14.56	11.66	8.65	9.09
Kulekhani II	32	62.49	5.09	4.90	4.13	3.09	3.97	6.52	7.60	6.89	6.90	5.33	3.99	4.07
Chameliya	30	157.82	15.12	17.10	19.58	14.54	10.31	8.09	7.14	7.33	9.47	13.87	18.20	17.06
Trisuli	24	119.08	10.15	10.04	9.94	10.22	10.61	10.13	9.22	8.76	9.18	10.17	10.52	10.15
Gandak	15	28.76	2.32	1.99	2.56	2.18	3.24	2.95	2.80	2.64	1.31	1.34	2.85	2.58
Devighat	15	83.73	6.84	6.77	6.80	7.20	7.50	7.31	6.78	6.55	6.71	7.25	7.32	6.68
Modi	14.8	54.79	3.84	4.86	6.47	6.15	4.91	3.72	2.84	2.73	3.40	4.79	6.24	4.85
kulekhani III	14	35.57	5.73	3.83	2.53	2.32	1.89	3.15	3.05	0.75	2.50	1.31	2.55	5.95
Sunkoshi	10.05	54.32	5.25	5.24	5.84	5.99	4.95	3.91	3.26	2.96	3.15	3.74	4.94	5.09
Puwakhola	6.2	31.05	3.59	3.58	3.66	3.76	2.81	1.96	1.54	1.44	1.42	1.70	2.37	3.22
Total	564.05	2,721.66	251.46	257.11	261.96	250.50	238.44	205.83	177.87	165.34	178.44	213.76	262.02	258.92
Plant Factor		0.55	0.61	0.62	0.64	0.61	0.58	0.50	0.43	0.40	0.43	0.52	0.64	0.63

4.4 Power Generation Projection, FY 2022/23 to 2032/33 [Base Case]

In FY 2021/22 the cumulative power generation from NEA and IPP's in INPS is 1033.39 MW and 970.22 MW respectively. For upcoming decade up to FY 2032/33, power generation from IPP's, NEA & GoN was projected based on hydropower projects current progress & historical trend of project completion in Nepal.

Table 4.2 Power Generation Projection, FY 2022/23 - FY 2032/33 [Base Case]

Fiscal Year	Developing entity				Total	Cumulative Installed Capacity, MW
	NEA power generation projection, MW	IPPS power generation projection, MW		GoN/ IBN power generation projection, MW		
		Under Construction	At Various Stage			
2021/22	1,033.39	970.22	-	-	2003.61	2,003.61
2022/23	168.10	1,220.00	-	-	1388.10	3,391.71
2023/24	-	610.00	-	-	610	4,001.71
2024/25	77.00	305.00	-	-	382	4,383.71

Fiscal Year	Developing entity				Total	Cumulative Installed Capacity, MW
	NEA power generation projection, MW	IPPS power generation projection, MW		GoN/ IBN power generation projection, MW		
		Under Construction	At Various Stage			
2025/26	-	152.50	92.55	-	245.05	4,628.76
2026/27	102.00	762.50	277.65	68.00	1210.15	5,838.91
2027/28	140.00	-	185.10	-	325.10	6,164.01
2028/29	-	-	185.10	197.10	382.20	6,546.21
2029/30	-	-	277.65	-	277.65	6,823.86
2030/31	-	-	185.10	-	185.10	7,008.96
2031/32	-	-	277.65	-	277.65	7,286.61
2032/33	-	-	370.20	-	370.20	7,656.81

It is projected that in the FY 2022/23 there would be maximum addition of 1388.1 MW power in INPS. Whereas in FY 2030/31 there would be minimum addition of 185.10 MW power in INPS.

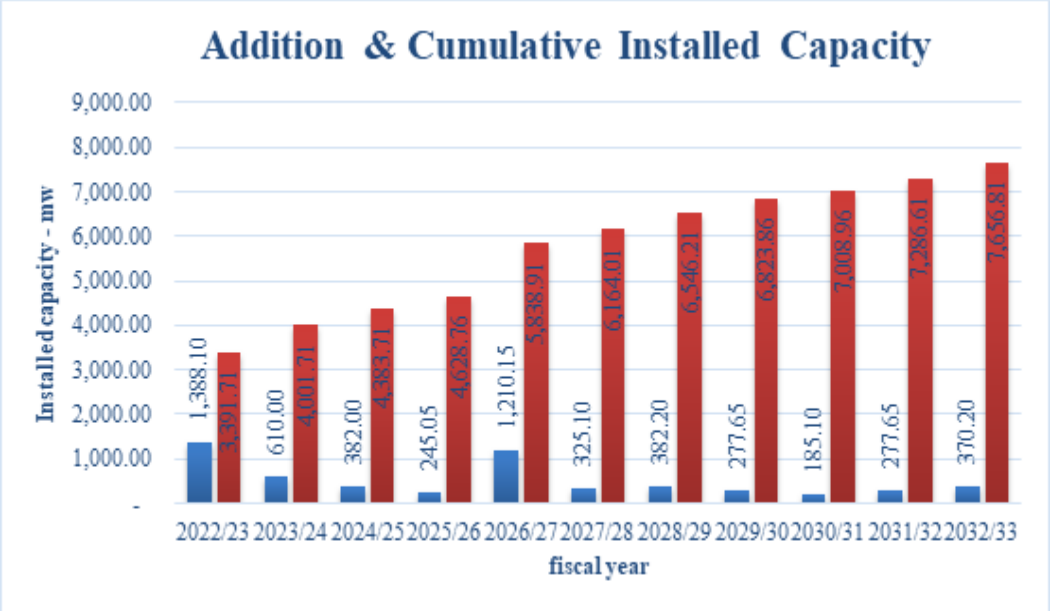


Figure 4.3 Installed Capacity Addition - FY 2022/23 - FY 2032/33 [Base Case]

4.5 Energy Generation Projection, FY 2022/ 23 to 2032/33 [Base Case]

For the formulation of Energy Generation Projection of INPS, 15% of INPS power loss ((NEA, Load Forecast Report, 2015), reserve of 10% and calculated plant factor of 0.55 was considered.

Table 4.3 Energy Gen. Projection, FY 2022/23 - FY 2032/33 [Base Case]

Fiscal Year	**Yearly Cumulative Installed Capacity, MW**	**INPS System loss %**	**Reserve %**	**Net Available Capacity, MW**	**Total Available Energy, GWh with plant factor 0.55**
2021/22	2,003.61	15%	10 %	1,502.71	7,240.05
2022/23	3,391.71	15%	10 %	2,543.78	12,255.95
2023/24	4,001.71	15%	10 %	3,001.28	14,460.19
2024/25	4,383.71	15%	10 %	3,287.78	15,840.54
2025/26	4,628.76	15%	10 %	3,471.57	16,726.03
2026/27	5,838.91	15%	10 %	4,379.18	21,098.91
2027/28	6,164.01	15%	10 %	4,623.01	22,273.66

Fiscal Year	Yearly Cumulative Installed Capacity, MW	INPS System loss %	Reserve %	Net Available Capacity, MW	Total Available Energy, GWh with plant factor 0.55
2028/29	6,546.21	15%	10 %	4,909.66	23,654.74
2029/30	6,823.86	15%	10 %	5,117.90	24,658.03
2030/31	7,008.96	15%	10 %	5,256.72	25,326.88
2031/32	7,286.61	15%	10 %	5,464.96	26,330.17
2032/33	7,656.81	15%	10 %	5,742.61	27,667.89

It is projected that in FY 2022/23 total available energy in INPS would be 12,255.95 GWh. Whereas in FY 2032/33 it would increase up to 27,667.89 GWh.

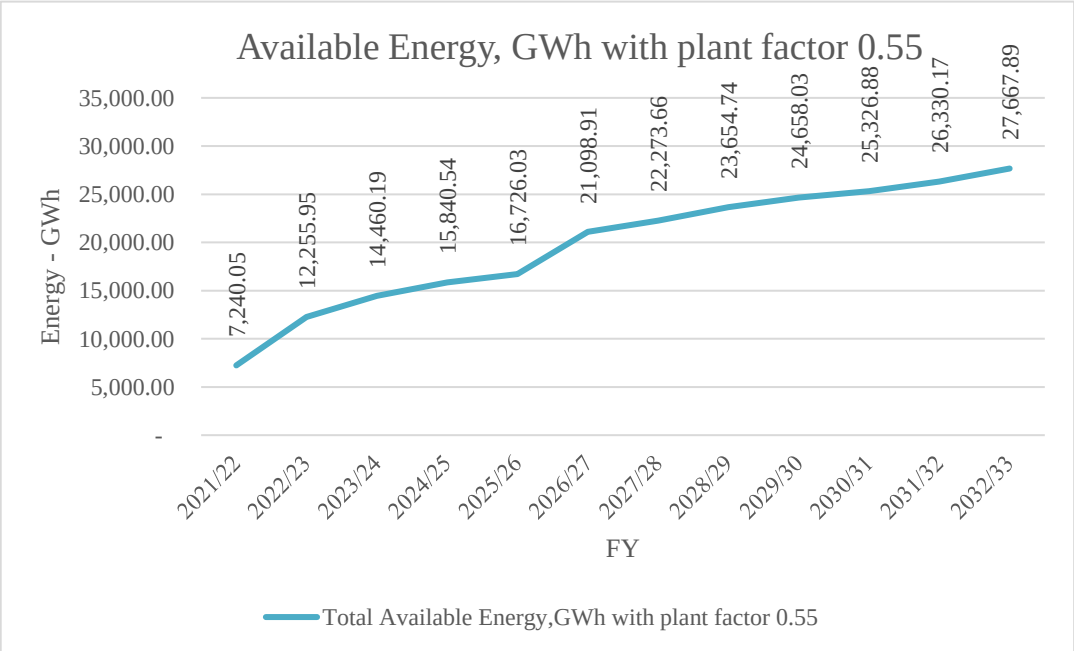


Figure 4.4 Available Energy - FY 2022/23 - FY 2032/33 [Base Case]

4.6 Power & Energy Demand Projection, FY 2022/23-2032/33 [Base Case]

For the fiscal year 2021/22 the Nepal internal peak power and Energy demand is 2378.90 MW and 9684.74 GWh respectively. As per the NEA load forecast report Base Case Nepal internal Peak power demand for the upcoming decade is projected to

increase at an average rate of 7.67% while the internal peak energy demand is projected to increase at an average rate of 7.87%.

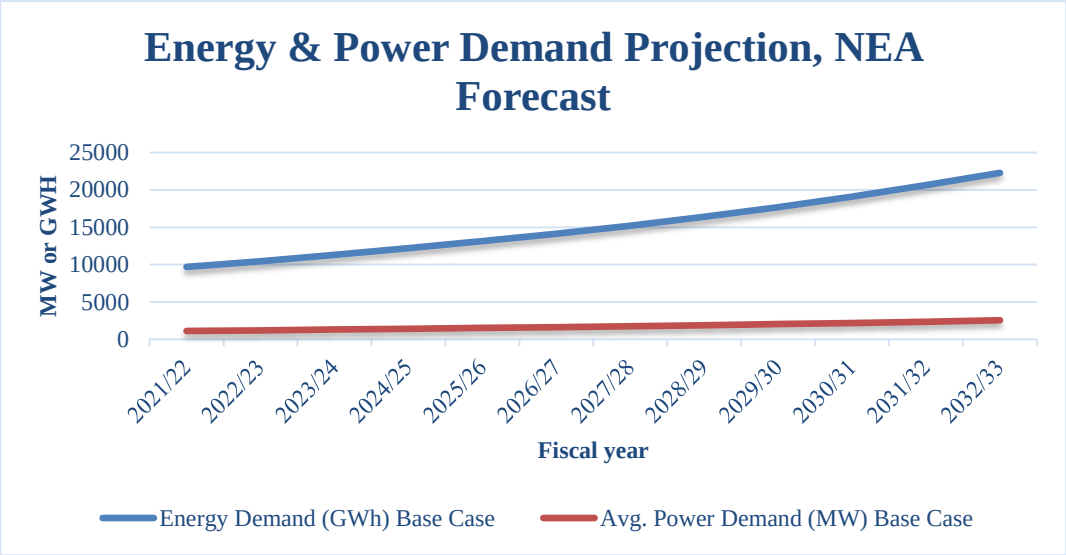


Figure 4.5 Energy & Power Demand, NEA Forecast

4.7 Projected Net Exportable Energy, FY 2022/23-2032/33 [Base Case]

The electricity demand & generation projections data were analyzed in finding out the net exportable power & energy projections up to FY 2032/33. From year 2022 AD, energy export is seen feasible. Nepal could export more than 05 thousand GWh energy in FY 2027/28, 2028/29 & 2029/30.

Similarly, Nepal could export more than 2 thousand MW power from FY 2026/27.

Table 4.4 Energy Export Table, FY 2022/23 - FY 2032/33 [Base Case]

Fiscal Year	Total Available Energy, GWh	Avg. Power Demand Projection, MW	Avg. Power Export Projection, MW	Energy Demand Projection, GWh	Net Exportable Energy Projection, GWh
2022/23	12,255.95	1,192.93	1,350.85	10,450.09	1,805.86
2023/24	14,460.19	1,289.53	1,711.76	11,296.26	3,163.93
2024/25	15,840.54	1,391.80	1,895.99	12,192.15	3,648.39
2025/26	16,726.03	1,499.56	1,972.02	13,136.11	3,589.92

Fiscal Year	Total Available Energy, GWh	Avg. Power Demand Projection, MW	Avg. Power Export Projection, MW	Energy Demand Projection, GWh	Net Exportable Energy Projection, GWh
2026/27	21,098.91	1,613.23	2,765.95	14,131.89	6,967.02
2027/28	22,273.66	1,733.28	2,889.73	15,183.53	7,090.13
2028/29	23,654.74	1,869.69	3,039.97	16,378.48	7,276.26
2029/30	24,658.03	2,018.79	3,099.11	17,684.57	6,973.46
2030/31	25,326.88	2,180.12	3,076.60	19,097.89	6,228.99
2031/32	26,330.17	2,354.72	3,110.24	20,627.35	5,702.82
2032/33	27,667.89	2,543.68	3,198.93	22,282.64	5,385.25

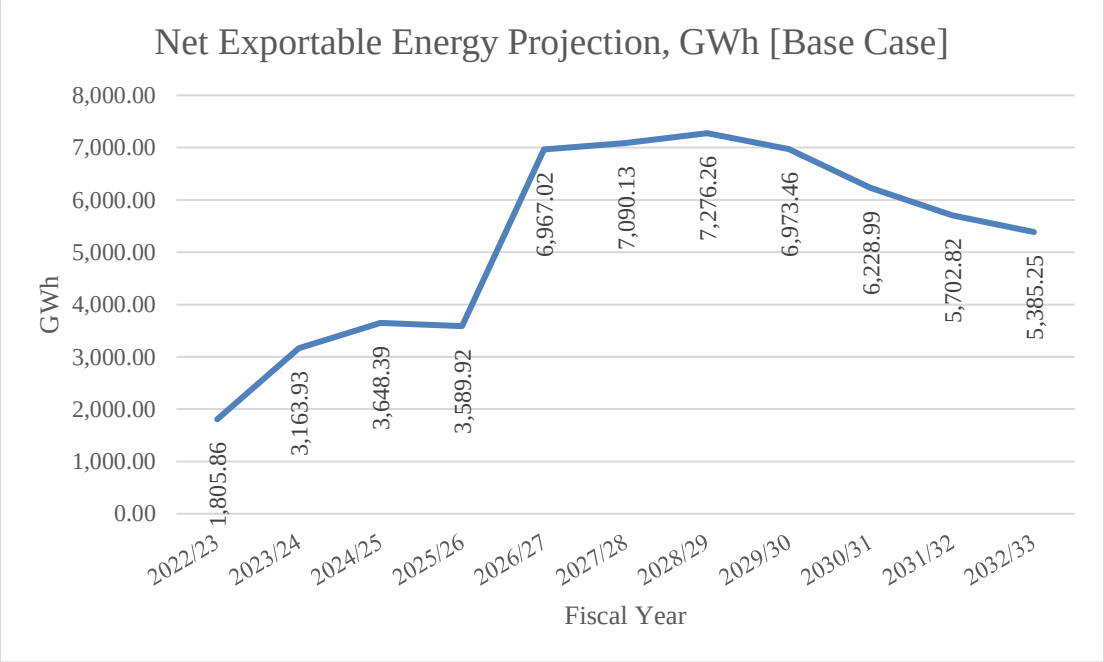


Figure 4.6 Net Exportable Energy Projection [Base Case]

4.8 Power Generation Projection, FY 2022/23 to 2032/33 [Business As Usual]

In FY 2021/22 the cumulative power generation from NEA and IPP's in INPS is 1033.39 MW and 970.22 MW respectively. For upcoming decade upto FY 2032/33, power generation from IPP's, NEA & GoN was projected based on hydropower projects current progress & historical trend of project completion in Nepal.

Table 4.5 Power Gen. Projection, FY 2022/23 - FY2032/33 [Business as Usual]

Fiscal Year	**Developing entity**					
	NEA power generation projection, MW	**IPPS power generation projection, MW**		**GoN/ IBN power generation projection, MW**	**Total**	**Cumulative Installed Capacity, MW**
		Under Construction	**At Various Stage**			
2021/22	1,033.39	970.22	-	-	2003.61	2,003.61
2022/23	168.10	1,220.00	-	-	1388.10	3,391.71
2023/24	-	610.00	-	-	610	4,001.71
2024/25	77.00	305.00	-	-	382	4,383.71
2025/26	-	152.50	92.55	-	245.05	4,628.76
2026/27	102.00	762.50	277.65	68.00	1210.15	5,838.91
2027/28	140.00	-	185.10	-	325.10	6,164.01
2028/29	-	-	185.10	197.10	382.20	6,546.21
2029/30	-	-	277.65	-	277.65	6,823.86
2030/31	-	-	185.10	-	185.10	7,008.96
2031/32	-	-	277.65	-	277.65	7,286.61
2032/33	-	-	370.20	-	370.20	7,656.81

It is projected that in the FY 2022/23 there would be maximum addition of 1388.1 MW power in INPS. Whereas in FY 2030/31 there would be minimum addition of 185.10 MW power in INPS.

Chart of the additional installed capacity for this case is presented in Figure 4.3.

4.9 Energy Generation Projection, FY 2022/ 23 to 2032/33 [Business as Usual]

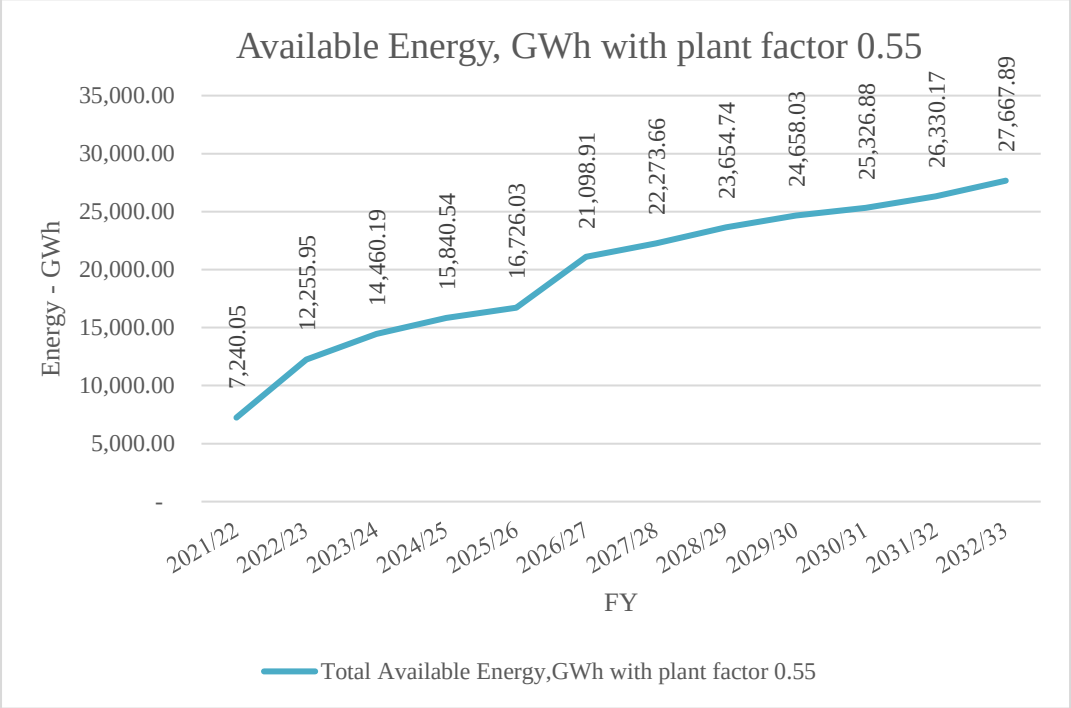


Figure 4.7 Available Energy -FY 2022/23 – FY 2032/33 [BAU]

For the formulation of Energy Generation Projection of INPS, 15% of INPS power loss, reserve of 10% and calculated plant factor of 0.55 was considered.

Table 4.6 Energy Gen. Projection, FY 2022/23 - FY 2032/33 [Business as Usual]

Fiscal Year	**Yearly Cumulative Installed Capacity, MW**	**INPS System loss %**	**Reserve %**	**Available Installed Capacity, MW**	**Total Available Energy, GWh with plant factor 0.55**
2021/22	2,003.61	15%	10 %	1,502.71	7,240.05
2022/23	3,391.71	15%	10 %	2,543.78	12,255.95
2023/24	4,001.71	15%	10 %	3,001.28	14,460.19
2024/25	4,383.71	15%	10 %	3,287.78	15,840.54
2025/26	4,628.76	15%	10 %	3,471.57	16,726.03
2026/27	5,838.91	15%	10 %	4,379.18	21,098.91

Fiscal Year	Yearly Cumulative Installed Capacity, MW	INPS System loss %	Reserve %	Available Installed Capacity, MW	Total Available Energy, GWh with plant factor 0.55
2027/28	6,164.01	15%	10 %	4,623.01	22,273.66
2028/29	6,546.21	15%	10 %	4,909.66	23,654.74
2029/30	6,823.86	15%	10 %	5,117.90	24,658.03
2030/31	7,008.96	15%	10 %	5,256.72	25,326.88
2031/32	7,286.61	15%	10 %	5,464.96	26,330.17
2032/33	7,656.81	15%	10 %	5,742.61	27,667.89

It is projected that in FY 2022/23 total available energy in INPS would be 12,255.95 GWh. Whereas in FY 2032/33 it would increase up to 27,667.89 GWh.

4.10 Power & Energy Demand Projection, FY 2022/23-2032/33 [Business as Usual]

For the fiscal year 2022/23 the Nepal internal peak power and Energy demand is 4,585.50 MW and 10,299.50 GWh respectively. As per the WECS report Business as Usual Nepal internal Peak power demand for the upcoming decade is projected to increase at an average rate of 12.89 % while the internal peak energy demand is projected to increase at an average rate of 12.80 %.

Table 4.7 Energy & Power Demand, FY 2022/23 - FY 2032/33, BAU

FY	BAU Energy Demand GWh	BAU Avg. Demand (MW)	Remarks
2022/23	10,299.50	1,175.74	
2023/24	11,379.00	1,298.97	
2024/25	12,458.50	1,422.20	

FY	BAU Energy Demand GWh	BAU Avg. Demand (MW)	Remarks
2025/26	13,705.81	1,564.59	
2026/27	15,120.93	1,726.13	
2027/28	16,536.04	1,887.68	
2028/29	17,951.16	2,049.22	
2029/30	19,366.28	2,210.76	
2030/31	21,040.92	2,401.93	
2031/32	22,975.09	2,622.73	
2032/33	24,909.26	2,843.52	

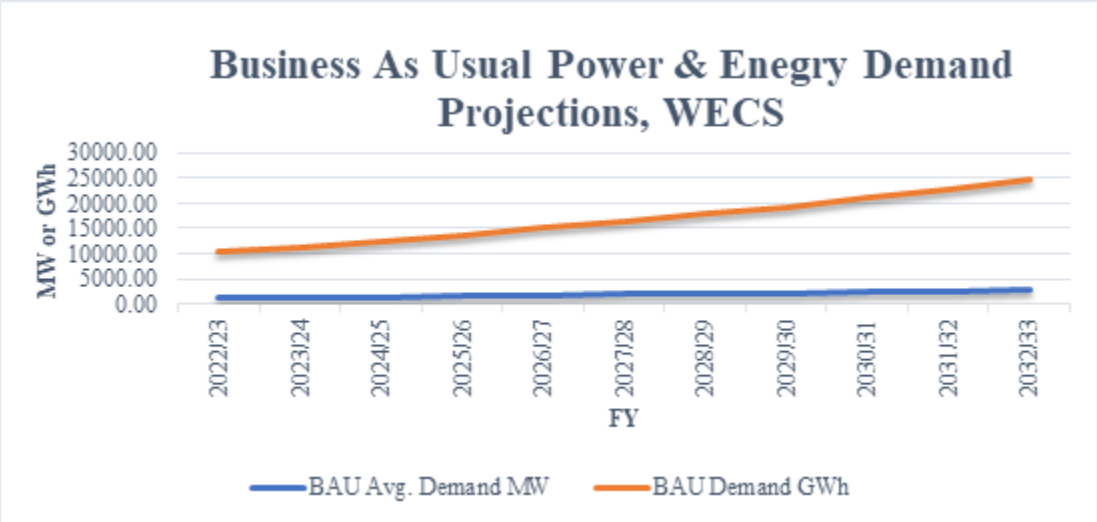


Figure 4.8 Power & Energy Demand, BAU, WECS

4.11 Projected Net Exportable Energy, FY 2022/23-2032/33 [Business as Usual]

The electricity demand & generation projections data were analyzed in finding out the net exportable power & energy projections upto FY 2032/33. From year 2022 AD, energy export is seen feasible. Nepal could export more than 05 thousand GWh energy in FY 2027/28, 2028/29 & 2029/30.

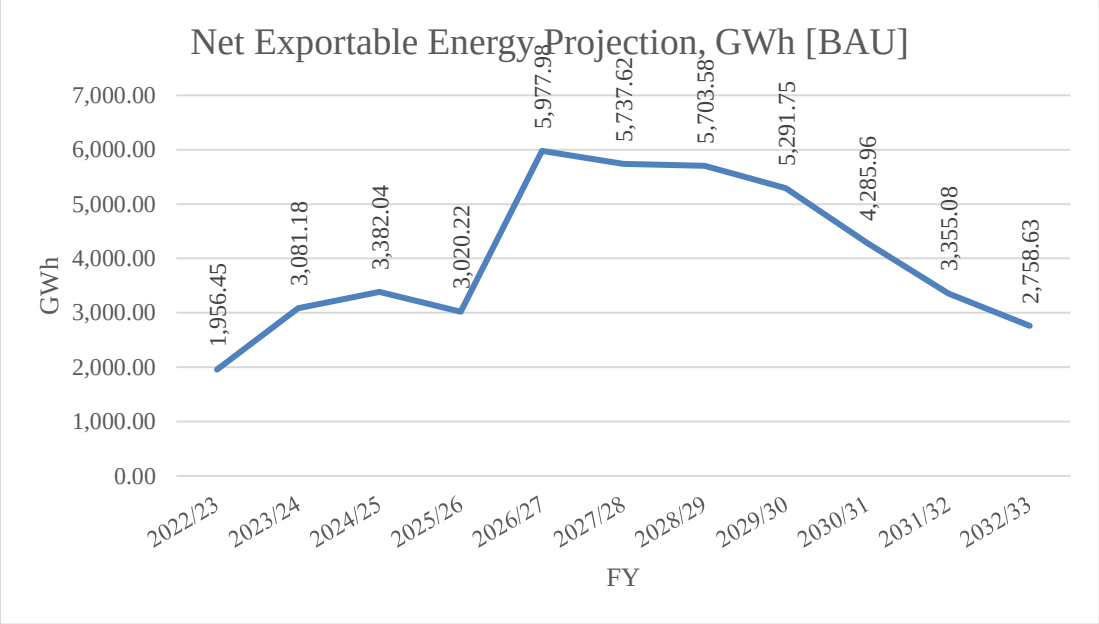


Figure 4.9 Net Exportable Energy Projection [BAU]

Table 4.8 Export Energy Table, FY 2022/23 - FY 2032/33 [Business as Usual]

Fiscal Year	**Total Available Energy, GWh**	**Avg. Power Demand Projection, MW**	**Energy Demand Projection, GWh**	**Avg. Power Export Projection, MW**	**Net Exportable Energy Projection, GWh**
2022/23	12,255.95	1,175.74	10,299.50	1,368.04	1,956.45
2023/24	14,460.19	1,298.97	11,379.00	1,702.31	3,081.18
2024/25	15,840.54	1,422.20	12,458.50	1,865.58	3,382.04
2025/26	16,726.03	1,564.59	13,705.81	1,906.98	3,020.22
2026/27	21,098.91	1,726.13	15,120.93	2,653.05	5,977.98
2027/28	22,273.66	1,887.68	16,536.04	2,735.33	5,737.62
2028/29	23,654.74	2,049.22	17,951.16	2,860.44	5,703.58
2029/30	24,658.03	2,210.76	19,366.28	2,907.13	5,291.75
2030/31	25,326.88	2,401.93	21,040.92	2,854.79	4,285.96

Fiscal Year	Total Available Energy, GWh	Avg. Power Demand Projection, MW	Energy Demand Projection, GWh	Avg. Power Export Projection, MW	Net Exportable Energy Projection, GWh
2031/32	26,330.17	2,622.73	22,975.09	2,842.23	3,355.08
2032/33	27,667.89	2,843.52	24,909.26	2,899.09	2,758.63

4.12 Power Generation Projection, FY 2022/23 to 2032/33 [Reference Scenario1]

In FY 2022/23 the cumulative power generation in INPS is 2,684.39 MW. For upcoming decade up to FY 2032/33, power generation from IPP's, NEA & GoN was projected based on hydropower projects current progress & historical trend of project completion in Nepal.

It is projected that in the FY 2028/29 there would be maximum addition of 1871.16 MW power in INPS. Whereas in FY 2032/33 there would be minimum addition of 370.20 MW power in INPS.

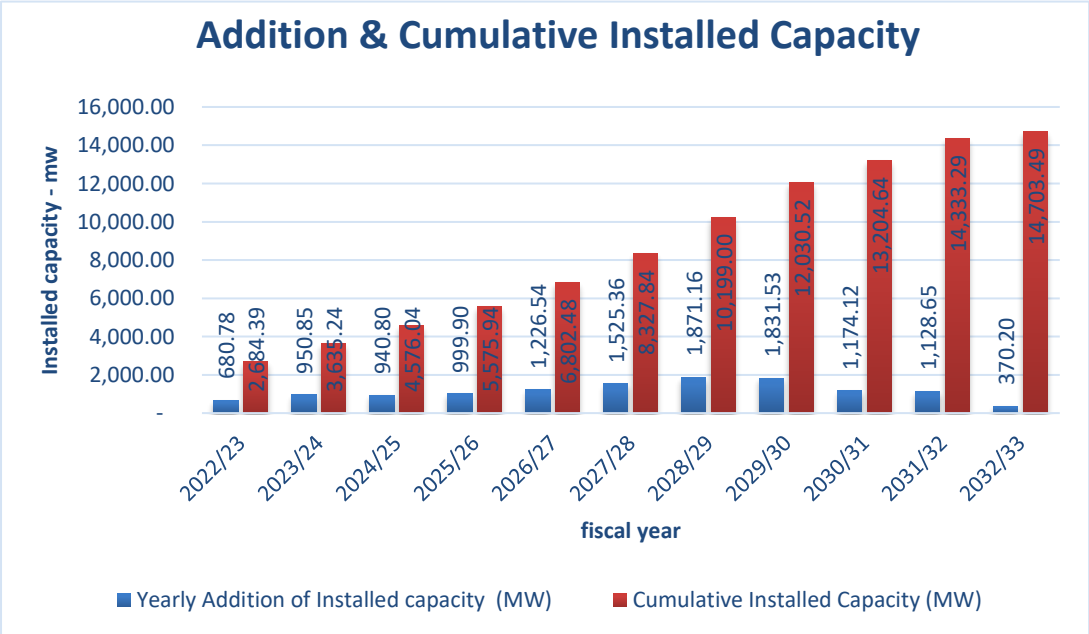


Figure 4.10 Addition Installed Capacity, FY 2022/23 - FY 2032/33, [Ref. Scenario 1]

Table 4.9 Power Gen. Projection, FY 2022/23 - FY 2032/33 [Ref. Scenario 1]

Year	Generation from				Total	Cumulative Installed Capacity, MW
	PPA completed Project, MW	PPA in Process Project	CA Completed Project	GoN / IBN Strategic Projects		
2021/22	2,003.61		-	-	2,003.61	2,003.61
2022/23	680.78		-	-	680.78	2,684.39
2023/24	950.85		-	-	950.85	3,635.24
2024/25	940.80		-	-	940.80	4,576.04
2025/26	907.35		92.55	-	999.90	5,575.94
2026/27	910.53	38.36	277.65		1,226.54	6,802.48
2027/28	983.95	356.31	185.10	-	1,525.36	8,327.84
2028/29	893.41	744.64	185.10	48.00	1,871.16	10,199.00
2029/30	106.00	1,250.88	277.65	197.00	1,831.53	12,030.52
2030/31	180.00	599.02	185.10	210.00	1,174.12	13,204.64
2031/32	-	216.00	277.65	635.00	1,128.65	14,333.29
2032/33	-	-	370.20	-	370.20	14,703.49

4.13 Energy Generation Projection, FY 2022/ 23 to 2032/33 [Ref. Scenario 1]

For the formulation of Energy Generation Projection of INPS, 15% of INPS power loss, reserve of 10% and calculated plant factor of 0.55 was considered.

Table 4.10 Energy Gen. Projection, FY 2022/23 - FY 2032/33 [Ref. Scenario 1]

Fiscal Year	**Cumulative Installed Capacity, MW**	**INPS System loss %**	**Reserve %**	**Available Installed Capacity, MW**	**Total Available Energy, GWh with plant factor 0.55**
2021/22	2,003.61	15%	10 %	1,502.71	7,240.05
2022/23	2,684.39	15%	10 %	2,013.29	9,700.05
2023/24	3,635.24	15%	10 %	2,726.43	13,135.95
2024/25	4,576.04	15%	10 %	3,432.03	16,535.52
2025/26	5,575.94	15%	10 %	4,181.95	20,148.65
2026/27	6,802.48	15%	10 %	5,101.86	24,580.77
2027/28	8,327.84	15%	10 %	6,245.88	30,092.65
2028/29	10,199.00	15%	10 %	7,649.25	36,854.07
2029/30	12,030.52	15%	10 %	9,022.89	43,472.28
2030/31	13,204.64	15%	10 %	9,903.48	47,714.98
2031/32	14,333.29	15%	10 %	10,749.97	51,793.35
2032/33	14,703.49	15%	10 %	11,027.62	53,131.07

It is projected that in FY 2022/23 total available energy in INPS would be 9,700.05 GWh. Whereas in FY 2032/33 it would reach up to 51,131.07 GWh

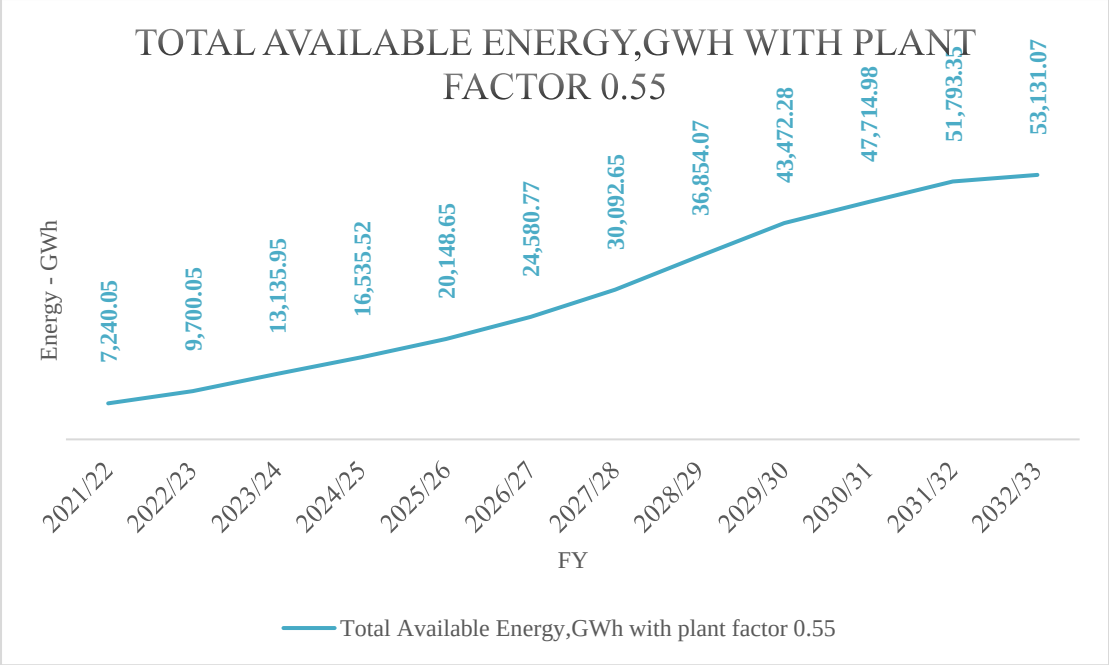


Figure 4.11 Available Energy FY2022/23 - Fy 2032/33 [Ref. Scenario 1]

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4.14 Power & Energy Demand Projection, FY 2022/23-2032/33 [Ref. Scenario 1]

For the fiscal year 2022/23 the Nepal internal peak power and Energy demand is 1175.74 MW and 10,299.50 GWh respectively. As per the WECS report Business as Usual Nepal internal Peak power demand for the upcoming decade is projected to increase at an average rate of 12.89 % while the internal peak energy demand is projected to increase at an average rate of 12.80 %.

Table 4.11 Energy & Power Demand, FY 2022/23 - FY 2032/33 [Ref. Scenario 1]

FY	**BAU Energy Demand GWh**	**BAU Avg. Demand MW**	**Remarks**
2022/23	10299.50	1175.74	
2023/24	11379.00	1298.97	
2024/25	12458.50	1422.20	
2025/26	13705.81	1564.59	
2026/27	15120.93	1726.13	

FY	BAU Energy Demand GWh	BAU Avg. Demand MW	Remarks
2027/28	16536.04	1887.68	
2028/29	17951.16	2049.22	
2029/30	19366.28	2210.76	
2030/31	21040.92	2401.93	
2031/32	22975.09	2622.73	
2032/33	24909.26	2843.52	

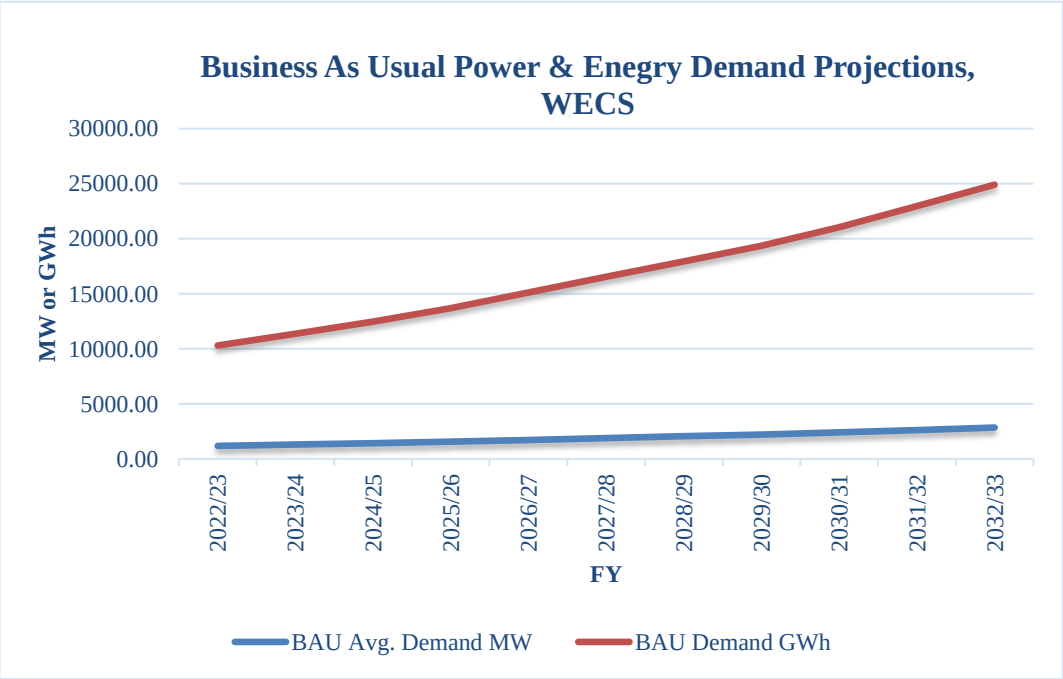

Figure 4.12 Power & Energy Demand, BAU, WECS

4.15 Projected Net Exportable Energy, FY 2022/23-2032/33 [Ref. Scenario1]

The electricity demand & generation projections data were analyzed in finding out the net exportable power & energy projections upto FY 2032/33. From year 2023 AD, energy export is seen feasible. Nepal could export more than 10 thousand GWh energy from FY 2027/28.

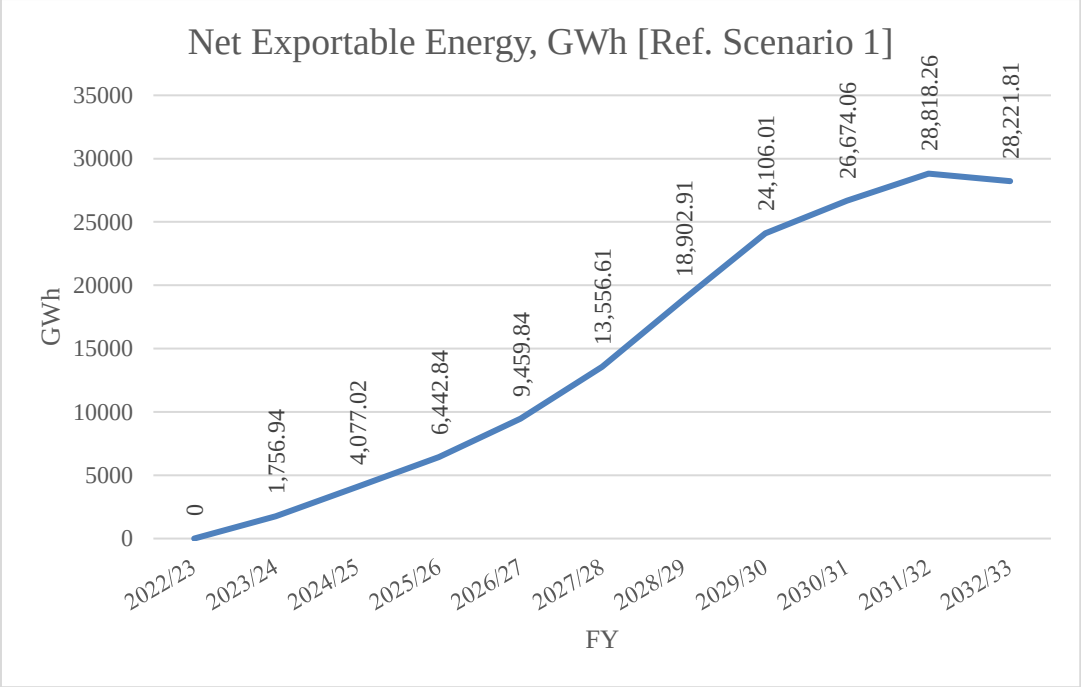

Figure 4.13 Net Exportable Energy Projection [Ref. Scenario 1]

Table 4.12 Energy Export Table, FY 2022/23 - FY 2032/33 [Ref. Scenario 1]

Fiscal Year	**Total Available Energy, GWh**	**Avg. Power Demand Projection, MW**	**Energy Demand Projection, GWh**	**Avg. Power Export Projection, MW**	**Net Exportable Energy Projection, GWh**
2022/23	9,700.05	1,175.74	10,299.50	837.55	- 599.45
2023/24	13,135.95	1,298.97	11,379.00	1,427.46	1,756.94
2024/25	16,535.52	1,422.20	12,458.50	2,009.83	4,077.02
2025/26	20,148.65	1,564.59	13,705.81	2,617.36	6,442.84
2026/27	24,580.77	1,726.13	15,120.93	3,375.73	9,459.84
2027/28	30,092.65	1,887.68	16,536.04	4,358.20	13,556.61
2028/29	36,854.07	2,049.22	17,951.16	5,600.03	18,902.91
2029/30	43,472.28	2,210.76	19,366.28	6,812.13	24,106.01

Fiscal Year	Total Available Energy, GWh	Avg. Power Demand Projection, MW	Energy Demand Projection, GWh	Avg. Power Export Projection, MW	Net Exportable Energy Projection, GWh
2030/31	47,714.98	2,401.93	21,040.92	7,501.55	26,674.06
2031/32	51,793.35	2,622.73	22,975.09	8,127.24	28,818.26
2032/33	53,131.07	2,843.52	24,909.26	8,184.10	28,221.81

4.16 Power Generation Projection, FY 2022/23 to 2032/33 [Reference Scenario2]

In FY 2022/23 the cumulative power generation in INPS is 2,684.39 MW. For upcoming decade up to FY 2032/33, power generation from IPP's, NEA & GoN was projected based on hydropower projects current progress & historical trend of project completion in Nepal.

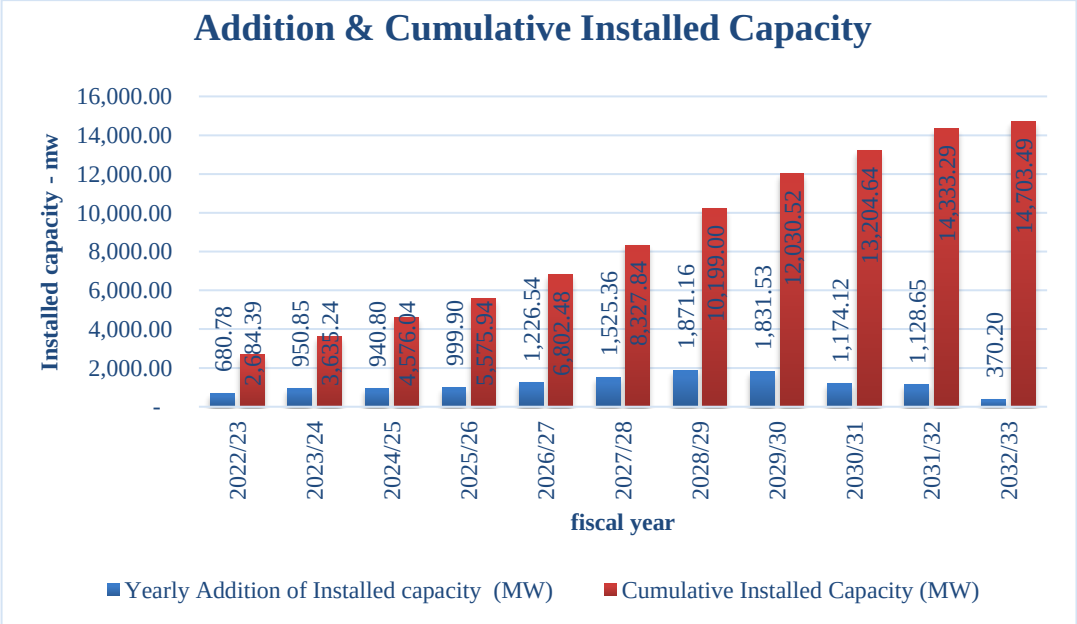

Figure 4.14 Capacity Addition, FY 2022/23- FY 2032/33 [Ref. Scenario 2]

Table 4.13 Power Gen. Projection, FY 2022/23 - FY 2032/33 [Ref. Scenario 2]

Year	Generation from				Total	Cumulative Installed Capacity, MW
	PPA completed Project, MW	PPA in Process Project	CA Completed Project	GoN / IBN Strategic Projects		
2021/22	2,003.61		-	-	2,003.61	2,003.61
2022/23	680.78		-	-	680.78	2,684.39
2023/24	950.85		-	-	950.85	3,635.24
2024/25	940.80		-	-	940.80	4,576.04
2025/26	907.35		92.55	-	999.90	5,575.94
2026/27	910.53	38.36	277.65		1,226.54	6,802.48
2027/28	983.95	356.31	185.10	-	1,525.36	8,327.84
2028/29	893.41	744.64	185.10	48.00	1,871.16	10,199.00
2029/30	106.00	1,250.88	277.65	197.00	1,831.53	12,030.52
2030/31	180.00	599.02	185.10	210.00	1,174.12	13,204.64
2031/32	-	216.00	277.65	635.00	1,128.65	14,333.29
2032/33	-	-	370.20	-	370.20	14,703.49

4.17 Energy Generation Projection, FY 2022/ 23 to 2032/33 [Ref. Scenario 2]

For the formulation of Energy Generation Projection of INPS, 15% of INPS power loss, reserve of 10% and calculated plant factor of 0.55 was considered.

It is projected that in FY 2022/23 total available energy in INPS would be 9,700.05 GWh. Whereas in FY 2032/33 it would reach up to 51,131.07 GWh

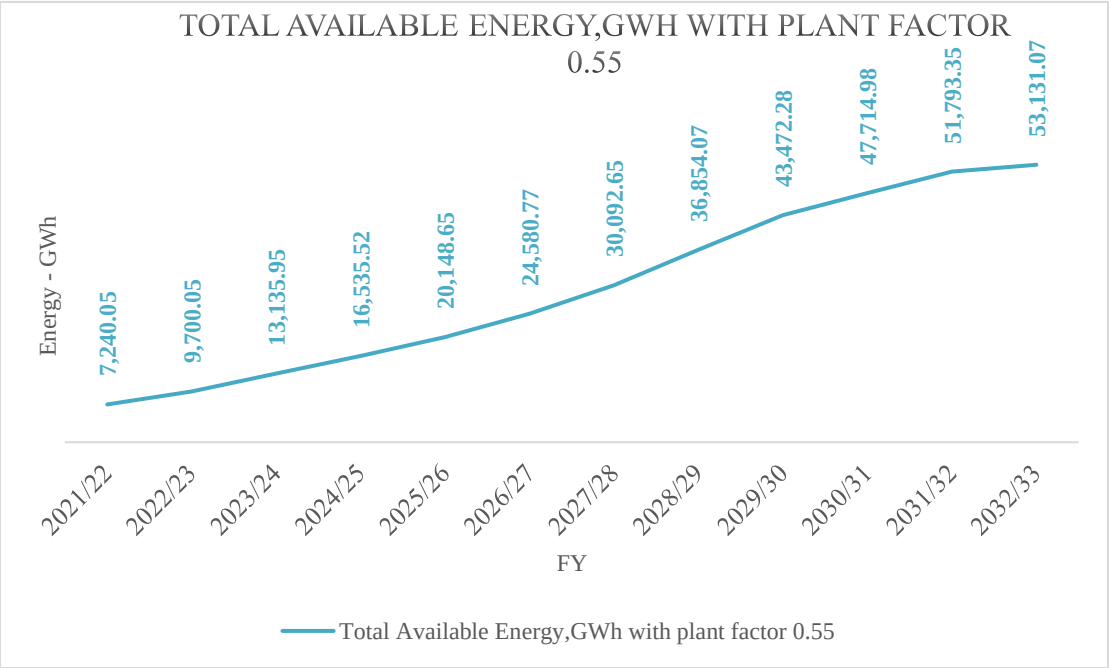

Figure 4.15 Energy Addition, FY 2022/23-FY 2032/33 [Ref Scenario 2]

Table 4.14 Energy Gen. Projection, FY 2022/23 - FY 2032/33 [Ref. Scenario 2]

Fiscal Year	**Cumulative Installed Capacity, MW**	**INPS System loss %**	**Reserve %**	**Available Installed Capacity, MW**	**Total Available Energy, GWh with plant factor 0.55**
2021/22	2,003.61	15%	10 %	1,502.71	7,240.05
2022/23	2,684.39	15%	10 %	2,013.29	9,700.05
2023/24	3,635.24	15%	10 %	2,726.43	13,135.95
2024/25	4,576.04	15%	10 %	3,432.03	16,535.52
2025/26	5,575.94	15%	10 %	4,181.95	20,148.65
2026/27	6,802.48	15%	10 %	5,101.86	24,580.77
2027/28	8,327.84	15%	10 %	6,245.88	30,092.65
2028/29	10,199.00	15%	10 %	7,649.25	36,854.07
2029/30	12,030.52	15%	10 %	9,022.89	43,472.28

Fiscal Year	Cumulative Installed Capacity, MW	INPS System loss %	Reserve %	Available Installed Capacity, MW	Total Available Energy, GWh with plant factor 0.55
2030/31	13,204.64	15%	10 %	9,903.48	47,714.98
2031/32	14,333.29	15%	10 %	10,749.97	51,793.35
2032/33	14,703.49	15%	10 %	11,027.62	53,131.07

4.18 Power & Energy Demand Projection, FY 2022/23-2032/33 [Ref. Scenario 2]

For the fiscal year 2022/23 the Nepal internal peak power and Energy demand is 1175.74 MW and 10,299.50 GWh respectively. As per the WECS report Reference Scenario Nepal internal Peak power demand for the upcoming decade is projected to increase at an average rate of 12.89 % while the internal peak energy demand is projected to increase at an average rate of 12.80 %.

Table 4.15 Energy & Power Demand Projection, FY 2022/23 - FY 2032/33 [Ref. Scenario 2]

FY	Ref. Scenario Energy Demand GWh	Ref. Scenario Avg. Demand MW	Remarks
2022/23	11487.17	1311.32	
2023/24	12837.77	1465.50	
2024/25	14188.37	1619.68	
2025/26	15872.98	1811.98	
2026/27	17891.61	2042.42	
2027/28	19910.23	2272.86	
2028/29	21928.85	2503.29	
2029/30	23947.48	2733.73	

FY	Ref. Scenario Energy Demand GWh	Ref. Scenario Avg. Demand MW	Remarks
2030/31	26532.09	3028.78	
2031/32	29682.68	3388.43	
2032/33	32833.28	3748.09	

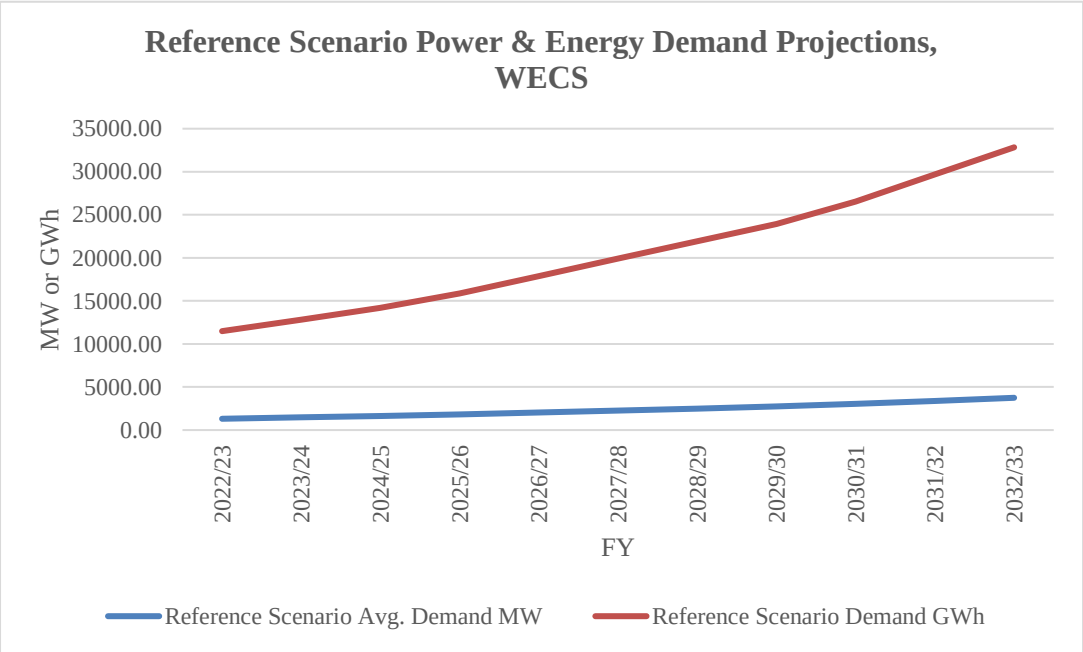

Figure 4.16 Power & Energy Demand, FY 2022/23 - FY 2032/33, WECS Ref. Scenario

4.19 Projected Net Exportable Energy, FY 2022/23-2032/33 [Ref. Scenario2]

The electricity demand & generation projections data were analyzed in finding out the net exportable power & energy projections up to FY 2032/33. From year 2023 AD, energy export is seen feasible. Nepal could export more than 10 thousand GWh energy from FY 2027/28.

Table 4.16 Energy Export Table, FY 2022/23 - FY 2032/33 [Ref. Scenario 2]

Fiscal Year	Total Available Energy, GWh	Avg. Power Demand Projection, MW	Energy Demand Projection, GWh	Avg. Power Export Projection, MW	Net Exportable Energy Projection, GWh
2022/23	9,700.05	1311.32	11,487.17	701.97	-1,787.11
2023/24	13,135.95	1465.50	12,837.77	1,260.93	298.18
2024/25	16,535.52	1619.68	14,188.37	1,812.35	2,347.15
2025/26	20,148.65	1811.98	15,872.98	2,369.97	4,275.67
2026/27	24,580.77	2042.42	17,891.61	3,059.44	6,689.16
2027/28	30,092.65	2272.86	19,910.23	3,973.02	10,182.42
2028/29	36,854.07	2503.29	21,928.85	5,145.95	14,925.21
2029/30	43,472.28	2733.73	23,947.48	6,289.16	19,524.81
2030/31	47,714.98	3028.78	26,532.09	6,874.71	21,182.89
2031/32	51,793.35	3388.43	29,682.68	7,361.54	22,110.67
2032/33	53,131.07	3748.09	32,833.28	7,279.53	20,297.79

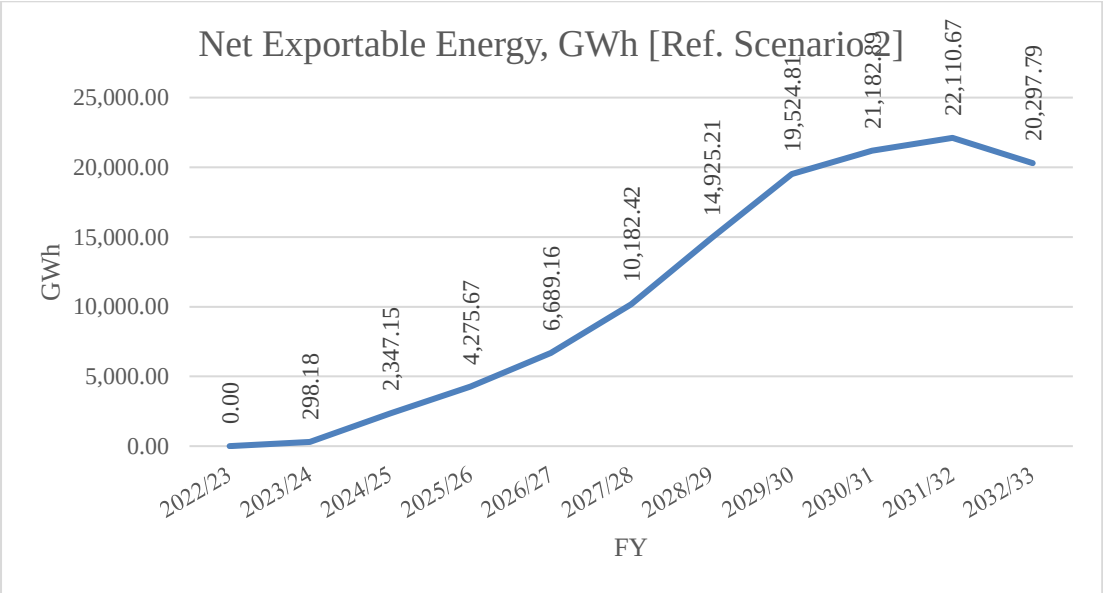

Figure 4.17 Exportable Energy Projection [Ref. Scenario 2]

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

- Currently in Nepal INPS, 130 number of power plants with total installed capacity of 2016.844 MW is in operation. Total 247 projects having installed capacity of 8,053.17 MW has already acquired license for construction from GoN and are at various stages of construction. Total 203 projects having installed capacity of 15,578.274 MW possess license for surveying from GoN. So, altogether total 580 projects having installed capacity of 25,648.288 MW are at various stages of development in Nepal. For FY 2021/22 the total projected Electricity demand in INPS is 2,378.90, while the total generated power is only 2003.16 MW. So, for FY 2021/22, Nepal is expected to import in an average of 375.29 MW of power ie 1,479.35 GWh of energy from neighboring country India.

  For FY 2022/23 power plants having installed capacity of 1,388.1 MW are expected to be connected in INPS making the cumulative total installed capacity of 3,391.71 MW. While the projected Peak power demand for that FY is expected to be 2,562.10 MW. Hence, from these projections Nepal will be able to export total of 829.61 MW i.e., 10,450.09 GWh of net energy to its neighboring countries.
- In Base Case, By the FY 2032/33 the total installed capacity of project in Nepal is projected to be 7,656.81 MW and the total Useable Generated Energy is expected to reach 27,667.89 GWh with 125.75 % increase from the base fiscal year 2022/23. The energy demand of the country is expected to reach a value of 22,282.64 GWh in FY 2032/33 & average power demand shall reach 2,543.68 MW. 113.23 % increase in demand will be seen from the base year. Average exportable energy of 5,257.46 GWh per fiscal year will be available in the INPS for the decade FY 2022/23 to 2032/33.

  In Business-as-Usual Case, By the FY 2032/33 the total installed capacity of project in Nepal is projected to be 7,656.81 MW and the total Useable Generated Energy is expected to reach 27,667.89 GWh with 125.75 % increase from the base fiscal year 2022/23. The energy demand of the country is expected to reach a value of 24,909.26 GWh in FY 2032/33 & power demand shall reach 2,843.52 MW. 141.85 % increase in demand will be seen from the base year. Average exportable energy of 4,050.04 GWh per fiscal year will be available in the INPS for the decade FY 2022/23 to 2032/33.

In Reference Scenario 1 Case, By the FY 2032/33 the total installed capacity of project in Nepal is projected to be 14,703.49 MW and the total Useable Generated Energy is expected to reach 53,131.07 GWh with 447.74 % increase from the base fiscal year 2022/23. The energy demand of the country is expected to reach a value of 24,909.26 GWh in FY 2032/33 & power demand shall reach 2,843.52 MW. 141.85 % increase in demand will be seen from the base year. Average exportable energy of 14,674.26 GWh per fiscal year will be available in the INPS for the decade FY 2022/23 to 2032/33.

In Reference Scenario 2 Case, By the FY 2032/33 the total installed capacity of project in Nepal is projected to be 14,703.49 MW and the total Useable Generated Energy is expected to reach 53,131.07 GWh with 447.74 % increase from the base fiscal year 2022/23. The energy demand of the country is expected to reach a value of 32,833.28 GWh in FY 2032/33 & power demand shall reach 3,748.09 MW. 185.83 % increase in demand will be seen from the base year. Average exportable energy of 10,913.35 GWh per fiscal year will be available in the INPS for the decade FY 2022/23 to 2032/33.

- For cross border power trade with neighboring country India, Bilateral agreement between India & Nepal on electric power trade, cross border transmission interconnections & grid connectivity on 2014. This bilateral agreement is a milestone towards possibility & opportunity of cross border power trade by Nepal with India. Similarly, with Bangladesh, Nepal signed an MoU in the field of power sector for trading of power in 2018. This MoU is also gateway towards power trade with neighboring country Bangladesh. Recently Nepal is trading the electricity to India in Indian Energy Exchange open market.

  Nepal is also associated in BIMSTEC regional cooperation. In BIMSTEC, all associated states including Nepal have agreed in mutual cooperation on energy sector. Also, all member states have agreed in establishment of BIMSTEC energy center for facilitating energy cooperation in the region. MoU for establishment of the BIMSTEC grid interconnections has also been signed by the member countries. The peak demand in the BIMSTEC region is growing at an annualized rate of 6.5 % during the period of 2015-2030 from 175 GW to 482 GW in 2030. So, looking after the ample demand of the BIMSTEC region, energy export market is a guarantee in the region.

5.2 Recommendations

i. High voltage cross border transmission line to evacuate around 2500 MW should be ready by FY 2026/27.

ii. Waste of energy is inevitable if cross border transmission line could not be constructed within FY 2026/27.

iii. Special Purpose Vehicle Authority need to be established by government to construct transmission line & cross border power trade.

iv. Policies to build, own, operate & transfer high voltage cross border transmission line by private sector need to be formulated.

v. Government initiated mega projects progress need to be expedited in rapid pace.

vi. Procedural & construction hurdles need to be taken care by government for timely completion of infrastructural power & transmission line projects. Policy to be forwarded by government in reduction of these defects preventing timely completion of infrastructural projects.

vii. The approved projects to trade in IEX need to be increased through diplomatic relations with India. IEX is becoming one of the stable markets in India for purchase & sell of electricity. As, generation by IPP's in Nepal is increasing day by day, Nepal needs to maintain good diplomatic relations for approval of IPP's projects from government of India to obtain power trade license in Indian Energy Exchange.

viii. Policy needs to be endorsed by GoN for direct link facilities in cross border power trade to private sector independent power producers.

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APPENDICES

Appendix 1: Projects in Operation

S.N.	Name of Project	Type of Project	Total PPA Capacity	COD FY
			kW	
1	Syauri Bhumey MHP	ROR	23	2074/75
2	Leguwa Khola MHP	ROR	40	2074/75
3	Gamgadi	Solar	50	2056/57
4	Simikot	Solar	50	2056/57
5	Sobuwa Khola-2 Micro Hydro	ROR	90	2075/76
6	Midim Khola Micro HPP	ROR	100	2075/76
7	Terhathum	ROR	100	2056/57
8	Ramechhap	ROR	150	2056/57
9	Syange Khola	ROR	183	2058/59
10	Baglung	ROR	200	2056/57
11	Doti	ROR	200	2056/57
12	Surnaiyagad	ROR	200	2056/57
13	Jomsom	ROR	240	2056/57
14	Phidim	ROR	240	2056/57
15	Sali Nadi	ROR	250	2064/65
16	Khandbari	ROR	250	2056/57
17	Gamgad	ROR	400	2056/57
18	Rairang Khola	ROR	500	2061/62
19	Pharping Hydropower Station	ROR	500	1967/68
20	Belkhu	ROR	518	2071/72
21	Dhunge-Jiri	ROR	600	2074/75
22	Sundarijal Hydropower Station	ROR	640	2056/57

S.N.	Name of Project	Type of Project	Total PPA Capacity	COD FY
			kW	
23	Solar Power Project	Solar	680.40	2069/70
24	Sisne Khola Small	ROR	750	2064/65
25	Vishnu Priya Solar Farm Project	Solar	960	2075/76
26	Seti-II	ROR	979	2065/66
27	Lower Piluwa Small	ROR	990	2068/69
28	Upper Hadi Khola	ROR	991	2066/67
29	Chhote Khola SHP	ROR	993	2070/71
30	Pheme Khola	ROR	995	2064/65
31	Pati Khola Small	ROR	996	2065/66
32	Miya Khola SHEP	ROR	996	2073/74
33	Jeuli Gad SHPP	ROR	996	2076/77
34	Tallo Chote Khola SHP	ROR	997	2076/77
35	Hadi khola Sunkoshi A HPP	ROR	997	2077/78
36	Suspa Bukhari Khola SHP	ROR	998	2072/73
37	Saiti Khola SHEP	ROR	999	2079/80
38	Dhalkabar Solar 1 MW, 11 kV	Solar	1,000	2078/79
39	Simara Solar Project 1 MW, 11 kV	Solar	1,000	2079/80
40	Fewa Kydropower Station	ROR	1,000	2025/26
41	Tinau	ROR	1,024	2056/57
42	Theule Khola HPP	ROR	1,500	2074/75
43	Seti Hydropower Station	ROR	1,500	2042/43
44	Thoppal Khola	ROR	1,650	2064/65
45	Middle Chaku	ROR	1,800	2069/70
46	Lower Chaku Khola	ROR	1,800	2070/71

S.N.	Name of Project	Type of Project	Total PPA Capacity	COD FY
			kW	
47	Chhandi Khola SHP	ROR	2,000	2072/73
48	Jhyadi Khola SHP	ROR	2,000	2073/74
49	Khani Khola HEP	ROR	2,000	2073/74
50	Grid Connected Solar Project, Nawalparasi	Solar	2,000	2079/80
51	Tatopani	ROR	2,000	2056/57
52	Jiri Khola Small	ROR	2,200	2071/72
53	Ridi Khola HPP	ROR	2,400	2066/67
54	Upper Syange Khola HPP	ROR	2,400	2078/79
55	Panauti Hydroposer Station	ROR	2,400	2032/33
56	Sunkoshi Small	ROR	2,500	2061/62
57	Daram Khola A	ROR	2,500	2072/73
58	Chake Khola Small HPP	ROR	2,830	2074/75
59	Piluwa Khola Small	ROR	3,000	2060/61
60	Chaku Khola SHP	ROR	3,000	2061/62
61	Bhairab Kunda	ROR	3,000	2070/71
62	Upper Puwa -1 HPP	ROR	3,000	2071/72
63	Midim Khola(Karapu) HPP	ROR	3,000	2074/75
64	Upper Rawa Khola SHP	ROR	3,000	2077/78
65	Everest Sugar and Chemical Industries Ltd.	Co-generation	3,000	2077/78
66	Indusankhar Sugar Industries	Co-generation	3,000	2078/79
67	Dhalkebar Solar Project (3 MW, 33 kV)	Solar	3,000	2078/79
68	Chatara Hydropower Station	ROR	3,200	2056/57
69	Kapadigad HPP	ROR	3,330	2075/76

S.N.	Name of Project	Type of Project	Total PPA Capacity	COD FY
			kW	
70	Charanawati Khola	ROR	3,520	2069/70
71	Dwari Khola SHPP	ROR	3,750	2073/74
72	Supermai Khola Cascade HPP	ROR	3,800	2076/77
73	Khudi Khola	ROR	4,000	2063/64
74	Saba Khola	ROR	4,000	2074/75
75	Puwa Khola -1 HPP	ROR	4,000	2074/75
76	Sardi Khola	ROR	4,000	2074/75
77	Chandranigapur Solar	Solar	4,000	2078/79
78	Upper Chhyangdi Khola SHP	ROR	4,000	2078/79
79	Som RadhaKrishna Solar Farm Project	Solar	4,000	2079/80
80	Baramchi Khola	ROR	4,200	2063/64
81	Tungun-Thosne Khola HEP	ROR	4,360	2073/74
82	Radi SHP	ROR	4,400	2070/71
83	Bijayapur-1	ROR	4,410	2069/70
84	Hewa Khola	ROR	4,455	2068/69
85	Mai Khola	ROR	4,500	2067/68
86	Bijayapur 2 Khola SHPP	ROR	4,500	2077/78
87	Miscallaneous	Isolated	4,536	2056/57
88	Upper Machha Khola Small HPP	ROR	4,550	2079/80
89	Upper Piluwa Khola 2 HPP	ROR	4,720	2079/80
90	Mardi Khola	ROR	4,800	2066/67
91	Padam Khola Small	ROR	4,800	2076/77
92	Siuri Khola	ROR	4,950	2069/70
93	Phawa Khola	ROR	4,950	2074/75

S.N.	Name of Project	Type of Project	Total PPA Capacity	COD FY
			kW	
94	Puwa-2 HPP	ROR	4,960	2079/80
95	Richet Khola SHP	ROR	4,980	2078/79
96	TalloTadi Khola HPP	ROR	4,993	2078/79
97	Tadi Khola (Thaprek)	ROR	5,000	2069/70
98	Mailung Khola	ROR	5,000	2070/71
99	Upper Hugdi Khola HEP	ROR	5,000	2071/72
100	Pikhuwa Khola SHP	ROR	5,000	2075/76
101	Ghalendi Khola HPP	ROR	5,000	2076/77
102	Ghatte Khola HPP	ROR	5,000	2077/78
103	Belchautara Solar Project	Solar	5,000	2078/79
104	Grid Connected Solar PV Project	Solar	5,000	2079/80
105	Rukumgad HPP	ROR	5,000	2079/80
106	Upper Mai C	ROR	5,100	2074/75
107	Daraudi A SHEP	ROR	6,000	2073/74
108	Lower Jogmai Khola HPP	ROR	6,200	2078/79
109	Puwakhola Hydropower Station	ROR	6,200	2052/53
110	Suri Khola HPP	ROR	6,400	2078/79
111	Rudi Khola B HPP	ROR	6,600	2076/77
112	Sapsu Khola HPP	PROR	6,600	2078/79
113	Grid Connected Solar Project, Morang	Solar	6,800	2079/80
114	Mai Cascade HPP	ROR	7,000	2072/73
115	Molung Khola HPP	ROR	7,000	2074/75
116	Upper Mardi Khola HPP	ROR	7,000	2076/77
117	Upper Khimti II HPP	ROR	7,000	2078/79

S.N.	Name of Project	Type of Project	Total PPA Capacity	COD FY
			kW	
118	Indrawati - III	ROR	7,500	2059/60
119	Upper Khorunga Khola SHP	ROR	7,500	2076/77
120	Jogmai Khola SHP	ROR	7,600	2073/74
121	Supermai HPP	ROR	7,800	2075/76
122	Mai sana Cascade HPP	ROR	8,000	2074/75
123	Upper Naugarh Gad SHP	ROR	8,000	2076/77
124	Taxar Pikhuwa Khola HPP	ROR	8,000	2077/78
125	Ankhu Khola - 1	ROR	8,400	2070/71
126	Naugarh Gad SHP	ROR	8,500	2072/73
127	Butwal Solar Project	Solar	8,500	2077/78
128	Upper Hewa Khola SHP	ROR	8,500	2078/79
129	Chepe Khola Small	ROR	8,630	2079/80
130	Rudi Khola A HPP	ROR	8,800	2075/76
131	Andhi Khola	ROR	9,400	2071/72
132	Mid Solukhola	ROR	9,500	2079/80
133	Mai Beni HPP	ROR	9,510	2078/79
134	Super Mai 'A'	ROR	9,600	2076/77
135	Sipring Khola HPP	ROR	9,658	2069/70
136	Iwa Khola HPP	ROR	9,900	2076/77
137	Kabeli B-1 Cascade	RoR	9,940	2078/79
138	Upper Mai Khola	ROR	9,980	2072/73
139	Lower Modi 1	ROR	10,000	2069/70
140	Mithila Solar PV Electricity Project	Solar	10,000	2077/78
141	Grid Connected Solar PV Project, Banke, Block-2	Solar	10,000	2079/80

S.N.	Name of Project	Type of Project	Total PPA Capacity	COD FY
			kW	
142	Makarigad HPP	ROR	10,000	2079/80
143	Sunkoshi Hydropower Station	ROR	10,050	2028/29
144	Lower Khare Khola SHPP	ROR	11,000	2078/79
145	Namarjun Madi HPP	ROR	11,880	2077/78
146	Jhimruk Khola	ROR	12,000	2051/52
147	Upper Khimti HPP	ROR	12,000	2078/79
148	Dordi-1 HPP	ROR	12,000	2079/80
149	Madkyu Khola HPP	ROR	13,000	2074/75
150	Thapa Khola	ROR	13,600	2074/75
151	Kulekhani III	STORAGE	14,000	2076/77
152	Hetauda Diesel Power Plant	THERMAL	14,410	2043/44
153	Modi Khola Hydropower Station	ROR	14,800	2057/58
154	Hewa Khola A	ROR	14,900	2073/74
155	Maya Khola HPP	ROR	14,900	2079/80
156	Devigat Hydropower Station	ROR	15,000	2040/41
157	Gandak Hydropower Station	ROR	15,000	2037/38
158	Madhya Modi HPP	ROR	15,100	2079/80
159	Kalangagad HPP	ROR	15,330	2079/80
160	Upper Solu Khola HPP	ROR	18,236	2079/80
161	Lower Modi Khola HPP	ROR	20,000	2078/79
162	Mai Khola	ROR	22,000	2071/72
163	Bagmati Khola SHPP	ROR	22,000	2075/76
164	Chilime	PROR	22,100	2060/61
165	Tallo Hewa Khola HPP	ROR	22,100	2076/77

S.N.	Name of Project	Type of Project	Total PPA Capacity	COD FY
			kW	
166	Upper Chaku A HPP	ROR	22,200	2077/78
167	Solu Khola HPP	ROR	23,500	2078/79
168	Trishuli Hydropower Station	PROR	24,000	2024/25
169	Likhu Khola A HPP	ROR	24,200	2078/79
170	Upper Madi HPP	ROR	25,000	2073/74
171	Kabeli B-1 HEP	ROR	25,000	2076/77
172	Singati Khola HPP	ROR	25,000	2078/79
173	Upper Dordi A HPP	ROR	25,000	2079/80
174	Batar (Nuwakot)	Solar	25,000	2079/80
175	Dordi Khola HPP	ROR	27,000	2079/80
176	Lower Likhu HPP	ROR	28,100	2079/80
177	Nyadi HPP	ROR	30,000	2078/79
178	Chameliya Hydroelectric Project	PROR	30,000	2074/75
179	Kulekhani II	STORAGE	32,000	2043/44
180	Upper Balephi A HPP	ROR	36,000	2079/80
181	Upper Kalangagad HPP	ROR	38,460	2079/80
182	Multiful Power Plant	THERMAL	39,000	2047/48
183	Mistri Khola HPP	ROR	42,000	2077/78
184	Super Madi HPP	ROR	44,000	2079/80
185	Bhotekoshi Khola	ROR	45,000	2057/58
186	Upper Marsyangdi A HPP	ROR	50,000	2073/74
187	Likhu-IV HPP	ROR	52,400	2078/79
188	Super Dordi Kha HPP	ROR	54,000	2079/80
189	Khimti I	ROR	60,000	2056/57

S.N.	Name of Project	Type of Project	Total PPA Capacity	COD FY
			kW	
190	Kulekhani I	STORAGE	60,000	2038/39
191	Upper Trishuli 3A Hydropower Station	ROR	60,000	2075/76
192	Marshyangdi Hdropower Station	PROR	69,000	2046/47
193	Middle Marshyangdi Hydropower Station	PROR	70,000	2065/66
194	Solu Khola(Dudhkoshi) HPP	ROR	86,000	2079/80
195	Kaligandaki A Hydropower Station	PROR	144,000	2058/59
196	Upper Tamakoshi HPP	PROR	456,000	2078/79
	Total – Projects in operation, MW		**2,684.39**	

Appendix 2: Power Purchase Agreement (PPA) Completed Projects

S.N.	Name of Project	Project Type	Capacity	ECOD
			kW	FY
1	Down Piluwa HPP	ROR	9,500	2080/81
2	Down Piluwa HPP	ROR	800	2080/81
3	Likhu 2 HPP	ROR	33,400	2080/81
4	Likhu 2 HPP	ROR	19,065	2080/81
5	Upper Sanigad HPP	ROR	10,700	2080/81
6	Ghar Khola HPP	ROR	8,300	2080/81
7	Ghar Khola HPP	ROR	5,700	2080/81
8	Ghatte Khola Small	ROR	970	2080/81
9	Upper Chameliya	ROR	40,000	2080/81
10	Sanjen (Upper) HPP	PROR	14,800	2080/81
11	Gelun Khola SHP	ROR	3,200	2080/81
12	Selang Khola SHEP	ROR	990	2080/81
13	Upper Mailung Khola HPP	ROR	14,300	2080/81
14	Khorunga Khola SHEP	ROR	4,800	2080/81
15	Upper Midim HPP	ROR	7,500	2080/81
16	Grid Connected Solar PV Project, Banke, Block-1	Solar	10,000	2080/81
17	Upper Ingua Khola SHPP	ROR	9,700	2080/81
18	Middle Bhotekoshi HPP	ROR	102,000	2080/81
19	Yambling Khola HPP	ROR	7,270	2080/81
20	Upper Chirkhwa Khola HPP	ROR	4,700	2080/81
21	Upper Lohore Sana	ROR	4,000	2080/81
22	Upper Suri Khola HPP	ROR	7,000	2080/81
23	Rasuwagadi HPP	ROR	111,000	2080/81
24	Sanjen HPP	PROR	42,500	2080/81

S.N.	Name of Project	Project Type	Capacity	ECOD
			kW	FY
25	Upper Parajuli Khola SHEP	ROR	2,150	2080/81
26	Seti Khola HPP	ROR	3,500	2080/81
27	Upper Fawa Khola	ROR	5,800	2080/81
28	Super Chepe	ROR	9,050	2080/81
29	Idi Khola SHPP	ROR	975	2080/81
30	Bhim Khola SHEP	ROR	4,960	2080/81
31	Seti Nadi HPP	RoR	25,000	2080/81
32	Likhu 1 HPP	ROR	51,400	2080/81
33	Likhu 1 HPP	ROR	25,600	2080/81
34	Middle Tara Khola SHP	ROR	1,700	2080/81
35	Middle Tara Khola SHP	ROR	500	2080/81
36	Nilgiri Khola HPP	ROR	38,000	2080/81
37	Lankhuwa Khola SHP	ROR	5,000	2080/81
38	Nilgiri Khola-2 Cascade HPP	ROR	62,000	2080/81
39	Nilgiri Khola-2 Cascade HPP	ROR	9,000	2080/81
40	Upper Gaddigag HPP	ROR	1,550	2080/81
41	Chepe A HPP	ROR	7,000	2080/81
42	Saurya Bidyut Project, Shivasakti	Solar	10,000	2080/81
43	Khani Khola (Dolakha) HPP	ROR	30,000	2080/81
44	Upper Richet	ROR	2,000	2080/81
45	Upper Mailung A HPP	ROR	5,000	2080/81
46	Upper Mailung A HPP	ROR	1,420	2080/81
47	Daram Khola HPP	ROR	7,300	2080/81
48	Daram Khola HPP	ROR	2,300	2080/81
49	Rele Khola HPP	ROR	6,000	2080/81

S.N.	Name of Project	Project Type	Capacity	ECOD
			kW	FY
50	Middle Tamor HPP	ROR	52,100	2080/81
51	Middle Tamor HPP	ROR	20,900	2080/81
52	Buku Kapati	ROR	5,000	2080/81
53	Lower Irkhuwa Khola	ROR	13,040	2080/81
54	Dudhkunda Khola HPP	ROR	12,000	2080/81
55	Upper Piluwa-3	ROR	4,950	2080/81
56	Junbesi Khola HPP	ROR	5,200	2080/81
57	Liping Khola HPP	ROR	16,260	2080/81
58	Karuwa Seti HPP	ROR	32,000	2080/81
59	Khani khola-1 HPP	ROR	25,000	2081/82
60	Khani khola-1 HPP	ROR	15,000	2081/82
61	Sunigad HPP	ROR	11,050	2081/82
62	Tinekhu Khola SHPP	ROR	990	2081/82
63	Upper Khadam Khola SHPP	ROR	990	2081/82
64	Langtang Khola HPP	ROR	10,000	2081/82
65	Langtang Khola HPP	ROR	10,000	2081/82
66	Upper Irkhuwa Khola	ROR	14,500	2081/82
67	Balefi A HPP	ROR	10,600	2081/82
68	Balefi A HPP	ROR	11,540	2081/82
69	Super Hewa Khola HPP	ROR	5,000	2081/82
70	Super Hewa Khola HPP	ROR	1,000	2081/82
71	Solar PV Project, Surkhet	Solar	1,200	2081/82
72	Baigundhura Solar Power	Solar	5,000	2081/82
73	Buku Khola HPP	ROR	6,000	2081/82
74	Jogmai Cascade	ROR	6,000	2081/82
75	Upper Chauri Khola Small	ROR	6,000	2081/82

S.N.	Name of Project	Project Type	Capacity	ECOD
			kW	FY
76	Madame Khola	ROR	24,000	2081/82
77	Middle Mewa HPP	PROR	49,000	2081/82
78	Middle Mewa HPP	PROR	24,500	2081/82
79	Upper Trishuli 3B HPP	ROR	37,000	2081/82
80	Thulo Khola	ROR	21,300	2081/82
81	Rahughat Mangale HPP	ROR	35,500	2081/82
82	Upper Rahughat HPP	ROR	48,500	2081/82
83	Rahughat	PROR	40,000	2081/82
84	Seti Khola	ROR	22,000	2081/82
85	Upper Tadi Khola HPP	ROR	11,000	2081/82
86	Phalankhu Khola SHPP	ROR	13,700	2081/82
87	Falankhu Khola HPP	ROR	5,000	2081/82
88	Falankhu Khola HPP	ROR	2,290	2081/82
89	Chauri Khola HPP	ROR	5,000	2081/82
90	Chauri Khola HPP	ROR	1,000	2081/82
91	Lower Chirkhwa HPP	ROR	4,060	2081/82
92	Dudhpokhari Chepe	ROR	8,800	2081/82
93	Super Kabeli	ROR	12,000	2081/82
94	Super Kabeli Khola-A	ROR	13,500	2081/82
95	Ksumti Khola Small	ROR	683	2081/82
96	Tallo Indrawati	ROR	4,153	2081/82
97	Mewa Khola HPP	ROR	50,000	2081/82
98	Syarpu Small HPP	ROR	3,236	2081/82
99	Lower Solu HPP	ROR	82,000	2081/82
100	Khimti-2 HPP	ROR	48,800	2081/82
101	Sanjen Khola HPP	ROR	78,000	2081/82

S.N.	Name of Project	Project Type	Capacity	ECOD
			kW	FY
102	Nupche Likhu HPP	ROR	57,500	2081/82
103	Mid Hongu Khola-B HPP	ROR	22,900	2081/82
104	Sakhu Khola-1 HPP	ROR	5,500	2081/82
105	Sagu Khola HPP	ROR	20,000	2081/82
106	Upper Thulo Khola A HPP	ROR	15,000	2081/82
107	Upper Thulo Khola A HPP	ROR	7,500	2081/82
108	Stul Khola Small HPP	ROR	1,506	2081/82
109	Mid Hongu Khola -A HPP	ROR	22,000	2081/82
110	Madhya Rawa	ROR	2,000	2081/82
111	Khorunga-Tangmaya	ROR	2,000	2081/82
112	Upper Sit Khola SHEP	ROR	905	2082/83
113	Gumu Khola	ROR	950	2082/83
114	Phedi Khola (Thumlung)	ROR	3,520	2082/83
115	Middle Super Daraudi	ROR	10,000	2082/83
116	Upper Piluwa Hills Small HPP	ROR	4,990	2082/83
117	Teliya Khola SHP	ROR	996	2082/83
118	Upper Bhurundi	ROR	3,750	2082/83
119	Mid Daram A Small HPP	ROR	3,000	2082/83
120	Mid Daram Khola B Small HPP	ROR	4,500	2082/83
121	Chepe Khola Cascade	ROR	2,000	2082/83
122	Bhalaudi Khola	ROR	2,645	2082/83
123	Super Nayadi HPP	ROR	40,270	2082/83
124	Hewa A Small	ROR	5,000	2082/83
125	Khani Khola	ROR	550	2082/83
126	Ribal khola	ROR	998	2082/83

S.N.	Name of Project	Project Type	Capacity	ECOD
			kW	FY
127	Kabeli-3 HPP	ROR	21,930	2082/83
128	Midim-1	ROR	13,424	2082/83
129	Irkhuwa Khola B HPP	ROR	15,524	2082/83
130	Upper Belkhu Khola SHPP	ROR	750	2082/83
131	Upper Belkhu Khola SHPP	ROR	246	2082/83
132	Middle Midim HPP	ROR	3,100	2082/83
133	Middle Midim HPP	ROR	1,700	2082/83
134	Gohore Khola Small HPP	ROR	950	2082/83
135	Rauje Khola HPP	ROR	17,712	2082/83
136	Jurimba Khola	PROR	7,630	2082/83
137	Menchet HPP	ROR	7,000	2082/83
138	Sangu (Sorun) Khola HPP	RoR	5,000	2082/83
139	Palun Khola Small	ROR	21,000	2082/83
140	Super Ghalemdi HPP	ROR	9,140	2082/83
141	Lower Balephi Khola HPP	ROR	20,000	2082/83
142	Rupse Khola SHPP	ROR	4,000	2082/83
143	Upper Myagdi HPP	ROR	20,000	2082/83
144	Chulepu Khola HPP	ROR	8,520	2082/83
145	Darbang Myagdi HPP	ROR	25,000	2082/83
146	Upper Lapche Khola HPP	ROR	52,000	2082/83
147	Upper Nyasem Khola HPP	ROR	41,400	2082/83
148	Leguwa Khola SHP	ROR	640	2082/83
149	Lower Selang Khola HPP	ROR	1,500	2082/83
150	Sabha Khola B HPP	ROR	15,100	2082/83
151	Lapche Khola HPP	PROR	99,400	2082/83
152	Lapche Khola HPP	PROR	60,600	2082/83

S.N.	Name of Project	Project Type	Capacity	ECOD
			kW	FY
153	Gulandi Khola Small	ROR	980	2082/83
154	Bhotekoshi-1 HPP	ROR	40,000	2082/83
155	Mashina HEO	ROR	891	2082/83
156	Myagdi Khola HPP	ROR	57,300	2082/83
157	Isuwa Khola HPP	PROR	97,200	2082/83
158	Kasuwa Khola HPP	PROR	45,000	2082/83
159	Tamor Khola-5	ROR	37,520	2082/83
160	Sabha Khola-C	ROR	4,196	2082/83
161	Lower Isuwa Cascade HPP	PROR	37,700	2082/83
162	Lower Isuwa Cascade HPP	PROR	2,400	2082/83
163	Bhrikuti Grid-Tied Solar Project	Solar	8,000	2082/83
164	Lower Mid Rawa	ROR	4,000	2082/83
165	Hidi Khola HPP	ROR	6,820	2082/83
166	Duhabi Solar Project 8 MW,33 kV	Solar	8,000	2082/83
167	Tinau Khola Small HPP	ROR	990	2083/84
168	Sanonilti Khola HPP	ROR	3,000	2083/84
169	Parwanipur Solar 8 MW, 11 kV	Solar	8,000	2083/84
170	Lower Tadi HPP	ROR	5,000	2083/84
171	Lamahi Solar Project	Solar	3,000	2083/84
172	Ankhu Khola HPP	ROR	34,000	2083/84
173	Sabha Khola A HPP	ROR	8,300	2083/84
174	Siddhi Khola HPP	ROR	10,000	2083/84
175	Saptang Khola Small HPP	ROR	2,500	2083/84
176	Jadari Gad Small	ROR	1,000	2083/84

S.N.	Name of Project	Project Type	Capacity	ECOD
			kW	FY
177	Tinau Khola Small HPP	ROR	675	2083/84
178	Salubyani Gad Small	ROR	233	2083/84
179	Sabha Khola A HPP	ROR	1,690	2083/84
180	Nuwagad Small	ROR	1,000	2083/84
181	Ruru Banchu-1 HPP	ROR	13,500	2083/84
182	Upper Nasam Khola A HPP	ROR	21,000	2083/84
183	Rurubanchu Khola-2	ROR	12,000	2083/84
184	Middle Trishuli Ganga HPP	ROR	19,410	2083/84
185	Lower Khorunga	ROR	5,500	2083/84
186	Super Sabha Khola Small	ROR	4,100	2083/84
187	Sona Khola HPP	ROR	9,000	2083/84
188	Rasuwa Bhotekoshi	ROR	120,000	2083/84
189	Super Ankhu HPP	ROR	23,500	2083/84
190	Upper Khudi	ROR	21,210	2083/84
191	Kunaban Khola HPP	ROR	20,000	2083/84
192	Super Trishuli HPP	ROR	25,000	2083/84
193	Tanahau HEP	STORAGE	140,000	2083/84
194	Aayu Malun khola	ROR	21,000	2083/84
195	Upper Ankhu Khola HPP	ROR	38,000	2083/84
196	Bhotekoshi-5 HPP	ROR	62,000	2083/84
197	Upper Daraudi B Small	ROR	8,300	2083/84
198	Upper Daraudi C Small	ROR	9,820	2083/84
199	Nyadi-Phidi HPP	ROR	21,400	2083/84
200	Shyam Khola	PROR	7,200	2083/84
201	Siwa Khola	PROR	9,300	2083/84
202	Upper Brahamayani HPP	ROR	15,150	2083/84

S.N.	Name of Project	Project Type	Capacity	ECOD
			kW	FY
203	Brahamayani HPP	ROR	35,470	2083/84
204	Pegu Khola	ROR	3,000	2083/84
205	Mewa Khola HPP	ROR	23,000	2083/84
206	Luja Khola	ROR	23,550	2083/84
207	Luja Khola	ROR	1,274	2083/84
208	Super Trishuli HPP	ROR	70,000	2083/84
209	Upper Deumai	PROR	8,300	2083/84
210	Kalika Kaligandaki	PROR	38,160	2083/84
211	Arun Khola-2	ROR	2,000	2083/84
212	Jumdi Khola SHPP	ROR	1,750	2084/85
213	Balefi HPP	ROR	23,520	2084/85
214	Badi Gad Khola HPP	ROR	6,600	2084/85
215	Salankhu Khola SHPP	ROR	2,500	2084/85
216	Lohore Khola SHPP	ROR	4,200	2084/85
217	Rawa Khola HPP	ROR	6,500	2084/85
218	Lower Midim Khola HPP	ROR	996	2084/85
219	Tangchhahara SHEP	ROR	2,200	2084/85
220	Khare HPP	ROR	24,100	2084/85
221	Kabeli -A HEP	PROR	37,600	2084/85
222	Upper Daraudi-1 HPP	ROR	10,000	2084/85
223	Lower Modi 2 Khola HPP	ROR	10500	2084/85
224	Sisa Khoal A HPP	ROR	2,800	2084/85
225	Nyam Nyam Khola HPP	ROR	6,000	2084/85
226	Upper Trishuli - 1	ROR	216,000	2084/85
227	Ilep (Tatopani) Khola	ROR	23,675	2084/85
228	Landruk Modi HPP	ROR	86,590	2084/85

S.N.	Name of Project	Project Type	Capacity	ECOD
			kW	FY
229	Marshyangdi Besi HPP	ROR	50,000	2084/85
230	Likhu Khola	ROR	30,000	2084/85
231	Nyasim Khola	ROR	35,000	2084/85
232	Dudh Khola	RoR	65,000	2084/85
233	Manang Marsyangdi	PROR	135,000	2084/85
234	Machha Khola	ROR	16,000	2084/85
235	Dudhkoshi 2 - Jaleshwor	PROR	70,000	2084/85
236	Sani Bheri 3	PROR	46,720	2084/85
237	Manahari Khola	PROR	4,444	2084/85
238	Simkosh Khola	PROR	3,450	2084/85
239	Upper Myagdi -1	ROR	53,500	2084/85
240	Super Machha Khola Sana	ROR	4,600	2084/85
241	Upper Junbesi	PROR	4,700	2084/85
242	Jum Khola	ROR	55,615	2085/86
243	Middle Kaligandaki	ROR	53,539	2085/86
244	Upper Tamor	PROR	255,281	2085/86
245	Tamakoshi-V	PROR	86,067	2085/86
246	Lapche Tamakoshi	PROR	40,000	2085/86
247	Upper Chhujung	PROR	40,700	2085/86
248	Bakan Khola	PROR	44,000	2085/86
249	Chhujung Khola	PROR	63,000	2085/86
250	Yaru Khola	PROR	30,542	2085/86
251	Dovan khola	PROR	24,500	2085/86
252	Tamakoshi-V	PROR	8,733	2085/86
253	Upper Modi 'A'	ROR	42,000	2085/86
254	Super Melamchi khola	ROR	23,600	2085/86

S.N.	Name of Project	Project Type	Capacity	ECOD
			kW	FY
255	Mathilllo Sankhuwa	ROR	40,000	2085/86
256	Super Tallo Bagmati	ROR	41,314	2085/86
257	Sani Bheri	ROR	44,520	2085/86
258	Jagudlla	PROR	106,000	2086/87
259	Kaligandaki Gorge	PROR	180,000	2087/88
	Total_PPA Completed Projects		**5,872,883.0**	

Appendix 3: PPA in Process – ROR type

S.N.	Project	Installed Capacity (kW)	ECOD Taken
1	Lodo Khola	1,600.00	2083/84
2	Gaddi gad	1,000.00	2083/84
3	Bagar Khola	5,500.00	2083/84
4	Trishuli sana	8,000.00	2083/84
5	Khimti-Gwang Khola	9,000.00	2083/84
6	Miwaje	4,950.00	2083/84
7	Upper Pikhuwa Khola	4,900.00	2083/84
8	Tallo Rupse Khola	1,860.00	2084/85
9	Tinau Khola	1,775.00	2084/85
10	Upper Seti	20,000.00	2084/85
11	Upper Sardi Khola	2,900.00	2084/85
12	Garjang Khola	900.00	2084/85
13	Lower Khani B	6,200.00	2084/85
14	Upper Piluwa Khola-1	7,700.00	2084/85
15	Mistri Khola-2	11,800.00	2084/85
16	Upper Kabeli	28,100.00	2084/85
17	Malta Bagmati	6,500.00	2084/85
18	Mathhilo Balephi	46,000.00	2084/85
19	Gashali Khola	4,500.00	2084/85
20	Dar Khola	6,500.00	2084/85
21	Mathhilo Sagu	10,000.00	2084/85
22	Upper Madi-0	43,000.00	2084/85
23	Sishuwa Khola	13,500.00	2085/86
24	Lower Nyadi	12,600.00	2085/86
25	Upper Bhurundi Khola A	4,500.00	2085/86
26	Chhomrong Khola	4,894.00	2085/86
27	Suti Khola	21,000.00	2085/86
28	Balephi Khola	40,000.00	2085/86
29	Upper Mewa Khola A	31,920.00	2085/86

S.N.	Project	Installed Capacity (kW)	ECOD Taken
30	Syalque Khola	4,800.00	2085/86
31	Ankhu Khola - 2	20,000.00	2086/87
32	Tamor Mewa	128,000.00	2086/87
33	Super Tamor	166,000.00	2086/87
34	Bajra Madi	24,800.00	2086/87
35	Jaldigad	20,731.00	2086/87
36	Super Sabha Khola A	9,550.00	2086/87
37	Upper Seti-1	13,000.00	2086/87
38	Madhya Chameliya	28,304.00	2086/87
39	Tiplyang Kaligandaki	58,000.00	2086/87
40	Upper Trishuli Casade-1	24,600.00	2087/88
61	Chyane Gumu Khola	76.00	2084/85
60	Surnayagad Laghu ja.bi.aa	90.00	2084/85
57	Ludee Khola	950.00	2084/85
46	Kisedi Khola	974.00	2084/85
50	Elun Khola	987.00	2084/85
56	Hudi Khola	991.00	2084/85
45	Chisang khola A	1,800.00	2084/85
48	Dhad Khola	1,800.00	2084/85
43	Tadi Khola Cascade	3,000.00	2084/85
51	Langdi Khola	3,260.00	2084/85
42	Madya Sunkoshi	3,400.00	2084/85
58	Lower Tara	3,500.00	2084/85
54	Lower Bhim Khola	3,600.00	2084/85
47	Badigad (Kolti)	4,500.00	2084/85
49	Garchyang Khola	6,600.00	2084/85

S.N.	Project	Installed Capacity (kW)	ECOD Taken
44	Upper Daraudi	9,200.00	2084/85
53	Upper Maiwa Khola	17,850.00	2085/86
59	Dana khola	34,800.00	2085/86
41	Chameliya (Chhatigad)	85,000.00	2086/87
55	Upper Trishuli-2	102,000.00	2087/88
52	Lower Barun Khola	132,000.00	2087/88
		1,275.26	

Appendix 4: PPA in Process – PROR Type

S.N.	Project	Project Location	Installed Capacity (kW)
1	Dev dhunga Chaku	Sindhupalchowk	3,412
2	Mudi Khola	Myagdi	14,700
3	Thuligad	Doti	17,000
4	Upper Dudh Khola	Manang	30,400
5	Induwa Khola	Sankhuwasabha	24,921
6	Isuwa Cascade-2 (PRoR) Hydropower Project	Sankhuwasabha	9,950
7	Isuwa (PRoR) Cascade-3	Sankhuwasabha	9,950
8	Budhigandaki Ka	Gorkha	103,400
9	Budhigandaki Kha	Gorkha	226,000
10	Nar Khola	Manang	61,110
11	Dhaula Khola	Myagdi	10,600
12	Lower Manang Marsyandi	Manang	139,200
13	Upper Marshyangdi-1	Lamjung	102,000
14	Tila-1	Kalikot	298,750
15	Tila-2	Kalikot	296,740
16	Bajhang Seti	Bajhang	216,000
17	Lower Hewa Khola A	Taplejung	6,930
18	Tallo Chameliya	Darchula	18,470
19	Budi Gandaki	Gorkha	340,423
	Total – PROR in Process, MW		**1,929.96**

Appendix 5: Connection Agreement (CA) Completed – Run Off River (ROR) Type

S.N.	Project	Installed Capacity (kW)	ECOD Taken
1	Daram khola laghu ja.bi.aa.	85.00	2084/85
2	Paropakar Sahakari Laghu	135.00	2084/85
3	Phedi Khola (Thumlung)	780.00	2084/85
4	Super Nyadi	2,000.00	2084/85
5	Thaligad	2,000.00	2084/85
6	Sabha Khola C	2,094.00	2084/85
7	Lower Bhim Khola	2,450.00	2084/85
8	Kalinchowk sana	3,000.00	2084/85
9	Kisedi Khola	4,100.00	2084/85
10	Pikhuwa Pashupati	4,100.00	2084/85
11	S. Mathillo Iwa	4,100.00	2084/85
12	S. Mathillo Iwa	4,100.00	2084/85
13	Chyandi Khola	4,200.00	2084/85
14	Lower Thulo Khola	4,750.00	2084/85
15	Syano Khola	4,750.00	2084/85
16	Super Iwa Khola	4,795.00	2084/85
17	Mathillo Melamchi	4,950.00	2084/85
18	Tallo Melamchi	4,960.00	2084/85
19	Jhyaku Khola	5,243.00	2084/85
20	Rawa	5,400.00	2084/85
21	Upper Ankhu	6,000.00	2084/85
22	Madhya Molung Khola SHEP	6,000.00	2084/85
23	Sabha Khola B	6,400.00	2084/85
24	Lower Mewa	6,630.00	2084/85
25	Piluwa Khola (Khawa)	6,730.00	2084/85

S.N.	Project	Installed Capacity (kW)	ECOD Taken
26	Lower Tawa	7,100.00	2084/85
27	Kabeli-3 Cascade	7,450.00	2084/85
28	Myagdi Khola	7,700.00	2084/85
29	Chino Khola	7,832.00	2084/85
30	Tadi Ghyamphedi	8,000.00	2084/85
31	Lower Kalangagad	8,000.00	2084/85
32	Tallo Dudhkunda	9,480.00	2084/85
33	Nimrung Khoola	9,800.00	2084/85
34	Likhu 4 A Cascade	12,230.00	2085/86
35	Myagdi Khola-B	12,500.00	2085/86
36	Upper Mudi Khola	12,730.00	2085/86
37	Madhya Mailung Khola	13,000.00	2085/86
38	Budum Khola	14,500.00	2085/86
39	Upper Kabeli-2	14,538.00	2085/86
40	Irkhuwa Khola ka	15,000.00	2085/86
41	Dana khola	15,150.00	2085/86
42	Mathillo Myagdi	17,000.00	2085/86
43	Upper Mailung B	17,000.00	2085/86
44	Dordi Dudh	19,000.00	2085/86
45	Tatopani Khola	19,000.00	2085/86
46	Uppallo Rurubanchu	19,600.00	2085/86
47	Rolwaling	20,660.00	2085/86
48	Super Inkhu	22,070.00	2085/86
49	Apsuwa Khola 1	22,248.00	2085/86
50	Myagdi Khola-A	23,700.00	2085/86
51	Super Seti	24,000.00	2085/86
52	Mathillo Inkhu	24,220.00	2085/86
53	Badigad	24,600.00	2085/86
54	Myardi	27,500.00	2085/86

S.N.	Project	Installed Capacity (kW)	ECOD Taken
55	Hongu Khola	28,900.00	2085/86
56	Hongu Khola -1	29,959.00	2085/86
57	Palun Khola - 1	30,000.00	2085/86
58	Mathhilo Apsuwa Khola	35,150.00	2085/86
59	Tamor Khola	35,288.00	2085/86
60	Super Palun	35,310.00	2085/86
61	Mathillo Simbuwa Khola	40,030.00	2085/86
62	Sankhuwa Khola	41,060.00	2085/86
63	Chhilung Khola	43,200.00	2085/86
64	Lower Apsuwa	54,000.00	2086/87
65	Himchuli Dordi	57,000.00	2086/87
66	Upper Tamor A	60,000.00	2086/87
67	Simbuwa Khola	69,477.00	2086/87
68	Ghunsa Khola	77,500.00	2086/87
69	Budhigandaki	91,150.00	2086/87
70	Dudhkoshi-9	166,000.00	2087/88
71	Dudhkoshi-6	171,000.00	2087/88
72	Surke Dudhkoshi	188,000.00	2087/88
	Total – Connection Agreement ROR Type, MW	**1,808.38**	

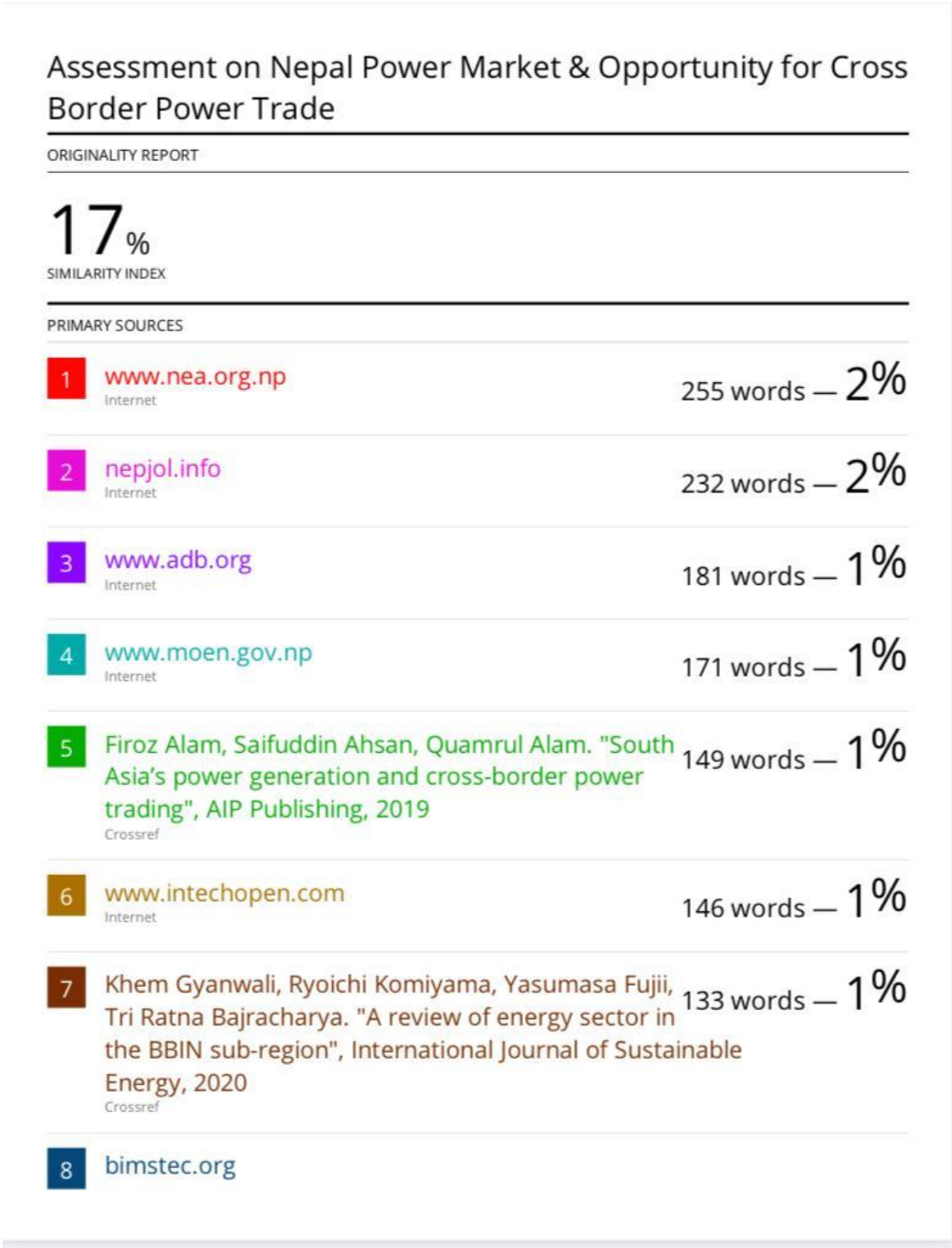
Appendix 6: Connection Agreement (CA) completed Peaking Run Off River (PROR) Type

S.N.	Project	Capacity KW	ECOD Taken
1	Daraudi Nadi	9,840	2084/85
2	Upper Sunigad	14,000	2085/86
3	Tejo Thogam	28,970	2085/86
4	Seti Nadi 3	86,211	2086/87
5	Marsyangdi Nadi	99,800	2086/87
6	Mathillo Arun	1,061,000	2089/90
	Total – CA Completed PROR Type, MW	**1,300**	

Appendix 7: Government Strategic Projects

Name of Project	Type	Capacity (kW)	ECOD
Chainpur Seti Hydroelectric Project	PROR	210,000	2087/88
Dudhkoshi Storage Hydroelectric Project	Storage	635,000	2088/89
Arun 3	ROR	900,000	
Bheri Babai Multipurpose	ROR	48,000	
Total - GoN Strategic Projects, MW		**1,793**	

Appendix 8: Plagiarism Test



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