

Ministry of Energy and Natural Resource

Bhutan Power System Operator

Thimphu: Bhutan



Transmission System Performance Report

Fourth Quarterly Report 2023



Table of Contents

- 1. INTRODUCTION 2**
- 2. TOTAL INSTALLED CAPACITY.....2**
- 2. NATIONAL PEAK DEMAND..... 2**
- 2.1. POWER (MW) CONSUMED BY COUNTRY 2
- 3. ENERGY AVAILABILITY AND REQUIREMENT FOR THE COUNTRY 3**
- 3.1. ENERGY (MU) CONSUMED BY COUNTRY 3
- 4. PERFORMANCE OF GENERATING PLANTS..... 4**
- 4.1. POWER AND ENERGY GENERATION 4
- 4.2. PLANT CAPACITY FACTOR..... 5
- 5. EXPORT AND IMPORT OF ELECTRICITY 5**
- 6. FREQUENCY PROFILE OF SELECTED SUBSTATIONS 6**
- 7. VOLTAGE PROFILE OF SELECTED SUBSTATIONS 7**



1. Introduction

The electricity transmission network in Bhutan is solely owned by Bhutan Power Corporation limited (BPC) and electricity generation is solely owned by Druk Green Power Corporation Limited (DGPC). Bhutan Power System Operator (BPSO) under Ministry of Energy and Natural Resource is responsible for safe, secure and efficient operation of Bhutan transmission network and generation.

This quarterly report is prepared in compliance to the Grid Code Regulation (GCR) 2008, clause 6.14.1, and “System Operator has to submit a quarterly report covering the performance of the Transmission System to all Licensees, Authority and Ministry”. This transmission performance report contains summary of growth of peak demand, performance of generating stations (power and energy generation), energy availability and requirement for the country, export and import of electricity to/ from India, frequency profile of selected substation and voltage profile of few important substations.

All the index and other calculations in this report have been executed based on the data received from substations and generating plants.

2. Total installed Capacity

2.1. Major Plants: 2326 MW

2.2. Mini & Micro: 8.1 MW

2.3. DG: 8.9 MW

2.4. Wind: 0.6 MW

3. National Peak Demand

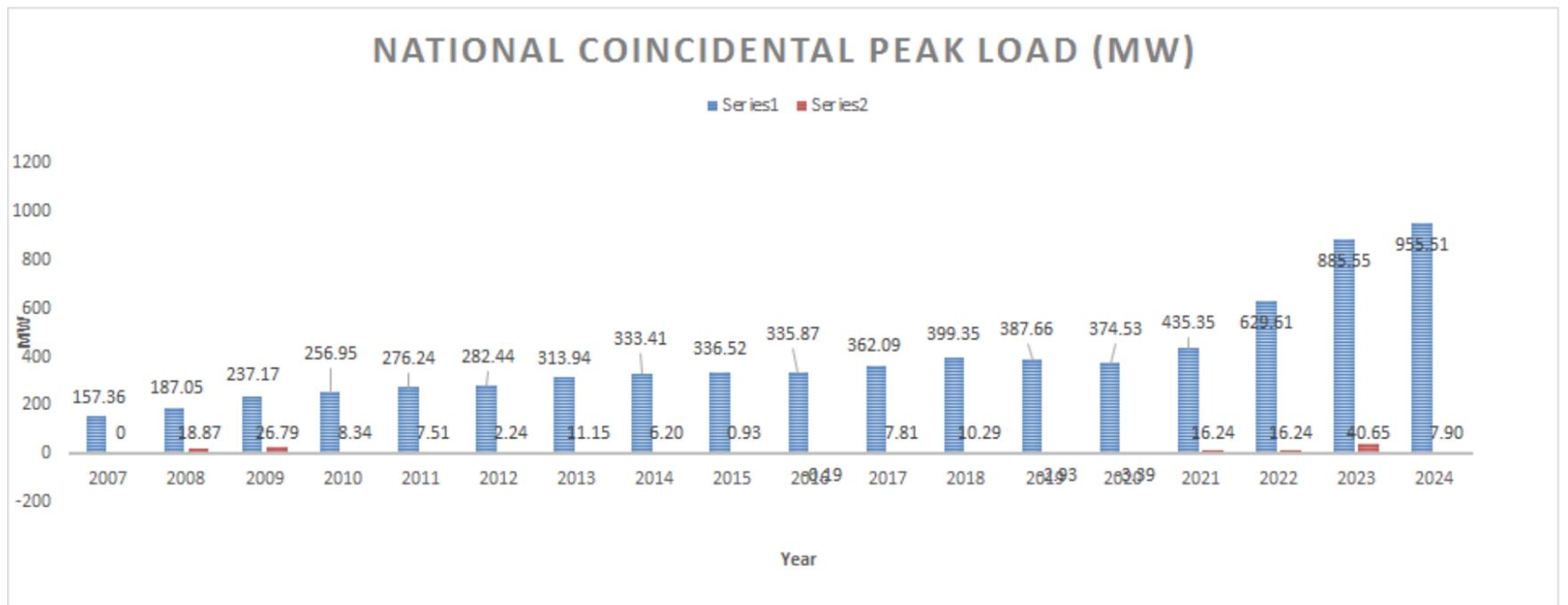
The national peak demand for the year 2023 is recorded at **955.51MW** which was occurred on December 30th, 2023 at 18:00 hours. This is calculated by summation of Generation minus Export/Import.

Table 3.1. The National Peak Demand since 2007

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Peak Load (MW)	157.36	187.05	237.17	256.95	276.24	282.44	313.94	333.41	336.52	335.87	362.09	399.35	387.66	374.53	435.35	629.61	885.55	955.51
% Growth over previous Year	-	18.87	26.79	8.34	7.51	2.24	11.15	6.20	0.93	-0.19	7.81	10.29	-2.93	-3.39	16.24	16.24	40.65	7.90

Source: from BPSO SCADA

Graph 3.1. The growth in National Peak Demand since 2007



3.1. Power (MW) consumed by country

Following methods are used to calculate peak demand for the Eastern Grid, Western Grid and National demand.

1. **National Demand** = (Sum of all total generation)-(Sum of all Export or Import)
2. **National Demand** = (Sum of all feeders loading at hydropower station) – (Sum of all Export/Import)
3. **National Demand** = (Sum of all substation loading)

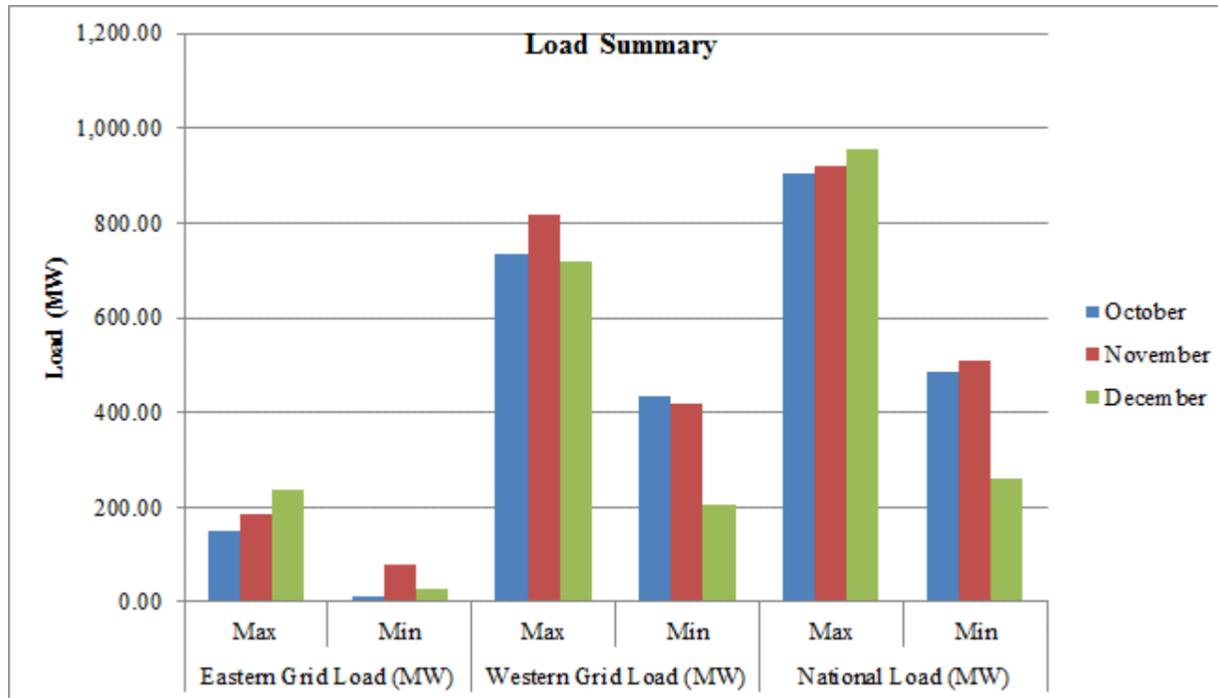
For this report, the National Demand was calculated using method-1.



Table 3.1.1. Domestic demand for Eastern Grid, Western Grid and National using method- 1

Grid	Eastern Grid Load (MW)		Western Grid Load (MW)		National Load (MW)		
	Max	Min	Max	Min	Max	Min	
October	150.47	12.47	736.07	433.06	905.21	485.90	27th Oct 2023 ,19hrs
November	186.99	77.24	818.27	419.63	921.87	509.96	18th Nov 2023, 1837hrs
December	235.22	29.31	720.29	205.14	955.51	259.94	30th Dec 2023, 18hrs

Graph 3.1.1. Domestic demand for Eastern Grid, Western Grid and National using method- 1



4. Energy Availability and Requirement for the country

4.1. Energy (MU) consumed by Country

The total energy consumed within Bhutan is computed from the total energy DGPC had sold to BPC including the royalty energy.

Table 4.1.1. Total Energy (MU) consumed

Month	Total Ex-bus (MU)	Total Export/Import (MU)	Total energy sold to BPC (MU)
July	1180.05279235	587.32328290	594.97574339
August	557.14849779	42.69519744	516.34544293
September	402.23893692	20.64326880	383.40882866

Graph 4.1.1. Total Energy (MU) consumed

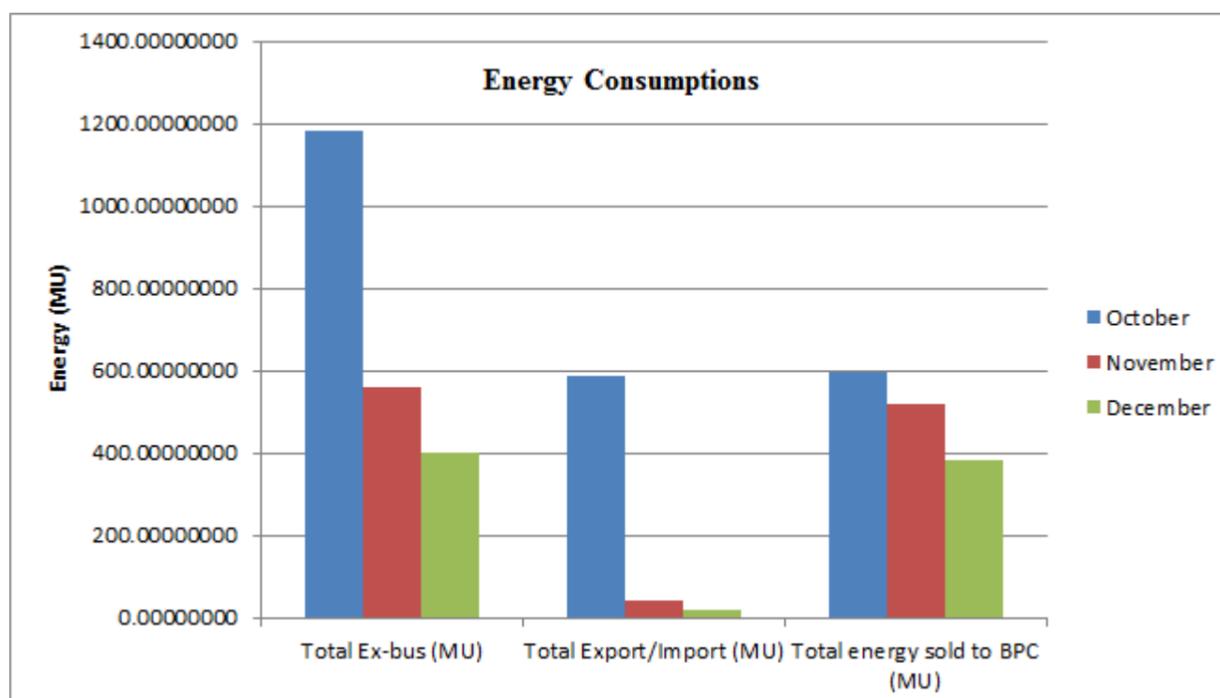
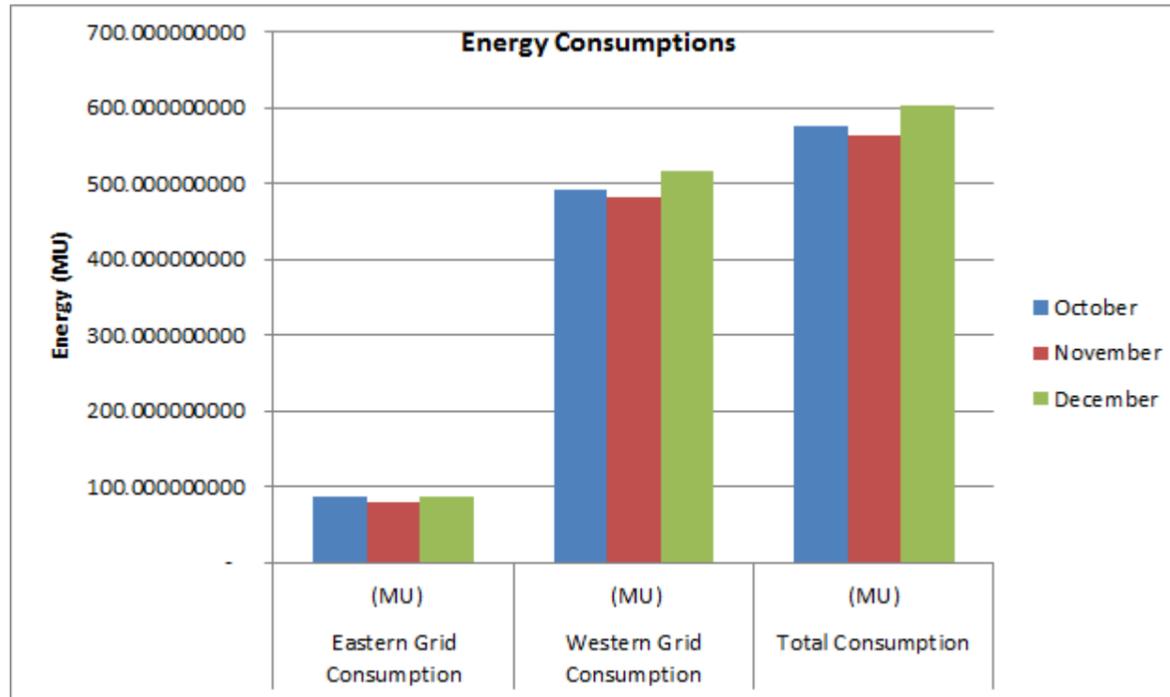




Table 4.1.2. Energy (MU) consumed

Grid	Eastern Grid Consumption	Western Grid Consumption	Total Consumption
Month	(MU)	(MU)	(MU)
October	85.641409540	490.782760	576.424169500
November	79.937689860	482.850343	562.7880329
December	86.010658610	516.415647	602.4263061

Graph 4.1.2. Energy (MU) consumed



5. Performance of generating plants

5.1 Power and Energy Generation

The maximum total generation for the fourth quarter of year 2023 was 2,538.89 MW in month of October and minimum generation was 1138.71 MW in the November month.

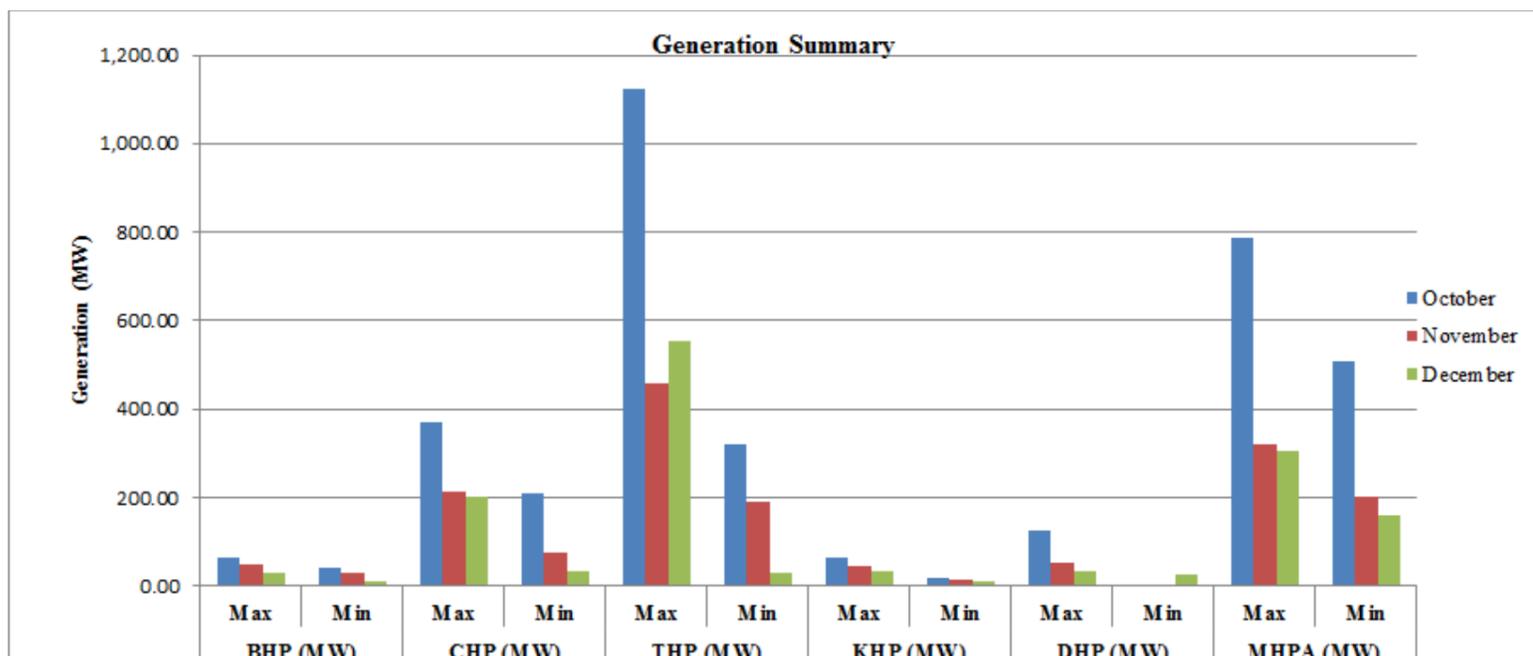
Table: 5.1.1 Summary of maximum and minimum generation by various hydropower plant

Generation By	BHP (MW)		CHP (MW)		THP (MW)		KHP (MW)		DHP (MW)		MHPA (MW)		TOTAL (MW)	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
October	66.10	41.70	369.73	208.66	1,122.00	320.00	66.00	16.50	127.09	0.00	787.97	507.11	2,538.89	1,093.97
November	48.00	29.10	212.28	77.36	460.00	190.00	45.17	13.04	52.85	0.00	320.41	200.50	1,138.71	510.00
December	31.60	9.80	201.47	34.02	555.00	30.00	32.29	11.01	34.02	24.27	305.81	159.00	1,160.19	268.10

DHP Whole Unit Shutdown on Octobetr 2nd at 7am and 30th November at 11hrs. BHP only one unit was running on 1/12/2023 at 12hrs

Source: Hydropower Plants (DGPC)

Graph: 5.1.1 Summary of maximum and minimum generation by various hydropower plant





5.1. Plant Capacity Factor

The capacity factor of each generating plant was calculated as below:

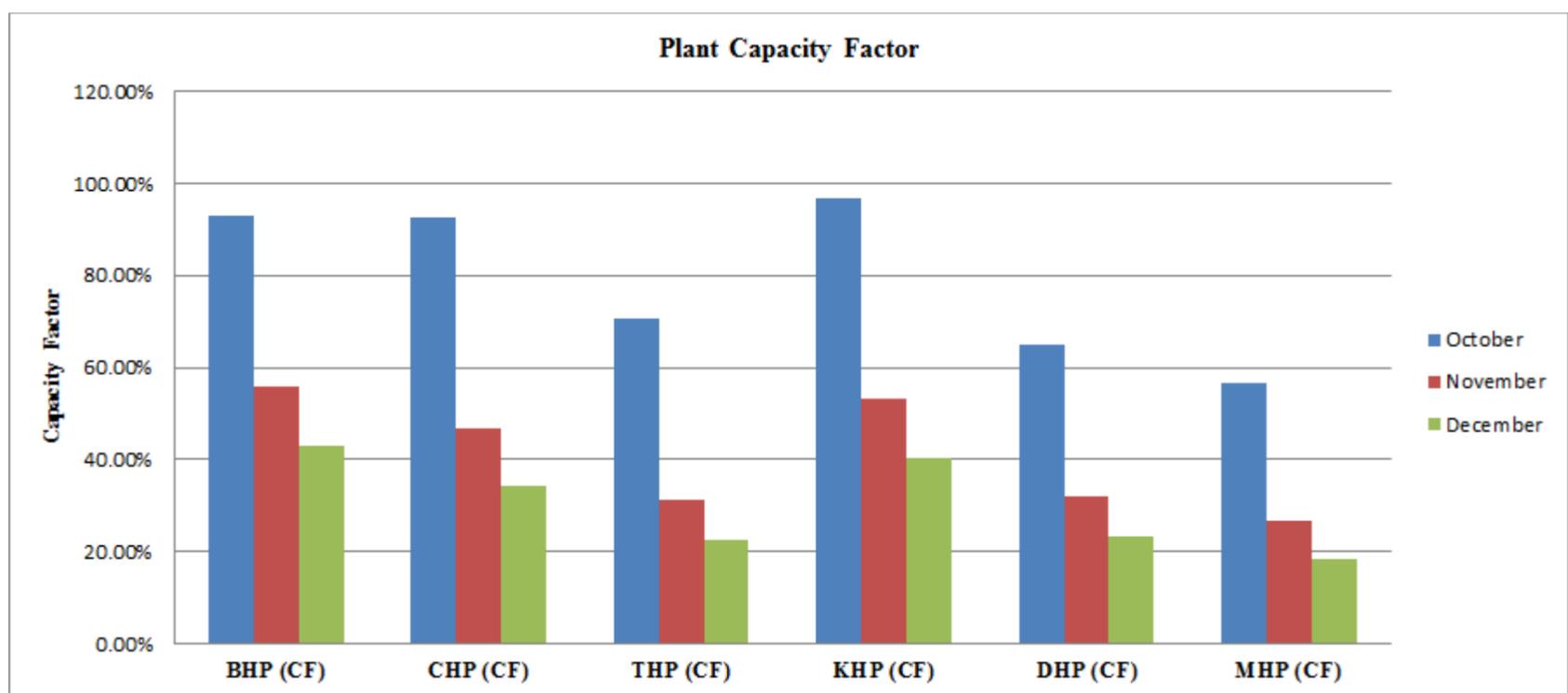
$$Capacity\ factor = \frac{Total\ energy\ plant\ has\ produce\ over\ a\ period}{Total\ energy\ plant\ would\ produce\ when\ operated\ at\ full\ capacity}$$

Table 5.2.1: Total generation and capacity factor of various hydropower plants

Month	BHP (MU)	BHP (CF)	CHP (MU)	CHP (CF)	THP (MU)	THP (CF)	KHP (MU)	KHP (CF)	DHP (MU)	DHP (CF)	MHP (MU)	MHP (CF)
October	42.86703	93.03%	223.69537	92.47%	518.542545	70.61%	41.881938	96.95%	59.01	65.04%	294.06	56.72%
November	25.81995	56.03%	113.01257	46.71%	228.012509	31.05%	22.930302	53.08%	29.12	32.10%	138.25	26.67%
December	19.74211	42.84%	82.87725	34.26%	166.472582	22.67%	17.463437	40.42%	21.06	23.22%	94.62	18.25%

Source: TD, BPC

Graph 5.2.1: Capacity factor of various hydropower plants



6. Export and Import of Electricity

Maximum export for the Fourth quarter of year 2023 was 1,004.27 MW in the month of October to Binaguria substation in India. The minimum export recorded was 3.53 MW to Salakoti and Rangia substation in India during the month of December.

Table 6.1. Export of electricity to India

Export To	Binaguri (MW)		Birpara (MW)		Salakoti and Rangia (MW)		Alipurduar(MW)	
	Max	Min	Max	Min	Max	Min	Max	Min
October	1,004.27	139.00	152.62	0.74	108.09	0.12	728.27	4.59
November	460.73	0.36	104.70	15.96	46.93	0.12	507.99	0.35
December	526.00	2.18	0.00	0.00	3.53	0.02	507.99	2.60

Graph 6.1. Export of electricity to India

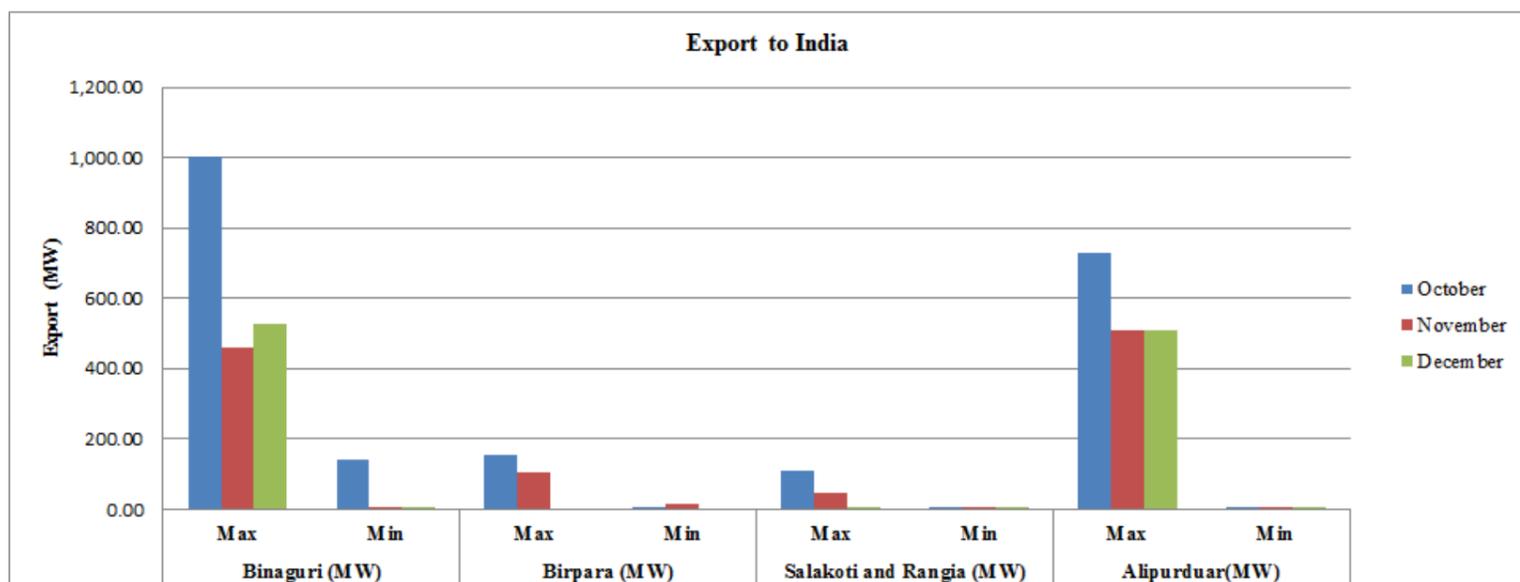
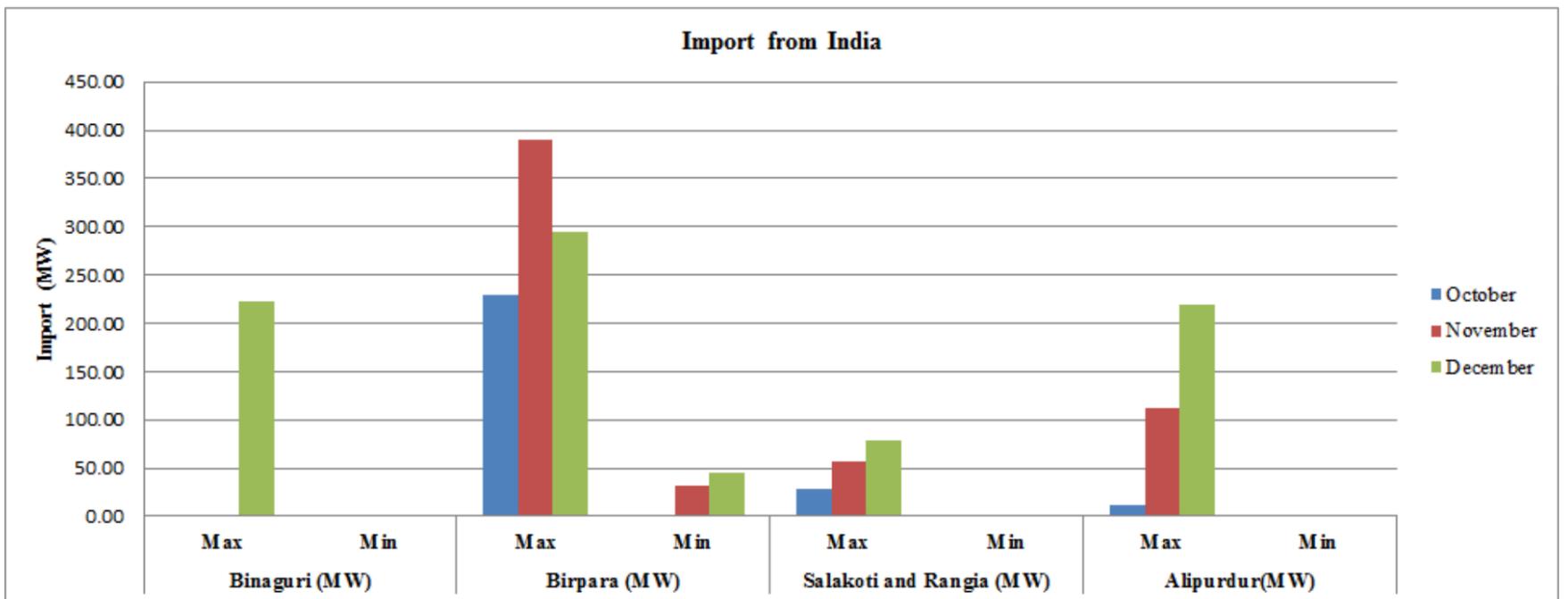




Table 6.2. Import of electricity from India.

Import From	Binaguri (MW)		Birpara (MW)		Salakoti and Rangia (MW)		Alipurdur(MW)	
	Max	Min	Max	Min	Max	Min	Max	Min
October	0.00	0.00	229.00	1.58	28.45	1.55	11.50	0.00
November	0.00	0.00	390.48	32.57	56.81	0.01	111.80	0.00
December	222.64	1.91	295.28	44.52	77.83	0.02	220.10	0.00

Graph 6.2. Import of electricity from India



7. Frequency profile

The nominal allowed frequency range shall be 50Hz ± 1% in Bhutan. The system is normally managed such that frequency is maintained within operational limit of 49.5 Hz to 50.5 Hz. However, frequency may move outside these limit under faulty condition.

As per the Grid Code 2008, clause 6.4.1 the frequency is classified into three different bands as follows:

- a. Normal state
The transmission System frequency is within the limit of 49.5Hz to 50.5Hz.
- b. Alert state
The Transmission System frequency is beyond the normal operating limit but within 49.0Hz to 50.0Hz.
- c. Emergency state
There is generation deficiency and frequency is below 49.0Hz.

The frequency at 220kV Bus at 220/66/11kV Semtokha substation in the western grid and 132kV Bus at 60MW Kurichhu Hydropower Plant in the eastern grid is considered.

7.1.Frequency Summary for the month of October to December, 2023

Table 6.1 Frequency summary for the month of October to December, 2023.

Substation/Plant	Bus Frequency at Semtokha Substation (Hz)		Bus Frequency at Kurichhu Hydropower Plant (Hz)	
	Max	Min	Max	Min
October	50.10	49.50	50.86	49.67
November	50.00	49.70	50.26	49.82
December	50.10	49.50	50.50	49.71

8. Voltage Profile of selected substation

As per the Grid Code 2008, clause 6.4.1 the voltage at all connection point is classified into three different bands as follows:

1. Normal State
The voltage at all connection points are within the limits of 0.95 times and 1.05 times of the normal values
2. Alert State
The voltage at all connection points are outside the normal limit but within the limits of 0.9 times and 1.1 times of the nominal values.
3. Emergency State
Transmission system voltages are outside the limit of 0.9 times and 1.1 times of nominal values.



Due to the location of 400/22/66/11kV Malbase substation in western grid and 132/33/11kV Nangkhor substation in the eastern grid, the voltage profile of these substations are considered.

8.1.Voltage Summary for the Month of October to December, 2023

Table 7.1 Voltage Summary for the month of July to September, 2023

Substation	Malbase Substation						Nangkhor Substation					
	400kV Bus Voltage (kV)		220kV Bus Voltage (kV)		66kV Bus Voltage (kV)		132kV Bus Voltage (kV)					
Month	Max	Min	Max	Min	Max	Min	Max	Min				
October	412.00	372.50	223.50	204.00	68.00	62.00	136.31	129.87				
November	413.50	350.00	223.50	204.50	67.00	62.00	135.77	125.51				
December	412.00	371.50	227.00	155.00	68.50	62.00	136.10	130.07	on 31st December 2023 at 10hrs low voltaage of 50V for both the 220kV Bus.			

9. Major Outages of Feeders and Equipment

The transmission lines and equipment which were shut down for annual maintenance and hand/force trip are not considered in the report.

This year the transmission department has started uploading the tripping reports in the google sheet therefore all the details of the Major and Minor Outages of the feeders and the equipment’s of the Eastern and Western grid can be easily downloaded from the link below:

<https://sites.google.com/view/tomd-trip-record/trip-register>