Ministry of Energy and Natural Resource

Bhutan Power System Operator

Thimphu: Bhutan

Transmission System Performance Report

First Quarterly Report 2024

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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) 2024 Clause No: 155, 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 Hydro Plants: 2326.0 MW

2.2. Mini & Micro: 8.1 MW

2.3. DG: 8.9 MW

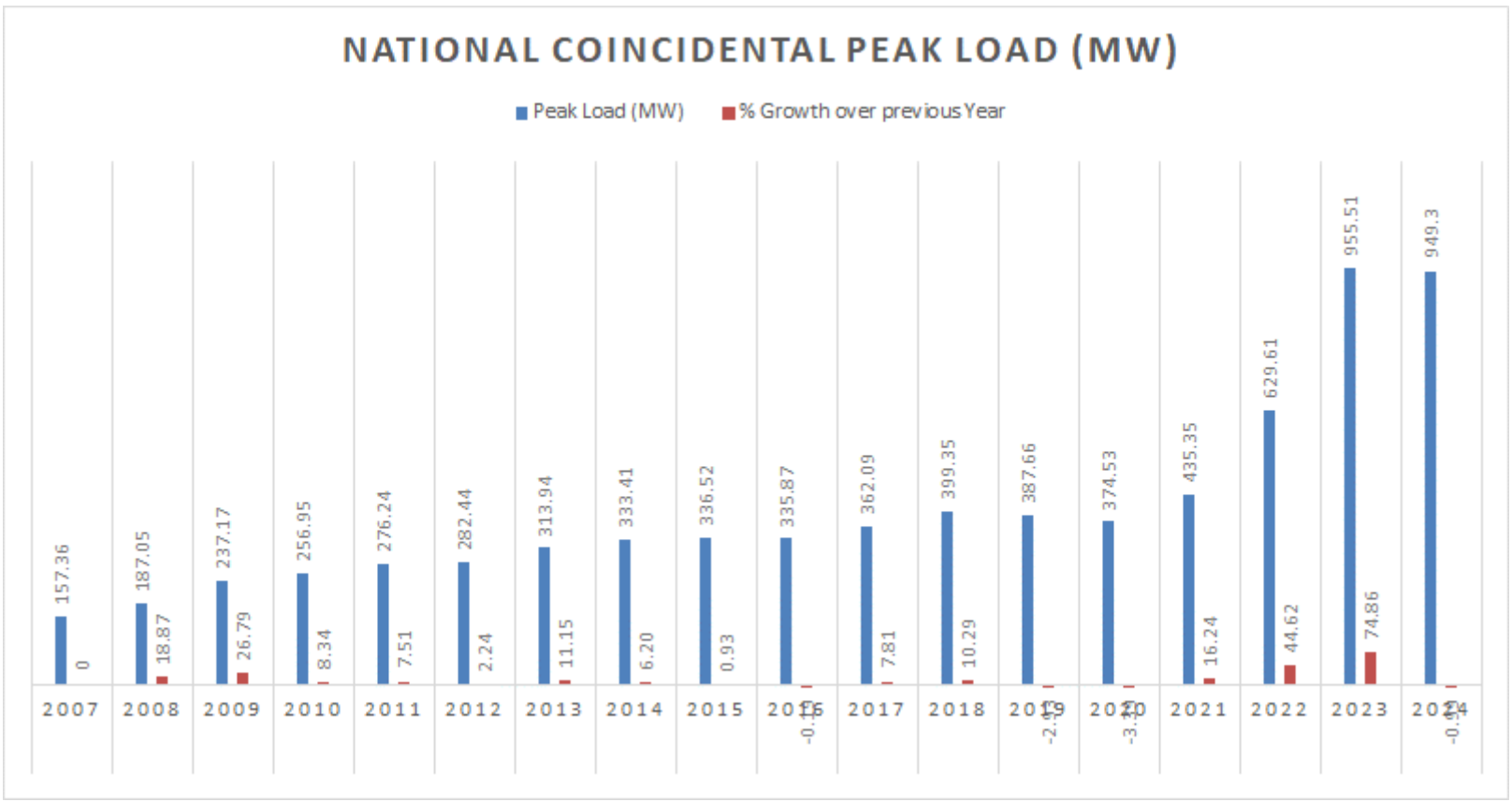
3. National Peak Demand

The national peak demand during first quarter 2024 is recorded at 949.30 which was occurred on February 14, 2024 at 17:00 hours. This is calculated by summation of Generation minus Export/Import.

Table 2.1. 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	955.51	949.3
% 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	44.62	74.86	-0.99

Graph 2.1. 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.

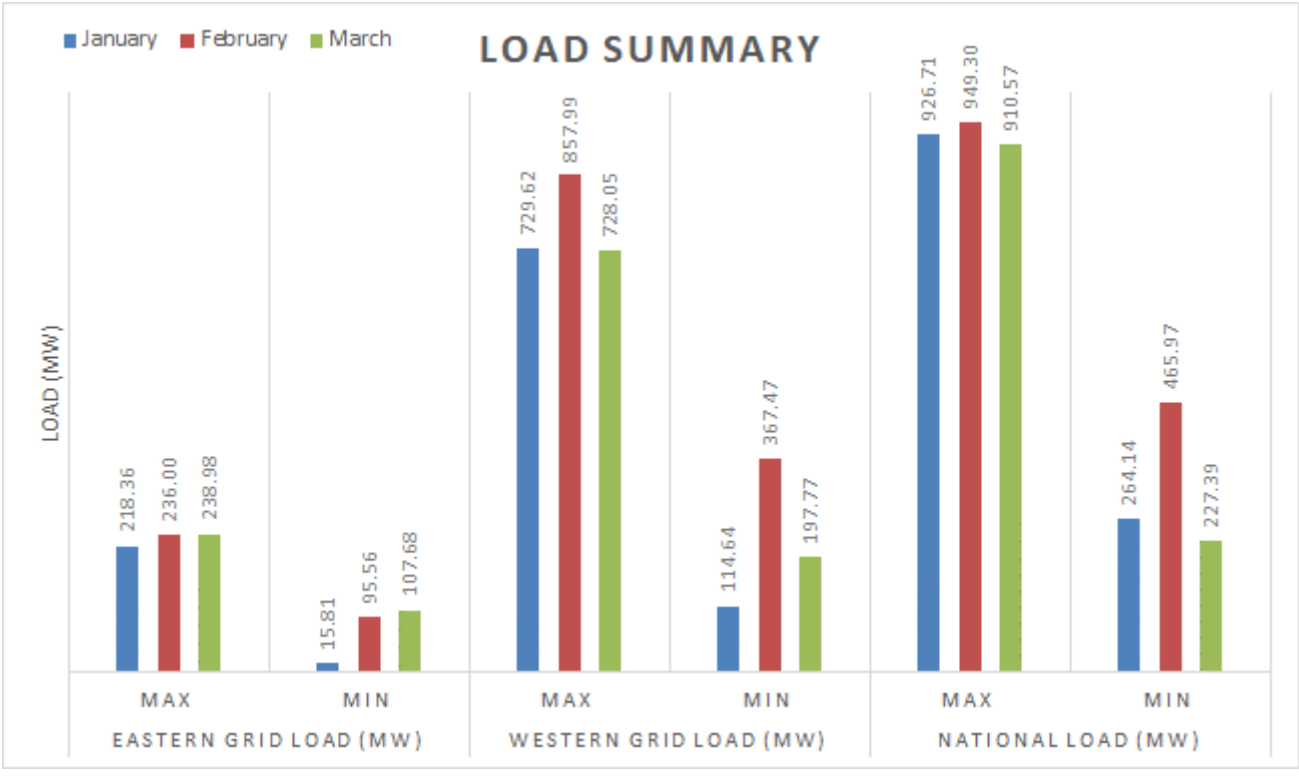
1. **National Demand** = (Sum of all total generation)-(Sum of all Export or Import)
2. **National Demand** = (Sum of all feeders loading at hydropower station) – (Sum of all Export/Import)
3. **National Demand** = (Sum of all substation loading)

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

Table 2.1.2. Domestic demand for Eastern Grid, Western Grid and National using method- 1

Grid	Eastern Grid Load (MW)		Western Grid Load (MW)		National Load (MW)	
Month	Max	Min	Max	Min	Max	Min
January	218.36	15.81	729.62	114.64	926.71	264.14
February	236.00	95.56	857.99	367.47	949.30	465.97
March	238.98	107.68	728.05	197.77	910.57	227.39

Graph 2.1.2. Domestic demand for Eastern Grid, Western Grid and National using method- 1



3. Energy Availability and Requirement for the country

3.1. 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 3.1.1. Total Energy (MU) consumed

Month	Total Ex-bus (MU)	Total Export/Import (MU)	Total energy sold to BPC (MU)
January	309.89099240	18.60729528	567.26079362
February	273.25819666	21.91324128	519.94803564
March	356.12642380	22.98395960	706.46045416

Graph 3.1.1. Total Energy (MU) consumed

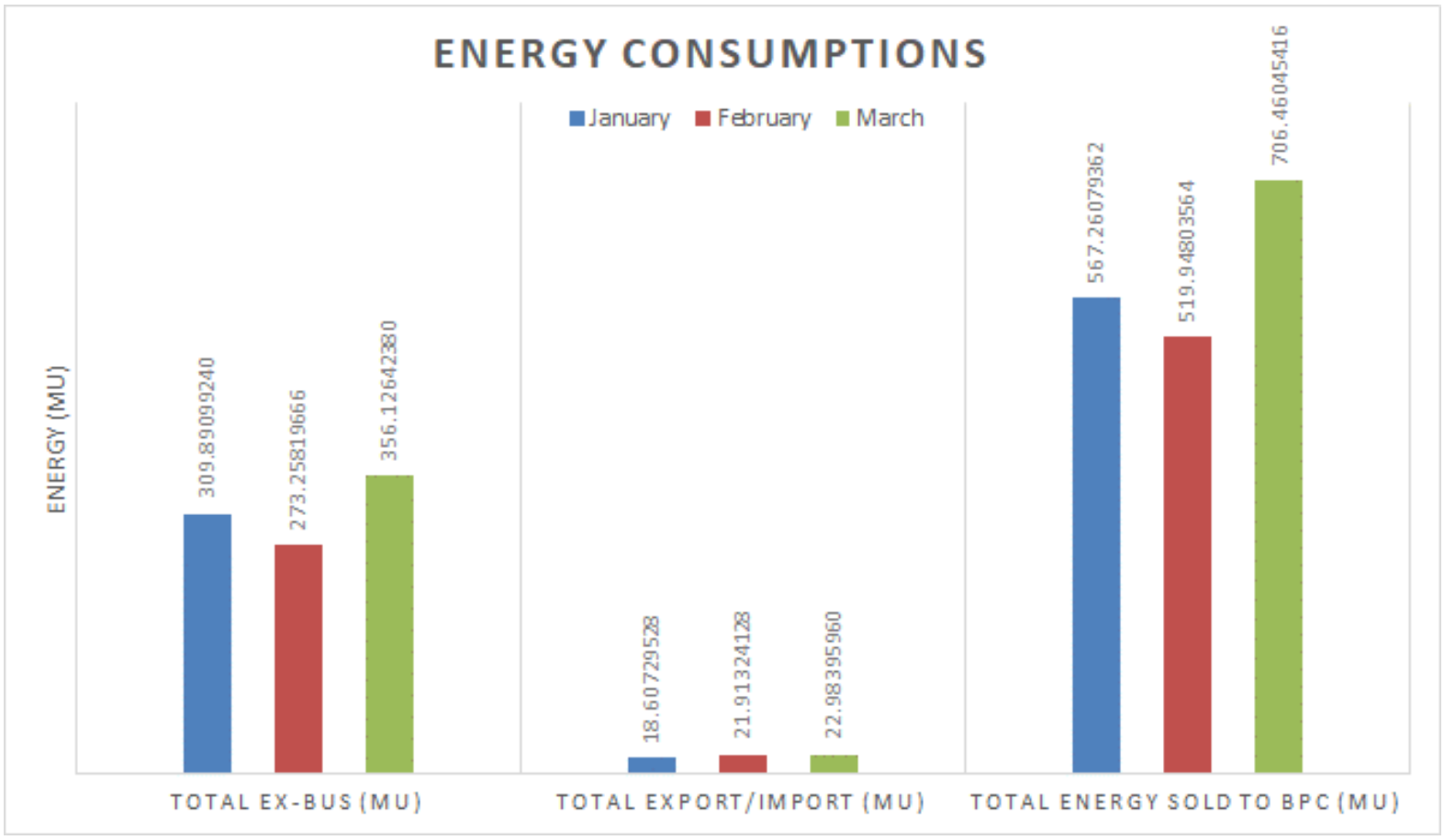
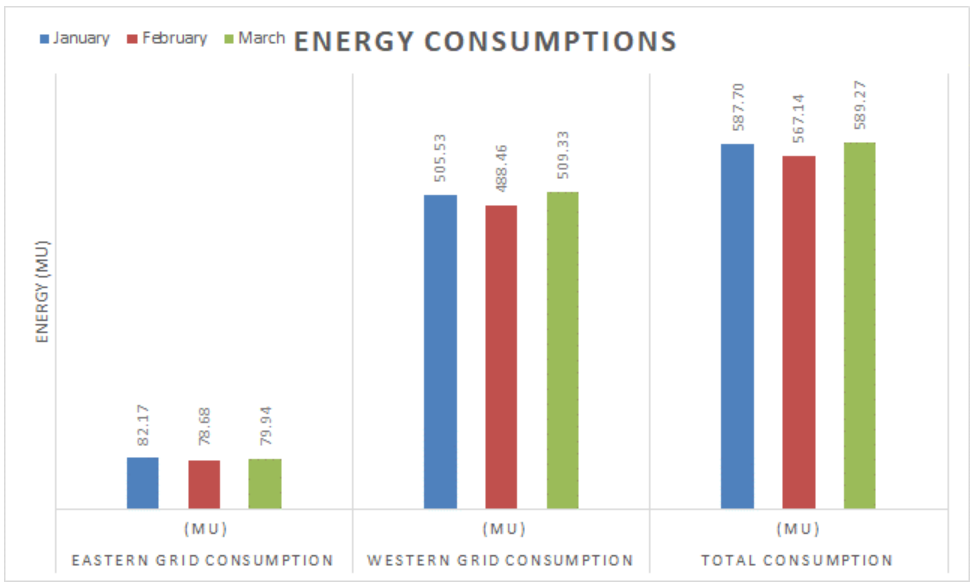


Table 3.1.2. Energy (MU) consumed

Grid	Eastern Grid Consumption	Western Grid Consumption	Total Consumption
Month	(MU)	(MU)	(MU)
January	82.17	505.53	587.70
February	78.68	488.46	567.14
March	79.94	509.33	589.27

Graph 3.1.2. Energy (MU) consumed



4. Performance of generating plants

4.1. Power and Energy Generation

The maximum and minimum total generation for the First quarter 2024 are as tabulated below:

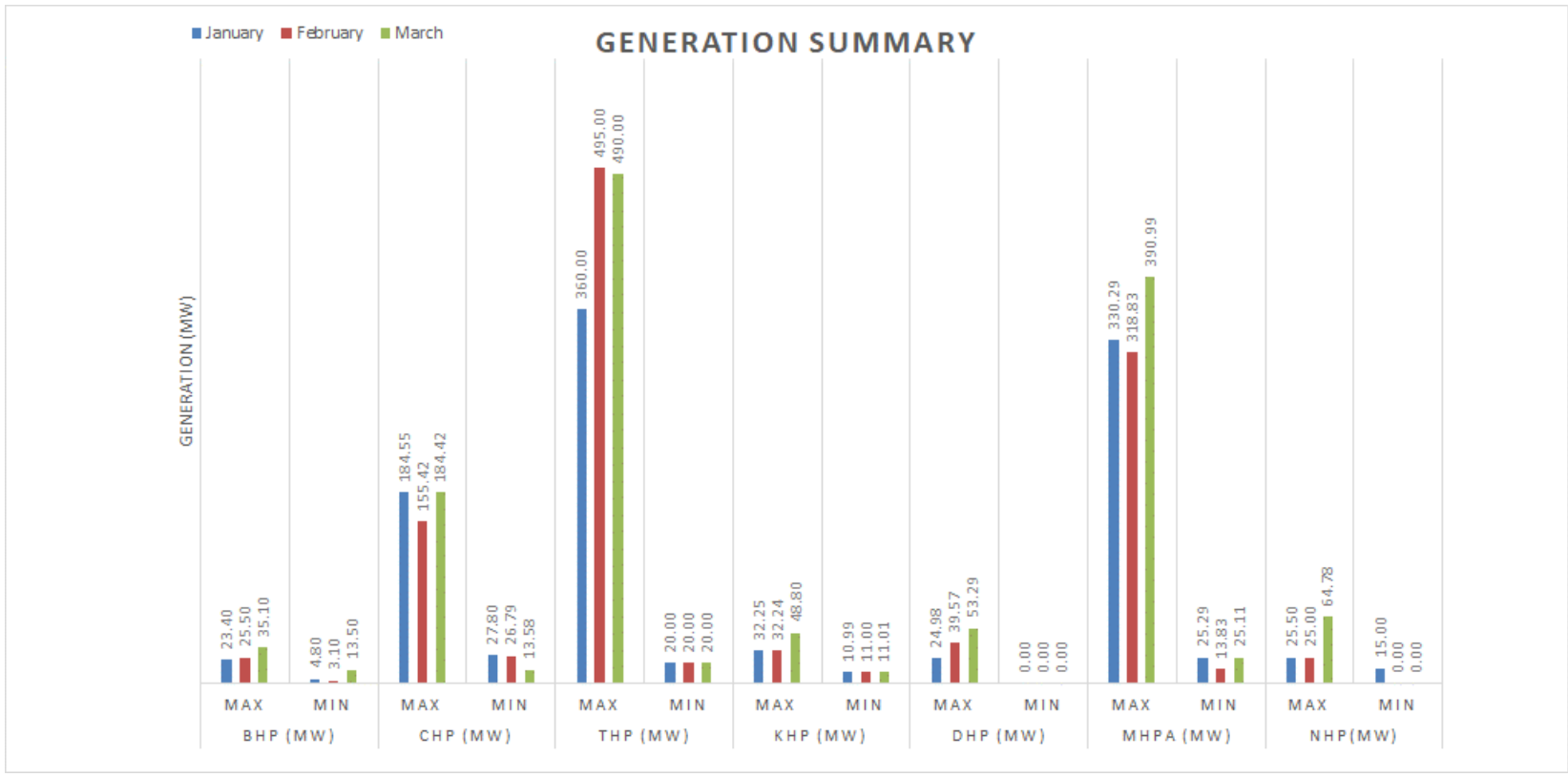
Table: 4.1.1 Summary of maximum and minimum generation by various hydropower plant

Generation By	BHP (MW)		CHP (MW)		THP (MW)		KHP (MW)		DHP (MW)		MHPA (MW)		NHP(MW)		TOTAL (MW)	
Month	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
January	23.40	4.80	184.55	27.80	360.00	20.00	32.25	10.99	24.98	0.00	330.29	25.29	25.50	15.00	980.97	103.88
February	25.50	3.10	155.42	26.79	495.00	20.00	32.24	11.00	39.57	0.00	318.83	13.83	25.00	0.00	1,091.56	74.72
March	35.10	13.50	184.42	13.58	490.00	20.00	48.80	11.01	53.29	0.00	390.99	25.11	64.78	0.00	1,267.38	83.20

Source: Hydropower Plants (DGPC)

DHP had shut down on 15th January at 22hrs, 2nd February at 13hrs and 27th March at 9hrs and for NHP had shut down on 1nd, 2nd, 6th, 10th,24th February 2024 and 7th, 13th, 16th, 27th, 28th and 31st March 2024.

Graph: 4.1.1 Summary of maximum and minimum generation by various hydropower plant



4.2. Plant Capacity Factor

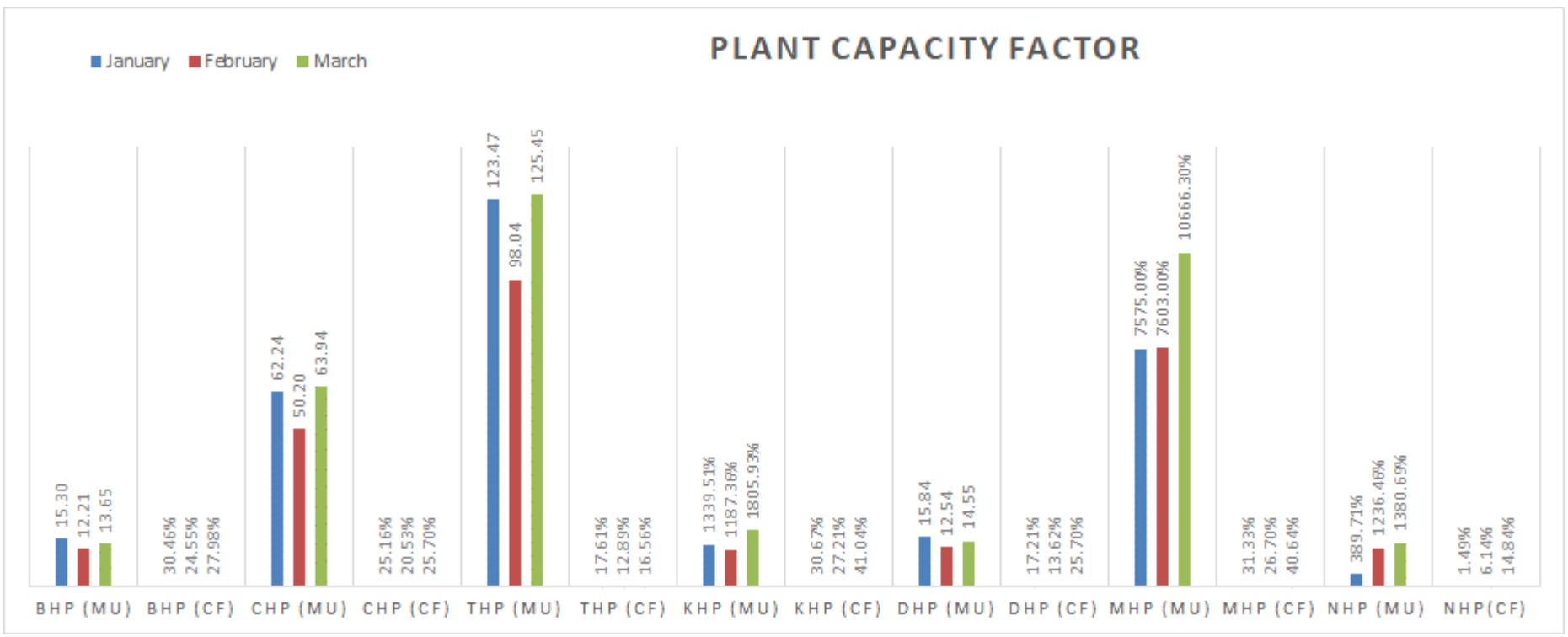
The capacity factor of each generating plant was calculated as below:

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

Table 4.2.1: 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)	NHP (MU)	NHP(CF)
January	15.30	30.46%	62.24	25.16%	123.47	17.61%	1339.51%	30.67%	15.84	17.21%	7575.00%	31.33%	389.71%	1.49%
February	12.21	24.55%	50.20	20.53%	98.04	12.89%	1187.36%	27.21%	12.54	13.62%	7603.00%	26.70%	1236.46%	6.14%
March	13.65	27.98%	63.94	25.70%	125.45	16.56%	1805.93%	41.04%	14.55	25.70%	10666.30%	40.64%	1380.69%	14.84%
Source: TD, BPC														

Graph 4.2.1: Capacity factor of various hydropower plants



5. Export and Import of Electricity

Table 5.1. Export of electricity to India

Export To	Binaguri (MW)		Birpara (MW)		Salakoti and Rangia (MW)		Alipurdur (MW)	
Month	Max	Min	Max	Min	Max	Min	Max	Min
January	297.27	1.73	245.71	14.32	15.02	0.16	33.10	0.14
February	265.46	0.82	0.00	0.00	32.03	0.05	507.99	1.42
March	338.00	3.18	14.71	14.71	41.23	0.02	251.41	0.11

Graph 5.1. Export of electricity to India

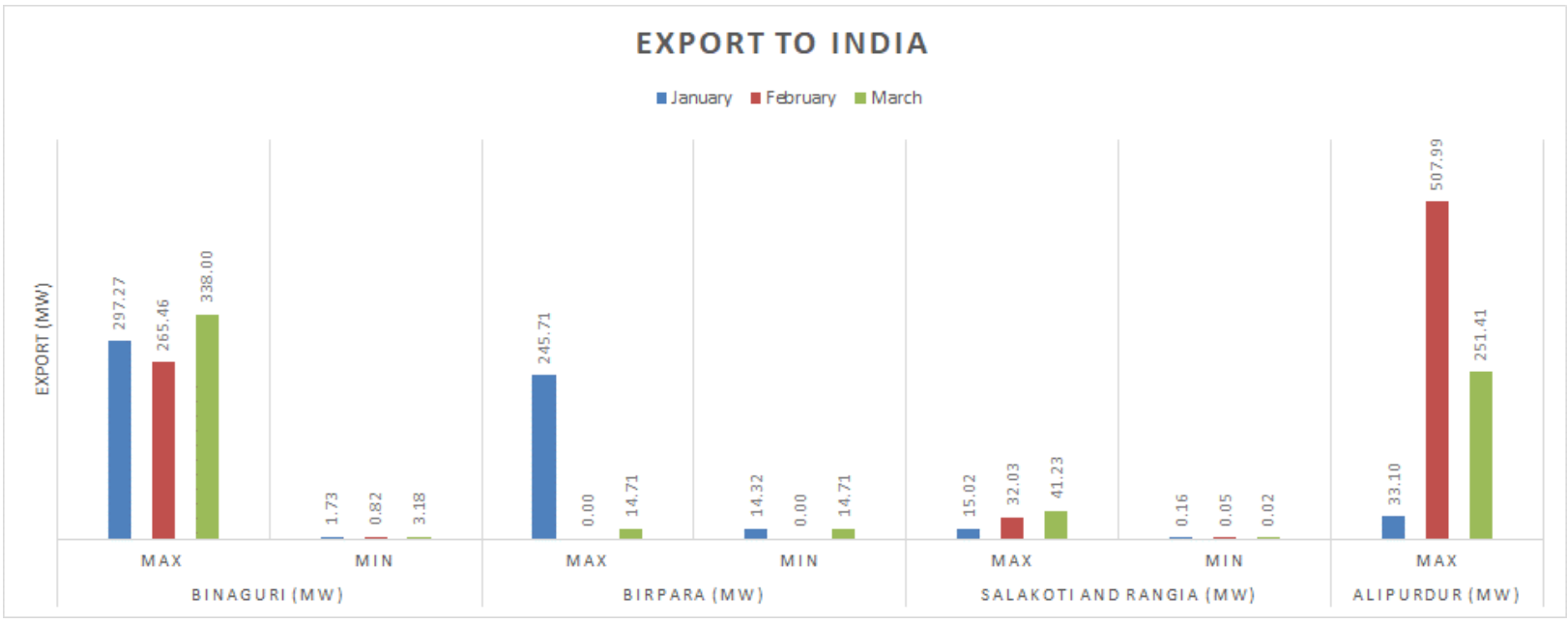
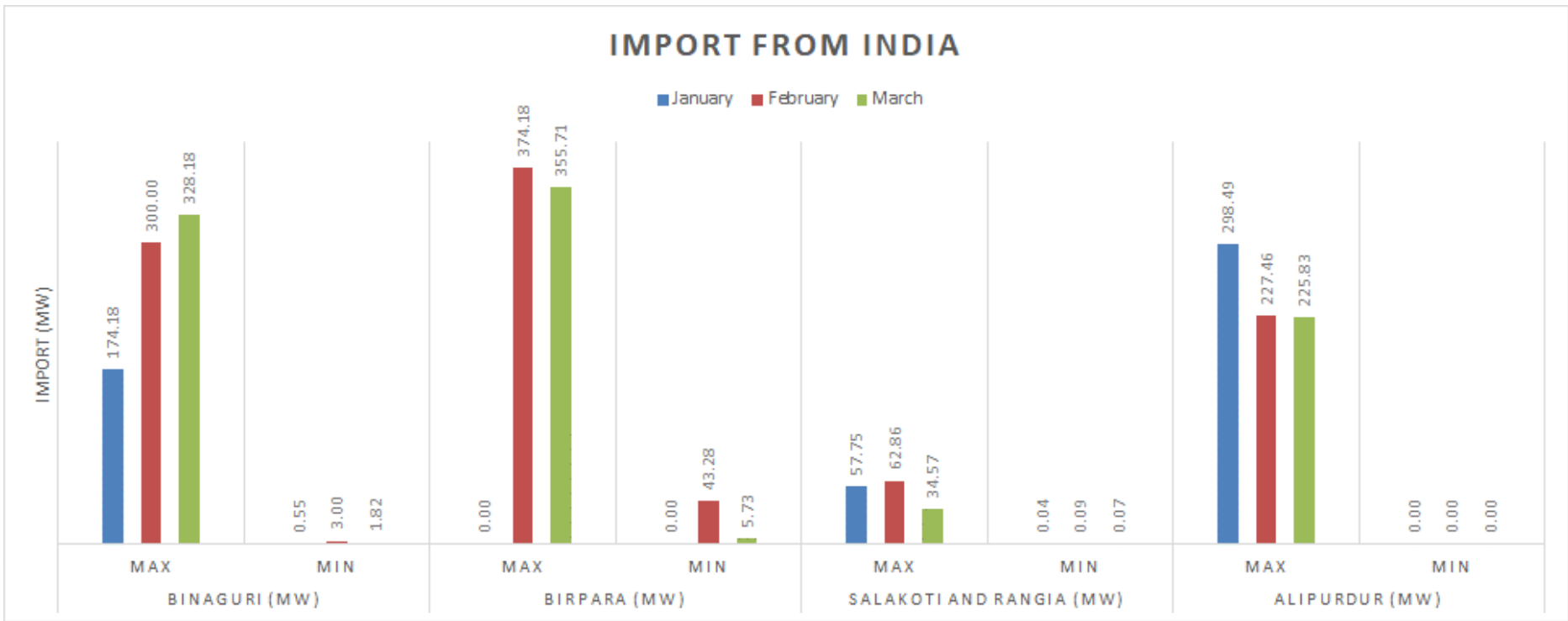


Table 5.2. Import of electricity from India.

Import From	Binaguri (MW)		Birpara (MW)		Salakoti and Rangia (MW)		Alipurdur (MW)	
Month	Max	Min	Max	Min	Max	Min	Max	Min
January	174.18	0.55	0.00	0.00	57.75	0.04	298.49	0.00
February	300.00	3.00	374.18	43.28	62.86	0.09	227.46	0.00
March	328.18	1.82	355.71	5.73	34.57	0.07	225.83	0.00

Graph 5.2. Import of electricity from India



6. 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 limits 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.

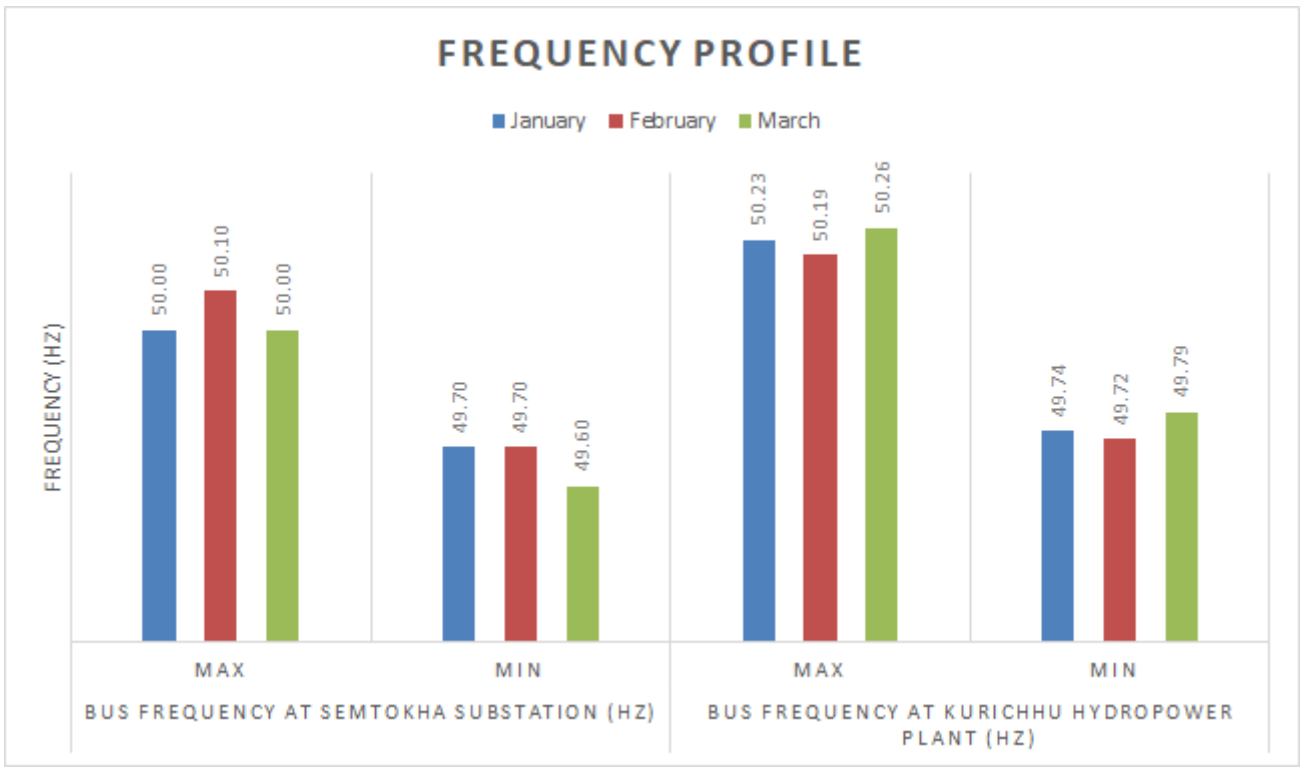
The frequency at 220kV Bus at 220/66/11kV Semtokha substation in the western grid and 132kV Bus at 60MW Kurichhu Hydropower Plant in the eastern grid is considered.

6.1. Frequency Summary for First Quarter 2024

Table 6.1 Frequency summary for the month of January to March, 2024.

Substation/Plant	Bus Frequency at Semtokha Substation (Hz)		Bus Frequency at Kurichhu Hydropower Plant (Hz)	
Month	Max	Min	Max	Min
January	50.00	49.70	50.23	49.74
February	50.10	49.70	50.19	49.72
March	50.00	49.60	50.26	49.79

Graph 5.3. Frequency Profile for First Quarter 2024.



7. 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.

7.1. Voltage Summary for the First Quarter, 2024

Table 7.1 Voltage Summary for the month of January to March, 2024

Substation	Malbase Substation						Nangkhor Substation	
Voltage Level	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
January	410.00	386.50	227.00	212.00	69.50	63.00	136.73	129.87
February	410.00	371.50	228.00	210.00	70.50	62.00	139.87	127.58
March	410.00	375.00	231.00	205.50	69.00	62.25	136.94	129.45

Graph 5.3. Frequency Profile for First Quarter 2024.