Ministry of Energy and Natural Resource

Bhutan Power System Operator

Thimphu: Bhutan

Transmission System Performance Report

Second Quarterly Report 2023

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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) 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.

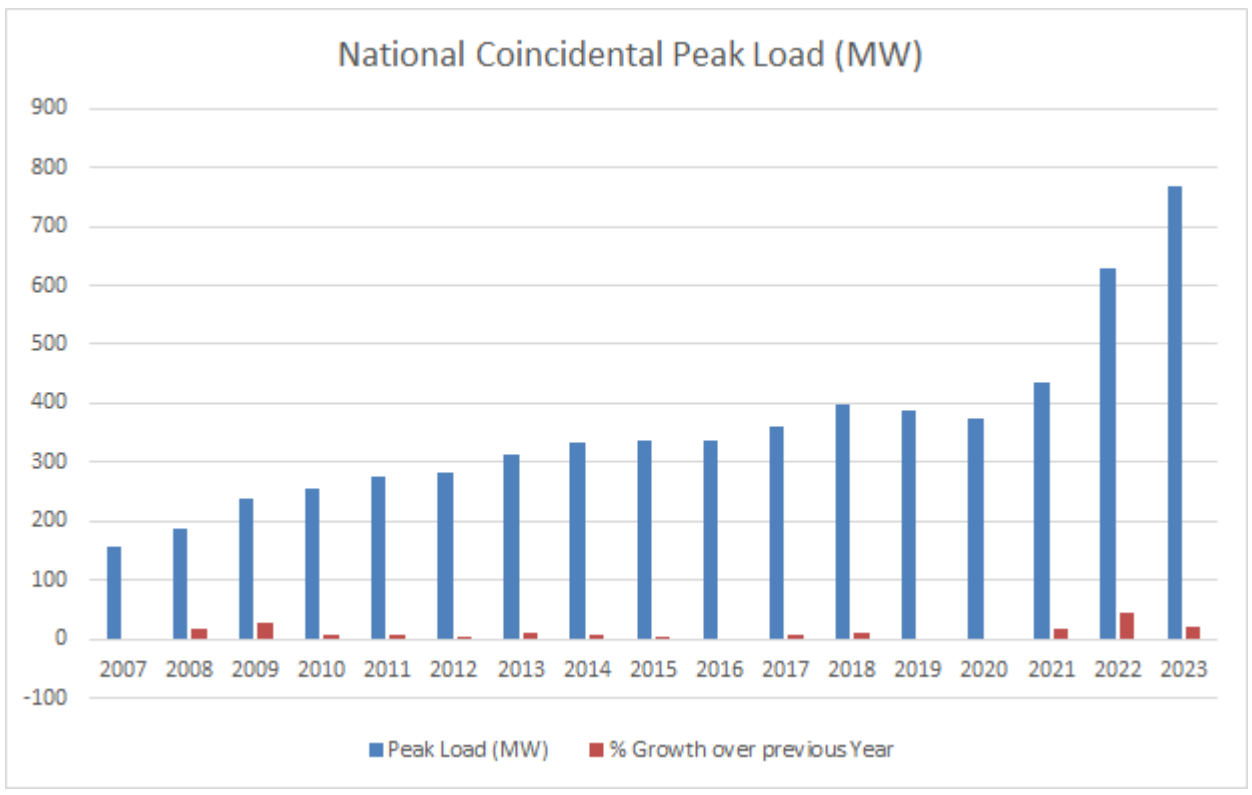
2. National Peak Demand

The national peak demand till June 2023 is recorded at 767.14**MW** which was occurred on May 10, 2023 at 18:00 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
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	767.14
% 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	21.84

Graph 2.1. The growth in National Peak Demand since 2007



2.1. Power (MW) consumed by country

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

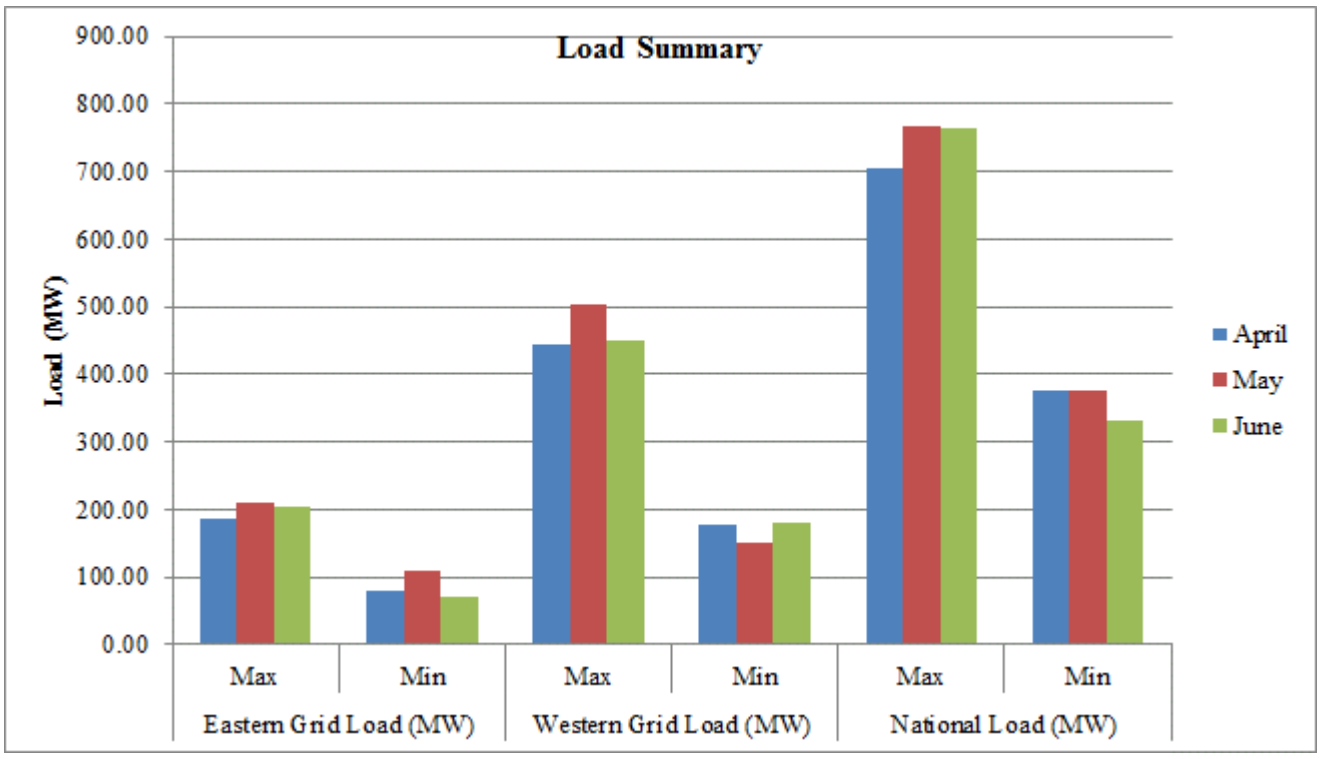
1. **National Demand** = (Sum of all total generation)-(Sum of all Export or Import)
2. **National Demand** = (Sum of all feeders loading at hydropower station) – (Sum of all Export/Import)
3. **National Demand** = (Sum of all substation loading)

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
April	187.51	80.00	443.64	176.95	703.87	376.72
May	211.14	110.00	502.24	149.89	767.14	376.76
June	204.16	71.95	450.00	180.00	765.15	331.89

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)
April	461.17706910	55.49837844	427.12108747
May	647.82660453	144.76109654	489.05953156
June	1136.27906555	668.29699148	450.28644517

Graph 3.1.1. Total Energy (MU) consumed

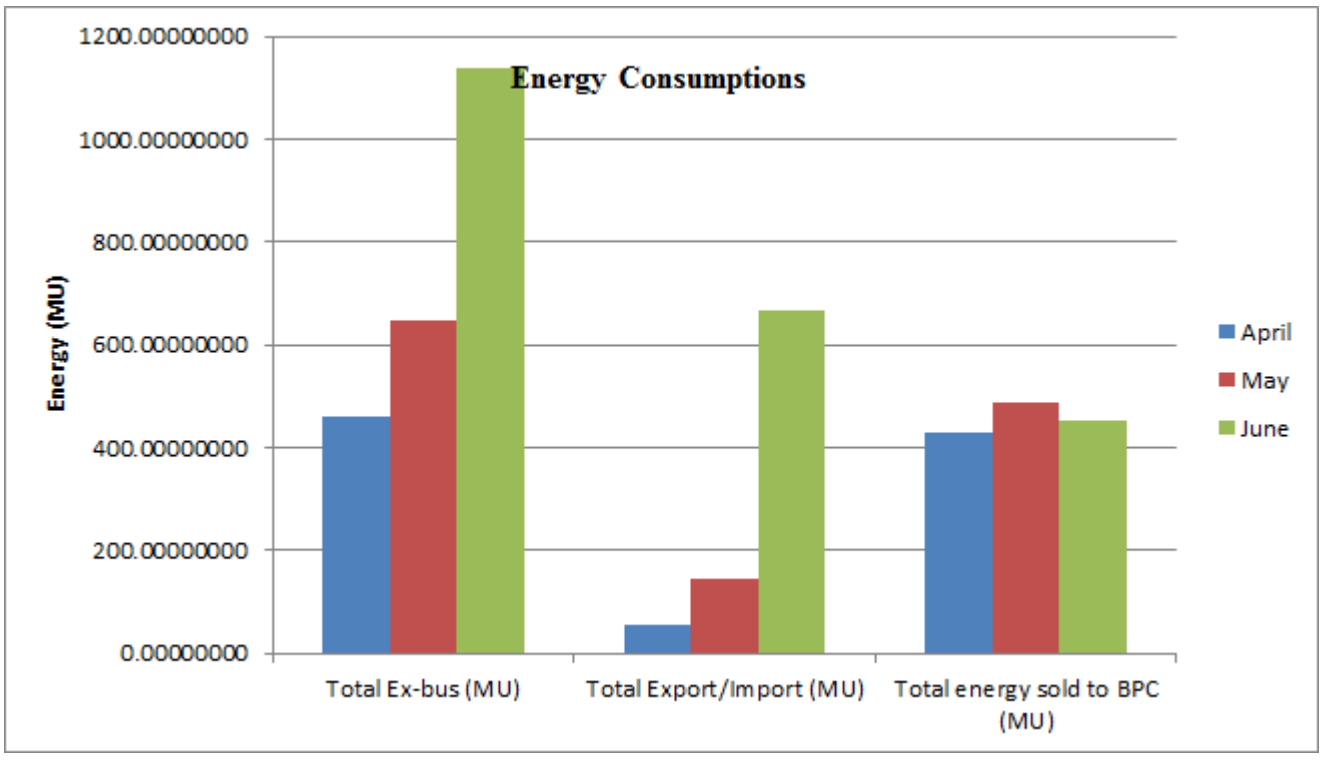
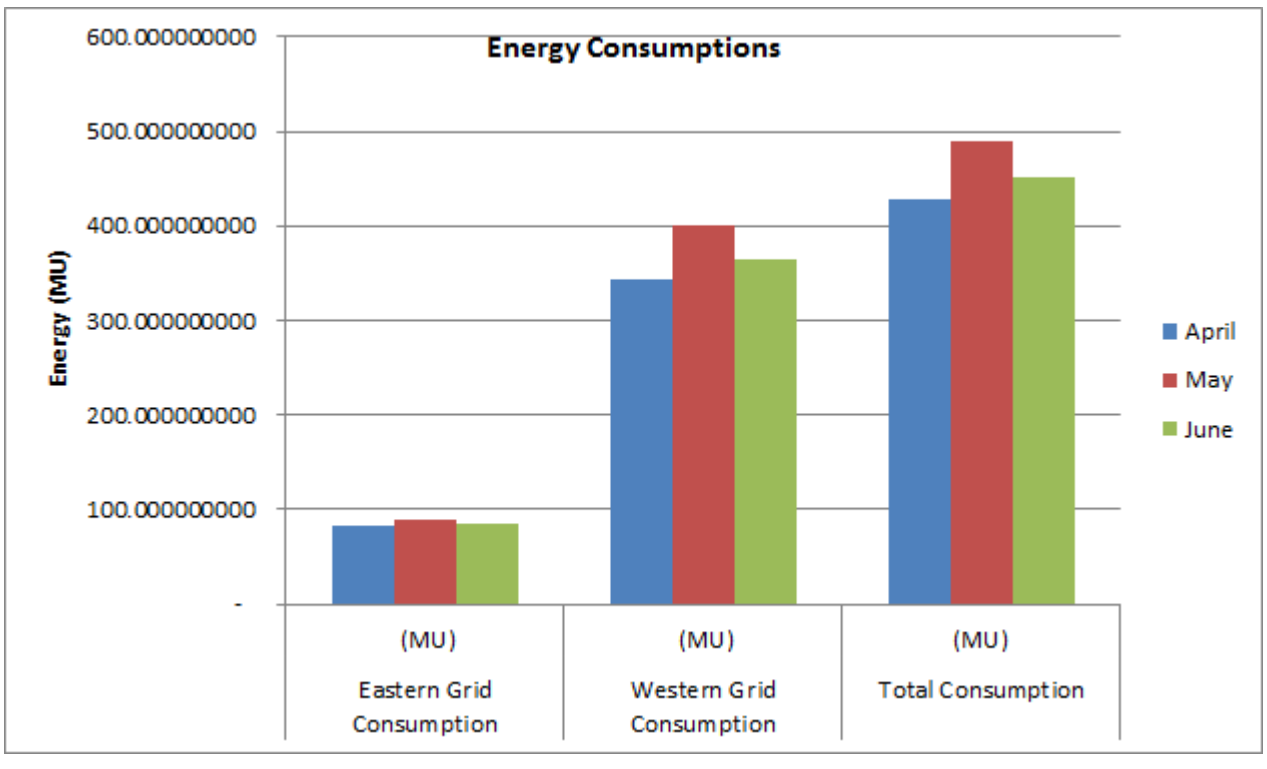


Table 3.1.2. Energy (MU) consumed

Grid	Eastern Grid Consumption	Western Grid Consumption	Total Consumption
Month	(MU)	(MU)	(MU)
April	83.157061250	343.964026	427.121087465
May	89.069808600	399.989723	489.0595316
June	85.23918177	365.047263	450.2864452

Graph 3.1.2. Energy (MU) consumed



4. Performance of generating plants

4.1. Power and Energy Generation

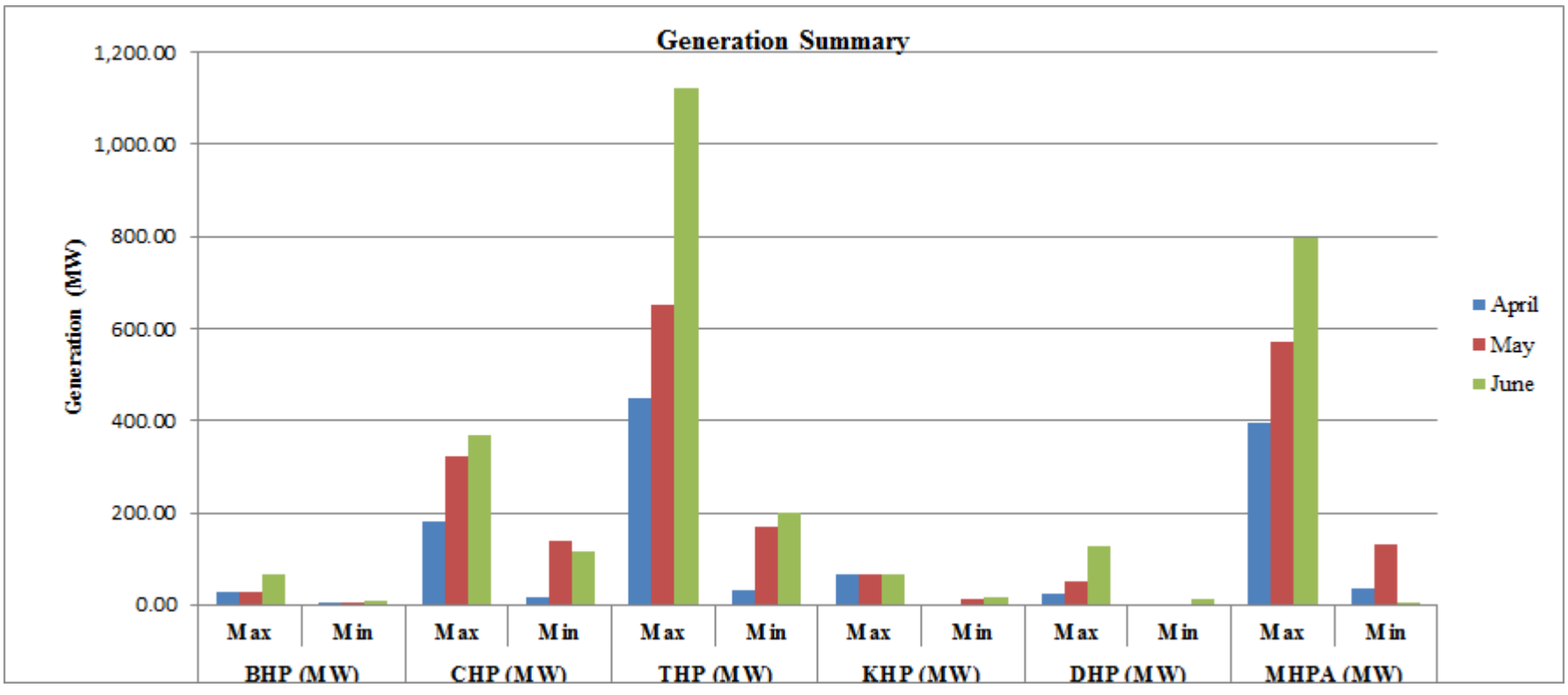
The maximum total generation for the Second quarter of year 2023 was 2,544.86 MW in month of June and minimum generation was 1146.13 MW in the April month.

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)		TOTAL (MW)	
Month	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
April	26.10	4.00	182.60	17.50	450.00	30.00	66.00	0.00	25.27	0.00	396.16	37.38	1,146.13	88.88
May	26.70	2.80	324.25	139.73	650.00	170.00	66.00	11.25	50.33	0.00	570.15	130.48	1,687.43	454.26
June	65.60	10.20	369.49	117.03	1,122.00	200.00	66.00	16.50	126.98	13.54	794.79	0.09	2,544.86	357.36

Source: Hydropower Plants (DGPC)

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



4.2.Plant Capacity Factor

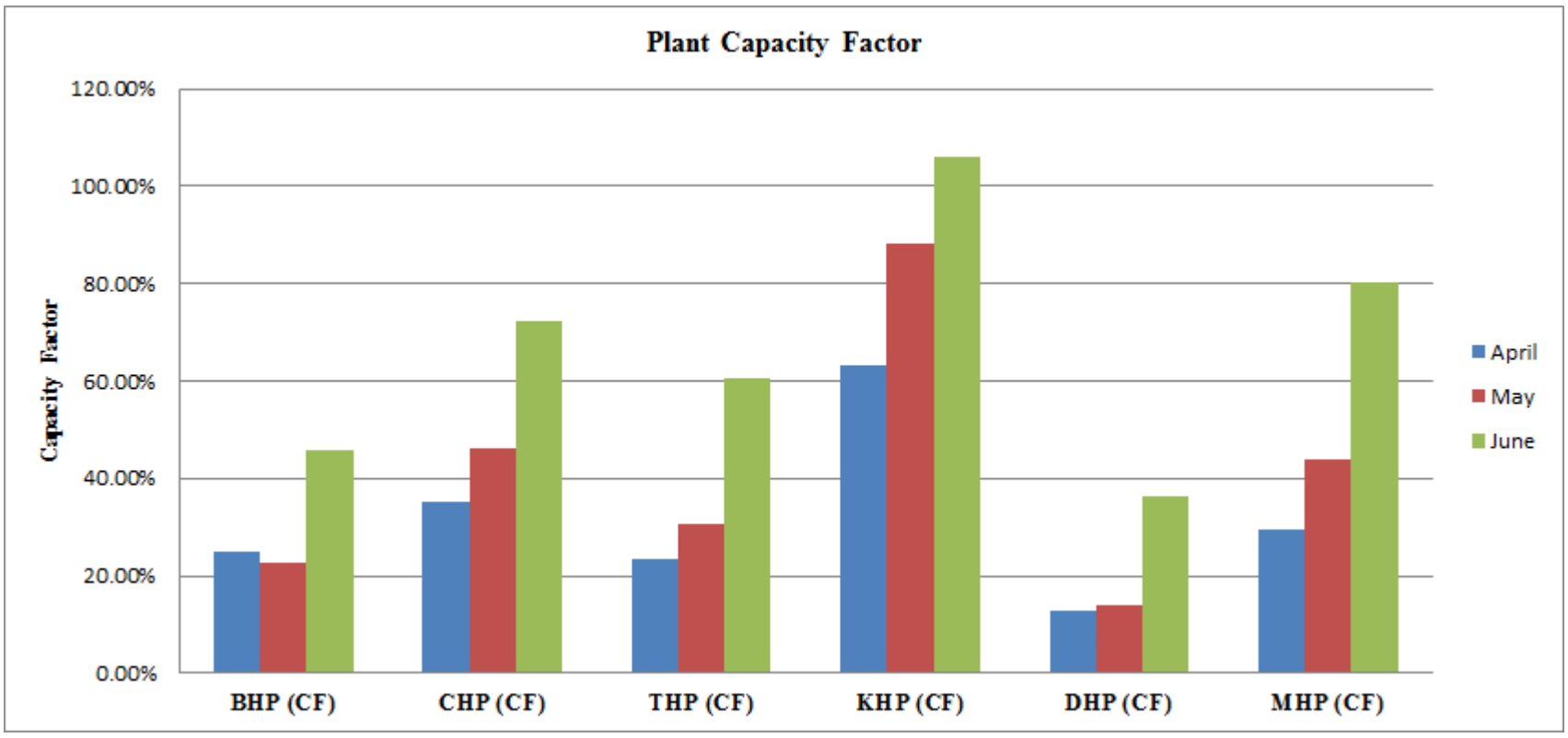
The capacity factor of each generating plant was calculated as below:

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

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)
April	11.43318	24.81%	84.75275	35.03%	172.920000	23.55%	27.328418	63.26%	11.63	12.82%	153.11	29.54%
May	10.88075	22.85%	115.93679	46.38%	232.94836	30.70%	39.325543	88.09%	13.28316	14.17%	235.452	43.95%
June	21.14190	45.88%	175.13903	72.40%	445.22545	60.62%	45.770594	105.95%	33.01	36.39%	415.99	80.25%
Source: TD, BPC												

Graph 4.2.1: Capacity factor of various hydropower plants



5. Export and Import of Electricity

Maximum export for the Second quarter of year 2023 was 1,109.00 MW in the month of June to Binaguria substation in India. The minimum export recorded was 49.06 MW to Salakoti and Rangia substation in India during the month of April.

Table 5.1. Export of electricity to India

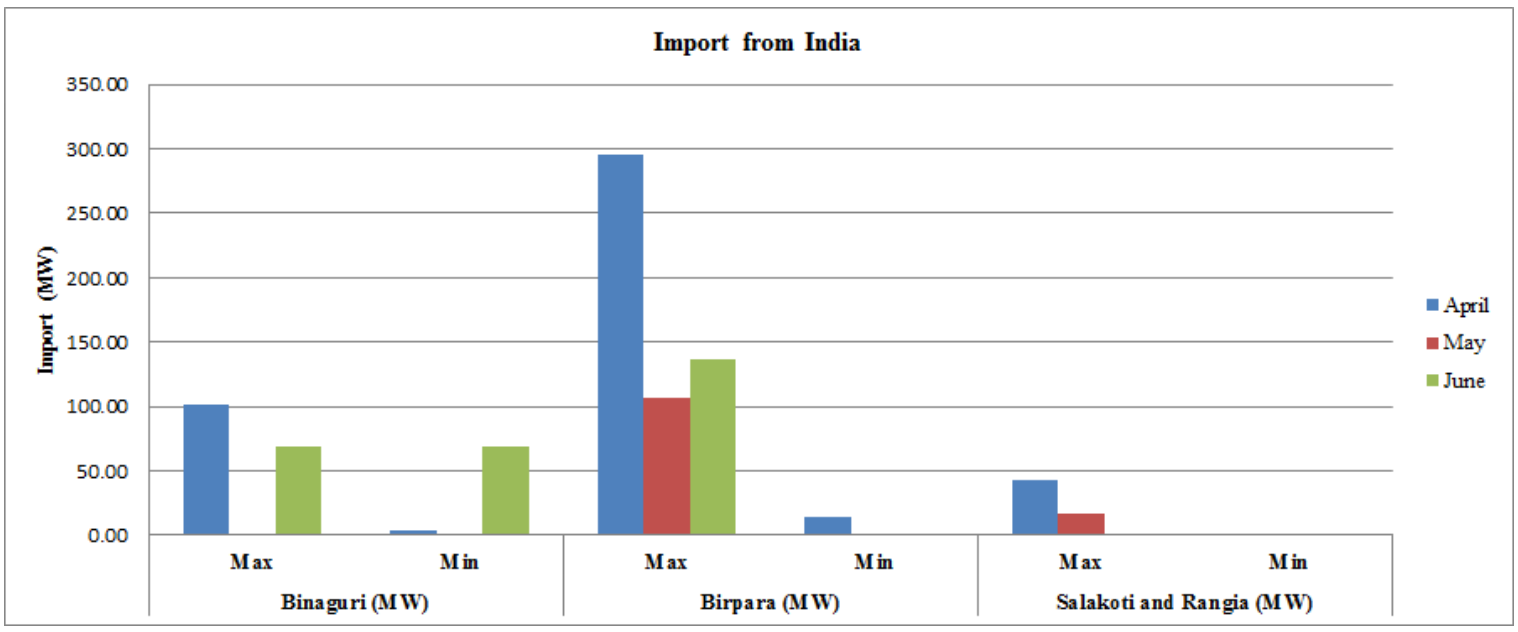
Export To	Binaguri (MW)		Birpara (MW)		Salakoti and Rangia (MW)	
Month	Max	Min	Max	Min	Max	Min
April	440.00	0.36	46.29	4.63	49.06	0.13
May	567.27	50.54	120.92	0.07	78.23	0.12
June	1,109.00	40.64	203.28	0.55	89.79	0.69

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)	
Month	Max	Min	Max	Min	Max	Min
April	101.36	3.82	295.95	14.17	42.48	0.10
May	0.00	0.00	106.57	0.06	16.34	0.33
June	69.00	69.00	136.21	1.36	0.00	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 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.

6.1.Frequency Summary for the month of April to June, 2023

Table 6.1 Frequency summary for the month of April to June, 2023.

Substation/Plant	Bus Frequency at Semtokha Substation (Hz)		Bus Frequency at Kurichhu Hydropower Plant (Hz)	
Month	Max	Min	Max	Min
April	50.20	49.60	50.30	49.46
May	50.10	49.70	50.26	49.73
June	50.10	49.49	50.25	49.50

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 Month of April to June, 2023

Table 7.1 Voltage Summary for the month of April to June, 2023

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
April	416.50	398.50	224.50	208.50	69.35	62.00	137.77	129.40
May	414.00	386.00	221.00	207.50	67.00	61.00	136.31	130.08
June	414.00	395.00	221.50	210.00	68.50	62.00	139.01	128.62

8. 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:

hhttps://sites.google.com/view/tomd-trip-record/trip-register