



རྒྱལ་ཁབ་རྒྱུ་རྩུག་གཞུང་། རྒྱལ་ཁབ་རྒྱུ་རྩུག་ལྷན་ཁང་འཕེལ་རྒྱུ་ལྷན་ཁང་། རྒྱུ་རྩུག་གི་ལས་འགན་ལྷན་ཁང་།

Royal Government of Bhutan
Ministry of Energy & Natural Resources

Bhutan Power System Operator

Thimphu



Best Practices in Power System Operation

Jigme Dorji



Overview

Bhutan Power System Overview

1. Importance of Real-time Data
2. Historical Data and System Improvement
3. Grid Operation
4. Conclusion



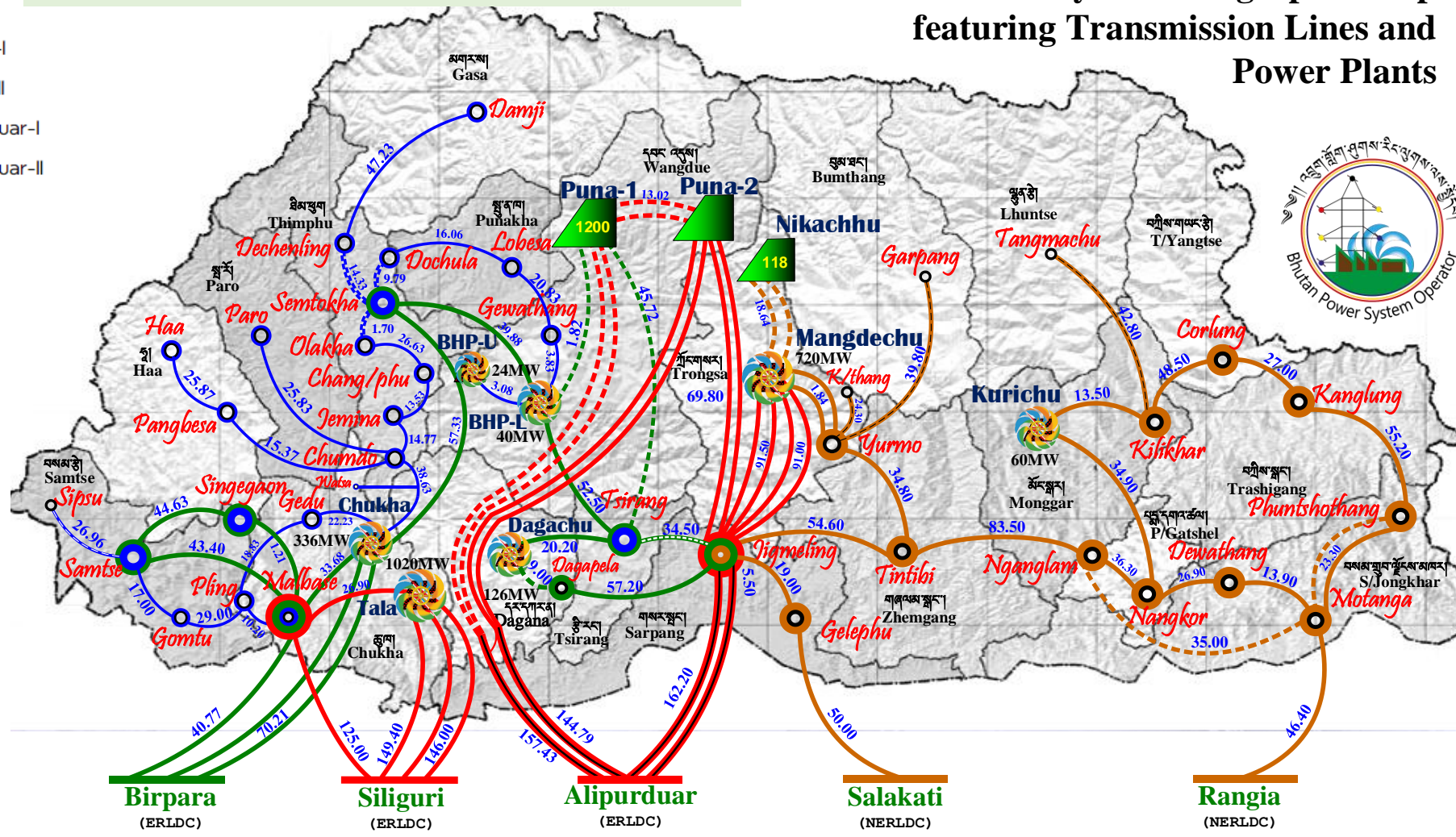
Bhutan Power System Overview



Total installed Capacity (large sources)
3500 MW

Bhutan Power System Geographic Map featuring Transmission Lines and Power Plants

- 400kV THP-Siliguri-I
- 400kV THP-Siliguri-II
- 400kV THP-Siliguri-IV
- 400kV Malbase-Siliguri
- 400kV: 8 lines
- 400kV Puna-ALipurduar-I
- 400kV Puna-Alipurduar-II
- 400kV Jigmeling-Alipurduar-I
- 400kV Jigmeling-Alipurduar-II
- Cross-border Lines: 13 total**
- 220kV: 3 lines
- 220kV CHP-Birpara-I
- 220kV CHP-Birpara-II
- 220kV Malbase-Birpara
- 132kV: 2 lines
- 132kV Motanga-Rangia
- 132kV Gelephu-Salakati
- Plants (11)**
- East (3)**
- 720 MW MHP
- 118 MW NHP
- 60 MW KHP
- West (8)**
- 1020 MW THP
- 1020 MW PHP
- 336 MW CHP
- 126 MW DHP
- 64 MW BHP
- 18 MW SHP
- 17.38 MWp Sephu



Network Developed by: Bhutan Power System Operator (BPSO)



1. Importance of Real-time Data



Given utmost importance

SCADA

PMU

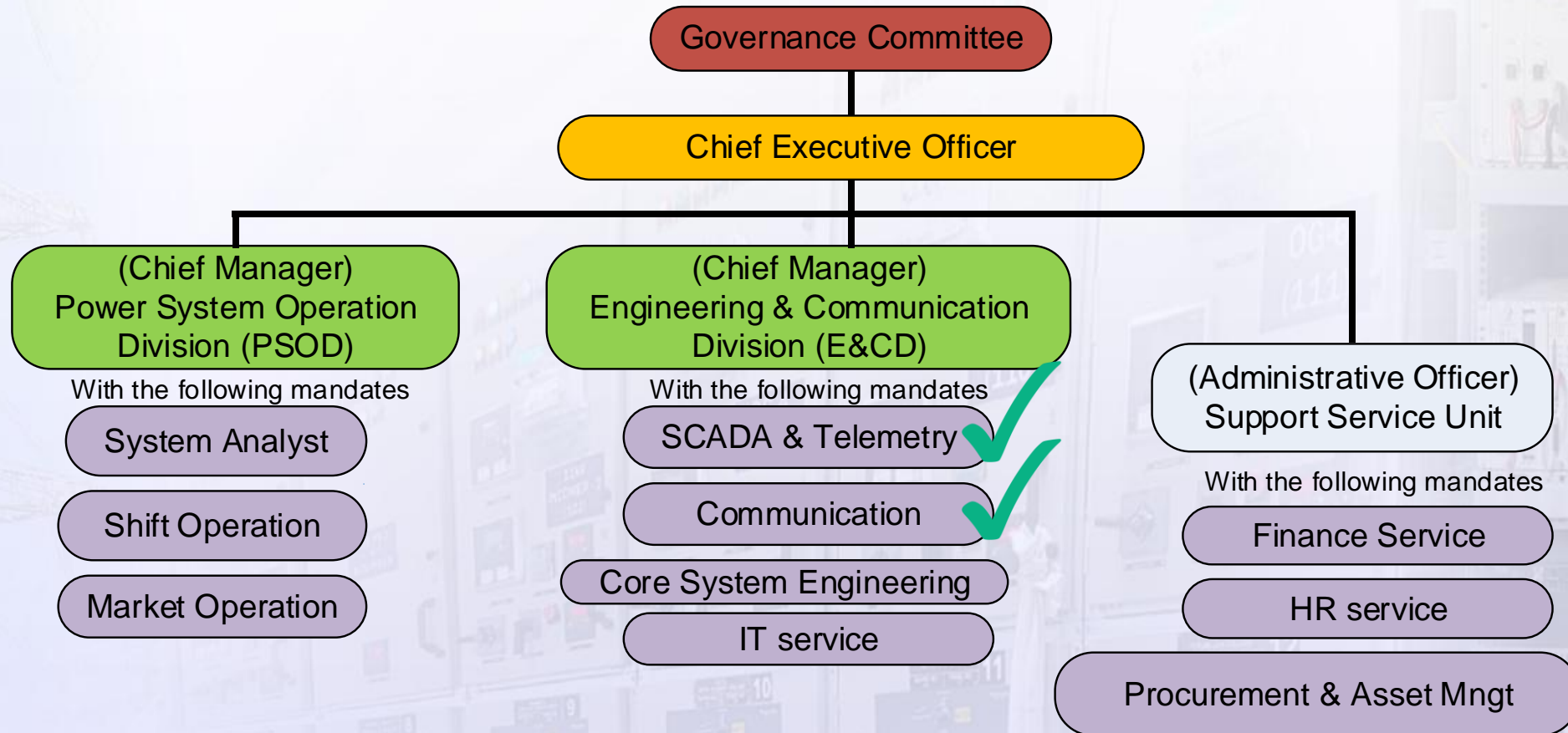




1. Importance of Real-time Data

Dedicated team for SCADA Data

✓ given utmost importance





1. Importance of Real-time Data

Real-time Data:

- ✓ given utmost importance

Required signal list for SCADA from site for new stations
(BPSO website)

TYPICAL SIGNAL LIST

1. ENERGY MEASUREMENT

Device Type	Analog	Description	CT Ratio	VT Ratio	Remarks				
GENERATOR UNIT	MW	Real Power	REQUIRED	REQUIRED	kV in phase-phase or average				
	MX	Reactive Power							
	KV_RY	R-Y phase kV							
	KV_YB	Y-B phase kV							
	KV_BR	B-R phase kV							
	KV	3 phase Average kV							
	I_R	Current							
	I_Y	Current							
	I_B	Current							
	PF	Power Factor							
	MWHE	Real Power Export							
	MXHI	Reactive Power Import							
	MXHE	Reactive Power Export							
TRANSFORMER	MW	Real Power	REQUIRED	REQUIRED					
	MX	Reactive Power							
	I_R	Current							
	I_Y	Current							
	I_B	Current							
	PF	Power Factor							
	TPI	Tap Position Indicator							
	MWHI	Real Power Import							
	MWHE	Real Power Export							
	MXHI	Reactive Power Import							
	MXHE	Reactive Power Export							
	BUS	KV_RY				R-Y phase kV	NOT REQUIRED	REQUIRED	
		KV_YB				Y-B phase kV			
KV_BR		B-R phase kV							
KV		3 phase Average kV							
HZ		Frequency							
BUS COUPLER	MW	Real Power	REQUIRED	REQUIRED					
	MX	Reactive Power							
	I_R	Current							
	I_Y	Current							
	I_B	Current							
FEEDER/ LOAD/ LINE	MW	Real Power	REQUIRED	REQUIRED					
	MX	Reactive Power							
	KV_RY	R-Y phase kV							
	KV_YB	Y-B phase kV							
	KV_BR	B-R phase kV							
	KV	3 phase Average kV							
	I_R	Current							
	I_Y	Current							
	I_B	Current							



1. Importance of Real-time Data

Real-time Data:

✓ given utmost importance

Fast-time charging form

Form for Intimation to BPSO by Licensee Regarding Anticipated Charging of New Elements to the Existing Grid (Amended Format-2020)

Document(s) must be produced for review, if required. Advertisement may be made in the media, if required, by the concerned agency after approval for the test-charging is sought from the System Operator.

(Approval shall be given only if there is a real-time data available in and reporting to BPSO Control Room)

1. **Name of Licensee:** _____ (Eg: TD, BPC)

2. **Name of the element:** _____ (Eg.: 400kV Jigmeling-MHPA line)

3. **Type of Element:**

i. Transmission Line

iv. Bus

ii. ICT

v. Bay

iii. Reactor

vi. Generator

vii. *Other:* _____ (*specify*)

4. **Voltage level:** _____ kV (eg.: 400kV)

5. **Likely date and time of Charging:** (day/month/year)

6. **Protection settings are in place:** (*tick if protection settings are in place*)

7. **Date of Application:** (day/month/year)

8. **SCADA Data Validation one week prior to test-charging:** (*tick if validation is done one week in advance*)

9. **Protection settings are done taking care of the nearby stations:** (*tick if settings are done taking care of nearby stations*)

10. **Any other relevant details/information:**

Note: The concerned Licensee certified that the element(s) is/are tested and is/are safe to charge.

(Name and Designation of the authorized person with official seal)

For System Operator Use

Approved: Not Approved:

Remarks:

By:



1. Importance of Real-time Data

Real-time Data:

✓ given utmost importance



Denial of synchronization



Denial of COD



Programme deferrals

[Redacted] Synchronization NOT APPROVED

External Inbox x

AI Overview



BPSO Controlroom

Mar 31, 2026, 12:30 PM (7 days ago)

to [Redacted]

Dear Sir,

This concerns the proposed synchronization of [Redacted] to the grid. We regret to inform you that the synchronization of Yungichhu is **NOT APPROVED** due to the unavailability of real-time SCADA data in the BPSO control room.

Further, BPSO must be notified 14 days before the anticipated charging or synchronization date for the first charging or synchronization. The SoP is https://bpso.bt/uploads/documents/SOP_fornewconnectiontotheexistingGrid54th-OCC.pdf

Thank you,



Control Room

(Power System Operation Division)
Bhutan Power System Operator

Reply

Reply all

Forward

Share in chat



1. Importance of Real-time Data



Other Data/Information:

- ✓ Advance information



འཇམ་ལྷན་པོའི་རྒྱུ་རྐྱེན་ལྷན་ཁང་།
 Ministry of Energy and Natural Resources
 Royal Government of Bhutan
 Bhutan Power System Operator
 Thimphu: Bhutan



14/BPSO/Puna-II/2025/646

5th June, 2025

To
 Joint Managing Director
 Office of the Joint Managing Director
 Punatsangchhu-II Hydroelectric Project Authority
 Wangduephodrang
 Bjimithangkha: Bhutan

Subject: Declaration of Commercial Operation Date (COD) for Unit-IV of Puna-II

Dear Sir,

With reference to the letter no. **PHPA-II/EIC(EMC)/BPSO/2025/772**, dated 3rd June, 2025, BPSO had been intimated that various tests on the **Unit-IV** had been conducted and completed.

With the completion of the required tests, this office is pleased to inform you that the COD for the Unit-IV is hereby issued and is w.e.f. **5th June, 2025 @ 00:00 Hrs (BST)**. As part of the operation, you may please submit the following in consonance with the SOP for

Operationalization of Grid Discipline Mechanism Regulation 2024:

1. Day Ahead Generation Schedule in 96 blocks on daily basis,
2. Weekly ABT meter data every Monday,
3. Disturbance Recorder (DR) data, and
4. Event Information Report (EIR) as and when there is a system disturbance.

This is submitted for kind information and necessary action.

Enclosed: COD Certificate for Unit-IV

Thanking you,

Yours sincerely,



2. Historical Data and System Improvement

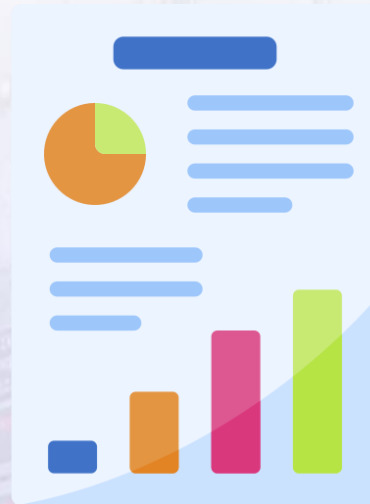
Event Information:

- ✓ Disturbance Records (DRs) from the sites
- ✓ Event Information Reports (EIRs) from the sites
- ✓ Flash Report from BPSO Control Room

**Submission to the
System Operator within
24 hours**



Post-mortem analysis



Detailed report with
recommendation
within 2 weeks



Action Taken Reports
from site
within 2 weeks



3. Grid Operation



Outage Plans

✓ Annual Outage Plans: 31st Dec for next year

- No repeated shutdowns
- Proper coordination
- Reliability
- Demands-supply match
- Voltage stability

Under no circumstances should breakers be opened or closed without the approval of SO

Approval must be sought for any Work nearby the electrical installation of 66kV and above



Annual

2-week time



Ad hoc

3-day time



Emergency

No approval required

འབྲུག་རྒྱུག་ཤུགས་རིང་ལུགས་ལས་ཚུན་དཔ།
Bhutan Power System Operator

རྒྱལ་ཤུགས་དང་རང་བཞིན་ཐོན་སྐྱེད་ལྗན་ལག
Ministry of Energy and Natural Resources

Power System Operation Division



Annual Outage Plan 2026

(31-December-2025)

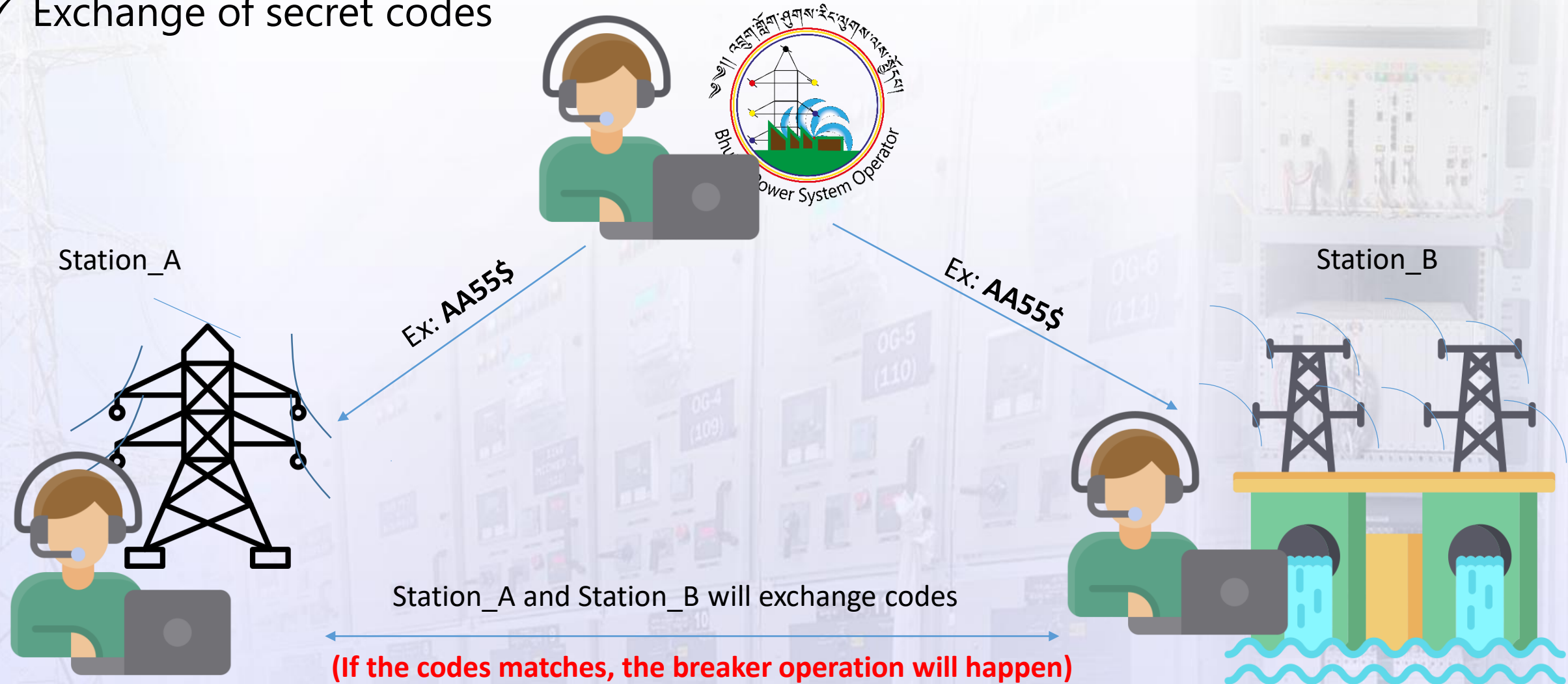


3. Grid Operation



Breaker operation

- ✓ Exchange of secret codes





3. Grid Operation

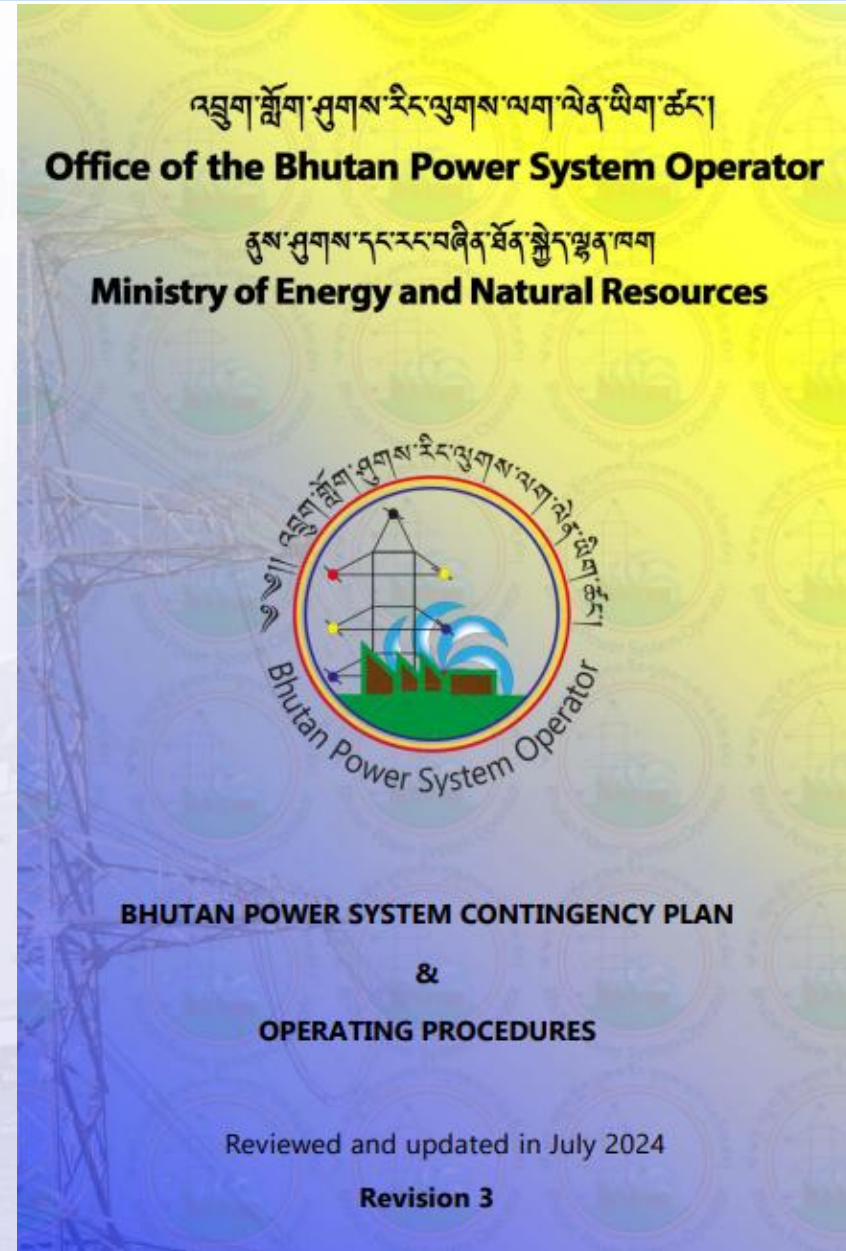


KPIs



- No overloading of transmission elements
- No over-/under-voltage
- System restoration after blackouts

Periodic review, deliberation, and finalization of Contingency Plans





3. Grid Operation

Protection



- Joint protection settings
- Corrective actions
- Special Protection Schemes

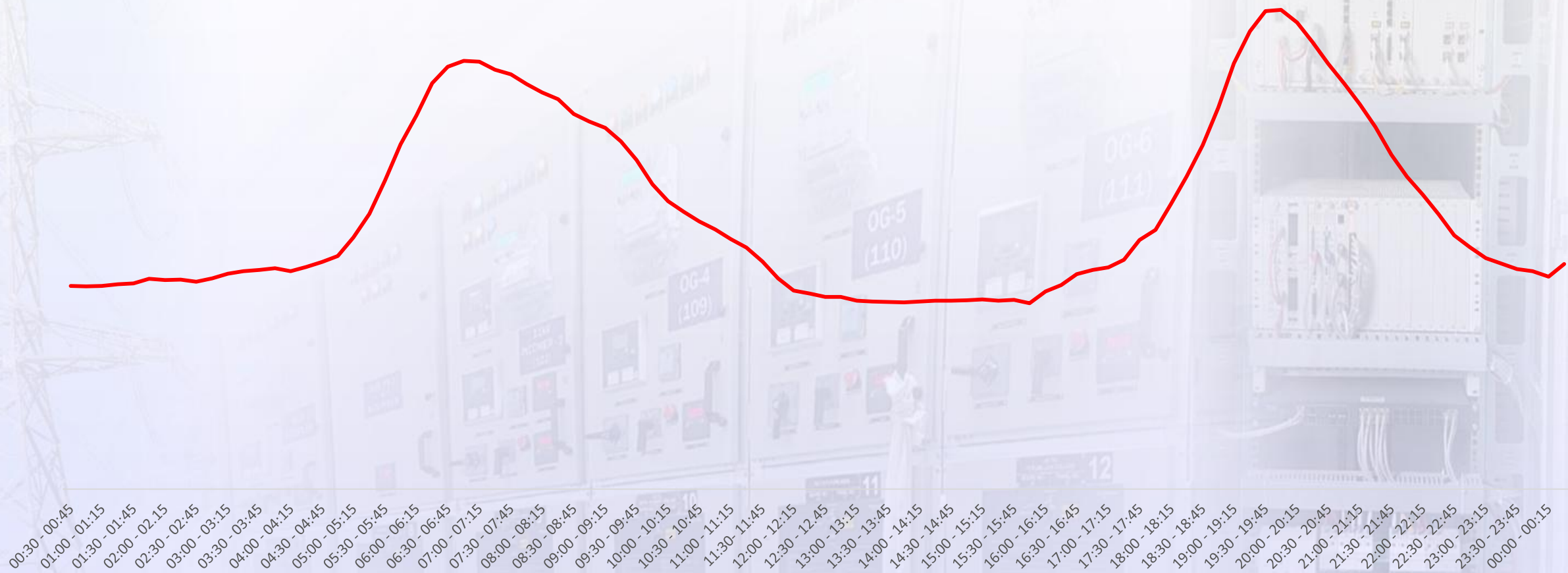




3. Grid Operation

❖ Forecasting and scheduling

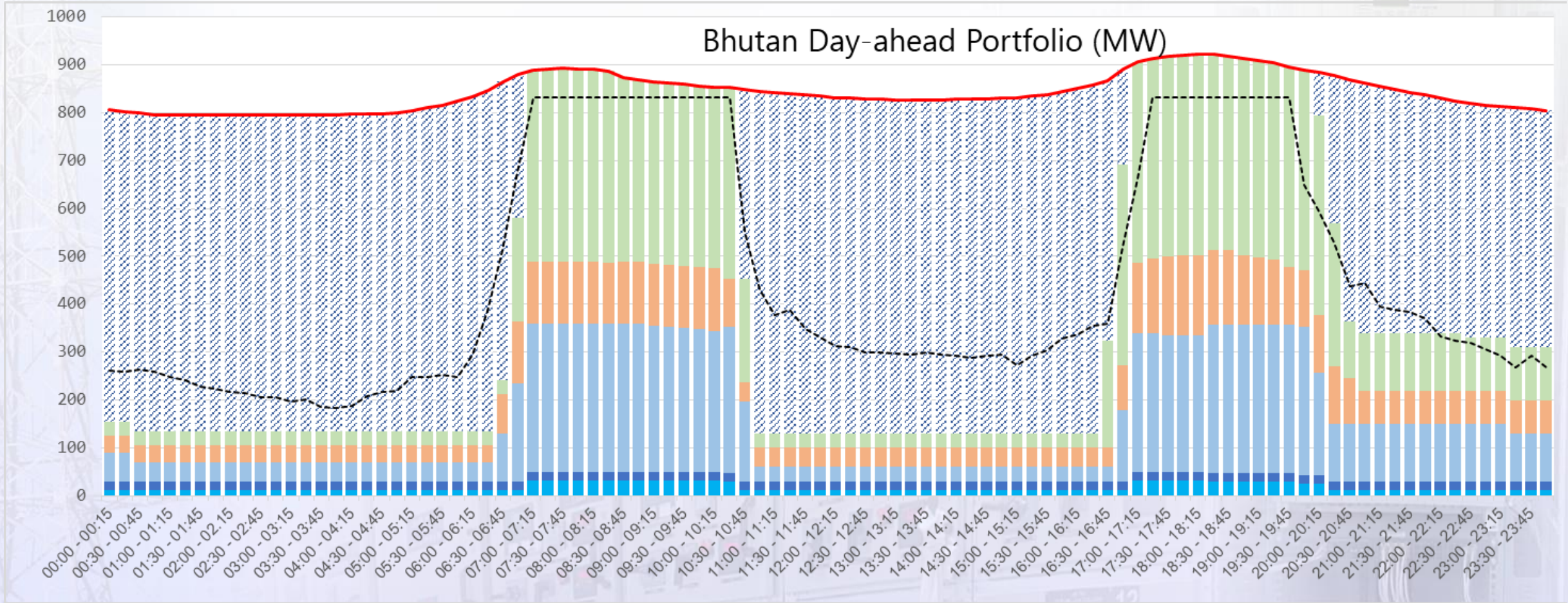
Typical Day Demand Pattern





3. Grid Operation

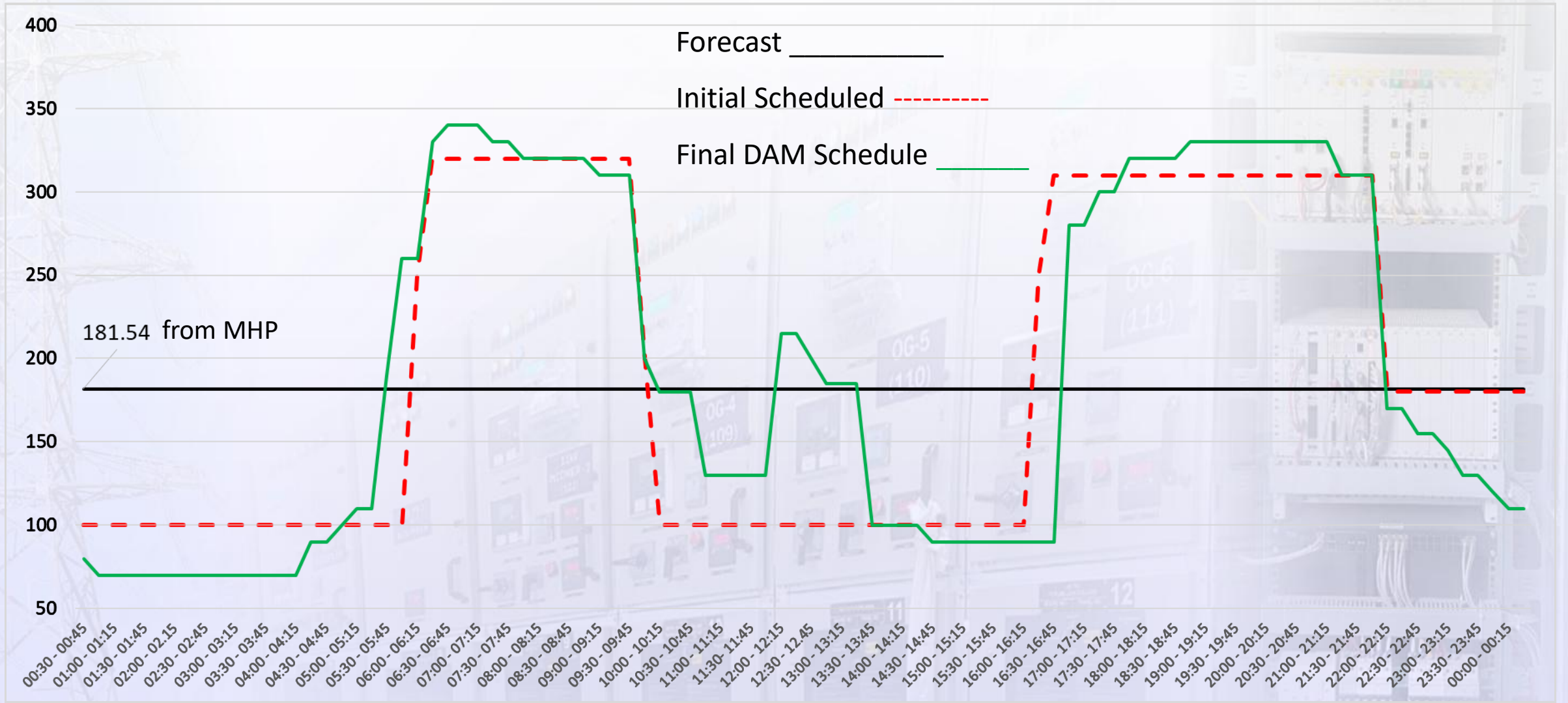
Import and Export Scheduling





3. Grid Operation

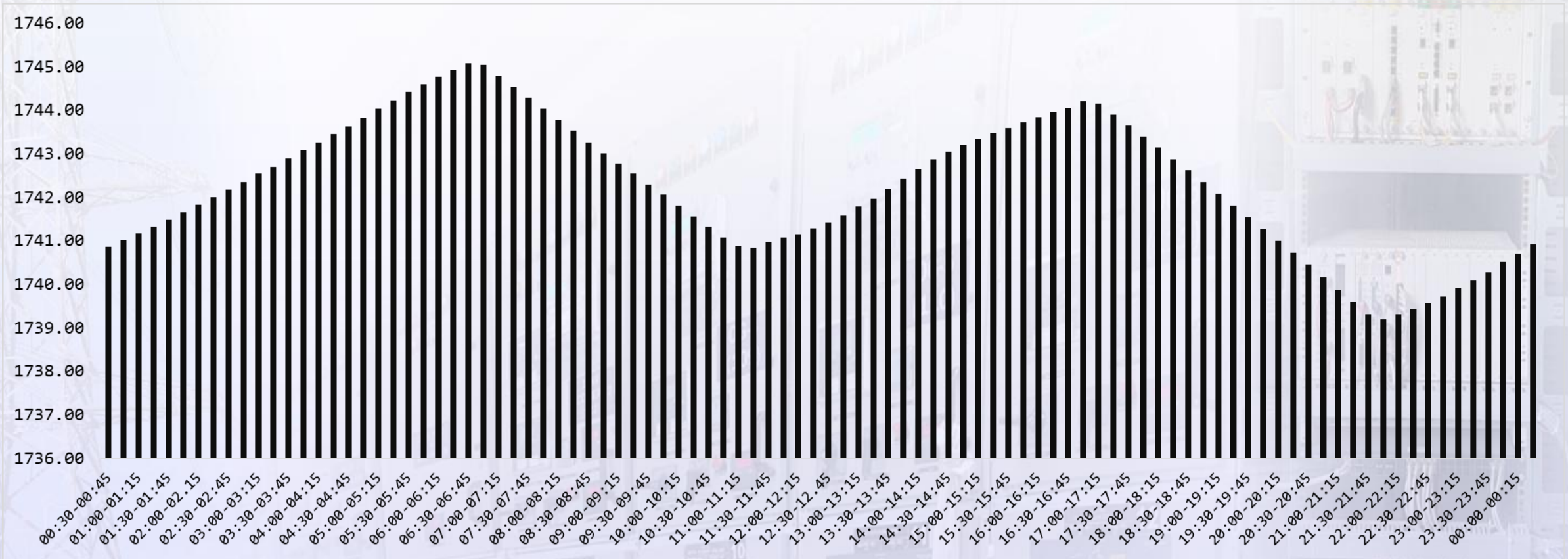
BPSO's schedules are based on the Forecasts of Plants





3. Grid Operation

Import and Export Scheduling





3. Grid Operation

System operation for stability and security

49.83	49.97	49.95	49.98	49.93	49.97	50.05	49.97	50.01	49.97	49.95	50.02	50.04	49.81	49.88
49.94	49.98	49.96	49.99	49.94	49.99	50.07	49.97	50.01	49.91	49.92	50.00	50.01	49.93	49.94
49.98	49.98	49.95	50.00	49.94	49.98	50.03	49.96	50.01	49.97	49.92	50.00	49.98	49.91	49.94
49.97	49.98	49.94	49.99	49.93	50.00	50.02	49.96	50.02	49.97	49.92	49.99	49.98	49.91	49.94
49.98	49.98	49.96	50.02	49.96	49.96	50.03	49.99	50.00	49.99	50.00	50.04	49.96	49.96	49.96
49.97	50.00	49.98	49.98	49.95	49.97	50.03	49.97	50.01	49.99	50.00	50.04	49.97	49.97	49.98
49.98	50.02	50.01	49.98	49.97	49.97	50.04	50.02	50.01	50.00	50.00	50.04	49.94	49.99	49.99
49.97	50.01	49.97	49.97	49.98	49.98	50.03	49.99	50.00	50.01	49.99	50.01	49.99	49.99	49.99
49.95	50.02	49.98	49.99	49.93	49.97	50.04	50.00	50.00	50.01	49.99	50.01	49.99	49.94	49.94
49.95	49.99	49.97	49.98	49.94	49.98	50.01	50.00	49.97	49.99	49.98	49.91	49.99	49.99	49.99
49.98	49.99	49.98	50.00	49.97	49.97	50.02	50.00	50.00	49.96	49.96	49.96	49.96	49.96	49.96
49.98	49.99	49.95	49.99	49.96	49.96	50.01	49.99	49.96	49.96	49.96	49.96	49.96	49.96	49.96
50.00	50.01	49.93	49.97	49.97	49.96	50.00	50.00	49.97	49.99	49.95	49.95	49.92	49.92	49.97
50.00	50.05	49.97	49.99	49.97	50.00	49.99	50.00	50.03	50.00	49.97	49.97	49.92	49.92	49.99
49.96	50.11	49.98	49.98	49.98	49.98	50.00	49.99	50.00	50.04	50.02	49.98	49.97	49.97	49.98
49.96	50.14	50.04	49.98	49.97	50.00	50.02	49.98	50.02	49.98	49.98	49.91	49.99	49.99	49.99
49.95	50.05	49.94	49.97	49.97	50.01	50.00	49.99	49.98	50.04	50.01	49.96	49.96	49.96	49.96
49.95	50.01	49.93	50.00	50.00	50.01	50.01	50.00	50.04	49.99	50.02	49.98	50.04	49.98	49.97
49.99	50.01	49.95	49.99	49.97	49.99	49.99	49.99	50.01	50.03	50.00	50.02	50.04	49.96	49.96
50.00	50.00	49.95	49.97	49.97	49.95	49.98	50.02	50.01	50.03	50.01	50.03	50.03	49.97	49.97
49.99	49.96	49.97	49.97	49.97	49.91	50.00	50.02	49.99	49.97	49.96	50.00	50.00	49.99	49.99
49.96	49.96	49.97	49.97	49.95	49.97	50.00	50.00	50.01	50.01	50.01	50.01	50.01	50.01	50.01
50.00	50.00	50.01	50.00	49.98	49.99	49.99	49.99	49.99	49.99	49.99	49.99	49.99	49.99	49.99
50.05	49.99	50.00	49.98	49.98	49.98	49.99	49.99	49.99	49.99	49.99	49.99	49.99	49.99	49.99
50.00	50.04	50.01	50.02	49.98	49.97	50.01	49.95	49.98	49.96	49.92	49.93	50.03	49.94	49.94
50.01	50.01	49.99	49.95	49.95	49.96	49.92	50.00	50.00	50.05	49.91	49.91	49.91	49.91	49.91
50.02	49.98	49.97	49.98	49.98	49.96	49.98	50.01	49.99	49.97	49.87	49.87	49.87	49.87	49.87
50.00	50.00	50.00	50.01	50.01	49.91	49.98	50.03	49.99	49.90	49.92	49.94	50.02	49.99	49.99
50.00	50.00	50.00	50.02	50.02	49.95	49.97	50.03	50.03	50.03	50.03	50.03	50.03	50.03	50.03
49.99	50.02	50.02	50.02	50.03	50.03	49.92	50.03	50.06	50.06	50.03	49.99	50.15	49.96	49.96
49.99	50.05	50.02	50.04	50.05	50.05	49.75	49.99	50.08	50.06	50.00	49.99	50.06	49.95	49.95
50.04	50.07	50.06	50.04	50.04	50.10	50.04	49.98	49.97	50.08	50.01	50.00	50.02	49.95	49.95
50.02	50.08	50.05	50.08	50.05	50.02	49.97	50.01	50.06	50.01	50.05	50.01	50.02	49.91	49.91
50.00	50.03	50.04	50.04	50.03	50.05	49.93	49.99	50.05	50.01	50.01	50.03	50.03	49.99	49.99
50.01	50.02	50.02	50.06	50.02	50.06	49.97	49.99	50.04	49.96	49.96	49.96	49.96	49.96	49.96
50.02	50.04	50.01	50.04	49.98	49.98	49.95	49.97	50.01	49.95	50.02	49.98	49.97	49.95	49.95
50.01	50.04	50.01	50.04	50.01	50.01	50.01	50.01	50.01	50.01	50.01	50.01	50.01	50.01	50.01
50.05	49.92	49.97	50.02	50.01	49.88	49.95	49.99	50.00	49.98	50.15	50.02	49.99	49.96	49.96
50.05	49.92	49.96	50.04	49.99	49.92	49.92	49.99	50.01	50.09	49.98	50.02	50.01	49.96	49.96
50.06	49.93	49.99	50.02	50.03	49.96	49.98	50.00	50.02	50.11	50.04	49.96	49.98	49.97	49.97
50.07	49.90	49.90	49.90	49.90	49.90	49.90	49.90	49.90	49.90	49.90	49.90	49.90	49.90	49.90
50.01	50.00	49.99	50.00	49.94	49.94	50.04	50.04	50.01	50.04	50.04	50.04	50.04	50.04	50.04
50.05	49.99	49.99	50.00	50.03	50.04	50.04	49.97	49.95	50.00	50.00	50.00	50.00	50.00	50.00
50.01	49.97	50.02	50.02	50.02	50.02	50.02	50.02	50.02	50.02	50.02	50.02	50.02	50.02	50.02
50.01	49.99	50.01	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
50.01	49.99	50.01	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00

1-Jan-23	2-Jan-23	3-Jan-23	4-Jan-23	5-Jan-23	6-Jan-23
2890.56	2543.58	2768.60	2891.75	2891.16	2804.14
2771.61	2449.57	2768.06	2879.26	2840.60	2750.36
2750.50	2360.10	2700.54	2840.32	2771.00	2800.43
2543.42	2138.69	2543.60	2768.81	2768.15	2768.35
2543.25	2115.69	2543.33	2768.47	2768.08	2768.12
2543.16	2107.64	2500.83	2768.03	2600.71	2543.86
2450.00	2083.90	2449.23	2700.24	2543.01	2543.10
2449.45	2083.25	2360.23	2590.53	2543.35	2500.53
2449.57	2000.13	2151.46	2543.57	2543.57	2543.04
2449.34	1999.80	2151.01	2543.32	2543.10	2449.60
2419.99	1999.74	2138.90	2540.89	2449.72	2200.95
2419.16	1999.68	2138.73	2543.00	2449.81	2400.08
2449.27	2030.16	2138.95	2543.20	2449.57	2449.53
2449.02	2083.27	2151.53	2543.28	2449.80	2500.99
2449.30	2107.29	2151.02	2543.18	2500.08	2540.09
2360.90	2103.67	2350.61	2590.30	2540.47	2543.33
2540.95	2138.31	2449.51	2650.24	2590.08	49.70
2595.41	2151.80	2612.30	2768.45	2768.00	2804.03
2748.75	2543.33	2768.68	2840.61	2900.93	2910.93
2939.00	2891.38	2938.71	3218.08	3350.87	3450.50
3428.40	3000.38	3225.43	3300.09	3428.56	3610.08
3726.43	3510.20	3624.61	3662.09	3735.46	3735.98
3814.93	3735.45	3814.12	4078.08	4099.70	4228.70
4270.70	4058.87	4270.05	4552.89	4718.98	4680.36
4680.35	4430.84	4718.60	5300.16	5500.78	6490.00
6000.42	5300.04	5600.70	6000.83	6000.83	6000.83
6509.36	6300.28	7270.52	8000.48	10000.84	12000.00
15000.00	5000.39	7500.45	10000.41	12000.00	12000.00
6500.20	6000.30	7600.31	12000.31	12000.00	12000.00
7600.51	7500.50	8500.37	10000.77	12000.00	12000.00
8400.38	8000.53	8863.98	11225.80	12000.00	12000.00
8192.51	10000.58	8000.60	10000.31	12000.00	12000.00
8400.14	12000.00	8963.05	8963.45	12000.00	12000.00
8400.52	12000.00	8500.58	8500.92	12000.00	12000.00
8400.72	12000.00	8000.92	10000.63	12000.00	12000.00
8400.07	10000.00	8000.50	8500.31	12000.00	12000.00
8400.68	12000.00	8500.70	10020.40	12000.00	12000.00
8400.91	12000.00	10070.21	11370.72	12000.00	12000.00
8400.04	12000.00	8500.00	10070.24	12000.00	12000.00
8400.48	12000.00	7600.13	10000.66	12000.00	12000.00
8400.32	12000.00	7600.83	10020.76	12000.00	12000.00
8400.18	12000.00	7600.83	10020.76	12000.00	12000.00
8400.74	12000.00	7600.83	11779.90	12000.00	12000.00
6999.07	10000.00	6999.02	10020.61	11570.93	12000.00
7000.54	8863.44	7387.49	8500.11	9000.76	9000.54
7000.69	8900.62	8000.57	6999.17	9000.39	9000.39
6999.55	7690.52	8000.43	7150.47	8500.60	8500.60
6998.36	8863.41	8000.83	6200.49	8500.20	9000.06
4998.84	7600.89	7387.14	6200.75	7250.09	8770.08
4999.81	6420.73	5762.85	5500.25	6570.51	8170.25
4000.52	4020.26	5000.43	5000.35	6570.05	6570.05
3947.29	4680.95	5026.97	5600.04	5959.16	6140.40
3756.22	4680.58	4999.39	4999.46	5200.38	5400.56
3735.30	4600.43	4914.93	4750.33	5000.21	5000.37
3708.12	4390.18	4998.82	4608.98	4800.50	5000.72
3726.30	4400.90	4999.02	4150.24	4680.25	4900.73
3726.04	4546.65	5000.00	4270.78	4800.00	4900.04
3708.26	4600.85	5000.07	4680.26	5000.93	5400.14
3726.35	4820.50	5700.29	4999.78	5499.38	5800.66
3708.87	4899.12	5482.72	5620.69	5959.60	6000.65
4000.10	4999.30	6000.27	4999.47	6000.32	6000.90
4000.34	6000.00	6000.16	6000.15	6000.70	6140.39
4099.32	6000.42	6000.63	6000.45	6000.84	6450.43
4342.06	6000				



3. Grid Operation

Bhutan-India



- a) **Coordination meetings**
- b) **Joint studies:** tripping analysis, load flow, ATC/TTC, etc.
- c) **Outage** analysis and approvals
- d) Communication and SCADA data improvement
- e) Human-resource development



3. Grid Operation

Within Bhutan

Operation Coordination Meeting every two months: Operational level

Bhutan Power System Coordination Committee



4. Conclusion

1. **Data for system operation:** all the connected users must ensure the availability
2. **Outage Management:** *proper, in-advance planning*
3. **System Analysis:** *reports, recommendations and actions taken reports*
4. **Operation:** *Stability- and security-driven, not commercial-driver.*
5. **Coordination:** *Timely coordination*

बन्नु'को

Thank you