Task Force-2 Meeting on Advance Transmission System Interconnections - SARI/EI

By

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Outline

- Overall Power Sector Scenario
- Load Projections (in MW)
- Planned Generation & Transmission System Expansions
- Cross Border Interconnection Links - Existing and Planned
- Power Export / Import – Existing and Planned
- Transmission Planning Code/Criterion
- Grid Operation Code
- Metering Regulations
- Protection Coordination Review
- Emergency Restoration Plan and Black Start facilities
- National Load Despatch Center
- Power Despatch on Existing Cross Border Interconnections
- Land Acquisition and Right of Way
- Comments and Views on Open Access

Overall Power Sector Scenario

- The steep and rugged Himalayan mountains and fast running rivers promise huge hydropower potential
  - ✓ Over all potential – 30,000 MW
  - ✓ Techno-economically viable – 23,500 MW (Res. ~ 8,000 MW)
- Total installed capacity – 1,488 MW (5% of potential)
- Peak load demand in 2013 – 291 MW *(10.2% avg. PD growth with 15.23% Energy Demand growth)*
- Plant Load Factor – 62%
- Overall System reliability (BPC) of the existing system (2012)
  - SAIFI : **5.76** Interruptions/Customer
  - SAIDI : **5.50** Hours/Customer

Current Generation & Transmission Scenario

Existing Hydroelectric Generating Stations		
Name of Plant	**Installed Capacity (No. x Unit size)**	**Transmission Voltage (kV)**
Chhukha (CHP)	336 (4x84)	220kV, 66kV
Basochhu-I (BHP)	24 (2x12)	66kV
Basochhu-II (BHP)	40 (2x20)	220kV, 66kV
Kurichhu (KHP)	60 (4x15)	132kV
Tala (THP)	1,020 (6x170)	400kV
Mini/Micro	8 (17 nos)	6.6kV/415V
Total	**1,488 MW**	

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Existing Power Transmission Lines	
Line Voltage	**Line Length (ckt. km)**
400 kV	74.143
220 kV	285.163
132 kV	344.456
66 kV	311.517
Total	**1,015.279**

Existing / Planned Transmission System in Bhutan

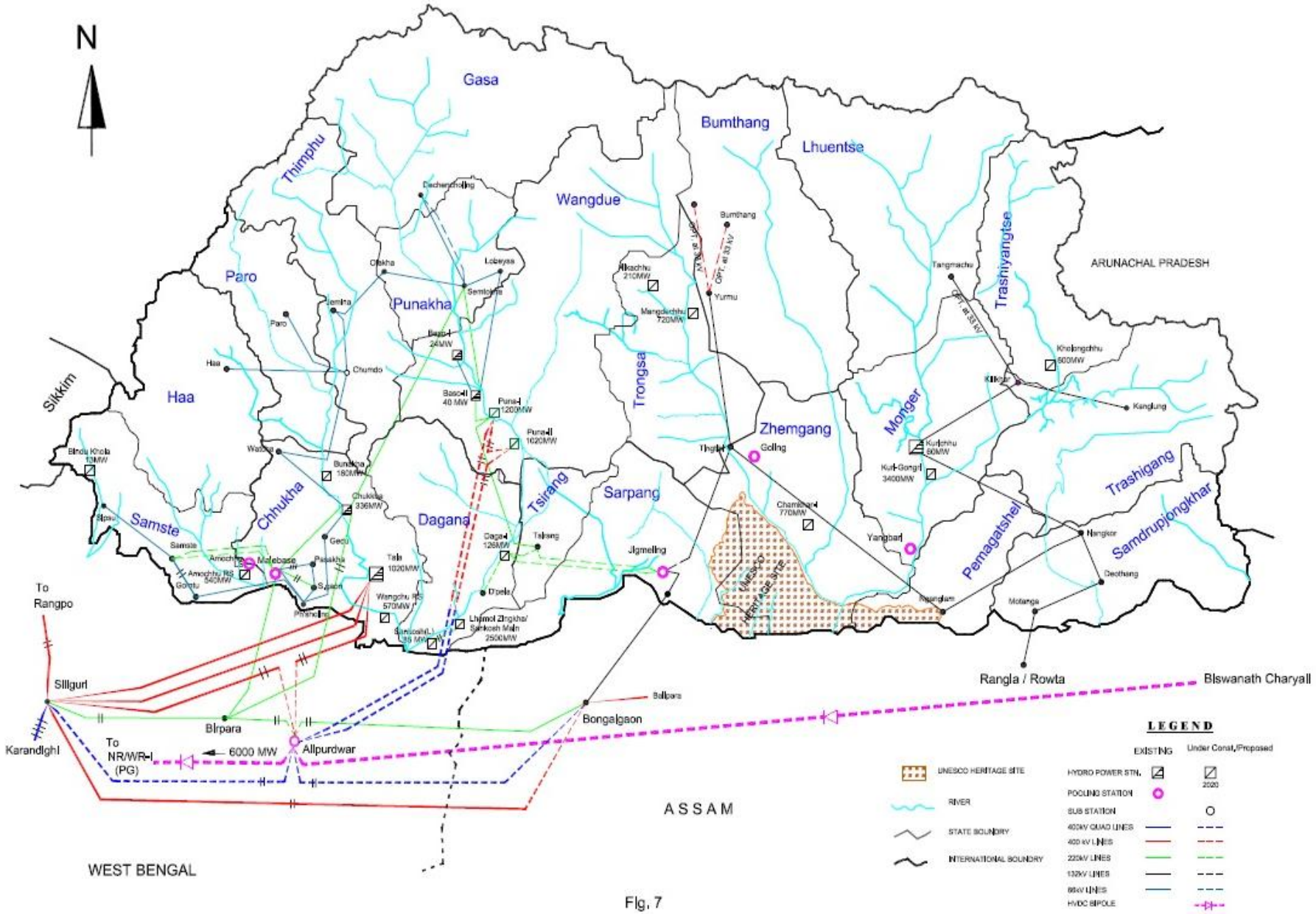
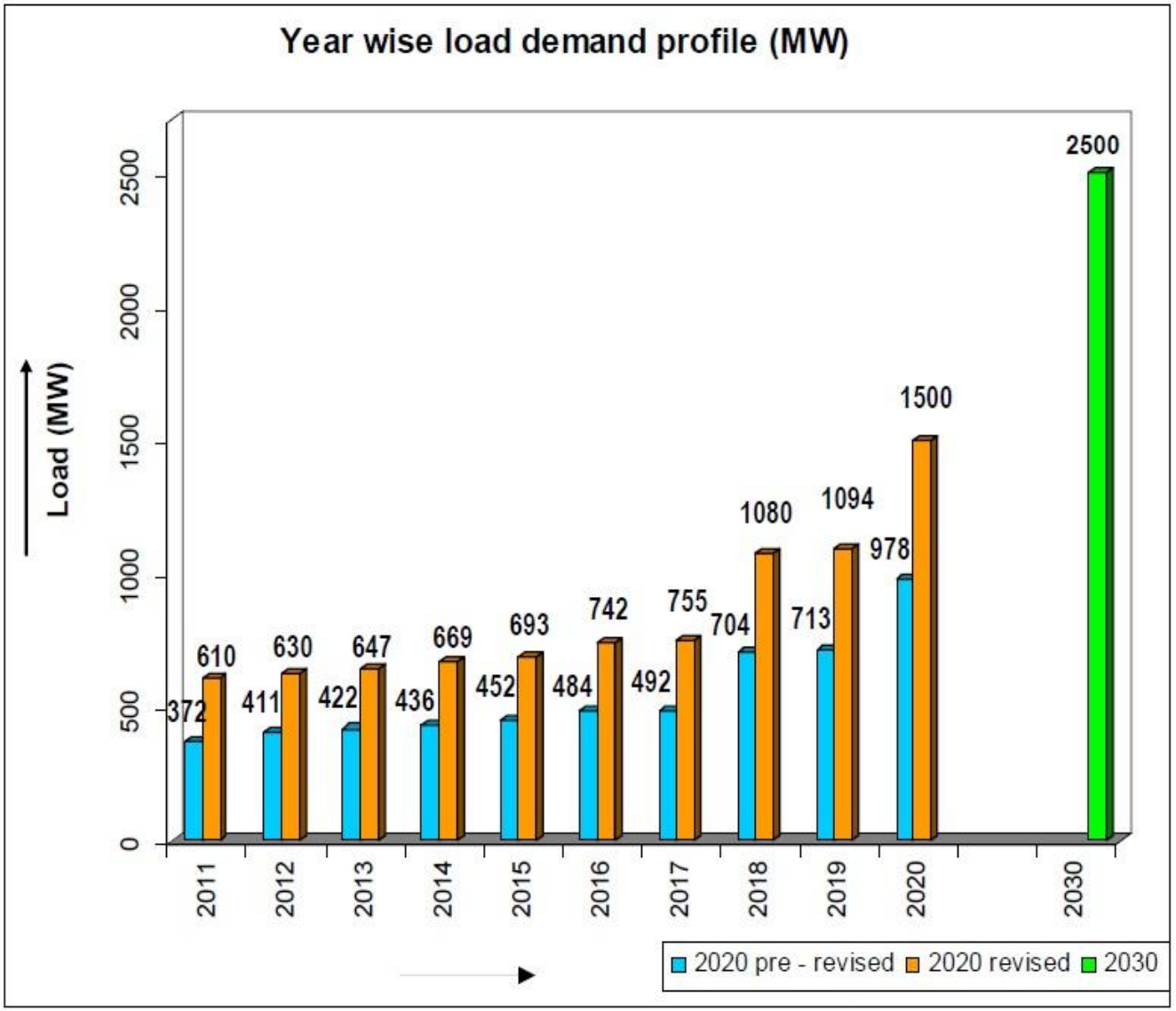


Fig. 7

Load Projections over the next 20 years



Planned Generation Expansions

Sl. No.	Name of HEP	Installed Cap. (MW)	Year of Commissioning	Mode/Remarks
1.	Punatsangchhu-I	1200	2016	IG/Under construction
2.	Punatsangchhu-II	1020	2017	-do-
3.	Mangdechhu	720	2017	-do-
4.	Sankosh	2560	2023	IG/DPR under review
5.	Kuri-Gongri	2640	2025	IG/DPR yet to initiate
6.	Wangchhu	570	2022	JV/DPR under review
7.	Bunakha	180	2020	-do-
8.	Kholongchhu	600	2021	JV/DPR cleared
9.	Chamkharchhu-I	770	2024	JV/DPR under review
10.	Amochhu	540	2022	IG/DPR cleared
11.	Nikachhu	118	2019	PPP/DPR under progress
12	Dagachhu	126	2014	PPP/Under construction
	Total	**11,044 MW**	**37% new addition**	

Generation Capacity Outlook by 2020 & 2030

Existing Installed Capacity (IC)	Capacity addition by 2020	**I.C. by 2020**	Capacity addition by 2030?	I.C. by 2030?
1,480	11,864	**13,344**	14,653	**27,997**
5 HEPs	13 HEPs		60 HEPS	78 HEPs

- Hydropower Policy 2008 (www.moea.gov.bt)

Planned Transmission Expansions

National Transmission Grid Master Plan-2012:

- Bhutan has embarked upon a target of developing a minimum of 10,000MW by 2020:
  - ✓ *Integrated and holistic road map for development of optimal transmission lines by optimizing RoWs and minimizing impacts on environment (Integrated Evacuation Systems for the 10,000MW HEPs)*
  - ✓ *Identification of major Pooling/Sub-pooling Stations within Bhutan*
  - ✓ *System strengthening within Bhutan to meet the load demand and load growth of the country and ensure Reliability of Supply & Long-Term Energy Security (400 kV integrated national grid with strong interconnection between Eastern & Western parts of Bhutan)*
  - ✓ *Grid reinforcement Studies/Plans in India for import of Power from Bhutan by 2020 & beyond*
  - ✓ *Cost Estimates*

Existing & Planned System by 2015-17

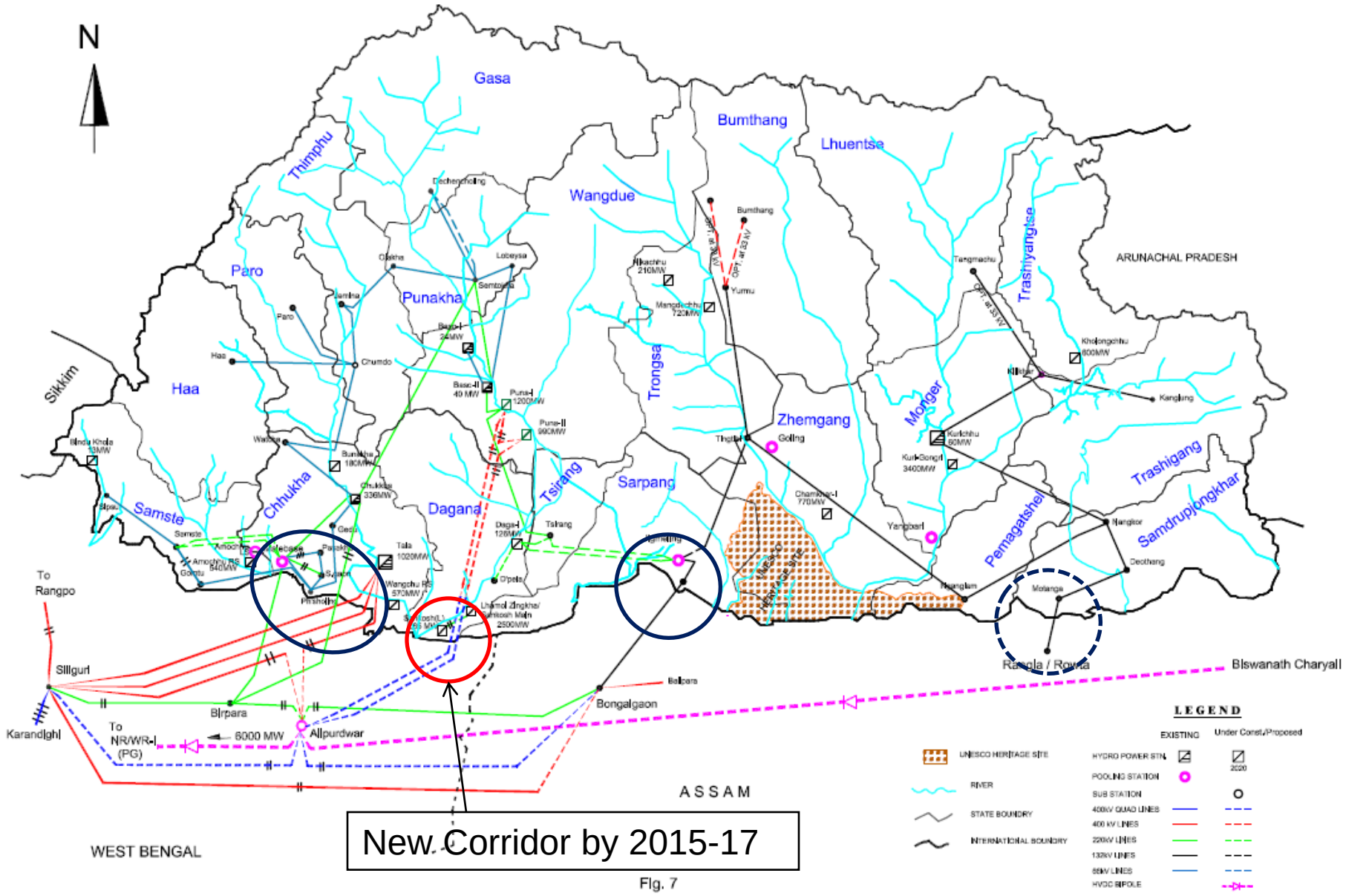


Fig. 7

Planned Power Transmission Lines

Line Voltage	Line Length (ckt. km)
400 kV	1,416
220 kV	112
132 Kv	275
66 kV	94
Total	**1,897**

Cross Border Interconnection links – Existing and Planned

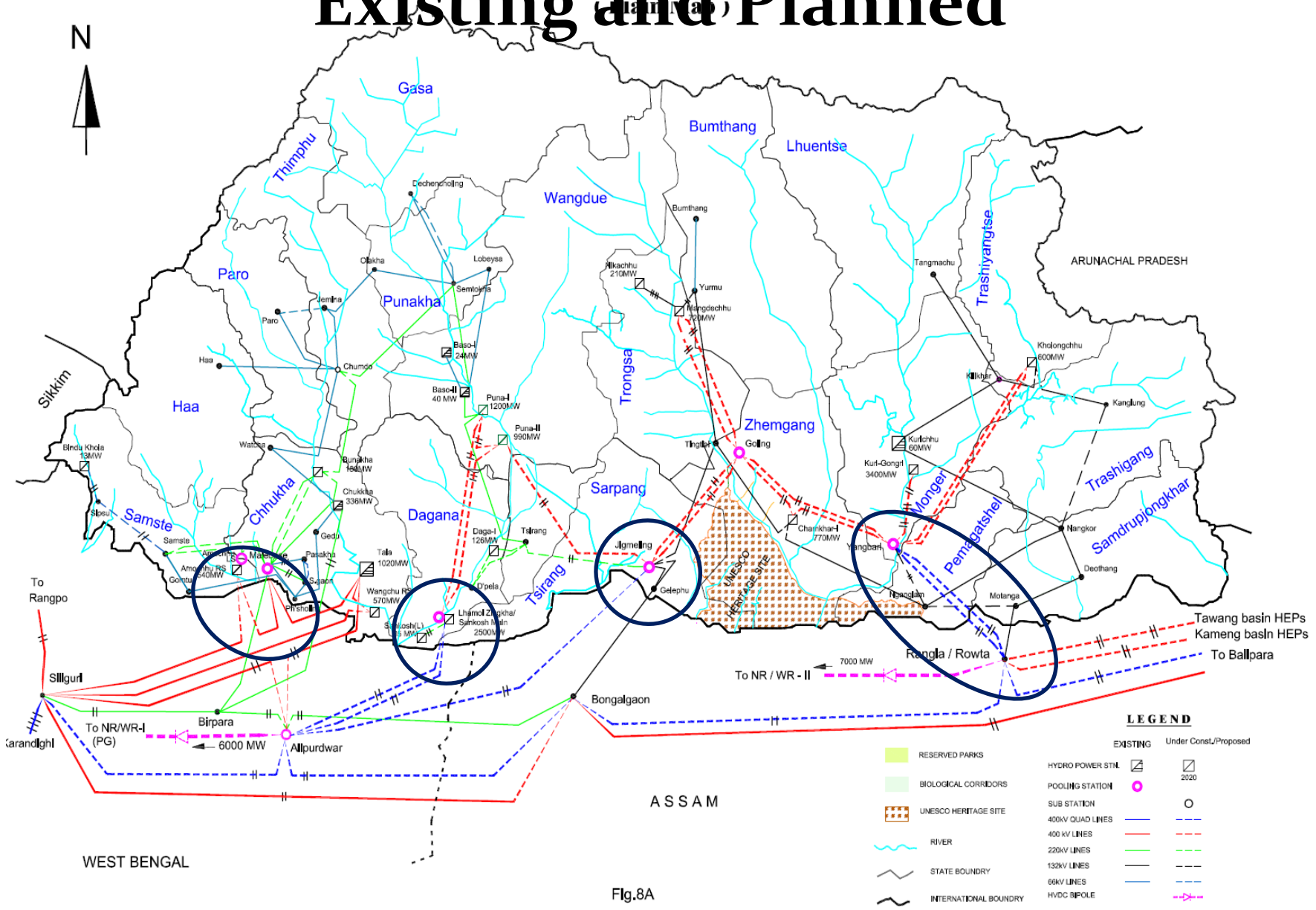
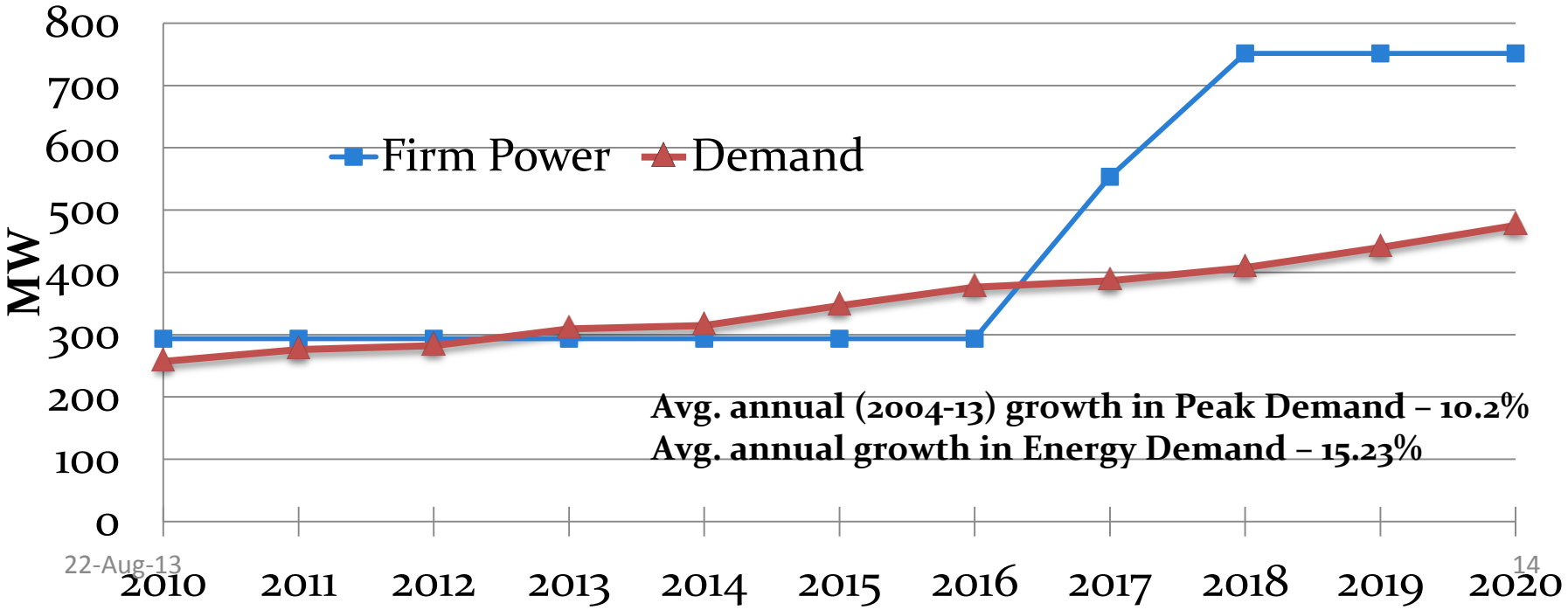


Fig.8A

Demand and Supply – Short Term

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020
Demand (MW)	282.4	309.5	314.5	346.7	376.4	386.5	407.4	440.0	475.2
Firm Power (MW)	293.5	293.5	293.5	293.5	293.5	553.5	751.5	751.5	751.5
Shortage/ Excess (MW)	11.1	-16.0	-21.0	-53.2	-82.9	167.0	344.1	311.5	276.3



Power Exports – Existing and Planned

- Bhutan has always been Net Exporter of power
- Power exported to India through Power Purchase Agreements

Trends in Power export (MU)				
GWh/Year	**1988-2006**	**2007-2008**	**2012**	**2017-2025**
Generation	1,429.58 - 3,336.63	6,400.74 -7,135.35	7,304.52	13,246.46 - 48,504.97
Export	1,313.18 - 2,027.44	4,533.20 -5,922.38	5,579.49	10,329.13 -41,985.91

Land Acquisition and Right of Way

- Land Act 2007 www.land.gov.bt
- Land Rules & Regulations-2009 (2013 Version currently under review)

System Parameter Limits

- The Grid Code Regulation 2008 of Bhutan.

System Operating State	Voltage	Frequency
Normal	0.95 to 1.05 times nominal values	49.5Hz to 50.5Hz
Alert	Outside normal limit but within 0.9 to 1.1 times nominal values	Beyond normal limit but within 49Hz to 51Hz
Emergency	Outside above limits	Beyond above limits

- Control on system voltage using shunt reactor installed at KHP and THP apart form transformer taps.
- Frequency of the system largely dependent on Indian grid.

Transmission Planning Norms

- Owing to topological conditions, widespread biological and reserved Parks, difficult hilly terrain and environmental concerns, the Transmission Planning criterion followed are:
  - ✓ Meeting the requirements of adequacy, security and reliability
  - ✓ Amenable to development in stages
  - ✓ Cost economy
  - ✓ Right of Way (RoW) optimization
  - ✓ Ease of operation and maintenance
  - ✓ Minimum environmental impact
  - ✓ (N-1) contingency including tower outage

Grid Operation Code

- Bhutan Electricity Authority Grid Code Regulation 2008 www.bea.gov.bt

- Aims to create a level playing field for all Users, without any discrimination

- Establish basic rules, procedures, guidelines and standards to be followed by various Licensees and all power utilities connected to the Transmission System so as to plan, develop, maintain and ensure secure, reliable and efficient operation of the Transmission System in economic manner.

Metering Regulation

- For international metering guided by long term PPAs
- For Domestic all meters are jointly read amongst parties
- Main and check meters installed at all required locations
- 0.2 class accuracy required for 66 kV and above metering

Protection Coordination Review

- Two committees in the power sector established for discussion and to resolve issues related to protection, operation, maintenance and any other issues related to National Power system:
- System Coordination Committee (SCC)

  Highest body, Authorization and endorsement, Members are from DHPS, BEA, DGPC and BPC
- Protection Coordination Committee (PCC)

  Does ground works of any TECHNICAL issues related to power system, Members are usually field engineers of DGPC and BPC
- SCC meets on a quarterly basis whereas PCC members meets on monthly basis.

Emergency Restoration Plan & Black Start Facilities

- Based on Grid Code Regulation 2008, a separate document called Operationalization of Grid Code Regulation (draft) is prepared by BPC.
- Operationalization of Grid Code Regulation (draft) contains:
  - Authorizing and monitoring maintenance,
  - Black-start capabilities and system restoration,
  - Control of voltage and reactive power,
  - Interchange scheduling,
  - Elaboration of other major clauses
- Copy available at http://nldc.bpc.bt/

Load Dispatch Centers

- The National Load Dispatch Center (NLDC), Bhutan is executed by BPC.

- The NLDC, Bhutan at Thimphu is connected to the Eastern Load Dispatch Center (ELDC) in the east, located in Tingtibi and the Western Load dispatch Center (WLDC) located at Malbase in Pasakha, which is also the backup control center.

- Currently 40 stations report to the load dispatch center at Thimphu.

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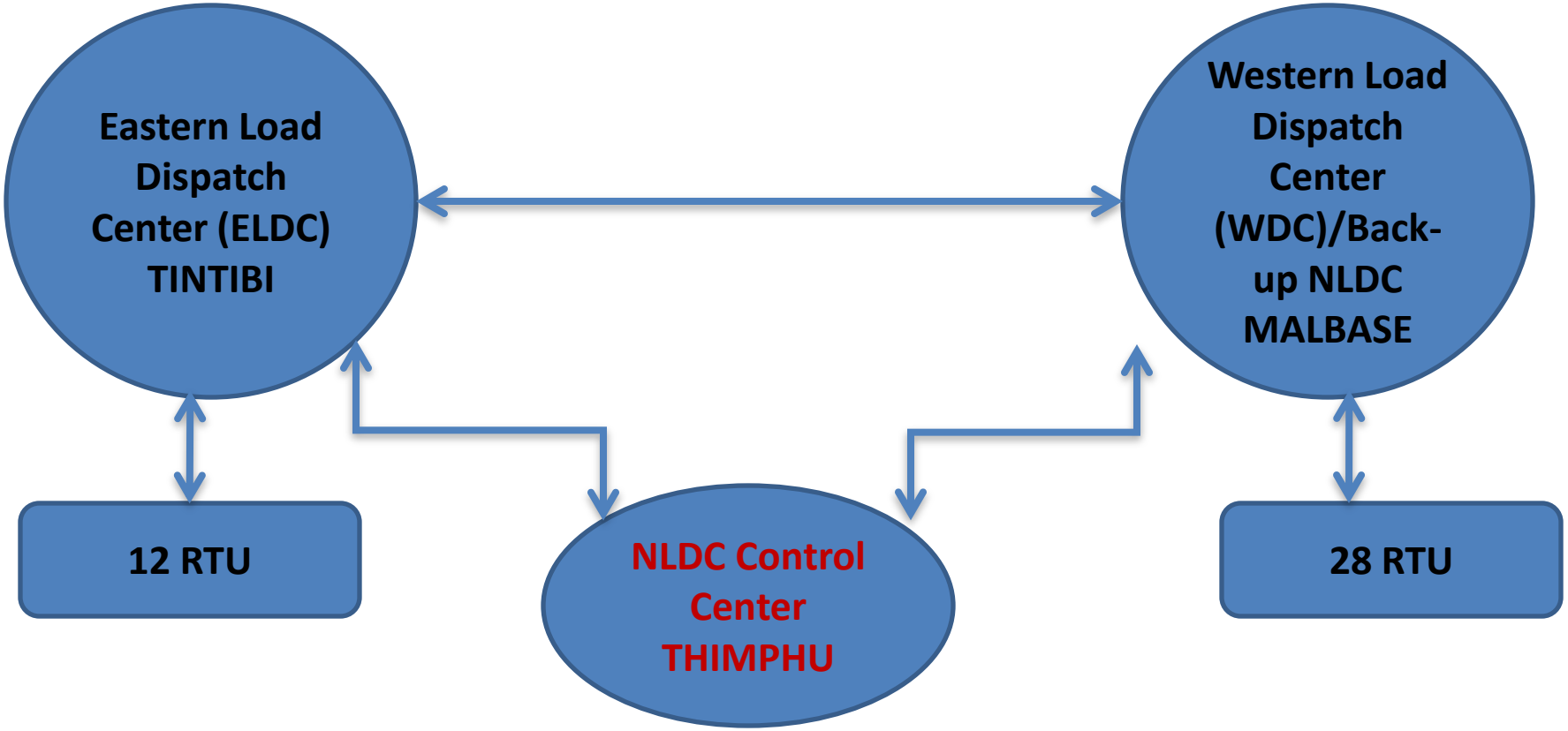
Eastern Load Dispatch Center (ELDC) TINTIBI
Western Load Dispatch Center (WDC)/Back-up NLDC MALBASE
12 RTU
NLDC Control Center THIMPHU
28 RTU

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- BPC, NLDC having applied for a License to BEA is currently awaiting for the same for becoming Bhutan Power System Operator (BPSO), required as per the electricity Act of Bhutan-2001 as well as a the EDP 2010.

Power Dispatch on Existing Cross Border Interconnections

- Existing PPAs
- Don't have any documented procedure
- However, the establishment of a protocol through MoU or as appropriate for bilateral cooperation and coordination for load dispatch, scheduling and integrated power system operation including harmonization of code & practices is seen as important

Balancing Mechanisms for Unscheduled Power Exchange on Existing Cross Border Interconnection Links

- Bhutan, at present do not have Balancing mechanisms for Unscheduled Power Exchange – exports based on surplus power

- In process for an energy banking agreement with West Bengal, India.

Open Access

- All power transactions with India are on long term PPAs and surplus energy basis
- Open Access is seen as balanced and level playing field but needs more exposure and understanding to truly ascertain the implications, obligations and benefits
- Open Access should facilitate sale of power from surplus region to deficit region with free, fair and minimal burden to the seller , particularly giving priority to renewable energy

Thank You