First Meeting of Task Force 2 (SARI/EI Phase IV)

ADVANCEMENT OF TRANSMISSION SYSTEMS INTERCONNECTION

21-22 August 2013, Thimpu Bhutan

Country Presentation: Nepal
Dipak Prasad Upadhyay
Former General Manager Grid Development
Nepal Electricity Authority

USAID-SARI/EI-IRADe

Agenda

1. Power Sector Scenario of Nepal
2. Current Generation and Transmission Scenario
3. Demand Projection
4. Generation Expansion Planned
5. Transmission Expansion Plan for Next Five Years
6. Cross Boarder Interconnections Existing and Planned
7. Demand Supply Scenario for Next 20 Years
8. System Parameter Limits
9. Transmission Planning Code
10. Grid Operation Code
11. Grid Connectivity Regulations
12. Metering Regulation
13. Metering Standards
14. Protection Coordination Review
15. Emergency restoration Procedure and Black Start Facilities
16. Load Dispatch Center
17. Power Dispatch on Existing Cross Boarder Interconnections
18. Transmission Pricing, Loss Sharing and Congestion Management
19. Land Acquisition and Right of Way
20. Comments and Views on Open Access

POWER SECTOR SCENARIO OF NEPAL

- **Installed Capacity: 750.66 MW**
  - *93% Hydroelectricity*
- **Peak Power Demand: 1094.62 MW**
  - *719.6 MW Supplied*
  - *375 MW Shed*
- **Energy Supplied (2012): 4218.135 GWh**
- *Total Consumers: 2.59 Million (14.34 % growth)*
- *Domestic Generation: 82.56% (3467.93 GWh)*
- *Import from India: 17.44% (792.52 GWh)*

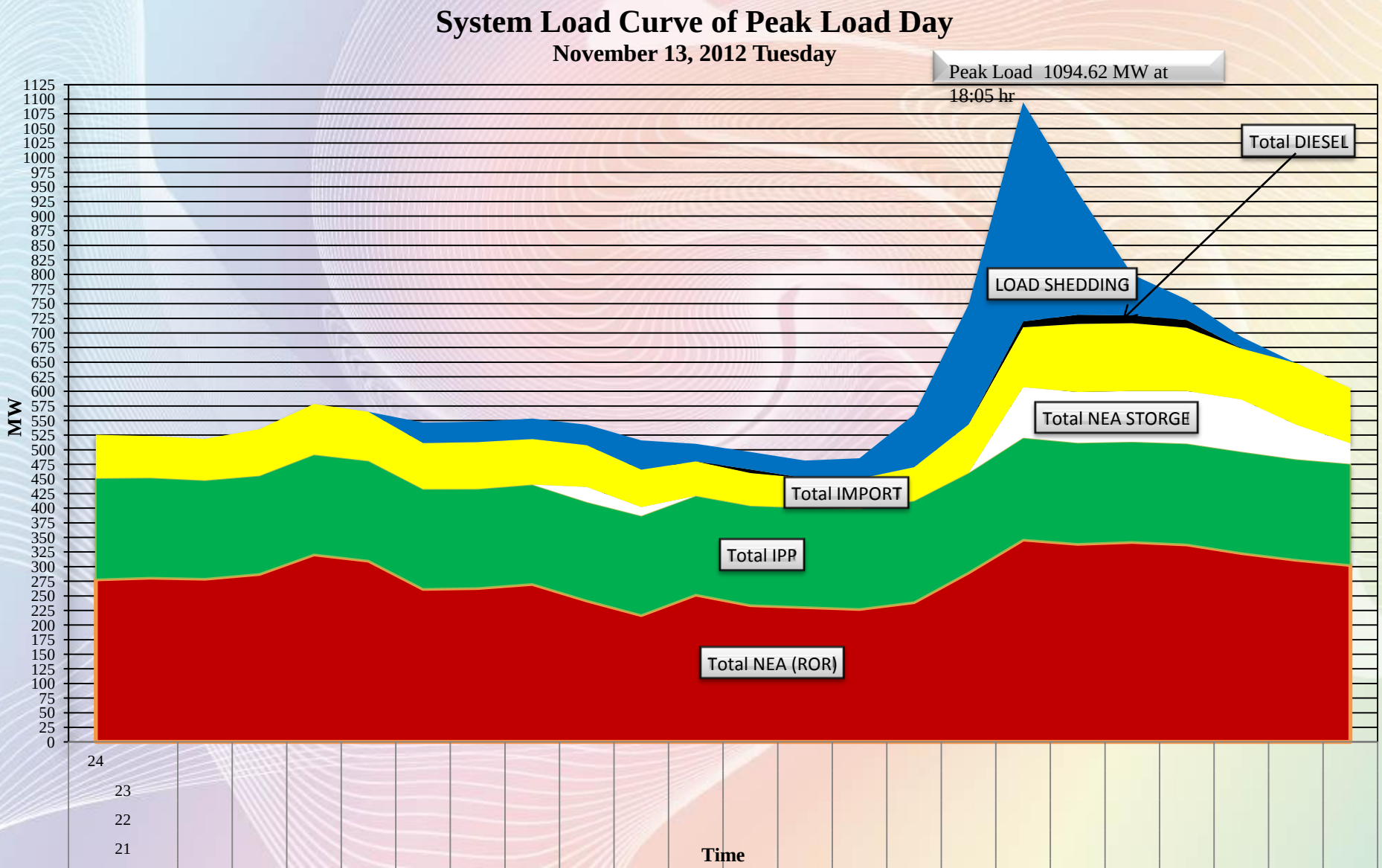
POWER SECTOR SCENARIO OF NEPAL

- **Growth in Generation:** **6.6%**
- **Growth in Load Demand:** **7.7%**
- **Energy Export to India:** **3.72 GWh**
- **Plant Load Factors**

Hydro-RoR	*66.68%*
Hydro-Storage	*16.44%*
Hydro-Canal Drop	*13.64%*
Diesel/Multi Fuel	*3.98%*

- **Low discharge in the rivers causing severe load shedding during dry season**
- **Capacity short fall causing a few hour load shedding during wet season**

POWER SECTOR SCENARIO OF NEPAL



CURRENT GENERATION AND TRANSMISSION SCENARIO

- **Total Transmission Lines: 2640.9 circuit km**
  - *132kV: 2129.7 circuit km*
  - *66kV: 511.16 circuit km*
- **Grid Substations**
  - *132kV: 1315.20 MVA*
  - *66kV: 463.75 MVA*
- **Power Exchange with India**
  - *Gandak-Ramnagar (132kV Single Circuit)*
  - *Duhabi-Kataiya (132kV Single Circuit)*
  - *Mahendranagar-Tanakpur (132kV Single Circuit)*

CURRENT GENERATION AND TRANSMISSION SCENARIO

- **Current Generation:** **750.66** MW
  - *750.66 MW Installed Capacity*
    - *93% Hydroelectricity*
    - *693 MW is on-grid*

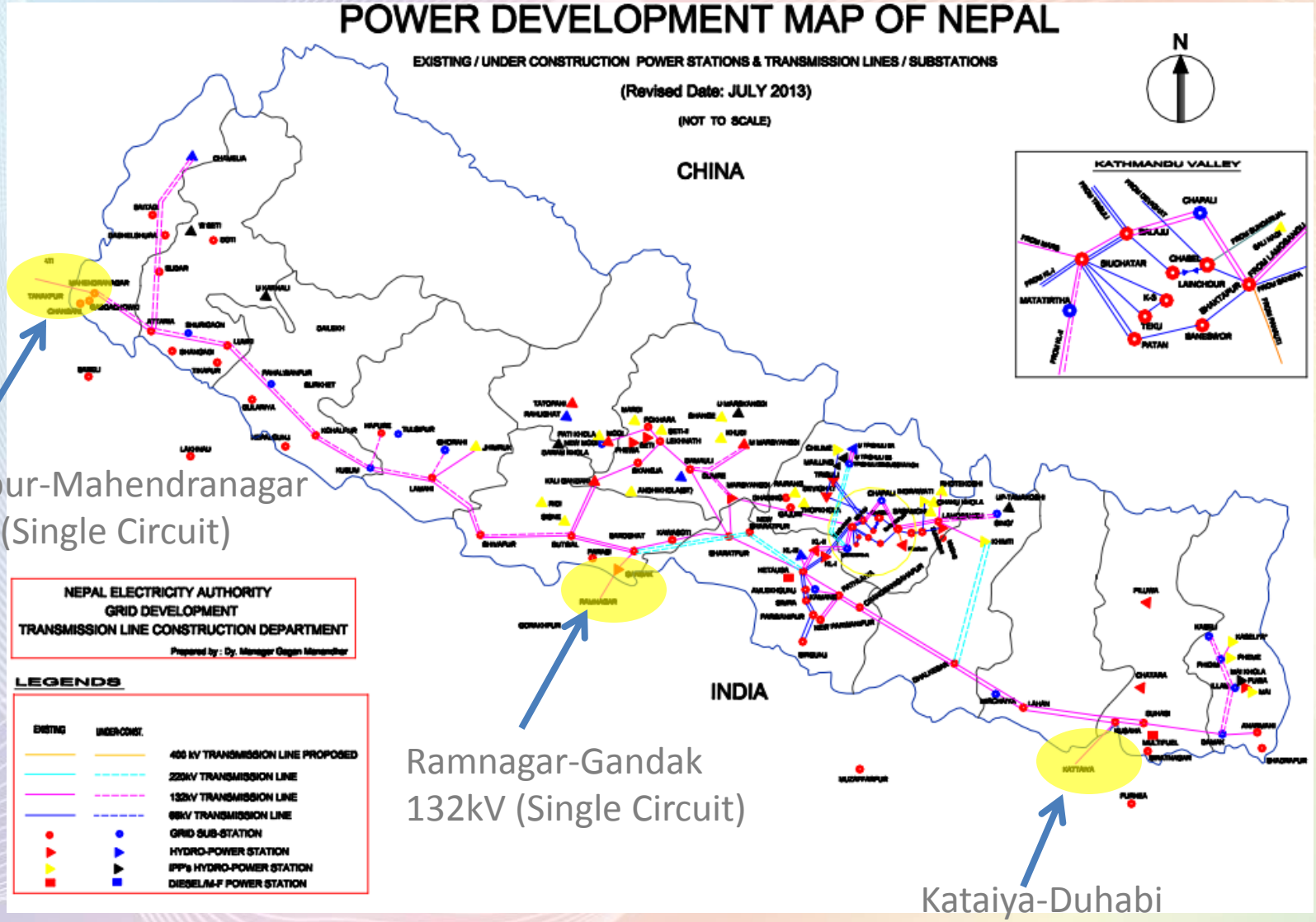
- **Expected Growth (5 yrs):** **1067 MW**

  Independent Power Producers: 65 MW

  Public Private Partnership: 866 MW

  NEA: 136 MW

CURRENT GENERATION AND TRANSMISSION SCENARIO



Tanakpur-Mahendranagar
132kV (Single Circuit)

Ramnagar-Gandak
132kV (Single Circuit)

Kataiya-Duhabi
132kV (Single Circuit)

CURRENT GENERATION AND TRANSMISSION SCENARIO

- **Transmission Lines Under Construction:**

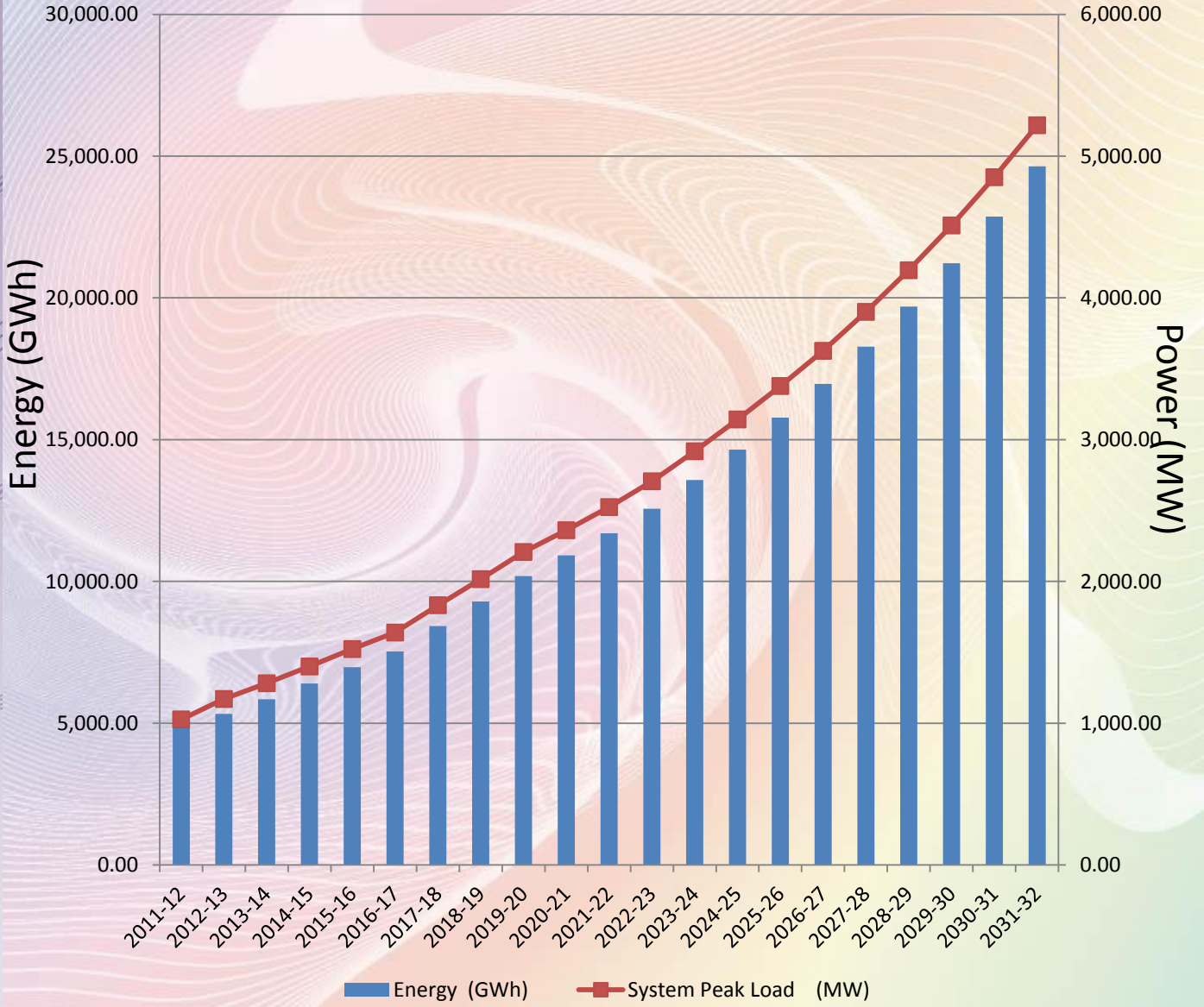
  752 circuit km

  - *132kV: 461 circuit km*
  - *220kV: 220 circuit km*
  - *400kV: 285 circuit km*

- **Substations Under Construction**

  - *132kV: 529.5 MVA*

DEMAND PROJECTION



GENERATION EXPANSION PLANNED

- In the next 20 years
- Hydro, Thermal, Wind, Solar, Others
- Public
- Private
- Any Dedicated Export oriented Power Plant
- Availability of climate data for renewable
- Environmental constraints

TRANSMISSION EXPANSION PLANNED FOR THE NEXT 5 YEARS

2,419 km of new transmission lines in the next 5 years

- *132kV: 1044 km*
- *220kV: 795 km*
- *400kV: 580 km*

2 cross border interconnection lines with India

CROSS BORDER INTERCONNECTION LINKS EXISTING AND PLANNED

Current Power Exchange with India (Radial)

Gandak-Ramnagar (132kV Single Circuit)

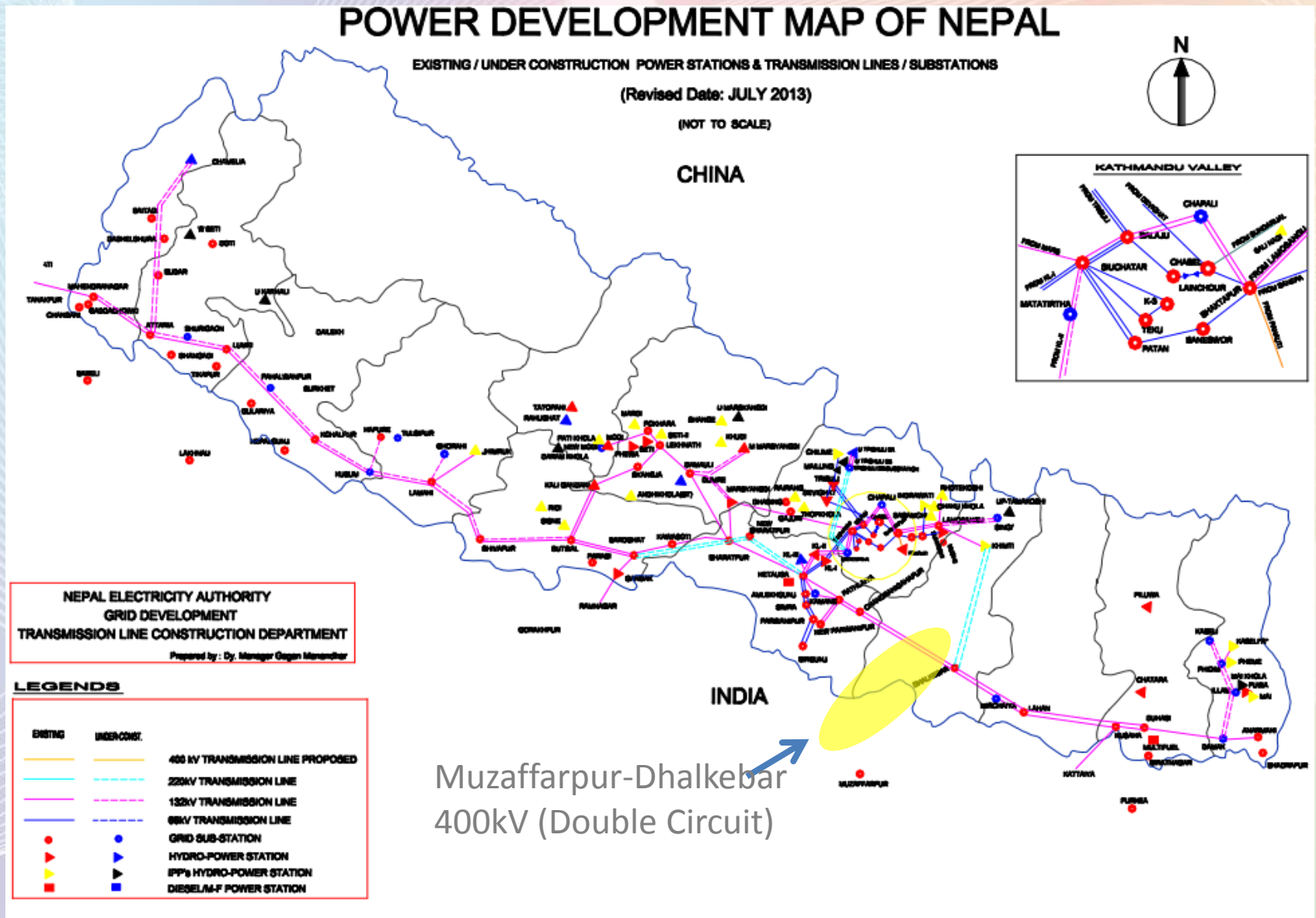
Duhabi-Kataiya (132kV Single Circuit)

Mahendranagar-Tanakpur (132kV Single Circuit)

Future Power Exchange

- 400kV Double Circuit Muzaffarpur-Dhalkebar to start construction soon
- 400 kV Double Circuit Bardghat-Gorakhpur under study
- Other Interconnections required in the visible future are being discussed

CROSS BORDER INTERCONNECTION LINKS EXISTING AND PLANNED



Muzaffarpur-Dhalkebar
400kV (Double Circuit)

DEMAND SUPPLY SCENARIO FOR THE NEXT 20 YEARS

POWER EXPORT/IMPORT - EXISTING AND PLANNED

- Present Import 165 MW
  - Koshi and Mahakali 25 MW
  - Power Exchange 50 MW
  - Trading 90 MW
- Present Export negligible

- Import in 2017/18 280 MW
- Export Projects by 2017/18 2000 MW

SYSTEM PARAMETER LIMITS

Operational Limits

- *Voltage variation*
  - *Normal operation: +/- 5% of nominal*
  - *Emergencies: +/- 10% of nominal*
- *Frequency variation*
  - *Normal operation: +/- 2.5% of nominal frequency.*
  - *Emergencies: +/- 5% of nominal frequency.*
- *Transmission Loss not to exceed 4.5% of the Received Energy*

1. ***Under frequency relays being employed for load dropping***
   - ***Group A moving below 49 Hz***
   - ***Group B moving below 48 Hz***
2. ***Shunt Capacitors are employed to compensate for the Reactive Power***

TRANSMISSION PLANNING CODE

Transmission Planning Code

- *Grid Code Chapter 3 dedicated for System Planning*
- *Transmission planning follows the operational limits provided in the Grid Code*
- *Transmission planning is carried out by System Planning Department.*
- *Government of Nepal approves investments in transmission.*

Criterion

- (N-1) for sigle ckt radial lines having load >50 MW and second ckt stringing for load >35 MW
- Comparison of Investment and Loss for Power Plant Interconnectors
- D/C or M/C shall have to be justified on the basis of economics and maximum sustainable system fault
- (N-1) for transformers either by excess capacity or shared spare transformer

GRID OPERATION CODE

The GRID CODE

- *Provision of GCMC, Represented from all Users*
- *Specifies rules, regulations and technical as well as operating requirements that each Grid User must meet*
- *Ensures quality of power supply, security and reliability of the Power System*
- *Chapter 10 dedicated to Transitory Provisions*
- *Penalty provision for defaulters*
- *Formats are provided in the Annexes*

Internal document of NEA, and not Law.

GRID CONNECTIVITY REGULATION

Some features of the GRID CODE

The Fault Clearance Time for a fault on the Grid where the Generator's Equipment are connected or on the Generator's System where the Grid Owner's Equipment are connected *shall not be longer than 120 ms for 132 kV and 220 kV and 150 ms for 66kV systems.*

Bus switching schemes adopted

- **Single Bus One CB for each Incoming and Outgoing Ckts**
- **Double bus One CB & Bus Selection Disconnecting Switches; Line Ckts One CB & CB Bypass Disconnecting Switch**

System design short circuit level- older equipment 32 KA

METERING REGULATION

Metering regulations are incorporated in the Grid Code

The Metering Point shall be located at the Connection Point; adjustments for loss shall be incorporated

Both Main and Check Meters are required.

- *Main meter purchased by power supplier*
- *Check meter provided by power purchaser.*

Each power transformer in the Grid substation shall have separate Metering on the high voltage side and the low voltage side.

The load profile data up to at least six channels shall be recorded for at least 65 days with half an hour interval.

METERING STANDARDS

Instrument Transformers:

- *For Generators with total installed capacity exceeding 5MW, the accuracy shall be 0.2;*
- *For Distributors and HV Consumers with power transfer greater than 5MW, the accuracy shall be 0.2;*
- *For Generators, with total installed capacity equal to or less than 5 MW, the accuracy shall be 0.5; and*
- *For Distributors and HV Consumers with power transfer equal to or less than 5MW, the accuracy shall be 0.5.*

Meters:

- *For Generators, including IPP's, with total installed capacity exceeding 5MW, the accuracy shall be 0.1;*
- *For Distributors and HV Consumers with power transfer greater than 5MW, the accuracy shall be 0.1;*
- *For Generators, including IPP's, with total installed capacity equal to or less than 5MW, the accuracy shall be 0.2; and*
- *For Distributors and HV Consumers with power transfer equal to or less than 5MW, the accuracy shall be 0.2.*

METERING STANDARDS

Testing and Calibration

- *Prior to operation, Metering Equipment shall be re-tested at Grid Owner's laboratory against the Grid Owner's test meter*
- *The test meter shall be recalibrated and recertified at least every five (5) years.*
- *Instrument transformers shall be tested and recalibrated at least once every five (5) years.*
- *Meters shall be tested and recalibrated at least once every two (2) years.*

PROTECTION COORDINATION REVIEW

Protection Settings are reviewed by the Grid Operation Department and other concerned parties.

Conducted on a as-required basis.

System Operator Studies the Protection Coordination requirement

Operation and Reliability sub-committee reviews and recommends the actions on these aspect

Grid owner procures, installs, re-calibrates and resets the relays

EMERGENCY RESTORATION PROCEDURE AND BLACK START FACILITIES

Grid Code outlines the procedures to be followed after a partial or full black out.

- *Formation of discrete power islands and Generating Unit gradually feeding local Demand in each power island;*
- *Step by step integration of the power islands into larger subsystems; and*
- *Eventual restoration of the Grid.*

All power plants with large generators are required to have black start facility.

LOAD DISPATCH CENTER

Single Load Dispatch Center located in Kathmandu

- **Real time facilities**
- **Remote Switching**

The following is considered before issuing Dispatch Instructions:

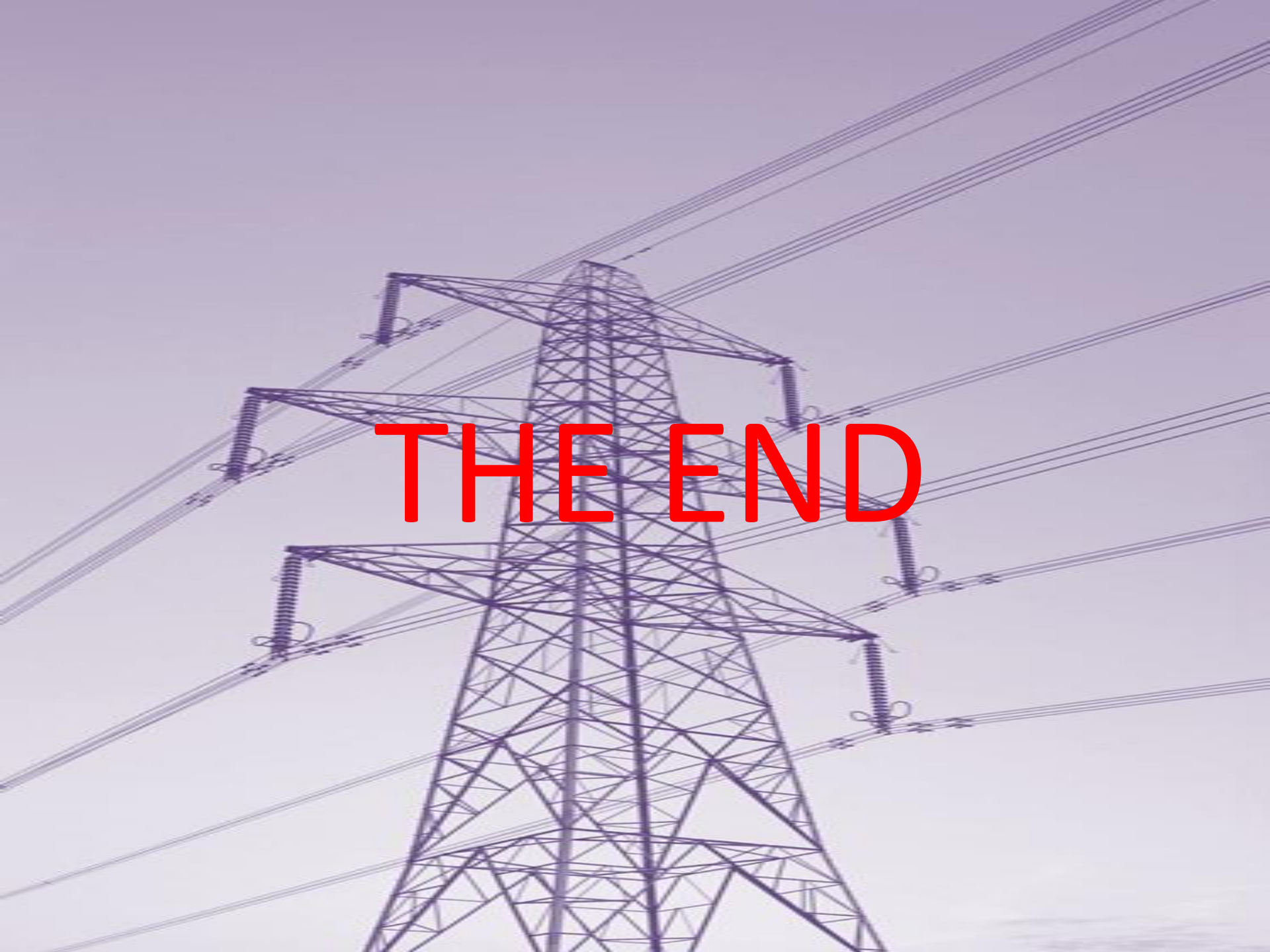
- The Generation Schedule
- Current Demand
- Current output of the Generators
- Any changes to Generator data
- Constraints of the Grid
- System losses
- Merit Order Table
- Ancillary Services requirements
- Power Quality, system reliability and security aspects.

(More detail can be found in the Grid Code)

LAND ACQUISITION AND RIGHT OF WAY

- Government Policy is to facilitate Land Acquisition
- ROW Land Acquisition requires to follow same procedure as in the case of other infrastructure (roads, buildings etc)
- It is time consuming and in some cases has taken more than a decade

COMMENTS / VIEWS ON OPEN ACCESS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