Energy Market Analytics

- *"SOUTH ASIA'S LEADING FIRM FOR*
- *POWER MARKET ANALYTICS & AUTOMATION"*

LEVERAGING ADVANCED ANALYTICS FOR CROSS-BORDER RENEWABLE ENERGY TRADE: INSIGHTS FROM BHUTAN AND NEPAL'S INTEGRATION WITH INDIA'S ELECTRICITY MARKET

Thematic Track Session 2.2: Building Regional Infrastructure for Seamless Power Trade

Presented by:

VICTOR VANYA B (CEO & Co-founder)

@ ACEF 2025, ADB HQ, Manila, Philippines

03rd Jun 2025

ABOUT **EMA**, INDIA

SOUTH ASIA's LEADING FIRM FOR ENERGY MANAGEMENT SOLUTIONS & DATA ANALYTICS

P-STAT™

INDIA'S LARGEST POWER MARKET DATA ANALYTICS PLATFORM

PREDICTIVE ANALYTICS

PRICE – DEMAND – GENERATION FORECASTS

P-OPT™

INDIA'S ONLY INTEGRATED PLATFORM FOR OPTIMAL DISPATCH & TRADING

USAID Implementation Partner for South Asia Cross Border Energy Trade thru PX Markets

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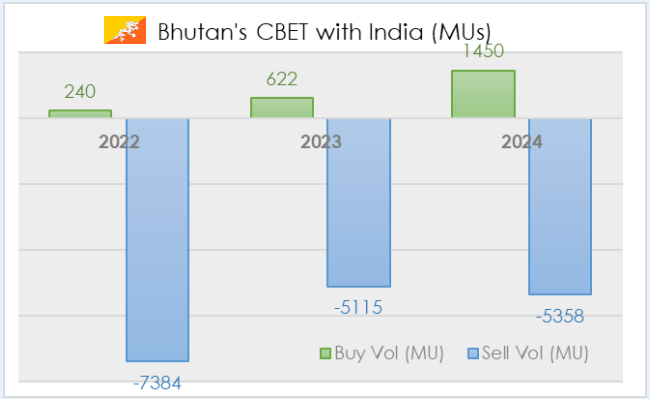
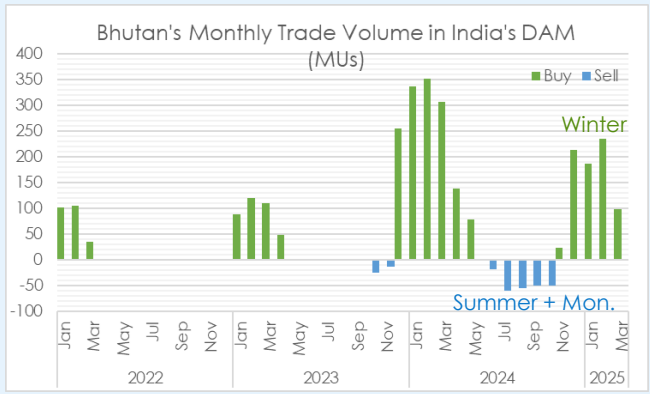
OVERVIEW OF BHUTAN & NEPAL'S CROSS BORDER TRADE WITH INDIA

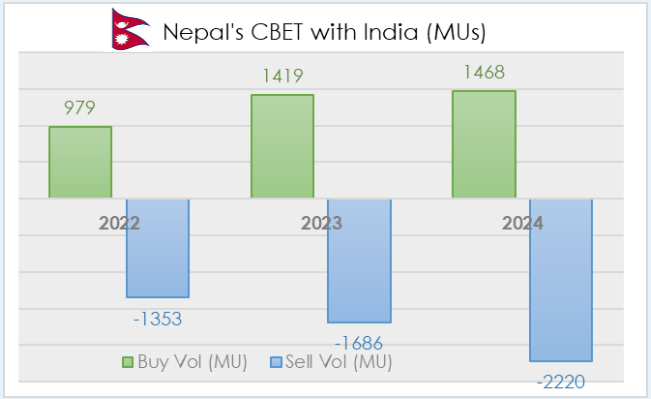
- Himalayan Countries, with high **Hydro dependency** and evolving market design
- Participation in **Indian PowerEx Spot Market** from Y2021
- Growing dependence on Indian Market due to **seasonal deficit**, especially in Winter months

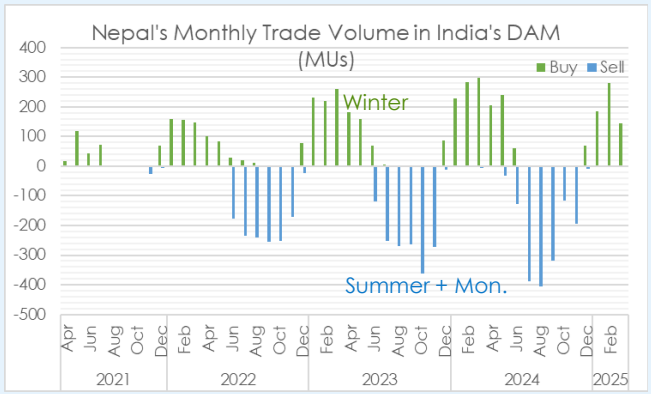
Installed : 2900 MW Peak Load: 1026 MW

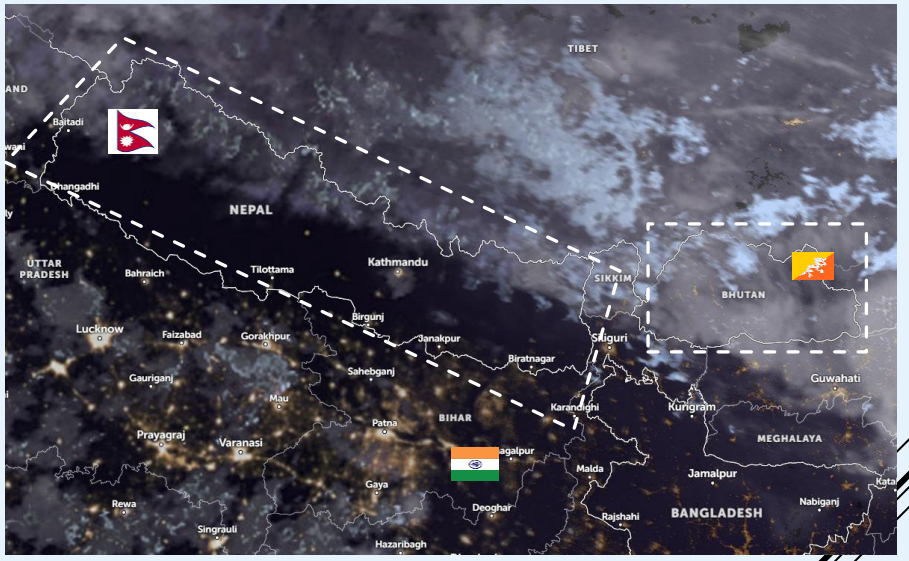


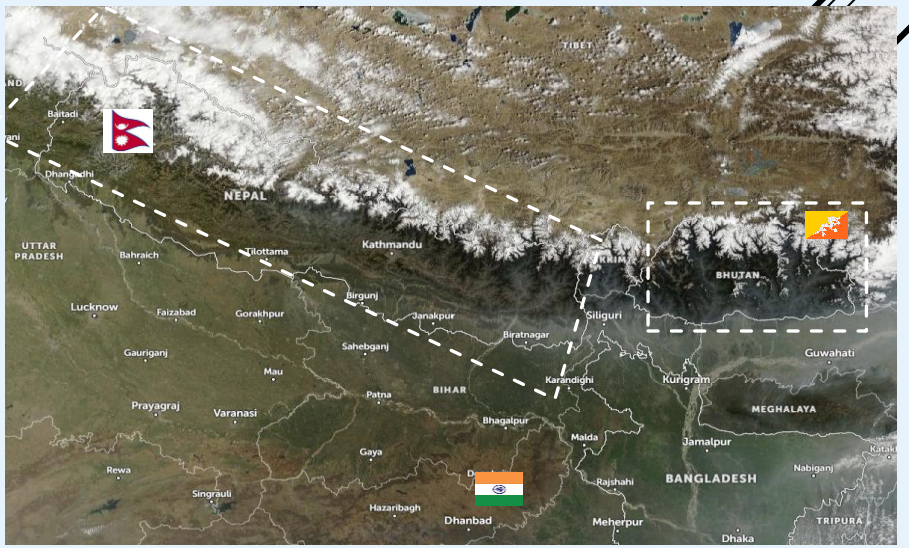


Installed : 3520 MW Peak Load: 2920 MW







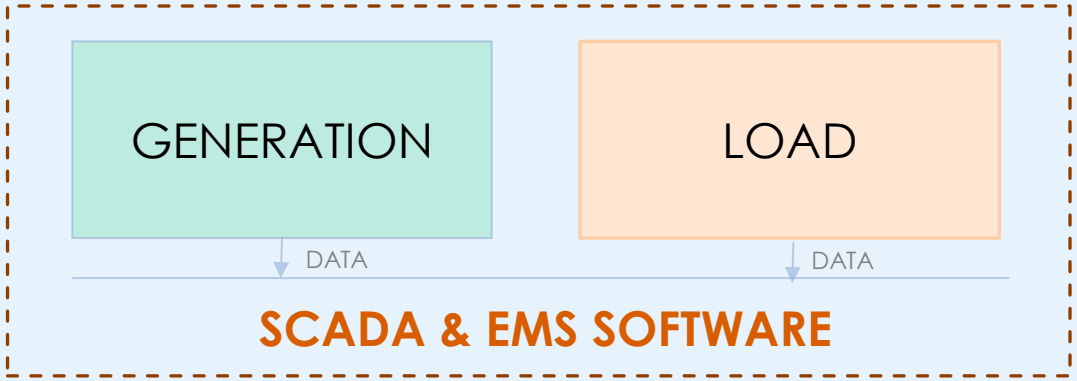


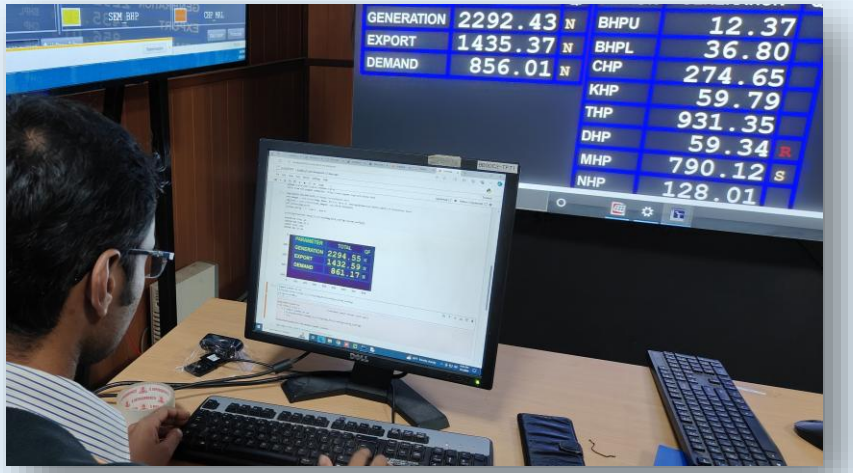
CROSS BORDER TRADE THRU INDIA'S POWER EXCHANGE MARKETS

Bottlenecks to participate in PX (DAM/RTM) based Cross-border Trade with India

	INDIA	BHUTAN	NEPAL
15. Min Timeblock Scheduling & Energy Accounting	Yes	No (limited to hourly, post facto)	No (limited to hourly, post facto)
Power Exchange based Spot Market (15. min bids)	Yes	No	No
Open Access to Transmission	Yes	No	Limited
Real-time Economic Dispatch & Unit Commitment mechanism /tools	Yes	No	No
Spot PX Market Trading Tools & Expertise	Yes	No	No
Balancing Mechanism & Market-linked Pricing	Yes	No	No
Efficient & accurate Real-time Generation-Load data	Yes	Limited	Limited
Generation / Hydro Inflow Forecasting Tools	Yes	Limited	No
Load Forecasting Tools	Yes	No	No

1. DATA ACQUISITION FOR ECONOMIC DISPATCH & TRADING





- SCADA & Energy Management System(EMS) data of both Generation & Load is the starting point for implementing Forecasting, Economic Dispatch and Trading tools

CHALLENGES

- Remote Plant & Substation locations
- Communication & Data Acquisition (Poor mobile/internet connectivity)
- Varying SCADA & Communication systems at sites, with limited vendor support
- Lack of skilled IT manpower & expertise

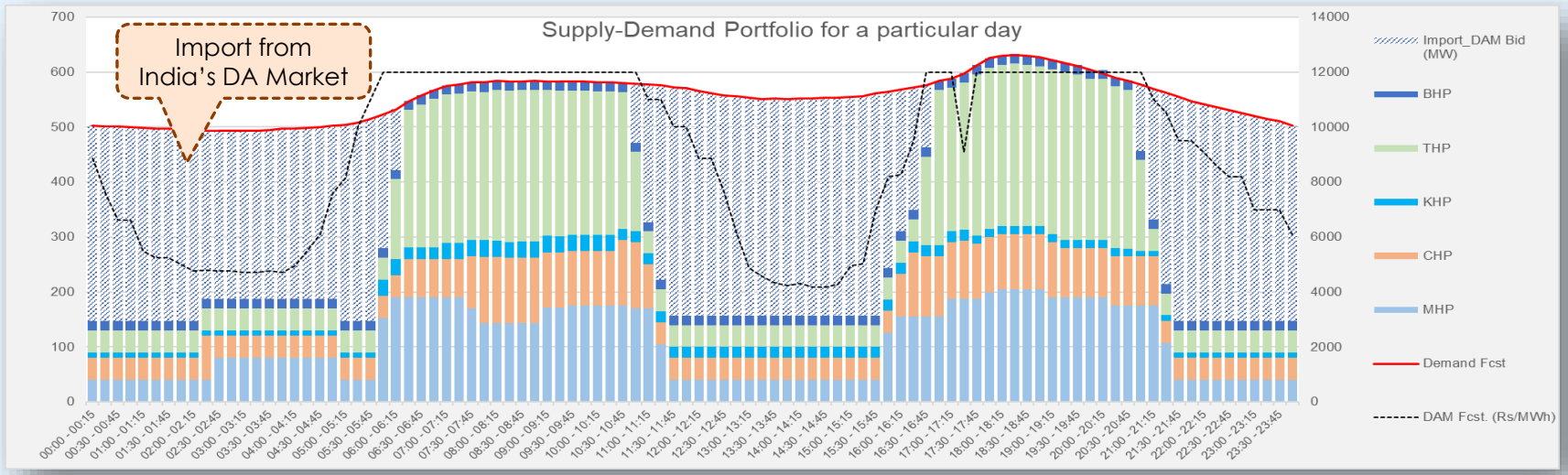
SOLUTIONS

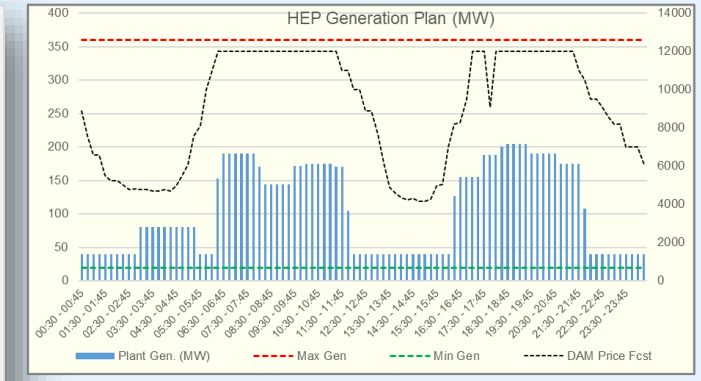
- Implementation of unified & centralised data-acquisition system
- SCADA data acquisition thru OPC-UA based data interface (API/ SFTP)
- Mobile/Web app for manual data communication by control room staff at site
- *'Jugaad'* approaches like Web-cam based picture data reading methods

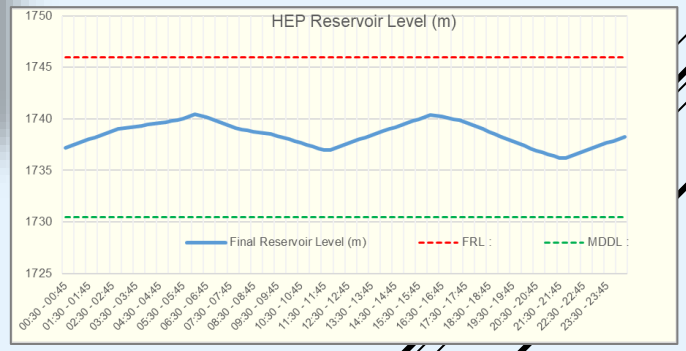
2. GENERATION & LOAD FORECASTING

- **Weather** is a major influencing parameter on both Generation & Demand side in the Himalayan Countries
- **INFLOW Forecasting** for Hydro-rich countries of Bhutan and Nepal is essential for optimal Dispatch & Trading
- Mountainous terrain with varying geographic & weather conditions- **Microclimates**
- **Load Forecasting** is challenging due to lack of timely and accurate weather data & forecasts
- Reliance of **Satellite based** weather assessments & real-time conditions has been the mainstay for forecasting
- **Weather & Inflow monitoring stations** at major nodes with reliable remote data sharing has to be implemented

3. ECONOMIC DISPATCH OPTIMISATION & SCHEDULING TOOLS







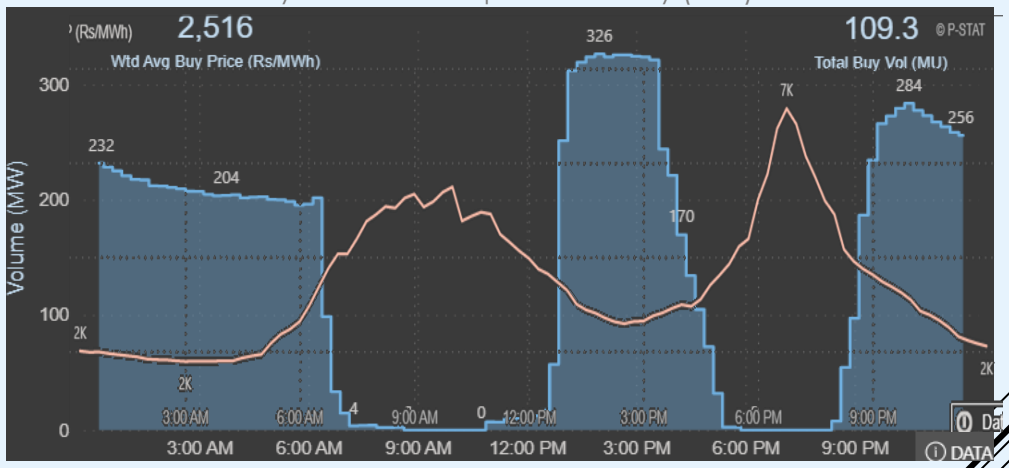
- Linear Programming based Dispatch Optimisation Tool implemented, with an aim to:
  1. **HEP Generation with Pondage** (DAM levels & Inflow) optimisation
  2. Overall **Generation & Demand optimisation**, with an Objective Function of 'Minimising Cost"
  3. **Buy/Sell** considering India's DAM Market Prices, so as to serve the Country's load at 'least cost'

- Nepal has high number of **Small/Mini HEPs** which limits potential for Reservoir/Pondage Optimisation. In addition Intra-country **Transmission congestion** has been a challenge for efficient resource utilisation.

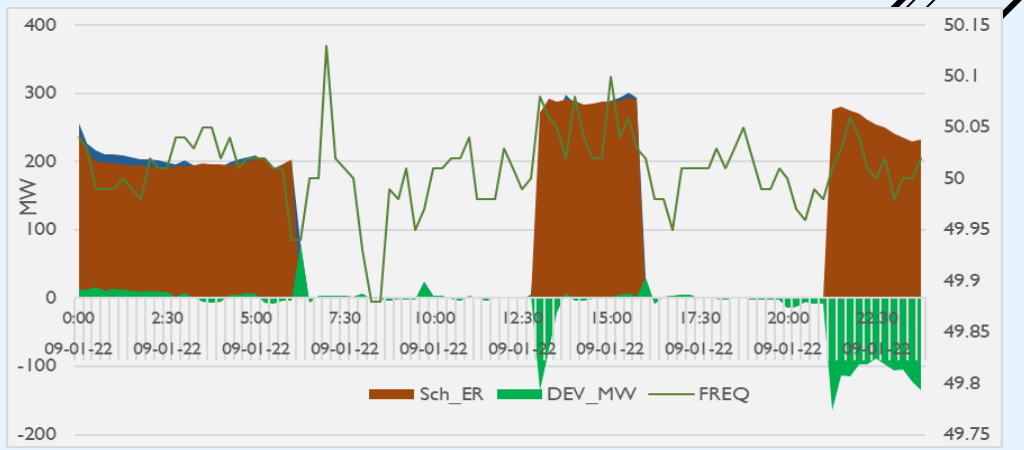
4. POWER EXCHANGE SPOT MARKET TRADING & RT BALANCING

- Day-Ahead Market (**DAM**) and Real-Time Market (**RTM**) are two Spot market segment where cross-border energy trading (**CBET**) is allowed. **Bhutan – 850 MW, Nepal 1100 MW**
- **Closed auction** with **15 min. timeblock** volume ticks for buy/sell
- **Price Forecasts** aid CBET in strategizing buy/sell on the markets
- **Bidding Strategy** incorporating 'risk' based on price discovery and liquidity forms key aspect of the trading software
- RTM trading, considering real-time changes in Inflow/Generation and Load with an aim on minimising deviations & penalties under India's **Balancing Mechanism. Analytical Process Automation** is a prerequisite.

DAM Buy Volume on a particular day (MW)



Cross-Border real-time Deviation on a particular day (MW)



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THANK YOU!

EMA Solutions Pvt. Ltd.

44, 2nd Floor, Regal Building, Connaught Place, New Delhi 110001 INDIA
CIN: U74999DL2019PTC346479
GoI Startup Recognition No: DPIIT34787
info@powermarkets.in

www.EnergyMarketAnalytics.com