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India Smart Grid Forum

India SMART UTILITY Week 2024

Supporting Ministries

Session : Virtual Power Plants (VPPs) And Power System Flexibility

Presented By

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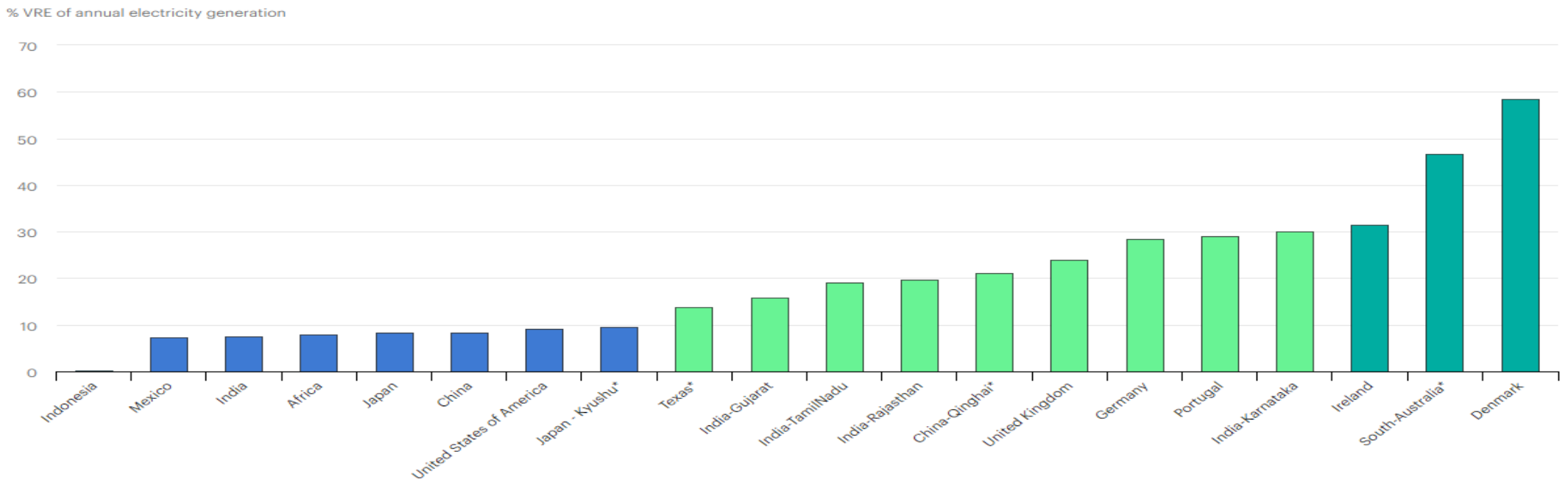
1 Understanding VPP and Flexibility Requirements

Transformation in Indian Power Sector

- India is the **third-largest producer and consumer** of electricity worldwide
- All India peak demand from 2009 has grown from 96 GW to **240 GW in 2023**
- **India stands 4th globally in Renewable Energy Installed Capacity**, with 43% of its total installed electricity capacity coming from non-fossil energy sources
- India to increase non-fossil energy capacity to **500 GW by 2030**, meet 50 percent of its energy requirements from renewable energy by 2030, and achieve the Net Zero emissions target by 2070
- Demand is being driven by growing numbers of **electric cars**, data centers and air conditioners
- Traditional power plants retiring, and most new supply is coming from **wind and solar**
- Flexibility is key for efficient operation of our power system i. e. more **flexible generation** to stronger transmission & distribution systems, more storage & the most important **more flexible demand**

RE Integration Status Worldwide

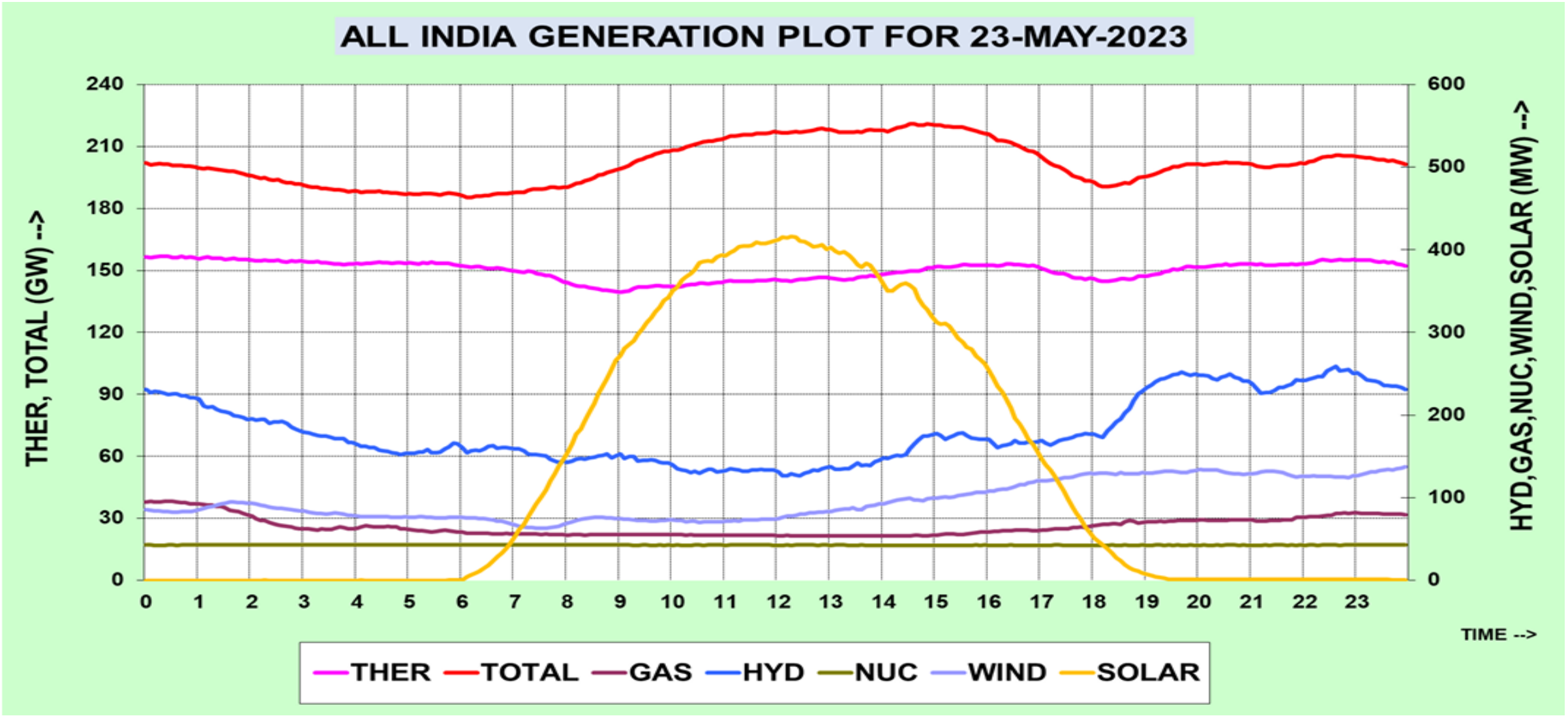


Phase 1 - No relevant impact on system
Phase 2 - Minor to moderate impact on system operation
Phase 3 - VRE determines the operation pattern of the system
Phase 4 - VRE makes up almost all generation in some periods

Source- IEA Report,2022

The pace at which RE is getting added, RE is going to decide how India's power system operates in very near future

All India Power Position



Source- POSOCO

Understanding Flexibility in Indian Energy Ecosystem

Expected All India Duck Curve (Considering 20GW of solar)

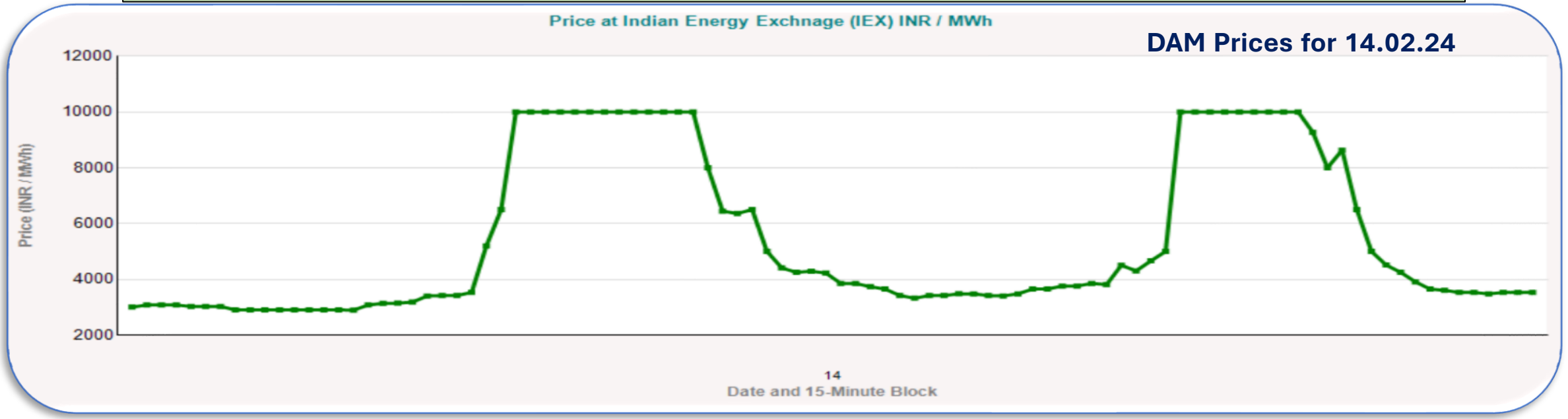
Source- NLDC, SCADA Data

Flexibility Challenges

1. Avoiding over generation during high solar
2. Meeting steep rise in net load from 18 hrs
3. Managing variability in RE supply

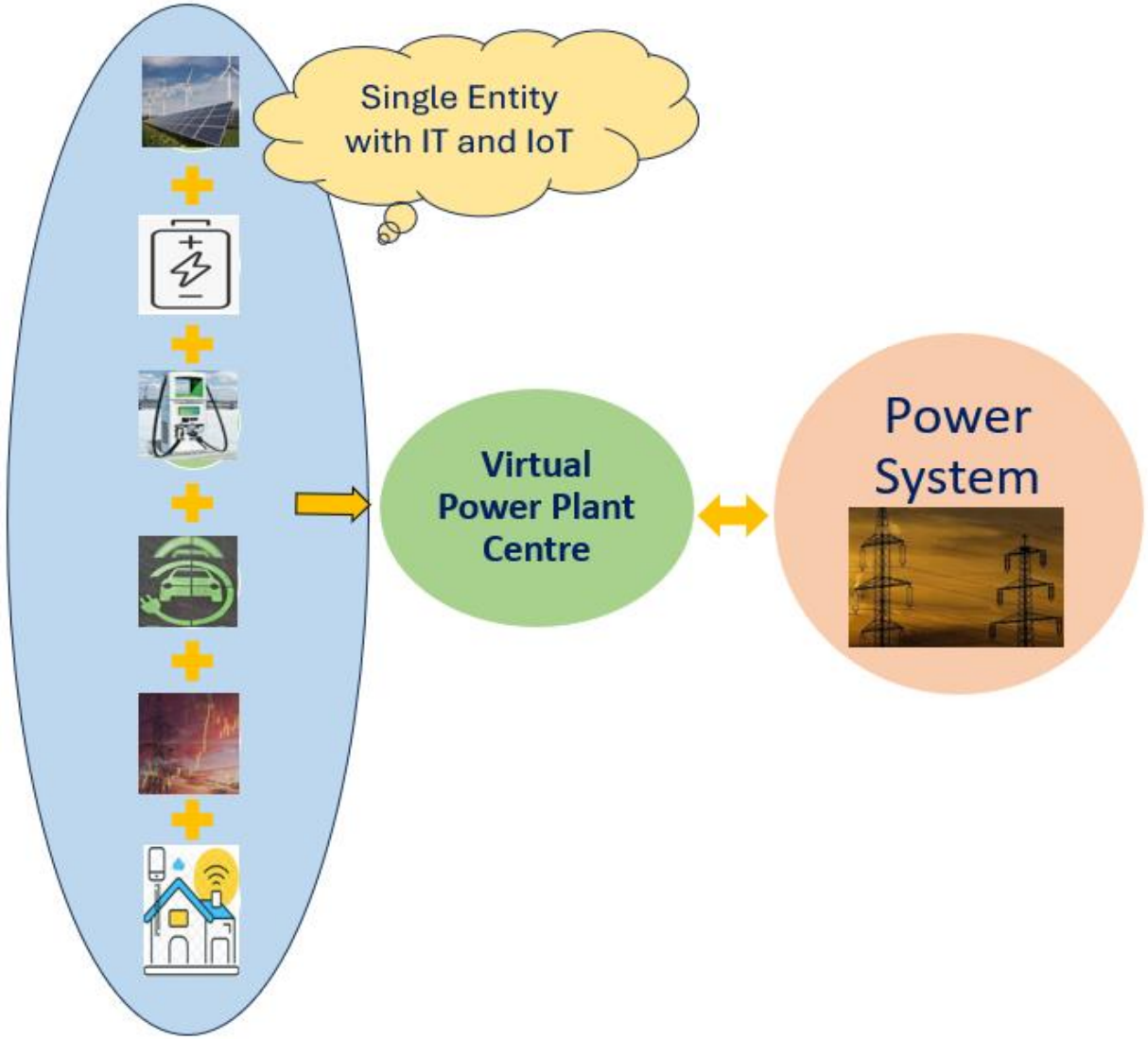
Signs of Inflexibility for Utilities and Indicators

- Difficulty in managing demand and supply efficiently and economically
- Renewable distress sale/curtailment
- Arranging sources to meet evening demand when RE not available and power becomes expensive
- DSM deviations



Source-IEX

Virtual Power Plant : A Solution for flexibility



- Network of decentralized, medium-scale power generating units as well as flexible power consumers, energy market and storage systems; controlled and operated by the Central Control System
- Designed to operate dynamically, to deliver value in real time, and can react quickly to changing demand-supply conditions
- Helpful in the efficient distribution of power, reducing grid congestion with optimized flexibility and operating resilience

Virtual Power Plants : Challenges & Opportunities

Present Barriers

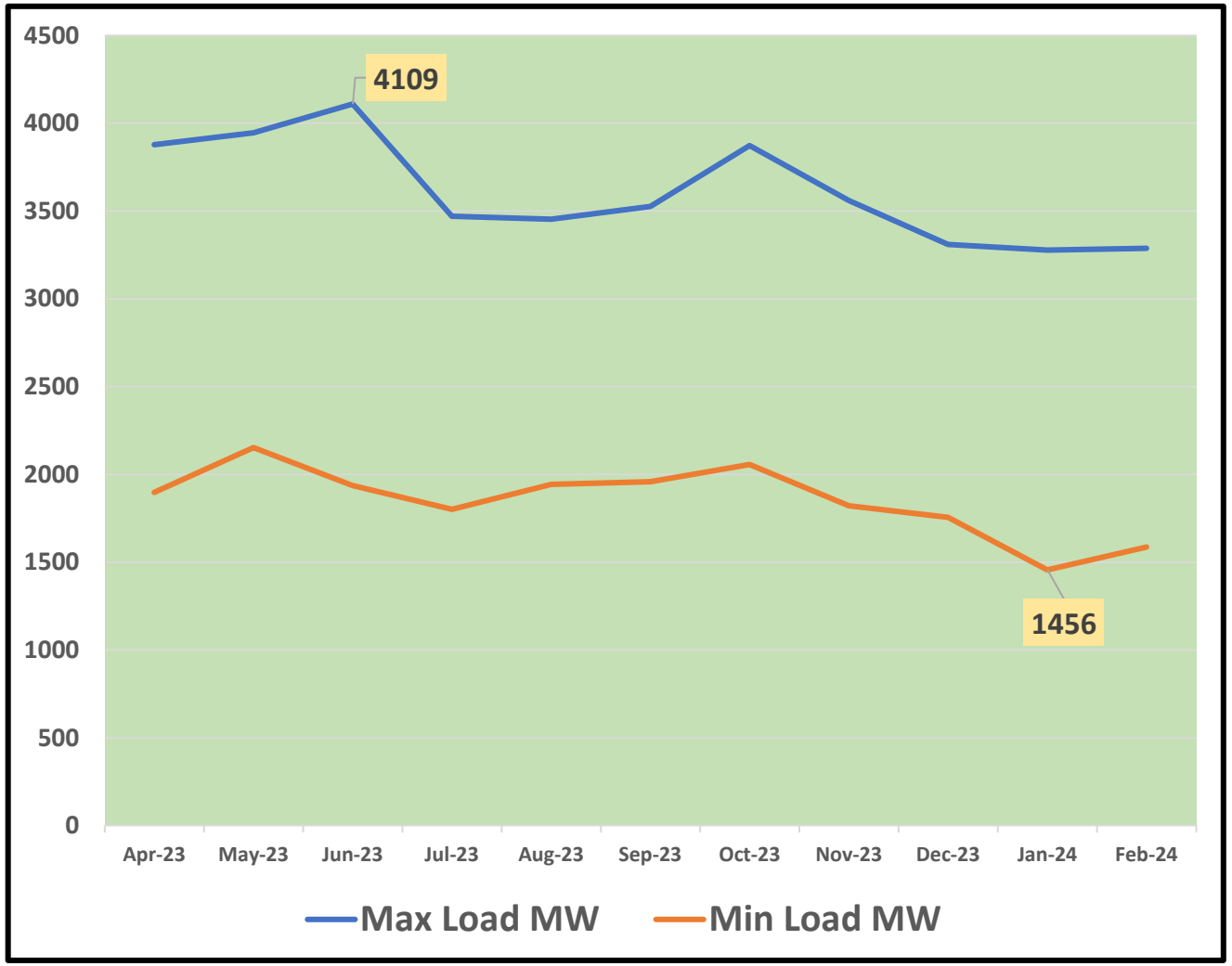
- Suitable technology, financing, and operation. Capacity building in terms of power generation/RE, information technology and optimization
- Storage in VPP must; but costly affair
- No real push through policies; cyber security concerns

Opportunities

- Increasing RE is possible only with increasing VPP's
- India still rural with limited grid infra, investment coming in RE sector, shift happening from centralized to decentralized generation
- Govt already pushing smart grids and decentralized generation

2 Tata Power - Used Cases

Mumbai Power System – Flexibility Challenges



Challenge is to meet max demand of 4100 MW and minimum demand of 1450MW (@1/3rd of peak) efficiently

Present measures being taken:

1. Planning Outages of conventional plants
2. Availability of transmission system/units
3. Ensuring fuel availability including water
4. Operating reactors, transformer taps for voltage control
5. Planning pumping operation of hydro
6. Keeping thermal tech min, hydro min
7. Deploying SPS (LTS) schemes
8. Islanding scheme of Mumbai

Mumbai Power System – Flexibility Challenges

Managing flexibility – **Improved RE integration through BESS**

- Simulation study conducted to examine the relevance of storage and system alternatives to address current and anticipated challenges to Mumbai Gird including grid disturbances under a high VRE outlook
- Dispatch simulations are performed for Mumbai grid and for all Mumbai DISCOMs using production-cost simulation tool, considering both technical and economic constraints of generation dispatch to meet the hourly demand profiles
- Load flow studies are performed to understand the benefits and use-cases of BESS for transmission deferral/congestion relief benefits and resilience support for Mumbai network.

Module A: Transmission-Level BESS

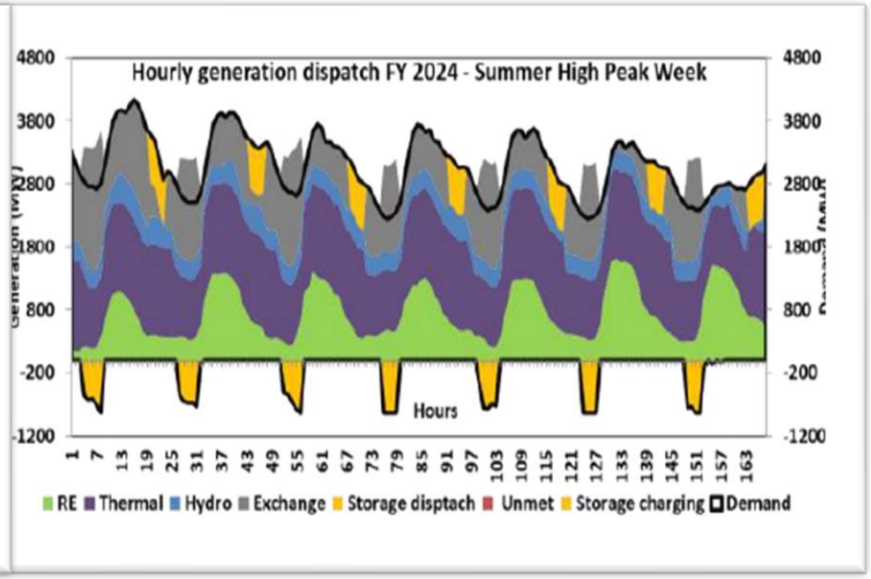
- Dispatch simulation with current generation expansion plan for next 5 years
- Load flow and dynamic stability studies
- To identify locations of BESS in Tata Power transmission network
- Stacking of value streams and business model
- Regulatory barriers for identified BESS sites

Module B: Generation Level Analysis

- BESS for resilience and its value for Mumbai
- Scenarios up to 100% RE
- BESS for backup power in Mumbai

Module C: Distribution-level BESS

- Use cases of BESS from international best practices in distribution system
- Battery storage system opportunities in identified long list of areas in the distribution system
- Detailed simulation studies for short listed substations, 2 or 3 substations
- Value streams for each prospective BESS site
- Distributional and regulatory considerations for identified BESS sites



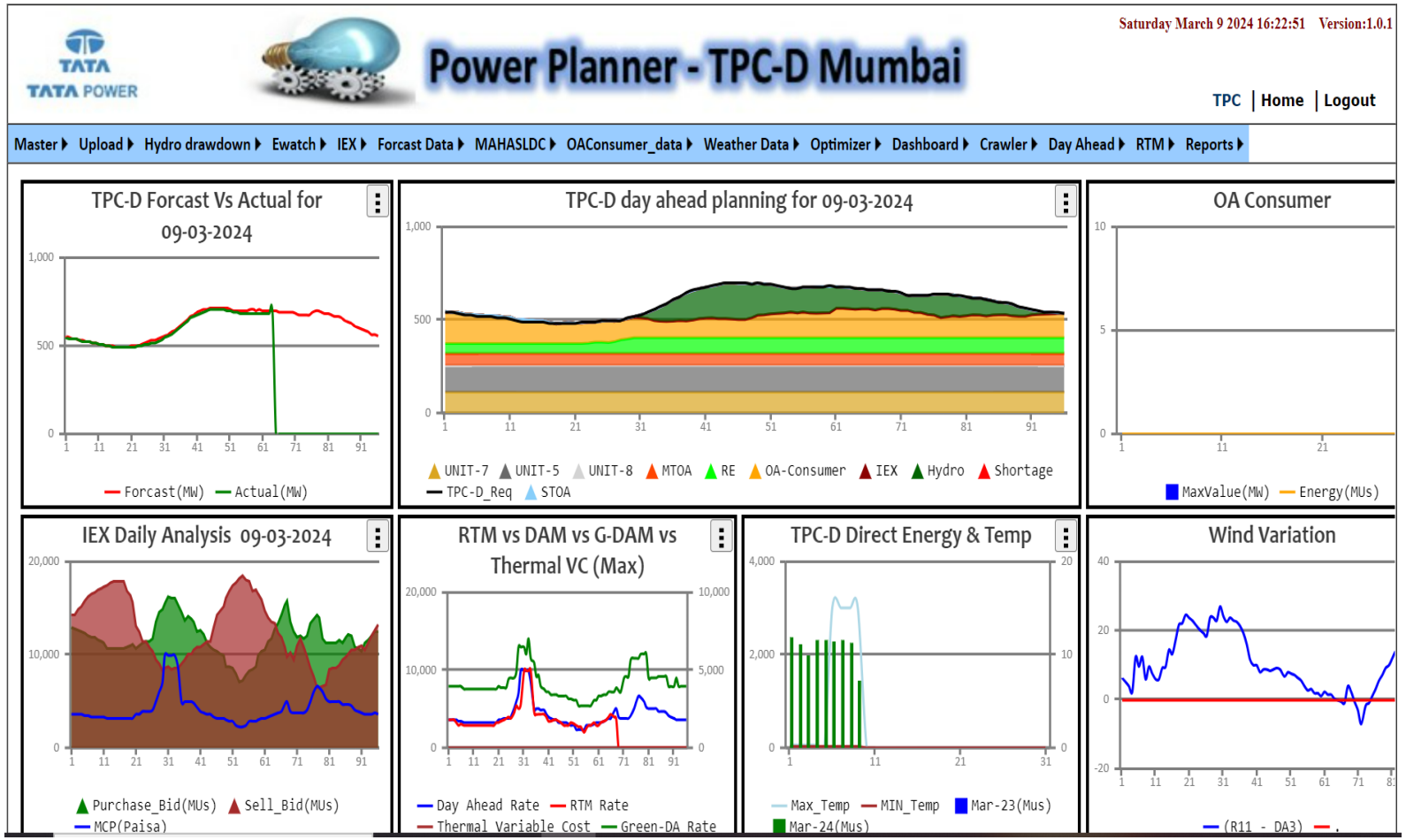
Source-PRDC & Fraunhofer Report

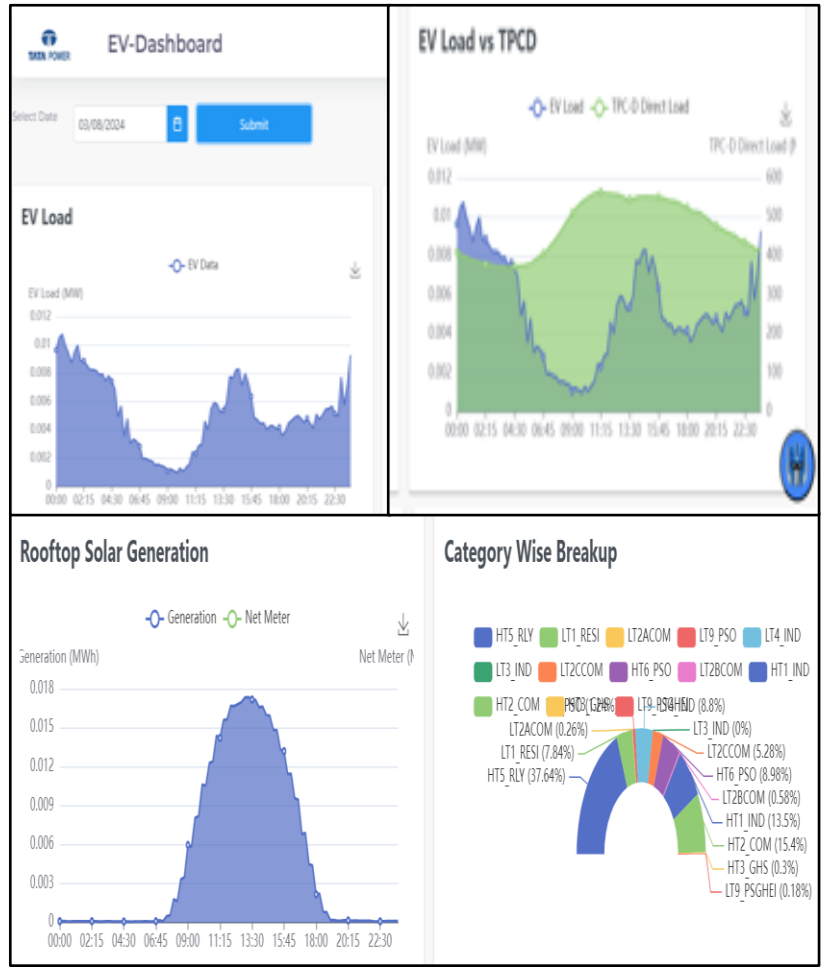
Outcome suggested to have 750 MW with 2/4 hours battery storage capacity to provide peak load management with maximum RE integration which will also help to optimize the system level cost

Managing Flexibility In Mumbai Distribution

Managing flexibility through ***Resource Optimization***

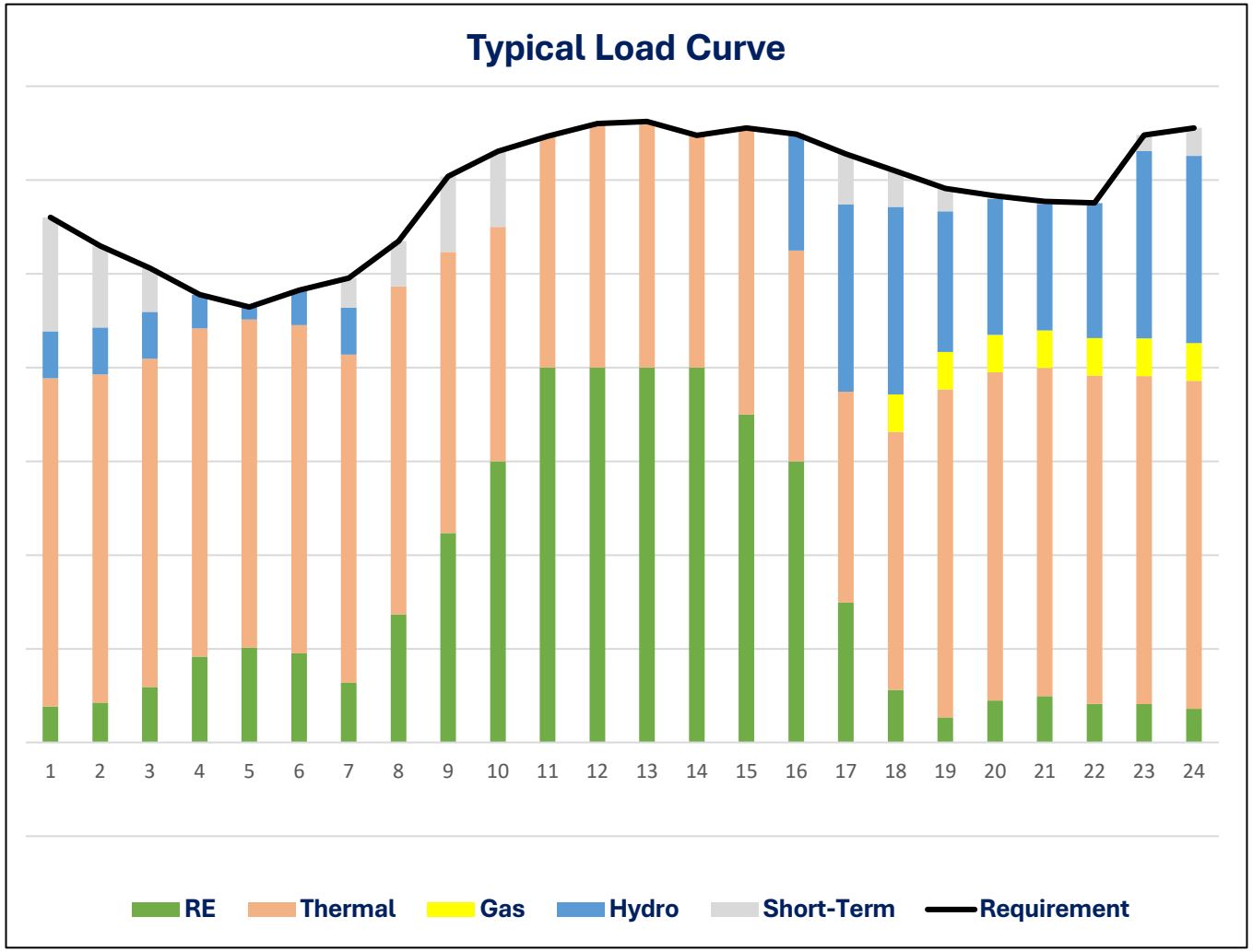
AI/ML based load forecasting is integrated with all resources including RE into 'Power Planner' to get the most optimized power planning. Data from new sources like rooftop solar & EV points is also integrated.





Managing Flexibility In Mumbai Distribution

Managing flexibility - ***Resource Optimization using Power Planner***



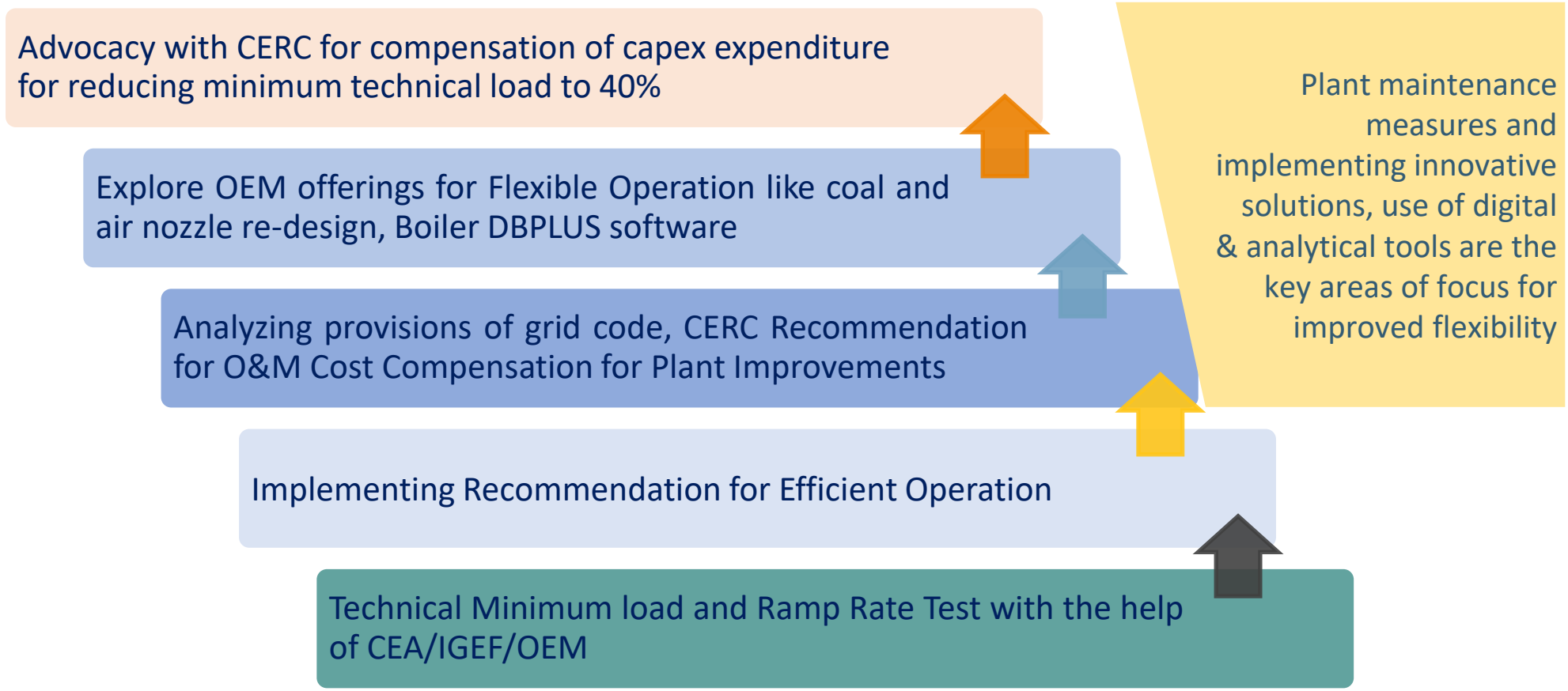
- Though peak is in day-time, no/very low shortage coz of excess RE availability. Thermal is kept at Tech Min during day
- Typically, Hydro is used to meet evening peak shortage and as a flexible resource
- Sudden variations in supply and demand managed (flexibility) by using gas plant (in open cycle), responsive hydro and efficient operation of thermal plants
- Using 'optimizer' module from In-house developed 'Power Planner' platform, sources are optimized to meet demand efficiently and economically

Managing Flexibility In Mumbai Distribution

Managing flexibility in Supply: ***Flexibilization efforts of Thermal plant***

Flexibilization Roadmap

- TATA Power's existing units are designed for stable operation up to 60% TMCR load without oil support.
- However, in actual operation, the minimum technical loads of these units vary from 55% to 65% TMCR load.
- Assessment of existing unit capabilities for flexible operation concluded along with its limitation and challenges.
- Discussion with OEMs (Siemens /GE) and technology provider (Fortum e-Next) underway about their offerings for flexible operation



Managing Flexibility In Mumbai Distribution

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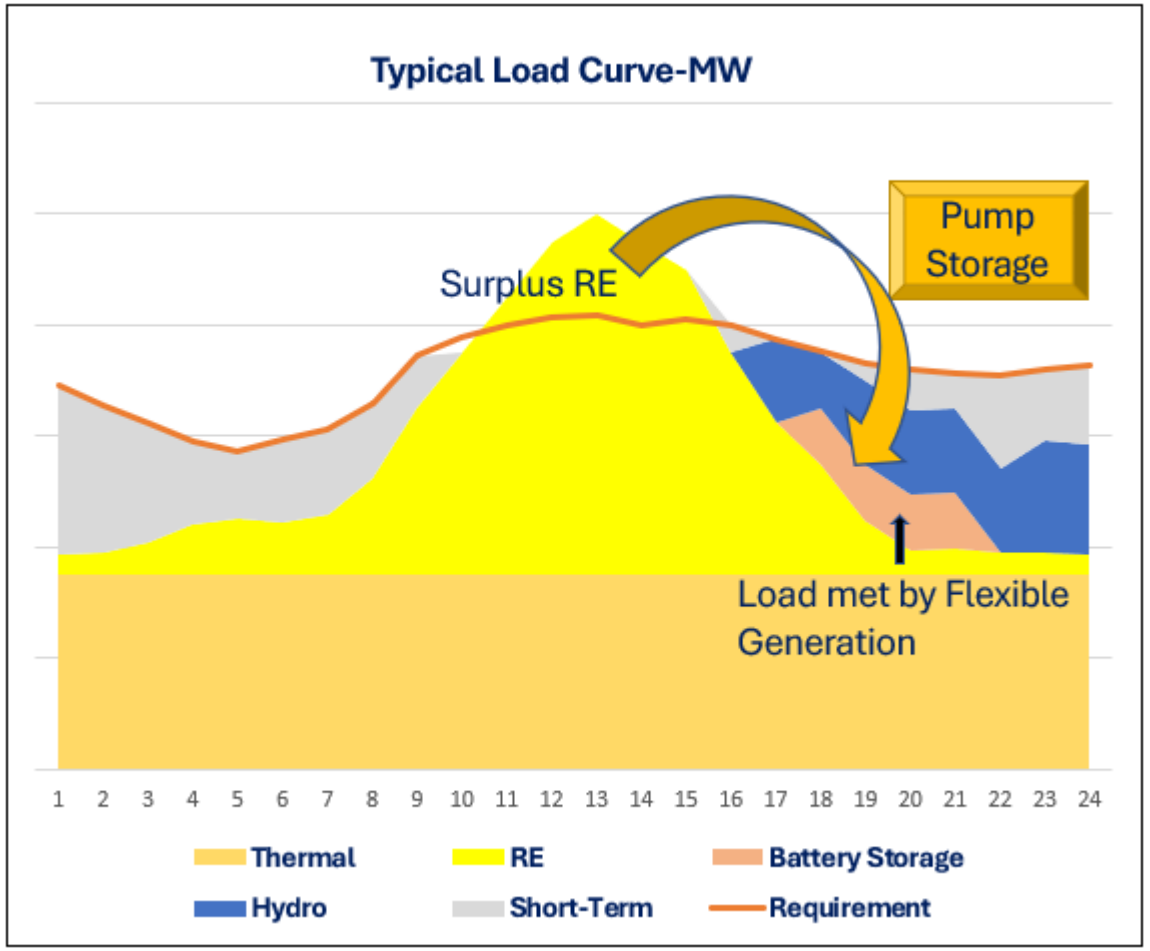
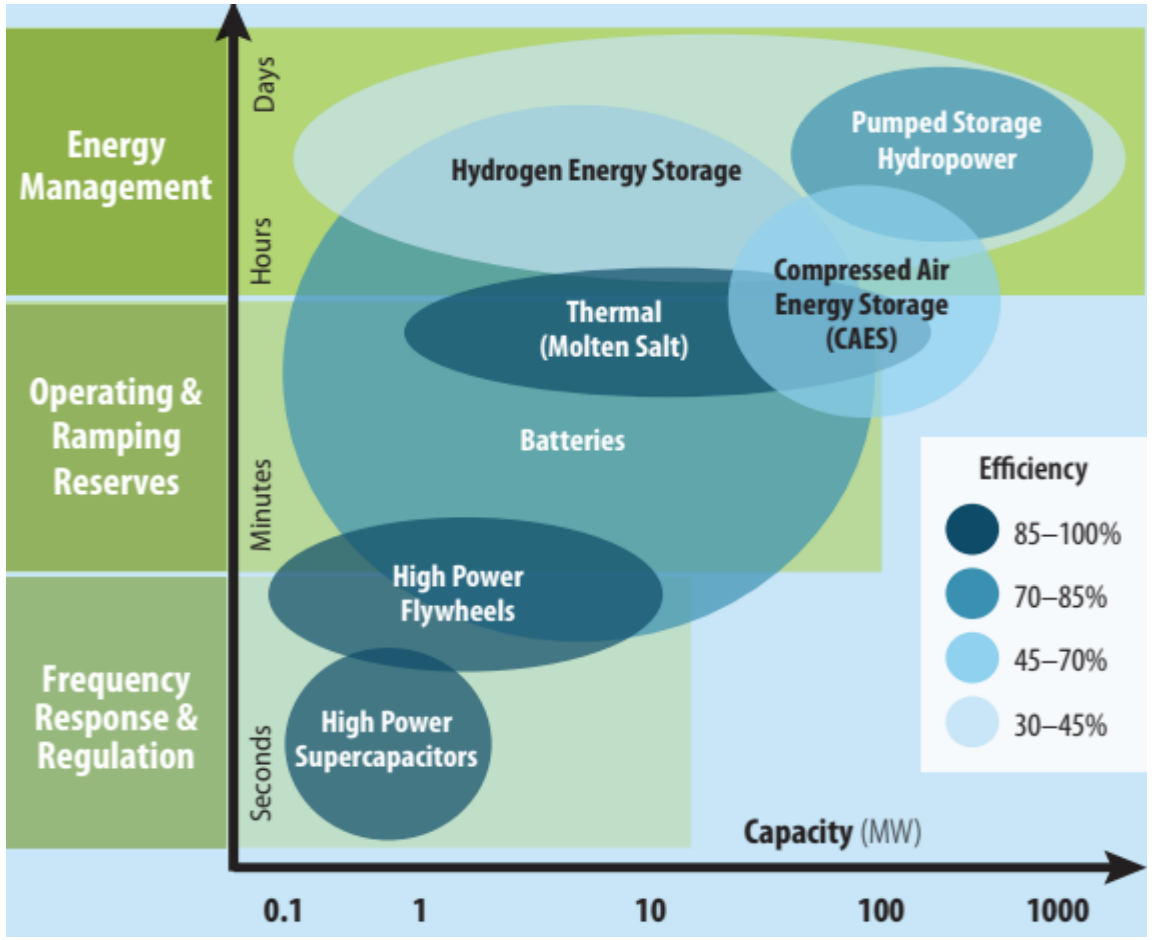
Managing flexibility in Supply: ***Pump storage Option***

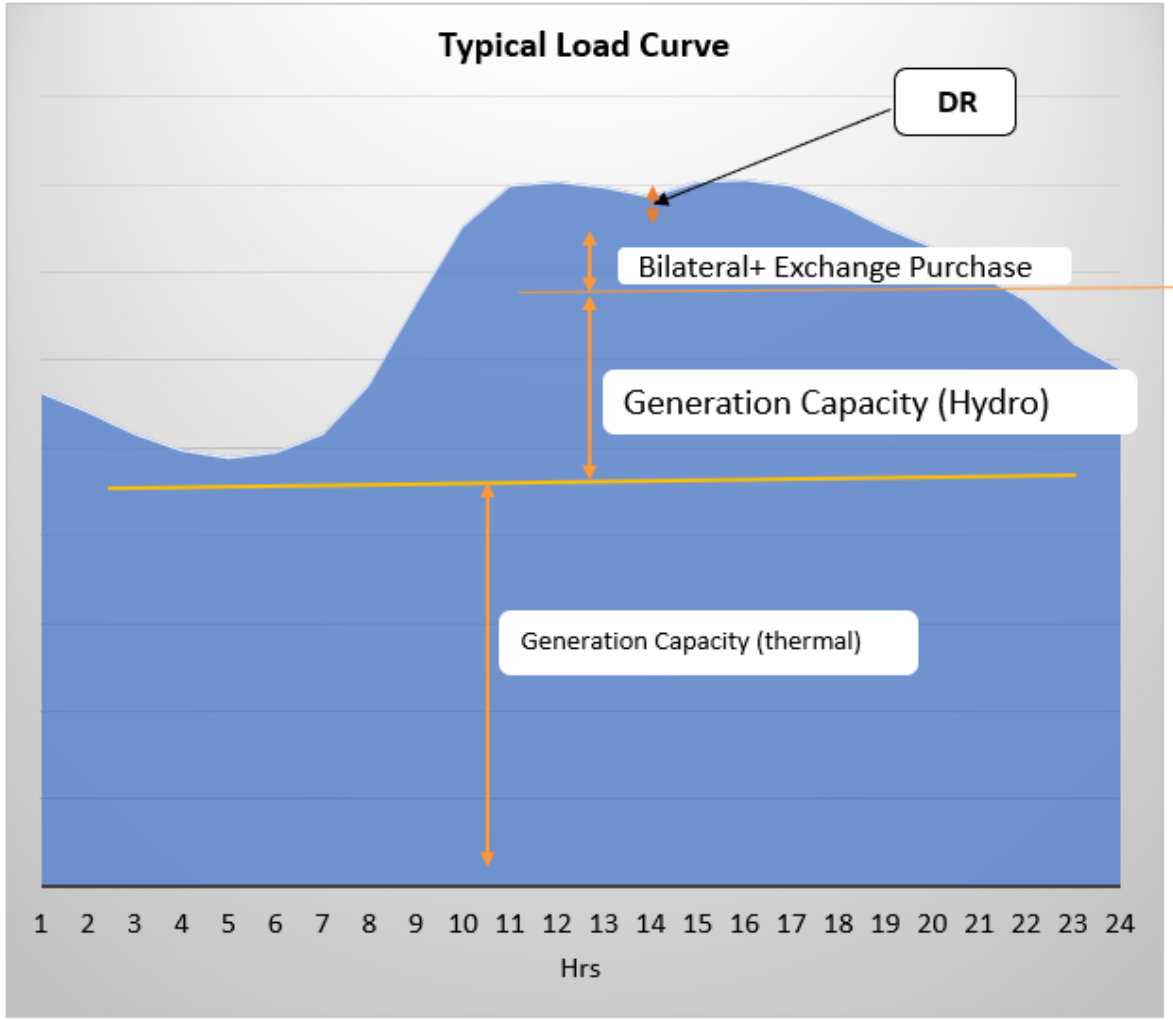


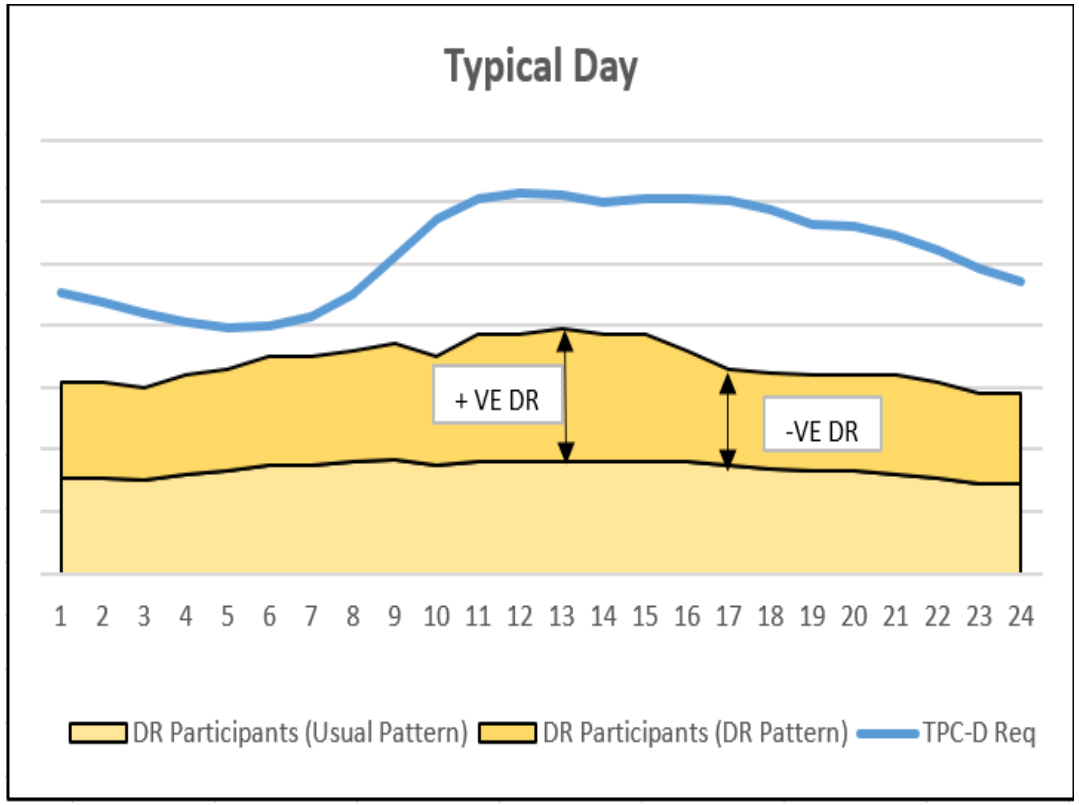


Source-NREL/BR-6A20-64764

Managing Flexibility In Mumbai Distribution

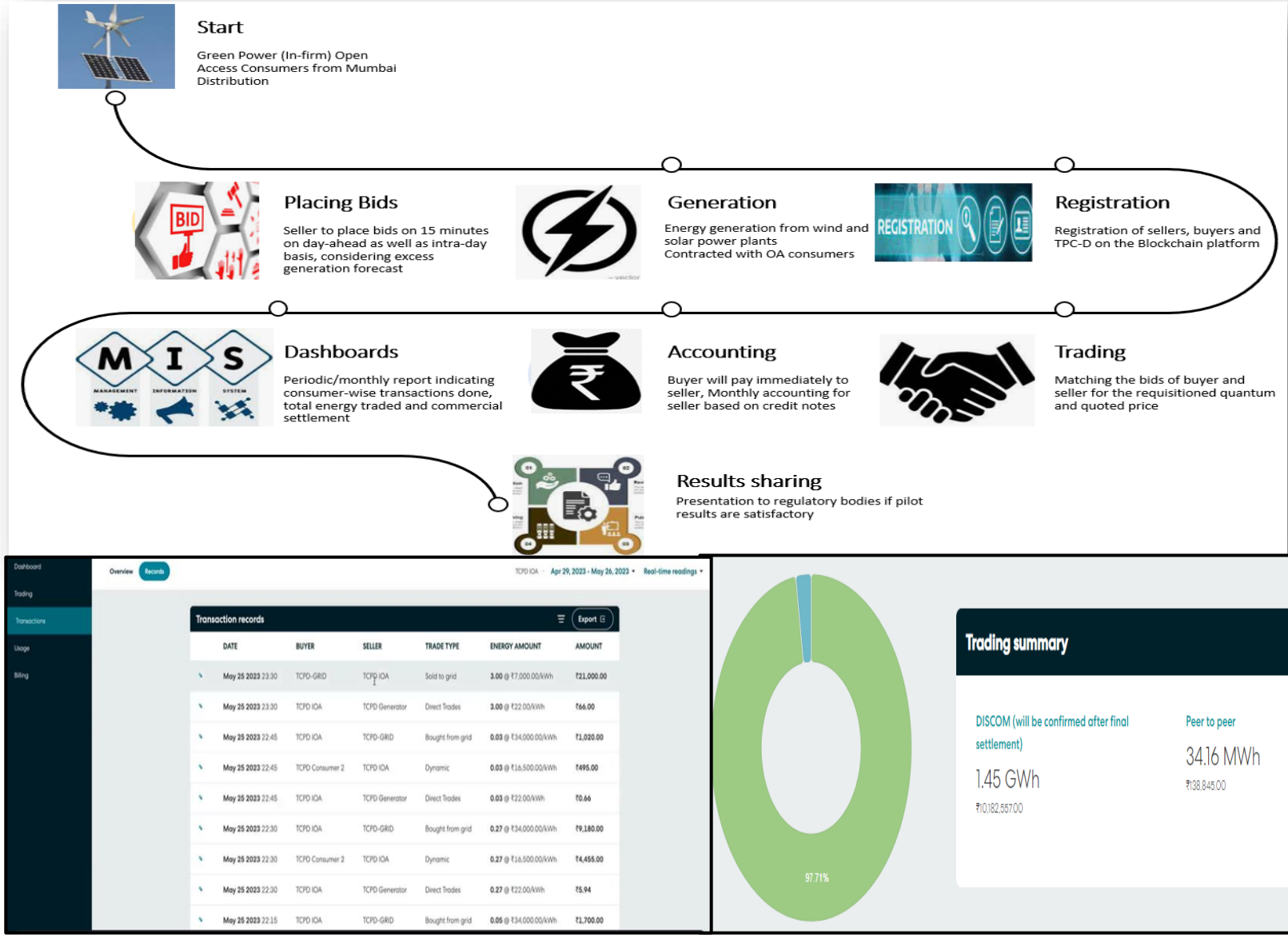
Managing flexibility in Demand: ***Demand Response***





- Usage is increased when solar availability is maximum and during evening peak hours load is reduced accordingly, by DR participants
- Market rate linked incentive is offered

Pilot project - Managing flexibility in Demand



Intra-Utility Exchange – ***'SPOC'***

- Enabling open access embedded consumers to transact excess RE energy on 'Blockchain' Based platform
- OA consumers and retail consumers to trade energy on day ahead & intra-day basis
- Pilot with intra-utility consumers, initial results promising

Way Forward..Traditional May Not Sufficient

- Six typical attributes of modernized electric infrastructure:

  (1) reliability,
  (2) resilience,
  (3) flexibility,
  (4) sustainability,
  (5) affordability, and
  (6) security

Traditional evaluation of **R**esource **A**dequacy do not comprehensively address these emerging attributes. Following measures are essential to sail through these transient times:

- **Regulatory Push-** Schemes for VPP, Incentive for Ramping Capability/flexible operations, Digitalization
- Energy Storage System - Pumped storage systems, Each **new RE with storage only**
- Accurate Demand Forecasting- **ST/LT exact load forecasting** and having source flexibility to meet the same
- Reserves- Need for **Flexibility Reserve** planning (Fast Response Ancillary Services)
- Demand Response/**Utility Exchange**
- **Hydro**- Evergreen flexible resource ; **Gas Plants**- Usage during high demand period
- Conventional Power Plants- **Improved start-up time/ramp rate**/tech minimum load

THANK YOU

For discussions/suggestions/queries email: ***isuw@isuw.in***

visit: www.isuw.in

Links/References (If any)