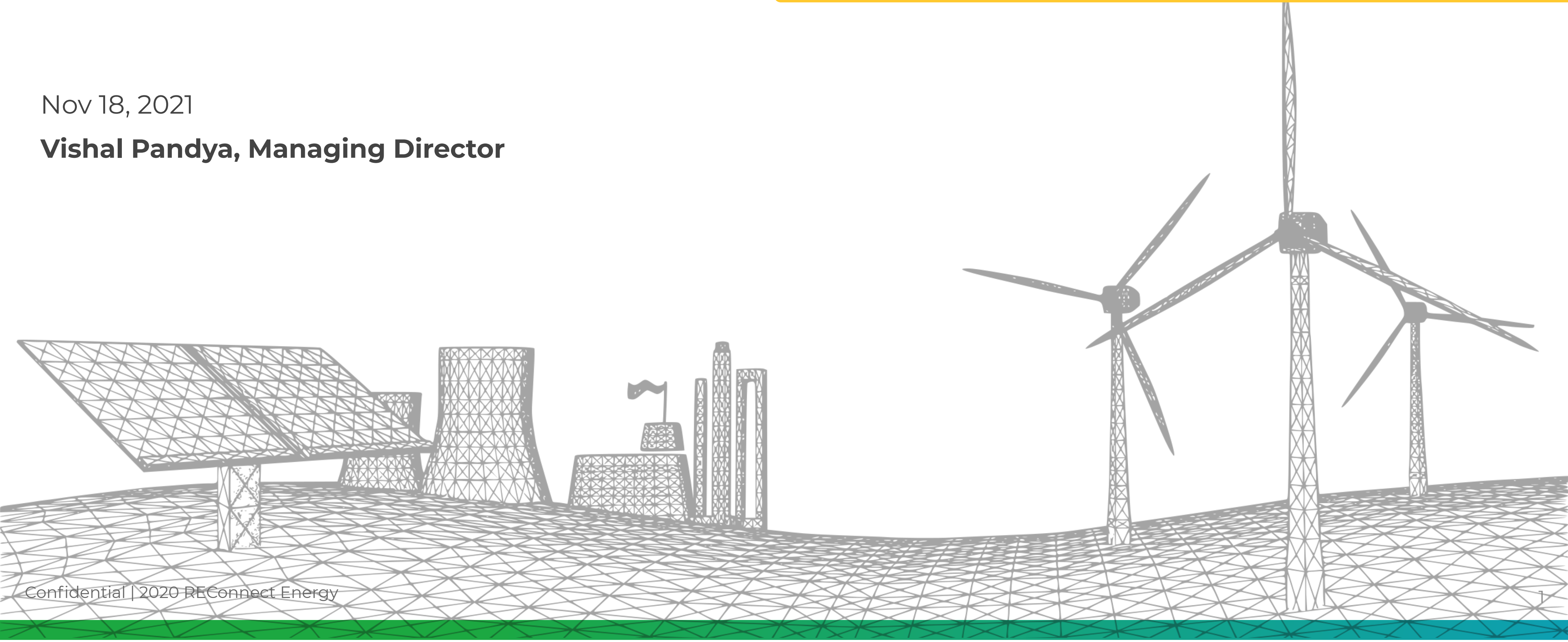
Recent Development in RE

India and Global Trends

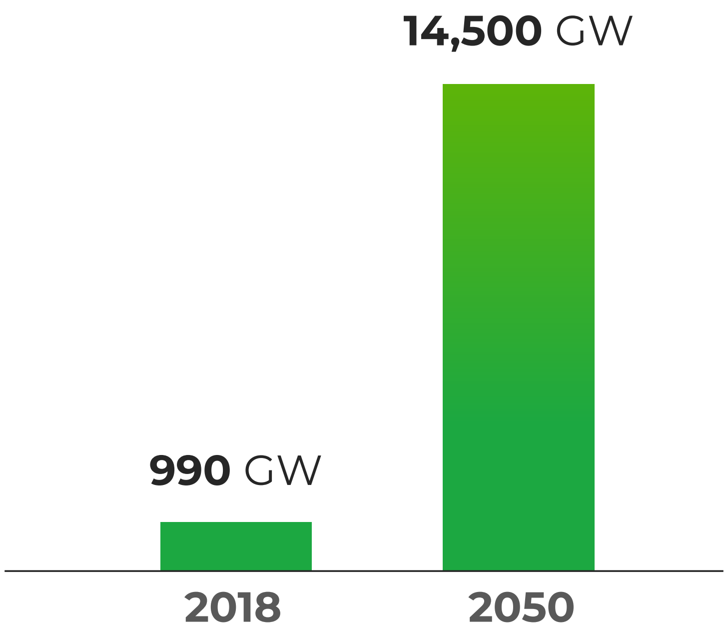
Private and Confidential.

Nov 18, 2021

Vishal Pandya, Managing Director



The Future of Energy is Green



Wind+Solar Installations as estimated by IRENA

86%
of Global Energy could come from Renewables by 2050

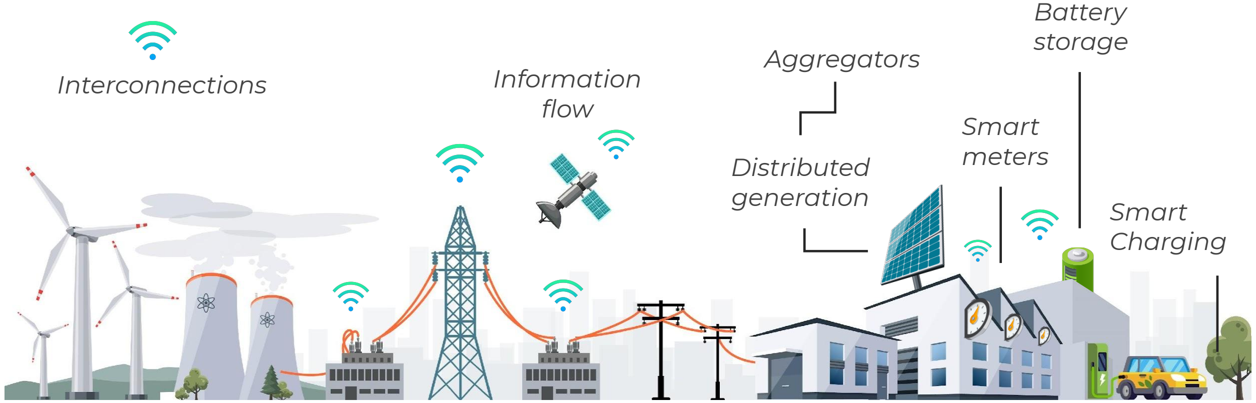
Electricity
would become the Singular Source of Energy

Realtime Decisions & Hyper Performance
would drive the Future Energy Systems

The New Grid. Rapid Rise of Variable Energy

Rapidly Changing
Grid Dynamics

Grid Scace RE, DERs, EVs
Prosumers, Smart Meters



Digital Applications

Generation | Transmission | Distribution | Consumption

Demand-Supply Forecasting & Balancing
Predictive Maintenance
Flexibility through Automation & Controls
Demand Side Management & Response

Concept Ref: Innovation Landscape for RE Powered Future (IRENA) 2019

Grid of the Future

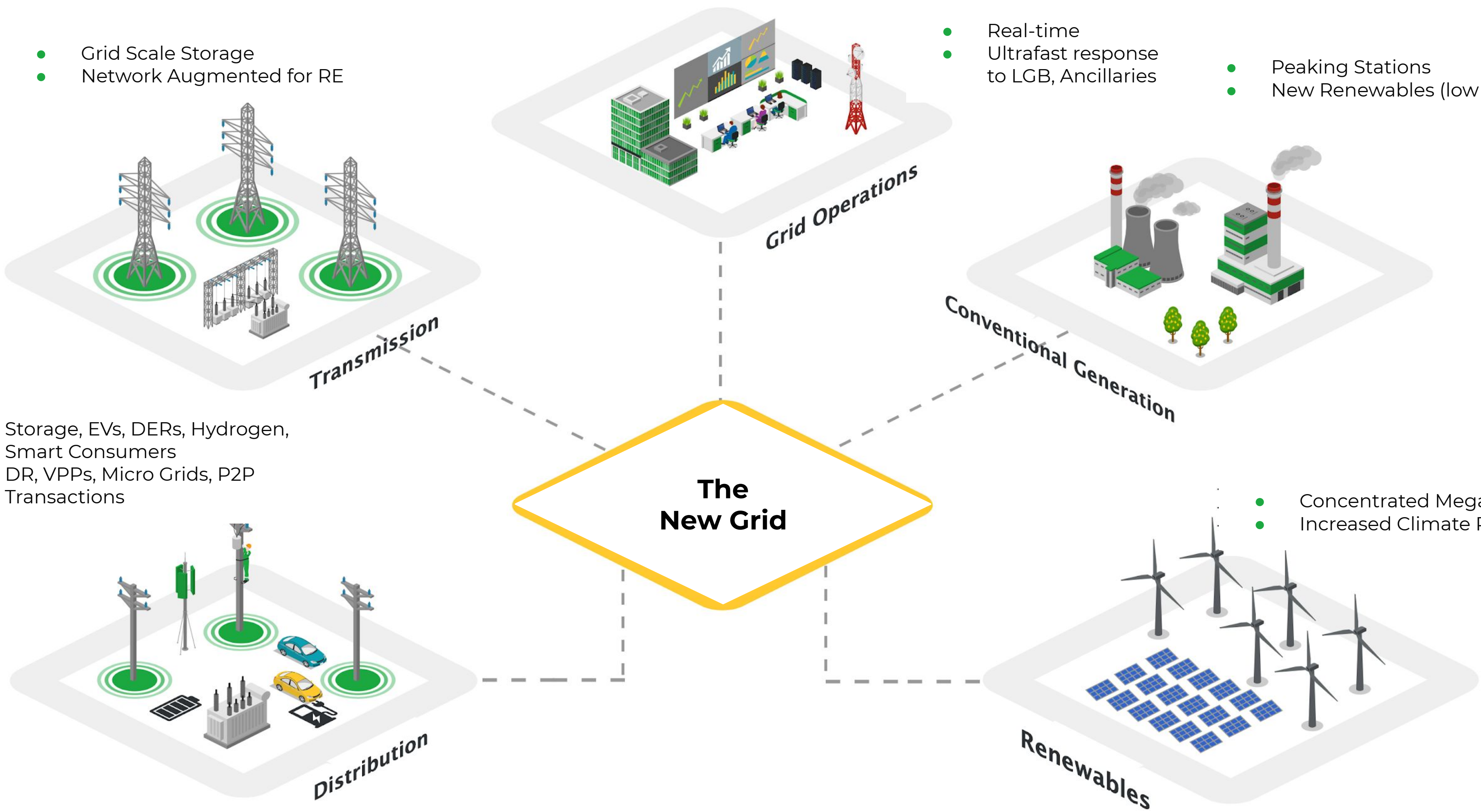
- Grid Scale Storage
- Network Augmented for RE

- Real-time
- Ultrafast response to LGB, Ancillaries

- Peaking Stations
- New Renewables (low PLFs)

- Storage, EVs, DERs, Hydrogen, Smart Consumers
- DR, VPPs, Micro Grids, P2P Transactions

- Concentrated Mega Parks
- Increased Climate Risk



Wind Energy in Western Region & Madhya Pradesh

WR Wind Duration Curve for 2019-20 Vs 2018-19

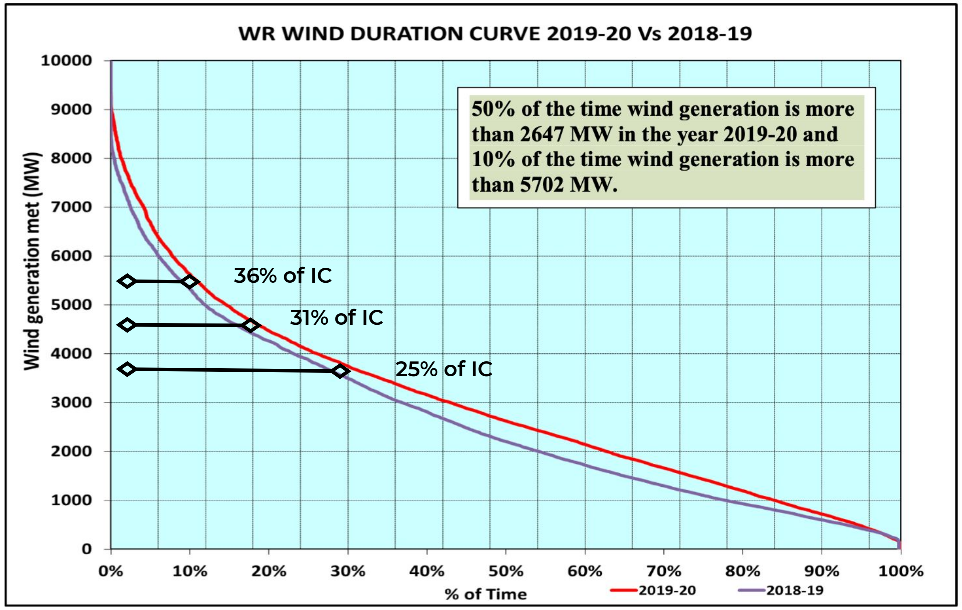


Figure 74: WR Wind Duration curve 2019-20 Vs 2018-19

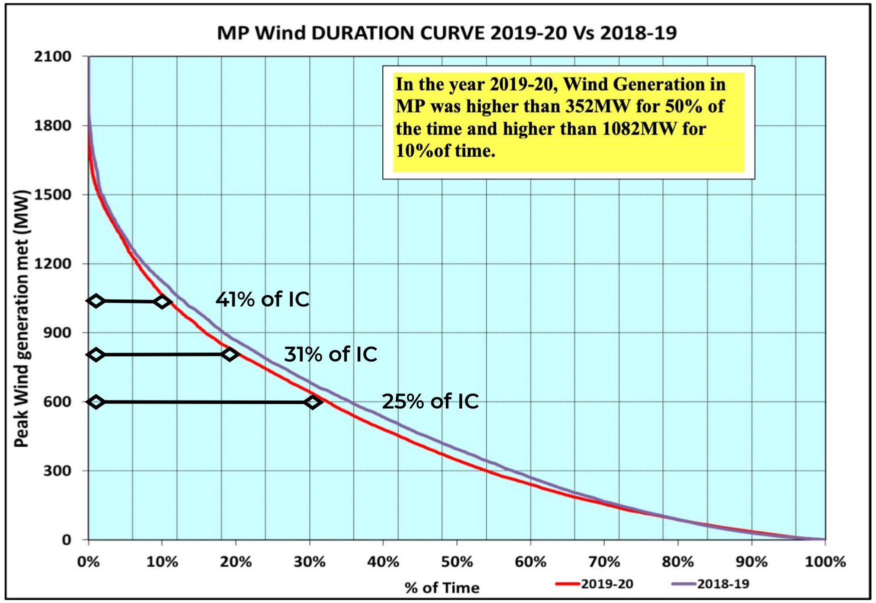


Figure 140 : Wind Generation duration curve of Madhyapradesh

LDC for 15,011 MW of Wind in WR

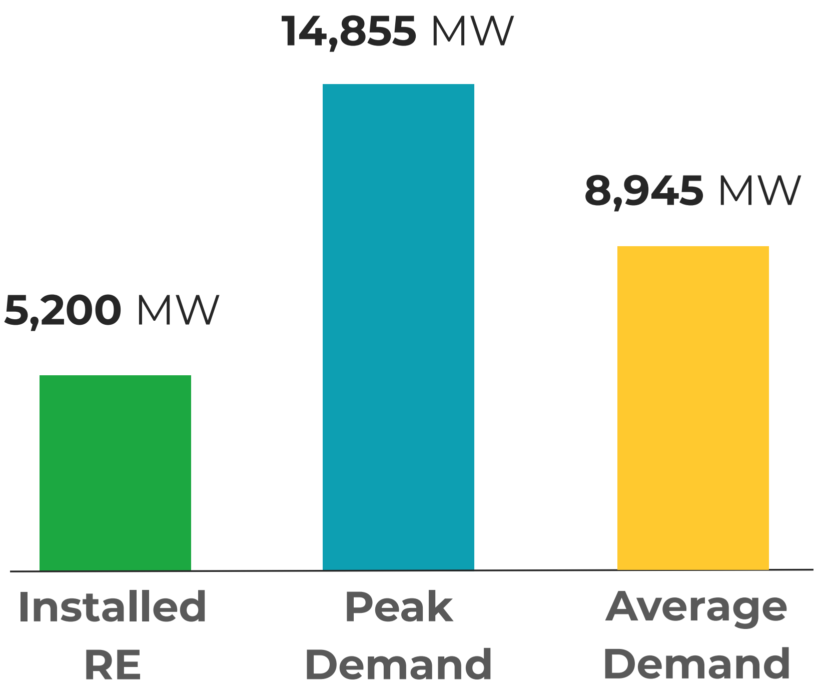
LDC for 2,520 MW of Wind in MP

***Source**: POSOCO/WRLDC Annual Report, IC = Installed Cap.*

"20/30 rule" in Wind Generation

only 20% of the time in a year, wind generation has crossed ~30% of installed capacity in MP as well as WR

Energy Balance in Madhya Pradesh



Note: *Peak/Average Demand as on FY20, Installed RE Capacity as on Mar'21*

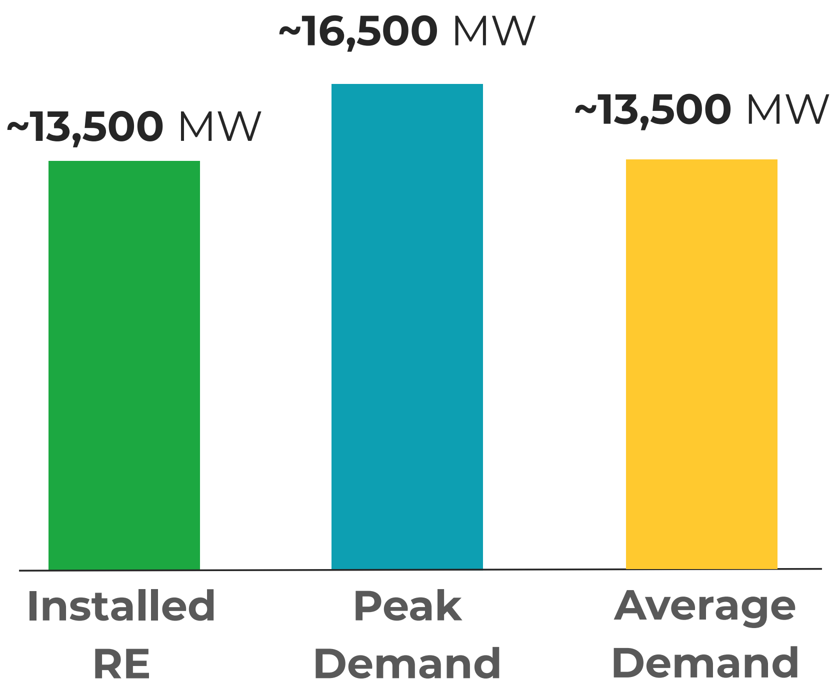
Source: *MNRE and POSOCO*

RE stands at 58% of Average Demand
expected to increase rapidly in next 5 years

44.5 Crore DSM Charges in FY21
between capping, additional and sign change DSM

Climate, Renewables, Demand
are linked, realtime market participation needs to be aligned

Energy Balance in Tamil Nadu



Note*: Peak/Average Demand as on Q1-FY22, Installed RE Capacity as on Mar'21*

Source*: MNRE and POSOCO*

RE stands at ~100% of Average Demand

tepid growth of RE and Demand in the past 5 years

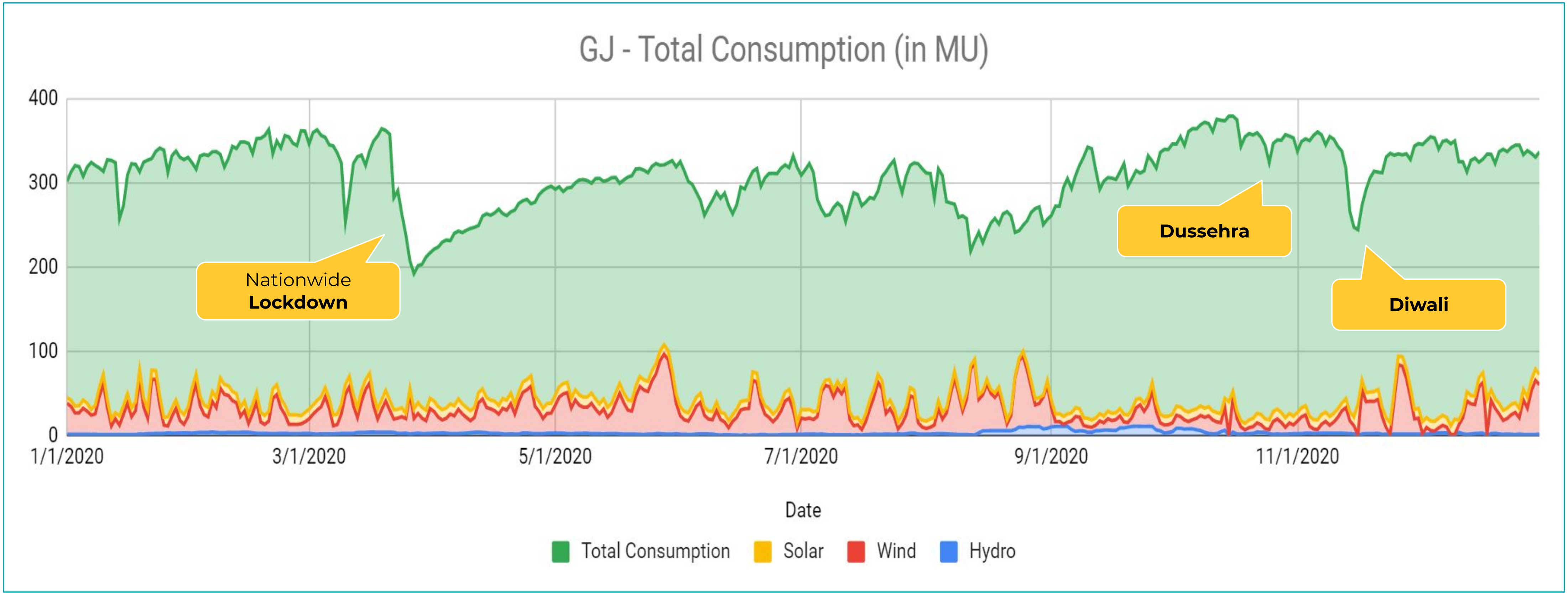
29 Crore DSM Charges in FY21

additional DSM alone

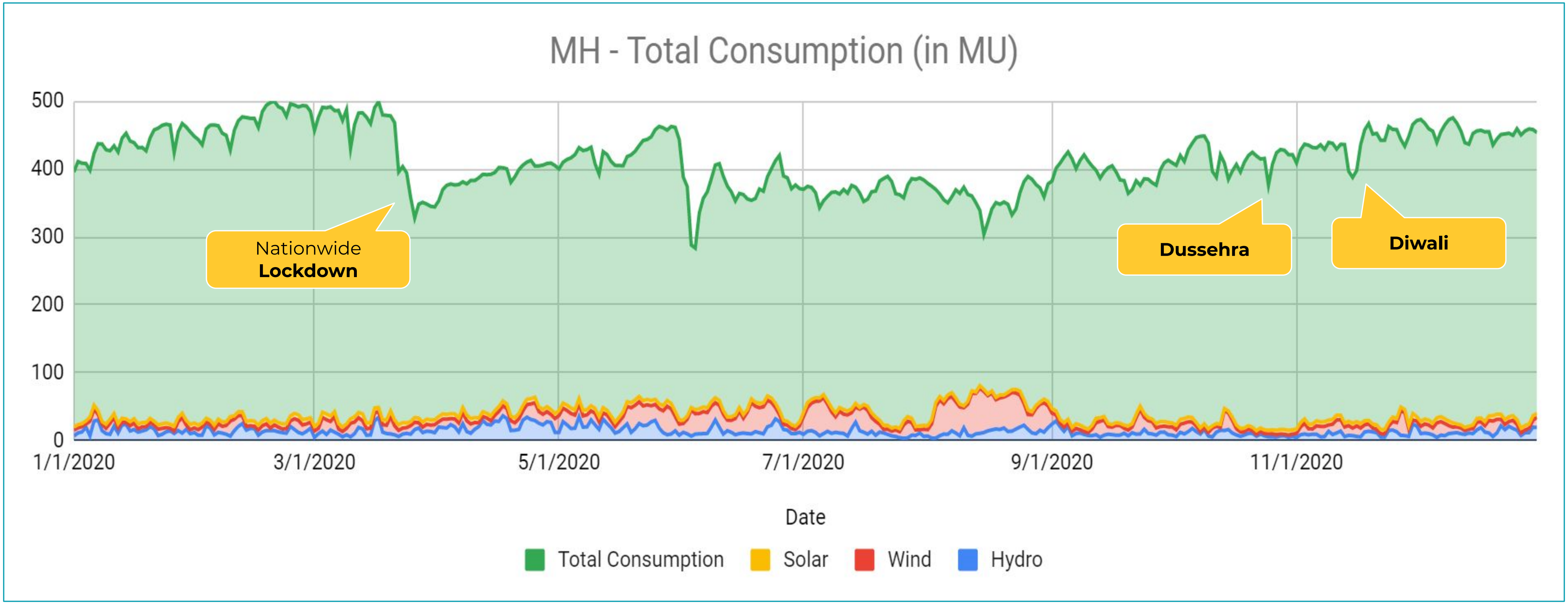
Climate, Renewables, Demand

are linked, realtime market participation needs to be aligned

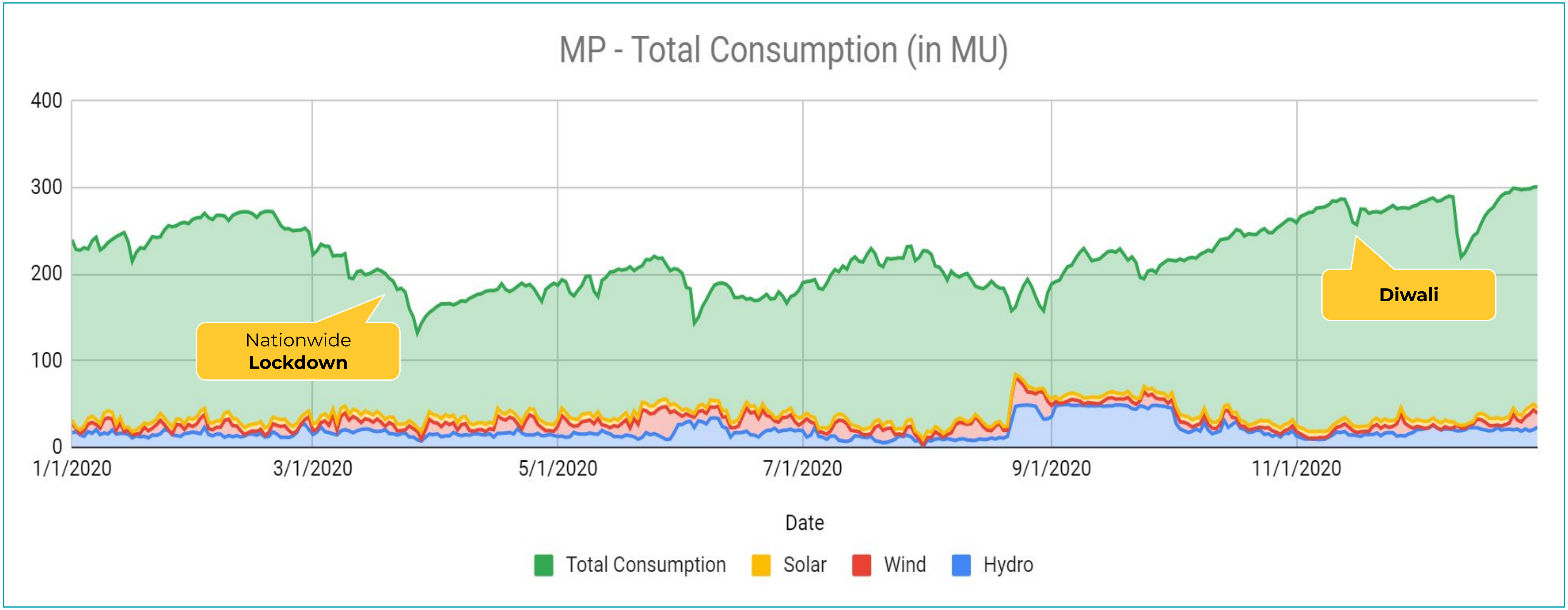
GJ Demand Met (CY 2020)(in MU)



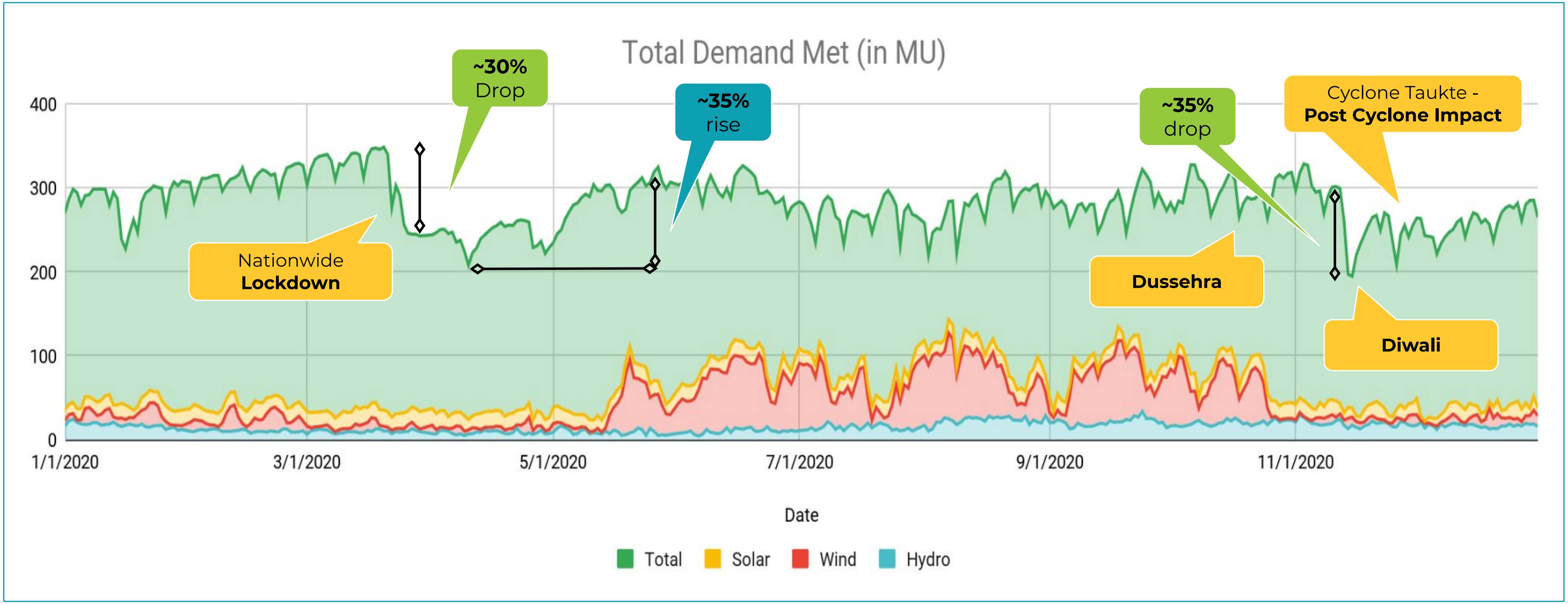
MH Demand Met (CY 2020)(in MU)



MP Demand Met (CY 2020)(in MU)



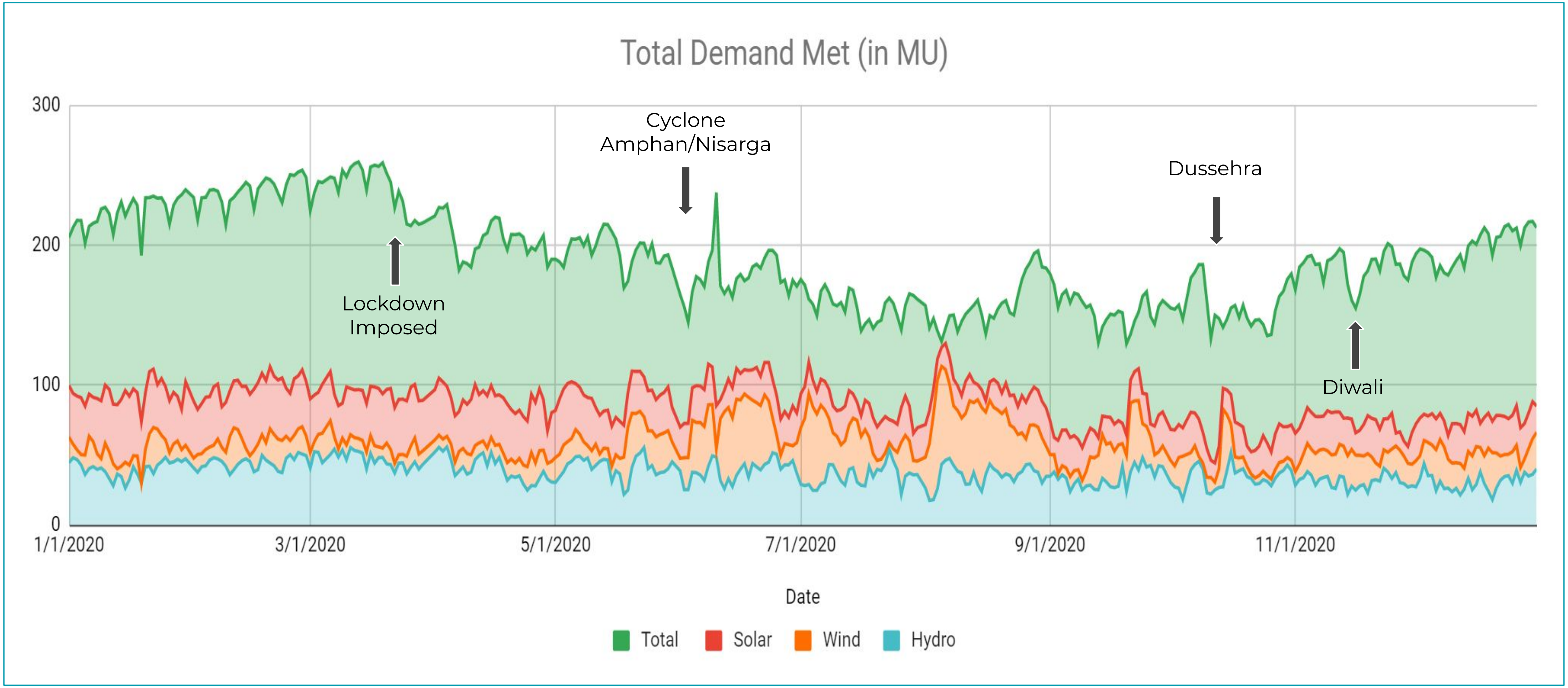
TN Demand & RE (CY 2020) -Key Events in CY 2020



Significant climate and non-climate led external factors affecting electric demand.

Karnataka Demand & RE - Key Events in CY 2020

Significant climate and non-climate led external factors affecting electric demand.



The Dispatch Problem. Between Merit Order and Must Run

Renewables
Must Run
~0 MC, Single Part Tariff

Electric Demand
Inelastic, Variable
LTA, MTOA, STOA, PX, RT

Conventional Gen.
Reducing LFs
Two Part Tariffs, Flexibility Expected

Factors Impacting Dispatch

Weather
wind speed, GHI, could cover
location specific, hyper local

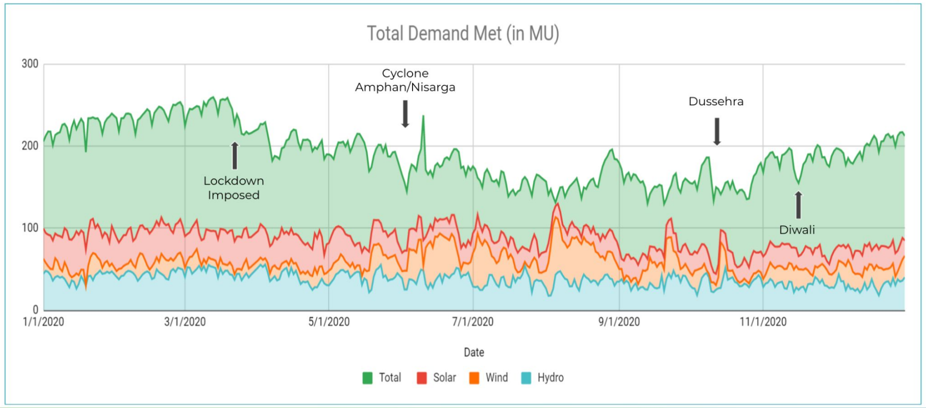
Weather: temperature, rain, humidity, wind
Social Factors: festivals, political events, holidays, special events
Grid: network congestion, supply issues, financial constraints

Renewables: variability, must run
Demand: load uncertainties, long term PPAs with two part tariffs = fixed costs for DISCOMs

Technology Trend # 1 - Autonomous Dispatch

India is transiting towards high RE % energy mix

Significant climate and non-climate led external factors affecting electric demand.



DA and Intra-Day FC has different dynamics

Feb'21 DA FC: **3.01% MAPE**

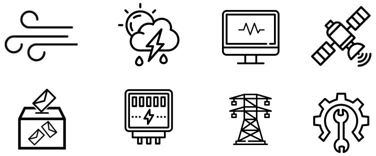
Mar'21 DA FC: **6.2% nMAPE**

Feb'21 ID FC: **1.62% MAPE**

Feb'21 ID FC: **2.4% nMAPE**

A layered and automated decision support system

Base Data / Inputs



- Weather Forecast, Remote Sensing
- Real-time generation/demand data
- Grid Data - contracts, constraints
- Non-climatic factors

Optimisation

- RE Uncertainties
- Demand Uncertainties
- Grid Constraints
- Contracts, MoD

Season Ahead Dispatch

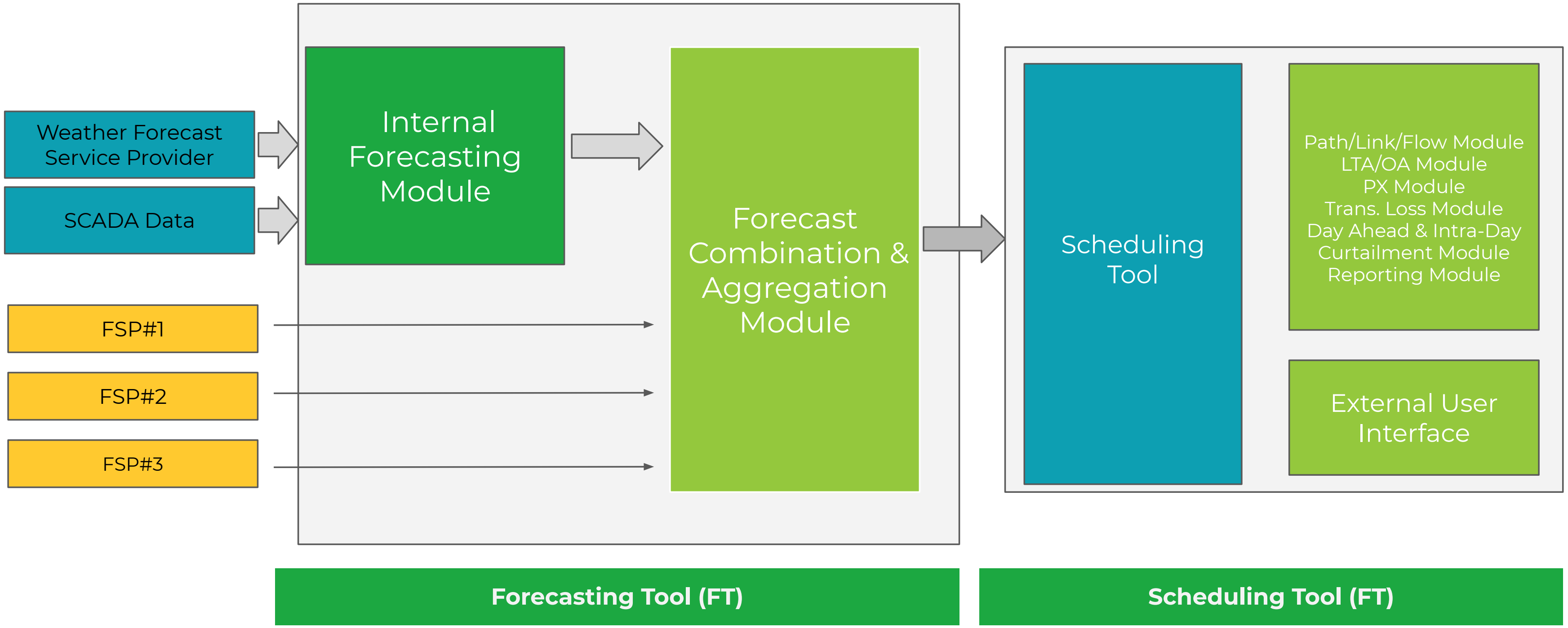
Week Ahead Dispatch

Day Ahead Dispatch

Hour Ahead Dispatch

Technology Trend # 2 Grid Integration of RE/REMCs

Functional Diagram of REMCs



Technology Trend # 3: Digitalisation of Wholesale Electricity Market

SAMAST: Scheduling, Accounting, Metering And Settlement of Transactions

Entity/User profile creation

Centralised data management module that will allow creation of multiple users and ensure seamless data flow between different collaborators such as generators, transmission and distribution agencies, OA customers, and regulatory agencies.

Meter Data Management

Collection, processing and validation of meter data from an end to end metering process to ensure correctness meter data for further process.

Open Access Management

Processing of open access power transaction applications in a customized flow for both Interstate and Intrastate for Buyer/Seller/Trader/Nodal Agency

Schedule Management

Scheduling of all intra-state entities including RE generators as per state/ central regulations

Load Forecasting

Demand forecasting for operational purposes through day-ahead scheduling.

Transmission Outage Planning

Planning and managing outages (shutdowns and tripping) of transmission network elements or generators for maintenance or other purposes/reasons

Energy Accounting

Application to generate provisional and final statements for State utilities in line with SEA (State Energy Accounts)

Deviation settlement system

Application to prepare Monthly/weekly State Deviation Settlement Account (SDSA) to be prepared by SLDC for the billing and settlement of Deviation charges

MIS Reporting

A single window master reporting platform for Load despatch centres to generate any important information/ reports from various functional SAMAST software modules.

Other Key Trends # Indian Grid and Indian Power Market

	Key Objectives / Scope
Power Market Regulations 2020	Market Coupling, OTC Market, Separate Clearing Houses
Real time Markets (RTM)	Shorter gate closure to market participation, better integration of RE, reduced imbalance costs to DISCOMs and Generators, RTM is already ~20% of DA-Spot Volumes
Pre-paid / flexible consumers	Granular and more comprehensive demand estimation, network monitoring/planning and consumer participation through DR programmes
Electricity Derivatives	Market coupling, national electricity prices, and deep integration of financial players in the mainstream electricity market
Aggregation of Assets	Renewables are aggregated in a few states, momentum towards larger aggregation services (DERs, demand side measures, EVs, BESS etc.)
EVs and BESS	New age energy players, will have a steep impact on the grid and electricity markets

Fast Changing Technology Landscape

Need an equally fast regulatory response.

Closing Remarks

Clean, Connected, Fast Markets

are power market regulations and power exchanges gearing up for such systemic changes?

Smart and Digital Consumer

with fast penetration of smart meters, DR/DSM measures will start playing out in the market. Do we have market mechanism to accommodate such trends?

New Age Players

DERs, EVs, BESS - will start interfacing with grid and the market in the future. Important to see how our power market evolve from where we are today!

Connected to Grid?

you may need

GRIDConnect

Driving Decisions Digitally

Thank You!