



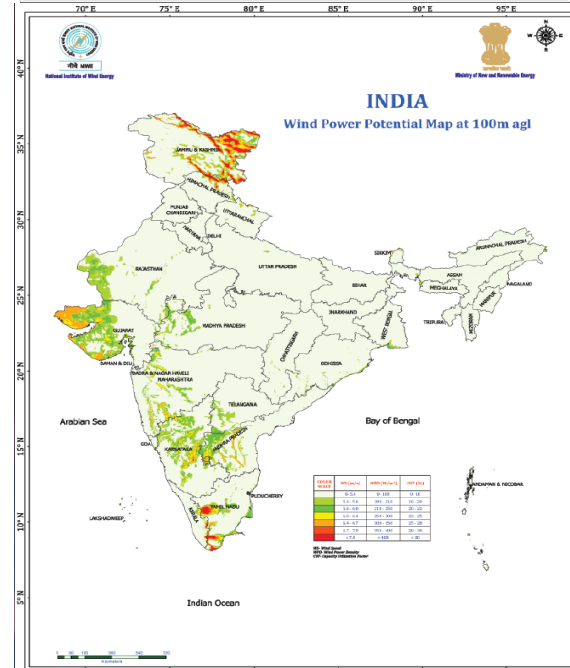
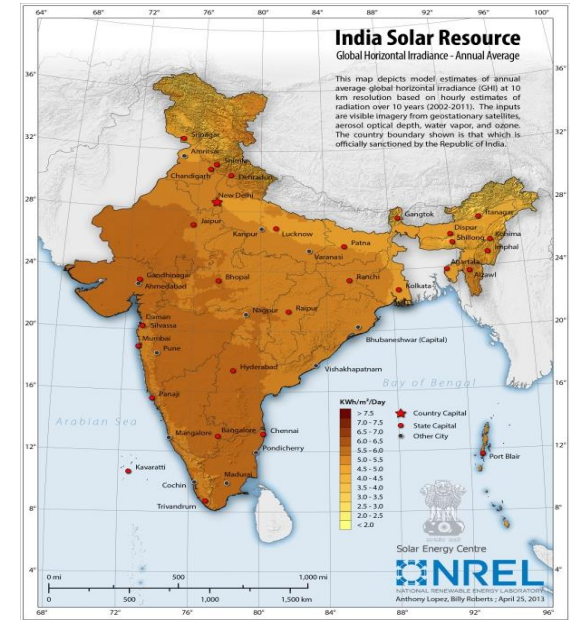
Transmission Planning for Large Scale Renewables

Power Grid Corporation of India Ltd.

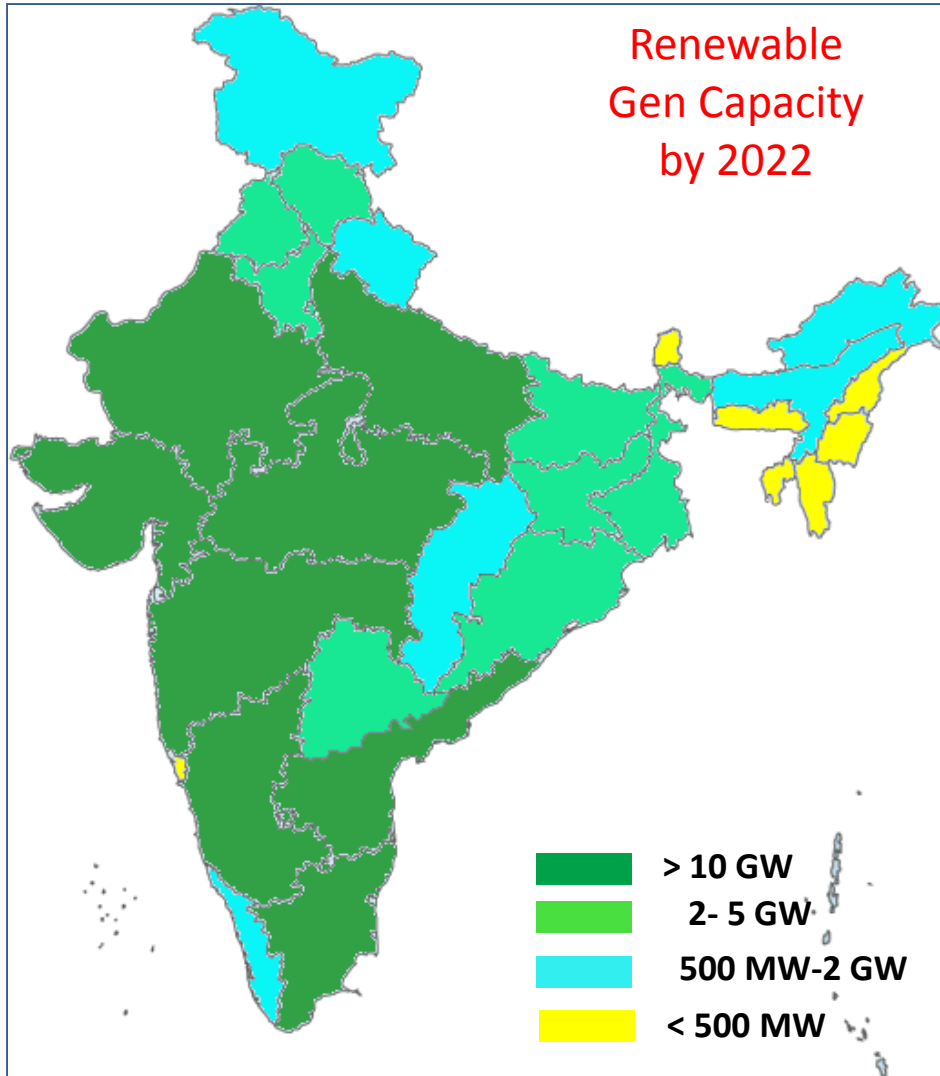
05th Jun 2017

Renewable Potential- India

- Abundant RE (Wind/Solar) Potential in India to achieve energy security & growth sustainability
- Solar Potential in India : about 20-30 MW/sq km, 5000 trillion units annually
 - Research shows solar potential > 750 GW (assuming 3% wasteland)
- Researchers Claim more than 1000GW Wind Generation Potential
 - Wind Power Potential (at 100m Agl) : 302 GW wind potential (As per NIWE data-official estimate)

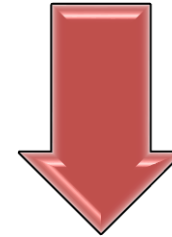


RE Capacity Goal by 2022: India



Renewable by 2022 : 175GW

- Solar :100GW
- Wind :60GW
- SHP/Biomass : 15GW



Solar Power : 100GW

- Solar Parks : 40GW
- Distributed : 40GW
- Roof Top : 20GW

Indian Power System : Paradigm shift in Generation Portfolio

2017

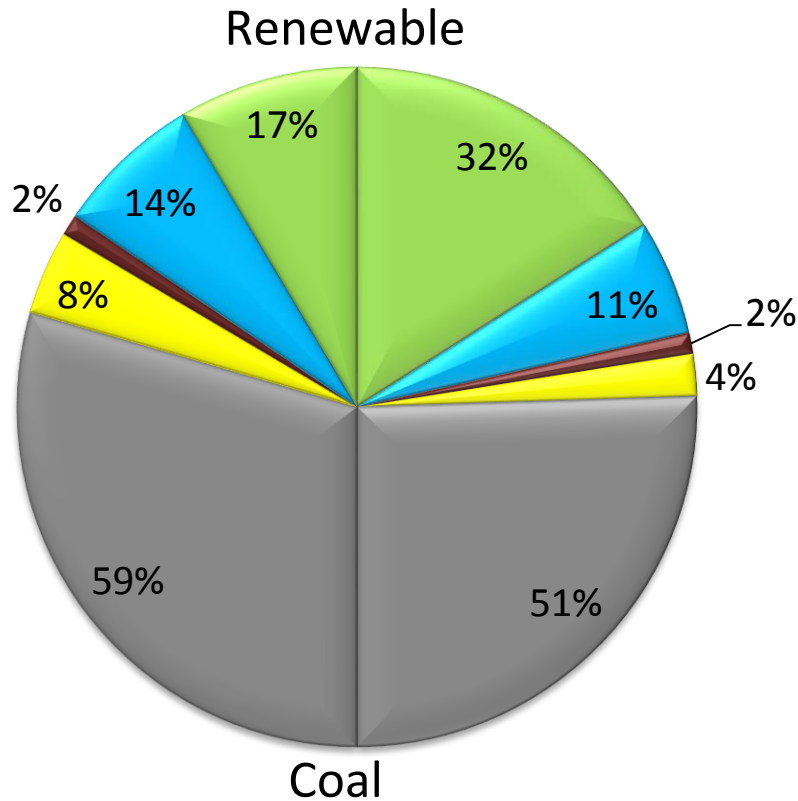
2022

Generation : 327GW

Renewable : 57.2GW

Peak Demand :
159GW

Annual Consumption:
1142BU



■ Renewable ■ Hydro ■ Nuclear ■ Gas ■ Coal

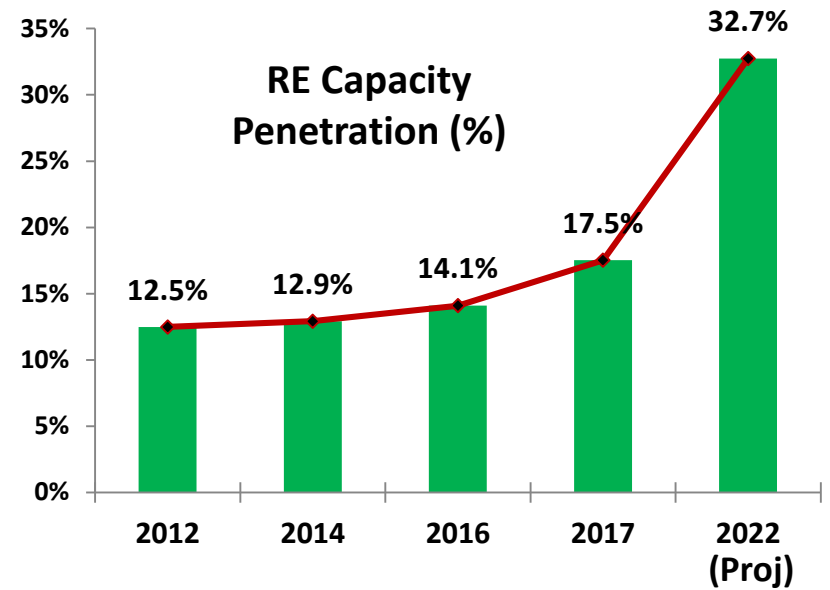
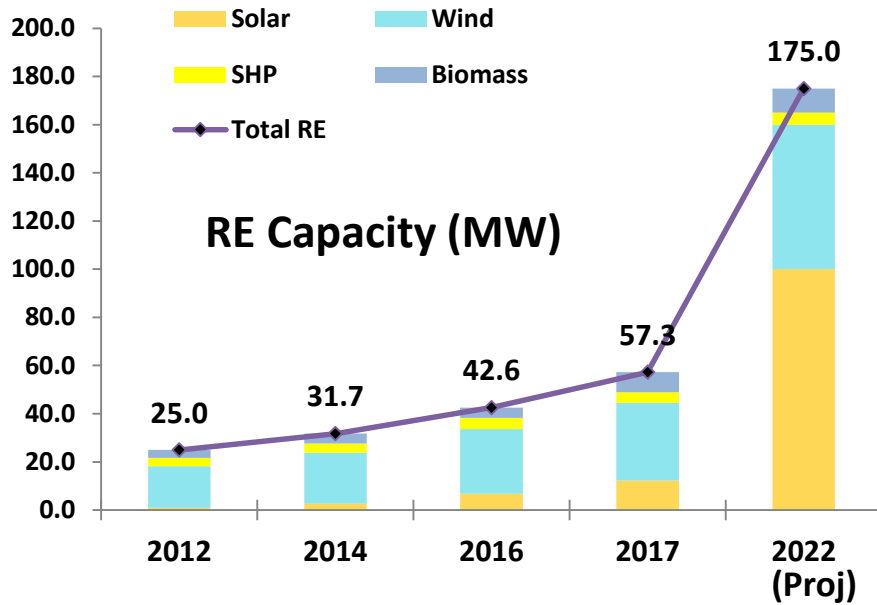
Generation : 534GW

Renewable : 175GW

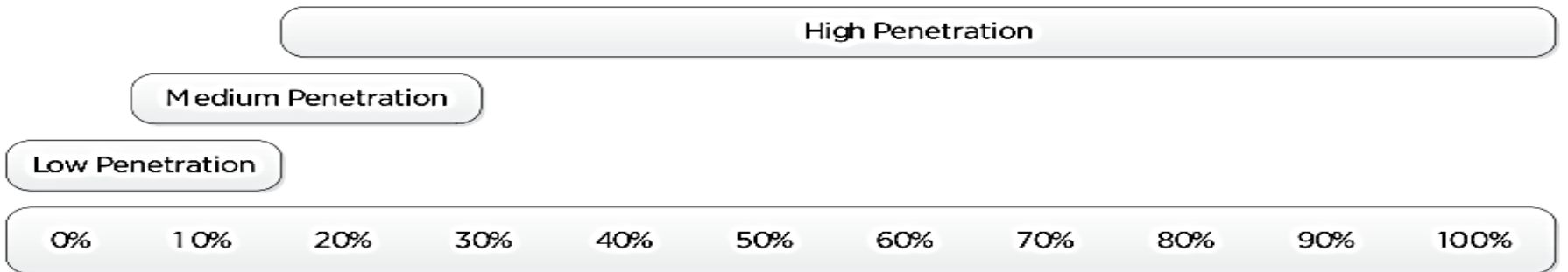
Peak Demand :
234GW

Annual Consumption:
1566BU

Growth in RE



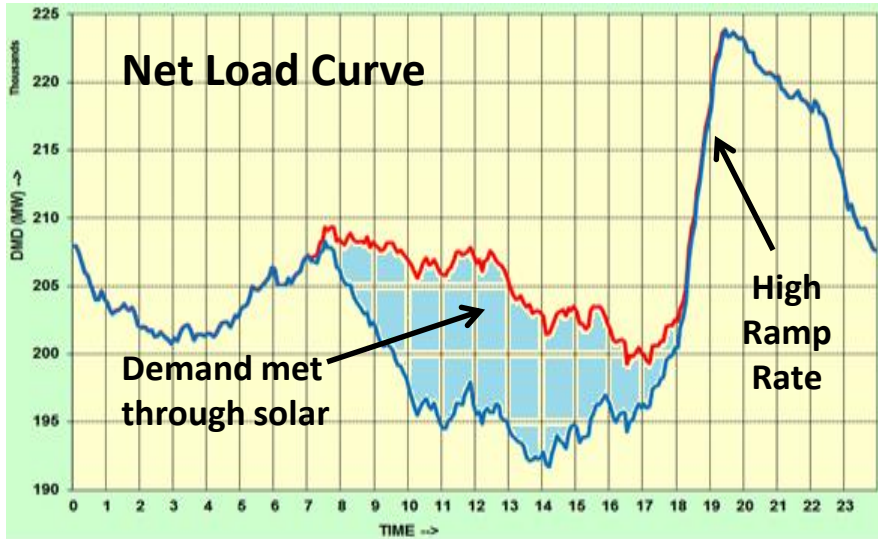
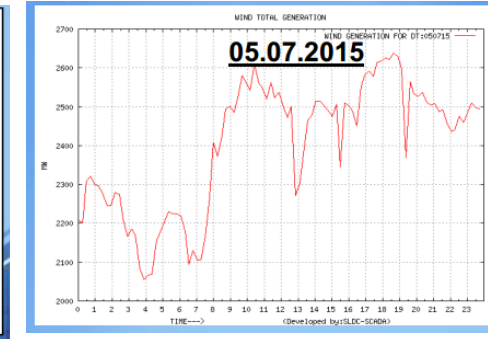
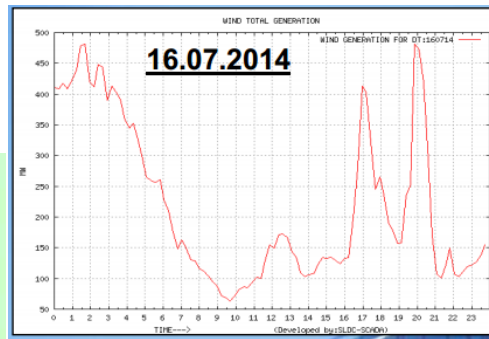
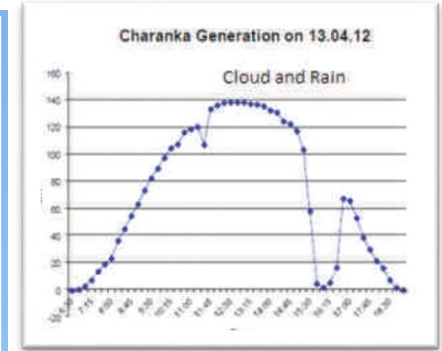
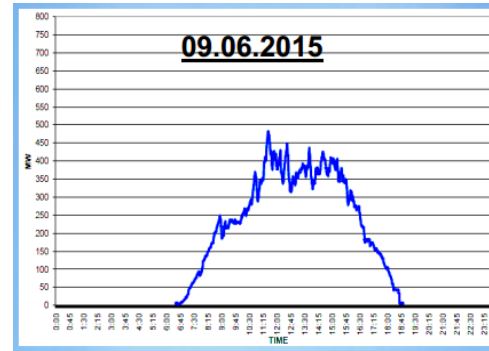
RE PENETRATION TO DOUBLE IN NEXT 5 YEARS



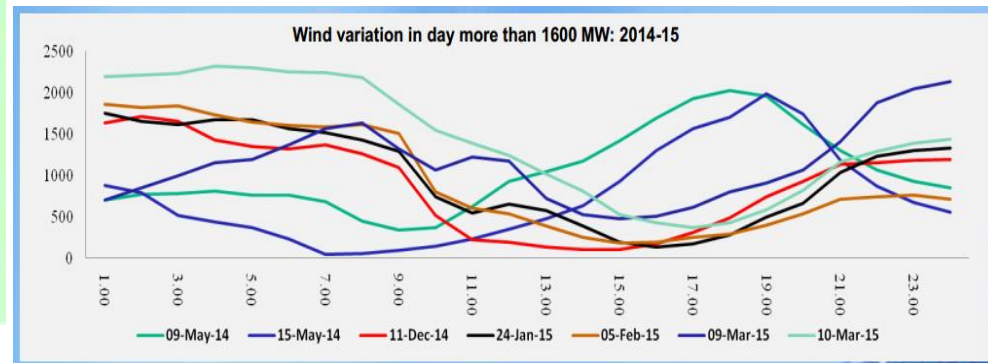
Renewable Grid Integration - Challenges

Issues- Grid Operational

- Variability
- Partial Predictability
- Managing Load Generation balance
- Voltage Ride through & Reactive Power Management



Giraffe Curve



Planning for Renewable integration

Factors affecting Transmission Planning:

- Low Gestation period of RE Generation (Wind / Solar)
- Strength of Grid (Fault Level) at the Point of RE interconnection: Reactive Power Management
- Quantum of RE generation- Phased development
- Destination of RE power

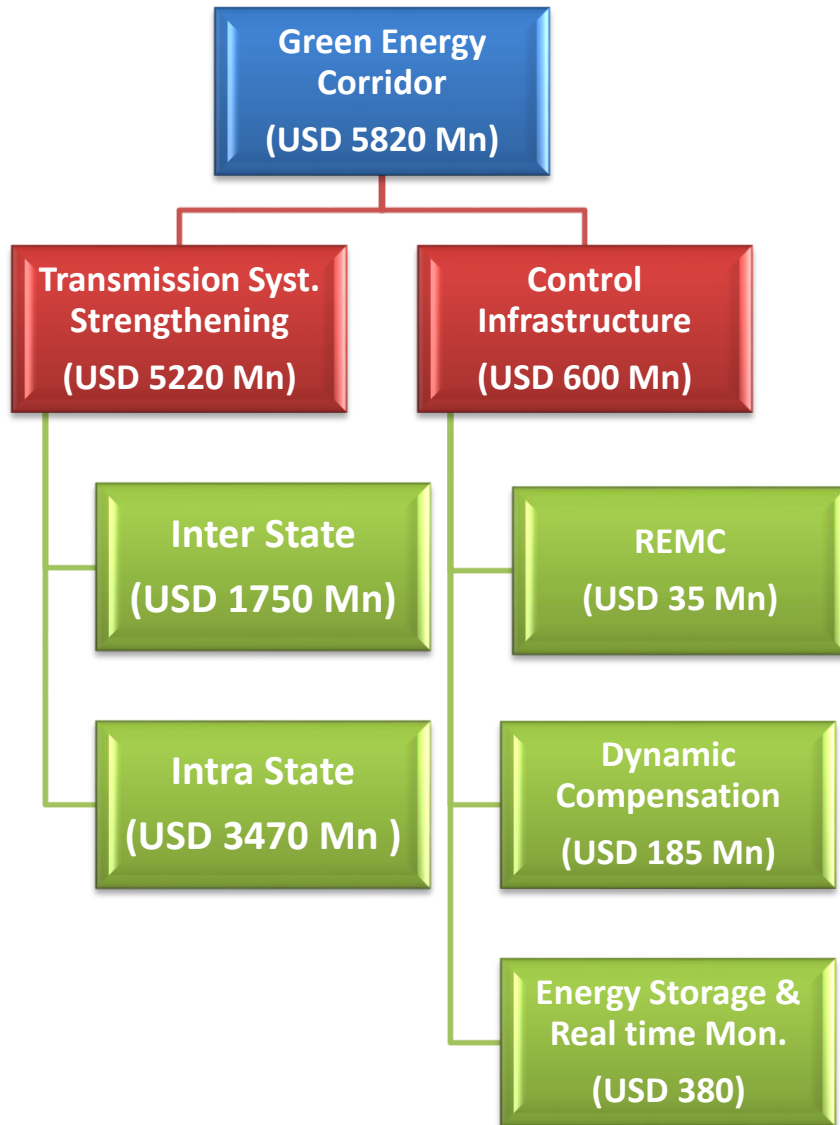
Planning for Renewable integration

- Transmission development to lead RE generation
- Phased development of Transmission in accordance to generation phasing
- Several load generation scenarios to be studied to take care of RE maximization/minimization (dispatches) under various seasons
- Robust tie lines to facilitate variation in direction of Power flow under various operating conditions
 - Necessary System Strengthening
- Provisions for maintaining grid Parameters
 - Suitable reactive power compensation (Switchable Reactors , FACT devices, etc.)

Genesis of Green Energy Corridor (GEC)

- MNRE, GoI and FOR/CERC (The regulator) entrusted POWERGRID to identify infrastructure requirement for integration of envisaged Renewable capacity addition in RE resource rich states (2012-17)
- Respective RE State Nodal Agency/State Tr. Utility provided information regarding pocket wise RE capacity developmental plan
- RPO (Renewable Purchase Obligation) data for states from FOR/MNRE
- Regional Demand/Conv. Generation projections from CEA
- SLDC/ POSOCO provided Load-Generation Operational data
- Based on all above information, POWERGRID formulated a comprehensive scheme under GEC

Green Energy Corridors : Components



- Transmission System Strengthening at Intra State (InSTS) as well as Inter state level (ISTS)
- Renewable Energy management centers equipped with RE forecasting, scheduling & monitoring systems
- Dynamic reactive Compensation (SVC/STATCOM) at strategic locations
- Grid Scale Energy Storage

Implementation & Financing Strategy

- Intra state transmission scheme to be Implemented by respective State Transmission Utilities
- Inter state transmission scheme to be implemented by POWERGRID
- Capacity utilization Factor for renewable generation viz. Wind & Solar is low, impacts transmission system utilisation
- In order to rationalize transmission charges to reduce burden on the consumers; financing strategy
 - Intra State Strengthening : 40% Grant such as NCEF/VGF, 40% debt through soft loan, 20% state equity
 - ISTS Strengthening : 70% Debt as soft loan, 30% equity

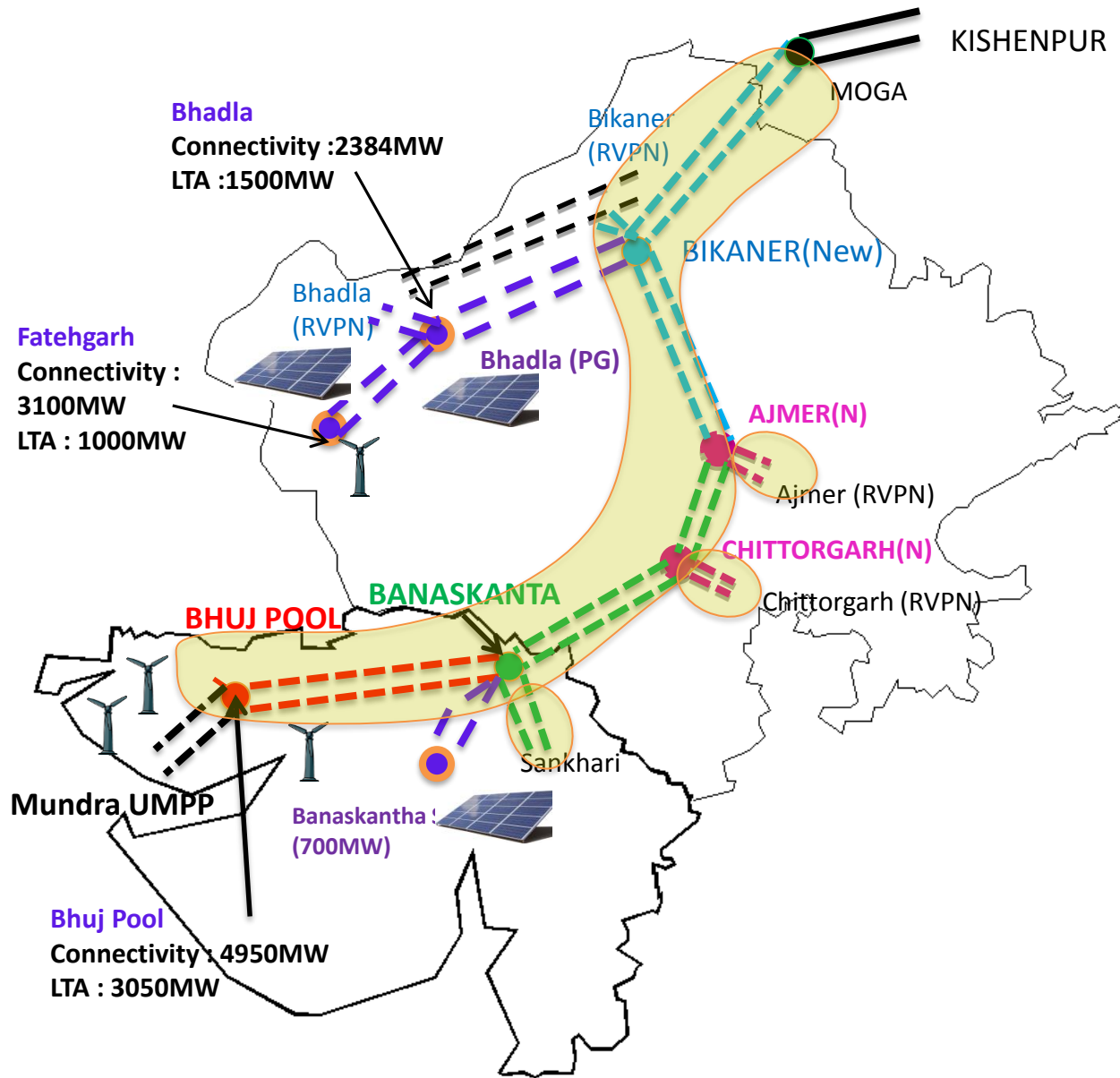
Green Energy Corridor- A Unique Endeavour

GEC Transmission Infra : Transmission planning & implementation from high potential renewable zones

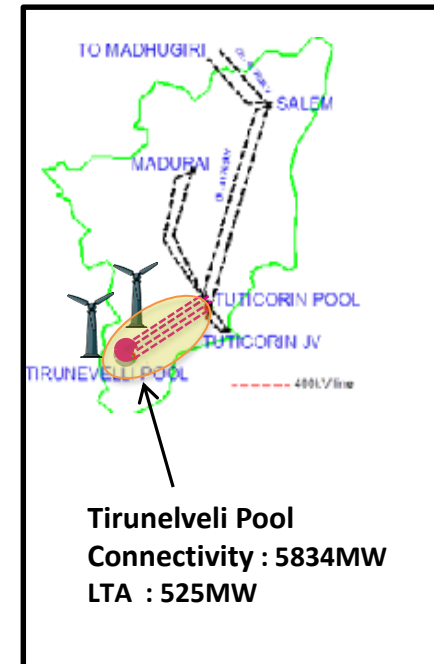
High capacity transmission corridors (765kV & 400kV) emanating from RE potential areas interconnected with distant load centers, integrated with National Grid (Hydro rich belts for balancing)

Numerous RE applications received for injection at pooling stations planned under GEC for commissioning in next 1-1.5 year

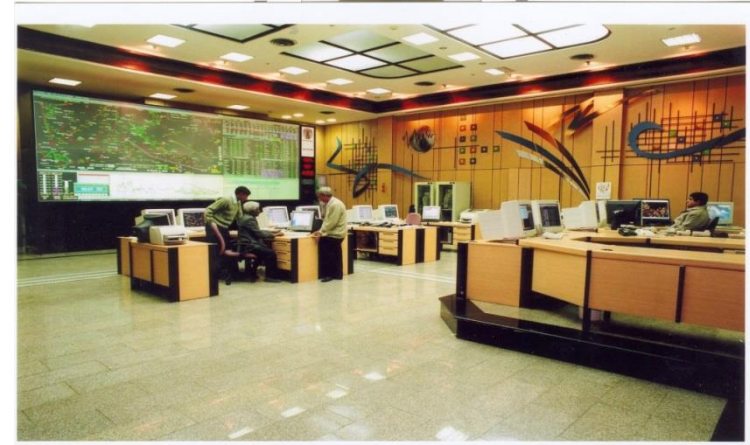
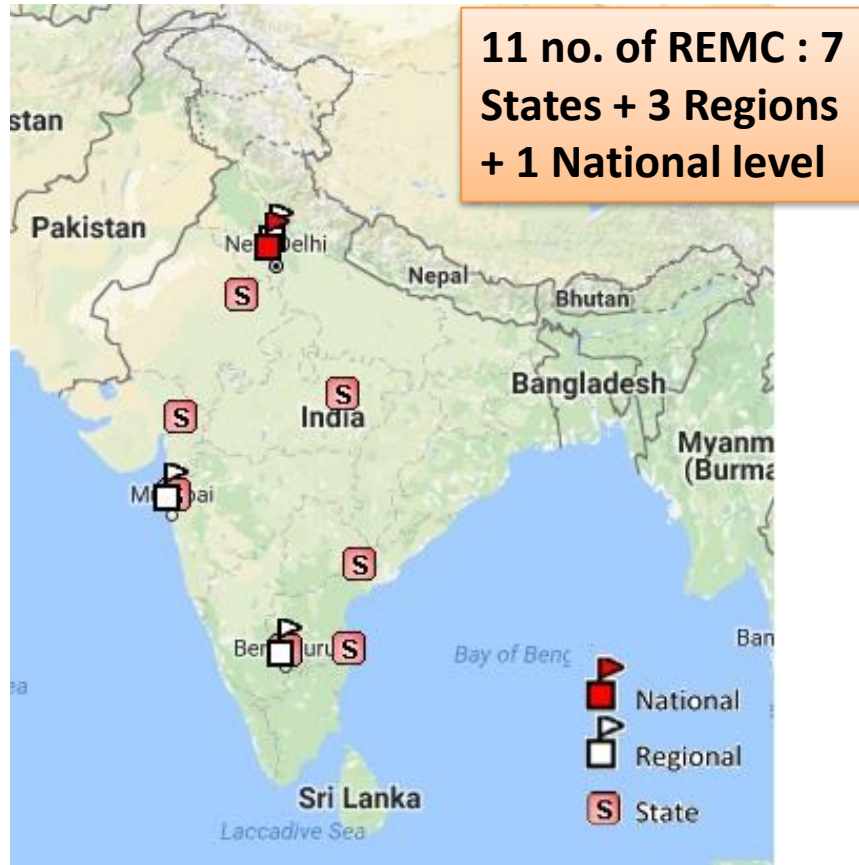
Green Energy Corridors -ISTS



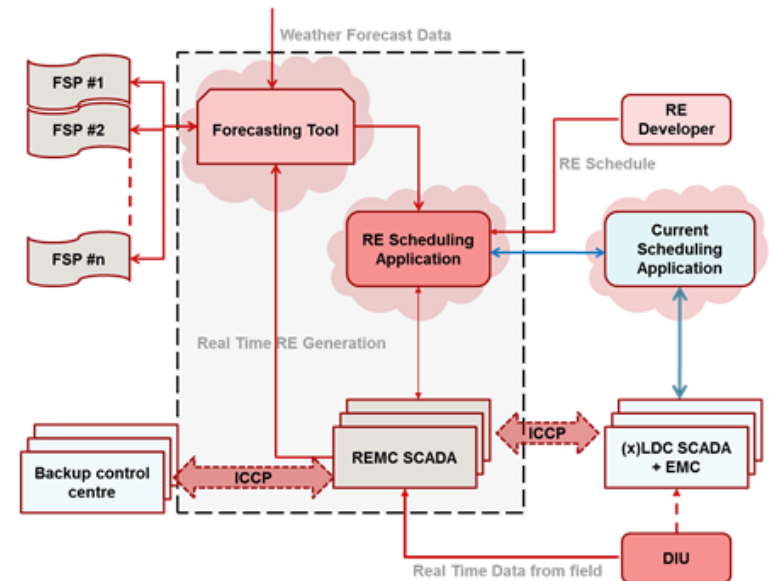
- **GEC Part A : KfW Tr-I**
- **GEC Part B : KfW Tr-II**
- **GEC Part C : KfW Tr-III**
- **GEC Part D : ADB**
- **Tr. Scheme for Solar Parks**



Renewable Energy Management Center

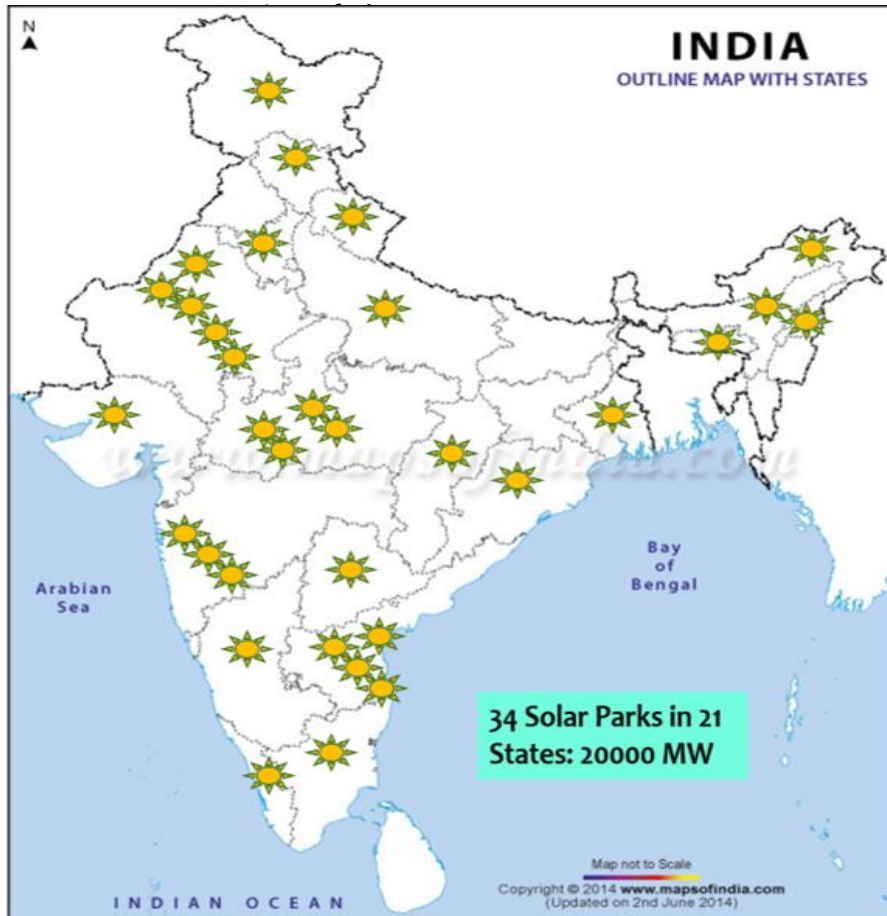


RE Forecasting, Scheduling, Monitoring etc.



Solar Parks Integration: GEC-II

34 Solar Parks 20 GW: Ph-I



- ❑ POWERGRID evolved comprehensive transmission plan for evacuation of about 20GW Solar Park capacity as part of GEC-II (Phase-1)
- **Inter State transmission for 13 solar parks(about 9220MW capacity)**
- **Intra State transmission for 21 solar parks(about 10,780MW capacity)**

Way forward

- Commissioning of GEC progressively from FY 18
- Establishment of Robust Transmission Path- More Such Green Corridors
- Identification of Flexible Supply & Demand Resources and Management
- Ancillary Service Support by Wind/Solar Generators- strict compliance to regulations (LVRT/Harmonics/DC injection/Active Power Control etc)
- Real Time Monitoring (Communication & Data telemetry), Visualization & Forecasting
- Dynamic Control, Energy Storage (PSP/BESS)



Thank You