NITI Aayog

Centre for Energy Regulation

Gujarat Power System Transformation Workshop

Session 2: Gujarat's power system in light of increasing solar and wind generation

7th October, 2020

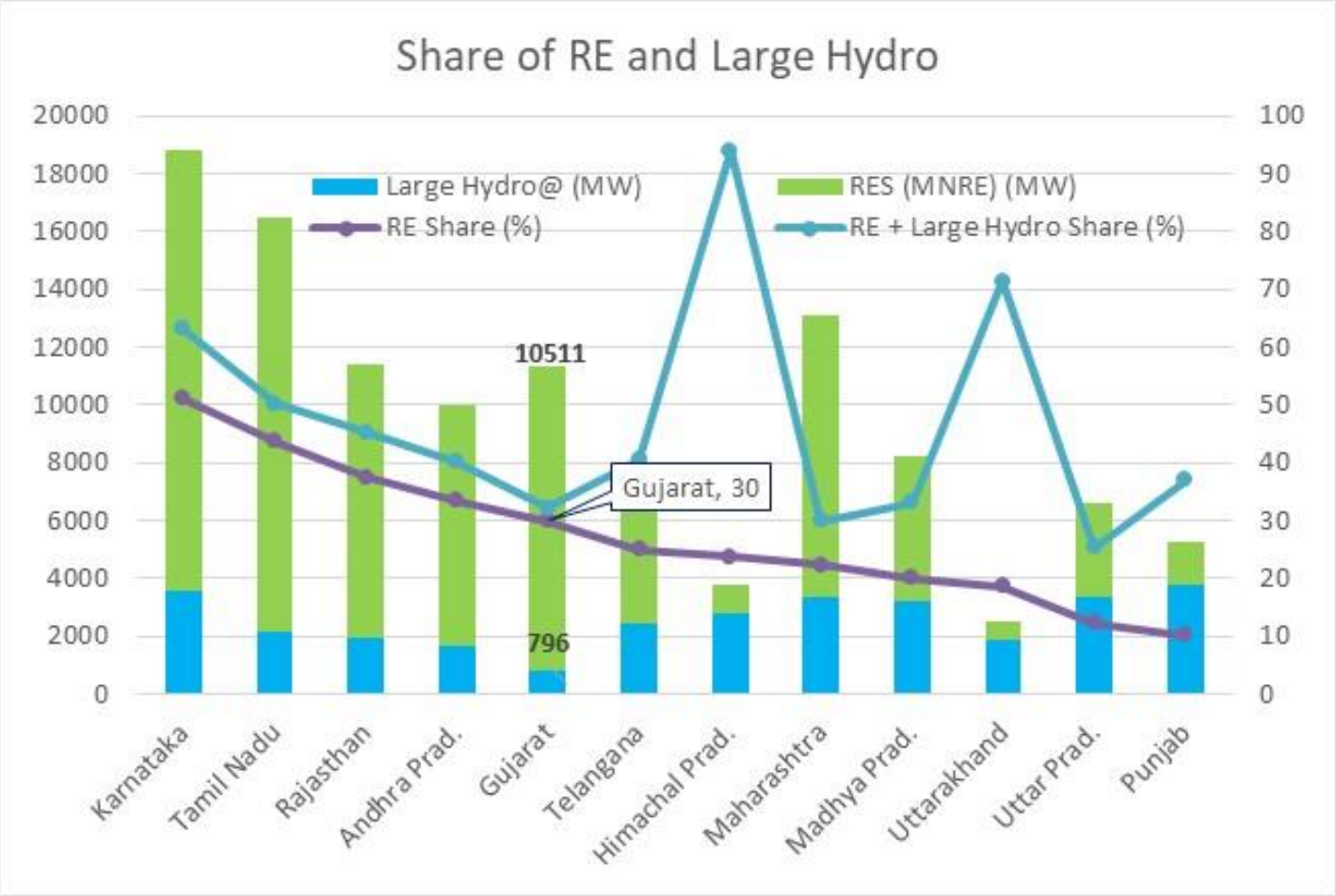
Power System Modelling with High VRE: Methodological Approach

Anoop Singh

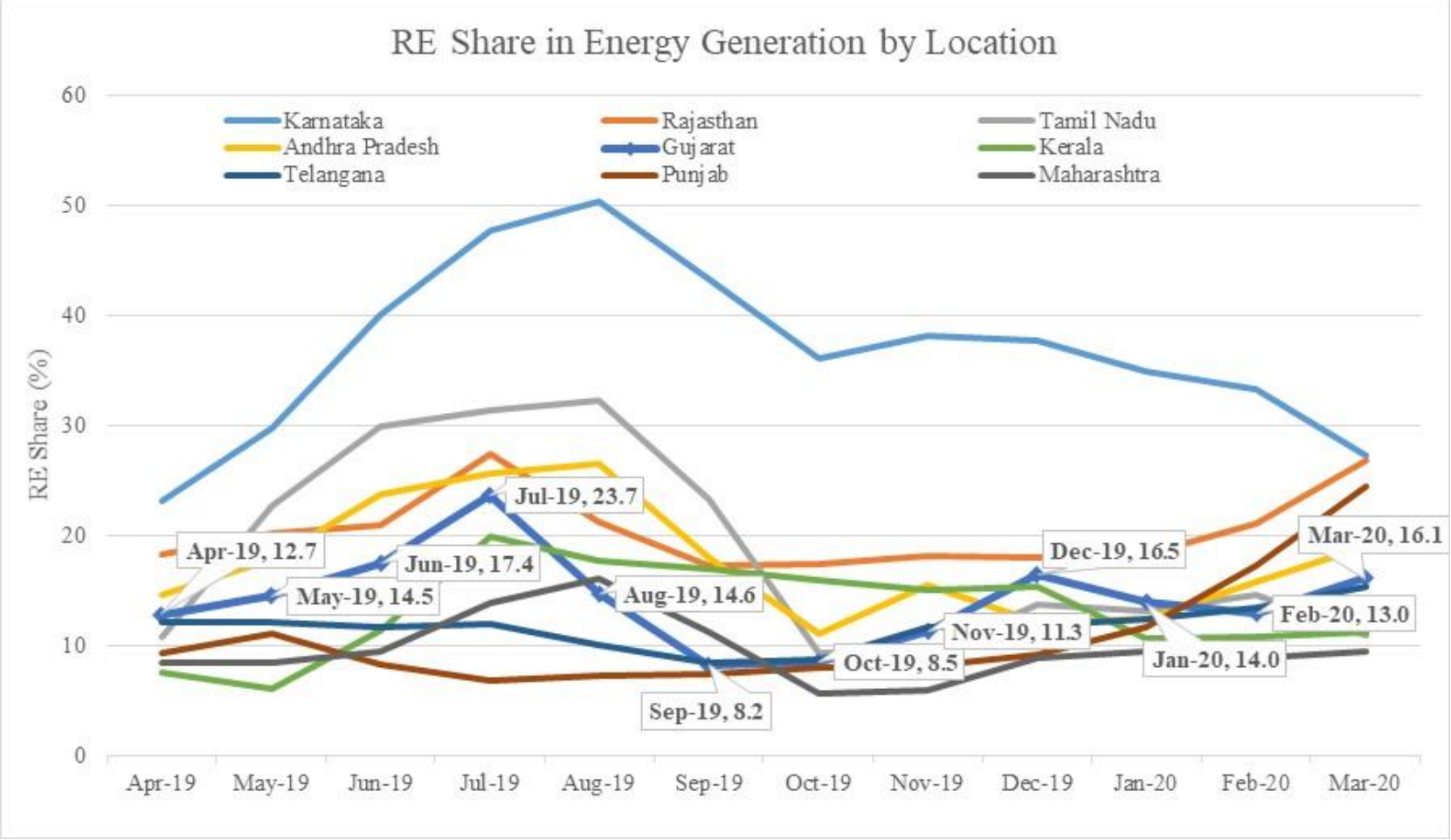
Professor, Dept. of Industrial and Management Engineering (IME), IIT Kanpur

Founder & Coordinator, Centre for Energy Regulation (CER) & Energy Analytics Lab (EAL)

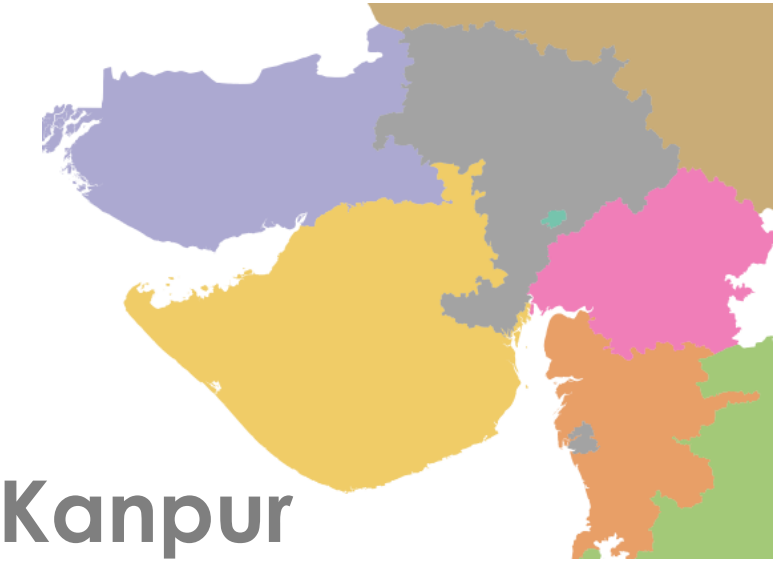
Share of RE and Large Hydro
(As on 31st March 2020)



Seasonality of RE Share in Energy Generation (2019-20)



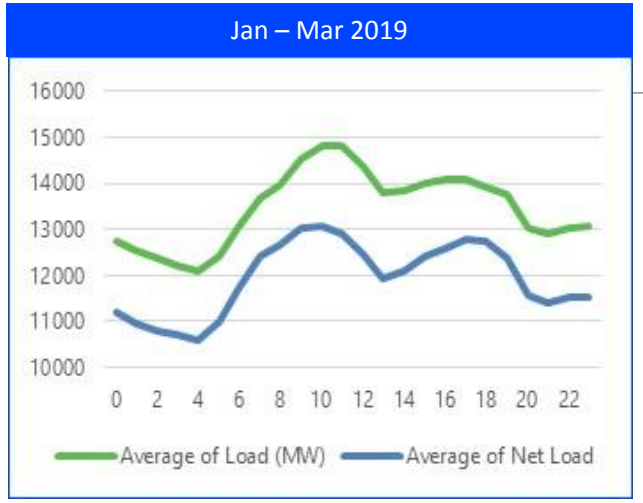
Gujarat RE Modelling Analysis

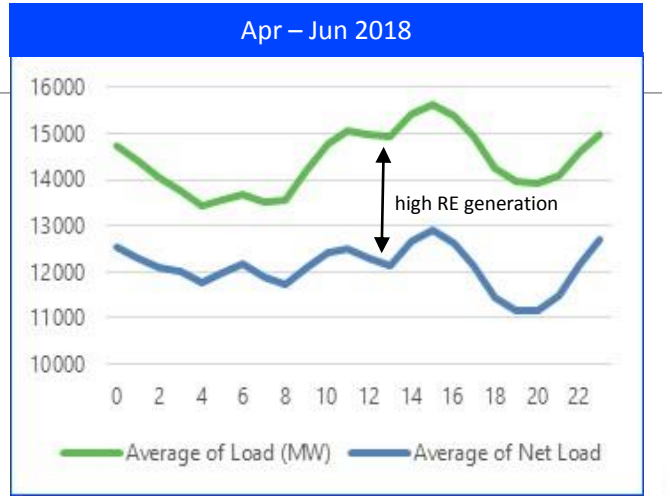


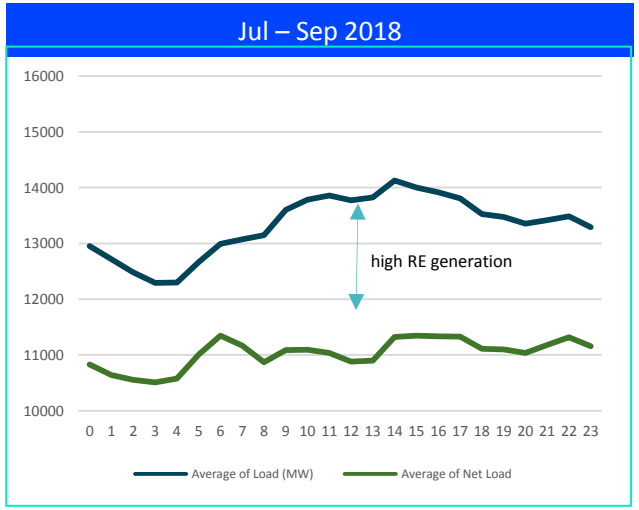
A collaboration between

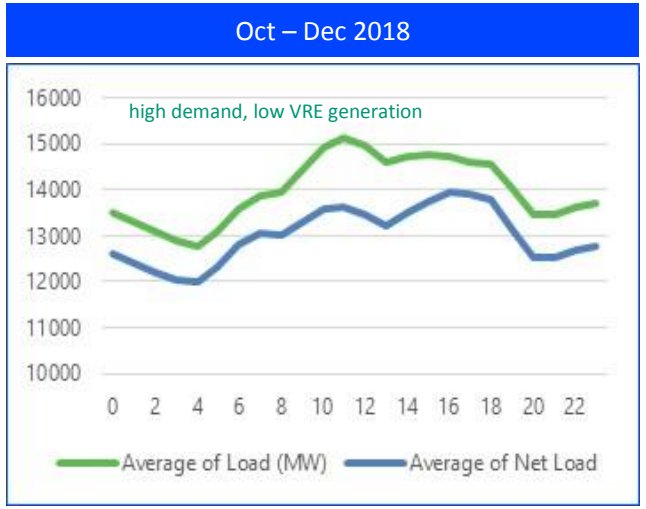
IEA and Centre for Energy Regulation, IIT Kanpur

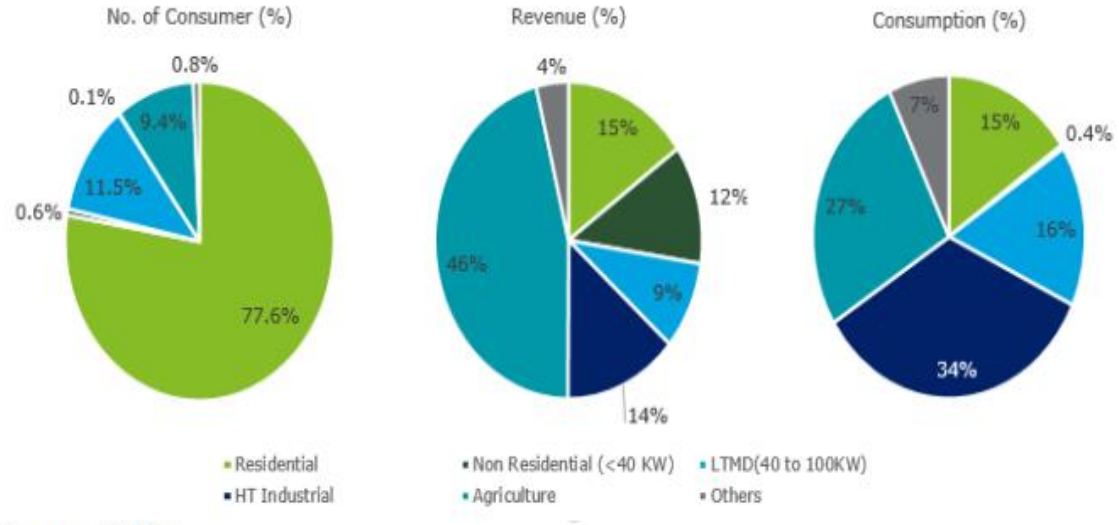
Overview of the Gujarat system – Seasonal Role of RE











Source: GUVNL

- Max hourly demand in 2018-19 was ~18000 MW in Sep 2018 and the min was ~7600 MW in Nov 2018
- Average rate of growth in demand has been around 5-7% during the last 5 years
- Seasonally, demand is highest during summer (Apr-Jun) and post monsoon season
- In 2018-19. net load was highest in October, lowest in July. This would change with higher solar penetration
- Gujarat has a wide industrial base with industry accounting for 60% of consumption and revenue

Key questions and scenario overview

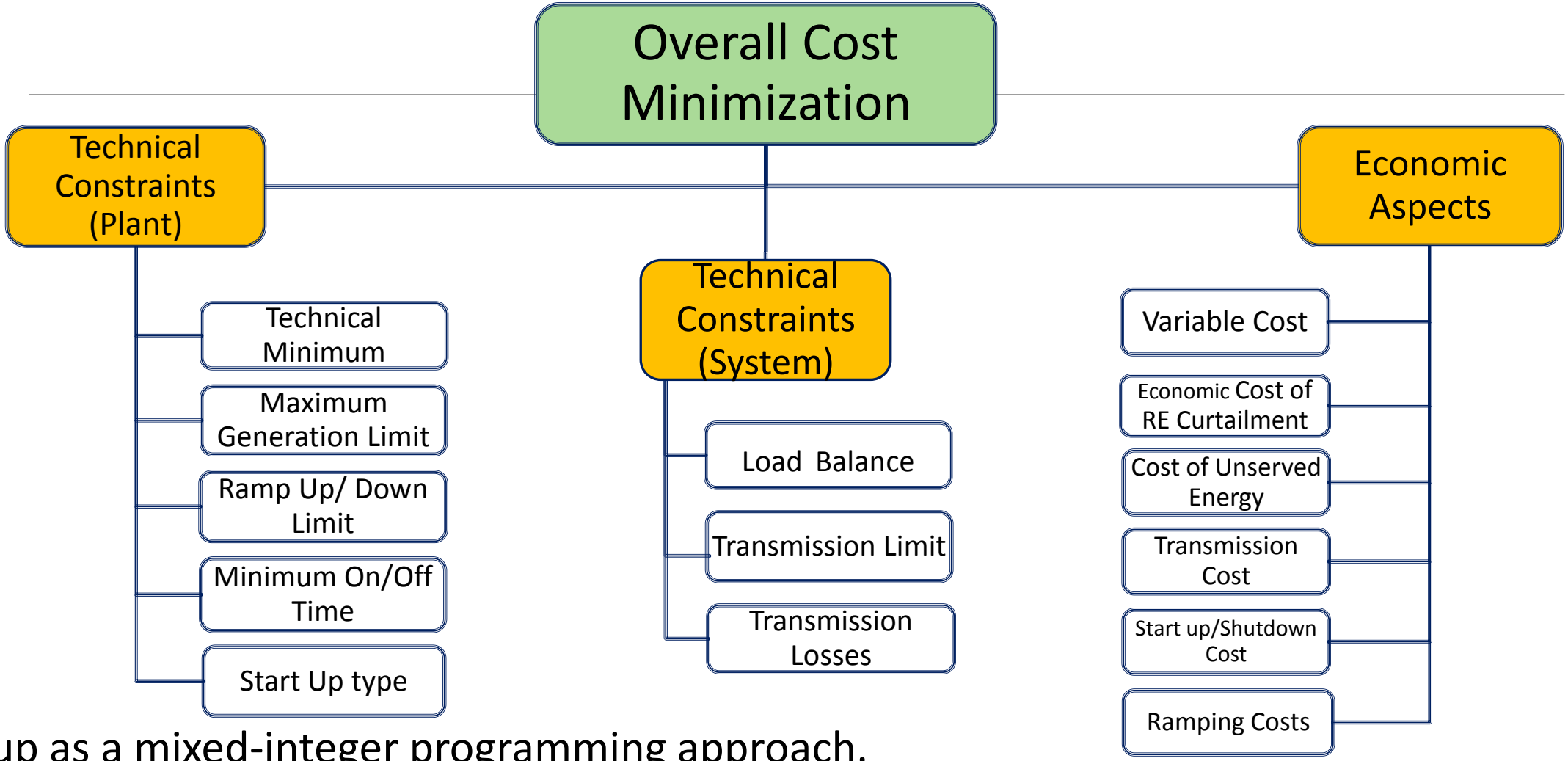
Key questions: To evaluate contribution of diverse flexibility options for the future Gujarat power system with an increasing share of variable renewable energy (VRE).

- What will be the impact of growing renewables in Gujarat over the next 2-10 years and what integration challenges will Gujarat experience?
- What are the roles of different flexibility options in addressing integration challenges – investment in grids, electricity trade, power plant flexibility, pumped storage hydropower, battery storage, demand response
- Policy and regulatory roadmap for RE integration for Gujarat

Important Disclaimers

- This modelling excercise is not a capacity expansion planning excercise
- We do not consider direct/indirect cost of system flexibility

Methdological Approach - Modelling Components

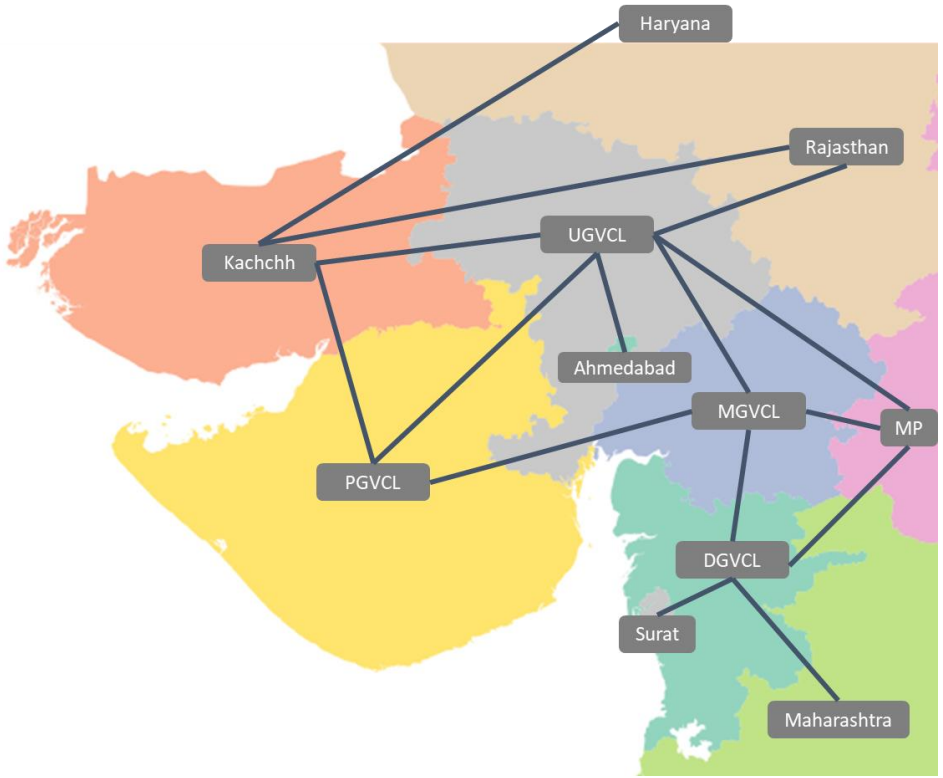


Setup as a mixed-integer programming approach.

Structure of the model – Annual Snapshot

- Intrastate nodes - one each for PGVCL, Kachchh, UGVCL, MGVCL, DGVCL, Surat and Ahmedabad
- Inter-state nodes - Rajasthan, MP, Haryana, Maharashtra
- Demand is modeled on the intrastate nodes, along with the generation capacity in that region
- Inter-state nodes only have generation capacity contracted by Gujarat and are the source of short-term electricity market purchases (and sales)
- Commercial software tool (PLEXOS)

Installed capacity (GW)	2018-19	2021-22	2029-30
Coal	14.0	16.9	13.7
Gas	4.1	4.1	4.1
Hydro	0.6	0.6	0.6
Nuclear	0.6	0.8	0.8
SolarPV	1.8	7.8	47.3
Wind	5.7	7.7	17.9



Data sources and assumptions (1)

Demand

- 15-minute (CER, Gujarat SLDC) / hourly (IEA, public data) demand profile
- Detailed demand projections by CER, IIT Kanpur accounting for Covid-19 impact
- Discom-wise disaggregation based on annual load profile for the state
- Demand response: agricultural demand profile based on pumping schedules

Conventional capacity

- Existing contracted capacity - (within state and from outside) 19000 MW (So: GERC tariff orders)
- Capacity additions - 2800 MW - coal and 238 MW – nuclear between 2018 and 2021. No further additions of gas or coal capacity considered.
- Retirement - about 2300 MW of coal and lignite coal capacity considered as per CEA's plans
- Costs - variable cost (fuel cost) of operation as approved by GERC.
- Operational parameters - for thermal power plants (generic) from CEA., CERC and GERC
- Gas availability - based on historical for 2018-19 and 2021-22 and allotted for 2029-30
- Key flexibility assumptions **Base case** 1) ramp up/ ramp down rates considered at 1-1.5%/min for coal power and 4%/min for gas 2) Technical min - 55% for NTPC & new power plants, 75% for GSECL coal power plants. 40% for gas power plant. **Flexible case:** coal ramp of 3%, 40% tech. min. - central plants and 55% - state plants

Data sources and assumptions (2)

Renewable capacity

- VRE locations for 2018-19 based on existing plants. Geospatial site selection for future years (e.g. accounting for land use, resource quality, distance from transmission).
- Generation profiles for based on ERA5 satellite RE analysis weather data (2018-19).
- Capacity for 2021-22 considered as per GUVNL input (15.5 GW wind+solar)
- Capacity for 2030 based on GUVNL input (65 GW wind+solar; Kutchh hybrid park is around 70% solar consistent with overall mix)

Storage

- Pumped storage hydropower based on re-establishment of pump mode at Kadana HPS)
- Battery storage in some scenarios - 2GW

Transmission

- All inter-state and intrastate, 400 kV and above transmission lines mapped and included in the model
- Limited expansion to address main congested corridors in 2030

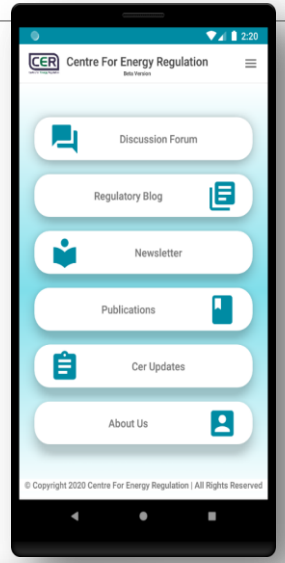
Trade

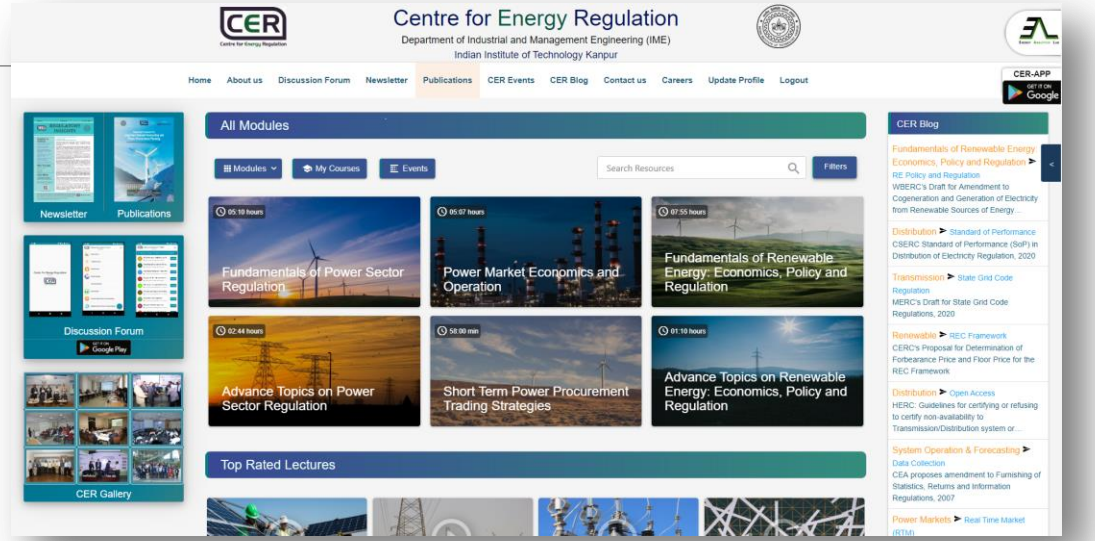
- Import availability from outer-state nodes within transmission constraint.

Centre for Energy Regulation - Outputs and Ongoing Activities – Newsletter, Database, Learning Portal, App

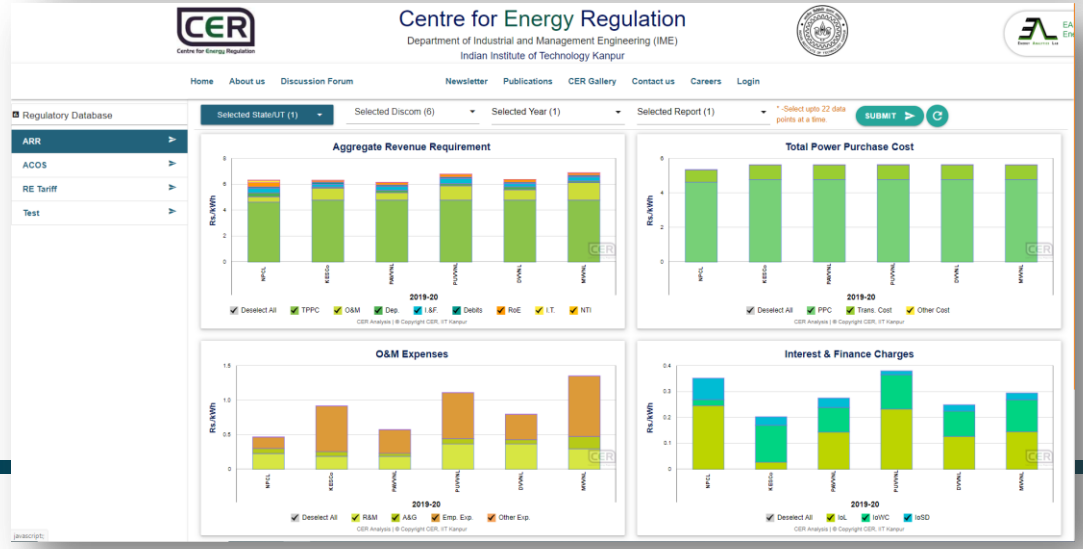




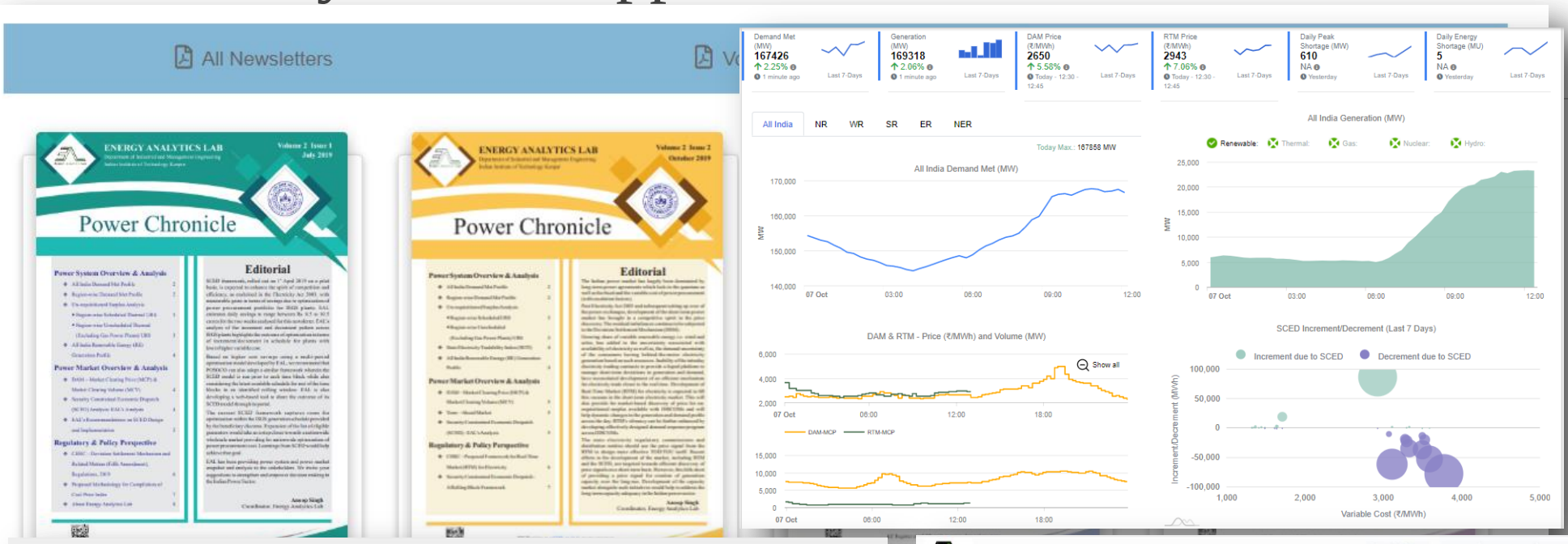


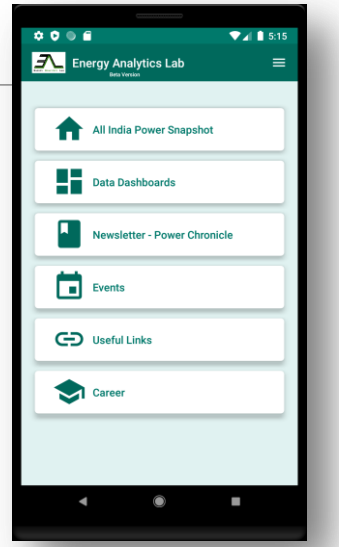


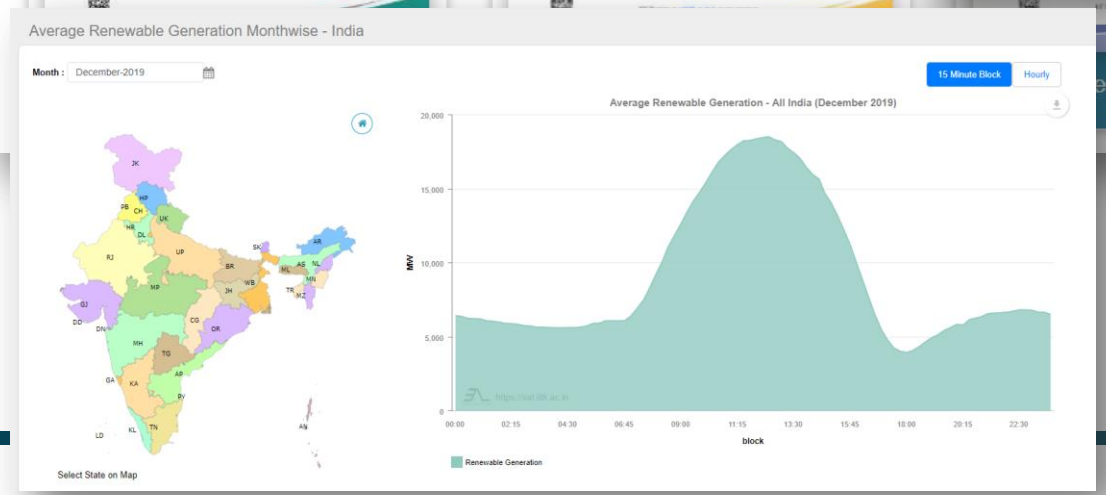


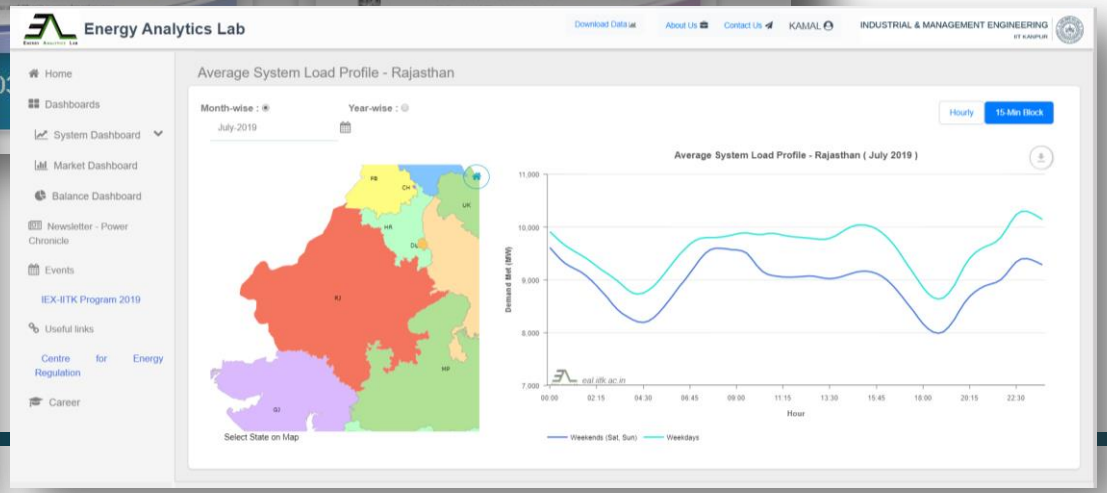


Energy Analytics Lab - Resources: Portal, Newsletter, Analytics and App









THANK YOU

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