MP ENSYSTEMS

Demand flexibility policies, regulations and modelling integrated approach

Dr. Mahesh Patankar, PhD
MP Ensystems Advisory pvt. ltd

14 May 2024

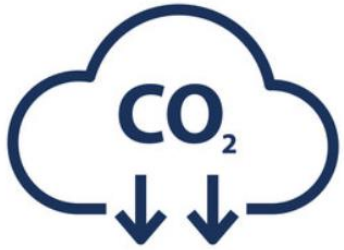
Presentation Structure

- Demand flexibility- concept
- Policy framework
- Project Objectives
- Model Framework
- Internal module (input, output)
- Seasonal variation in HT and LT consumer load
- Model Results
- DF pilot with Tata Power at Bhandup pumping station

National Decarbonization Goals & Energy Transition Journey

Net zero emissions by 2070

Commitment to LiFE



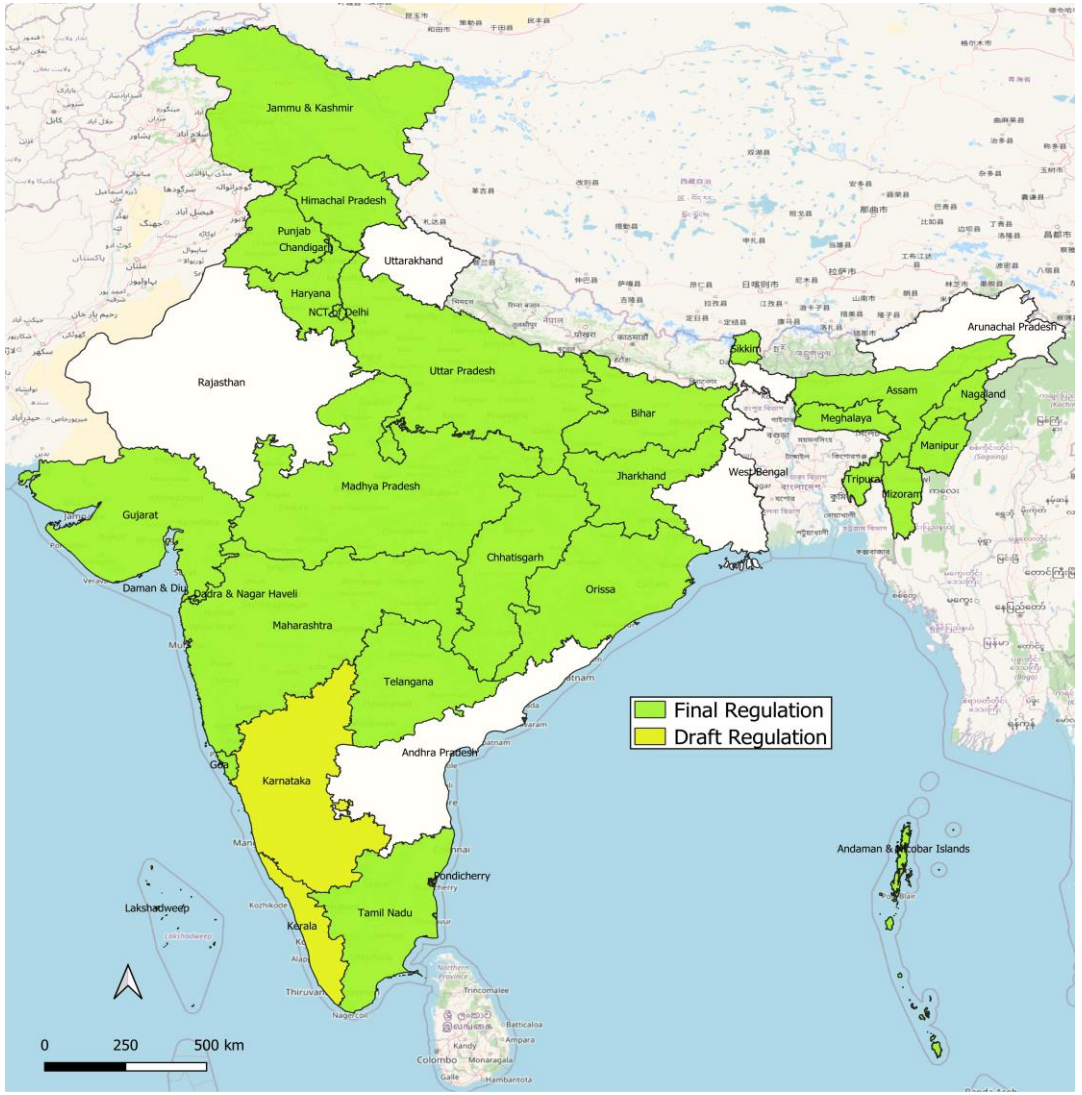
Reduce emission intensity by 45% by 2030 from 2005 level

50% Non Fossil fuel based cumulative power by 2030

- India's push towards 500 GW of renewable energy needs reforms in the wholesale power markets, transmission system upgrades, and demand flexibility
- Demand flexibility is possible even in the current regulatory regime with following starting points:
- Demand-side management regulations notified by several regulators support demand flexibility

DSM regulations in India

24 states (marked in the map below) have notified DSM regulations or draft DSM regulations.



DSM Methodologies

Load and market research	Cost-effectiveness assessment	Evaluation
Program implementation	Measurement, and Verification (EMV)	Monitoring and Reporting (M&R)

Types of DSM projects implemented in India

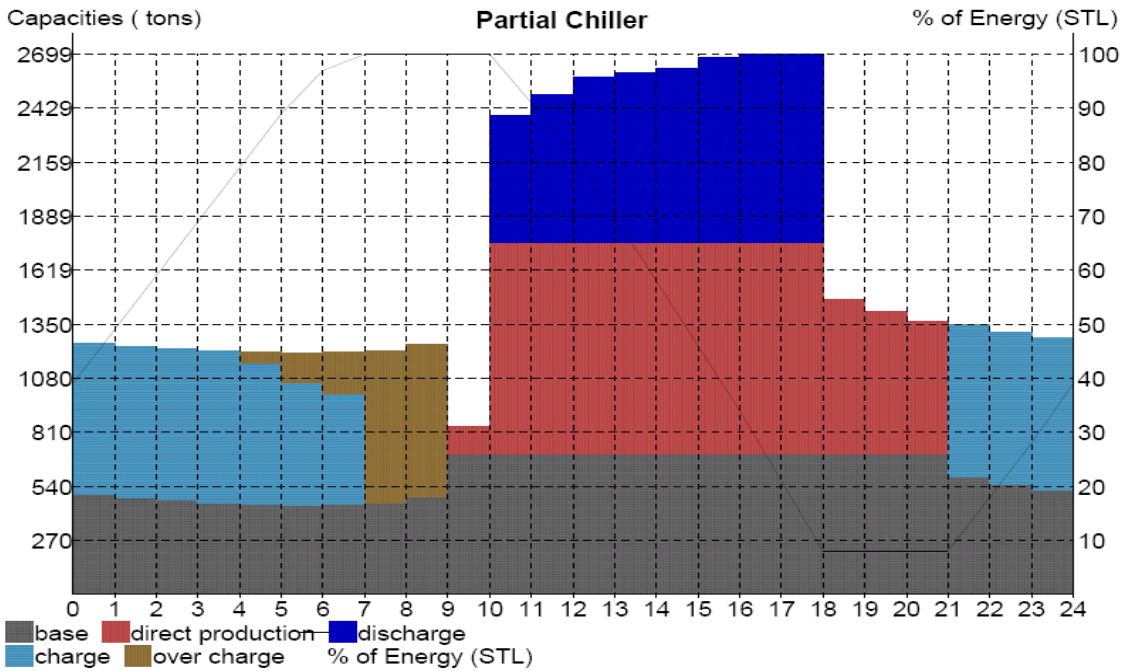
- Energy Efficient Appliance Programs
- Demand Response Programs
- Agricultural DSM Projects
- Municipal and Industrial Projects
- Government-led Initiatives

Utility-implemented or moderated demand-side management is not an unknown

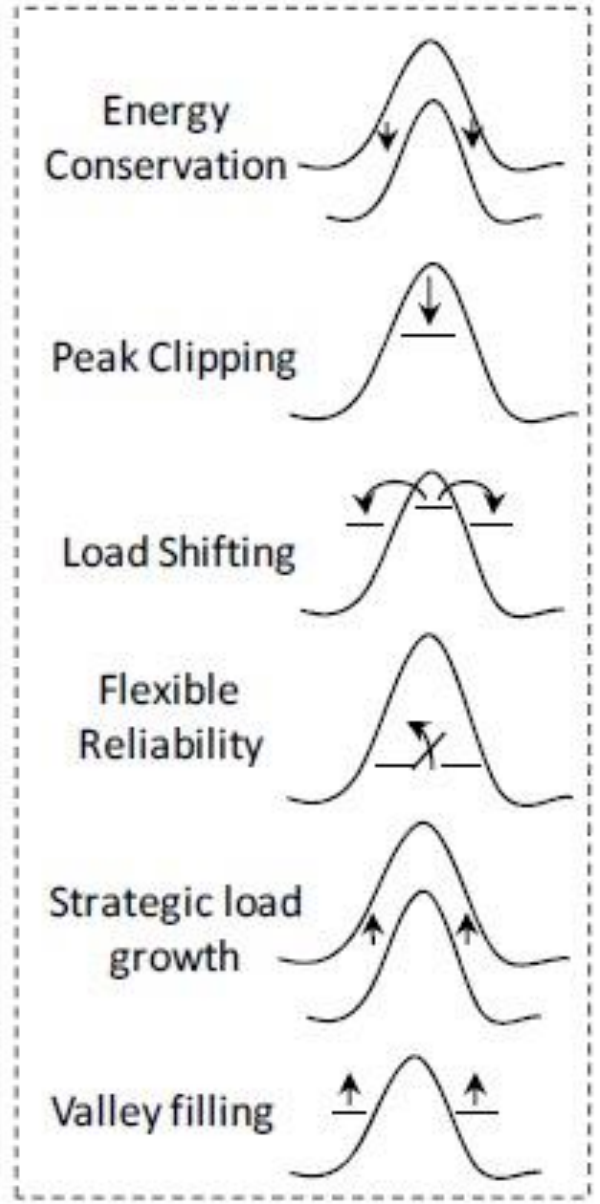
Tata Power, Mumbai – Load Shifting Example:

- Enrolled a Thermal Energy Storage (TES) capacity of over 15,000 TRh
- Resulted in shifting of 3.6 MU from peak to off-peak hours
- Consumers avoid Rs. 1 / kWh penalty on reduced consumption during peak time and receive Rs. 0.75 / kWh incentive for usage during night time

Example of TES load shift - Peak load of 2700 TR and storage of 6796 TRH



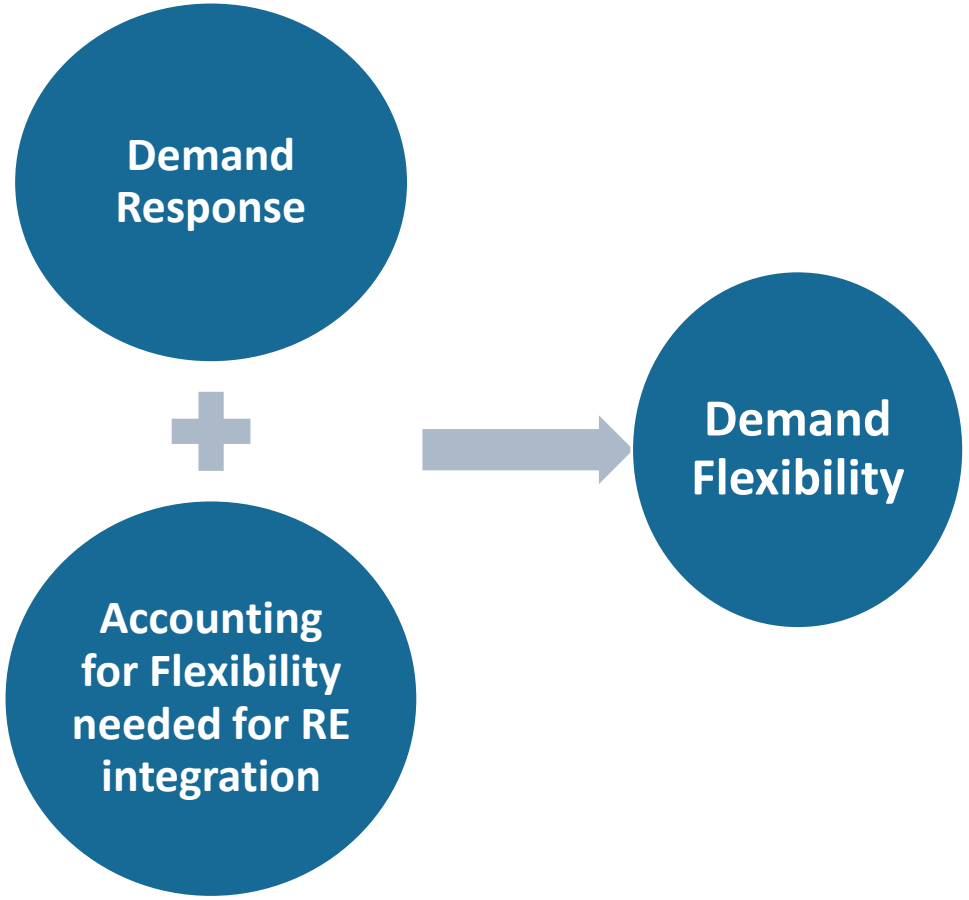
Resulting in about 740 kVA Load shifted from peak hours of 10 AM to 6 PM to off peak hours in the night.



Demand flexibility concept

The proportion of electricity consumption within a power network that can be adjusted, augmented, or rescheduled over a defined period through the implementation of pricing signals or the controlling of energy loads.

Source: https://www.igi-global.com/dictionary/improved-distributed-energy-systems-based-on-the-end-user-consumption-profile/89035



Demand flexibility key objectives

Renewable energy use maximisation

- RE prioritisation
- Minimise RE curtailment

Consumer bill reduction

- Shifting and adjusting loads to achieve improved energy cost

Utility power purchase cost optimisation

- Utilization of low cost RE, embedded RE to reduce overall power cost
- Optimal resource utilization

Modeling energy efficiency and demand flexibility to assess technical potential from select use cases. This will enable future demand forecasting with flexible demand and estimate the value of demand flexibility to the DISCOM.

https://cercind.gov.in/Regulations/Notification-Ancillary-Regulations-150223.pdf, https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/jun/doc2023628218801.pdf

Model framework

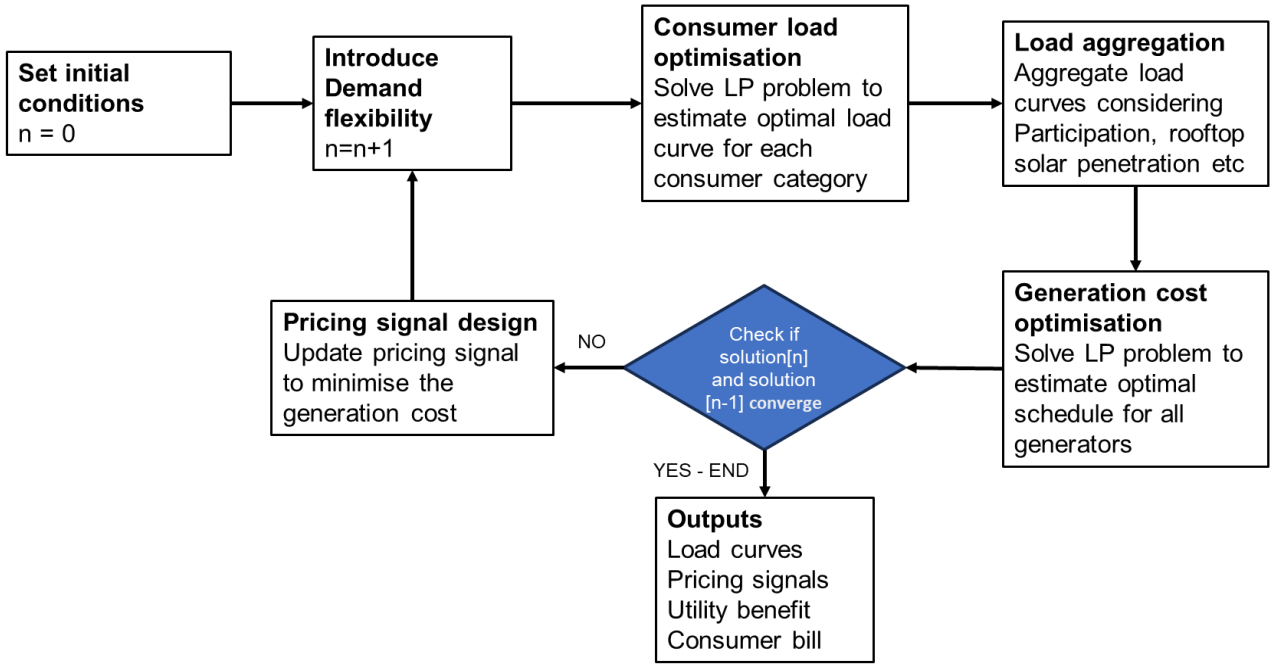
Objectives

- Maximize RE integration
- Optimise generation cost
- Minimise consumer bills

Constraints

- Flexible and adjustable load operation constraints
- Generator ramping constraints
- Technical minimum for conventional generator
- Load balancing and merit order dispatch

Optimisation algorithm

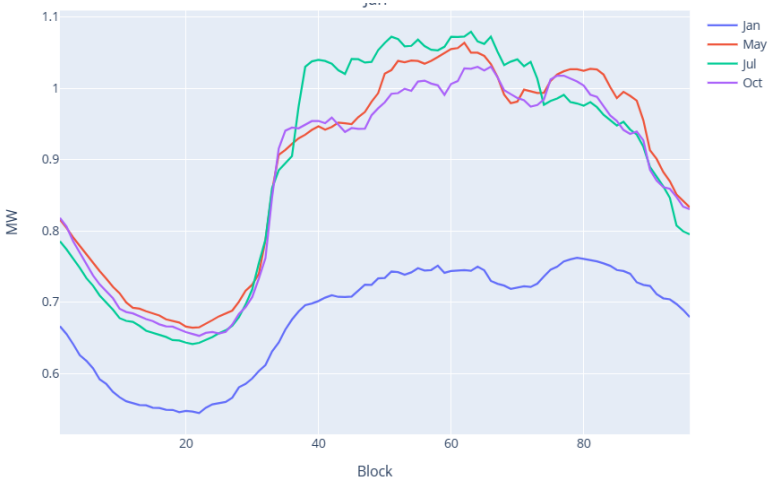


Internal modules and parameters

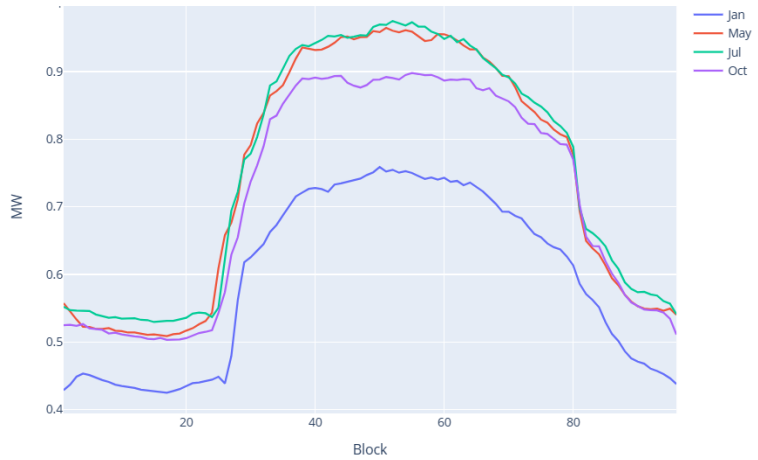
Module	Inputs	Outputs
Generation cost model	▪ MOD stack ▪ RE generation forecast ▪ Generation constraints ▪ **Projected net demand**	▪ Plant wise generation schedule ▪ Slot wise generation cost ▪ **Slot wise per unit generation cost**
Consumer load optimisation	▪ Fixed load pattern ▪ Flexible load assumptions ▪ Adjustable load pattern ▪ Pricing signal	▪ **Optimal load curve** ▪ Total consumer bill
Aggregation of consumer load curves to feeder/substation/utility demand	▪ Number of consumers ▪ % Penetration of solar rooftop ▪ % Participation of consumers for DF ▪ % T&D losses ▪ Consumer wise average solar rooftop capacity ▪ Consumer load curve base case ▪ **Optimal load curve** DF consumers	▪ **Projected net demand** to be scheduled by generator
Tariff design algorithm	▪ Pricing signals for consumer type ▪ **Slot wise per unit generation cost** ▪ Tariff constraints	▪ Updated pricing signal

Seasonal load variation in HT consumers

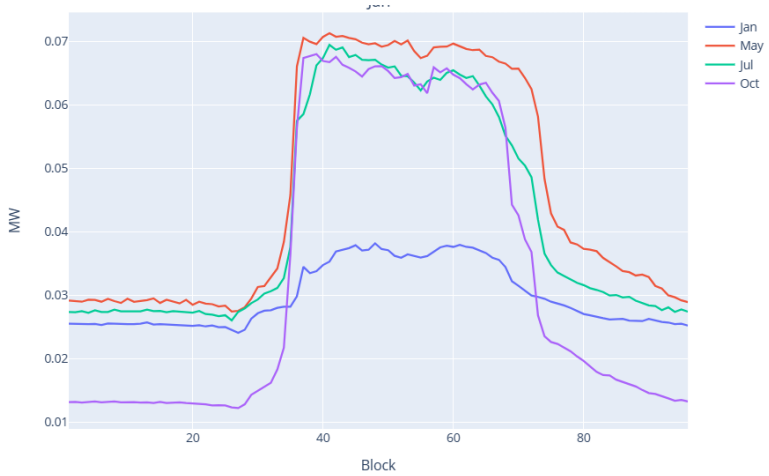
Hotel



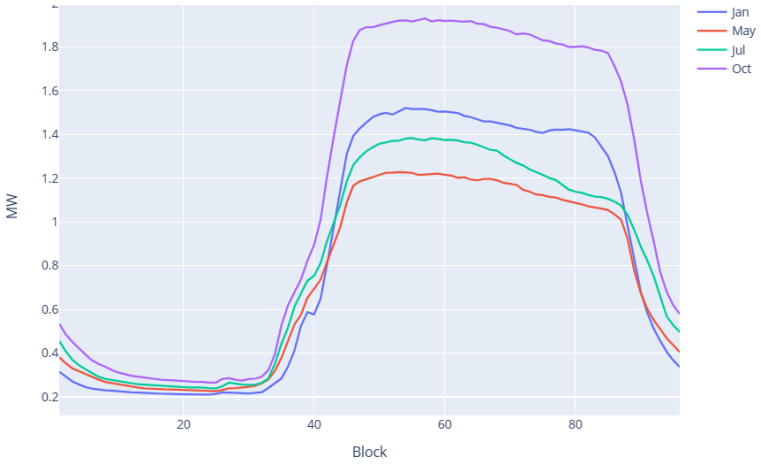
Hospital



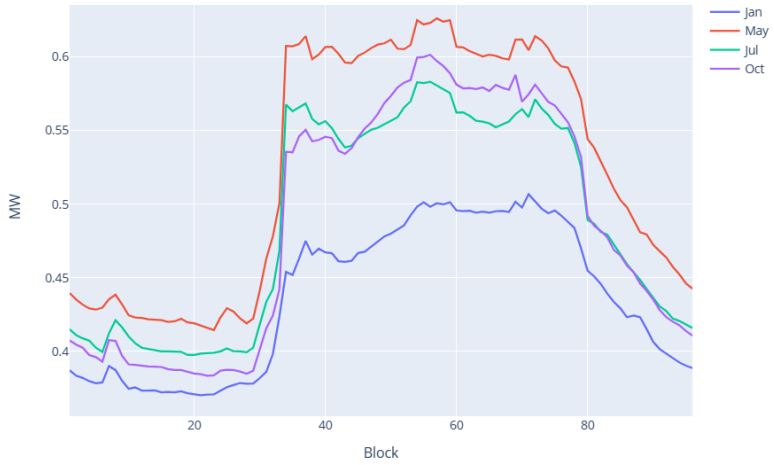
Industry



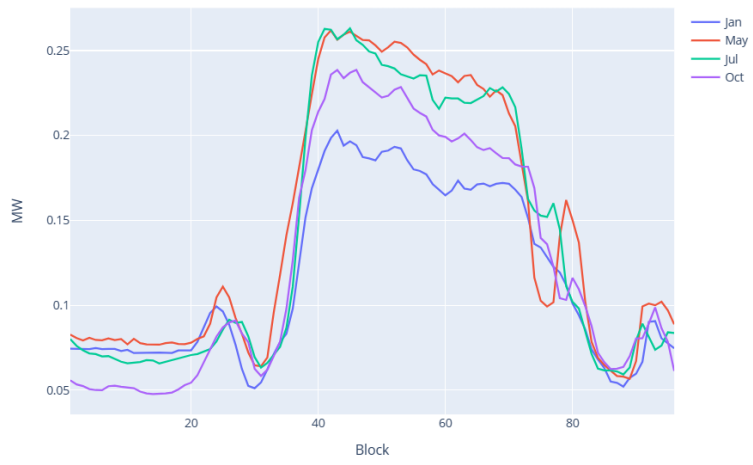
Mall



IT park

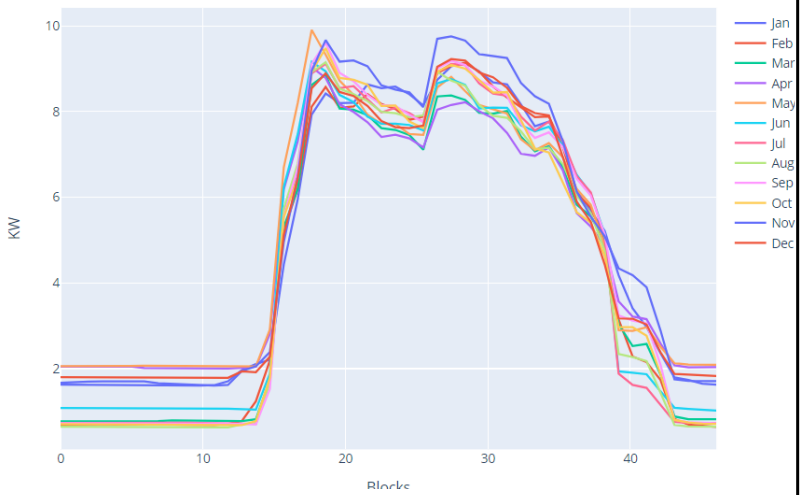


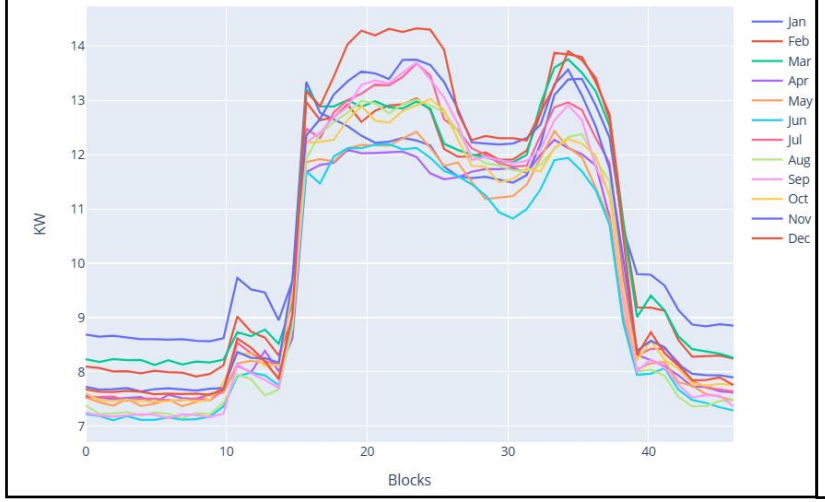
Bank



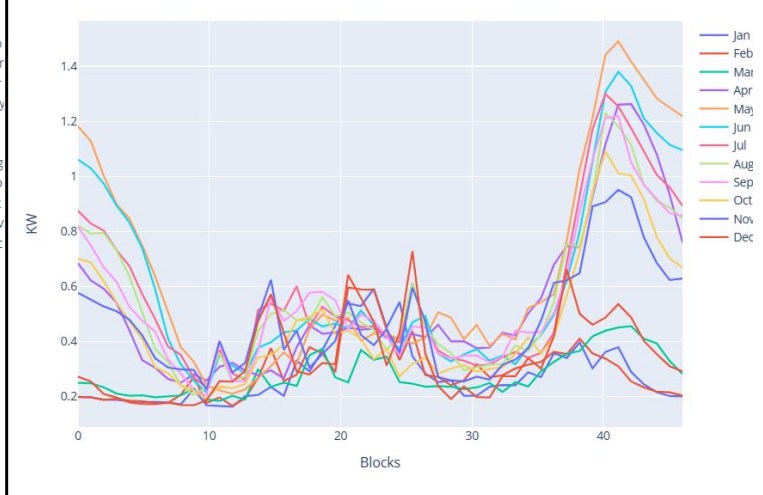
Monthly load variation in LT consumers

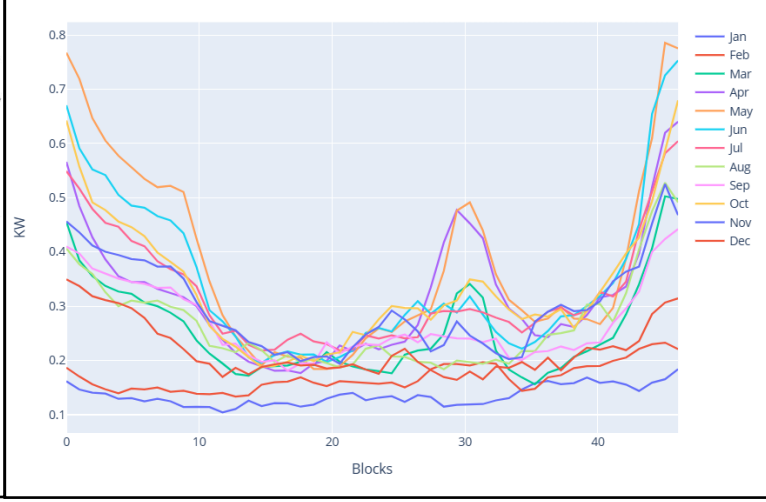
LT commercial



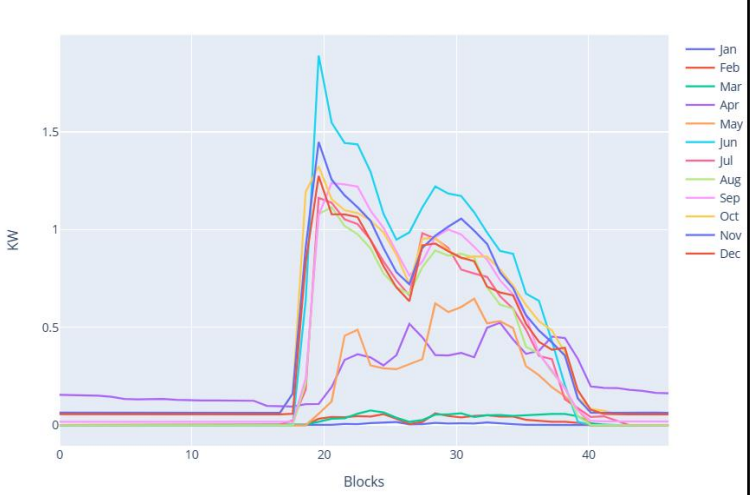


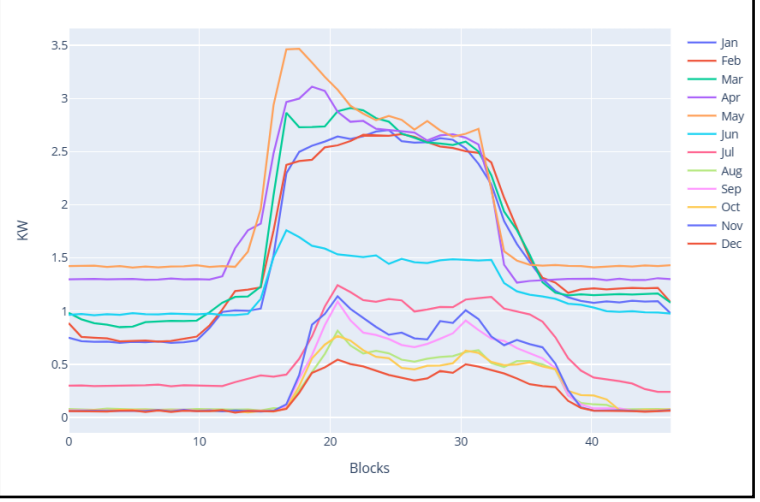
LT residential





LT industrial

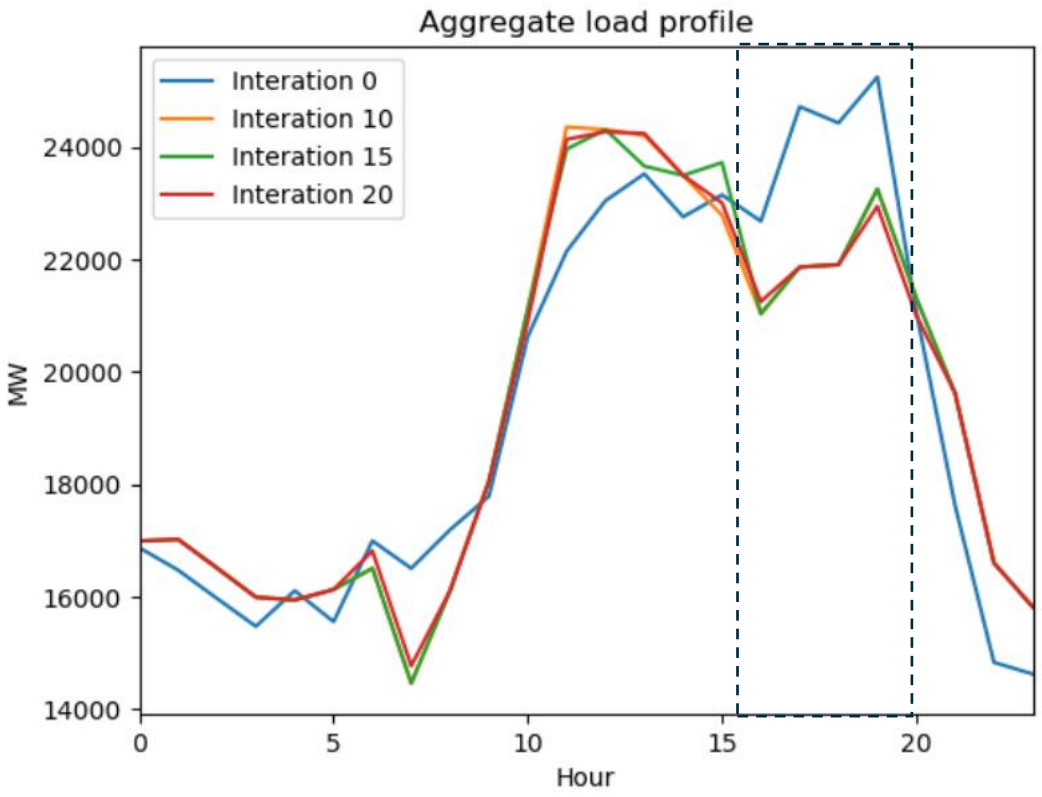




Results: Load shifting and per unit generation cost

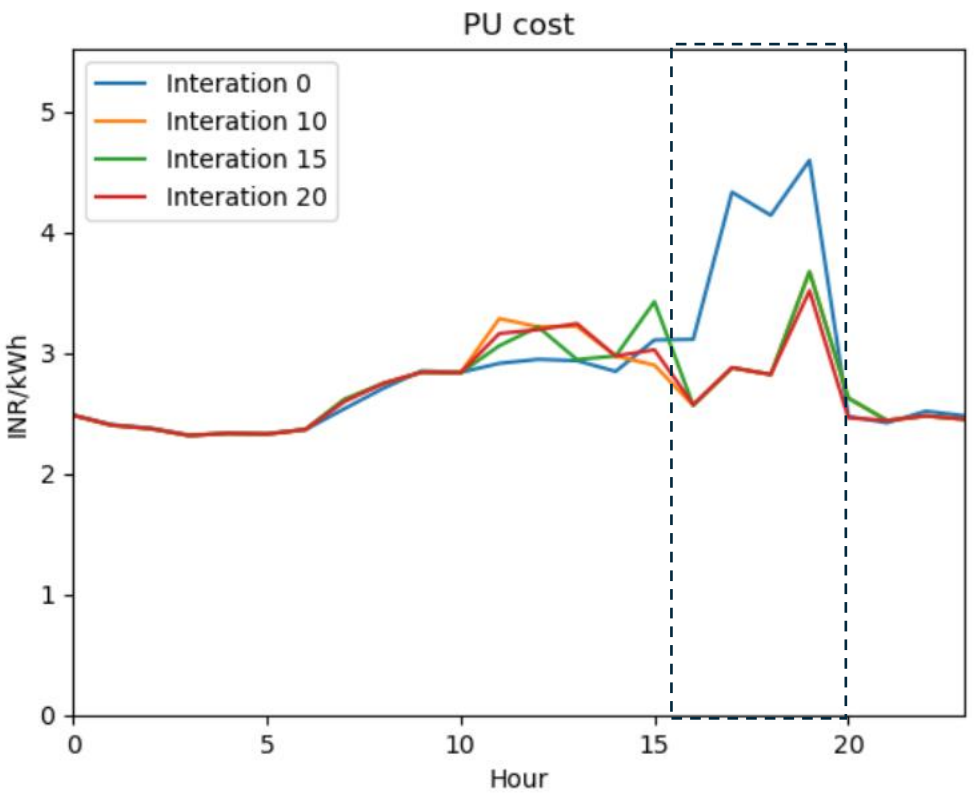
Load Shifting

5% of Energy shift (~ 25 GWh)



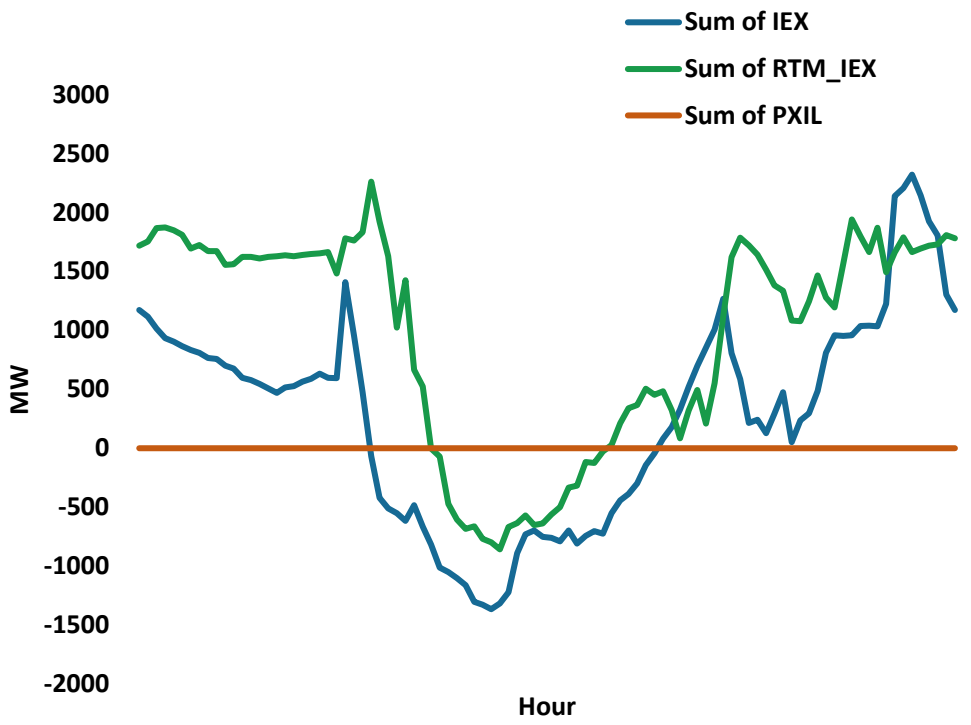
Reduction in peak generation cost

Peak PU cost reduced by 1 INR/kWh



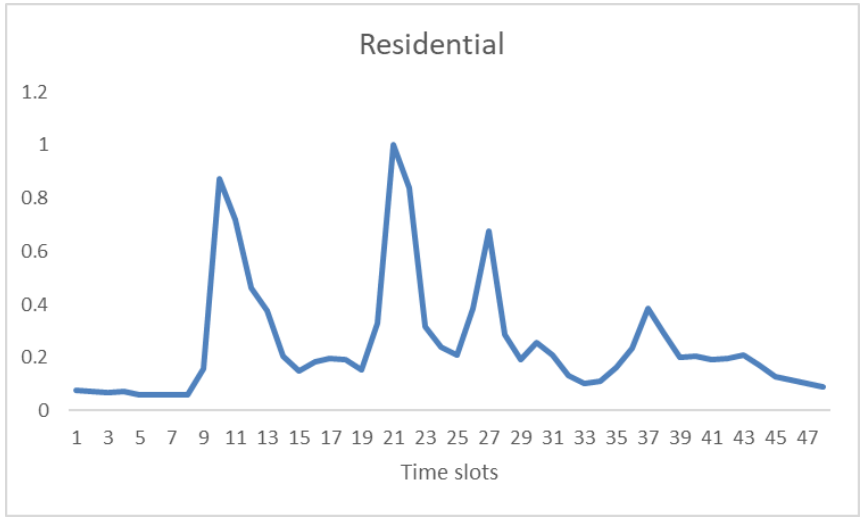
DF pilot at a large pumping station - Background

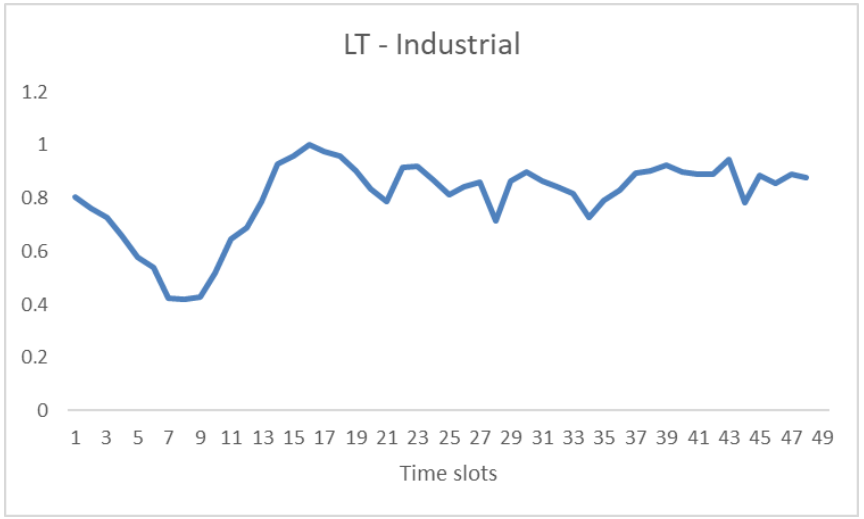
- Solar energy generators creates excess energy in solar generation period
- Water pumping loads in industrial /commercial / group housing / public water works can offer flexible demand potential.
- Excess energy can be absorbed by water pumping loads

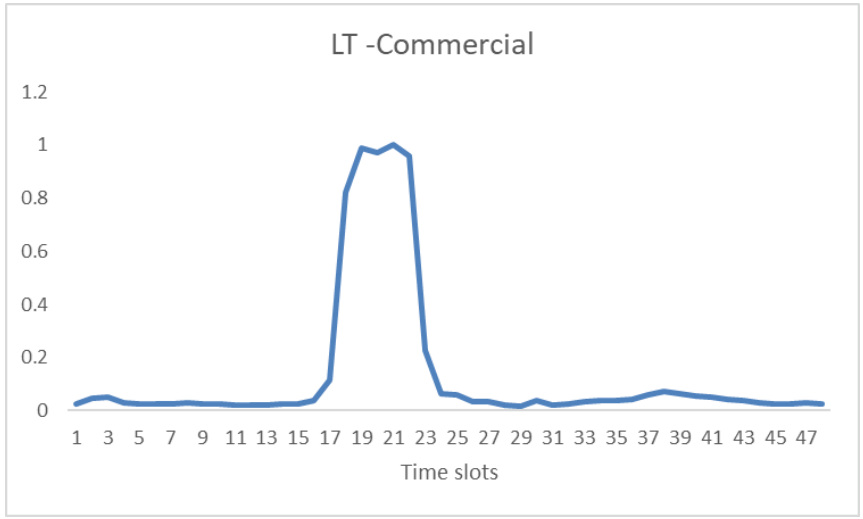


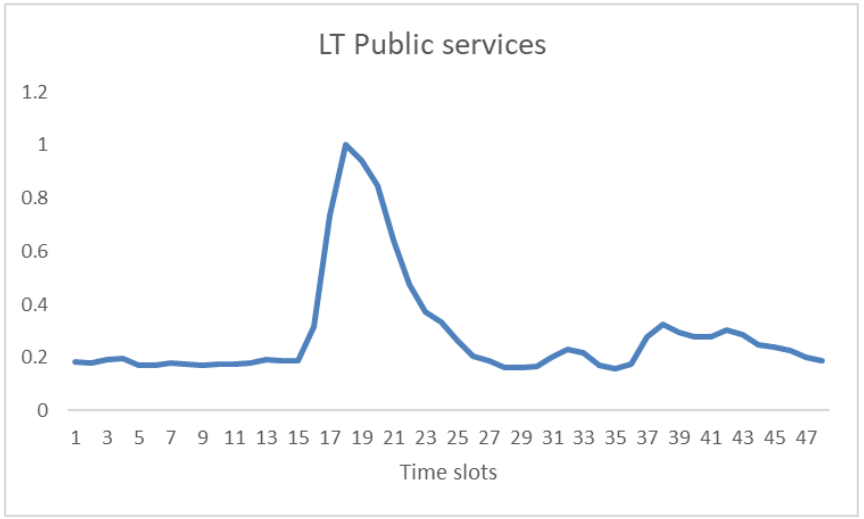
Power purchase from energy market on January 1st 2023, negative power represents sale of power

Water pumping loads of sample consumers (Normalised)

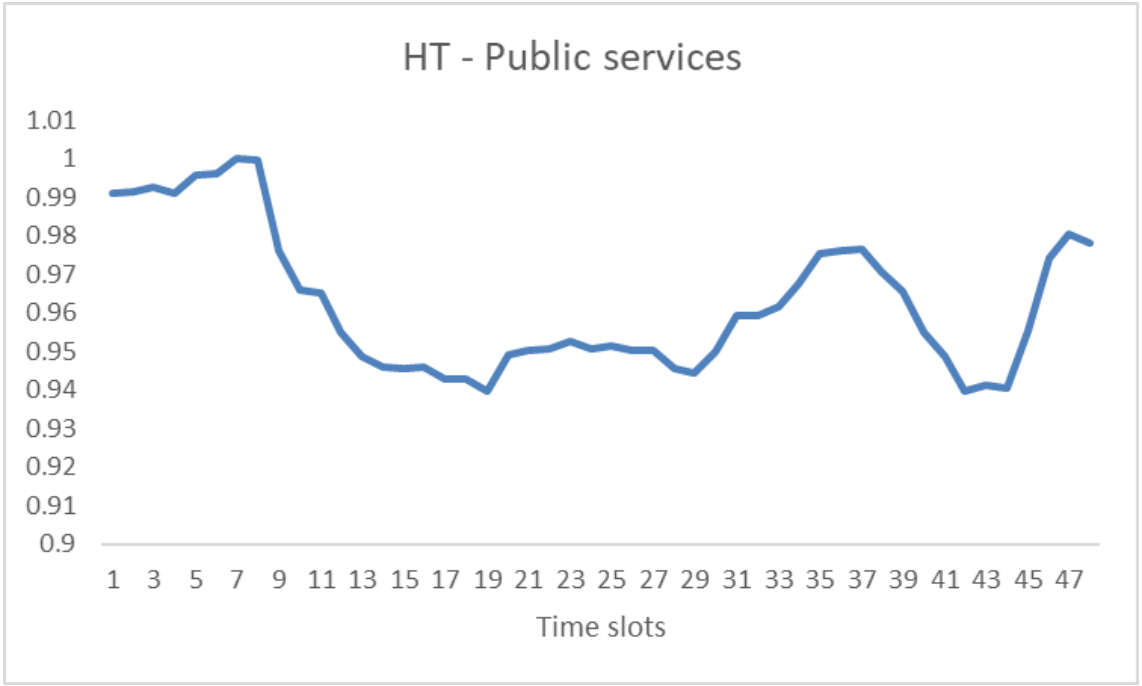




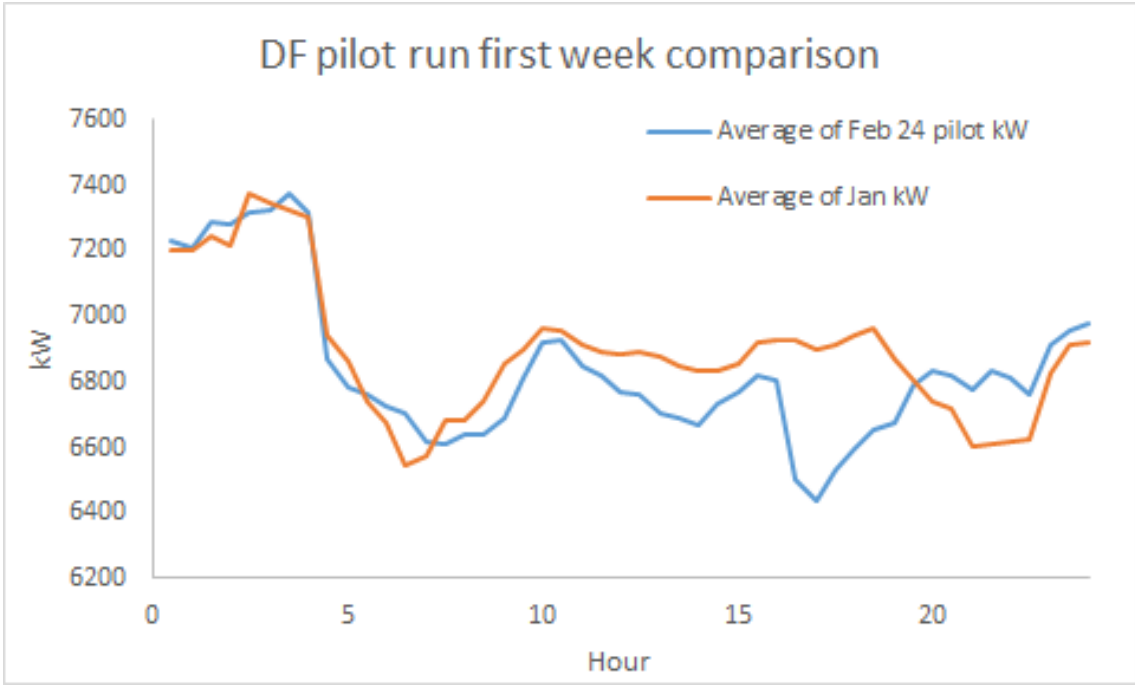




Pilot run on Pumping station first week results



Normalised load shape for HT – Public service water pumping



Pilot run first week load curve comparison with BAU case

Operational details of Pumping station

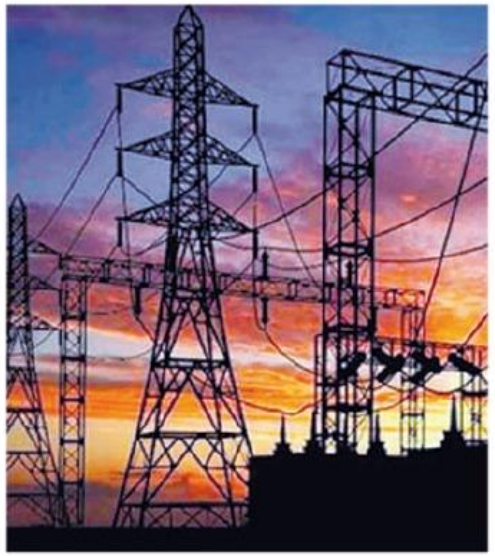
Time slots	Operation	Pumping load	Comments
23:00 to 04:00	Water supply to city	11 large pumps +2 trimer pumps	Maximum load period
04:00 to 09:30	Water storage at pumping station	10 large pumps +1 trimer pumps	Water is stored at facility for treatment
09:30 to 16:00	Water supply to city	11 large pumps +1 trimer pumps	Water level at station needs to be maintained above threshold level
16:00 to 23:00	Water storage at pumping station	10 large pumps +1 trimer pumps	Load is curtailed in this slot by 246 kW by shutting down 1 pump

DF pilot with Tata Power at Bhandup pumping station outcomes

BMC ties up with Tata to shift to green energy for water pumping

The collaborative initiative aims to reduce carbon footprint and cut power consumption bills

DHARMENDRA JORE
dharmendra.jore@mid-day.com



TATA Power will help the Brihanmumbai Municipal Corporation (BMC) to avail maximum green electricity to run its water pumping stations and save on its power consumption bills. BMC's water pumping stations together will shift a demand of over 50 megawatts daily, a quantity of supply that is sufficient to cater to the population of a rural district.

The company has identified 50 water pumping stations with high-demand flexibility characteristics. These stations have been using electricity mostly generated by conventional sources, not renewables such as solar. A 23-day trial project at the Bhandup pumping station achieved a remarkable shift of 345 KW for three hours daily. It accumulated 23,000 units of electricity and resulted in a carbon offset of 21 tonnes. The success encouraged the collaboration further.

Tata Power has hired MP Ensystems Advisory Pvt Ltd as a study partner for the project. This collaborative initiative will not only allow BMC to access clean renewable power to deliver water to Mumbaikars, but also help the civic corporation to save on its power consumption bills using the time of day tariff (ToD), it said in a statement on Thursday. In ToD mechanism variations in pricing are available throughout the day and the consumers don't pay a fixed price regardless of the time of consumption.

TPC and BMC will scale up the program to cover most of the water pumping stations. The initiative is expected to shift a monthly demand of 50 MW and accumulate 1.8 million units and a carbon offset of 1620 tonnes annually. Tata Power said the success of the flexible demand program has underscored the company's commitment to delivering solutions for sustainable development with the use of the latest technologies and capability building over a long period.

23 No. of days trial project was run at Bhandup

BMC's water pumping stations together consume over 50 megawatts daily.
REPRESENTATION PIC

The company has identified 50 water pumping stations with high-demand flexibility characteristics

Thank You

MP Ensystems Advisory Pvt. Ltd.

www.mpensystems.com

www.evci.in