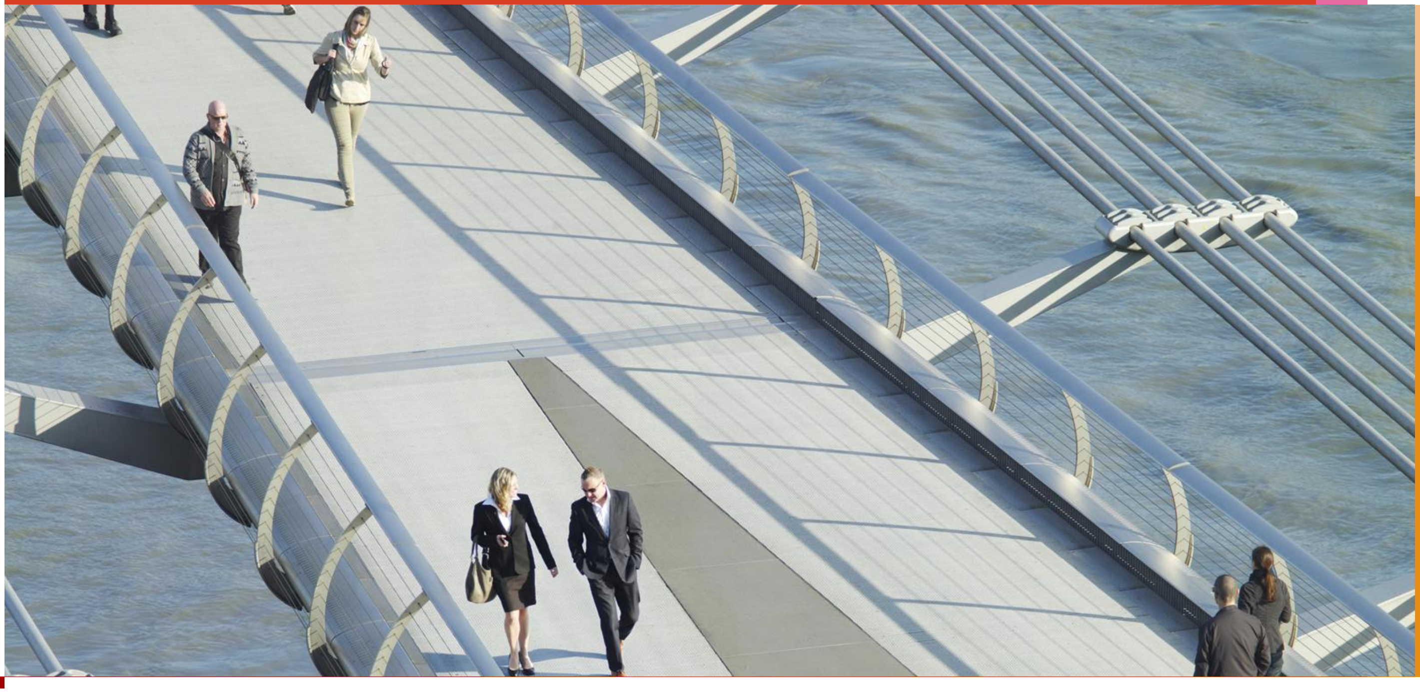
GRID – Power & Utilities

Coordinated power procurement & demand forecasting



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25 May 2016

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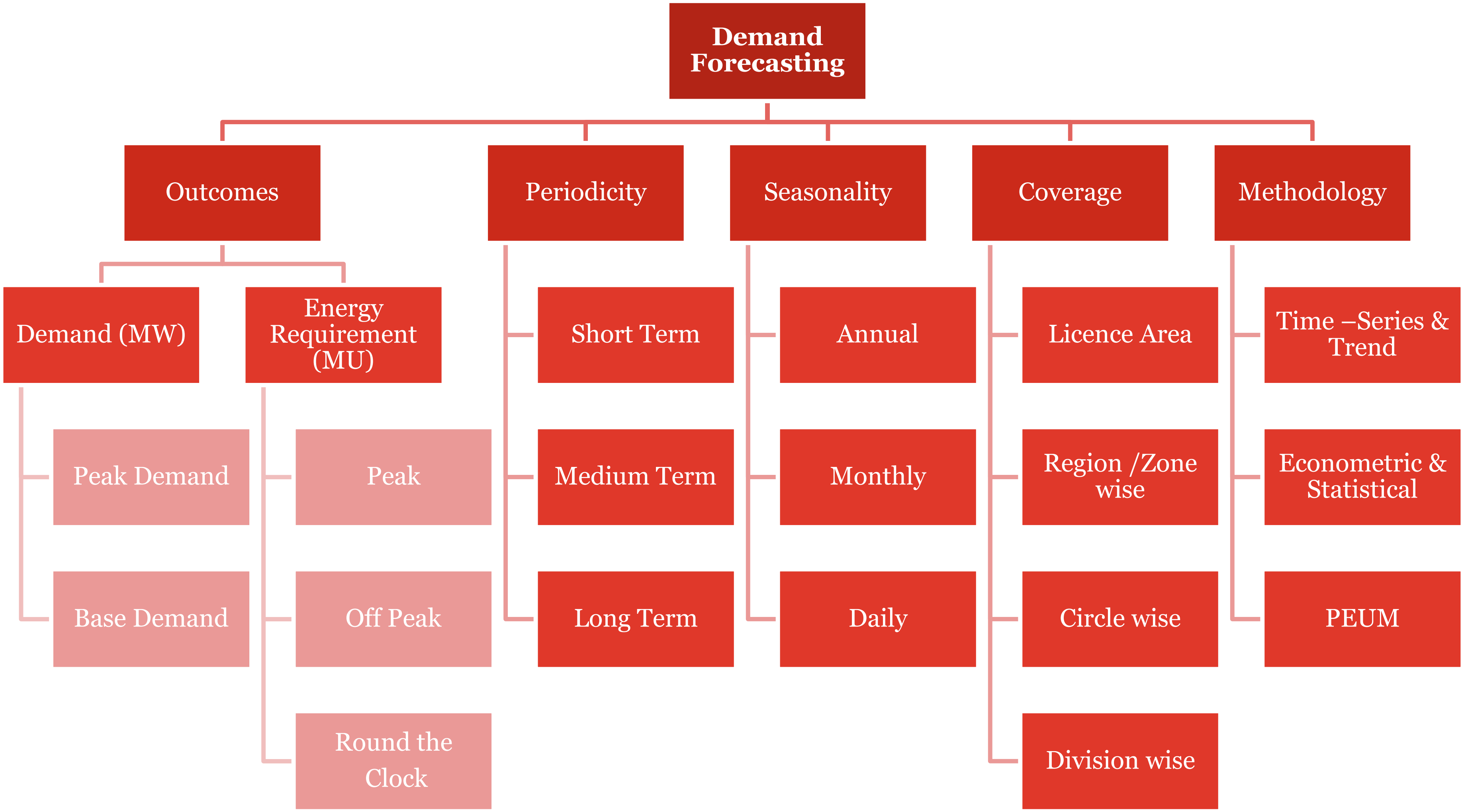


Electricity Demand Forecasting in India
Periodicity – Short, Medium and Long Term

	Short Term	Medium Term	Long Term
Period	• Day ahead • Weekly/ Monthly • Up to 3months	• Period from 3 months up to 3 years	• Period beyond 3 years • Long term forecast commonly carried out for 5 year and 10 year period
Output	• Day ahead time block wise Energy Requirement (MU) • Daily Peak Demand (MW), and Base Demand (MW)	• Monthly Energy Requirement (MU) • Monthly Peak Demand (MW), and Base Demand (MW)	• Yearly Energy Requirement (MU) & Demand (MW)

Applications

Demand Management

Distribution Network Planning

Generation Capacity Addition Plan

RE capacity addition

Transmission Perspective Plan

DSM &EE Planning

High Accuracy:
- Reliability of supply
- Lower power procurement cost
- Efficient Capex
- Competitive pricing
- Profitability

Importance of accuracy in Demand Forecasting

Low Accuracy:
- Load Shedding
- Stranded Assets
- High Tariff
- Loss of consumers
- Financial Losses

Electricity Demand Forecasting in India
Widely used forecasting methods

Time Series

- The explanatory variables used are lagged values of the variable to be predicted.
- The future behavior of variable is related to its past values, both actual and predicted, with some adaptation/adjustment built-in to take care of how past realizations deviated from those expected.
- E.g. CAGR, Exponential smoothing etc.

Econometric

- Econometric methods use the causal relationships between independent variables and the variable to be predicted.
- Model uses statistical techniques to establish relationships between dependent and independent variables.
- Types: Univariate/ Multivariate
- E.g. Regression

Partial End Use

- End use methods incorporate the anticipated trends of demand from each class of end users by undertaking load surveys.
- Partial end use is a combination of Time series coupled with End Use method to arrive at an optimum estimation of the forecast variable.
- Inputs used may include land use patterns, industrial policy, release of agriculture connections (nos.) etc.

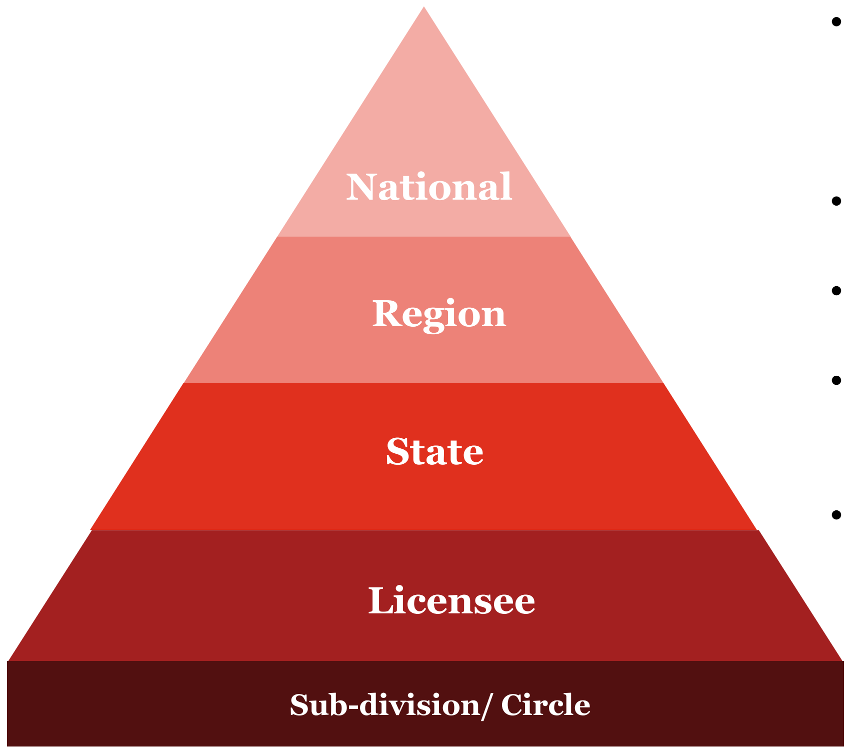
Approach to demand-supply forecasting

Approach to Demand Forecasting

Bottom up vs. Top Down

Bottom-up Approach:

- Forecast of individual units are summed up to arrive at aggregate forecasts
- Higher granularity of forecasts
- Higher complexity of models
- Lower requirement of data on independent variables
- Suitable when characteristics of individual units (eg. Sales pattern) differ across units



Top-down Approach:

- Forecasted totals are disaggregated based on historical proportions & other assumptions
- Lower granularity of forecasts
- Lower complexity of models
- Higher requirement of data on independent variables
- Suitable when characteristics of individual units (eg. Sales pattern) are largely similar across individual units

Approach to forecasting may be based on a number of factors:

- Availability and reliability of data
- Purpose or Application of forecast
- Underlying characteristics of variable across individual units and time periods

Demand – Supply forecasting

New influencers

Factors influencing Demand – Supply forecasting

24x7 Power Supply, DDUGVY & Rural electrification

	24 x 7 Power Supply	DDUGJY & Rural Electrification
Features	• Reliable 24x7 power supply to consumers by 2018-19 • Power supply for irrigation for 8-10 hours • Access to all unconnected households by 2018–19	• Separation of agriculture and non-agriculture feeders • Strengthening and augmentation of sub-T&D infrastructure • Rural electrification as per RGGVY targets
Impact on Forecasting	• Category wise consumption might change • Projection of category wise consumption will be required at the sub-division/ division level to capture the revised consumption pattern • The time series methodologies (historical trends) might not be useful for the projections; **specific trend may be required to be captured by sample studies** • **Bottom up approach** might be more relevant	• Consumption in rural areas might change • System strengthening/ augmentation of distribution S/s might play a role in change of consumption pattern. Loss trajectories might also revise and have an impact on the demand forecasting • Traditional methods such as on CAGR may not be adequate; **Specific trend of 'per household consumption' may be required by sample studies** • **Bottom up approach** might be more relevant

Factors influencing Demand – Supply forecasting

Energy efficiency and Self generation

	Energy Efficiency	Self Generation
Features	• Replacement of ICL with LED bulbs • Green buildings • Promotion of energy efficient equipment/ Replacement of pumps with energy efficient ones	• Policy support and regulatory obligations for self generation and micro generation • Increasing tariffs leading to shift towards self generation to reduce cost
Impact on Forecasting	• Adoption of energy efficiency measures might reduce energy requirement and peak demand • Category wise impact of energy efficiency might required to be incorporated in the future demand forecasting • **Periodic revision/** correction in forecast with latest data may be required to avoid over estimate • Impact of energy efficiency may vary across regions; so **bottom up approach** may be required	• Consumption pattern of consumers adopting self-generation (e.g roof top solar) may be more variable and intermittent • **Time-block wise** forecasting may be required due to nature of RE and to identify buckets of demand • Licensees may have to forecast **'net demand'** at feeder/DT level • Forecasting techniques may need to incorporate impact of banked power across time blocks

Factors influencing Demand – Supply forecasting
Competition and Megatrends

	Competition	Megatrends
Features	• Open access (OA) • Parallel licensees • Deemed licensees- Railways/ SEZs • Local energy systems- DDG	• Demographic and social change • Economic growth and policy initiatives • Rapid urbanization
Impact on Forecasting	• Consumers migrating to OA will be impacting demand of a licensee on daily/ seasonal basis. This needs to be incorporated in the demand forecasting for the licensee • The demand for deemed license/ distributed generation/ open access consumer's need to be captured separately. **There must be an entity (other than discoms) responsible for consolidating these demand forecasting for network planning** • **Bottom up** approach may be required	• Demand per household anticipated to rise at different rates for urban and rural consumers • **Demand-forecast models solely dependent on historical trends (CAGRs etc.) may lead to unreliable** forecasts of demand in the ensuing period. • **Bottom up approach** could lead to higher accuracy • **Multiple methods with end use/ econometric methods should** be used for more accurate forecasting

Factors influencing Demand – Supply forecasting
RE capacity addition and technological breakthrough

	RE capacity addition	Technological breakthrough
Features	• Renewables target to achieve 175GW (100 GW-Solar, Wind 60 GW, Others 15 GW) by the year 2022. • The mix of RE is expected to increase from 5% to 32% by the year 2022	• Metering - Advanced metering infrastructure on consumers, DTs, feeders etc. in the network • Smart Grid–SCADA systems etc. • Generation –Energy Storage Technologies, Efficiency of solar panels etc.
Impact on Forecasting	• The seasonal/ daily variation in generation from RE source might have impact on the grid stability and consumption pattern of the consumers embedded with flexible loads such as Electric Vehicles/ Battery Storage based load centres. This will have an impact on the **traditional demand forecasting framework** • **Time-block wise forecasting** may be required due to nature of RE and to identify buckets of demand to be met by RE sources	• Energy Storage solutions may change demand profile from consumers having own-generation; • Targeted DSM measures such as consumer specific dynamic pricing models might impact the demand-supply, • **Specific trend may be required to be captured by sample studies** • The technological breakthrough will support in accurate demand forecasting through recording **real time time-block wise data** at consumer level

Factors influencing Demand – Supply forecasting
Policy intervention

	Policy intervention
Features	• Time differentiated peak & off-peak pricing of generation to be introduced within a period of 2 years; • Segregated power procurement portfolio is encouraged for peak hours and off peak hours; • Peak and off-peak tariff to be charged to the consumers
Impact on Forecasting	• The policy interventions such as peak & off peak pricing of generation/ consumer tariff might have a significant impact on the consumption pattern of the consumers. • **Time-block wise forecasting to capture peak and off peak demand** may be required to provide more accurate demand forecasting

Approach to Demand Forecasting
Way Forward

Leverage of new data sources

- Availability of time-block wise Consumption at lowest level such as DT/ feeder level ;
- Data to be incorporated in real-time for accurate day-ahead forecasts
- Procedures need to be evolved for structured collection, analysis & incorporation of data to utilising in demand projections;

Change in approach to Forecasting

Periodicity

- Shift from one-time exercise to structured periodic forecasting-time block wise

Demand Side:

- Bottom-up Approach to be adopted for demand forecast

Supply side:

- Day ahead supply forecast to incorporate time block wise data from RE Sources

Develop Institutional structure

People

- Expertise – Economists, Statisticians and Data Analysts
- Industry Experts

Technology- IT Application

- Software such as SPSS, R, SAS etc.

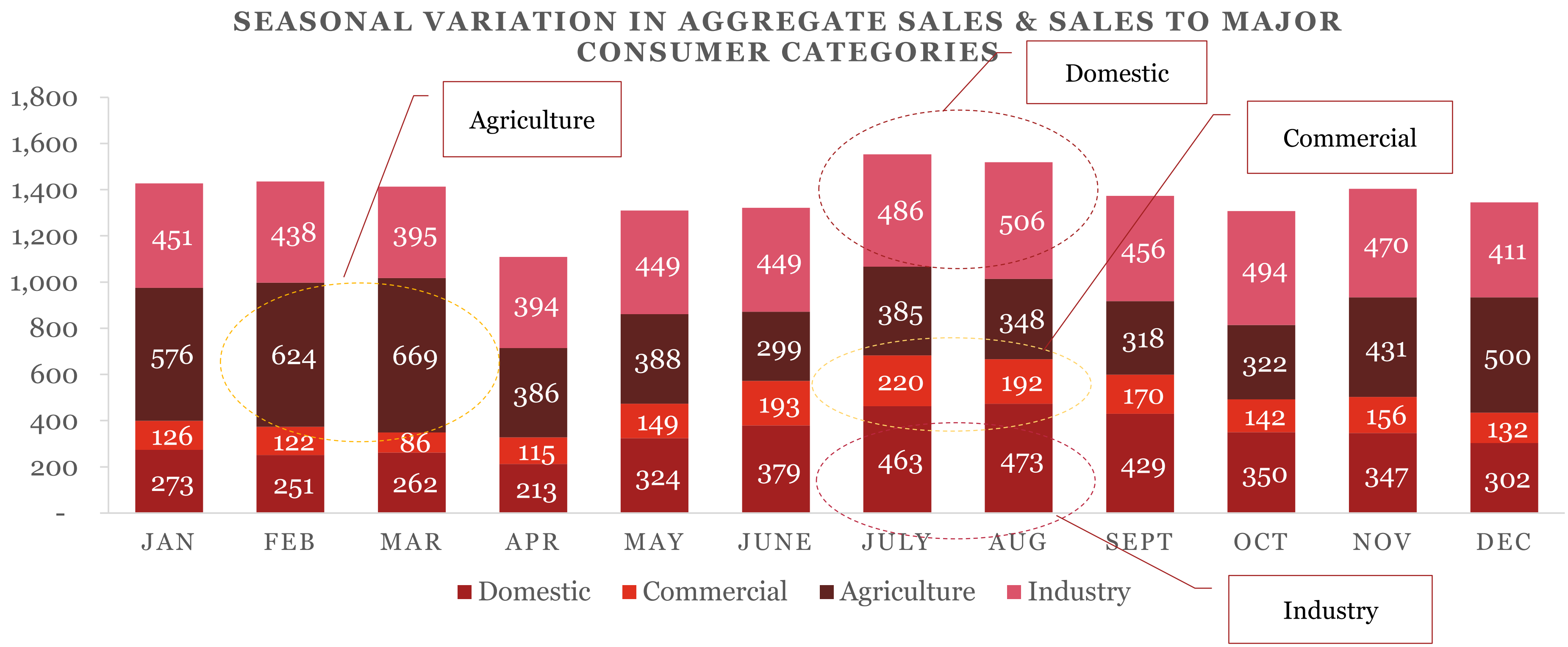
Structure

- Discom – Power Procurement cell, State – SLDC, Regional – RLDC/CEA, National - CEA

It has become essential to undertake forecasting by employing econometric & statistical modelling techniques in a bottom-up approach

Building blocks of power procurement

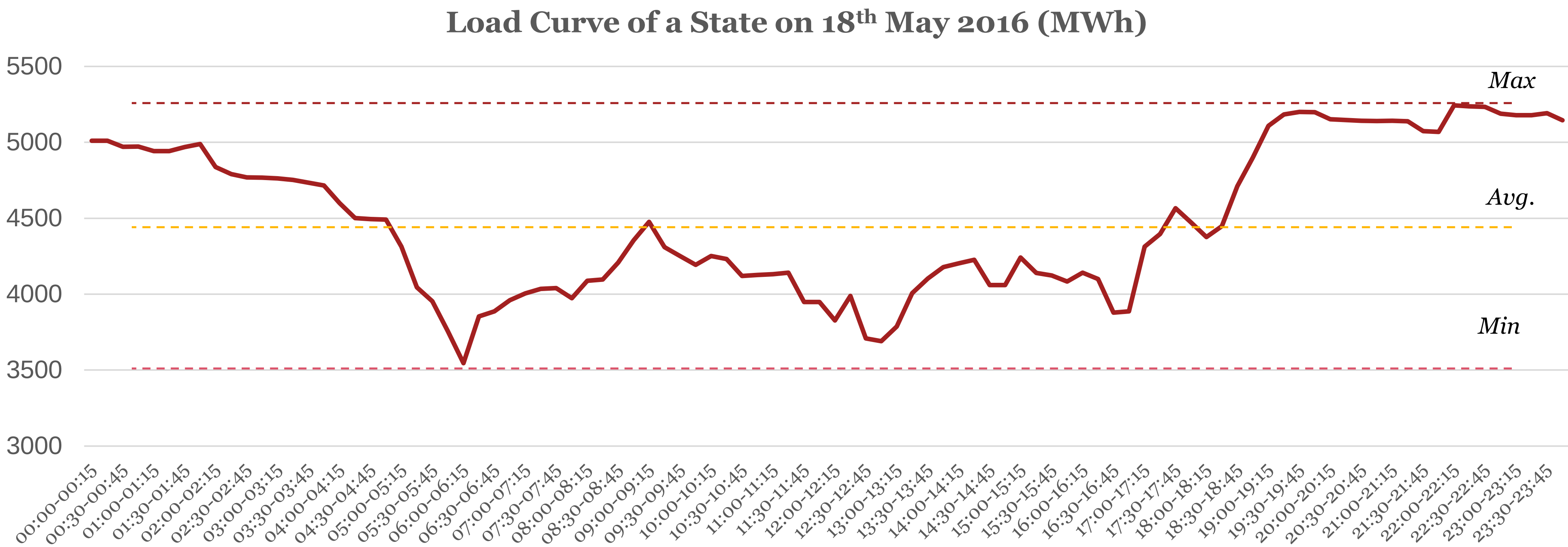
Building blocks of power procurement
Seasonality of aggregate & category wise consumption



- ***Demand from each consumer category varies from season to season while aggregate demand also has seasonal variation.***
- ***Need for season specific power procurement portfolio to cater to dynamics of sales mix and seasonal variations***

Data: Monthly Sales FY 2014-15 of a power utility in North India

Building blocks of power procurement
Variability in daily energy requirement



Scenario –I: Licensee has tied up RTC power to meet Avg. Demand.
- Licensee shall face deficit during peak hours – power cut or procurement of short term power (if available)

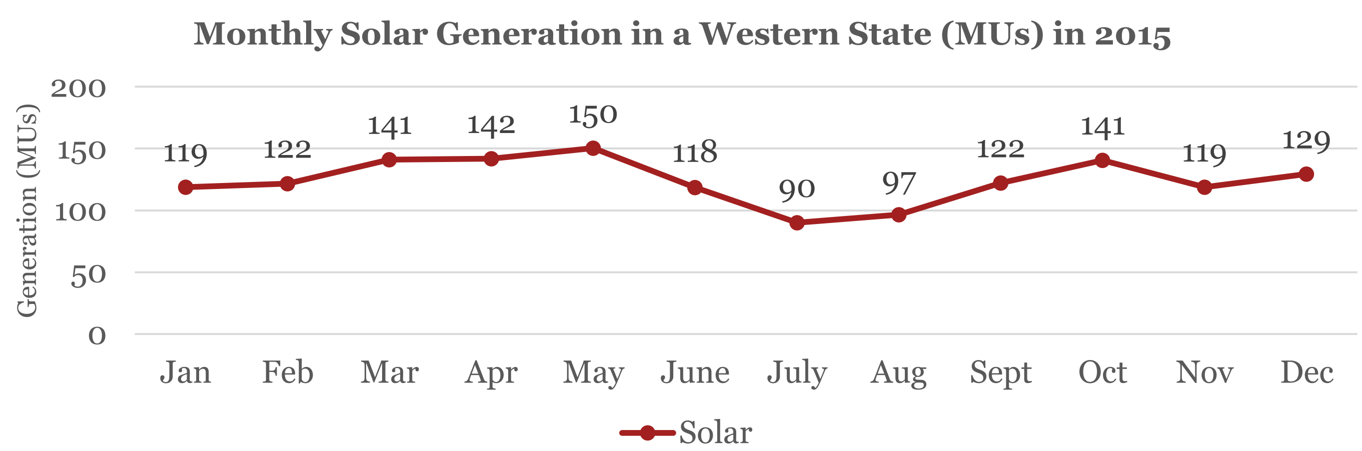
Scenario –II: Licensee has tied up RTC power to meet Max. Demand.
- Licensee shall face surplus during off peak hours- short term market sale (if possible) or stations may be backed down

Scenario-III (Optimal): Licensee segregates peak and off peak requirement and develops independent portfolios to meet peak and off peak requirement.

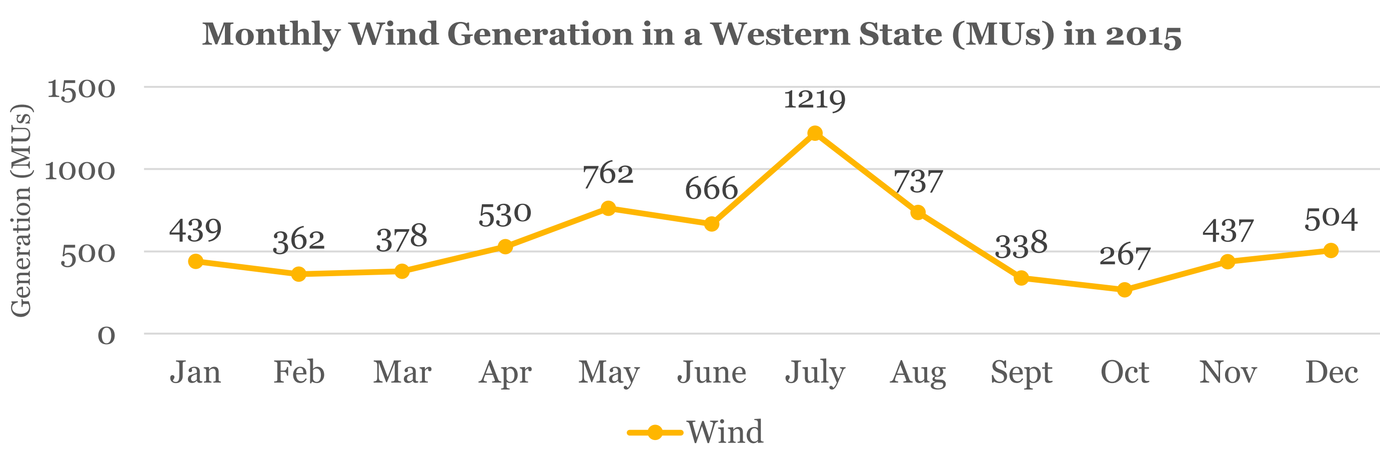
Data Source: NRLDC

Building blocks of power procurement

Seasonality & variability of supply from wind and solar



- *Monthly generation from Solar has varied from 90 MUs to 150 MUs in 2015*
- *Up to **67%** variation in solar generation b/w months*

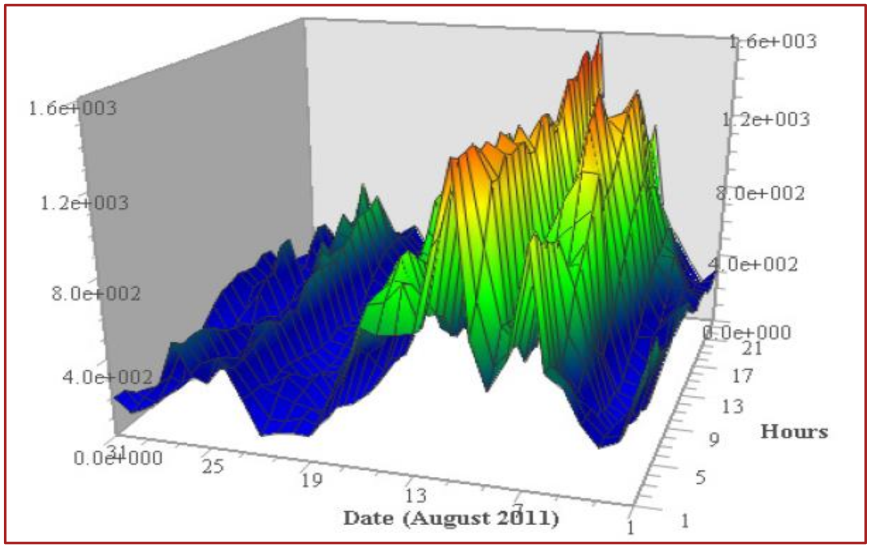


- *Monthly generation from Wind has varied from 267 MUs to 1219 MUs in 2015*
- *Up to **357%** variation in wind generation b/w months*

Data source: SLDC Data

Building blocks of power procurement
Variability in Solar generation

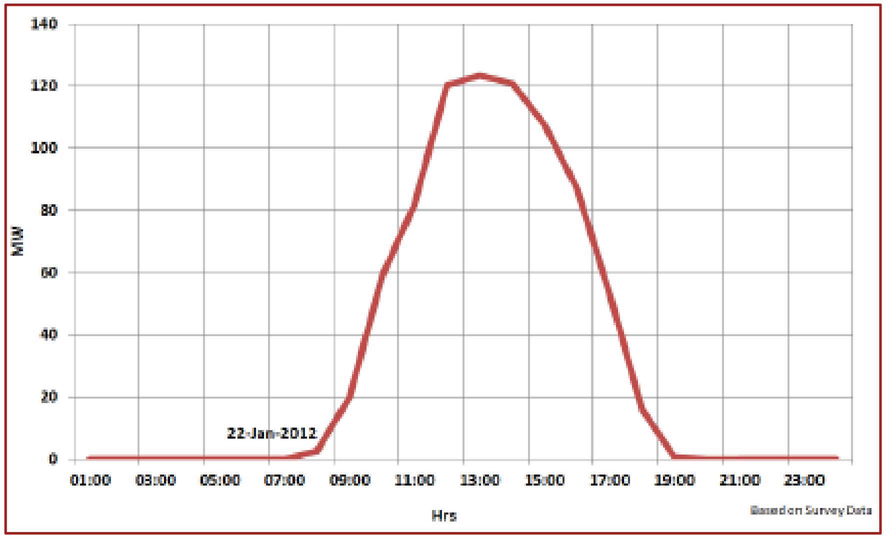
Wind generation pattern in Gujarat in Aug 2011



Source: Report on Green Energy Corridors by Mr. Y.K. Sehgal, Powergrid
Accessible at www.mnre.gov.in

- The variation can be observed across a month also with higher generation during 7th-15th of August'11

Solar Power generation pattern in Gujarat



Source: Report on Green Energy Corridors by Mr. Y.K. Sehgal, Powergrid
Accessible at www.mnre.gov.in. Data : 22nd Jan'2012

- The graph shows pattern of solar generation due to daily variation across the state of Gujarat
- The peak solar generation of ~120MW has been recorded between 1200 to 1400 hours on 22nd Jan'12

Building blocks of power procurement
Way Forward

Design of Procurement portfolio

Segregation

- Segregation of portfolio into peak power requirement and base power requirement to understand the buckets of demand

Design

- Portfolio design as per segregated buckets to meet variations on both demand side & supply side
- Development of independent procurement portfolios to meet specific load balancing and peaking requirements
- Design of portfolios considering the variability of renewable generation e.g. Solar and Wind

Margin

- Appropriate margin to be considered in the portfolio to deal with demand supply imbalances

Develop Institutional structure

People

- Operations expert- commercial, power market, regulatory experts are required

Technology

- IT Infrastructure for managing transactions in Power market to meet Short/Medium/Long term requirements

Structure

- Discom level - part of Power Procurement cell, State level – SLDC, Regional level – RLDC, National level - NLDC

Adding value…

Adding value…

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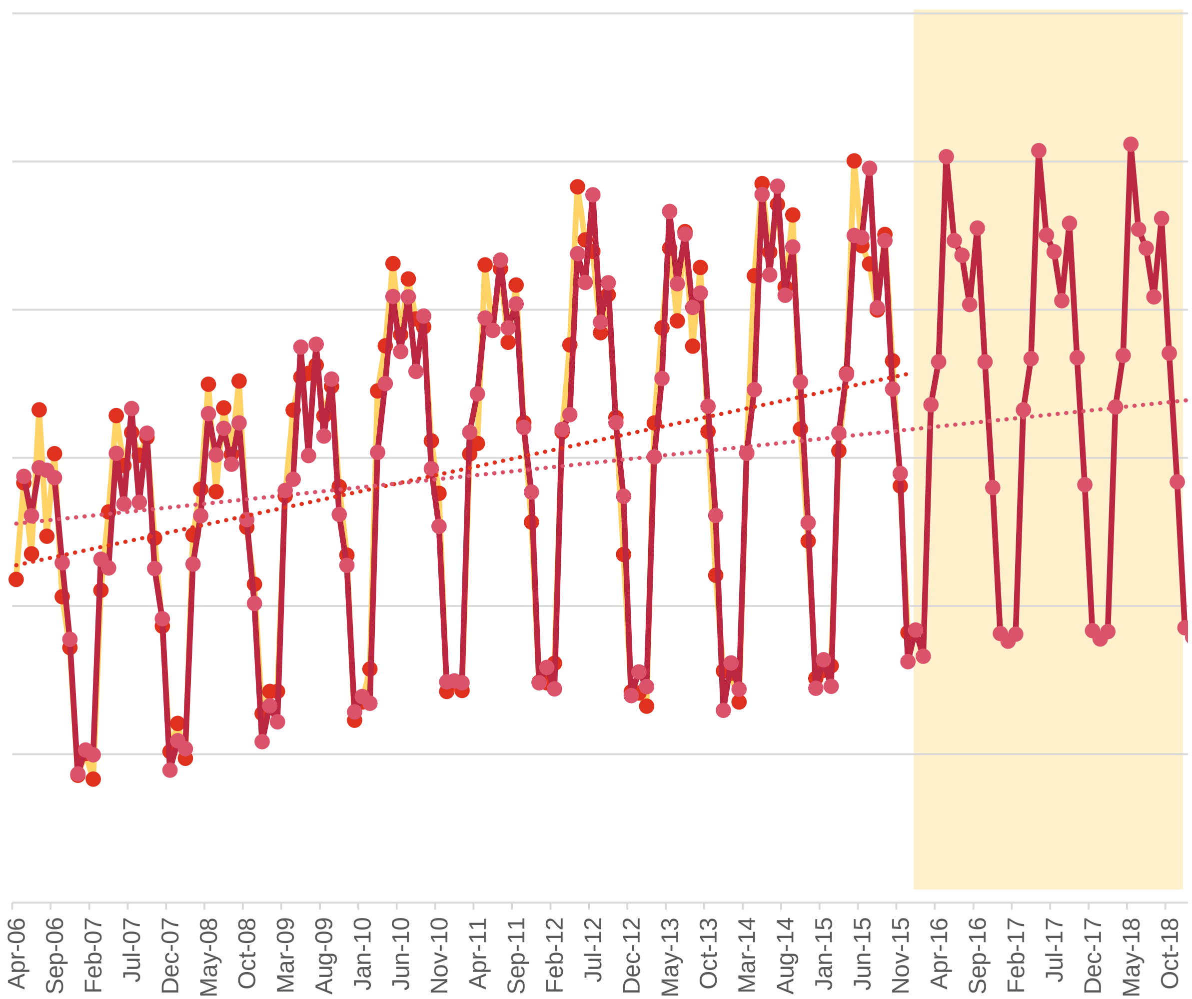
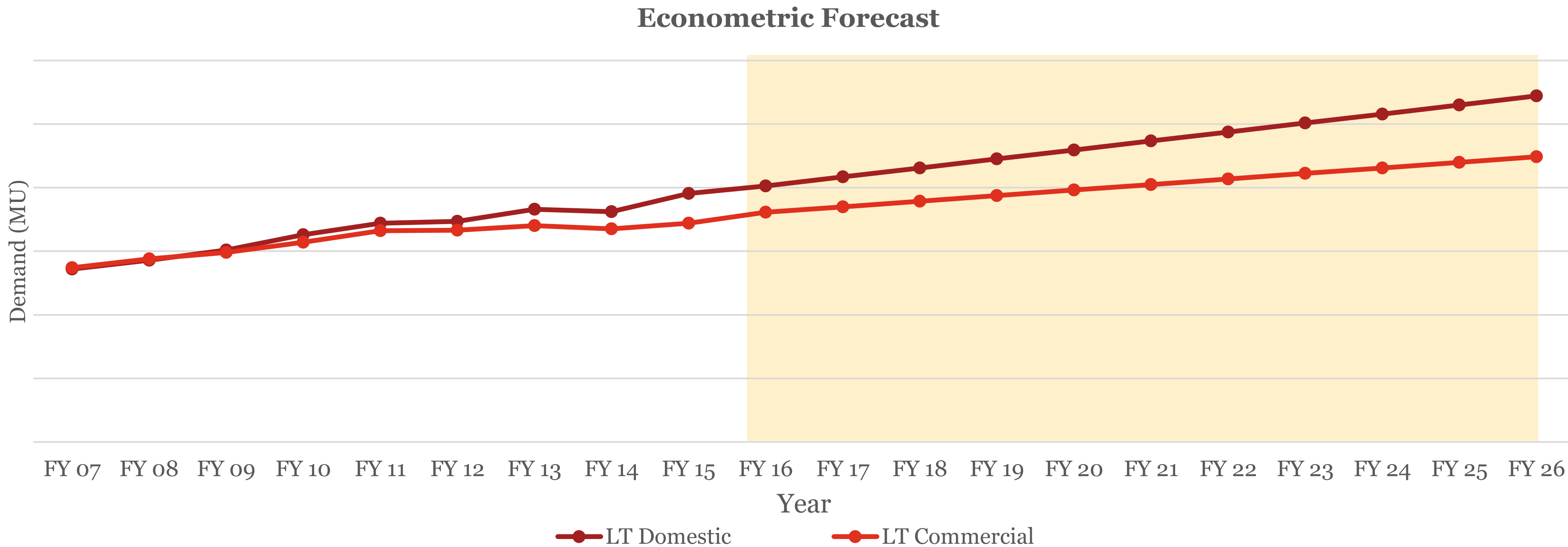
Appendices

Time Series Method

Exponential Smoothing



Econometric Method
Multivariate Linear Regression



Variables (Predictor)	LT Domestic	LT Commercial
Population	√	√
GSDP –Tertiary	√	
GSDP – Secondary		√
Electricity WPI		√

e.g. of regression equation: LT Domestic Category

Demand = -7093.167 + (0.00056084 * Population) - (0.00254 * GSDP-Tertiary)

Partial End Use Method

Time Series coupled with End Usage Method

Land Usage Method

The land-usage approach attempts to capture the impact of energy usage patterns of various zones. The land-usage model for electricity demand focuses on usage of land in terms of Residential, Commercial, Institutional and Industrial. The approach takes in to account the building by-laws and land usage norms, load per area norms and the level/stage of urbanization/development of these zones

Sample Methodology :

The following relation defines the land usage methodology being applied for a zone:

$L_z = A \times O \times S \times F \times LA \times UF$

L_z = Utilized Load of a zone (MW)

A = Area of the zone (sq. Kms)

O = % of the area occupied based on the level of urbanization/development.

S = Space Coverage Norms/By-laws specified for each consumer category (% of the occupied area that can be covered by any construction)

F = Floor to Space Index specified for each consumer category (The index represents how much height of a building can be allowed on a given size of area).

LA= Load per area (MW per sq. km)

UF= Utilization factor for each consumer category