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# India SMART UTILITY Week 2025

**Session :** DEEP DIVE SESSION ON AI, ML AND ROBOTICS  
USE CASES FOR UTILITIES

**Development of Large-Scale Time  
Series Day-Ahead Load Forecasting Methods  
Using Deep Learning Techniques**

***Presented By***

***Mr. Anil Kumar – Head Technical Services , TPWODL***



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# TPWODL @ Glance



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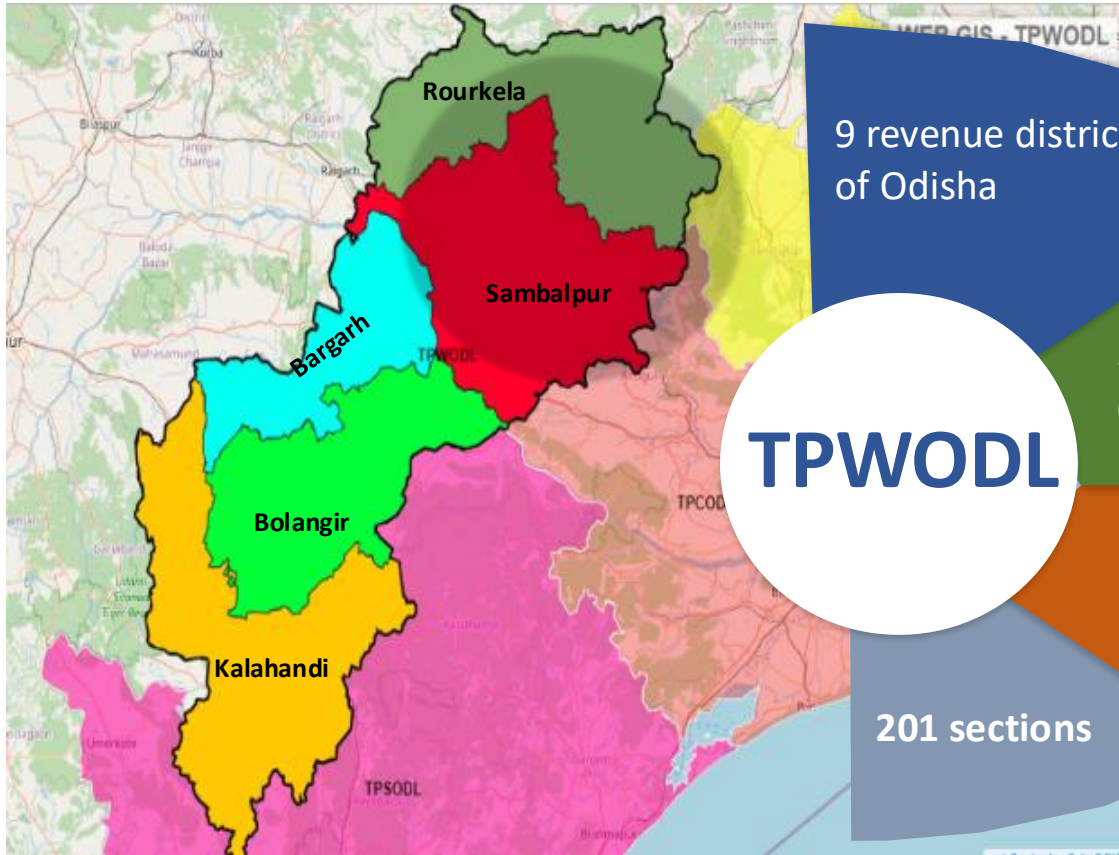
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Formation 1<sup>st</sup> Jan'2021,  
JV of TATA Power & Govt of Odisha

88 Lakh  
Population Served

21.86 Lacs  
Consumer Base

48,373 sq. Kms  
Distribution Area



5 Distribution Circles :  
Rourkela  
Sambalpur  
Bargarh  
Bolangir  
Kalahandi

Sundergarh

Jharsuguda

Deogarh

Sambalpur

Bargarh

Bolangir

Sonepur

Kalahandi

Nuapada



**13<sup>th</sup> AIRR POWER  
DISTRIBUTION UTILITY  
(by MoP)**

33/11 kV  
PSS:316

No. of Power  
Transformers: 649

No. of Distribution  
Transformers: 68800

33KV Line:  
5036 KM

11KV Line:  
47,857 KM

LT Line:  
56,318 KM



**WORLD'S LONGEST EARTHEN DAM**



it is recognised by the Guinness World Records as the largest fully seated hockey arena in the world



**Leaning Temple of Huma` (13.8 Deg) , Sambalpur**

The angle of inclination of Huma temple is 13.8 degrees it is approx. 4 times of Pisa tower



**Birsa Munda International Hockey Stadium in Rourkela**

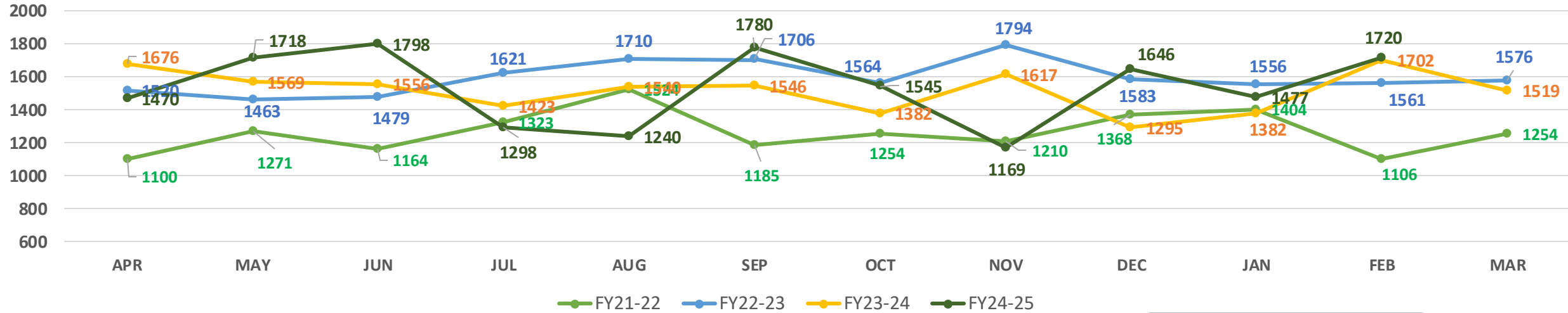
# TPWODL- Load & Energy Trend



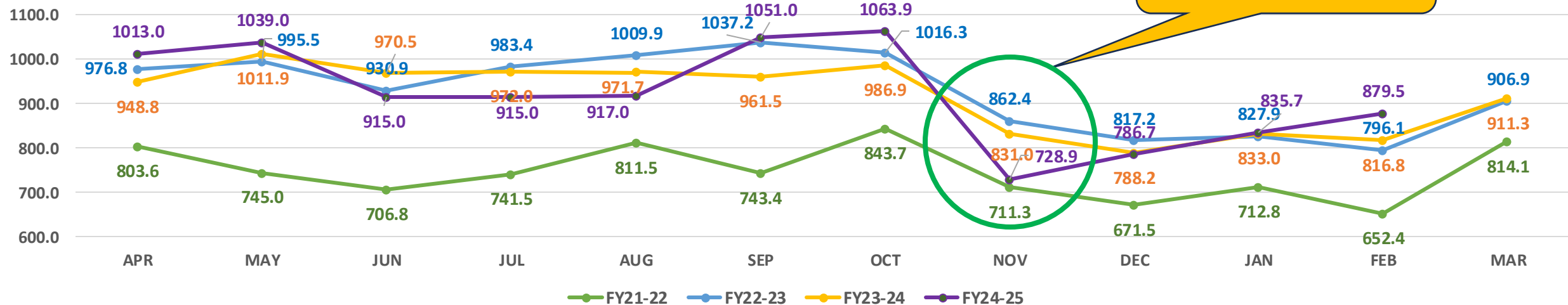
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## Peak Demand (in MVA)



## Energy Consumption (in MUs)



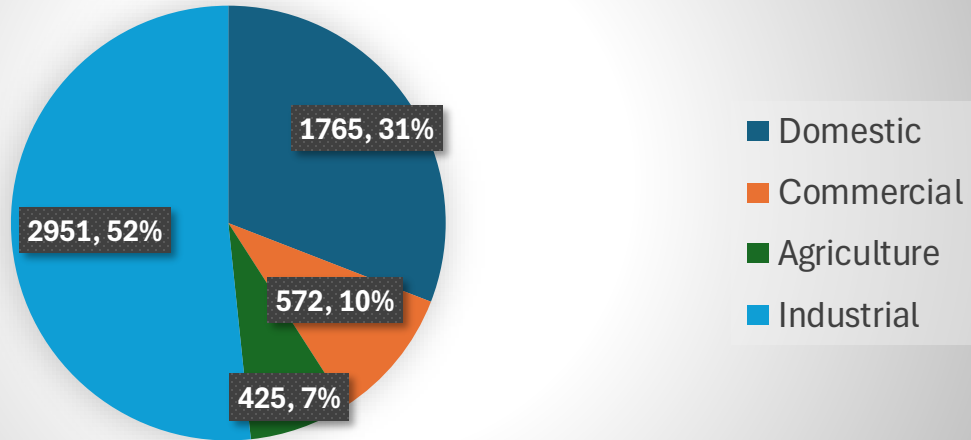
# TPWODL CONSUMER SEGMENT- ENERGY SALE (In Mus)



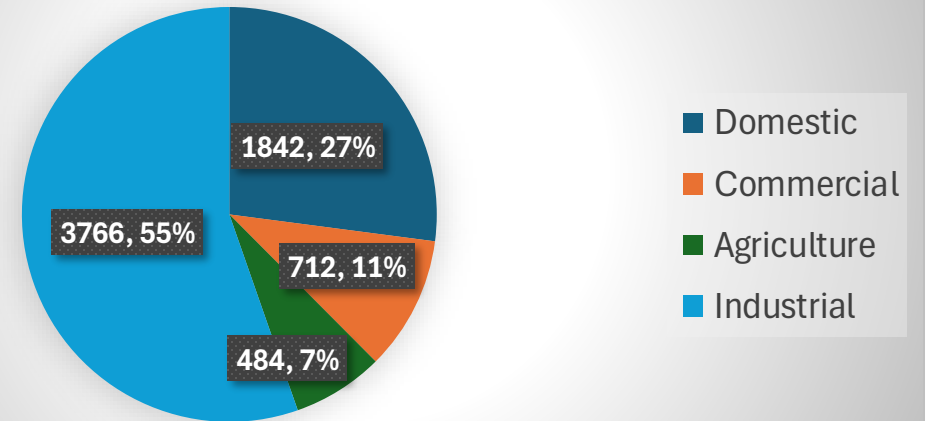
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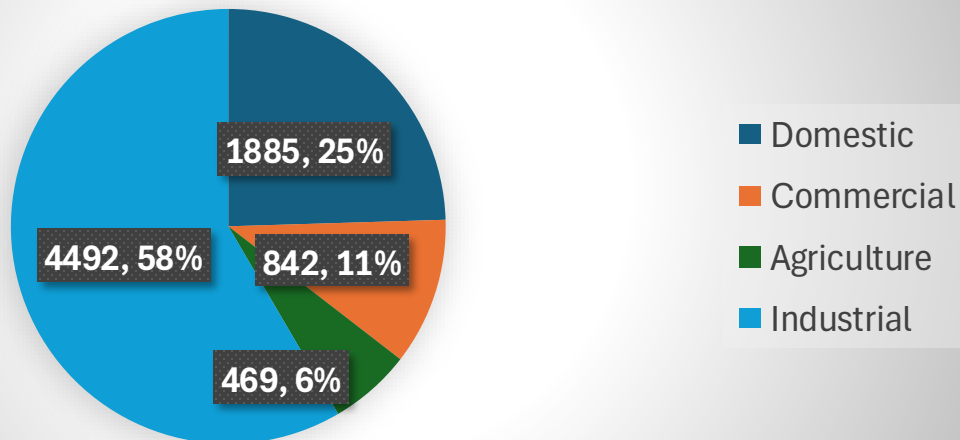
FY 21



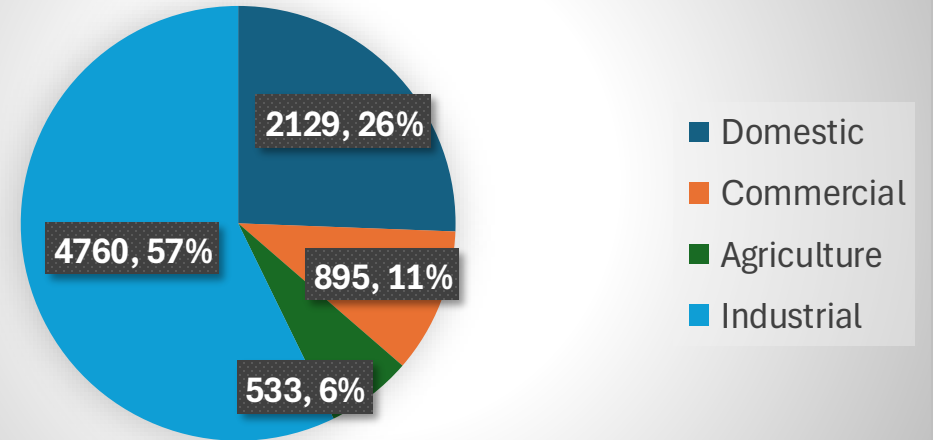
FY 22



FY 23

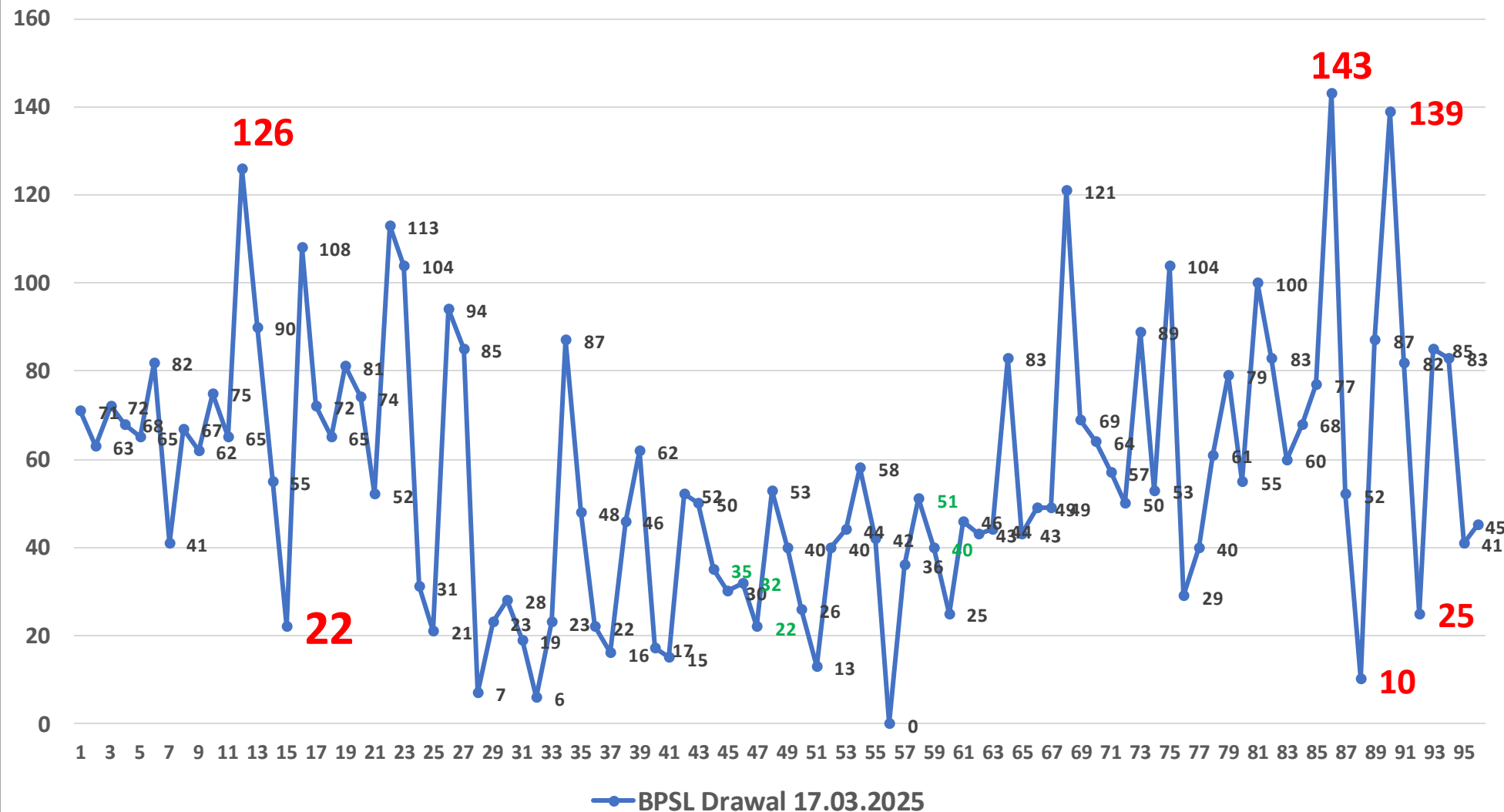


FY 24



CD = 200 MW

## M/s BPSL One Day Load Pattern



Drawl Pattern analysis of M/s BPSL - Variation of load pattern across 96 Blocks of a day:

- **Highest Load : 166 MW**
- **Lowest Load: 0 MW**
- In the 86<sup>th</sup> Block the Load value 143 MW in the next Block goes down to 52 MW – **Deviation in one time slot 90 MW**
- CD – 200 MW
- *Intra State ABT (If applicable) – 12% of Schedule or 150 MW which one is lesser*

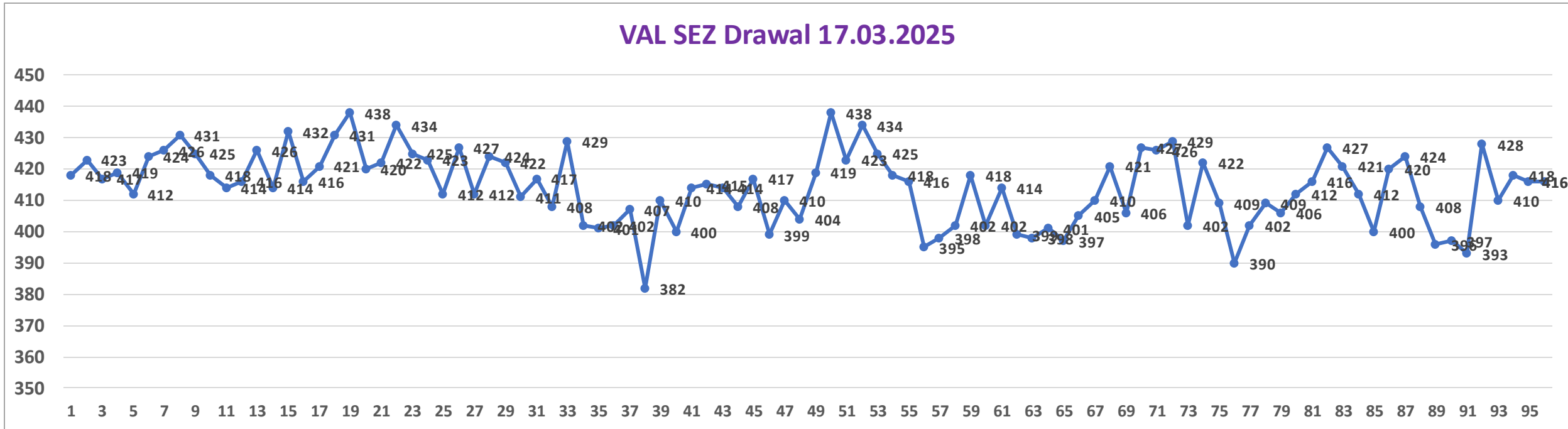
# M/s Vedant Aluminium Consumption Trend



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VAL SEZ Drawal 17.03.2025



The Drawal Pattern signature analysis of VAL SEZ says the variation of load pattern across 96 Blocks of a day:

- Highest Load : 438 MW    Lowest Load: 382 MW
- The Load includes TPA Value



# M/s Rourkela Steel Plant (SAIL) Consumption Trend

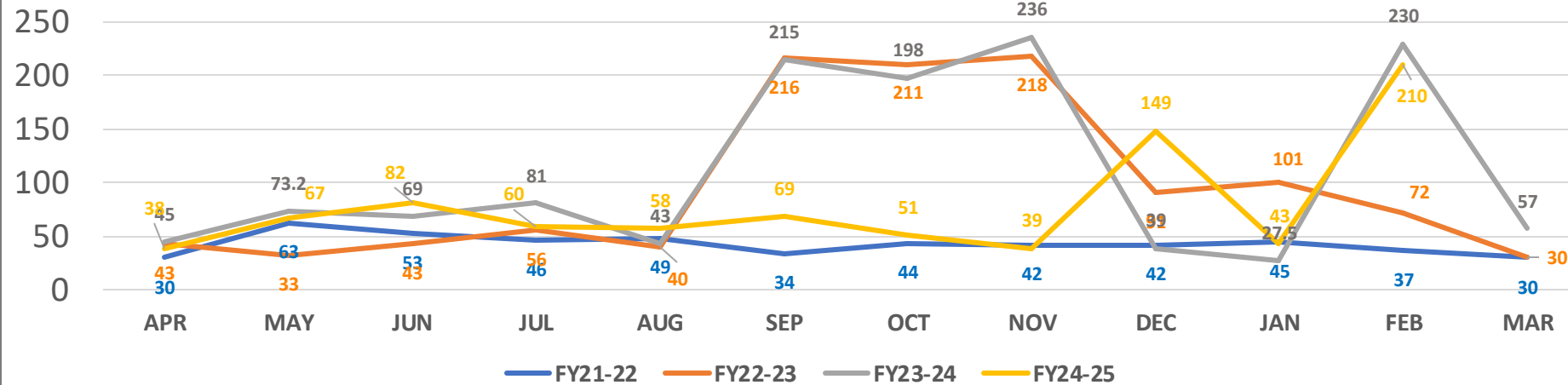


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## RSP - Peak Demand & Consumption FY 22 to FY 25

RSP SMD in MVA



### CD RSP

**FY21-22 : 170 MVA**

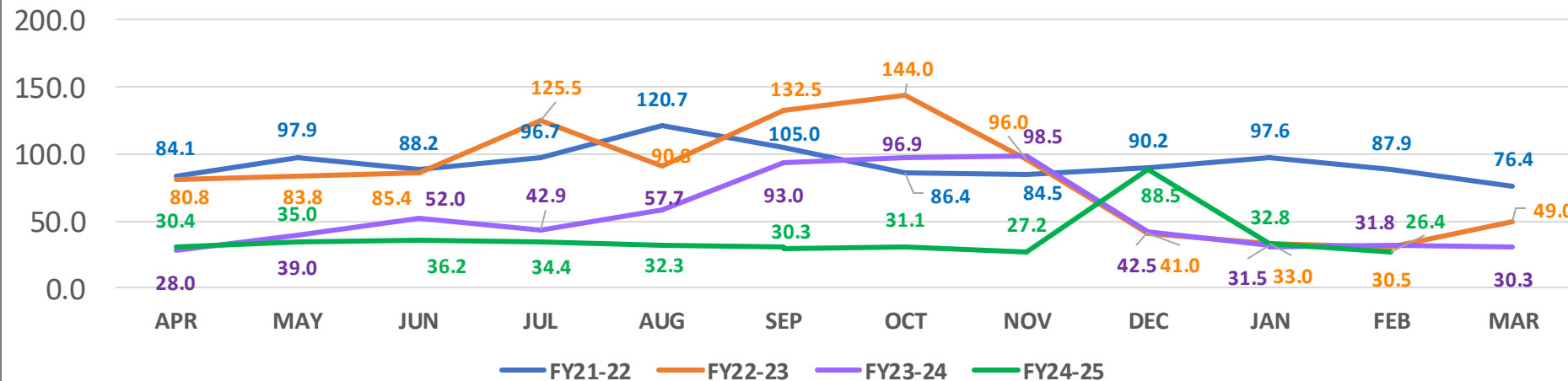
**FY22-23 : 170 MVA**

**FY23-24 : 170 MVA**

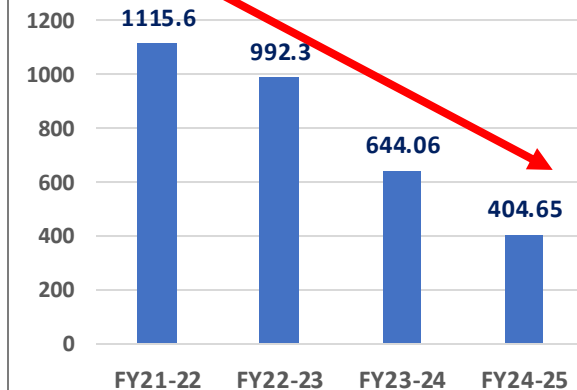
**\*CGP 250 MVA**

**FY24-25 : 170 MVA**

RSP Consumption in MUs

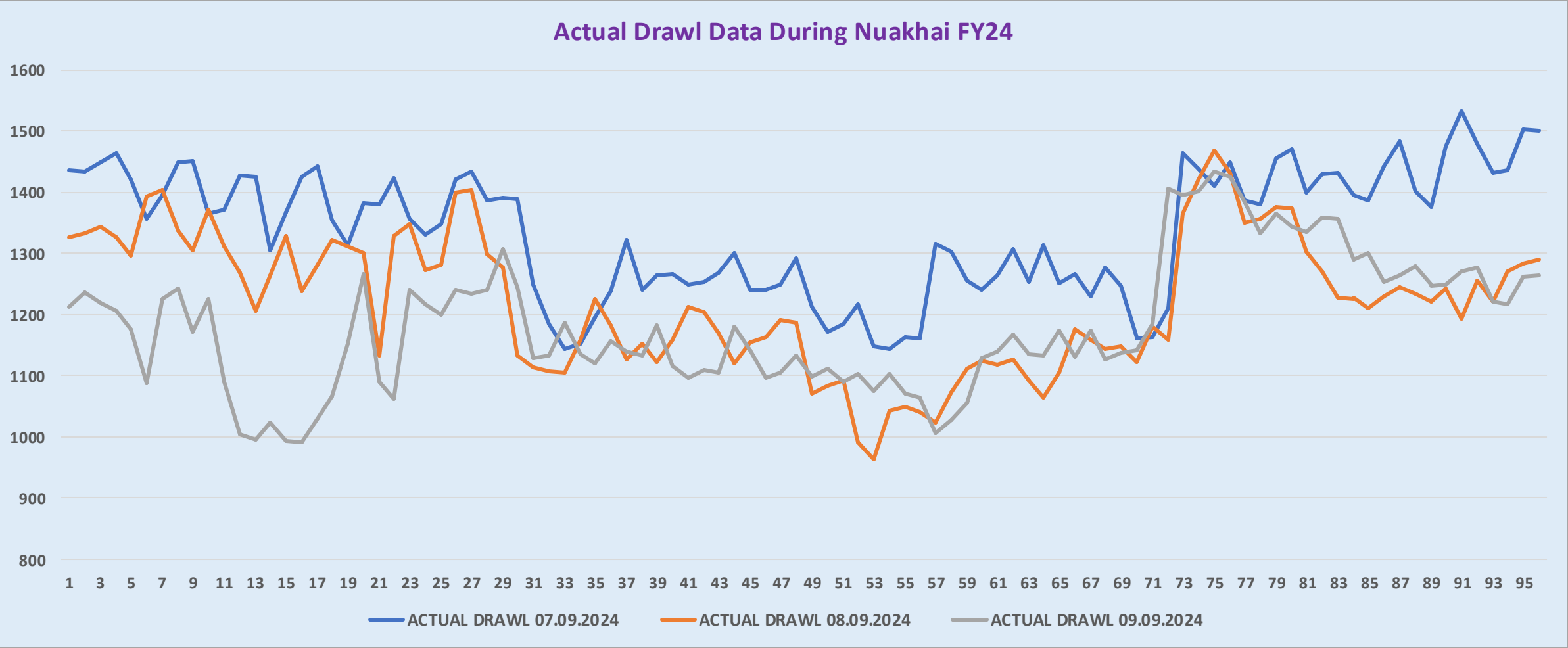


Energy(MUs)





Actual Drawl Data During Nuakhai FY24

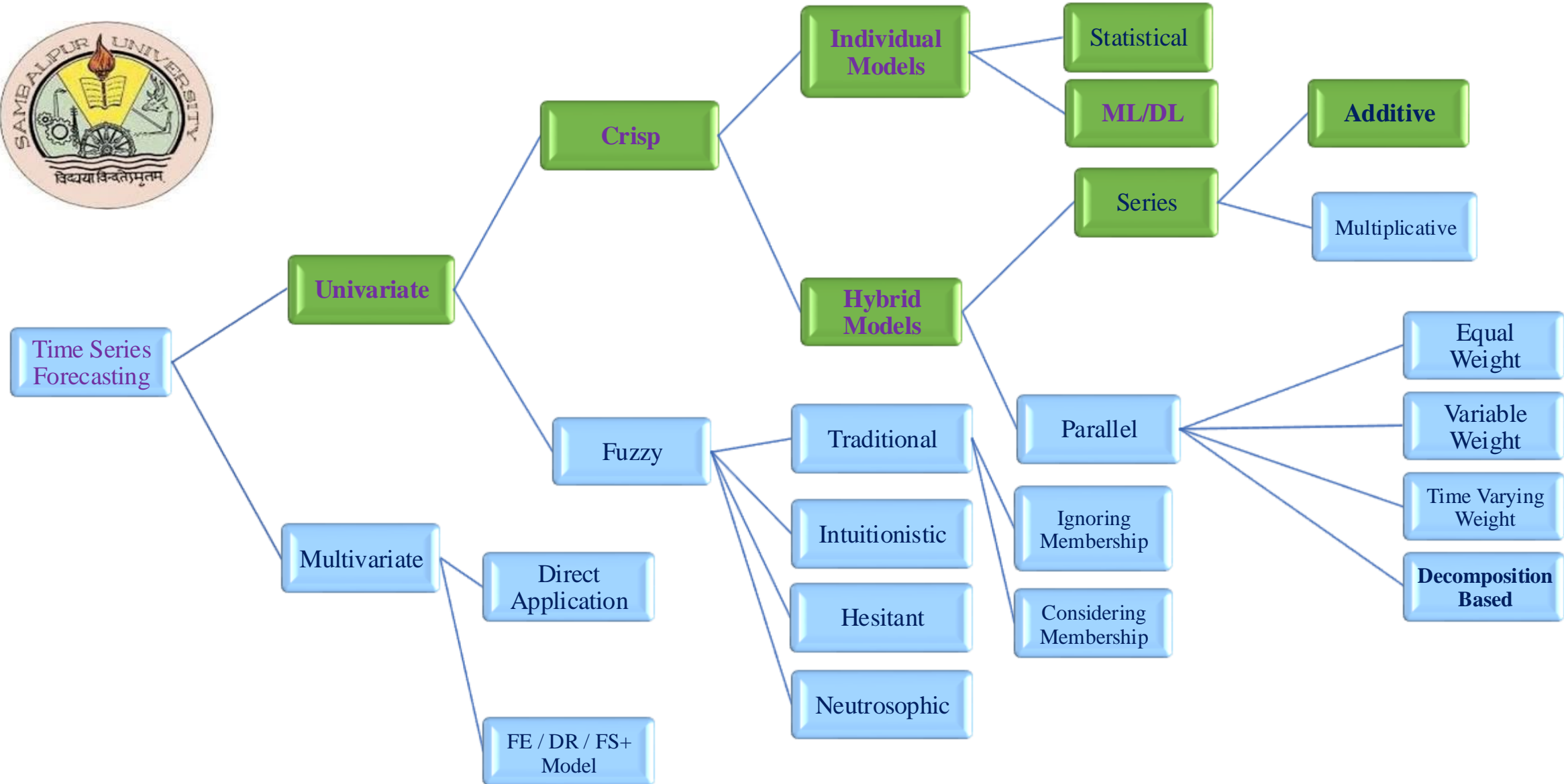


# TIME SERIES FORECASTING



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The number of significant inputs  $k$  of DL models will be determined by analyzing the autocorrelation and partial autocorrelation function of the time series.

The time series will be pre-processed (Normalization, Treatment of Trend and Seasonal Components).

The time series of length  $n$  will be transformed to  $n-k$  patterns using sliding window technique. Then the patterns will be splitted into Train, Validation and Test Sets.

Using the Train and Validation set determine the DL model parameters. Once the model parameters are determined, the forecasts on Test set are computed using the obtained model parameters.

De-normalize, Detrend and De-seasonalize the computed forecasts to obtain the true forecasts.

Measure the forecasting accuracy.

# CASE STUDY – TPWODL ML MODEL



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## Mean & Standard Deviation of Forecasting Accuracies – 24 Hrs (96- Time Block) Ahead Demand Forecast

Method	RMSE Mean $\pm$ Std. Dev	MAE Mean $\pm$ Std. Dev	SMAPE Mean $\pm$ Std. Dev
Linear Regression	260.06 $\pm$ 0	214.72 $\pm$ 8.75E-14	12.25 $\pm$ 3.65E-15
Lasso	842.2 $\pm$ 2.3328E-13	781.6 $\pm$ 0	53.33 $\pm$ 1.46E-14
Ridge	260.11 $\pm$ 0	214.78 $\pm$ 2.92E-14	12.25 $\pm$ 3.65E-15
Elastic Net	842.20 $\pm$ 2.33E-13	781.6 $\pm$ 0	53.33 $\pm$ 1.46E-14
Huber	221.03 $\pm$ 8.75E-14	171.47 $\pm$ 5.83E-14	9.73 $\pm$ 1.82E-15
SGD	263.50 $\pm$ 12.11439	218.0712 $\pm$ 12.896	12.43 $\pm$ 0.790274
Tweedie	531.51 $\pm$ 0	475.16 $\pm$ 1.17E-13	28.99 $\pm$ 1.09E-14
AdaBoost	449.02 $\pm$ 10.27059	370.98 $\pm$ 8.162398	21.43 $\pm$ 0.527343
Random Forest	426.26 $\pm$ 9.34617605	353.87 $\pm$ 6.847306	20.65 $\pm$ 0.426393
Gradient Boosting	337.46 $\pm$ 1.595517	279.44 $\pm$ 1.675245	16.26 $\pm$ 0.090986
Linear SVR	212.402 $\pm$ 14.36119625	160.49 $\pm$ 17.14428	9.11 $\pm$ 1.024866
MLP	315.56 $\pm$ 46.18374	268.40 $\pm$ 46.85049	15.49 $\pm$ 2.977513
SVR	571.57 $\pm$ 0	410.87 $\pm$ 1.75E-13	25.59 $\pm$ 7.29E-15
Extra Tree	434.82 $\pm$ 6.607523	360.5 $\pm$ 4.802157	21.07 $\pm$ 0.305813
Bagging	427.63 $\pm$ 25.90133	354.23 $\pm$ 19.52912	20.8 $\pm$ 1.213303
Decision Tree	535.82 $\pm$ 68.157	423.71 $\pm$ 58.0171	26.39 $\pm$ 3.685595
KNN Regressor	475.98 $\pm$ 5.83E-14	381.61 $\pm$ 1.17E-13	23.18 $\pm$ 1.09E-14
CNN	298.46 $\pm$ 19.22262	243.1 $\pm$ 19.35159	13.85 $\pm$ 1.150479
XGB	348.41 $\pm$ 1.17E-13	280.46 $\pm$ 0	16.6 $\pm$ 7.29E-15
STA_LR_LSVR_LSVR	214.06 $\pm$ 0.959424159	162.96 $\pm$ 1.128385	9.24 $\pm$ 0.06728
STA_HR_LSVR_LSVR	213.45 $\pm$ 1.408510065	162.22 $\pm$ 1.660384	9.2 $\pm$ 0.099127
STA_LSVR_LSVR_LSVR	<b>212.82 <math>\pm</math> 1.61</b>	<b>161.49 <math>\pm</math> 1.92</b>	<b>9.15 <math>\pm</math> 0.11</b>



Friedman p-value: 0.000 • Different • CritDist: 19.0

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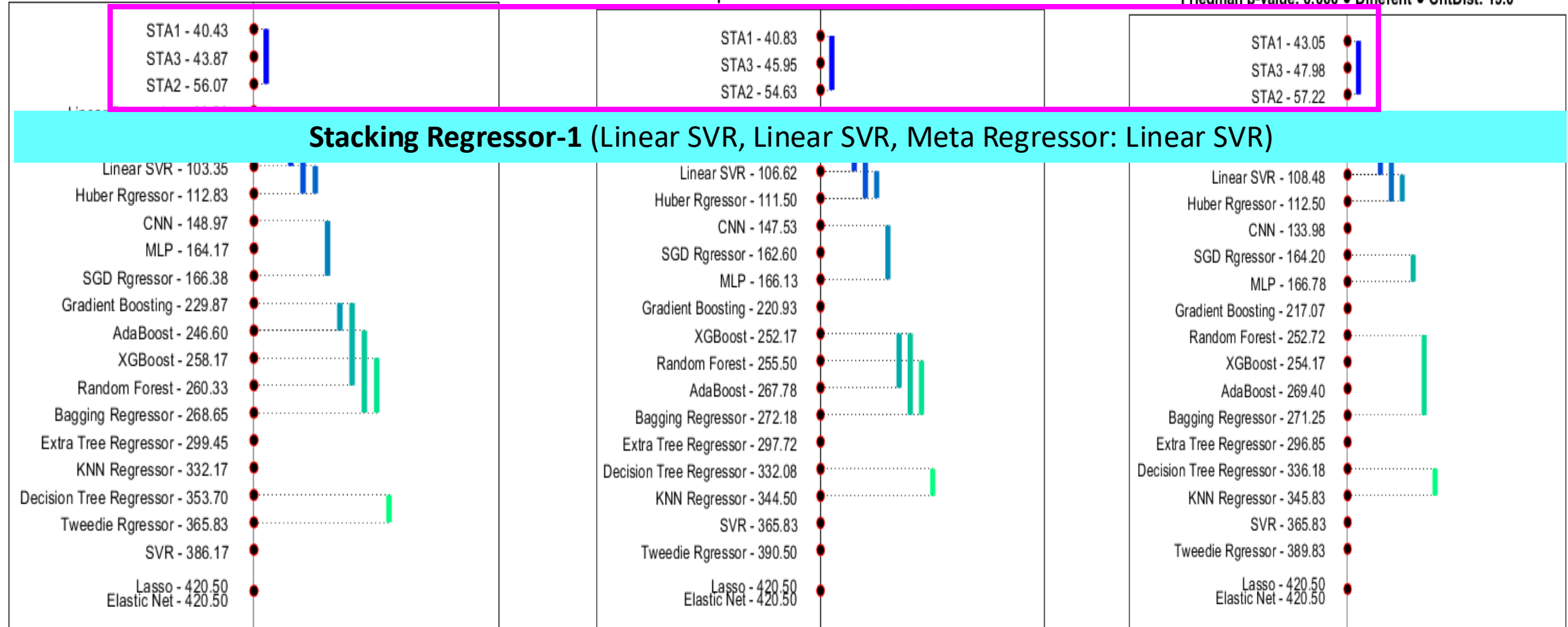


Figure 1: Friedman and Nemenyi Hypothesis Test  
Considering RMSE Measure

Figure 2: Friedman and Nemenyi  
Hypothesis Test  
Considering MAE Measure

Figure 3: Friedman and Nemenyi Hypothesis Test  
Considering SMAPE Measure

01



**Challenges & Opportunity to Intra State DSM regulation implementation in Odisha**

02



**Exchange of Real Time Data Information between DISCOM, SLDC and Industrial Consumers**

03



**Impact of Geo-Economic scenario on demand forecast**

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## THANK YOU

For discussions/suggestions/queries email: [isuw@isuw.in](mailto:isuw@isuw.in)

[www.isuw.in](http://www.isuw.in)

Links/References (If any)