“Replacing Human Intuition with Artificial Intelligence in Rural Power systems of India.”

by

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Presentation Outline

References

Publications

Introduction

L

Skills Acquired

Project Outline

Challenges in Data Gathering and Short Term Load forecasting

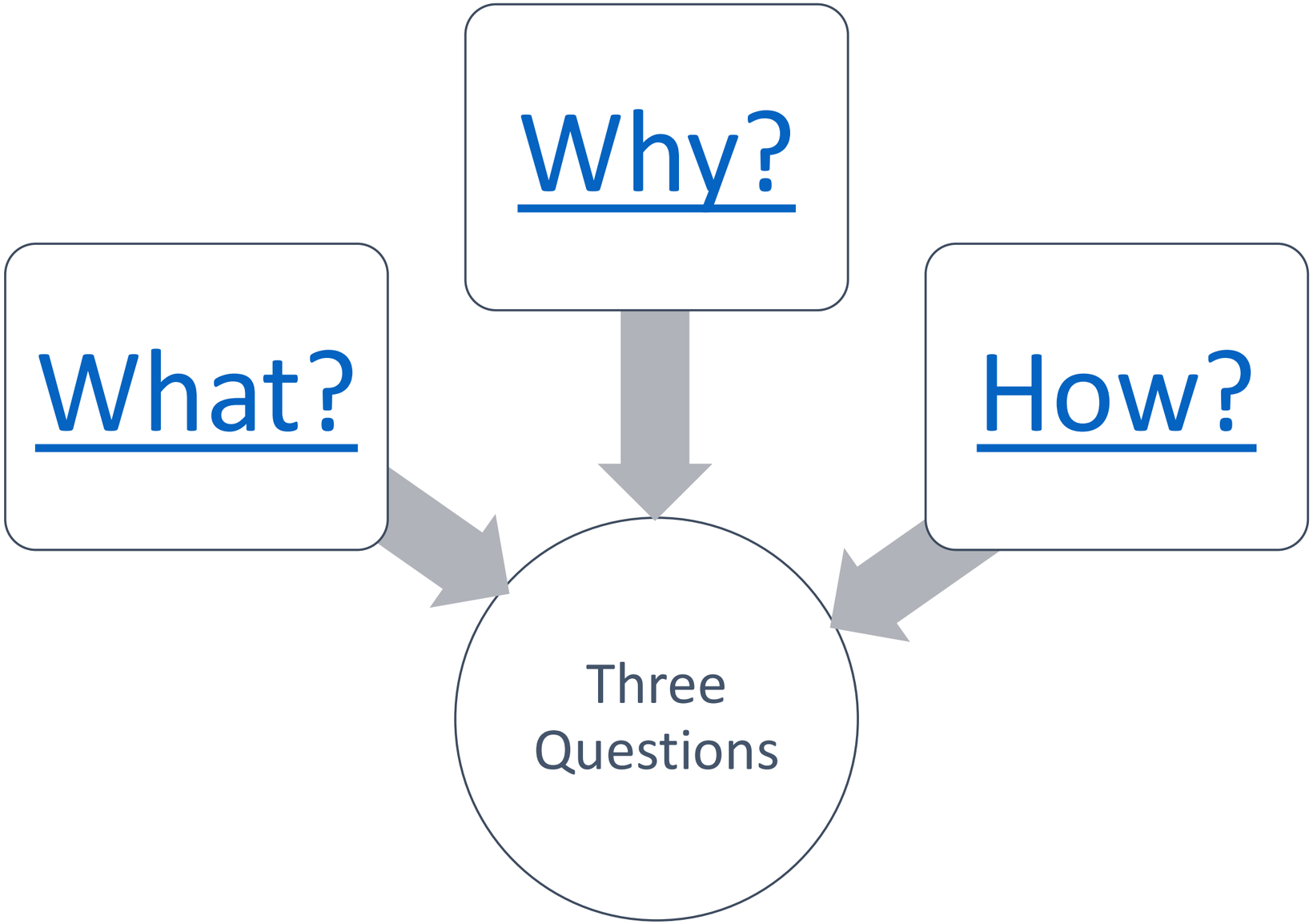
Effect of Replacing intuition based methods

Conclusion

Future Work

Introduction

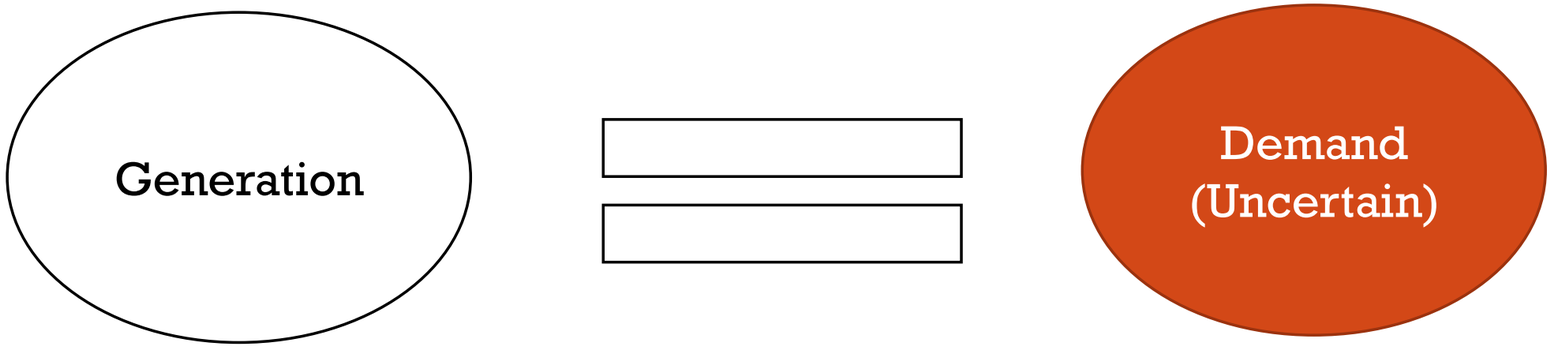
Back



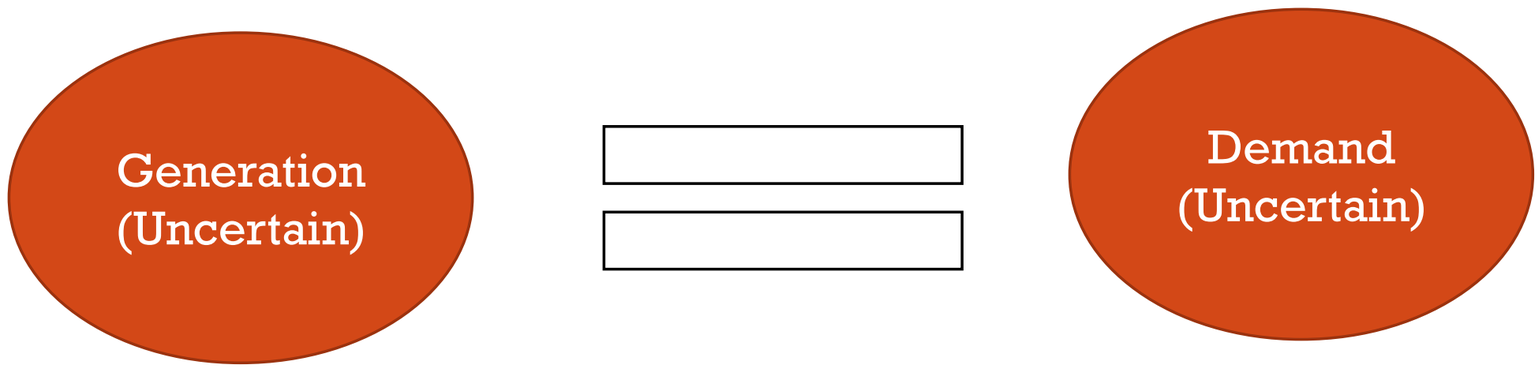
WHY ?

Generation = Demand

Before Renewables :- (Till 1st decade of 21st Century)



After Renewables :- (After 1st decade of 21st Century)



HOW ?

- **Focussing on area wise strategy and deploying Artificial Intelligence methodologies accordingly**
- **Conducting an in depth data analysis , coordinating with various stake holders to gather data.**
- **Connecting the dots of the challenges with academic methods and solving the problems.**

OBJECTIVES

(WHAT)

- To Develop Novel Short term Load Forecasting algorithms to make it compatible with scheduling algorithms.

- To Integrate Short term Load forecasting with active power scheduling considering grid integrated multi energy systems.

AIM 1 - Challenges in Data Gathering and Short Term Load forecasting

SURVEY AND PREREQUISITE

- Three types of Load Forecasting (Long, Medium and Short) , focus on short term

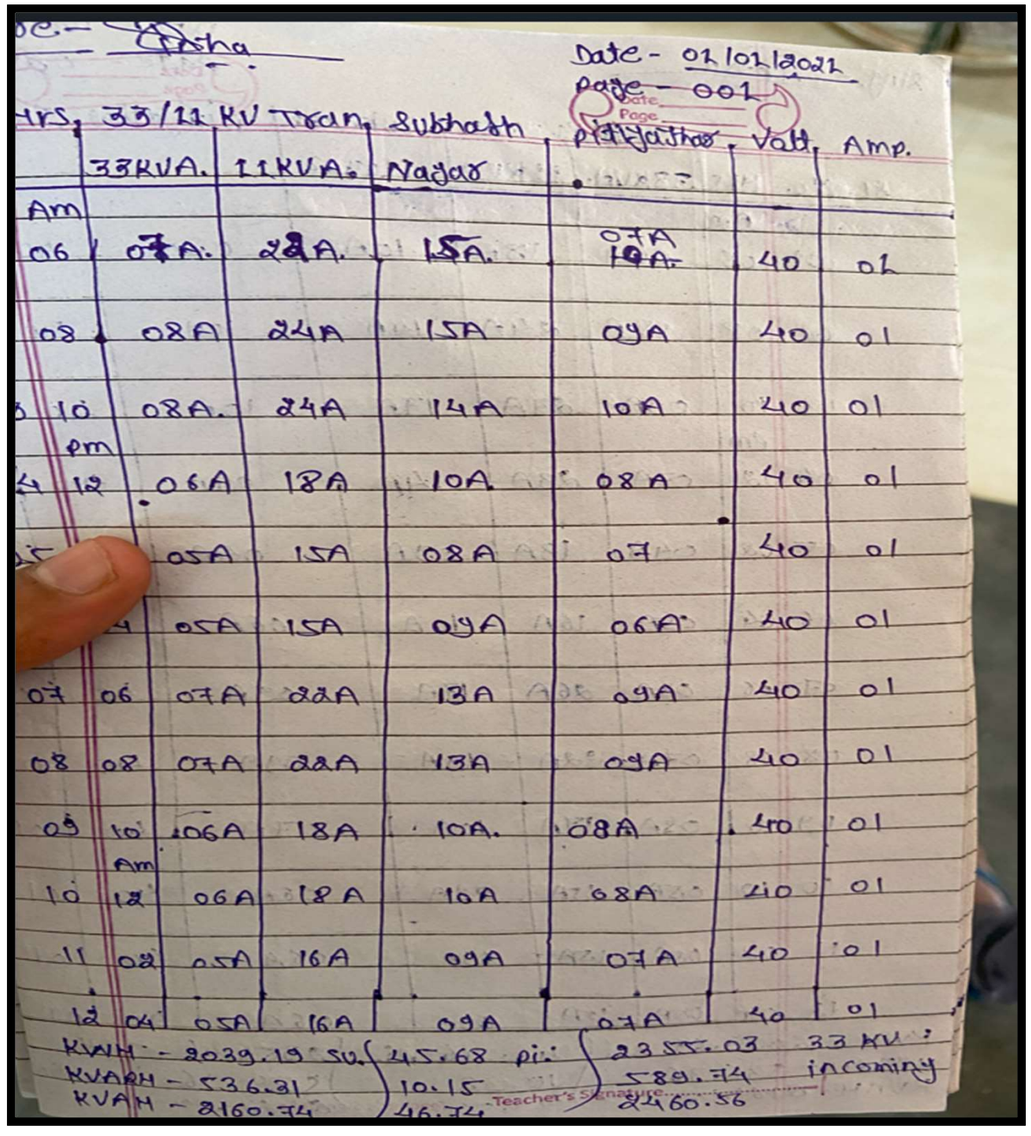
- Our survey believe that Discom level , state level and national level should have different forecasting strategies.

- To Integrate Short term Load forecasting with active power scheduling considering grid integrated multi energy systems.

DISCOM Level Challenges and Forecasting

Substation : Mahasamund (Chhattisgarh)

Problems faced during Load analysis and its Short term forecasting



Date - 01/01/2021
Page - 001

Hrs. 33/11 KV Tran. Subhash Nagar

	33KVA.	11KVA.	Pittjalthar	Volt.	Amp.
Am					
06	07A.	22A.	15A.	07A 10A.	40	01
08	08A	24A	15A	09A	40	01
10 pm	08A.	24A	14A	10A	40	01
12	06A	18A	10A	08A	40	01
	05A	15A	08A	07	40	01
	05A	15A	09A	06A	40	01
07 06	07A	22A	13A	09A	40	01
08 08	07A	22A	13A	09A	40	01
09 10 Am	06A	18A	10A.	08A	40	01
10 12	06A	18A	10A	08A	40	01
11 02	05A	16A	09A	07A	40	01
12 04	05A	16A	09A	07A	40	01

KVAH - 2039.19 SU. 45.68 pi. 2355.03 33 KV ;
KVARH - 536.31 10.15 589.74 incoming
KVAH - 2160.74 46.74 2460.56

Teacher's Signature

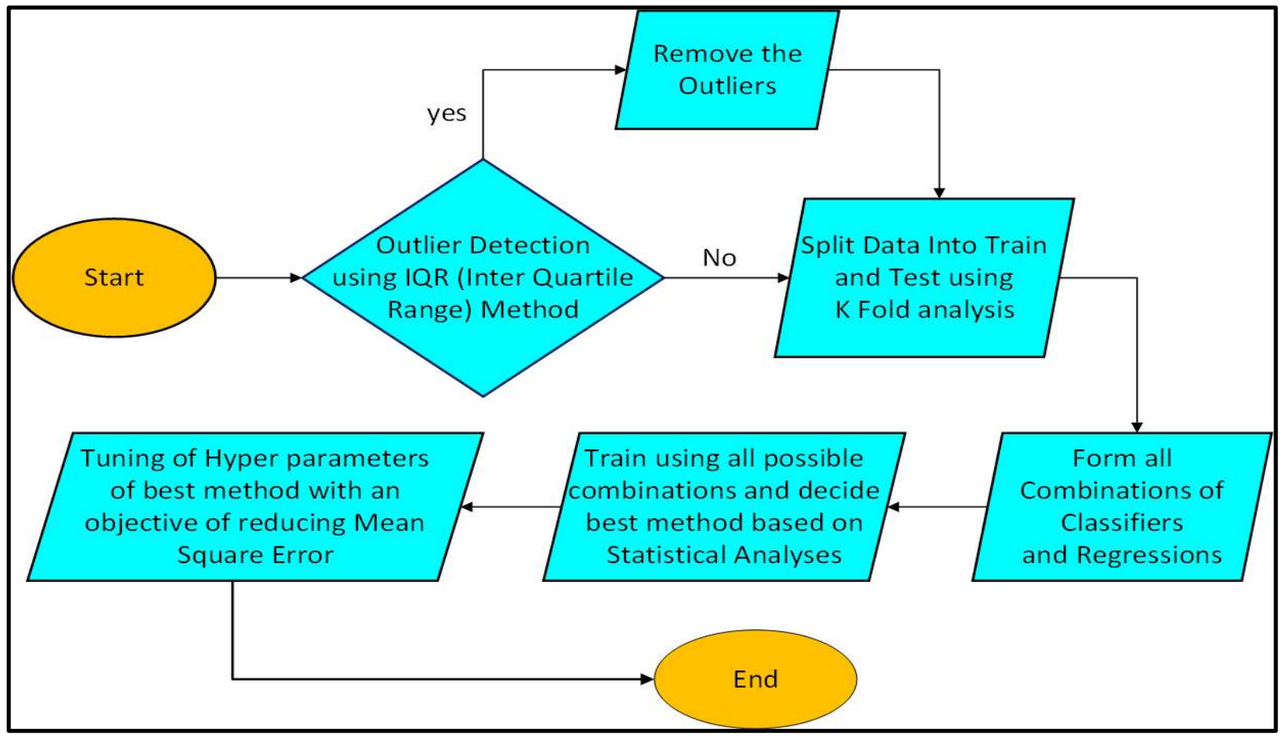
- Manual noting of data despite presence of Data Loggers (Ref – Left Side Image)
- A person Manually notes the data (Ref – Right Side Image)

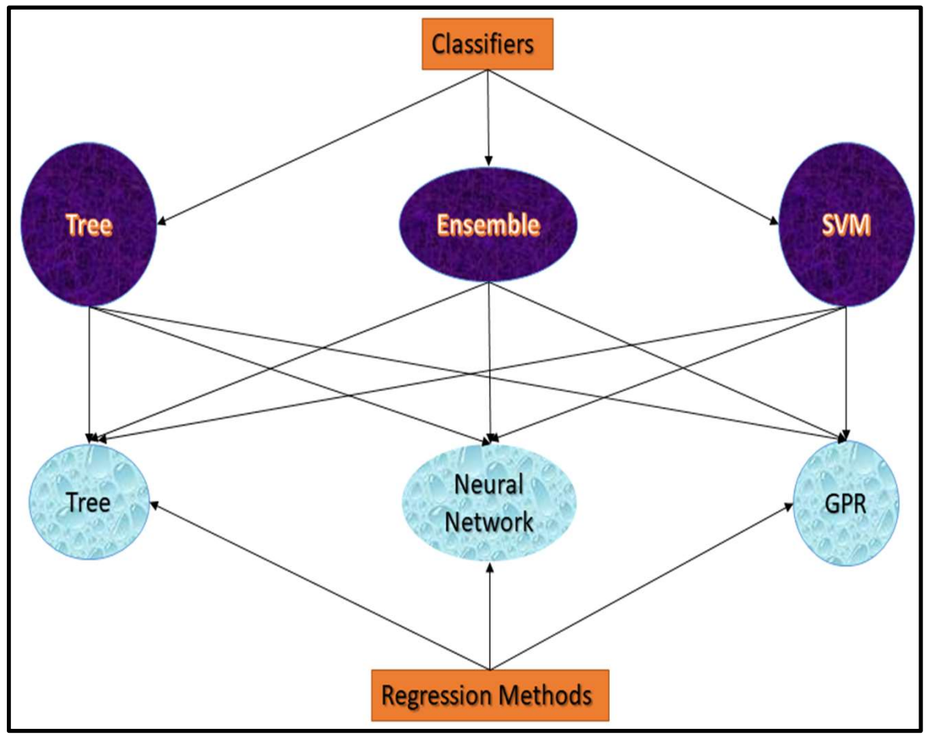
PROBLEMS FACED DURING LOAD ANALYSIS AND ITS SHORT TERM FORECASTING

- Load is in Amperes (becomes difficult for scheduling algorithms)
- Manual Switching's are used for feeder operation
- Manipulated data
- Load shedding without any reason
- Irregular nomenclature of Transformer Loading
  (Intense Survey is required)

PROBLEMS FACED DURING LOAD ANALYSIS AND ITS SHORT TERM FORECASTING

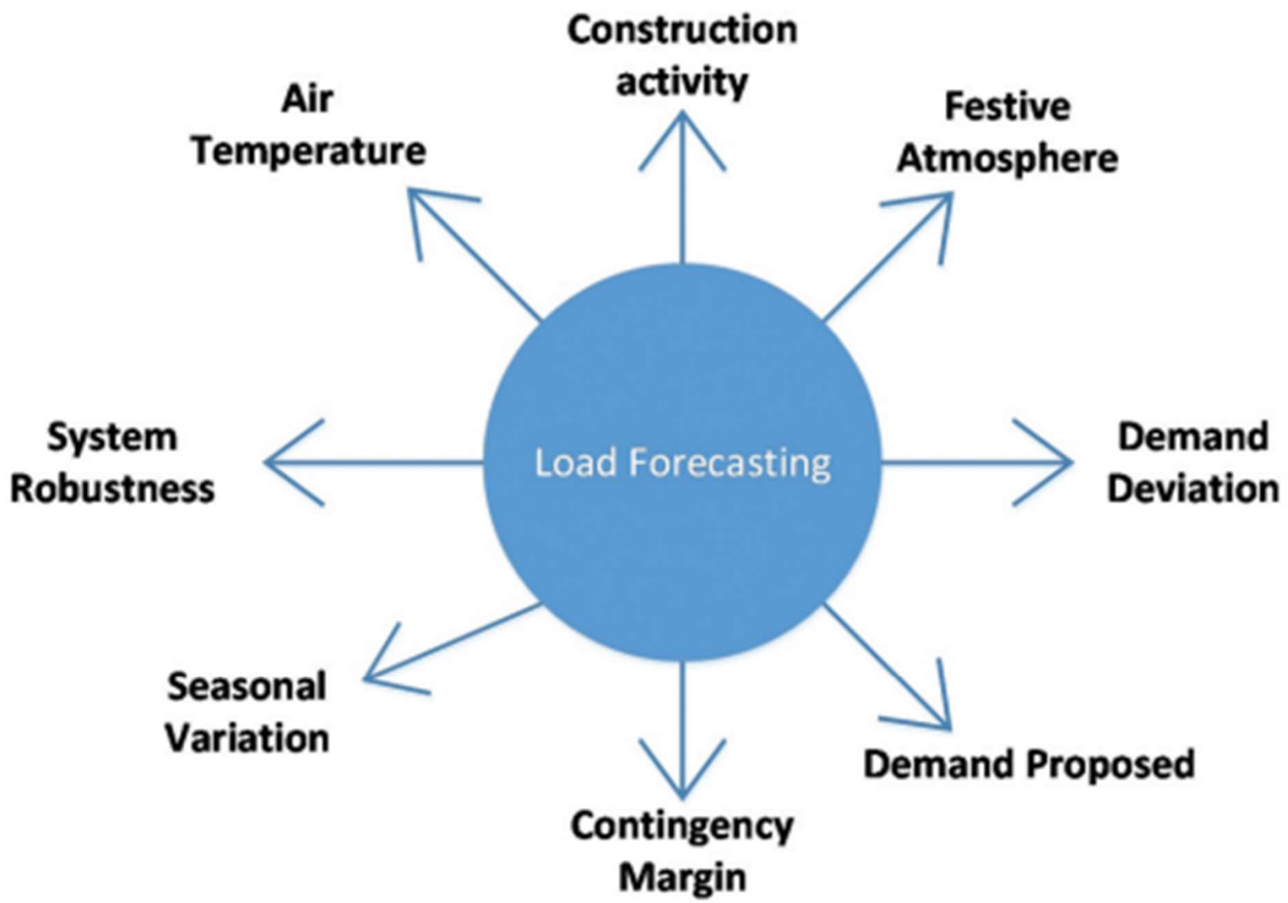
Machine Learning based Classifier –Regression mapping for short term load forecasting





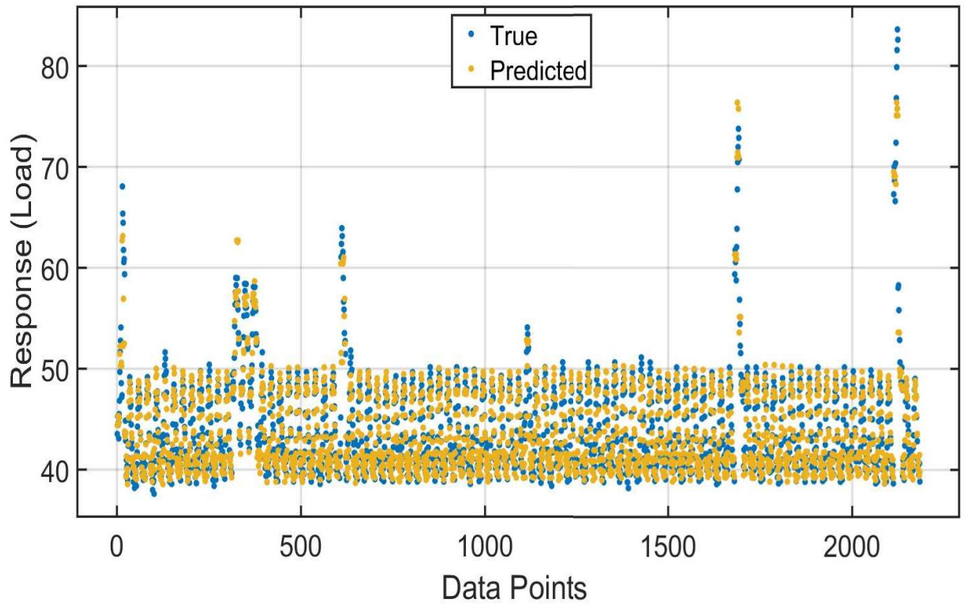
A) Left Side and right side Figure demonstrates proposed STLF methodology and considered methods and its mapping respectively

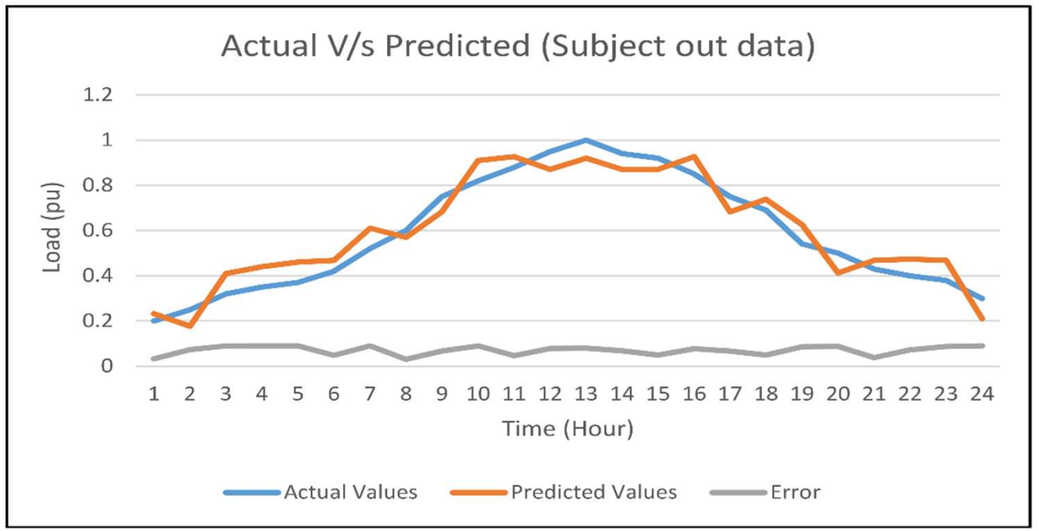
Load Forecasting Parameters Considered from Indian Perspective



All the above input parameters have correlation factor greater than 0.5

Load Forecasting Parameters Considered from Indian Perspective





RMSE	R Squared	MSE	MAE	Training Time
1.4793	0.91	2.18	0.80	0.9242

1. Load is in Amperes (A)

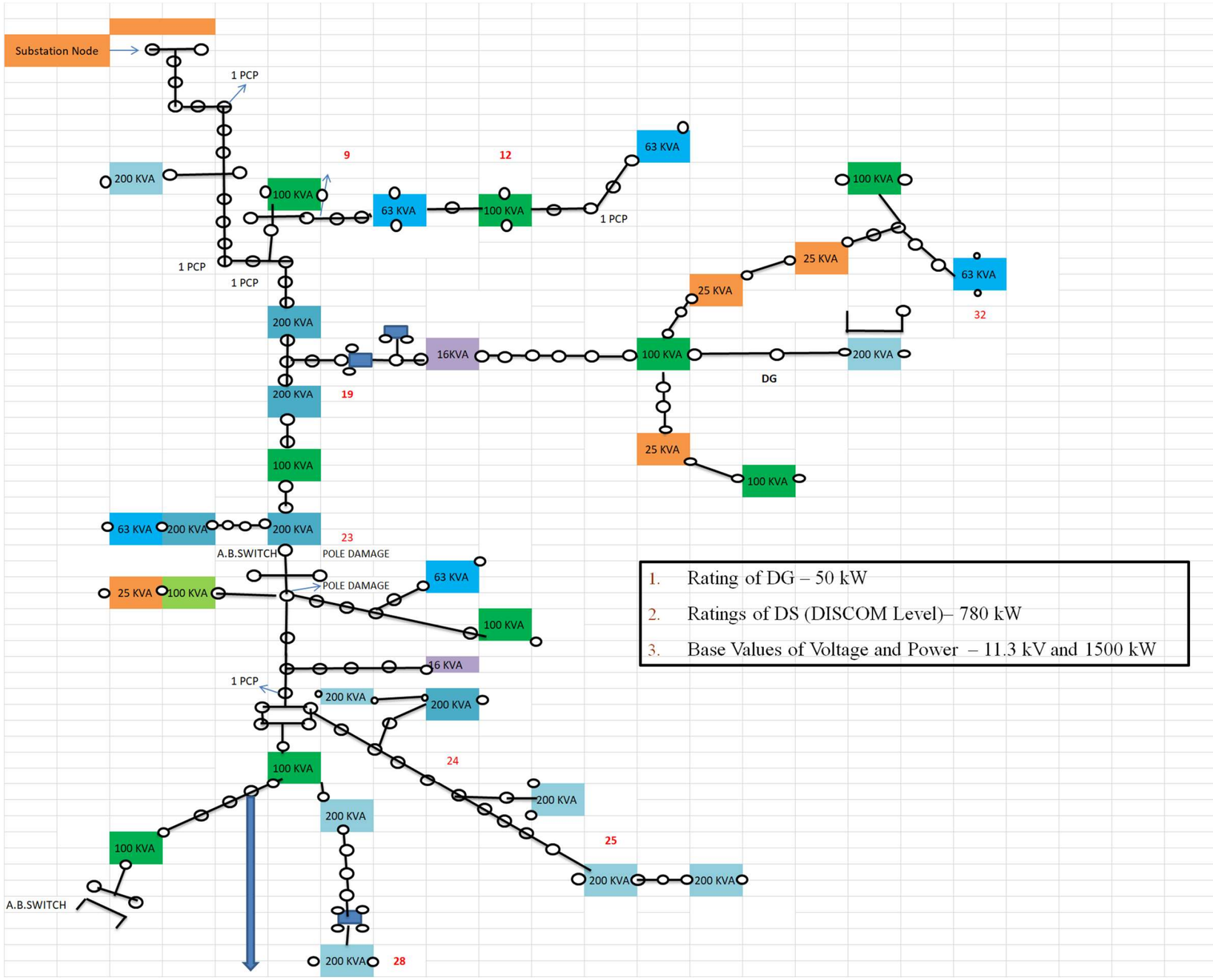
2. PU (Per Unit) = Actual Load/Maximum Load

3. The best method is “Tree – Neural Network”. Decision Tree as classifier and Neural Network as regression , K fold Analysis

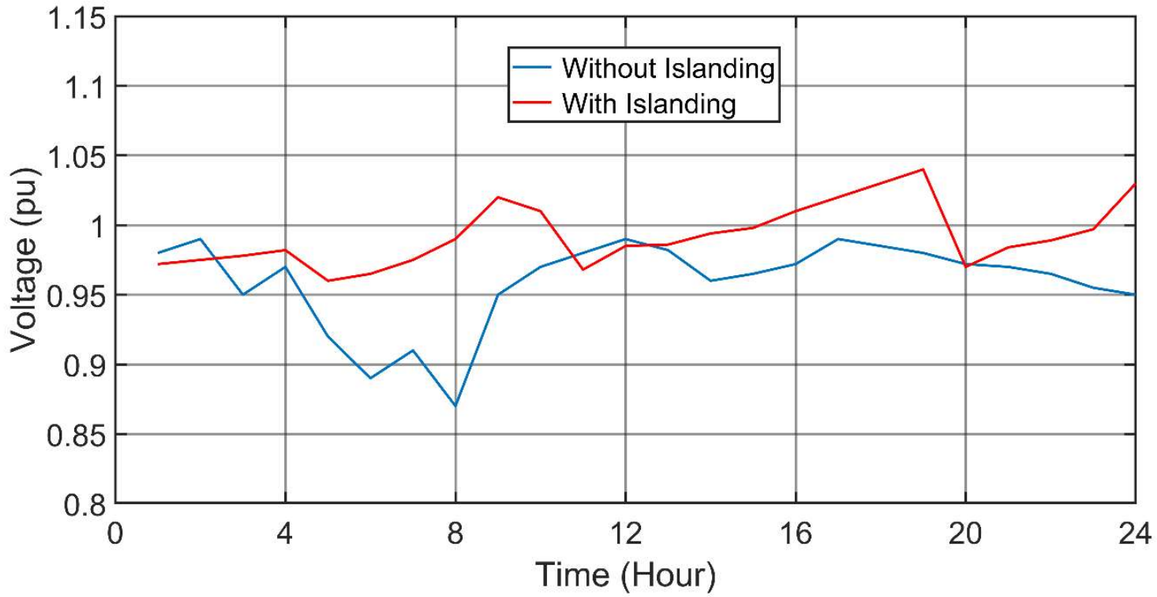
4. For Day Ahead : 9th Nov ‘2023 –During Diwali.

AIM 2 - To Integrate Short term Load forecasting with active power scheduling considering grid integrated multi energy systems. (Effect of Replacing intuition based methods)

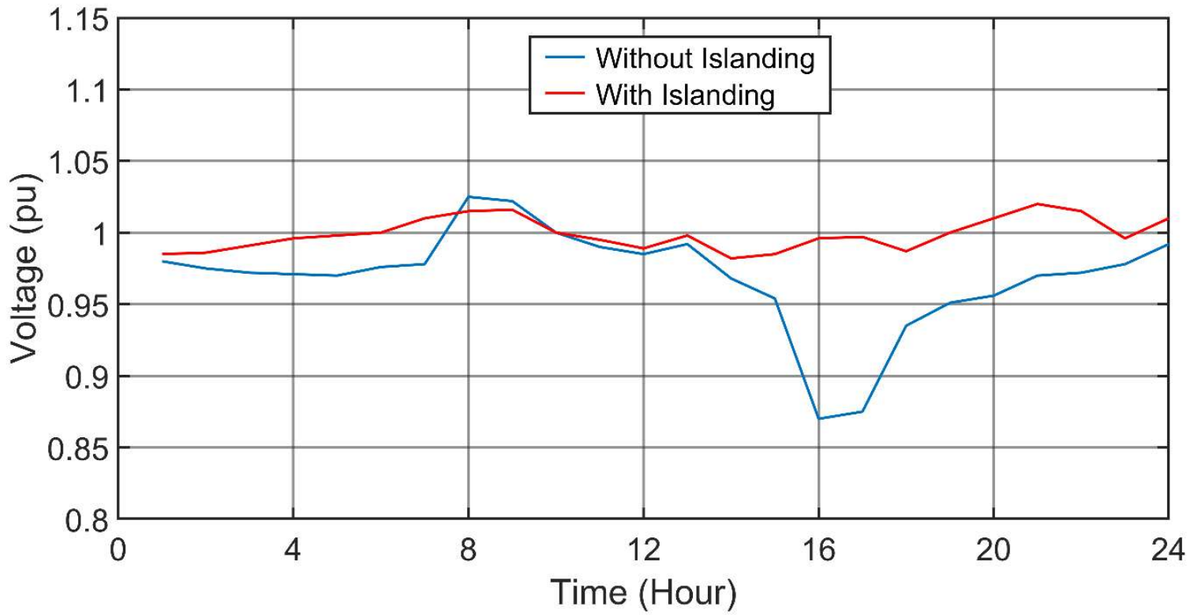
DG (Distributed Generation) and MG (Micro Grid) Modelling



Results and Analysis

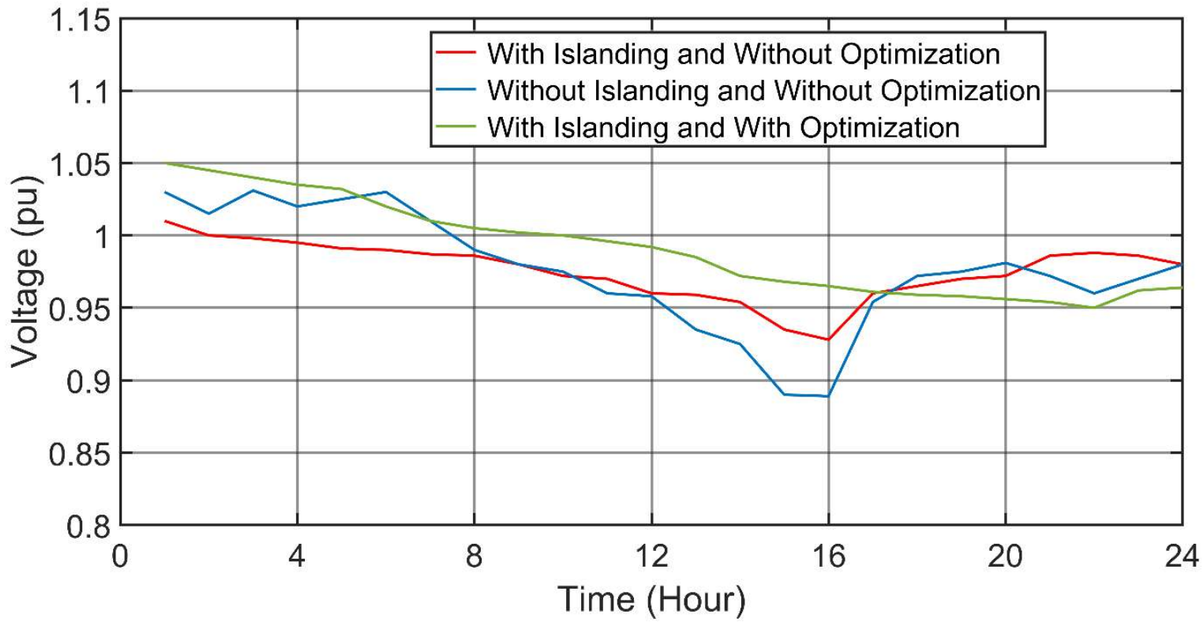


Voltage Congestion Management at Node 9 .

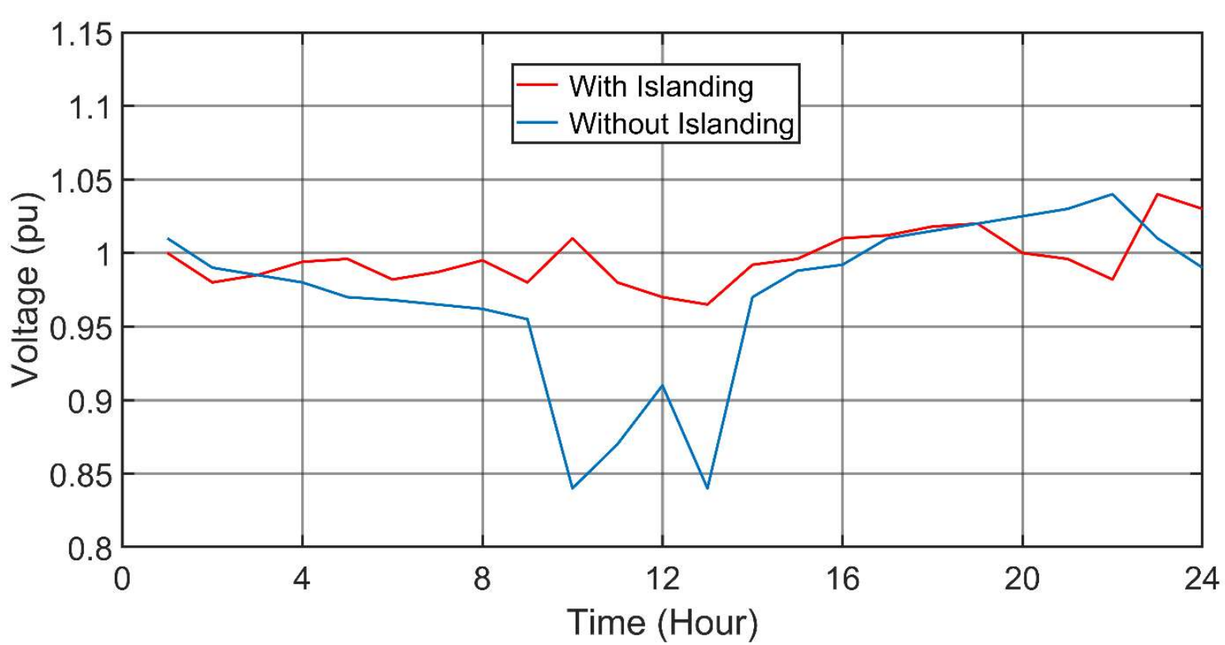


Voltage Congestion Management at Node 12 .

Results and Analysis

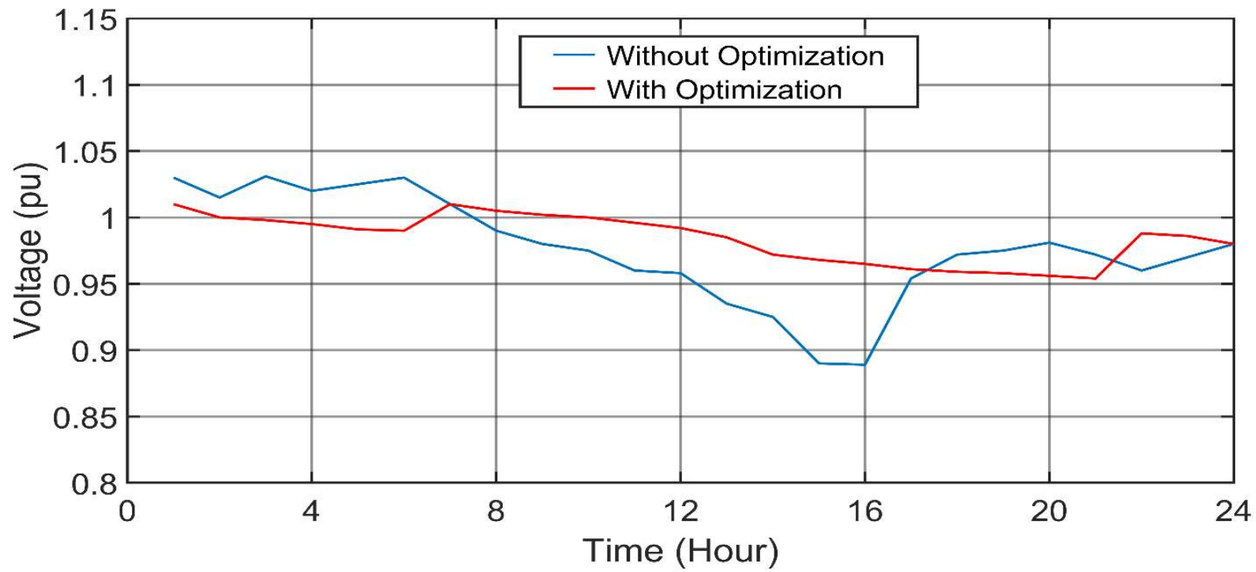


Voltage Congestion Management at Node 19 .

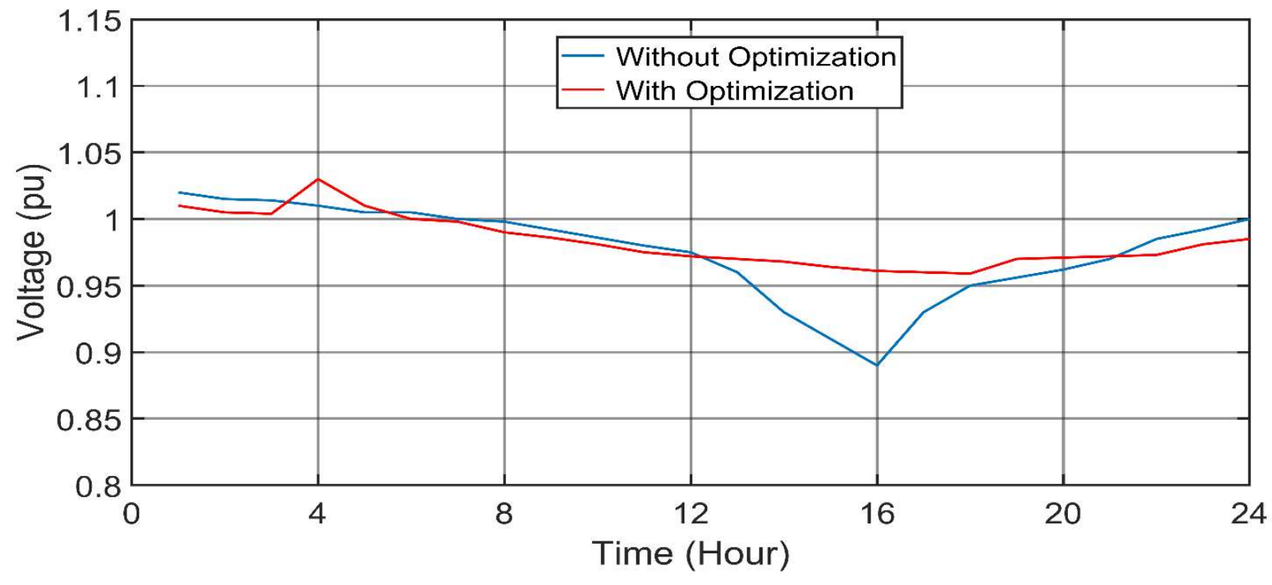


Voltage Congestion Management at Node 23 .

Results and Analysis

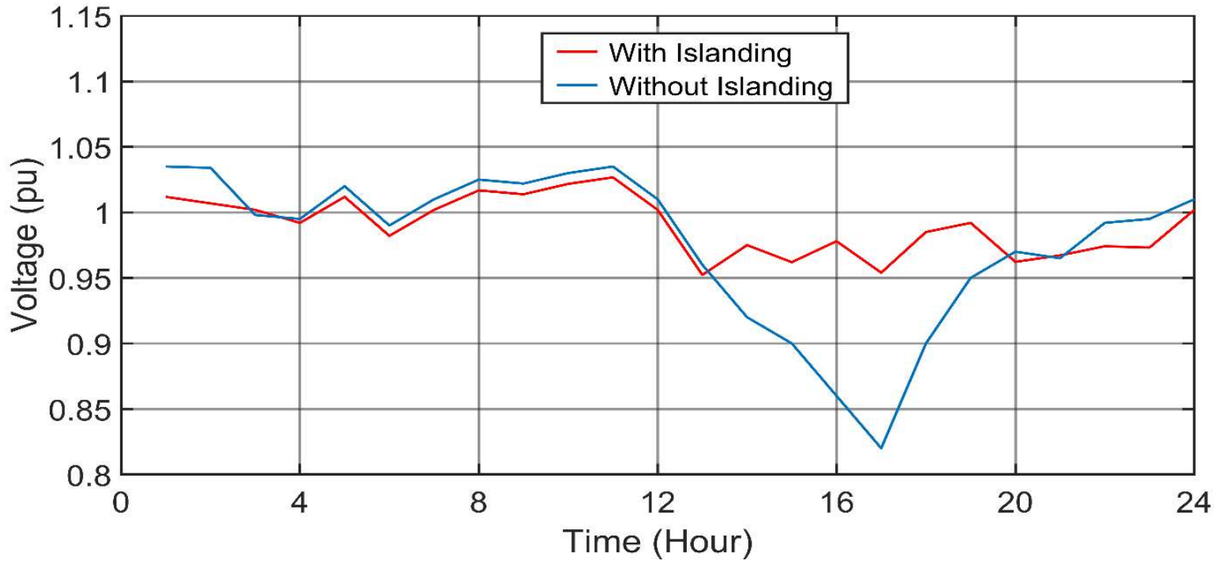


Voltage Congestion Management at Node 24 .

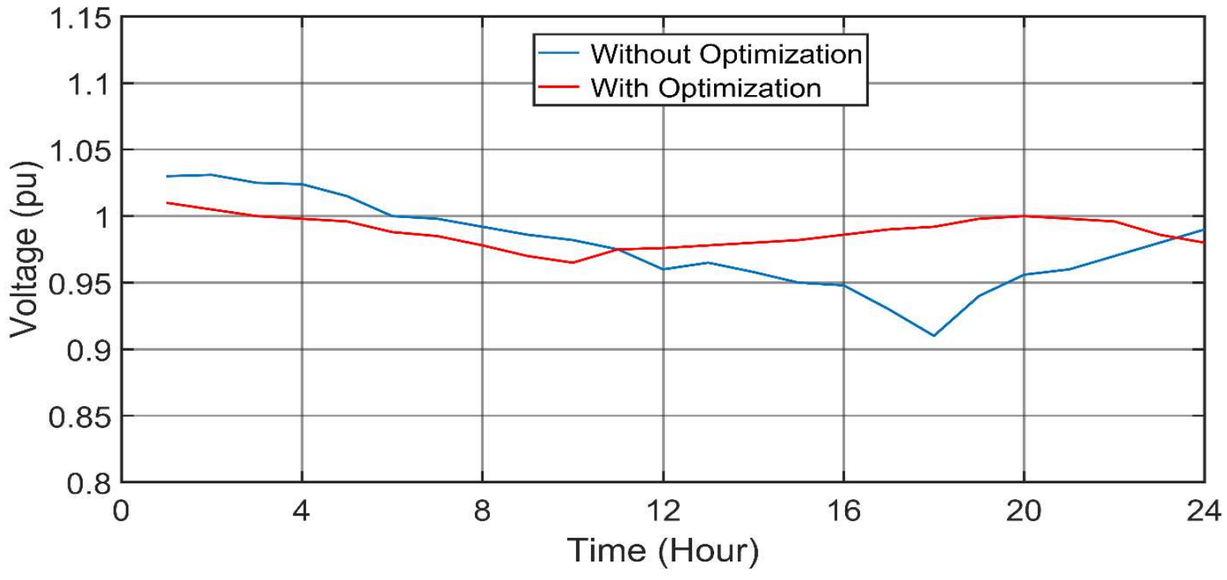


Voltage Congestion Management at Node 25 .

Results and Analysis

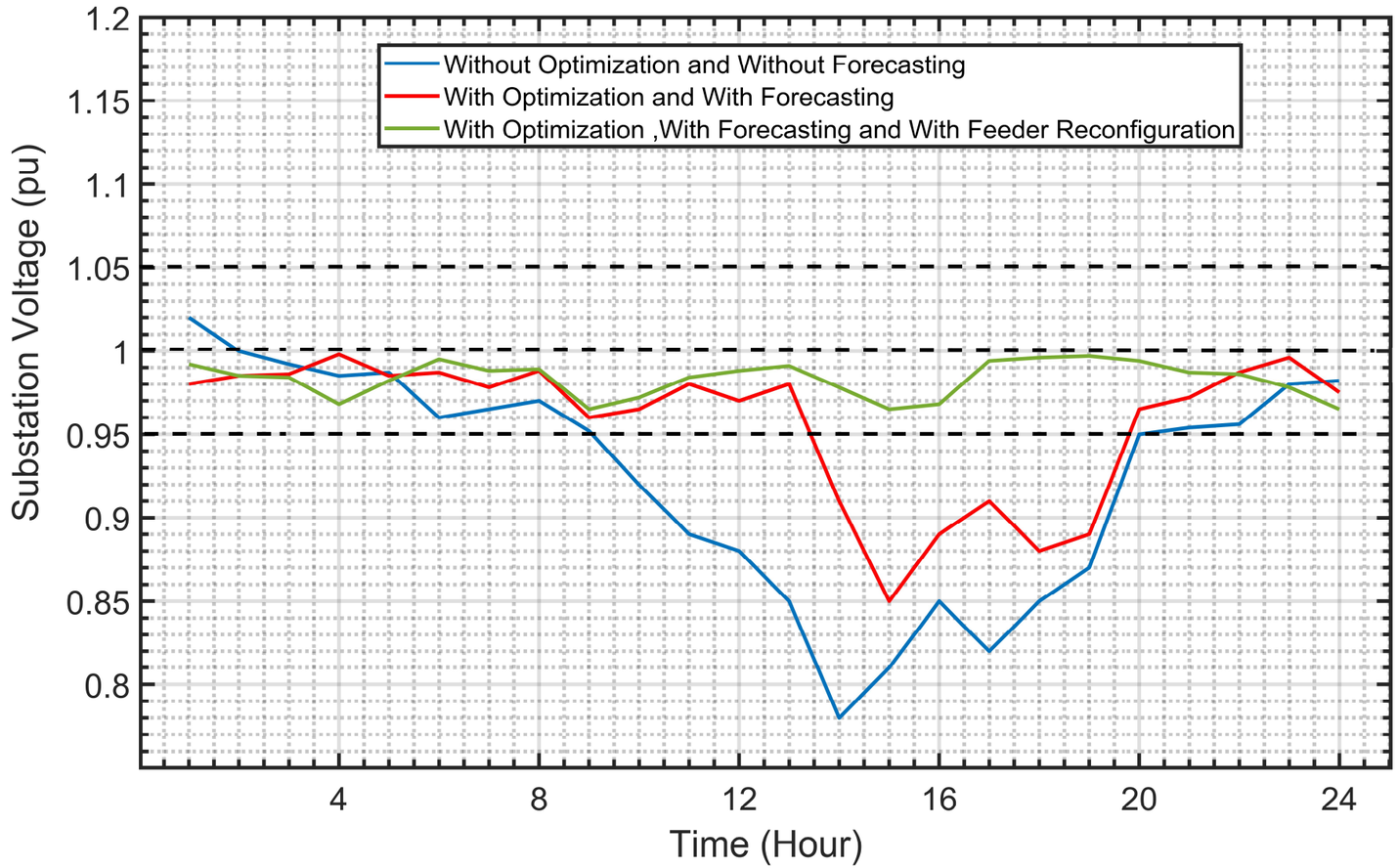


Voltage Congestion Management at Node 28 .



Voltage Congestion Management at Node 32 .

Result And Analysis



Conclusion

- Many places where there is a resource scarcity, decision making depends on Human Intuition .

- This Intuition leads to a placebo effect, causing significant errors in power system operation

- AI can replace this human intuition and produce better results if followed an established and area specific procedure.

Publications (Journals)

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2. **B. V. S. Vardhan**, M. Khedkar and P. Thakre, "A Comparative Analysis of Hold Out, Cross and Re-Substitution Validation in Hyper-Parameter Tuned Stochastic Short Term Load Forecasting," 2022 22nd National Power Systems Conference (NPSC), New Delhi, India, 2022, pp. 448-453, doi: 10.1109/NPSC57038.2022.10069288.

3. **B. V. S. Vardhan**, M. Khedkar and K. Shahare, "A Comparative Analysis of Various Stochastic approaches for Short Term Load Forecasting," 2022 International Conference for Advancement in Technology (ICONAT), 2022, pp. 1-6, doi: 10.1109/ICONAT53423.2022.9725931.

4. **B. V. S. Vardhan**, M. Khedkar, A. Shrivastav, K. Shahare, N. K. Kulkarni and P. Keshker, "Impact on Grid Side Protection in a Power System Network due to Fault Current Contribution of Distributed Generation sources," 2021 IEEE 2nd International Conference on Smart Technologies for Power, Energy and Control (STPEC), 2021, pp. 1-6, doi: 10.1109/STPEC52385.2021.9718664.

5. **B. V. S. Vardhan**, M. Khedkar, K. shahare and B. Ramesh, "Modelling based Approach for Day– Ahead Scheduling of Dynamic Market Participants for Distribution System," 2021 2nd International Conference for Emerging Technology (INCET), 2021, pp. 1-6, doi: 10.1109/INCET51464.2021.9456303.

6. Parjwal Thakre , Mohan Khedkar, **B V Surya Vardhan**, “A Comparative Analysis of Short Term Load forecasting using LSTM, CNN, and Hybrid CNN-LSTM” 2nd International Symposium On Sustainable Energy and Technological Advancements. 2023, NIT Meghalaya. **(Accepted)**

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9. B. Ramesh, M. Khedkar and **B. V. S. Vardhan**, "Priority Based Optimal Load Shedding in a Power System Network under Contingency Conditions," 2022 International Conference for Advancement in Technology (ICONAT), 2022, pp. 1-5, doi: 10.1109/ICONAT53423.2022.9725967.

Publications (News Letters)

1. **B.V. Surya Vardhan**, Mohan Khedkar , “Energy Saving Strategy For a Power System Operator Using Stochastic Short Term Load Forecasting Techniques” , Society of Engineers and Managers (SEEM),January to March 2022 , Vol 15 –No.1 ISSN-0974-0996

2. The Role of Advanced Meter Infrastructure (AMI) for Electricity Theft Detection in Smart City. Link–https://smartcities.ieee.org/newsletter/march-2023/the-role-of-advanced-meter-infrastructure-ami-for-electricity-theft-detection-in-smart-city

3. The Role of Artificial Intelligence and Block chain in Advanced Power Systems for Smart Cities. Link-https://smartcities.ieee.org/newsletter/march-2023/the-role-of-artificial-intelligence-and- blockchain-in-advanced-power-systems-for-smart-cities

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THANK YOU

Any Q ?