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ISGF
India Smart Grid Forum

DISTRIBUTION UTILITY MEET
DUM 2023

Empowering Utilities with Data Science

Transforming Customer Satisfaction through Smart Meters and Transformers

Presented By

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Executive Engineer
MPPKVVCL Indore





Electrical safety at workplace and home

1. **Follow appliance instructions**
   - Understanding home appliance safety improves both the performance of your device and your personal safety
2. **Never overloaded outlets**
   - Do not use extension cords or multi-outlet converters for appliances.
   - Only plug one heat-producing appliance into an outlet at a time.
3. **Replace or repair damaged electrical cords**
   - Consider electrical load capacity when buying power cord.
   - Pro tip: AWG stands for "American wire gauge." The lower the number, the thicker the cord!
4. **Keep your used and unused cords tidy and secure**
   - Keep stored cords away from children and pets
   - Unplug all your unused appliances
5. Keep electrical devices and outlets **away from water**
6. Ensure that all your **exhaust fans are clean**
7. Use **correct wattage** in all your fixtures and appliances

Overloaded outlets

Kitchen appliance near water

Kid playing with electrical cord

Pro tip: LED bulbs consume less power and reduce the risk of fixtures overheating.

Ref: https://www.constellation.com/energy-101/electrical-safety-tips.html

MPPKVVCL – Company Background

MPPKVVCL undertake activities of distribution and retail supply for and on behalf of **Madhya Pradesh State Electricity Board** in the areas covered by the Commissionaires of Indore and Ujjain.

Scale of Operations:

- Total Number of Consumers → 55,31,000
- Total Load → 11,500 MW
- Total Sales → MU 22,000+
- Total employee → 11,000+

MPPKVVCL operation zone

Speaker's introduction

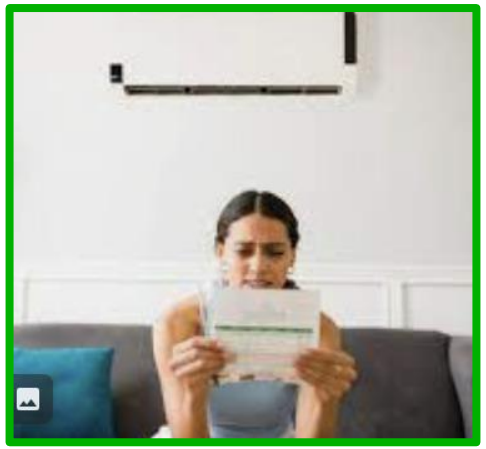
Ms. Anjali Sharma

- Mother of 6-year-old wonderful little boy
- Executive Engineer, MPKVVCL, Indore
- Head of Rajgarh O&M division
- B.Tech from RGPV University, Bhopal
- Dedicated to serving the nation through the delivery of exceptional service at workplace
- Passionate about classical Indian music and likes playing harmonium during free time

Improving customer satisfaction through data

1. Electricity Bill Projection

- Exploring the factors that influence electricity bills
- Training regression model for projecting electricity bills.
- Offer practical tips for consumers to optimize their energy expenses.



Smart meter data

2. Predicting Transformer Failures

- Predictive maintenance techniques used to forecast transformer failures.
- Real-world examples highlighting the benefits of early detection and maintenance.

Transformer

Why is bill projection important for consumers?

Problem: Challenges of High Electricity Bills

- Financial Strain
  - Creates financial strain for individuals
  - Impact on monthly budgets
- Limited Energy Access
  - Individuals limit their energy usage
  - Discomfort during extreme weather
- Budgeting Challenges
  - Unpredictable high bills
  - Stress and uncertainty
- Customer Dissatisfaction
  - Impacts customer satisfaction and trust on utility providers
  - Potential area to improve customer relations

MP: Power gets costlier, monthly bill may be up by Rs 95 if you use 2 ACs

TNN / Apr 1, 20

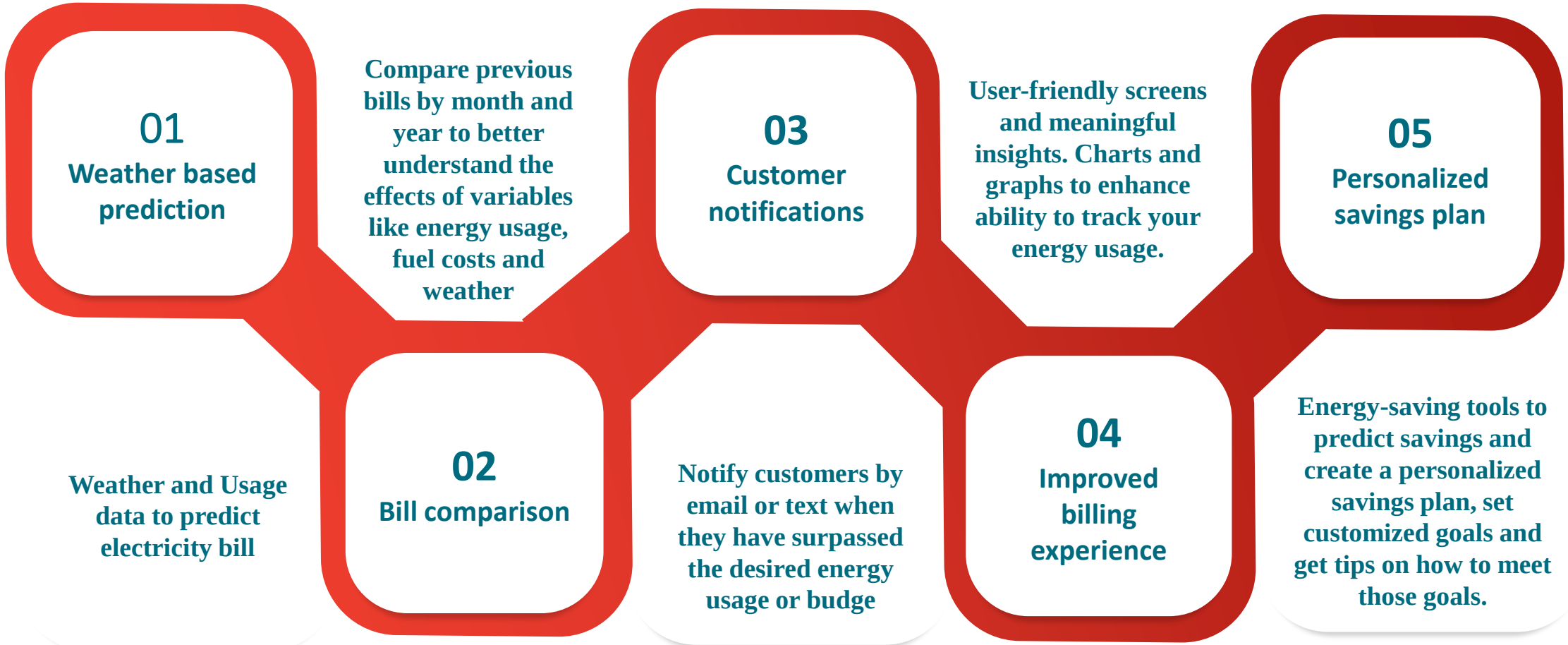
BHOPAL: Reeling from relentless hikes in petrol and diesel prices and an unusually scorching summer, people of Madhya Pradesh must now brace for steeper power costs. The state Electricity Regulatory Commission (MPERC) on Thursday announced a power tariff hike of 2. 64% for the 2023-23 fiscal.

Dissatisfied consumers

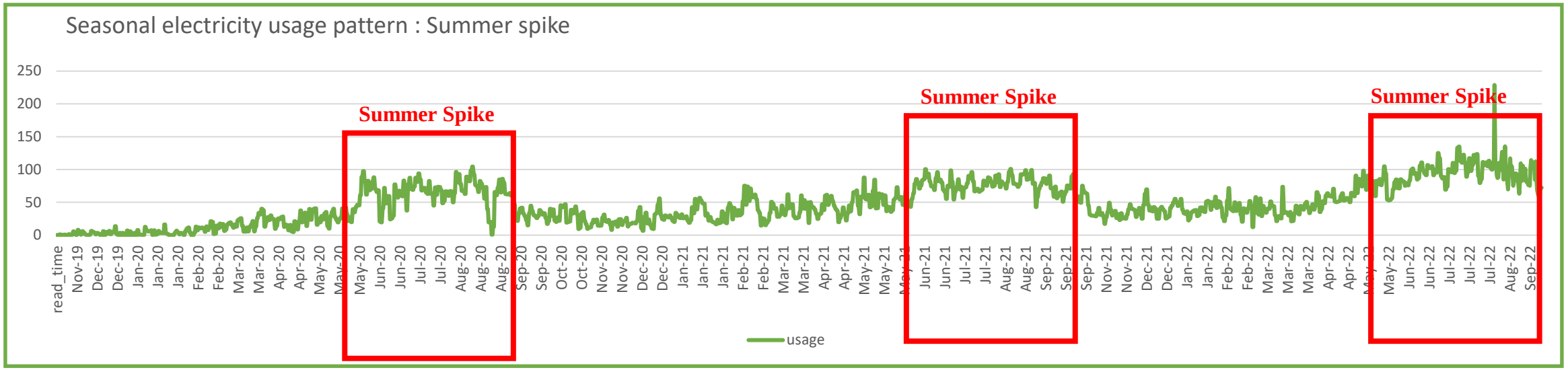
Madhya Pradesh Paschim Kshetra Vidyut Vitaran Company Ltd.

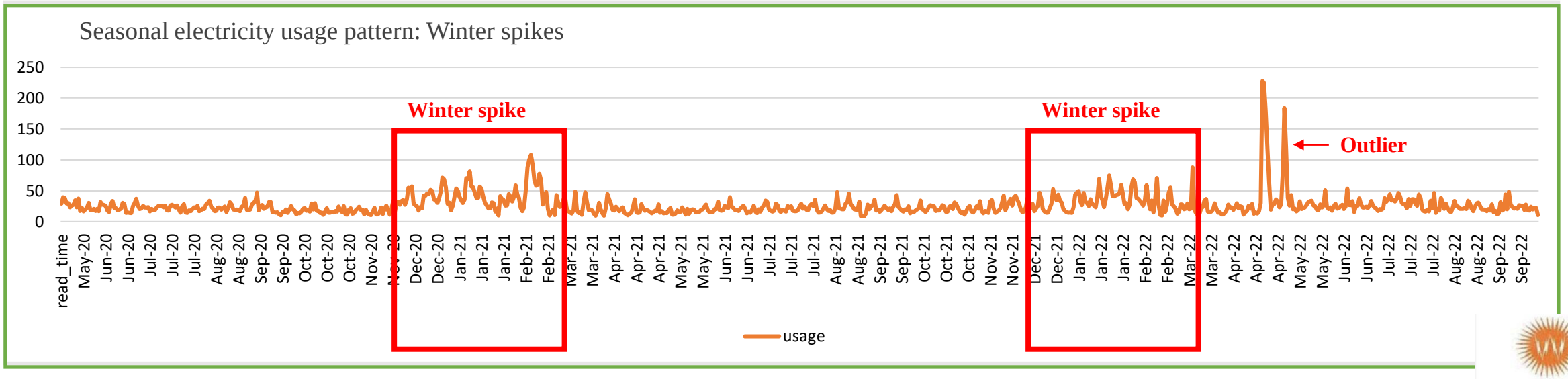
Solution and approach

Solution: Bill Projection– A CASE STUDY



Trends and Seasonality [Analyzing yearly pattern]

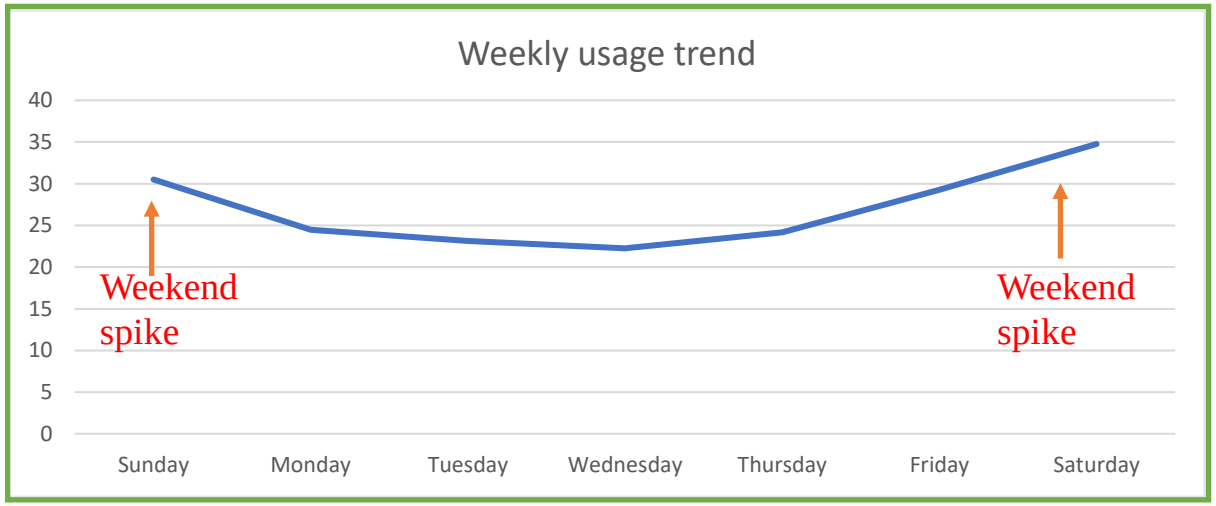




Trends and Seasonality [Analyzing Weekly and monthly pattern]

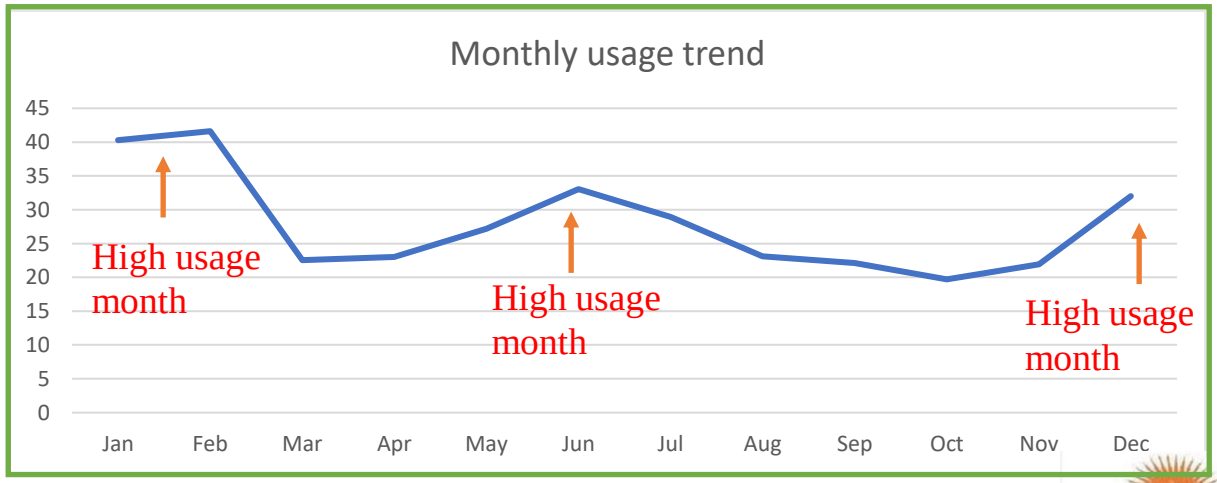
Weekly Trend:

- Fluctuation in energy usage throughout the week.
- Usage is significantly higher during the weekends (Saturday and Sunday)
- Pattern may indicate increased household activities and leisure on weekends.



Monthly Trend:

- Recurring seasonal pattern in customer consumption.
- Higher energy usage is observed during the winter months (e.g., December, January) and peak summer months (e.g., June, July).
- Trends suggest that energy consumption is influenced by seasonal factors, such as heating and cooling needs.



Model Training

Data Availability for model training

- **One year data**: Covers seasonality and scheduled to be re-trained on a monthly basis.
- **Usage(kwh):** Read on a daily basis
- **Weather(temp):** read hourly temperature

Prediction model

- 30-day regression model: Hourly temp for next 30 day
- Customers could see these projection on mobile app. And this will be updated daily. Actual & forecasted.

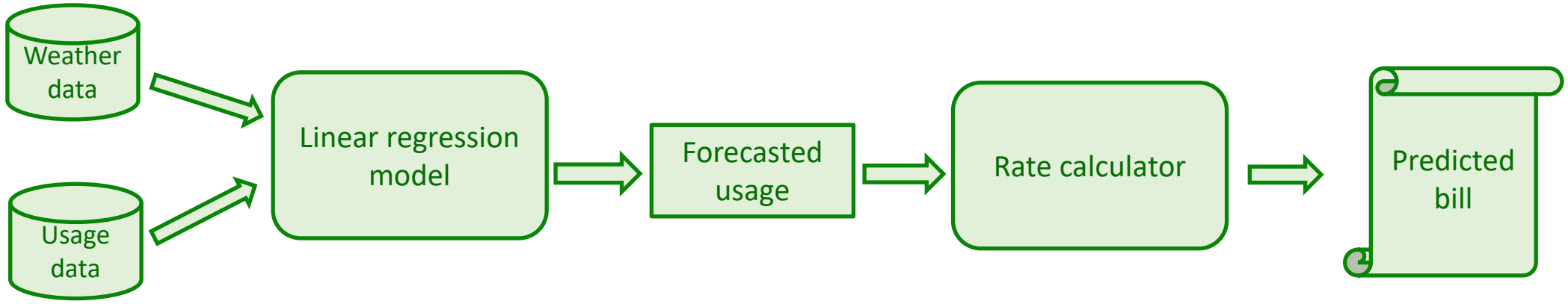
- Usage pattern
- Weather (Hourly temp)
- Month
- Weekday/weekend
- Covid
- Holidays

Predictor variables

- Actual usage
- Forecasted KwH
- Total usage
- Actual Cost
- Forecasted cost
- Total Cost

Model output

Model Configuration and Integration



- Model rules:
  - When model accuracy < 65%, usage predicted from the average of past 15 days.
  - Mean of the model r-square is the threshold for prediction.
  - Accounts < 30 days old → no projection.
    - To avoid the chances of high bill projection from poor model accuracy
- Net-metered customers and all inactive accounts → no projection.
- Retraining: Model retrained monthly, and riders are updated monthly.


मध्यप्रदेश पश्चिम क्षेत्र विद्युत वितरण कंपनी लिमिटेड: विद्युत देयक

Madhya Pradesh Paschim Kshetra Vidyut Vitaran Company Ltd.

Energy saving tips for our consumers

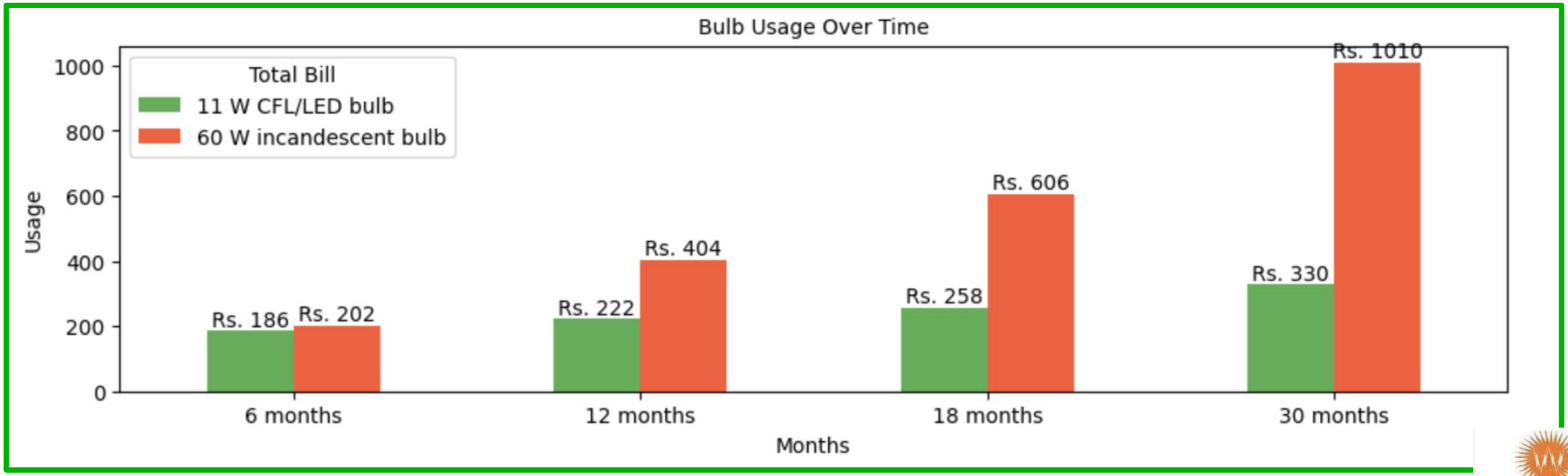
Energy Saving tips

- ✓ Incandescent bulbs are 10 to 20 times cheaper than CFL.
- ✓ CFL/LEDs are ideal for energy-efficient lighting in commercial spaces.

Graph shows the saving made by using a 11W CFL/LED against a 60W incandescent bulb over time.

Incandescent Bulb

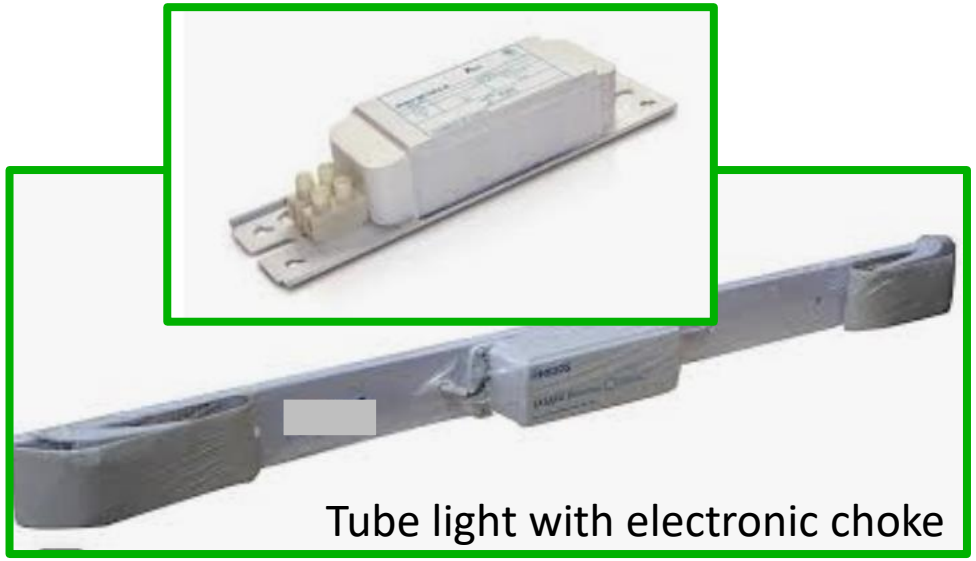
CFL/LED Bulb



Energy Saving tips

- ✓ Tube lights (36/40W) are brighter and use 40-60% less power than 60W/100W bulbs.
- ✓ Electronic choke tube lights are more energy-efficient.
- ✓ Efficiency varies among fluorescent tubes.
- ✓ LED tub-lights are even more efficient.

Below is the cost benefit analysis of the two different type of fluorescent tube lights.


Tube light with electronic choke

S. No.	Parameter	T-12 TL 40 W Regular	T-5 TL 28 W Ultra-Slim	Savings
1.	Cost (Rs.)	45	500	
2.	System Wattage	55	31	
3.	Tube & Choke	40+15	28+3	
4.	Light Output (Lumen)	2450	2900	450
5.	Annual (units) *	118	66	52 units
6.	Annual Expenditure	354	198	156

Energy Saving tips

- ✓ **”Zero-watt” bulbs** consume use 12-15 watts of power.
- ✓ Save energy with **refrigerator**
  - Minimizing refrigerator door openings.
  - Minimize defrosting: Defrost when frost exceeds 5mm thick, about 5-6 times yearly.
- ✓ Save energy with **washing machines**
  - Run full loads in washing machines to maintain consistent power consumption.
- ✓ Save 40% energy with computers
  - Enable sleep mode for computers, monitors, and copiers.
  - Turn off power strips for computers.
- ✓ Stand-by power loss
  - Unplug battery chargers for laptops, cell phones, and cameras when not in use.

Stop saying zero-watt bulb

Zero-watt bulbs

More than 50% people never shut down their work computers

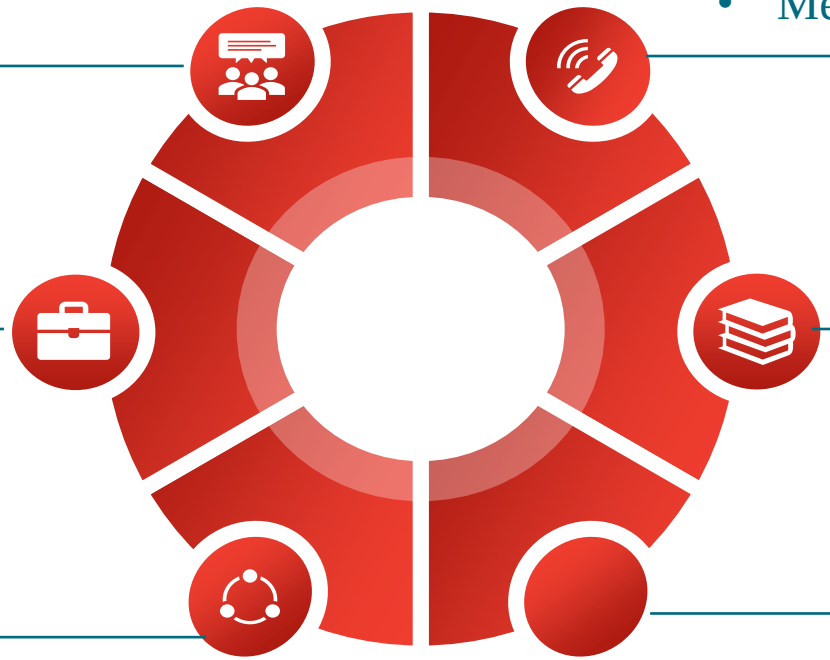
Turn off devices when not in use

Risks and challenges during implementation

Challenges and edge cases

Edge cases
- Meter dial roll over
- Meter change
- Tampered meter
- Stop/Inactive meters

Model accuracy
- Meters with inconsistent usage history
  - Seasonal accounts
- Storm/Hurricane season



Level Billed Accounts

Based on the rolling twelve-month billing average.

Automation issues
- Model monitoring and maintenance
- Regulatory compliance
- Data security and privacy

Trust on the product
- Quality and reliability
- Transparency
- Social proofs

Infrastructure issues
- Data collection and integration
- Data quality
- Model training for 55 lakh meters

Predictive maintenance through Data Science

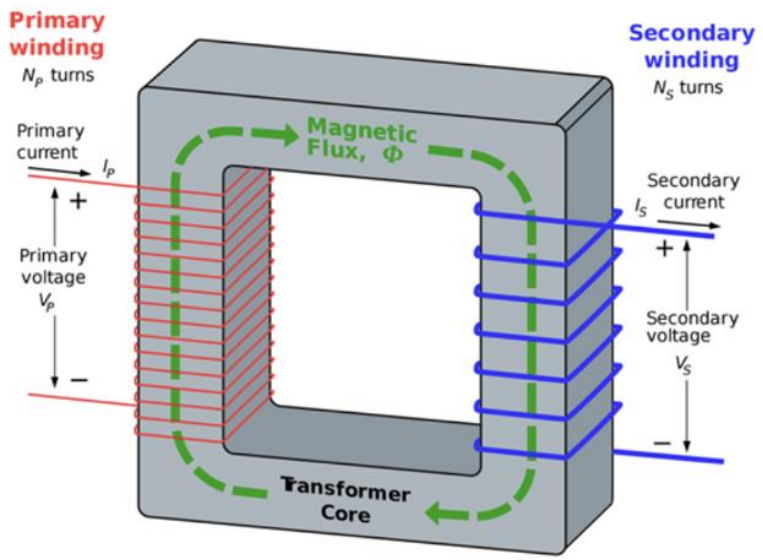
Predicting Transformer Failure

Solution: Identifying Potential Transformer failure

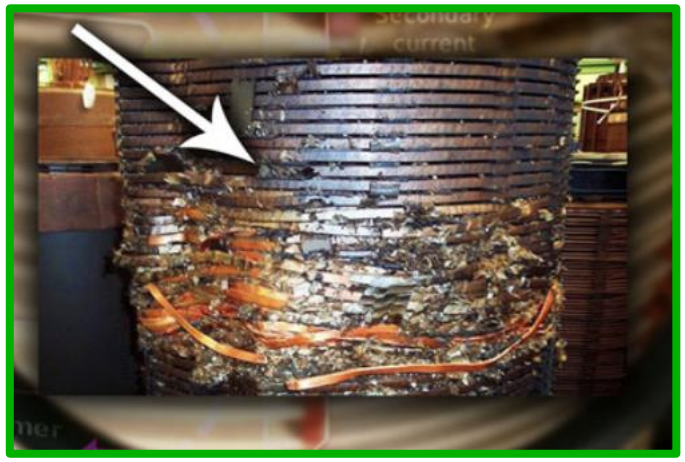
Significance of Addressing Winding Failures:

- Promptly identifying and rectifying winding failures.
- Potential financial and operational consequences if these issues are left unattended.
- Preventive maintenance and timely repairs in
  - Ensuring transformer reliability.
  - Minimizing downtime.
  - Enhancing the longevity of the equipment.
  - Reduces unplanned outages.

Transformer winding failure due to voltage fluctuations

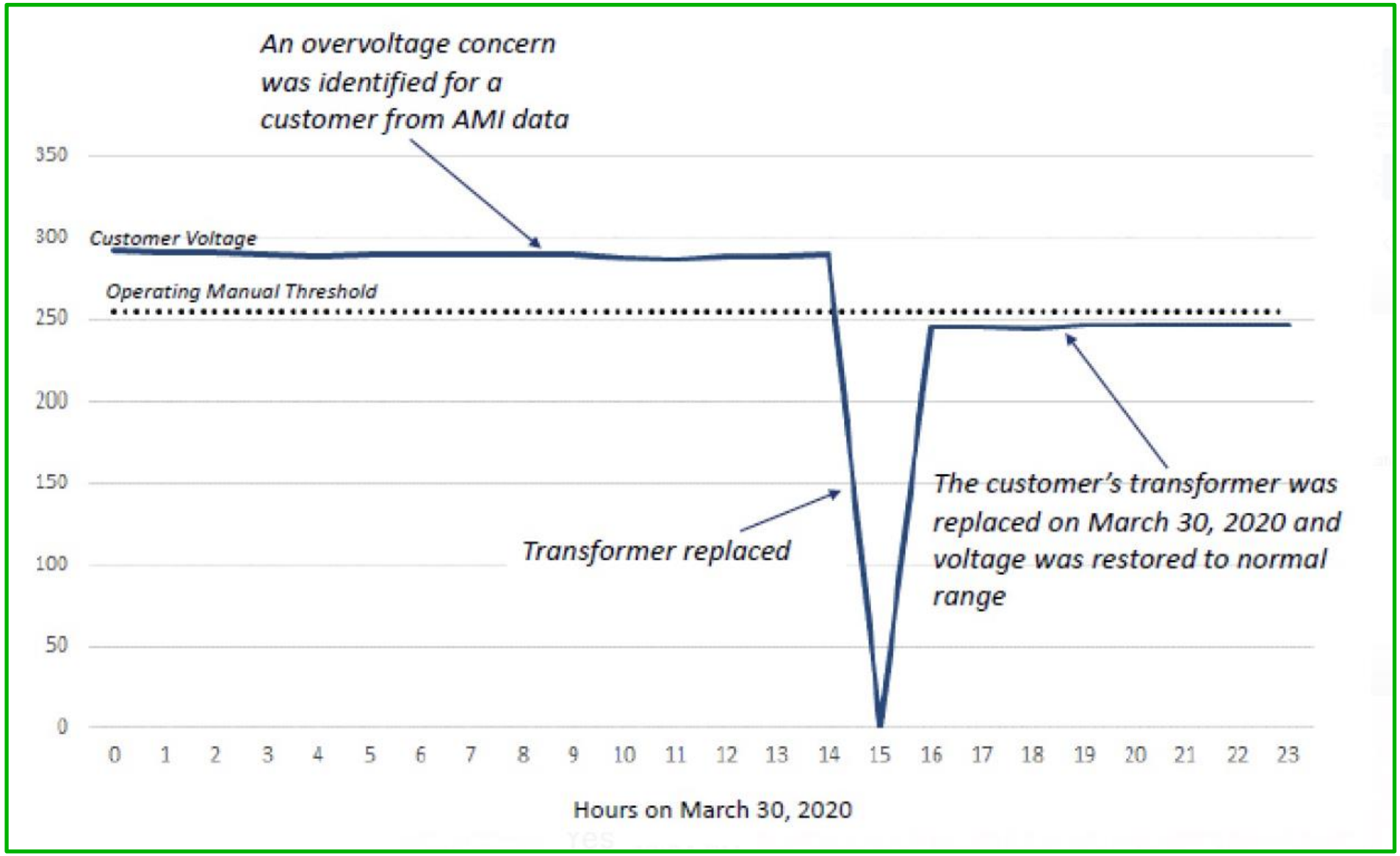


Basic Transformer Diagram

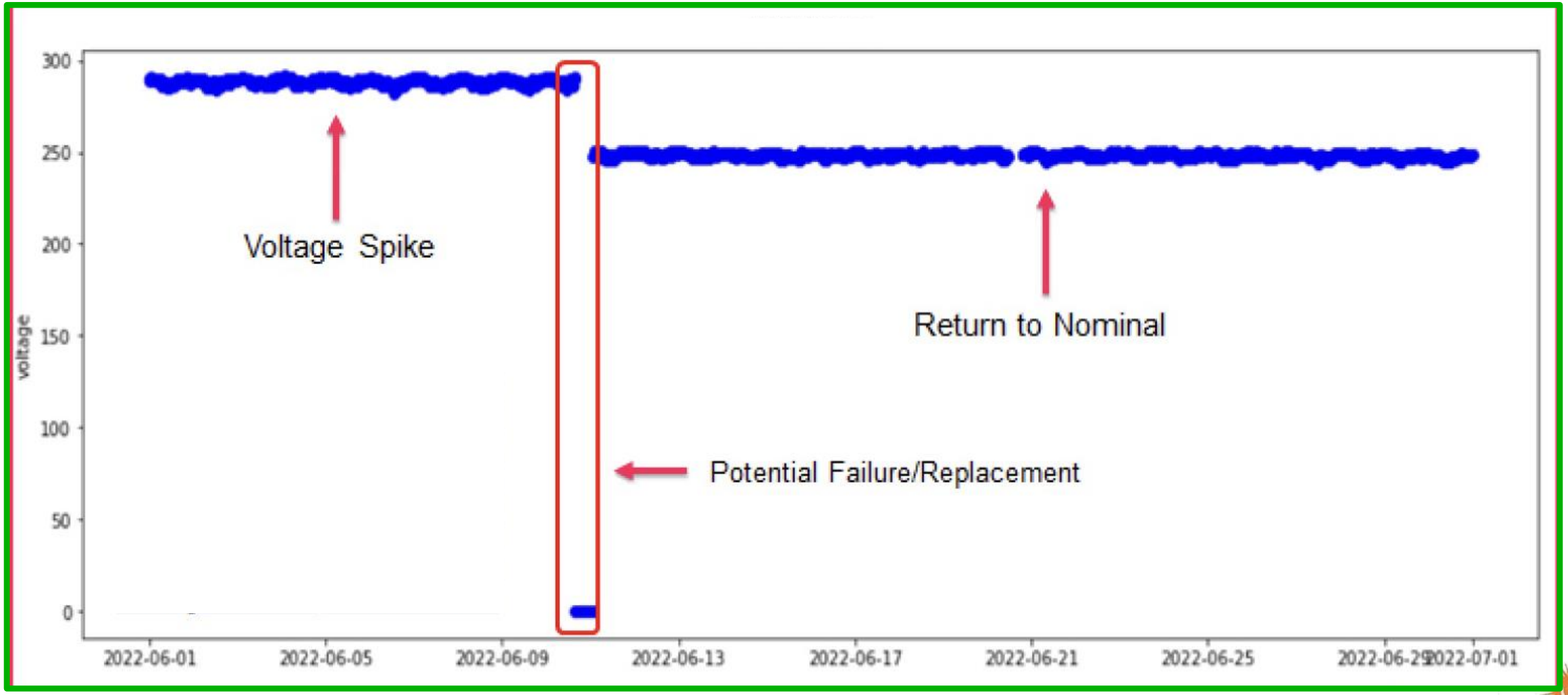


- Primary winding
  - The coil connected to the input voltage source, typically the higher voltage side.
- Secondary Winding
  - The coil connected to the load or the output side of the transformer, typically at a lower voltage.
- High Voltage Leading to Winding Failure
  - Overvoltage can stress insulation, leading to dielectric breakdown.
  - Voltage surges from transient events can cause excessive voltage stresses.
- Winding Failure Resulting in High Voltage Issues
  - Short-circuits in winding increase current and may cause overvoltage.
  - Inter-winding faults can lead to incorrect voltage levels, impacting output.

Failure Prediction: case study from American utility



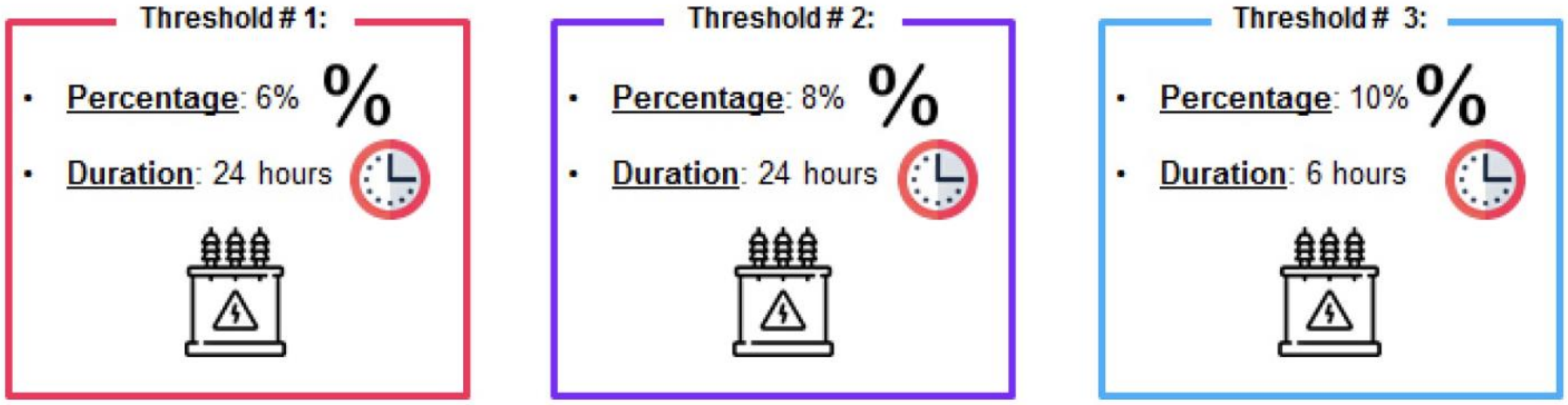
Transformer failure – Voltage return to nominal



Transformer failure – Voltage Threshold Testing

Thresholds:

- Few different approaches are tested to capture the voltage spikes in our data.
- Below are the thresholds we used (% is above nominal for the AMI meters)



Real-world examples of early detection and maintenance

- Transformer Failure and Unplanned Outage:
  - A transformer failure occurred, resulting in an unplanned power outage.
  - Disrupted the supply of electricity, causing inconvenience and potential economic losses.
- Importance of Voltage Monitoring:
  - Help detect irregularities in the electrical network, allowing for timely intervention and preventive maintenance.

मांगोद में ट्रांसफॉर्मर चालू हुई विद्युत सप्लाई!

सरदारपुर। अमझेरा विद्युत वितरण केंद्र के अंतर्गत आने वाले मांगोद केंद्र का 5, एम. वी. ए. का पॉवर ट्रांसफार्मर करीब दो माह से उतरा गया था। जिससे 10 गावों को विद्युत सप्लाई होती है। और 1025 खेती सिंचाई के स्थाई कनेक्शन है। इस पावर ट्रांसफार्म के नहीं होने से से विद्युत सप्लाई में कटौती के साथ विद्युत आपूर्ति हो रही थी। भारतीय किसान संघ सरदारपुर द्वारा दिनांक 16 अक्टूबर को ज्ञापन दिया गया था। और दो दिन में पावर ट्रांसफॉर्मर लग गया, जिसमे मालवा प्रांत के आदरणीय भाई साहब श्री दयारामजी, राजेंद्र शर्मा जी श्री महेशजी ठाकुर, श्री हरिसिंहजी पटेल श्रीलक्ष्मणसिंह जी राठौर के मार्ग दर्शन व तहसील उपाध्यक्ष रामप्रसाद राठौर, तहसील अध्यक्ष एमेश्वर चंदनोरा, सरदारपुर तहसील कार्य कारिणी के सभी कर्मठ कार्यकर्ता बंधुओं के सहयोग से यह काम हुआ तहदिल शुक्रिया व धन्यवाद।

- Avoiding Unplanned Outages:
  - The presence of a voltage monitoring system could have detected signs of trouble in the transformer before the failure.
  - Preventing the unplanned outage and ensuring uninterrupted power supply to consumers.
- Consumer Satisfaction and Happiness:
  - The happiness and satisfaction of electric consumers are directly impacted by the reliability of the power supply.
  - Unplanned outages and disruptions can lead to dissatisfaction among consumers
  - Affecting their overall experience and trust in the electrical service provider.

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THANK YOU

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