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Session : Technical Paper

TRANSFORMING POWER UTILITY O&M THROUGH ADVANCED ANALYTICS

Presented By

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INTRODUCTION

- Industry 4.0 have revolutionized various industries, and the power sector is no exception.
- Power utilities face challenges like variable load growth, lack of maintenance, outages, asset mismanagement, unreliable supply, and electricity theft.
- Machine learning can resolve these problems and reduce costs, enhance efficiency, improve planning, and enable better operation and control.

Power Utility Challenges

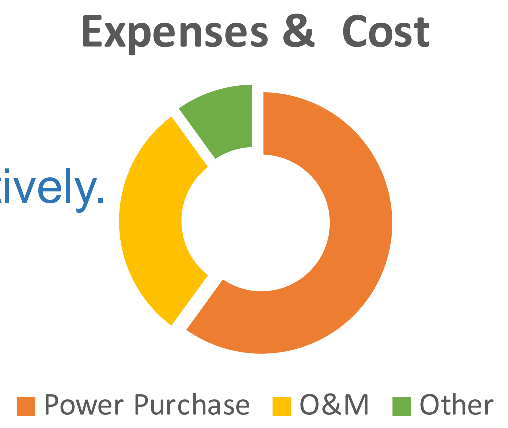
- Variable Load Growth
- Lack of Maintenance
- Repeated Outage
- Asset Mismanagement
- Unreliable Power supply
- Electricity Pilferage

Opportunities with Advance Analytics

- Reduced Maintenance cost
- Enhance efficiency
- Improved planning
- Better Operation & Control
- Cost Effectiveness
- Operation Excellence

CONTEXT

- The power utility sector faces numerous challenges, including aging infrastructure, ever increasing demand, and the integration of renewable energy sources.
- **Infrastructure aging** : It can result in equipment breakdowns, prolonged periods of downtime, and diminished reliability.
- **Cost** : Power Purchase Cost: 50-60% & Operation and Maintenance (O&M) Costs: 20-30% of total expenses.
- **Traditional approaches** to manage these challenges are no longer sufficient.
- **Advanced analytics** offers innovative solutions to address these challenges effectively.
- It has the potential to cut energy waste, lower energy cost.
- AI can also improve the planning, operation, and control of power systems.



RELEVANCE

Data-driven approach can enhance power distribution system reliability;

- **Theft detection** : Advanced metering analytics can detect energy theft based on consumption patterns, while ensuring robustness and customer privacy.
- **Asset Management** : Machine learning models can analyse the impact of assets on component lifespan, enabling better asset management.
- **Identify Abnormities**: Real-time video analytics can identify trends and alert users to abnormalities. Deep learning-enabled AI applications can detect hot spots, faults in overhead lines, and predict failures before they occur.
- **Predictive maintenance:** It is crucial for identifying fault locations, analysing abnormality patterns, and addressing them immediately.
- **Demand Prediction** : Accurate peak load prediction is essential for transformer capacity addition and planning, which can be done through linear regression models.
- **Load Optimization**: Geospatial analysis can make predictions more precise with respect to location.

APPLICATION OF ANLYTICS IN UTILITY

- AIML applications in power utilities cover various areas.
- Harnessing machine learning for predictive maintenance, precise demand forecasting, and smart grid optimization revolutionizes the power sector, while personalized customer engagement enhances satisfaction and loyalty.

Predictive Maintenance

Using machine learning algorithms to anticipate equipment failures and optimize maintenance schedules, reducing downtime and costs.

Demand Forecasting

Analysing historical data and external factors to predict future energy demand accurately, optimizing resource allocation and grid stability.

Grid Optimization

Implementing smart grid technologies and AI-driven algorithms to manage and distribute electricity more efficiently, improving reliability and resilience.

Customer Engagement

Personalizing services, offering energy usage insights, and implementing chatbots for customer support to enhance satisfaction and loyalty.

USE CASE : ELECTRICITY PILFERAGE DETECTION

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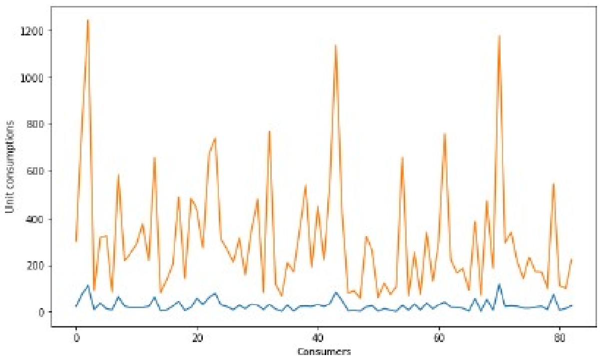
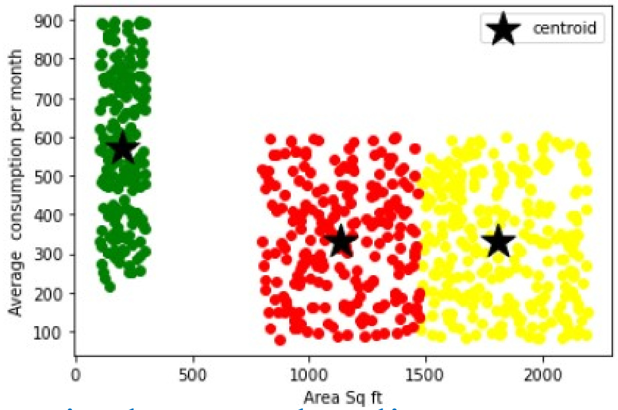
In the current system, T&D losses at the LT level are computed through a comparison between billed energy and the transformer's input energy.

Field teams conduct feeder-wise surveys to pinpoint areas of concern and eliminate theft suspicions from identified locations, constituting a labour-intensive and time-consuming procedure.

The proposed system of detecting theft is based on data analytics and machine learning K-Means clustering model.
By implementing this model, groups are formed, which are represented by the value of K.



On the basis of consumption analysis total and night consumption pattern, we can identify the location where probability of theft is high.



Also, in the same locality, K-Means clustering can be used to segregate the high and low consumption per square feet which will save **60-80% man-day.**

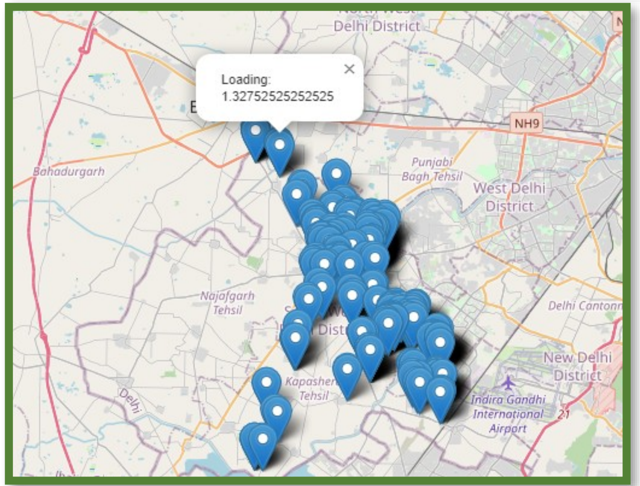
Identified locations

USE CASE : LOAD OPTIMIZATION

- The prime cause behind the LT cable burning is the overloading of the feeder. This excessive load leads to the burning of the LT AB cable, resulting in a substantial power outages.
- Geospatial analysis techniques were employed to create visual representations of transformer load distribution across the network. By assessing the proximity of overloaded and underloaded transformers, we were able to establish a systematic load redistribution strategy.

Heated LT cable

	DIVISION	KVA Rating	Name of Substation	FUNCTIONAL LOCATION	LATITUDE	LONGITUDE	loading
0	NAJAFGARH	400	W S NO 1 PAPRAWAT	1S-DL-RP-WTC-DNJF-1102-CWL109	28.595928	76.980325	0.361975
1	NAJAFGARH	400	BAWANI NGR DEENPUR	1S-DL-RP-WTC-DNJF-1102-CWL313	28.589413	76.993660	0.475900
2	NAJAFGARH	990	CHHAWLA STN 2	1S-DL-RP-WTC-DNJF-1102-CWL008	28.564276	77.000819	0.235758
3	NAJAFGARH	990	CHARA MANDI	1S-DL-RP-WTC-DNJF-1101-NAJ017	28.612337	76.990526	0.675293
4	NAJAFGARH	100	RAM KALA KHABAD MORE	1S-DL-RP-WTC-DNJF-1102-CWL063	28.536249	76.959038	1.187600




```
Transformer 1:
DIVISION                                    NAJAFGARH
KVA Rating                                        630
Name of Substation          JHARODA NO.6 NEAR MALLHA
FUNCTIONAL LOCATION    1S-DL-RP-WTC-DNJF-1101-NAJ401
LATITUDE                                    28.658386
LONGITUDE                                   76.953742
loading                                      0.532206
Name: 7, dtype: object
Transformer 2:
DIVISION                                    NAJAFGARH
KVA Rating                                        990
Name of Substation              JHARODA KALAN STN 2
FUNCTIONAL LOCATION    1S-DL-RP-WTC-DNJF-1101-NAJ030
LATITUDE                                    28.657669
LONGITUDE                                   76.954708
loading                                      1.327525
Name: 11, dtype: object
```

Visualization of nearby matching transformers

Transfer of load

USE CASE : PREDICTIVE MAINTENANCE

- Crucial parameters affecting the lifespan of substation equipment, such as the number and duration of outages, peak loading of transformers, and aging of transformers, were considered.
- A logistic regression classification machine learning model, chosen for its high accuracy (94%), was implemented with the dataset.
- This powerful machine learning algorithm utilizes the sigmoid function, providing probabilities for the selection of preventive maintenance with both continuous and discrete datasets of crucial parameters.

Material store room

	Substation Code	NCC no	BD	Trf Age	IBD	Power OFF in Hrs	Vol. balancing	Current unbalancing (max)	Peak Loading (%)	PM
0	AKJ680	583	12	20	8	10	0.05	0.460000	0.508898	1
1	AKJ327	587	11	10	6	32	0.01	0.750410	0.778923	1
2	AKJ329	570	12	22	5	21	0.04	0.138194	0.431729	1
3	AKJ679	565	11	19	11	16	0.04	0.250000	0.513507	1
4	AKJ338	577	7	10	5	47	0.02	0.163464	0.705611	1

```
LR: 0.941667 (0.076779)
LDA: 0.916667 (0.092754)
KNN: 0.896576 (0.103423)
CART: 0.918534 (0.081466)
NB: 0.917453 (0.082547)
SVM: 0.902778 (0.092962)
```

Various classification algorithms accuracy result with PM data

PM of X’mer substation

WAY FORWARD

- AIML technologies offer immense potential to transform power utilities, enabling them to overcome challenges and thrive in an increasingly complex environment.
- By embracing AIML, power companies can improve efficiency, reliability, and sustainability, ultimately delivering better services to customers and driving positive outcomes for society as a whole.

Embrace Innovation
- Encourage collaboration with technology partners and invest in R&D to stay at the forefront of AIML advancements.

Data Integration
- Ensure seamless integration of data from various sources to enhance the accuracy and effectiveness of AIML applications.

Skill Development
- Provide training programs to equip employees with the necessary skills to leverage AIML technologies effectively.

Regulatory Support
- Advocate for supportive policies and regulations that facilitate the adoption of AIML in the power utility sector.

Continuous Improvement
- Continuously monitor and evaluate AIML initiatives, seeking opportunities for optimization and innovation.

THANK YOU

For discussions/suggestions/queries

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