Smart Energy consumption using Big Data

Minor Project Presentation (IA-1)

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Introduction

- Growing urbanization → Rising energy demand
- Traditional monitoring = limited & inefficient
- Big Data + AI = Real-time monitoring & prediction
- Tools: Apache Spark, Hadoop, Kafka, Cloud, ML/DL
- Benefits: Cost savings, grid reliability, carbon footprint reduction

Problem Statement

- Huge & complex energy consumption patterns
- Traditional forecasting fails at:

  Handling large-scale smart meter data

  Real-time demand prediction

  Anomaly/cyber-attack detection

  Renewable energy integration

- Consequences → Grid instability, high costs, energy wastage

Objectives

- **Monitor & process** smart meter/IoT energy data in real time
- **Predict future consumption** using ML/DL models
- **Detect anomalies** to ensure grid reliability & security
- **Enable renewable integration** and track carbon footprint
- **Visualize insights** through dashboards (Grafana / Power BI / Tableau)

Related Works (Literature Survey)

- **Big Data Pipelines**
→ Real-time processing of massive smart meter & IoT data enables fast **forecasting & anomaly detection** → we use similar pipelines for energy data handling.

- **Early Energy Analytics** → Showed how raw consumption data can be turned into **actionable insights** → forms the base of our system design.

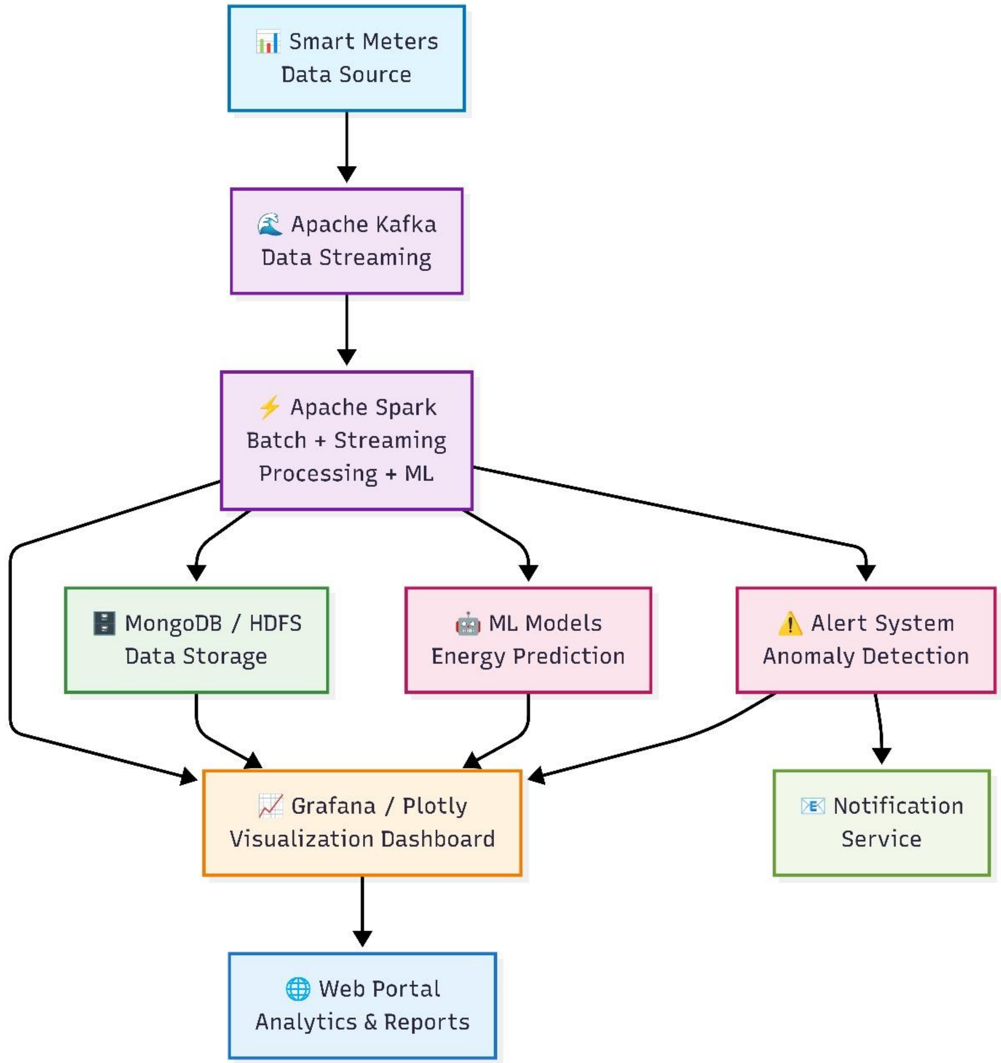
- **ML for Forecasting & Fault Detection** → Proved effectiveness of ML in **predicting demand, detecting faults, and optimizing control**
→ directly applied in our consumption prediction module.

- **Interpretable ML** → Highlighted the need for **trustworthy, explainable predictions**
→ we ensure transparency in our model outputs for decision-making.

- **Carbon Tracking** → Demonstrated near real-time carbon intensity & emission monitoring → we extend this by integrating **energy + carbon analytics** in one framework.

Proposed Technology/Methodology (Planned)

- **Smart Meters + Kafka:** Real-time energy data streaming.
- **Spark ML Processing:** Batch + streaming with predictive models.
- **Data Storage:** MongoDB / HDFS for scalable storage.
- **Dashboards:** Grafana/Plotly for visualization & anomaly alerts.
- **Web Portal:** Analytics, reporting, and notification services.



Progress (Till IA – 1)

•**Scope Finalization** – Studied the real-world problem and defined objectives clearly.

• **Literature Survey** – Reviewed existing research papers on smart energy systems, ML for efficiency (15–30%), and real-time carbon tracking frameworks.

• **Data Understanding** – Identified potential datasets (building energy, HVAC, grid data, renewable integration cases).

• **Blueprint / Dummy Model** – Built an initial dummy model to test interdependencies among parameters (kept as a baseline reference).

• **Planning** – Divided responsibilities (data collection, modeling, system framework, reporting).

•**Documentation Work** – Prepared initial draft with problem statement, objectives, and literature review findings.

Conclusion

Significant progress has been made:
from literature study → dataset collection → cleaning → development of a basic linear regression model.

Next Steps: Implement advanced ML models, integrate optimization techniques, and design the framework for renewable energy and real-time carbon tracking.

Expected Outcome: An efficient, ML-driven energy management system capable of delivering **15–30% energy savings** while supporting sustainability through automated optimization and carbon monitoring.

Roadmap for IA-2 Evaluation

Week 5 – Feature engineering & exploratory analysis

Week 6 – Model planning with evaluation metrics

Week 7 – Advanced ML model implementation (baseline forecasting)

Week 8 (IA 2) – Framework design & preliminary results

Week 9 – Model refinement & hyperparameter tuning

Week 10 – Optimization/control integration (MPC/RL baseline)

Week 11 – Testing & validation on complete dataset

Week 12 (Final) – Final report & presentation preparation

References

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