Predictive Modeling of Battery Powered Vehicles (BPVs) Charging Load on the Power Grid: A Machine Learning Approach

Thesis Proposal submission info

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1. Motivation, Existing Systems & Research Gaps

1.1 Motivation

- Battery Powered Vehicles (BPVs) are becoming a central component of global efforts toward sustainable transportation.
- In Bangladesh, particularly in expanding cities, the adoption rate of BPVs is rising rapidly.
- This growing adoption is contributing to increased electricity demand, especially from BPV charging.
- Accurate forecasting of BPV charging load is essential for:
    - Ensuring grid stability
    - Avoiding overloading or underutilization of power supply
    - Preventing power imbalances and system stress
    - Promoting efficient energy planning

1.1 Motivation

- Without predictive models, utilities may misjudge supply needs, leading to:
  - Inefficiencies in generation and distribution
  - Higher operational costs
  - This research proposes a machine learning-based model to forecast BPV charging load at the city level.
  - The objective is to provide decision-makers with data-driven tools for smart power grid management.

1.2 Existing Systems & Research Gaps

Reference	Journal Metrics	Existing Systems/Methods	Research Gaps	Key Contributions
Vulfovich et al. (2021)	**Journal**: Simulation Modelling Practice and Theory **Quartile**:Q1 **Impact Factor:** 4.719 (2022)	- Modified First Harmonic Approximation (MFHA) modeling - SN-compensated inductive power transfer links - Load-independent-voltage-output frequency systems	- Focused on component-level analysis rather than system-level - Limited scalability for grid integration - Insufficient consideration of multiple charging scenarios	- Advanced modeling of power transfer links - Load-independent voltage output techniques - Simulation frameworks for inductive charging
Schreiber & Ulbig (2023)	**Journal**: Energy and AI **Quartile**:Q1 **Impact Factor:** 7.762 (2022)	- Model selection, adaptation, and combination - Transfer learning for renewable forecasts - Wind and PV power prediction	- Focus on generation rather than load prediction - Limited application to BPV charging load profiles - Insufficient integration of charging behavior patterns	- Transfer learning techniques for power systems - Model adaptation methodologies - Renewable energy integration framework

1 . 2 Existing Systems & Research Gaps

Reference	Journal Metrics	Existing Systems/Methods	Research Gaps	Key Contributions
Yaprakdal (2023)	**Journal**: Energies **Quartile**:Q1 **Impact Factor:** 3.252 (2022)	- Ensemble deep learning for hour-ahead load forecasting - Feature selection approach - Comparative analysis with state-of-the-art methods	- Not specifically focused on BPV charging loads - Limited temporal resolution (hour-ahead only) - Lack of spatial distribution consideration in grid impact	- Novel ensemble deep learning architecture - Effective feature selection methodology - Comparative benchmarking of forecasting models
Klausmann et al. (2023)	**Journal**: Energy and AI **Quartile**:Q1 **Impact Factor:** 3.252 (2022)	- Ensemble deep learning for hour-ahead load forecasting - Feature selection approach - Comparative analysis with state-of-the-art methods	- Not specifically focused on BPV charging loads - Limited temporal resolution (hour-ahead only) - Lack of spatial distribution consideration in grid impact	- Novel ensemble deep learning architecture - Effective feature selection methodology - Comparative benchmarking of forecasting models etc.
Crespo & Aliberti (2024)	**Journal:**Engineering Applications of Artificial Intelligence **Quartile:Q1** **Impact Factor:** 8.036 (2022)	- Comparative analysis of ML techniques - Short-term grid power forecasting - Uncertainty analysis for wave energy converters	- Focus on wave energy rather than BPV charging - Limited consideration of charging behavior variability - Insufficient integration with charging infrastructure	- ML comparison framework for power forecasting - Uncertainty quantification techniques - Short-term grid power prediction methods

2. Objectives

- Design a machine learning model to forecast BPV charging load in Bangladeshi cities (Specially in Khulna, Jashore etc).
- Use a combination of synthetic datasets (traffic, temperature, trip patterns).
- Compare performance of various models: Linear Regression, Random Forest, XGBoost, LSTM, Quantile LSTM . . . etc .
- Simulate different demand scenarios (rush hours, weekends, seasons).
- (Optional) Visualize predictions and usage patterns .

3.Technology / Tools

- **Languages/Platforms:** Python, Jupyter Notebook, Google Colab
- **Visualization**: Matplotlib, Seaborn, OpenStreetMap (OSM)
- **Traffic Simulation:** SUMO (Simulation of Urban Mobility), TraCI framework
- **Communication Modeling:** OMNeT++ (for BPV-grid data exchange simulation)
- **Big Data Processing**: KNIME (optional, for visual workflow and preprocessing)

4.Time Line

Fig-1: Timeline of research working

5. References (Selected Q1/Q2 Journals & Papers)

1. **Klausmann et al. (2023)** - Energies (Q1)
Adaptive control for battery storage with peak load limitation. [Citations: 11]

2. **Yaprakdal (2023)** - Energies (Q1)
Ensemble deep learning for hour-ahead load forecasting with feature selection. [Citations: 19]

3. **Vulfovich et al. (2021)** - Simulation Modelling Practice and Theory (Q1)
Modified harmonic approximation modeling for inductive power transfer links. [Citations: 14]

4. **Schreiber & Ulbig (2023)** - Energy and AI (Q1)
Transfer learning for renewable energy forecasting; a focus on generation. [Citations: 23]

5. **Crespo & Aliberti (2024)** - Engineering Applications of Artificial Intelligence (Q1)
A comparative study of machine learning for short-term grid forecasting with uncertainty analysis. [Citations: 9]

6.Suggestions / Any question

If you have any question ,

you may ask .

Thank You