1. **Summary of the Paper**

- **Title**: Charging Strategies for Electric Vehicles Using a Machine Learning Load Forecasting Approach for Residential Buildings in Canada
- **Paper Name**: (Applied Sciences_2024_Charging Strategies for Electric Vehicles Using a Machine Learning Load Forecasting Approach for Residential Buildings in Canada)
- **Authors**: Ahmad Mohsenimanesh (Corresponding Author), Evgueniy Entchev
- **Journal**: Applied Sciences
- **Publisher**: MDPI
- **Published Year**: 2024
- **Workflow/Process**: The study involves analyzing EV charging behaviors and developing strategies to optimize charging loads during peak periods, particularly in winter. It utilizes a hybrid machine learning approach for load forecasting.
- **Methodology**: The methodology includes a hybrid machine learning method that combines similar day selection, complete ensemble empirical mode decomposition with adaptive noise, and deep neural networks to predict EV charging loads.
- **Approaches**: The paper proposes three charging strategies: Overnight Charging, Workplace/Other Charging Sites, and Overnight Workplace/Other Charging Sites, aimed at reducing peak electricity demand.
- **Source**: The study is based on data collected from 1000 EVs across nine provinces in Canada.
- **Dataset**: The dataset includes charging loads for thirty-five vehicle models, charging locations, and levels.
- **Dataset Availability**: The dataset is not explicitly stated as open-accessible.
- **Dataset Source Link**: Sorry, can't generate citation of the paper due to insufficient data.
- **Research Gaps**: The paper identifies a lack of effective charging strategies for residential EV fleets and the need for improved load modeling techniques that account for non-linear patterns and seasonal variations.
- **Research Key Findings**: The proposed strategies can significantly reduce the Peak-to-Average Ratio (PAR) and energy costs, with reductions of approximately 54% and 56% in charging costs during spring and winter, respectively.
- **Paper's Results/Output**: The Overnight Workplace/Other Charging Sites strategy resulted in PAR values being approximately half of those on the predicted load profile, indicating effective load management during peak periods .

2. **Summary of the Paper**

- **Title**: DiffPLF: A Conditional Diffusion Model for Probabilistic Forecasting of EV Charging Load
- **Paper Name**: (PSCC_2024_DiffPLF)
- **Authors**: Siyang Li, Hui Xiong, Yize Chen
- **Journal**: Power Systems Computation Conference
- **Publisher**: IEEE
- **Published Year**: 2024
- **Workflow/Process**: The paper proposes a novel diffusion model, DiffPLF, which utilizes a denoising diffusion process combined with a cross-attention mechanism to forecast EV charging load probabilistically. The model is trained to predict multiple probabilistic intervals based on historical data and covariates .
- **Methodology**: The methodology involves selecting informative covariates such as weather forecasts, calendar variables, and the number of EVs to improve forecasting accuracy. The model approximates the conditional predictive distribution of future charging loads .
- **Approaches**: The approach includes a task-informed fine-tuning technique to enhance the model's adaptability for probabilistic time-series forecasting, allowing for controllable generation of charging demand profiles .
- **Source**: Not specified
- **Dataset**: Not specified
- **Dataset Availability/Public/Open-accessible**: Not specified
- **Dataset Source Link**: Not specified
- **Research Gaps**: The paper identifies the need for improved forecasting methods due to the stochastic nature of EV charging behaviors and external factors affecting load patterns .
- **Research Key Findings**: The findings indicate that DiffPLF significantly outperforms traditional methods, achieving a 39.58% improvement in Mean Absolute Error (MAE) and a 49.87% improvement in Continuous Ranked Probability Score (CRPS) .
- **Paper's Results/Output**: The results demonstrate that DiffPLF can effectively predict complex temporal patterns of erratic charging loads and generate controllable forecasts based on specific covariates .

3. **Summary of the Paper**

- **Title**: Divide-Conquer Transformer Learning for Predicting Electric Vehicle Charging Events Using Smart Meter Data
- **Paper Name**: (arXiv_2024_Divide-Conquer Transformer Learning for Predicting Electric Vehicle Charging Events Using Smart Meter Data)
- **Authors**: Fucai Ke, Hao Wang
- **Journal**: arXiv preprint
- **Publisher**: arXiv
- **Published Year**: 2024
- **Workflow/Process**: The paper develops a home charging prediction method using historical smart meter data, inspired by nonintrusive load monitoring (NILM). It employs a self-attention mechanism-based transformer model with a "divide-conquer" strategy to process data for predicting EV charging occurrences at one-minute intervals.
- **Methodology**: The methodology involves leveraging smart meter data to predict future EV charging events, enhancing utility for charging management.
- **Approaches**: The approach includes a transformer model that processes historical data to learn EV charging representations, focusing on predictive accuracy.
- **Source**: Not specified
- **Dataset**: Historical smart meter data
- **Dataset Availability/Public/Open-Accessible**: Not specified
- **Dataset Source Link**: Not specified
- **Research Gaps**: The paper addresses the lack of effective prediction methods for home EV charging due to limited access to relevant data.
- **Research Key Findings**: The method achieves high prediction accuracy of over 96.81% across different time spans, demonstrating its effectiveness using only smart meter data.
- **Paper's Results/Output**: The results indicate that the proposed method outperforms baseline models, achieving higher F1 scores, AUC, AP, and ACC, while maintaining lower MSE .

4. **Summary of the Paper**

- **Title**: Electric Load Prediction of Electric Vehicle Charging Stations Based on Moving Average-Gated Recurrent Unit
- **Paper Name**: (Processes 2025_Electric Load Prediction of Electric Vehicle Charging Stations Based on Moving Average-Gated Recurrent Unit)
- **Authors**: Wei Huang, Chuanhong Ru, Jian Qin, Yong Lin, Qingxi Cai, Bing Song
- **Journal**: Processes
- **Publisher**: MDPI
- **Published Year**: 2025
- **Workflow/Process**:
  - The process begins with historical data collection of electric loads from charging stations.
  - Data is smoothed using the moving average method to reduce noise.
  - The smoothed data is then modeled using the gated recurrent unit (GRU) to predict future electric loads.
  - The model's validity is tested against actual datasets from electric vehicle charging stations.
- **Methodology**:
  - The moving average method is employed for data smoothing.
  - The GRU is utilized for modeling and predicting future electric loads based on the processed data.
- **Approaches**:
  - The study compares the proposed MA-GRU method with the classic LSTM model, highlighting the advantages of the MA-GRU in terms of prediction accuracy.
- **Source**:
  - The research is based on the historical electric load data from electric vehicle charging stations.
- **Dataset**:
  - The dataset consists of historical electric load data from actual charging stations.
- **Dataset Availability/Public/Open-Accessible**:
  - The dataset's availability is not specified in the provided context.
- **Dataset Source Link**:
  - No specific link is provided for the dataset.
- **Research Gaps**:

- o The paper addresses the challenges of predicting short-term power consumption due to various influencing factors.
- **Research Key Findings**:
  - o The MA-GRU method demonstrates improved prediction accuracy compared to the LSTM model.
- **Paper's Results/Output**:
  - o The proposed MA-GRU model effectively balances the load of the power grid and enhances the reliability of electric vehicle charging stations .

5. **Summary of the Given Paper**

- **Title**: Electric Vehicle charging station load forecasting with an integrated DeepBoostapproach
- **Paper Name**: (Alexandria Engineering Journal_2024_Electric Vehicle charging station load forecasting with an integrated DeepBoostapproach)
- **Authors**: Joveria Siddiqui, Ubaid Ahmed, Adil Amin, Talal Alharbi, Abdulelah Alharbi, Imran Aziz, Raza Khan, Anzar Mahmood
- **Journal**: Alexandria Engineering Journal
- **Publisher**: None
- **Published Year**: 2024
- **Workflow/Process**:
  - o The study begins with the identification of the need for effective forecasting of Electric Vehicle (EV) charging loads due to the increasing adoption of EVs.
  - o It employs a novel DeepBoost approach that integrates multiple machine learning models for improved forecasting accuracy.
- **Methodology**:
  - o The methodology includes the use of Categorical Boosting (CatBoost), Extreme Gradient Boosting (XgBoost), Long Short-Term Memory Network (LSTM), and Linear Regression (LR) models to forecast day-ahead EV charging station load.
- **Approaches**:

- o The proposed DeepBoost model is compared against conventional models like CatBoost, XgBoost, and LSTM, as well as hybrid methodologies.
- o The study also implements data preprocessing strategies and hyper-parameter optimization techniques to enhance model performance.
- **Source**:
  - o The research is based on data collected from EV charging stations in the Pukou District, Nanjing.
- **Dataset**:
  - o The dataset consists of EV charging load data recorded at 5-minute intervals.
- **Dataset Availability/Public/Open-Accessible**:
  - o The dataset is not explicitly stated as open-access in the provided context.
- **Dataset Source Link**:
  - o Sorry, can't generate citation of the paper due to insufficient data.
- **Research Gaps**:
  - o The paper identifies the need for improved forecasting methods to handle the additional load on the grid due to EVs.
- **Research Key Findings**:
  - o The DeepBoost approach significantly outperforms conventional models, with a reported improvement in Mean Absolute Error (MAE) by 9.4%, 32.7%, and 88% compared to CatBoost, XgBoost, and LSTM, respectively.
- **Paper's Results/Output**:
  - o The proposed model achieved a RMSE of 60.53 and MAE of 46.83, indicating its effectiveness in forecasting EV charging loads .

6. **Summary of the Paper**

- **Title**: Electric Vehicle Charging Load Time-Series Prediction Based on Broad Learning System
- **Paper Name**: (IEEE_2023_Electric Vehicle Charging Load Time-Series Prediction Based on Broad Learning System)
- **Authors**: Wang Sike, Yu Liansong
- **Journal**: IEEE

- **Publisher**: None specified
- **Published Year**: 2023
- **Workflow/Process**: The paper establishes a time-series prediction model for EV charging load using a broad learning system (BLS). It analyzes actual charging load data, processes it, and constructs a prediction model that accounts for various influencing factors and time-series characteristics.
- **Methodology**: The methodology involves data analysis and processing followed by the establishment of a BLS-based prediction model. Simulation experiments validate the model's performance against traditional models.
- **Approaches**: The approach includes using a broad learning system to capture the nonlinear and random nature of EV charging loads, improving prediction accuracy and reducing computation time compared to back propagation neural networks and long-short term memory models.
- **Source**: State Grid Electric Power Research Institute Wuhan Nanrui Co., LTD, Wuhan, China
- **Dataset**: Actual data from a region in the UK regarding EV charging loads.
- **Dataset Availability**: Not specified as open-accessible.
- **Dataset Source Link**: Not provided.
- **Research Gaps**: The paper addresses the low accuracy in EV charging load prediction due to the nonlinear and random characteristics of the data.
- **Research Key Findings**: The BLS-based model demonstrates superior prediction performance and efficiency compared to traditional models.
- **Paper's Results/Output**: The proposed model effectively predicts EV charging loads, providing a strong reference for optimal scheduling of EVs in realistic environments .

7. **Summary of the Paper**

- **Title**: Machine learning-based multivariate forecasting of electric vehicle charging station demand
- **Paper Name**: (Electronics Letters_2024_Machine learning-based multivariate forecasting of electric vehicle charging station demand)

- **Authors**: Najmul Alam, M A Rahm, Md Rashidul Islam, M J Hossain
- **Journal**: Electronics Letters
- **Publisher**: None
- **Published Year**: 2024
- **Workflow/Process**: The study involves a comparative analysis of univariate and multivariate forecasting models, focusing on the incorporation of metadata such as charging time, GHG savings, and gasoline savings to enhance prediction accuracy. The models are evaluated based on their performance metrics (MSE, RMSE, MAE) under normal and noisy conditions.
- **Methodology**: The research employs machine learning techniques to forecast electric vehicle charging station (EVCS) demand, comparing the performance of various models including GRU and CNN + LSTM.
- **Approaches**: The study utilizes a multivariate forecasting approach that integrates historical metadata to capture complex dependencies among variables, contrasting it with traditional univariate methods.
- **Source**: The findings are derived from experimental results obtained through model performance analysis.
- **Dataset**: The dataset includes historical data related to EVCS demand, metadata on charging times, GHG savings, and gasoline savings.
- **Dataset Availability/Public/Open-accessible**: The dataset's availability is not explicitly mentioned in the provided context.
- **Dataset Source Link**: Not provided in the context.
- **Research Gaps**: The study identifies a lack of comparative analysis between univariate and multivariate forecasting methods incorporating metadata, which this research aims to address.
- **Research Key Findings**: The research indicates that multivariate forecasting models, particularly the GRU model, significantly outperform univariate models in terms of accuracy and reliability for EVCS demand forecasting.
- **Paper's Results/Output**: The GRU model achieved an MSE of 8.86864×10^{-6}, an RMSE of 0.00297, and an MAE of 0.00266, demonstrating its effectiveness in capturing complex temporal dependencies and providing reliable predictions .

8. **Summary of the Given Paper**

- **Title**: Evaluating machine learning algorithms for energy consumption prediction in electric vehicles -A comparative study
- **Paper Name**: (Scientific Reports_2025_Evaluating machine learning algorithms for energy consumption prediction in electric vehicles -A comparative study)
- **Authors**: Izhar Hussain (Corresponding Author), Kok Boon, Ching 1, Chessda Uttraphan, Kim Gaik Tay, Adil Noor.
- **Journal**: Scientific Reports.
- **Publisher**: Not explicitly provided.
- **Published Year**: 2025.
- **Workflow/Process**: The authors drafted the manuscript, reviewed the article, and contributed to the analysis of results, incorporating mathematical formulations and theoretical aspects into the paper .
- **Methodology**: The study employed various machine learning algorithms, including LSTM, ARIMA, and ensemble models, to forecast energy demand .
- **Approaches**: The research evaluated models like LightGBM, Gradient Boosting, and Extra Trees, focusing on their performance metrics such as RMSE and R^2 .
- **Source**: Not explicitly provided.
- **Dataset**: Datasets from wind farms, solar farms, EV charging stations, and SCADA systems were utilized .
- **Dataset Availability**: Not explicitly stated; however, datasets are implied to be accessible for research purposes.
- **Dataset Source Link**: Not provided.
- **Research Gaps**: The study highlights the limitations of existing models in capturing complex non-linear interactions and the dependency on historical data .
- **Research Key Findings**: The Extra Trees Regressor achieved the best performance metrics, indicating the effectiveness of ensemble models in energy demand predictions .
- **Paper's Results/Output**:
  - Extra Trees Regressor: MAE = 0.5888, MSE = 3.2683, R^2 = 0.9592, RMSE = 1.8078, NRMSE = 0.020.
  - LightGBM showed slightly less resilience in capturing complex patterns compared to other models .

9. **Summary of the Paper**

- **Title**: Forecasting Battery Electric Vehicle Charging Behavior: A Deep Learning Approach Equipped with Micro-Clustering and SMOTE Techniques
- **Paper Name**: (EV Studies_2022_Forecasting Battery Electric Vehicle Charging Behavior: A Deep Learning Approach Equipped with Micro-Clustering and SMOTE Techniques)
- **Authors**: Hanif Tayarani, Trisha V Ramadoss, Vaishnavi Karanam, Gil Tal, Christopher Nitta
- **Journal**: EV Studies.
- **Publisher**: University of California, Davis
- **Published Year**: 2022
- **Workflow/Process**: The study involves collecting data from 400 households and 800 cars, focusing on 400 PEVs, and utilizing a Micro-Clustering Deep Neural Network (MC-DNN) to analyze trip and charging data for forecasting charging events. The methodology includes data logging over a year and applying various error criteria for performance assessment.
- **Methodology**: The MC-DNN is trained on a robust dataset of trips and charges from California (2015-2020), employing techniques like micro-clustering and SMOTE for better prediction accuracy.
- **Approaches**: The proposed method integrates K-means clustering in unsupervised space and DNN in supervised space, utilizing error criteria such as accuracy, precision, recall, F-measure, and G-mean for evaluation.
- **Source**: Advanced Plug-in Electric Vehicle (PEV) Driving and Charging Behavior Project.
- **Dataset**: The dataset includes trip and charging data from 132 BEVs, totaling 1,570,167 vehicle miles traveled.
- **Dataset Availability/Public/Open-Accessible**: Not specified.
- **Dataset Source Link**: Not specified.
- **Research Gaps**: The paper suggests that future work could explore Generative Adversarial Networks (GAN) to create synthetic datasets based on internal combustion engine vehicle behavior.
- **Research Key Findings**: The MC-DNN outperforms benchmark methods in predicting BEV charging behavior, indicating its effectiveness for utility managers and electricity load aggregators.

- **Paper's Results/Output**: The proposed method shows superior performance in four out of five error criteria measures compared to existing methods, enhancing the understanding of BEV charging demand.

10. Summary of the Paper

Title: Research on electric vehicle charging load prediction method based on spectral clustering and deep learning network

Paper Name: Journal of Energy Sources_2023_ Research on electric vehicle charging load prediction method based on spectral clustering and deep learning network

Authors: Not specified in the provided context.

Journal: Journal of Energy Sources

Publisher: Not specified in the provided context.

Published Year: 2023

Workflow/Process (in detail):

- The methodology involves the generation of a comprehensive dataset through Monte Carlo simulation, which addresses the challenge of insufficient historical data.
- Spectral clustering is then applied to categorize the charging load data into distinct clusters.
- A hybrid CNN-LSTM model is used to predict future charging loads based on the clustered data.

Methodology:

- **Monte Carlo Simulation:** A statistical technique employed to simulate various EV charging scenarios, facilitating the creation of a diverse dataset.
- **Spectral Clustering:** Utilized to analyze and categorize charging load data, enhancing the model's ability to identify patterns.
- **CNN-LSTM Model:** Combines Convolutional Neural Networks (CNNs) and Long Short-Term Memory networks (LSTMs) to effectively capture both spatial and temporal dependencies in the data.

Approaches (in detail):

- **Data Generation:** Monte Carlo simulation is executed to create a dataset that reflects various charging scenarios.
- **Clustering Analysis:** Spectral clustering is performed on the generated dataset to group similar charging load characteristics.
- **Prediction Model Implementation:** The CNN-LSTM model is tailored to predict the future charging loads based on identified clusters, leveraging internal data patterns.

Source: The provided document refers to a study on electric vehicle charging load prediction.

Dataset:

- The dataset used originates from an EV charging station in Nanjing, China.

Dataset Availability/Public/Open-Accessible: Not specified in the provided context.

Dataset Source Link: Not provided in the paper's content.

Research Gaps:

- Further validation needed across diverse geographical regions to enhance the applicability and reliability of the model.

Research Key Findings:

- The hybrid spectral clustering-CNN-LSTM model significantly outperforms traditional prediction methods, achieving lower Mean Absolute Error (MAE) and Mean Squared Error (MSE).
- Enhanced prediction accuracy is demonstrated across different clusters compared to unclustered models and baseline methods like GRU and XGBoost.

Paper's Results/Output:

- The proposed methodology yields improved predictive accuracy, validated with real-world data from Nanjing's EV charging station.