





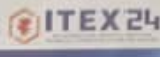
## DYNAMIC MACHINE LEARNING SYSTEM FOR BEV CHARGING DEMAND PREDICTION



**INVENTOR:** ROSLIMAZARINAH ZAKARIA  
FACILITY: CENTRE FOR MATHEMATICAL SCIENCES  
UNIVERSITI MALAYSIA MALANG AL-SULTAN  
ABDULLAH  
EMAIL: roslimazarinah@umpsa.edu.my





**CO-INVENTORS:** SHAHRIZAL SALEEM, NITI ROSLIANDAR YAZIZ,  
NOOR KHADIEAH AHMAD RAZI  
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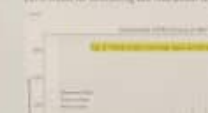



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**Product Background**

- EV Battery Electric Vehicle (BEV) relies on its recharge battery for propulsion. Recharge periods charging from the electric grid due to its high battery capacity.
- The variable and uncertain charging patterns of BEVs create substantial difficulties to the power grid by causing surges in peak power usage. Fluctuations in frequency and voltage levels, and an overall increase in average utilization that needs to be carefully managed.

**Methods**

- Machine learning is considered as a powerful tool for predicting the power demand of BEVs.
- The study of dynamic learning with random forest algorithm is used to predict the power demand of BEVs.

**Usefulness/ Applicability**

- Accurate load demand prediction is useful for planning, control, and operation of power systems.
- Helps in the design of charging infrastructure.
- Helps in the design of charging infrastructure.

**Novelty/ Inventiveness**

- Machine learning is used for predicting the power demand of BEVs.
- Dynamic learning with random forest algorithm is used for predicting the power demand of BEVs.

**Marketability & Commercialization**

- Machine learning is used for predicting the power demand of BEVs.
- Dynamic learning with random forest algorithm is used for predicting the power demand of BEVs.

**Status of Innovation**

Patent Pending

**API Services**

- Machine learning
- Dynamic learning
- Random forest
- Power demand prediction

**Achievement/Reward**

ITEX 24 Gold Award

**Environmental Impact/ SDGs**

SDG 7: Affordable and Clean Energy

**Collaboration**

Centre for Mathematical Sciences



## RECLAMATION OF UNDERWATER

**Product Background**

- Underwater cleaning robot

**Novelty/ Originality/ Inventiveness**

- Robots for cleaning, monitoring and detecting gas, water levels and data to monitor water usage, and water temperature
- Equipped with integrated modular underwater sensor module for efficient data logging (depth ranging 270m)

**Benefits/Usefulness/Applicability**

- Enhanced cleaning efficiency
- Improved navigation
- Comprehensive coverage and cleaning
- Comprehensive data collection (temperature, pressure and depth)
- Proactive maintenance
- Reduces the need for manual labour
- Applicable to various underwater environment (seawater, ports, etc.)
- Contribute to government's green efforts, promoting cleaner and sustainable ecosystems

**Status of Innovation**

- TTR, Level B
- Prototype

**SDG Impact**

SDG 14: Life Below Water

**Publication**

Impact and Commercialization of Reclamation of Underwater Environment: Monitoring and Data Collection Using Underwater Sensor Module

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## **Associate Professor Dr. Roslinazairimah produces electricity forecasting software for electric cars**

9 August 2024

PEKAN, 27 May 2024 – It is common knowledge that the use of electric cars in Malaysia is gaining attention, especially Malaysian automotive enthusiasts and consumers.

However, the increasing use of electric cars will also affect the generation and distribution of electricity in Malaysia because the battery capacity of electric cars is large and needs to be connected to the electricity supply system to be charged.

The lecturer of the Centre for Mathematical Sciences (PSM) Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA), Associate Professor Dr. Roslinazairimah Zakaria produced software to predict the electricity requirements with high accuracy using statistical modelling hybridised with machine learning models.

This research was conducted with the lecturer of PSM UMPSA, Dr. Siti Roslindar Yaziz, lecturer of Universiti Teknologi Mara (UiTM), Dr. Noor Fadhilah Ahmad Radi and UMPSA postgraduate student, Syahrizal Salleh.

According to her, the increase in the use of electric cars in Malaysia will lead to an increase in the need for electricity that needs to be generated by electricity producing industries such as Tenaga Nasional Berhad (TNB).

# DYNAMIC MACHINE LEARNING SYSTEM FOR BEV CHARGING DEMAND PREDICTION



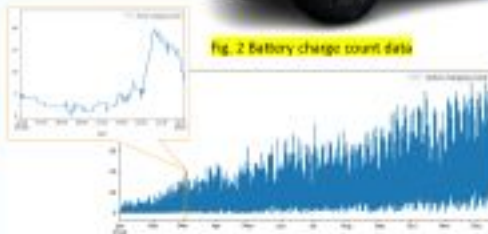
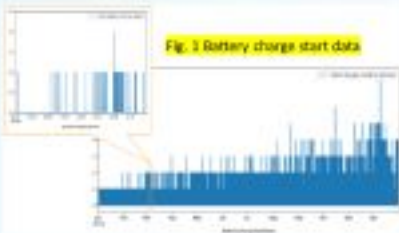
**INVENTOR: ROSLINAZAIRIMAH ZAKARIA**  
**FACULTY: CENTRE FOR MATHEMATICAL SCIENCES**  
**UNIVERSITY: UNIVERSITI MALAYSIA PAHANG AL-SULTAN ABDULLAH**  
**EMAIL: roslinazairimah@umpsa.edu.my**  
**CO-INVENTORS: SYAHRIZAL SALLEH, SITI ROSLINDAR YAZIZ, NOOR FADHILAH AHMAD RADI**



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## Product Background

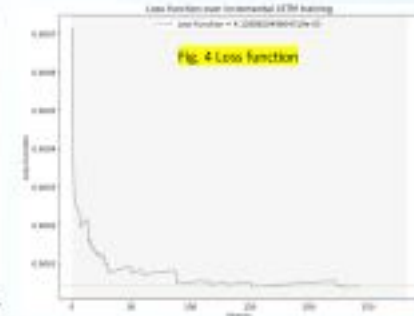
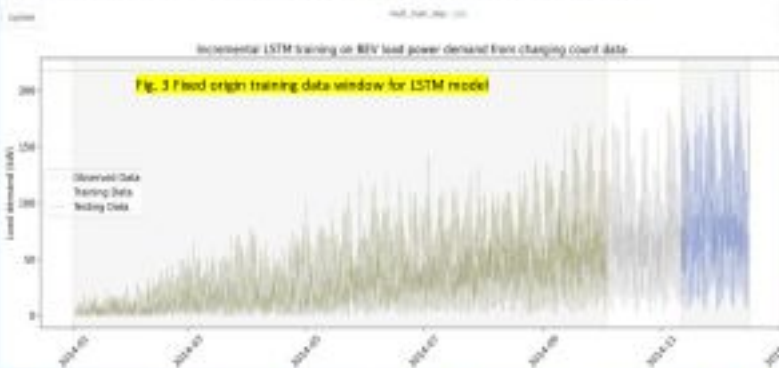
- A Battery Electric Vehicle (BEV) relies on its onboard battery for propulsion, requiring periodic charging from the electric grid due to its large battery capacity.
- The variable and uncertain charging patterns of BEVs create substantial difficulties for the power grid by causing surges in peak power usage, fluctuations in frequency and voltage levels, and an overall increase in energy demand that needs to be carefully managed.



## Methods

- Feature engineering to transform multivariate discrete start-stop BEV charging data to univariate continuous time series BEV
- The use of fixed origin training data window for Long Short-Term Memory model suitable for ML Ops workflow for production use.

## LSTM Model for forecasting BEV load power demand from charging behavior



## Usefulness/ Applicability

- Accurate ultra-short-term forecasting is crucial for ensuring there is enough energy to meet peak demand, preventing financial losses and potential blackouts across the market.
- Statistical model developed able to predict the electricity demand from BEV at high accuracy.

## Novelty/ Inventiveness

- Ready-to-use system
- BEV data transformation procedure
- Forecasting electricity demand using hybrid Box-Jenkins-Machine Learning

## Marketability & Commercialization

Electricity utility providers can develop comprehensive ecosystem to fulfil the electricity demand from BEV  
**TNB, PERCOUA, Sarawak Energy, etc.**

## Status of Innovation

TRL – level 6

## API Services

- Installation and setup
- Technical support
- Maintenance
- Hardware support
- Application support
- Warranty

## Achievement/Award

- OTREX 2023
- OTREX 2024

## Publication

1. Salleh, S., Zakaria, R., Yaziz, S.R. 2024. Enhancing BEV Charging Prediction Using LSTM Networks on Feature-Engineered 1-Minute Resolution Start-Stop Charging Data. *Jurnal Teknologi* (Scopus, under review)
2. Salleh, S., Zakaria, R., Yaziz, S.R. 2024. Battery Electric Vehicle Charging Load Forecasting Using LSTM on STL Trend, Seasonality and Residual Decomposition. *Springer* (Scopus, under review)
3. Salleh, S., Zakaria, R., Mansor, M.M. 2024. LSTM Model Performance Comparison Between Estimation of BEV Charging Electricity Load Demand and Its Reconstructed STL Time Series. *ICEM*, Springer (Scopus, under review)
4. Salleh, S., Zakaria, R., Yaziz, S.R. 2023. Forecasting Electricity Demand from Battery Electric Vehicles using Box-Jenkins Modeling. *IEEE* (Scopus, under review)

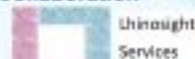
## Acknowledgement

UMPSPA Distinguished Research Grant: RDU233808  
 International Matching Grant: UIC241582/RDU242702)

## Environmental Impact/ SDGs



## Collaboration



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“An accurate electricity demand forecasting model is absolutely necessary to avoid demand exceeding the capacity of the electricity generated.

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“The lack of electricity can cause power outages, affect other industries and further stunt the country’s economic growth.

“The need for electricity from private chargers is dynamic because it depends on consumer activities such as during festive seasons, weekdays and weekends,” she said.

She added that the location of electricity needs will also change depending on the movement of electric vehicles such as swarm models.

“The infrastructure of the electricity supply system in strategic locations needs to be improved to ensure adequate electricity supply,” she said.

Malaysia is one of the countries that signed the Paris Agreement (Paris Climate Accords) in 2016 to limit the increase in global temperature to 1.5 °C since the era of industrialisation (starting in 1800).

In 2021, the 26th Conference of the United Nations Climate Change Conference (COP26) known as the Glasgow Climate Pact with the majority of members of the United Nations Framework Convention on Climate Change (UNFCCC) agreed to reduce the use of coal and fossil-based fuels for electricity generation and switch to green technologies to generate electricity such as solar and wind technologies.

She said that now we can be proud when Malaysia has shown a commitment by formulating policies to increase the use of electric cars to reduce carbon dioxide emissions.

“Electric cars rely on the energy stored in the battery to drive them.

“This software can reduce the gap between generation and the demand for electricity needed.

“In turn, it can reduce the risk of power outages and optimise operating costs,” she said.

The research, which began in 2021, was completed in early 2024 using data from a private electric car charger taken from research titled My Electric Avenue in 2017 in the United Kingdom.

According to her, the observed data should be changed to a time series format that can be modelled.

“After that, a statistical model hybridised with a machine learning model was built to predict electric energy consumption by electric cars that are being charged at private chargers for the next few minutes (ultra-short term load forecasting).

“This software can predict the amount of electricity needed with high accuracy at 98.8%.

“To extend the functionality of this software, private electric charging data from electric car manufacturers such as Perodua and Proton are needed to accurately predict electricity demand according to a dynamic location at a time and we have also held preliminary discussions with Perodua,” she said.

She said this is because the electric car private charging data obtained from Perodua or Proton can be analysed using this software to provide accurate information to electricity supply companies such as TNB to plan and develop appropriate and sustainable infrastructure.

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“The estimated cost of the software is based on a working day wage of RM2,000 per day for a researcher for a period of five to ten days.

“Previously, I produced a machine learning model to predict chilli prices in Malaysia as well as economic indicators using econometric models,” she said.

The software won a silver medal in the Invention, Creative and Innovation Competition (CITREX) 2023 and CITREX 2024, while it received a gold medal in the 35th International Invention, Innovation & Technology Competition & Exhibition, Malaysia (ITEX) 2024 which took place on 16 to 17 May 2024 at the Kuala Lumpur Convention Centre (KLCC).

**By: Nur Hartini Mohd Hatta, Centre for Corporate Communications**

**Translation by: Dr. Rozaimi Abu Samah, Faculty of Chemical and Process Engineering Technology**

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