

**TECH OFFER**

**Deep Neural Network (DNN) Approach for Non-Intrusive Load Monitoring (NILM)**



**KEY INFORMATION**

**TECHNOLOGY CATEGORY:**

**Energy** - Sensor, Network, Power Conversion, Power Quality & Energy Management  
**Infocomm** - Artificial Intelligence  
**Infocomm** - Big Data, Data Analytics, Data Mining & Data Visualisation  
**Sustainability** - Sustainable Living  
**Sustainability** - Low Carbon Economy

**TECHNOLOGY READINESS LEVEL (TRL):** **TRL4**

**COUNTRY:** **SINGAPORE**

**ID NUMBER:** **TO174652**

**OVERVIEW**

Existing methods for load monitoring typically focus primarily on residential building data, while few look at the effectiveness of such systems for industrial or commercial buildings. Apart from the use of this technology for real-time supply-demand response, such methods can be extended for use in anomaly detection, small-scale load change detection, or an estimation of energy usage, without the associated high costs of sub-metering equipment. The proliferation of neural networks for such demanding tasks solves the computationally expensive problem of traditional methods like Hidden Markov Models (HMM) and fuzzy clustering algorithms.

This technology offer is a neural network solution for residential and industrial energy management. It utilises a time-series forecasting tool to predict load, renewable energy generation, and electricity prices, without the need for costly sub-metering equipment. It is based on reinforcement learning algorithms which are trained by rewarding and penalising neural network algorithms for good or bad decisions respectively, the solution is a non-intrusive technique that helps residential and commercial end-users save on energy costs in the open energy market by scheduling their load demand for heating, ventilation, air conditioning (HVAC) systems, washing machines, and charging of their Electric Vehicles (EVs).

## TECHNOLOGY FEATURES & SPECIFICATIONS

This technology is an integrated platform that consists of the following components:

- Non-intrusive load monitoring (NILM) and data analytics tools for smart homes
- Time series forecasting tool for renewable energy and dynamic electricity pricing
- Reinforcement learning-based neural network for energy management systems
- Electricity plan recommendation tool for residential and commercial users
- Support data imputation - tolerant to missing data by estimating values that are missing

Integrates with several types of Deep Neural Network (DNN) models:

- Long Short Term Memory (LSTM)
- Bidirectional Short Term Memory (Bi-LSTM)
- Time Distributed Dense Layer

## POTENTIAL APPLICATIONS

The technology can be deployed for use in smart buildings, smart homes, and for commercial/industrial applications such as smart factories, server farms, etc to enable the following applications:

- Anomaly detection e.g. fault detection
- Small load change detection
- Energy data analytics for energy monitoring
- Energy disaggregation (addresses the problem of separating the electricity usage into individual disaggregated components)
- Determine equipment on-off status

## UNIQUE VALUE PROPOSITION

Non-intrusive load monitoring (NILM) represents a cost-efficient technology for observing power usage in buildings. It tackles several challenges in transitioning into a more effective, sustainable, and digital energy efficiency environment. Compared with existing smart home management systems that use model-based methods and only consider simple objectives, this technology helps to reduce energy costs by shifting electricity load demand to a low electricity price period while ensuring that electricity consumption needs are still met.

The technology owner is interested to collaborate with smart building operators, in-home integrated system suppliers, and smart appliance manufacturers to test-bed or collaborate to build new products/services.