Big Data Driven Hybrid AI Method for Energy Demand Forecasting and Operational Planning in Industrial Greenhouse Production

Nicolai Bo Vanting
Center for Energy Informatics, Mærsk Mc-Kinney Møller Institute, SDU
nva@mmmi.sdu.dk

University of Southern Denmark

Introduction

Globally the greenhouse production of vegetables and ornamental plants contributes to the emission of CO2, as the production in the northern hemisphere require artificial heating and lighting during winter to ensure satisfying production yield. Depending on the geographical region, energy for artificial heating and lighting is typically generated onsite using fossil fuels (gas, oil, coal but gradually moving to renewable sources.) To facilitate the green transition of industrial greenhouse production, there is an urgent need for new AI-based forecasting methods to coordinate the greenhouse production with the operation of a grid connected local sustainable energy system based on distributed renewable energy resources. Sustainable energy systems for greenhouses will typically include PVs and wind turbines for electricity generation for LED light installation and a heating system based on short-term thermal storage and heat exchange systems. Short-term thermal storage is typically using insulated water tanks. Providing better coordination of the greenhouse production process with energy supply allows industrial greenhouses to become active players in providing balancing services for the main grid. This will not only reduce the greenhouse industry's CO2 emissions but also help to improve its profitability.

Objectives

- Improve prediction accuracy of load forecast using complex data sources
- Demand side load profile analysis to optimize profitability of providing energy flexibility
- Facilitate demand response participation for industrial greenhouses through load prediction and scheduling

Methodology

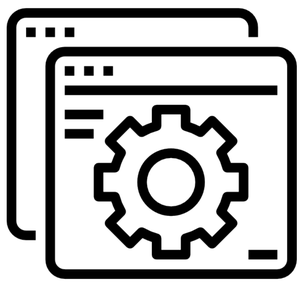
- Applications of Deep Learning using Hybrid Neural Networks
- Machine Learning frameworks including Tensorflow Keras or PyTorch
- Data Analytics
- Big Data
- Programming in Python and/or R

Project description

1. Project aim:

This project aims to develop a big data driven hybrid AI method for forecasting the energy demand of industrial greenhouse plant production. Energy demand forecast provide necessary information for planning and optimizing the operation of a grid connected local energy system that is based on distributed renewable energy resources. The application of the method provides the means for optimizing the operation of the local energy system and the operational planning of the interaction with the main grid in response to different energy pricing models.

2. Target application:



Industrial greenhouses are chosen in this project because the greenhouse production has a high degree of flexibility in using different energy sources. The production (the plants) also tolerates some degree of dynamics in the climate. Combining the flexibility and the production tolerance with the right decisions, the growers have the possibility to be an active player in the energy market.

3. Course of action:

To develop the big data driven hybrid AI framework method for industrial load forecasting and operational planning, industrial greenhouse energy consumption, its distributed energy resources (e.g., combined heat and power), control strategies and production flow will be investigated and applied in the project with a set of mixed big data.

Elements of the project

The project will be conducted in collaboration with the Chinese Academy of Sciences, Århus Universitet and Tsinghua University. The success of the project will be secured by the collaborative effort of the group of experts from each university. The essential elements of the project can be seen from the figure below: