Application of Deep Neural Networks in a solar PV-wind hybrid system with Hydrogen storage system

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Introduction

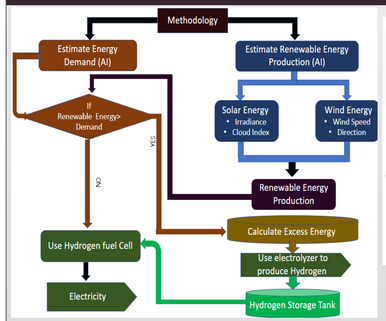
Renewable energy in the power industry has been the focus of research studies and the evidence of renewable energy growth is illustrated by the introduction of new advanced technologies. Grid Integration of renewable energy has been limited due to renewable energy intermittent issues which causes frequency instabilities, hence the need for efficient and sustainable energy storage systems.

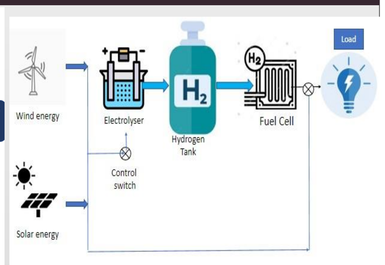
Problem Statement: **Limitation on the Integration of renewable energy generation in the power grid due to intermittency issues of renewable energy sources**

Storing energy in chemical form such as hydrogen and converting it into electricity when energy from the hybrid system is insufficient is a sustainable energy storage method. Accurately forecasting renewable energy and energy demand improves grid management and minimizes costs. Application of artificial intelligence in the grid integration of renewable energy is useful in load forecasting and predicting the available renewable energy resources such as hourly wind speed, hourly solar irradiance, and cloud cover index.

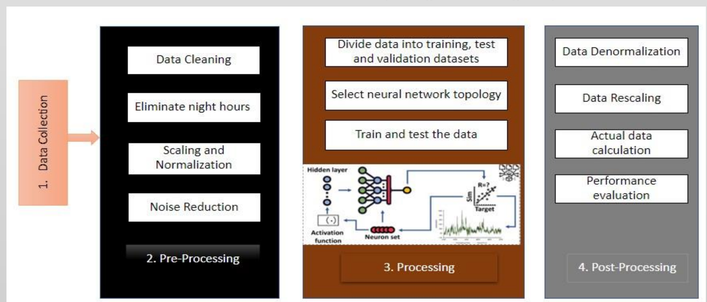
Deep neural networks, as a subject of machine learning, are fundamental for gathering and analyzing unstructured data. Forecasting energy demand to begin with requires dealing with various datasets which have different trends and behavioral structure in different power markets. DNN models can learn these trends and use large amounts of data to predict sequential data. Integration of hydrogen and renewable energy is a great contribution to the current energy landscape and incorporating deep neural networks simplifies grid management and enhances energy trading through a fast and reliable energy market.

Methodology

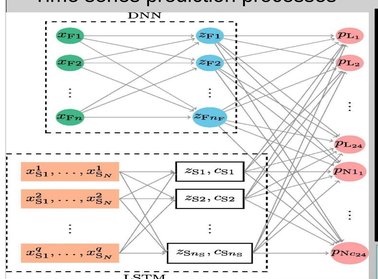




Renewable energy system layout with Hydrogen storage system



Time series prediction processes

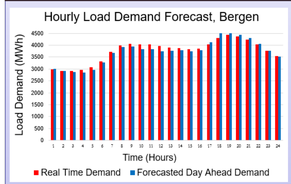


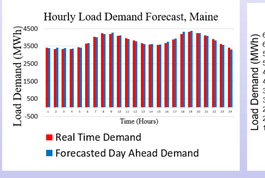
Previous years' energy demand,
Energy Consumption trends,
Number of customers/Population.
Climatic factors:
Dry bulb temperature
Dew point temperature
Global solar radiation
Humidity
Wind speeds

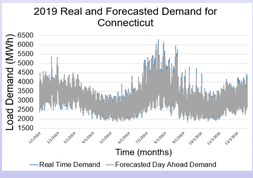
Software used:
Microsoft Excel
Python
Keras, Numpy, Tensorflow, Sklearn

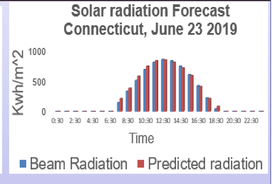
NE-ISO-Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.
Nord Pool-Bergin, Oslo, Kr.sand, Tr.heim, Molde, Tromsø

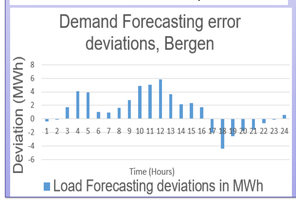
Results

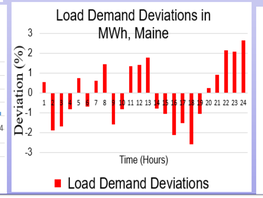


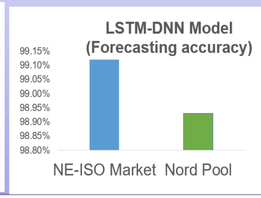


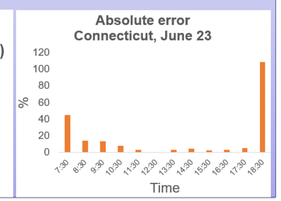












Summary

- Dependency on fossil fuels is reduced
- Hydrogen is a clean fuel which produces water as a by product
- Excess renewable energy can be stored as Hydrogen and used at nighttime
- Accurately forecasting energy demand, available solar and wind energy resources improves grid operation and management
- Reduced grid outage issues caused by frequency instabilities

Limitations
Model is more beneficial for a competitive power market than for regulated markets, in terms of the local marginal price (LMP) of electricity
Caution is needed when using Hydrogen, since it is a flammable gas, susceptible to leakages without detection due to its lack of smell

Ongoing Work

Comparison of Deep Neural Network Model to other Machine Learning Models for performance evaluation

References

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