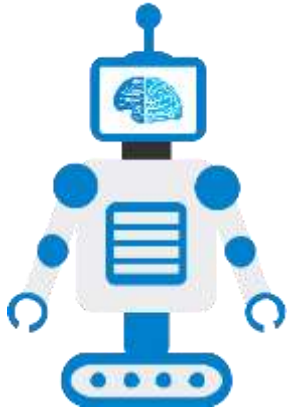
Artificial intelligence in energy systems

What do the different terms mean

Artificial Intelligence

Broad field of mathematical and computational techniques to mimick learning and perception based decision making



Machine learning

Subset of artificial intelligence that focuses on learning patterns from data and make predictions or decisions based on that learning

Deep learning

Subset of machine learning. Works with unstructured data and helps detect features as well

Modus Operandi for all the cases

Collect data from sensors, consumer usage patterns etc

Develop machine learning models using the appropriate method.

Validate several aspects of the model like parameter sensitivity, accuracy etc.

AI and ML Libraries

Artificial Intelligence Basic Libraries

1. Numpy
2. Pandas

Machine Learning Libraries

1. Scikit-Learn
2. Spark

Deep Learning Libraries

1. Keras
2. TensorFlow

Platform for Python Programming

1. NLTK - The Natural Language Toolkit
2. MXNet
3. Jupyter Notebook

Machine learning in Energy distribution

PREDICTIVE MAINTENANCE

Use sensor data to predict machine failures before they occur

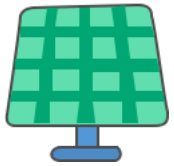
DEMAND FORECASTING

Forecast energy demand to optimize supply and pricing

ANOMALY DETECTION

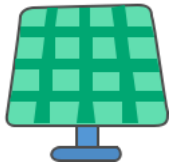
Detect abnormal energy usage to identify issues

Demand forecasting at consumer level




- Change in user specific patterns key to demand forecasting
- Machine learning can be implemented at the consumer level in several areas
- Improves prediction accuracy both for consumer and discom
- Helps in targeted policy

Demand forecasting at discom level




- KSEB using using Data Driven Deep Learning Networks based load farecasting on day-ahead basis – Could achieve about 98% accuracy
- Demand Side Management (DSM) Activities through energy systems modelling (MOU with Prayas group)

Anomaly Detection

WHAT IS ANOMALY DETECTION?

identification of rare events which raise suspicions by differing significantly from the majority of the data.

WHY DETECT ANOMALIES IN ENERGY USAGE?

Detecting anomalies in energy usage data can identify equipment faults, energy theft, or changes in usage patterns.

HOW TO DETECT ANOMALIES

Machine learning techniques like clustering, classification, and outlier detection can be used to automatically detect anomalous energy usage data.

CHALLENGES IN ANOMALY DETECTION

Challenges include handling different data types, filtering noise, and detectin previously unknown anomaly types. Careful data preprocessing is key.

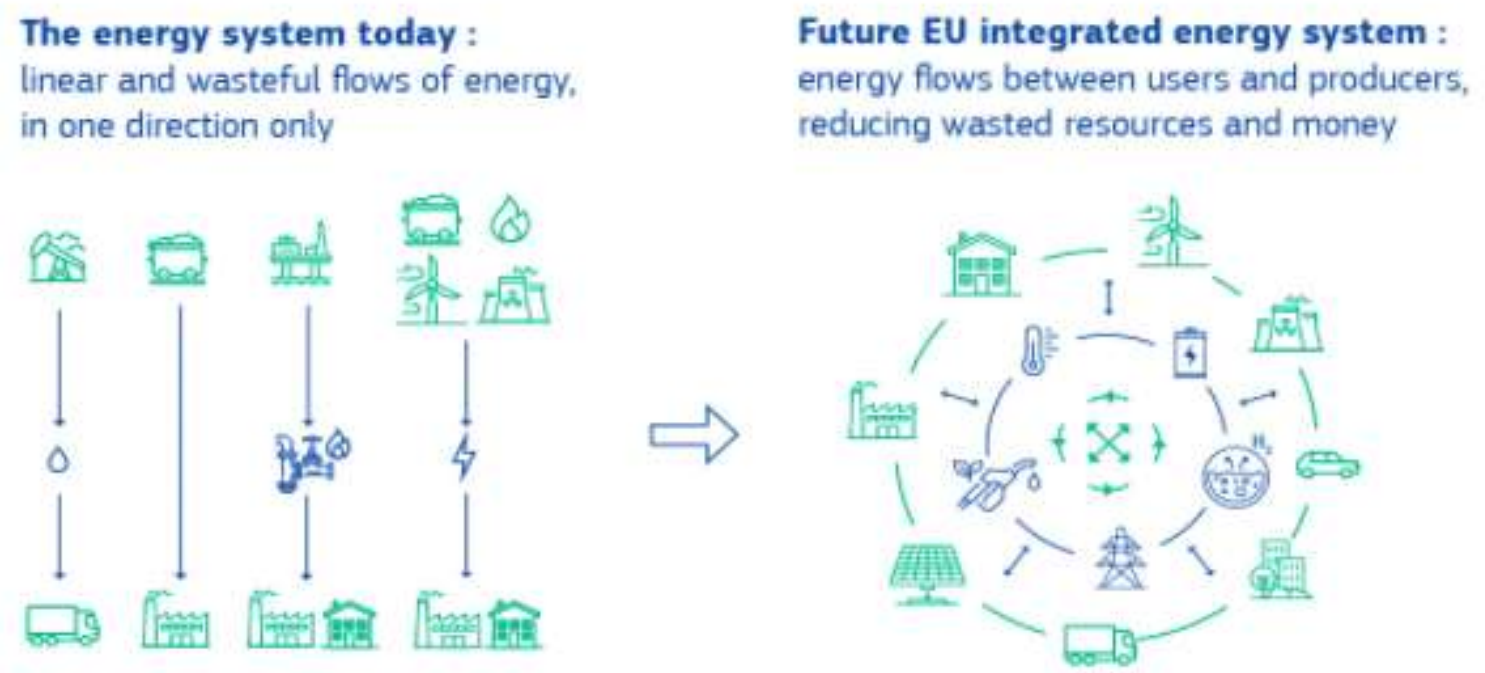
BENEFITS OF ANOMALY DETECTION

rapid identification of issues, reduces costs, improves efficiency, and leads to better understanding of energy usage patterns.

WHEN WILL ANOMALY DETECTION BE INEVITABLE

Introducing renewables increases intermittency. Anomaly detection will be crucial then

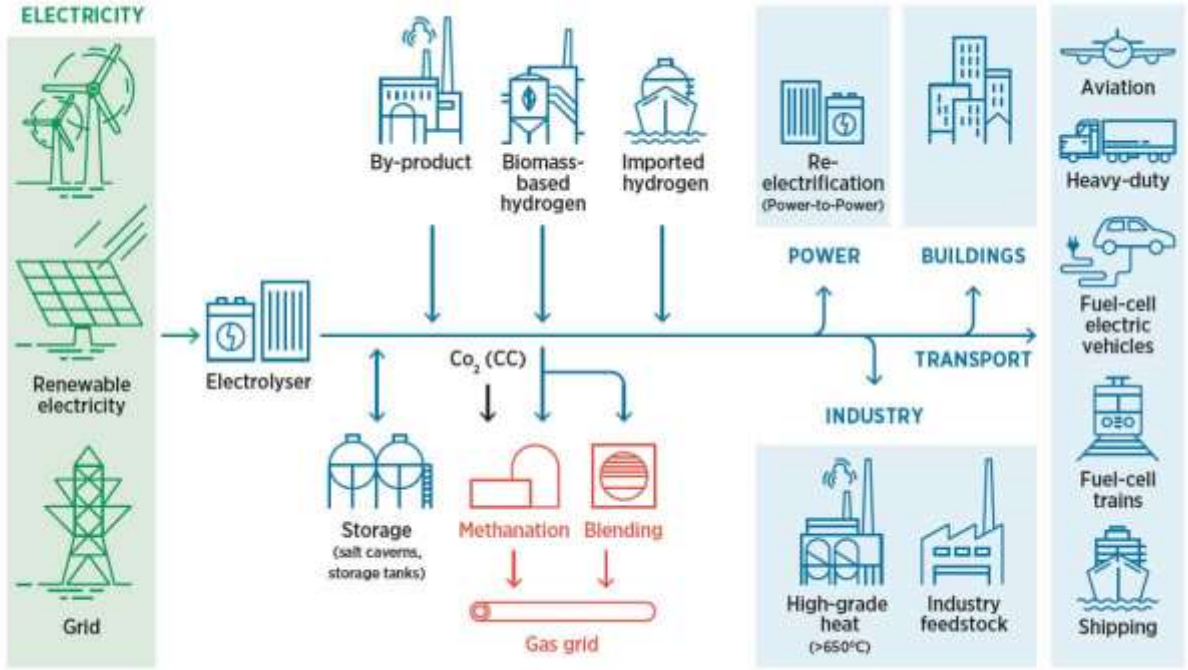
Machine learning in sector coupling (integrated open grids):



Machine learning models combined with energy system simulations are essential to plan the integrated energy system which does not exist at present (no sensor data to train the models with).

Role of AI in the Hydrogen economy

- Helps in cross sector forecasting
- ML models are necessary as most of the Hydrogen based systems do not exist at present and can only be simulated
- Helps in targeted Hydrogen policy



Challenges

DATA PRIVACY AND SECURITY ISSUES

Privacy concerns and cybersecurity risks of collecting and storing customer data need to be addressed.

HIGH UPFRONT COSTS

Installing smart meters, sensors and analytics systems requires major capital investment.

INTEGRATION WITH LEGACY SYSTEMS

Integrating AI systems with old infrastructure can be technically challenging.