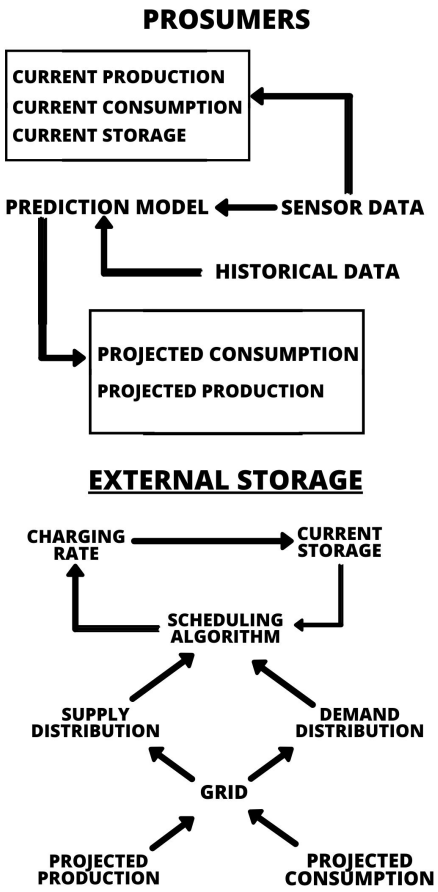
Renewable Energy Forecasting For An Integrated Smart Grid

Organisation name : Mathworks
Team name : ayeAyeTea
Team leader name: Devashish Kaushik
College code : U-0273
(Indian Institute Of Technology, Indore)

PROBLEM STATEMENT

An increasing dependence on renewable sources of energy and their intermittent nature necessitates a framework for integrating them with the conventional sources of energy. Accurate forecasting models for demand and supply prediction, alongwith scheduling algorithms would ensure grid stability and efficient distribution of energy, thus minimising wastage. Smart Grids in conjunction with real time sensors, storage systems and aforementioned algorithms would be able to switch seamlessly from an energy source to another, or peak up the energy output of a generating station as and when needed, thus minimising human intervention and oversights.
By predicting the renewable energy outage for a given duration, smart grids would be able to switch to conventional sources of energy, while keeping in mind their ramping periods and the need to minimise conventional energy usage.

WORKFLOW



1. **Data acquisition and validation** : Real time data would be acquired from sensors in associated grids, which in conjunction with historical data from varied sources would be used for training of the prediction model for demand forecasting.
2. **Simulation of the MIcroGrid**: A graph theoretical computer model of the grid shall include energy sensitive and energy insensitive components. The former, mainly prosumers, are units that shall either be a supply, sink, or both of the energy. The latter, would be the transmission lines and distribution stations, which would account for transmission losses, Use of multiple grid simulations would be used to allow flexibility of the product over various grid architectures.
3. **Prediction Modelling** : Standard statistical algorithms(ex, ARIMA) would be used in conjunction with Machine learning algorithms(ex, RNNs) for forecasting supply. Such models shall also be used for predicting the demand in the grid in advance, using real time as well as historical data.
4. **Scheduling System**: The scheduling system determines the optimal changes in production levels at various facilities, as well as any changes in the distribution network for meeting the forecasted demand with available (as forecasted) production capacities and storage units. We anticipate that the use of well-characterised optimization algorithms such as ADMM should be sufficient for this task. However, we have both the data and the expertise to make use of Machine Learning for this task, if required.
5. **Front end web-application**: This shall be developed using HTML/ CSS/ JavaScript with a LAMP-based server runtime. It is mainly intended to show grid operators the current state of energy-exchange throughout the nodes of the grid, and show scheduled changes in production at various plants to allow human oversight of the system.

Uses, requirements and challenges:

Targeted Users:

- **Grid Operators :** System shall automate majority of work associated with grid operation, removing human error and inefficiencies. This will reduce operational costs and energy wastage, while preserving overall human oversight.
- **Law enforcement :** For tracking power theft,, detecting energy usage in sites used by antisocial elements, etc.
- **Auditors :** To verify filings, grid efficiencies, etc.
- **Discoms :** To gauge usage and distribution patterns for informing future changes and getting an accurate idea of current efficiency and sources of losses.

Technology bucket :

- Python with libraries such as Scipy, Tensorflow, etc for algorithm
- Mathworks products such as MatLab, SImulink and SimScape for grid simulation
- Web technologies such as HTML, CSS, Javascript
- A standard LAMP server configuration

Show Stoppers:

- **Lack of data granularity and data in general:** The prediction model relies heavily on requisite data being available to forecast demand and supply, which again, is what the scheduling algorithm is based on.
- **Hardware deficiencies:** Lack of proper hardware, for instance, real-time sensors, and storage components in the grid would be a hindrance to the implementation of the simulated model in practice.
- **Inaccurate weather prediction:** Use of Met dept data for supply prediction will result in uncertainties in the former being transferred to the latter.