SMART INDIA HACKATHON 2020

Problem Statement- AG343

1. Edition/Category (Hardware or Software):

Software

2. Sector/Theme *(Smart Communication, Healthcare & Biomedical devices, Smart Vehicles, Robotics and Drones, Renewable Energy):*

Renewable Energy

3. Title of Problem Statement:

Renewable Energy forecasting, for an integrated Smart grid.

4. Background (short description):

Advances in technology have enabled large-scale harnessing of sources of renewable energy (solar, wind etc.). Smart grids which integrate both conventional energy sources and renewable sources are envisioned to be a sustainable power generation solution. However, all sources of renewable energy are affected by environmental factors (such as wind speed, intensity of solar radiation, cloud cover) which causes fluctuations in power generated from these sources. Also, the availabilities are subjected to daily/annual cycles (eg. Solar energy available during daytime only). While smart metering enables real-time demand forecasting; accurate models that forecast power generated by renewable energy sources are also needed. Accurate forecasting models will ensure grid stability, smooth scheduling and energy management. For instance, if the model forecasts renewable energy outage for a certain duration of time, the smart grid must seamlessly switch to the conventional energy source for that duration and ensure that the generated power meets the demand forecast. Literature proposes various learning-based forecasting models for renewable energy sources based on open data sources; as well as scheduling strategies for demand-supply matching. Further, simulation software to realistically model microgrids are also available. The problem defined here is to come up with a framework which: realistically simulates a microgrid; forecasts demand and supply of (renewable) energy; seamlessly schedules supply of renewable (and conventional energy) to meet the demand; and provides actionable insights about the functioning of the smart grid system.

5. Problem Statement:

1. Simulate the microgrid/utility system with various consumers and prosumers.
2. For the renewable energy sources, using environment time series data from open data forums-develop energy generation forecasting models.
3. For the consumers/prosumers using energy consumption time series data from open data forums-develop energy demand forecasting models.
4. Develop scheduling algorithms for the utility/microgrid controller.
5. Integrate the forecasting model and scheduler with the simulation setup in 1.
6. Prototype the following use case with developed models:

An Integrated Smart Grid utility manager would want to remotely monitor the operations of the deployed system in real-time. The manager will require a dashboard that provides a *micro- and macroscopic spatio-temporal trend* of: (a) consumer demand maps; (b) prosumer supply; (c) solar/wind energy generated; (d) conventional energy generated; (e) outages; (f) accuracies of

forecasting models for energy demand and energy generated (conventional and renewable); (g) scheduling decision report.

6. Outcome Expected:

1. A microgrid simulation model (with scheduling strategy integrated at controller).
2. Forecasting models to predict demand, renewable energy generated. (possibly Statistical/Machine Learning models).
3. Scheduling strategy/algorithm to manage resources to meet demands. (optimization algorithm based on forecasting model of demand and generation).
4. A web-application of the dashboard with appropriate visualizations and reports.

7. References (links, images, etc.):

- http://www.aungz.com/PDF/88170082.pdf
- https://www.mathworks.com/videos/microgrid-system-development-and-analysis-part-3-using-simscape-power-systems-to-simulate-microgrids-1522853406434.html
- https://www.researchgate.net/publication/326827833_Strategic_Scheduling_in_Smart_Grids

Simulations developed in Step 1 can be used to generate synthetic data based on models available in literature. In addition to that, below are some links which provides available data and can be used for modeling:

- Time series data (European---possibly to generate synthetic data):
  - https://data.open-power-system-data.org/time_series/
  - https://data.open-power-system-data.org/weather_data/
  - https://data.open-power-system-data.org/time_series/2019-06-05
- India Solar data generation
  - https://openei.org/datasets/dataset/india-direct-normal-global-horizontal-irradiance-solar-resourc13
  - https://data.nrel.gov/submissions/43

7. MATLAB, Simulink and toolboxes:
Complimentary/Free software would be available for all the student team members who will submit their abstract.

- Curve Fitting, Statistics and Machine Learning toolbox, Deep Learning toolbox (optional) -for forecasting models.
- Optimization toolbox (optional): Scheduling algorithm
- Simscape, Simscape Electrical, Simulink: to model microgrid/utility
- Any Web application: for dashboard
- Signal Processing Toolbox (reviewed)
- Control toolbox
- System Identification
- MATLAB and Simulink
- Stateflow
- App Designer
- ThinkSpeak
- Simulink Design Optimization