Power Distribution in Smart Grids with Renewable Energy Sources

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Energy markets are at the heart of one of the biggest societal challenges of our time - creating a sustainable, reliable and affordable energy provision is of immense importance. Smart grid is a digital technology that allows a two-way communication between distributed power generation units and customers and sensing along the transmission lines. It provides an opportunity to move the energy industry towards more reliable, available and efficient along with environmental benefits. To advance smart grid functionality, we propose to develop a feasible distribution strategy to meet the day to day demand and supply needs of every unit within the network.

Our project considers a smart grid installation that manages power distribution in a network of distributed generation units (an apartment complex, for instance). For simplicity, we assume that the complex consists of 10 apartments (actual size can be several hundreds) whose primary source of power is solar energy harnessed through solar panels. The secondary sources include power received through transmission lines from power stations based on coal, gas, nuclear and hydroelectric energy etc. Our project aims at proactively distributing the power optimally between the units that have excess and shortage of power. Optimal distribution entails ensuring minimal power losses during transmission.

There are several challenges in formulating an optimal distribution strategy for smart grid technology, and they are the following:

- Intermittent production and consumption by the units based on weather, size of the installation, location and so on.
- Monitoring and collecting the real-time power generation and consumption data from each unit.
- Transmitting the excess power between proximal units and simultaneously ensuring minimal loss due to transmission.

A linear programming problem based on the network-flow model can be framed to incorporate all the challenges mentioned as constraints, which has an objective function that aims to minimize the net power loss during transmission either from power plant or each unit. We plan to simulate and test the optimal smart grid distribution by using processes as place holders for units.

References:

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