Autonomous Cost-Effective Photovoltaic Configuration

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1 Problem Statement

Household Photovoltaic (PV) generators can be configured in two ways, (1) generate active power for cost savings (2) generate reactive power for network stability (via voltage management). The goal of this optimization problem is to provide the *best* compromise between network stability and costs mitigation. The balance of stability and efficiency is managed by reconfiguration of the PV generators to inject the minium amount of reactive power.

2 Inputs

1. A distribution grid including,
   (a) substations (modeled as generators, with bounds and costs)
   (b) demand nodes (homes some with PV and some without)
   (c) line capacities, and other side constraints
2. The lowest acceptable system voltage (this is our measure of stability).
3. PV Generator model (given $\langle X \rangle$ sun light, $\langle Y \rangle$ active or $\langle Z \rangle$ reactive power can be generated)
4. The sun light profile for each PV generator over a given day.
5. The load profile for each demand node over a given day.

Note that the last two items may be reviled or hidden in the simulation, depending on the nature of the experiment.

3 The Optimisation Module

At teach time step the following steps occur.

1. The generation capabilities of each PV (light input) and the demand requirements are sent to a single optimizing agent.
2. This central agent calculates the most cost effective generation which meets the voltage bound. (this is a kind of economic dispatch optimization)
3. The central agent sends instructions to PV cells on how much active and reactive power to generate, as well as dispatch instructions to the substations.
4. Simulation proceeds with the current time step given these updated parameters

4 The Analisys

In evaluating the optimization module we would want to look at the accuracy of the model (how accurate is the optimization model's approximation to what really happened (in the simulator)). This is likely as simple as outputting two network state data files and comparing them.

We would also want to see how much the approach saves over some other methods. Such as,

1. no stability, each PV generator simply produces only active power.
2. "local" optimization at each PV generator. This would require adding some basic logic each PV generator of the form, "if my voltage is below the given threshold, generate enough reactive power make it above the threshold, and maybe pass a message to my topological neighbors".