System Design Specification

Energy Freedom Project

The role of the microgrid and the Building Management System

Version 1.1

A microgrid is substantially more than just backup power, it is a system of loads, storage and generation, connected to the electric grid but capable of "islanding" to operate independently with seamless transition to/from the grid. This microgrid is contained in a private home and management of the microgrid must be contained within the Building Management System (BMS). In other words, the building consists of the microgrid and other systems. The core of the microgrid is the battery that gets support from both solar and the grid to dynamically supply the load. However, both the battery and the grid can be part of the load when the battery is charging or when solar power is stored in the grid.

The end consumers of the dynamic energy supply (battery, grid, solar) are the electrical loads that all conveniently meet together in the household circuit breaker panel. The largest consumer is the internal climate (temperature and humidity) and it is highly dynamic with strong correlations with the outside temperature, occupant activities (and habits), and demands for comfort (including survival). The rest of the circuit breakers are for lighting, food preparation, water (hot and cold), personal hygiene, entertainment (including hobbies, artistic activities), communications, home business equipment and charging an electric vehicle.

The BMS has sensor monitoring, data storage, data reports (visual graphics, charts, flows and a library of academic articles), displaying monitors, communication links, command and control of the microgrid components as well as other building hardware. The BMS must respond to time-varying changes in:

1. Demand: Both present and projected demands from the battery must be considered with full knowledge of its depth of discharge that could lead to exhausting all its energy.
2. Solar Supply: Solar generation capacity, both present and projected must be considered. Further, decisions must be made to direct this energy to the load with any excess going to charge the battery or to store in the grid or both. When the solar supply is less than the load demand, then a decision must be made to extract energy from the grid or the battery or both.
3. Unusual Demand: A major variable in the demand is the occupant’s behaviour. For example doing the laundry on Saturday, or going to visit relatives in Europe for a month, or cooking a turkey at Christmas. These types of non routine high and low power demands may not be predicted by the controlling algorithm so they must be estimated by sensors in real time. The unusual low demands are easy to handle as excess solar energy is first used to fully

charge the battery and the rest is stored in the grid. Of course, other creative ways to store excess solar energy may be developed. The unusual high demand, both actual and projected needs to be estimated with a 48 hour “look ahead” to determine if the battery charge state down to the reserve level is threatened. The “reserve” is a human setting that only permits lower discharge when the grid is not available as happens in an emergency. Thus in normal operations the grid is used as a microgrid “peaker” to escape from an unavoidable energy shortage.

The BMS algorithm must make battery charge or discharge decisions, grid power storage or zeroing out grid credits, adjusting a very smart internal climate thermostat, time shifting EV charging and many other energy efficiency tasks. Future interactions with the grid are likely to add additional energy flow complexities but limits must be established to honour the fundamental requirement of survival with “islanding” being either forced by grid outages or an intentional operator manually activating the off-grid switch.

A history of past activities and their outcomes will be maintained and displayed in appropriate ways for real-time decision making while watching the time now energy flows in order to decide on improving the controlling algorithm energy efficiencies. Further, this history shall be used to improve projections on depleting energy resources by identifying demand candidates for time shifting, rationing and denial or to return to the grid as a peaker energy supplier.

The BMS survival mode shall use the same forward planning of the normal operational mode but it will tightly manage the demand through more aggressive rationing, time shifting, and denial. As with all emergency measures, there will be escalation levels of demand management disaster response based on the critical availability of battery and solar energy resources. Manual override will be permitted by authorized operators.