The DC Micro-Grid House: Home Conversion of AC to DC Power to Promote Energy Efficiency

Objective:

- To implement a whole-home AC to DC conversion and demonstrate improved energy efficiency.

Problem

- Traditional homes operate on AC circuitry, but are comprised of devices, appliances, and electronics which require a conversion to DC power. Each of these conversions incur losses, which restricts energy availablity and efficiency, and lead to higher costs. In addition, alternative energy sources naturally produce DC power, and thus suffer multiple conversion losses in order to be used within an AC system.

Expected Results / Impact:

- Reduction in energy consumption, electrical complexity and cost, and improved overall efficiency.
- Integrated DC-solution incorporating alternative energy sources (e.g. solar PV, etc.) and battery storage.
- Development of new direct-DC appliances, technologies, and infrastructure.
- Real-Time monitoring and intelligent control of appliances, systems, and energy sources.
- Novel demonstration of an inhabited home fully operated by DC power.

Approach:

- Instrument the AC-powered house to serve as a living lab and establish a baseline on energy consumption and usage patterns.
- Develop and install new DC technologies, appliances, and power delivery systems through collaboration with corporate partners.
  - Current partners include: Whirlpool Corp., Regal Beloit, Duke Energy, Rheem Manufacturing, and United Technologies Carrier
- Retrofit the AC powered home to generate and supply DC power.
- Compare the performance of the AC to DC electrification schemes.

Herrick Laboratories PURDUE UNIVERSITY

Schedule

Fall of 2017 – Baseline (Completed)
- Occupation of the house and initial retrofit
- Installation of baseline AC appliances
- Development of Data
- One year of baseline data collection

Fall of 2018 – DC Retrofit (Currently Ongoing)
- Installation of DC infrastructure and micro-grid
- Retrofit of appliances to operate from DC power
- Design of control system for energy management

Fall of 2019 – DC Optimization
- Optimization of DC House
- Additional year of DC data collection
- Energy comparisons to baseline and previous year

CHPB CENTER FOR HIGH PERFORMANCE BUILDINGS AT PURDUE

The DC Micro-Grid House:
Home Conversion of AC to DC Power to Promote Energy Efficiency

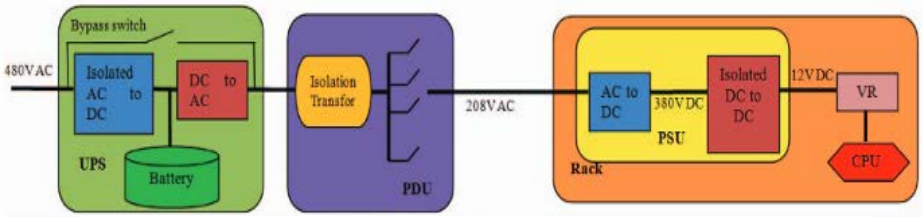

Figure 1: Traditional AC-distribution System

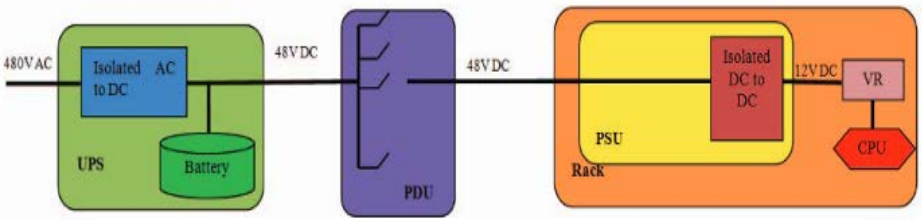

Figure 2: Converted 48 VDC Distribution System

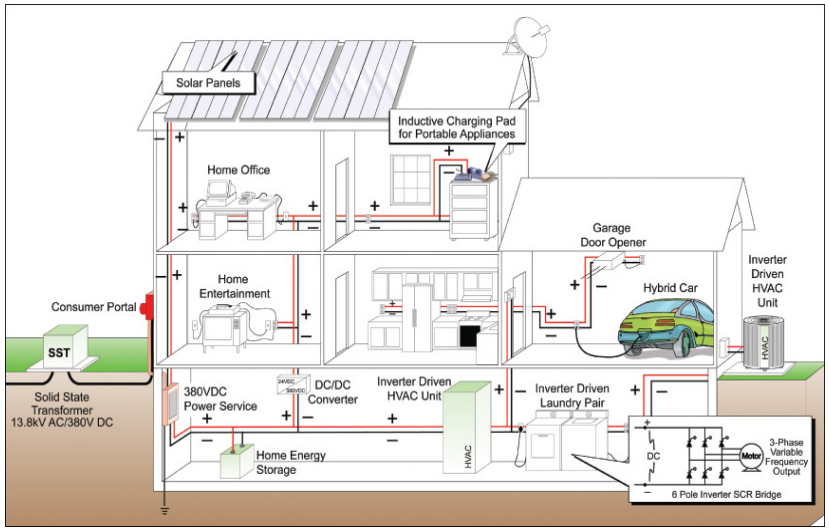

Figure 3: Example of a Proposed Residential DC Micro-Grid Infrastructure

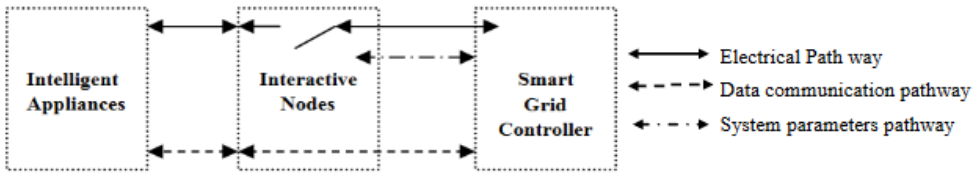

Figure 4: Demonstration of an intelligent electrical system integration

Herrick Laboratories PURDUE UNIVERSITY

CHPB CENTER FOR HIGH PERFORMANCE BUILDINGS AT PURDUE