Exhibit A

PODR05-V20 and PODR05-D21

Statement of Work

University of California Irvine and University of California Davis

Smart Power For The Smart Home: Inverter Controls, Power Factor Corrections, And Peak Demand Reductions

Introduction and Background

The proposed research advances three technology elements to enable smart management of electric loads and generation for zero net energy residences:

A. Inverter-integrated active power factor correction
B. Load signature analysis for wireless load monitoring and control
C. Integrated design and control of HVAC and storage for shifting peak demand

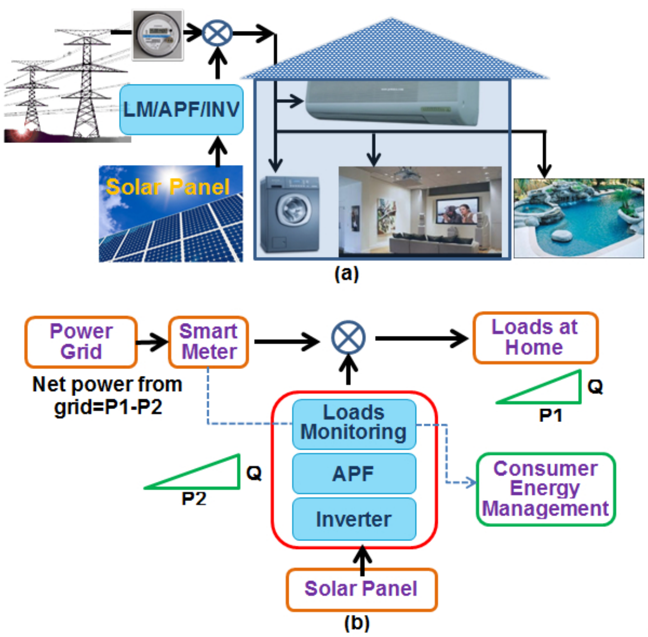


Fig 1 (a) A proposed smart power delivery unit, consisting of inverter (INV), active power factor corrector (APFC), and loads monitoring (LM) for load signature. (b) a schematic of the power flow for both real and reactive power in a typical residential setting.

The research proposed here advances residential peak load reductions, inverter-integrated power factor improvements, and meter-integrated sub-load monitoring – three necessary components of a smart grid for which there are no existing competitive market incentives. For example, utilities charge residential customers according to real power consumed (kWh), even while generation and distribution must supply considerably more apparent power to cover the inefficiencies related to low power factor. Also, so long as residential electricity rates are generally not charged according to time-of-use there is currently little incentive for end users to shift consumption to off-peak periods.

A. Inverter-integrated active power factor correction

Currently, connecting PVs to the grid via inverters typically calls for a static power quality factor of 0.95 for inverter implementation. Typical American households have a dynamic power quality factor varying from 0.8 to 0.95 depending on the signature of loads and their use at the time. (Appliances such as HVAC, motors, and lighting generate reactive and harmonic power, which is typically about 20% of the power consumption.) While PV via inverter provides mostly real power to home loads, the reactive power consumed by the loads would need to come from electric grid and thus lower the energy efficiency of the total system. Surging demand on reactive power at peak hours further induce instability to the grid. If the time dependent reactive power consumption at loads can be balanced via the PV/inverter by dynamically adjusting power quality factor in an inverter unit, the power demand on the grid becomes more manageable. In this work we propose a smart power delivery unit consisting of PV inverter, active power filter (APF) as adaptive power factor corrector and load signature monitor for dynamic power factor control and real-time load signature detection. The load signature information wirelessly communicates to a counsel unit at home or to a utility grid management unit. Subsequently, the energy data can be displayed on home appliances and utilized for demand response at home.

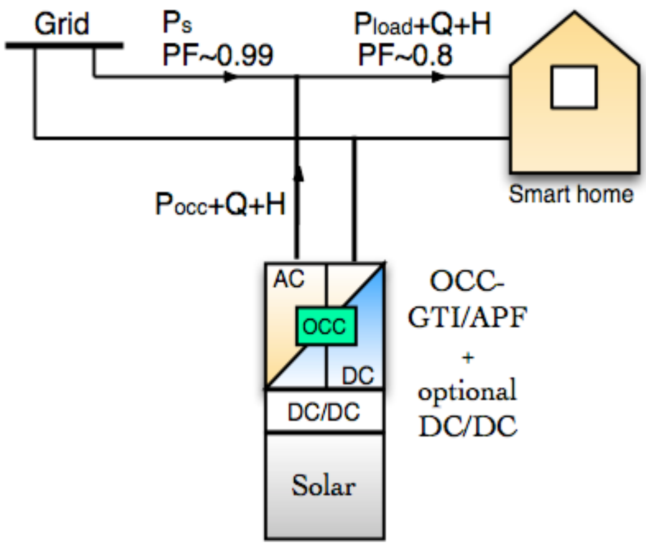


Figure 2. Grid Tied APFC Inverter enabling ZNE home

A grid-tied inverter active power filter (GTI/APF) has demonstrated active power processing with reactive and harmonic cancellation capability for three-phase systems. We propose a grid-tied inverter (GTI) integrated with APF as shown in Figure 2 that harnesses power from the renewables and cancels the reactive Q and harmonics H in the meantime. The power flow to or from the grid is thus purely sinusoidal and active. The proposed concept can be realized by using the one-cycle control (OCC) technology, featuring fast and stable dynamics and precise harmonic and reactive cancellation.

B. Load Signature Analysis for Wireless Monitoring and Control

Load Signature is the electrical behavior of an individual appliance/piece of equipment when it is in operation – a unique pattern of voltage, current and power, at various time scales. Each type of appliance or electronic device has its own 'signature' wave form as it starts, operates, or shuts down.

Advances in the knowledge of power measurement and appliance recognition would benefit both the utilities and consumers. The proposed power monitoring system will measure the performance of the APF/inverter, report the overall load, and recognize the consumer behavior daily usage. Short- and long-term usage patterns can be utilized to promote energy conservation in a smart home.

C. Integrated design and control of HVAC and storage for shifting peak demand

Residential peak loads are not coincident with generation from on-site PV. Consequently, the grid must absorb and distribute electricity generated from solar in the middle of the day, while still also supplying electricity for peak consumption when generation from solar wanes. This non-simultaneity between local energy demand and supply may strongly affect the power quality on the neighborhood feeder level electrical network.

We envision smart ZNE residences that actively shift electricity uses away from grid peak periods, so that net electricity output corresponds as closely as possible with when it is useful to the neighborhood level distribution network. This can be achieved with sophisticated design and control of mechanical systems, and with short-term battery storage. The appropriate mix of load shifting and storage is contingent on application -- especially on the relative balance of solar availability and end use electrical services within a neighborhood. Previous research has identified that heterogeneity of load and generation in a neighborhood provides more stability for feeder level distribution and peak generation reduction for the grid as a whole. The research proposed herein will develop a parametric assessment of the value that HVAC load shifting and short-term electrical storage can have on feeder level power distribution in various scenarios.

The study will draw from results of various zero net energy (ZNE) residential pilot installations with which UC Davis is involved, including for example the Honda Smart Home. Monitored data from such a home will be used as validation for the parametric simulations in the proposed research. The Honda Smart Home, for example, features on-site electrical storage, direct DC solar vehicle charging, and a mechanical system designed to shift loads away from peak periods. The mechanical approach for this home relies mostly on a highly insulated envelope, passive and active nighttime ventilation cooling, intermittent ventilation to avoid operation during peak periods, and thermal delivery techniques that can glide through peak periods with little or no electrical demand.

Simulations conducted for the research here will evaluate the combined benefits of automated power factor correction, HVAC peak load shifting, and on site electrical storage. The focus will be on improvements to feeder level stability that result from maximizing the output of near unity power factor electricity during peak demand periods. Models will be developed to mirror the level of on-site generation and electrical loads demonstrated for the home. Electrical load distributions and demand profiles measured for the home will be used as input and validation for the models. The simulations effort will be extended to a range of scenarios that aim to describe the benefits and challenges of smart ZNE homes in various circumstances, in order to inform strategic deployment of ZNE homes more broadly.

Objective and Purpose

A. Active Power Factor Correction Inverter

1. Research and develop smart power delivery (SPD) unit for dual use of the smart home and smart grid.
2. Deploy SPD system in one or two smart home projects at UC Davis for demonstration and in field evaluation.

B. Load Signature Analysis for Wireless Monitoring and Control

1. Develop load signature detection units for inverter or meter-integrated monitoring of power consumption, power factor, and harmonic distortion that identifies, categorizes and meters demand from various electric loads.
2. Provide the utility end use information for billing, efficiency program marketing, or demand response control.
3. Provide load consumption feedback and display for users, or for automated home energy management systems.

C. Mechanical Systems and Energy Storage for Shifting Peak Demand

1. Characterize the impacts that ZNE homes have on neighborhood and grid level distribution and generation requirements
2. Compare alternative scenarios for the control of off-peak HVAC efficiency measures and on-site short-term energy storage.
3. Model and describe the combined impacts of power factor correction, off-peak HVAC efficiency, and on-site storage.

Technical Approach

A. Active Power Factor Correction Inverter

The proposed unit is illustrated in Figure 1. The smart power delivery unit resides in a conventional inverter box and in real time supplies both real power to loads and reactive power to balance non-ideal power consumption as depicted. In addition, the information from an installed smart meter and a power monitoring device inside the smart power delivery unit will be co-processed for determination of signature of loads in real time. The various load information will be available for display on household appliances such as TV or mobile devices.

The diagram of the proposed grid tied APFC inverter is shown in Figure 3. An H-bridge inverter possibly additional DC/DC converter (not shown) will be used as the power processing stage. The one-cycle control (OCC) core shown in the dashed box will control the H-bridge to perform PV power processing and reactive and harmonic cancellation. The OCC control core is comprised of a clock, an integrator with reset, a comparator, a flip, flop, and a compensator, AV(s), as well as protection circuit (not shown).

When the load (smart home) pulls harmonics current as shown in Figure 3 as i_{load} (an extreme case when the load is a diode rectifier), the OCC-GTI/APFC will produce a harmonic current that cancels the one in the load and ensures the current draw from the grid, i_s, is pure sinusoidal and has PF~0.99. The OCC method is simple, fast, and precise, yielding a cost effective, reliable, and versatile solution.

We will build a 1.5kVA APFC inverter to demonstrate the concept with a smart home. It can stand next to a PV inverter for retrofit.

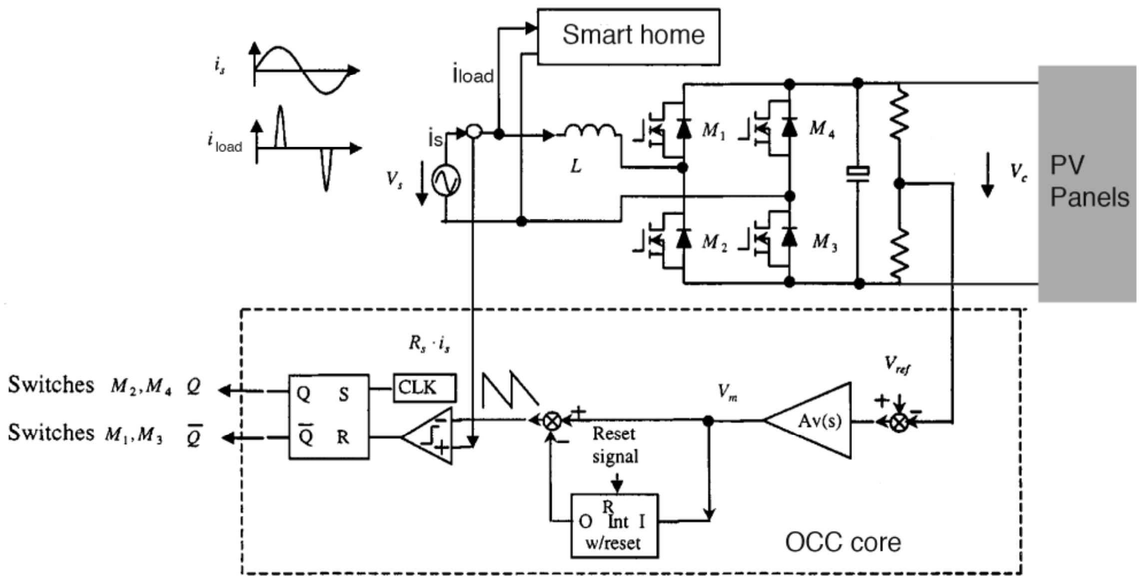


Figure 3: Control Schematic for Grid Tied APFC Inverter

B. Load Signature Analysis for Wireless Monitoring and Control

Using the real and reactive power (P and Q) one can track and identify appliances. Power factor can be measured by using energy meter ICs. In addition, the current waveform of each appliance has its unique micro-load signature. Using fast Fourier transformation (FFT), for example, the harmonic contents (or features in the frequency domain) can be obtained. CalPlug has demonstrated that an appliance can be correctly identified by an algorithm surveying at least three different types of load signatures simultaneously. CalPlug has been assembling a database of load signatures and also a database of typical usage patterns by consumers, which can significantly improve the recognition rate of the appliances.

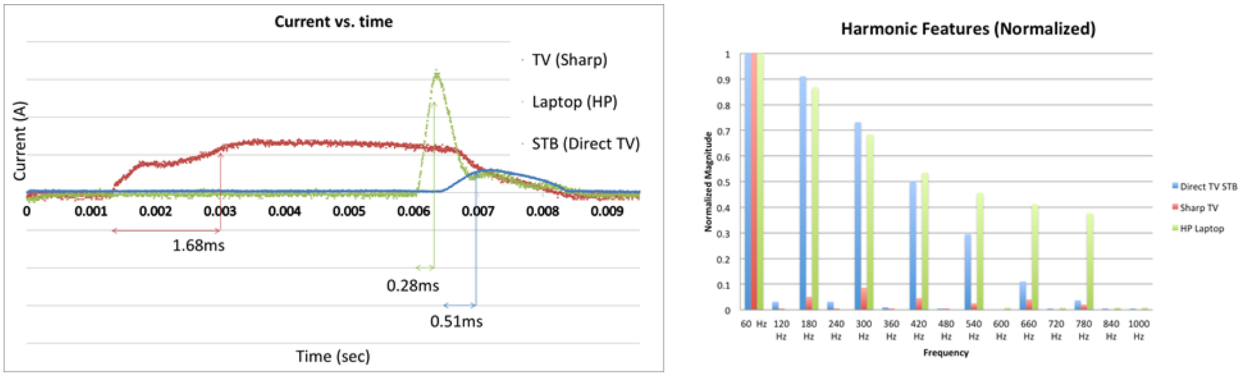
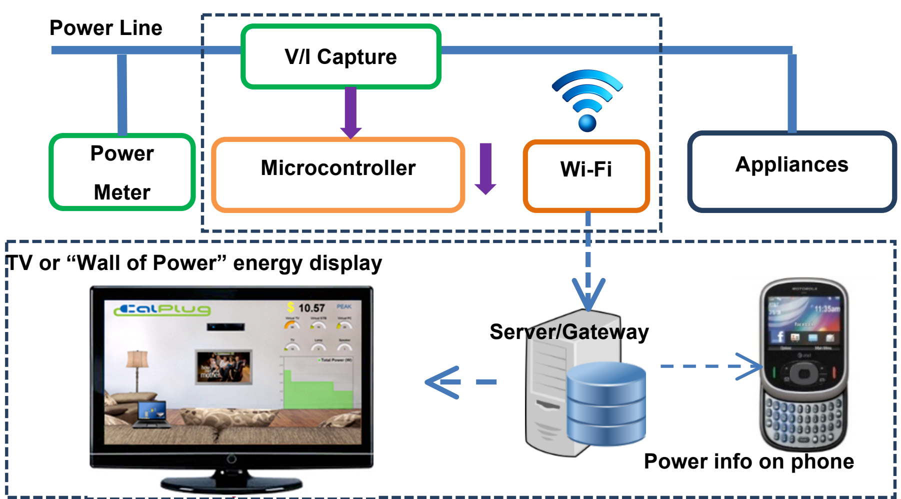


Figure 5. Typical household appliances' load signature in temporal and frequency domain

The wireless loads monitoring system, as shown in Figure 6, is comprised of the energy display system and a measuring module, marked by the dotted line in Figure 6. The measuring module uses a current sensor to capture the current waveform and uses a high speed A/D converter to sample the waveform. It also measures the real power and reactive power at the same time and then sends to a server to do appliance recognition via the Wi-Fi module. The power information as well as the active appliances can be accessed via accessing the webpage by a TV or a smartphone. In addition, the CalPlug "Wall of Power" energy display project has already been shown to provide a real-time cross-platform service for utility data display and will be the web and database software used. The user interface is designed to be scalable to the display form factor using Web 2.0 technologies.

The power monitoring system will be primarily utilized to evaluate the performance of the proposed APF.

Figure 6: Block diagram of the wireless monitoring system



C. Mechanical Systems and Energy Storage for Shifting Peak Demand

A number of peak shifting mechanical strategies have recently been applied by UC Davis for the Honda Smart Home. The effort proposed here will conduct a parametric simulations analysis to explore these dynamics. The study will utilize various simulation tools to assess the dynamic correlations between residential building end uses, and distribution level electrical grid systems. Building level end use, thermal systems, generation and storage will be modeled primarily utilizing Simergy or EnergyPlus. Tools such at LT Urban or SUNtool will be used to aggregate neighborhood level demand characteristics; this effort will utilize grid modeling approaches such as those described by PVUpscale, International Energy Agency (IEA) Photovoltaic Power Systems Programme (PVPS).

These disparate perspectives will be combined utilizing tools such as Integrated District Energy Assessment by Simulation (IDEAS), software developed by the University of Leuven, Belgium. This model describes the built environment, energy consumption and supply, and networks and control in just one model, a more effective analysis of smart grid systems.

Modeling will focus on the impact that individual ZNE homes, and neighborhoods can have on feeder level electric quality and stability when outfitted with zero peak mechanical systems and inverters outfitted with active power factor management. The peak shifting values of various mechanical design strategies will be considered. The primary peak shifting mechanical design techniques to be considered include:

1. Envelope upgrades (including improved insulation and air leakage sealing)
2. Passive and active nighttime ventilation cooling
3. Intermittent ventilation to avoid operation during peak heating or cooling periods
4. Thermal delivery techniques (passive building mass, or active radiant surfaces) that can glide through peak periods with little or no electrical demand

Inputs for these simulations will be based on measured values, end use load profiles, and power factor characteristics demonstrated by the Honda Smart Home and others. Parametric modeling will generalize these results according to stochastic diversity in user behavior, and to normalize for typical end use load profiles as described by the California Energy Commission's Residential Appliance Saturation Study.

Statement of Work

Task 1. Develop & Bench Test Active Power Factor Correction (APFC) Inverter (UC Irvine)

1. UC Irvine will design, simulate, and build a single phase one-cycle control/active power filter (OCC/APF) of 1.5kW. Capable of correcting power factor from 0.8 to 0.99 at point of connection. It can be used in combination with a 3 kW inverter or a 5 kW converter.
2. Test the APF at the UCI Power Electronics Laboratory.
3. Test in a smart house in Davis or Irvine. The test will be together with the monitoring device from CalPlug.
4. Create a MATLAB APF to be used by UC Davis for grid modeling.

5. Write interim and final report on APF development testing results.

Deliverable: Interim Report on APF Development Testing Results. **Due Date:** July 31, 2014

Deliverable: Final Report on APF Development Testing Results. **Due Date:** August 31, 2014

Task 2. Field Evaluation of APFC Inverter and Load Monitoring Tool in ZNE Residence (UC Davis)

1. UC Davis Western Cooling Efficiency Center will conduct an installation and measured evaluation of the active power factor correction (APFC) inverter technology and the load signature monitoring hardware within one or two ZNE residences in the Davis area.
2. UC Davis will manage and facilitate the installation and commissioning of the APFC and load signature monitoring device developed by UC Irvine.
3. UC Davis will install monitoring and instrumentation for the inverter system to measure:
    - AC Voltage, amperage, active power, reactive power, power factor, and harmonic waveform distortions on the grid side of inverter system and on the load side of inverter system
    - DC voltage, amperage, power, and noise on the generation side of inverter system
4. Measurements will compare performance in various scenarios, for the home with a standard inverter system, and for the APFC as a retrofit, over a range of generation and load conditions.
5. Results from monitored field study will be analyzed to assess:
    - All energetic flows for the APFC device, including thermal efficiencies
    - The extent to which power factor is corrected for electricity distributed on grid
    - The improvement to harmonics generated by smart home during specific load and generation scenarios
6. Write interim and final report on process and results of field evaluation including findings and recommendations

Deliverable: Interim Report on Field Evaluation. **Due Date:** August 31, 2014

Deliverable: Final Report on Field Evaluation. **Due Date:** September 30, 2014

Task 3. Load Signature Analysis for Wireless Monitoring and Control (UC Irvine)

1. UC Irvine will design and build the printed circuit board (PCB) for the loads monitoring system. The board should be able to measure the power and capture the waveform and send the information to the server via wireless. Also the board should be able to communicate with the smart meter to read the power information.
2. Preliminary test of the board in CalPlug
3. Develop the server to communicate with the power measuring board and do analysis to recognize the appliances.
4. Design a smartphone interface to show the loads information.
5. System optimization and algorithm optimization.

6. Test the loads monitoring system with the APF/Inverter.
7. Test in a smart house in UC Davis or Irvine.
8. Write interim and final reports on loads monitoring system.

Deliverable: Interim Report on Loads Monitoring System. **Due Date:** September 30, 2014

Deliverable: Final Report on Loads Monitoring System. **Due Date:** November 30, 2014

Task 4. Parametric Assessment of the Grid Benefits of APFC in Combination With Integrated Mechanical Design and Control for Peak Shifting (UC Davis)

1. UC Davis will compile and analyze relevant field data from the Honda Smart Home and/or other ZNE residential project as input for models
2. Construct baseline model of minimum efficiency residential
3. Construct archetype model for ZNE home in Energy Plus
4. Develop structure for input of EnergyPlus results into IDEAS or other method to describe dynamics with feeder level electrical grid.
5. Utilize MATLAB model for APFC inverter to evaluate power factor correction as part of neighborhood scale electric distribution model.
6. Simulate home in various scenarios to assess impact of load profiles on grid:
    a. Alternate mechanical system efficiencies
    b. Alternative load shifting strategies
    c. Different levels of generation and storage
    d. Differences in stochastic user behaviors
    e. Differences in end use load profiles, including electric vehicle use
7. Consider the value of this residential design approach (A) as retrofit or infill within an existing residential neighborhood, as a part of the feeder network with standard residential loads and (B) as part of a network of similar homes in a ZNE neighborhood with diversity of behavior and end use load profiles.
8. Write interim and final report on parametric assessment of grid benefits of AFPC.

Deliverable: Interim Report on Parametric Assessment of Grid Benefits of AFPC. **Due Date:** December 31, 2014

Deliverable: Final Report on Parametric Assessment of Grid Benefits of AFPC. **Due Date:** January 31, 2015

Task 5. Prepare Final Report (UC Irvine assisted by UC Davis)

Write final report on smart power for the smart home: inverter controls, power factor corrections, and peak demand reductions.

Deliverable: Final Report On Smart Power For The Smart Home: Inverter Controls, Power Factor Corrections, and Peak Demand Reductions. **Due Date:** February 28, 2015