Dramatic Peak Residential Demand Reduction in the Desert Southwest

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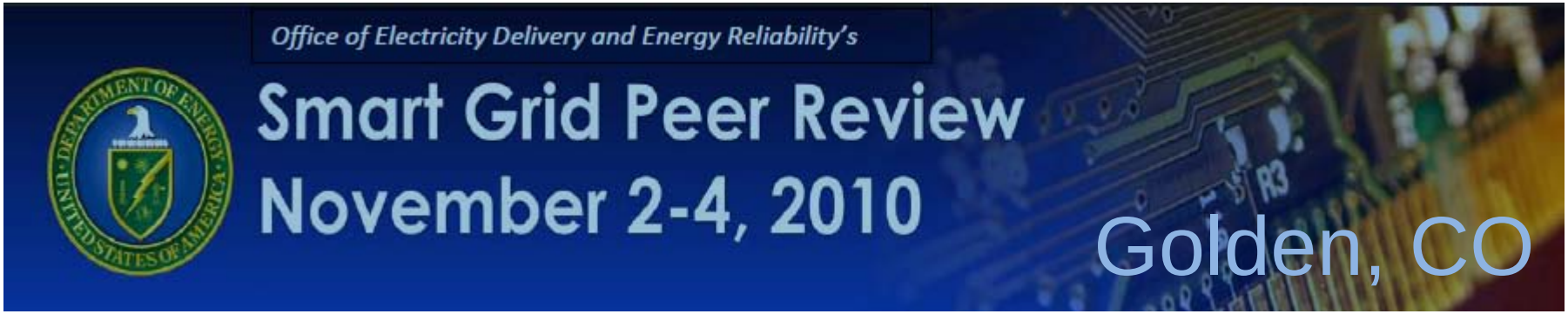
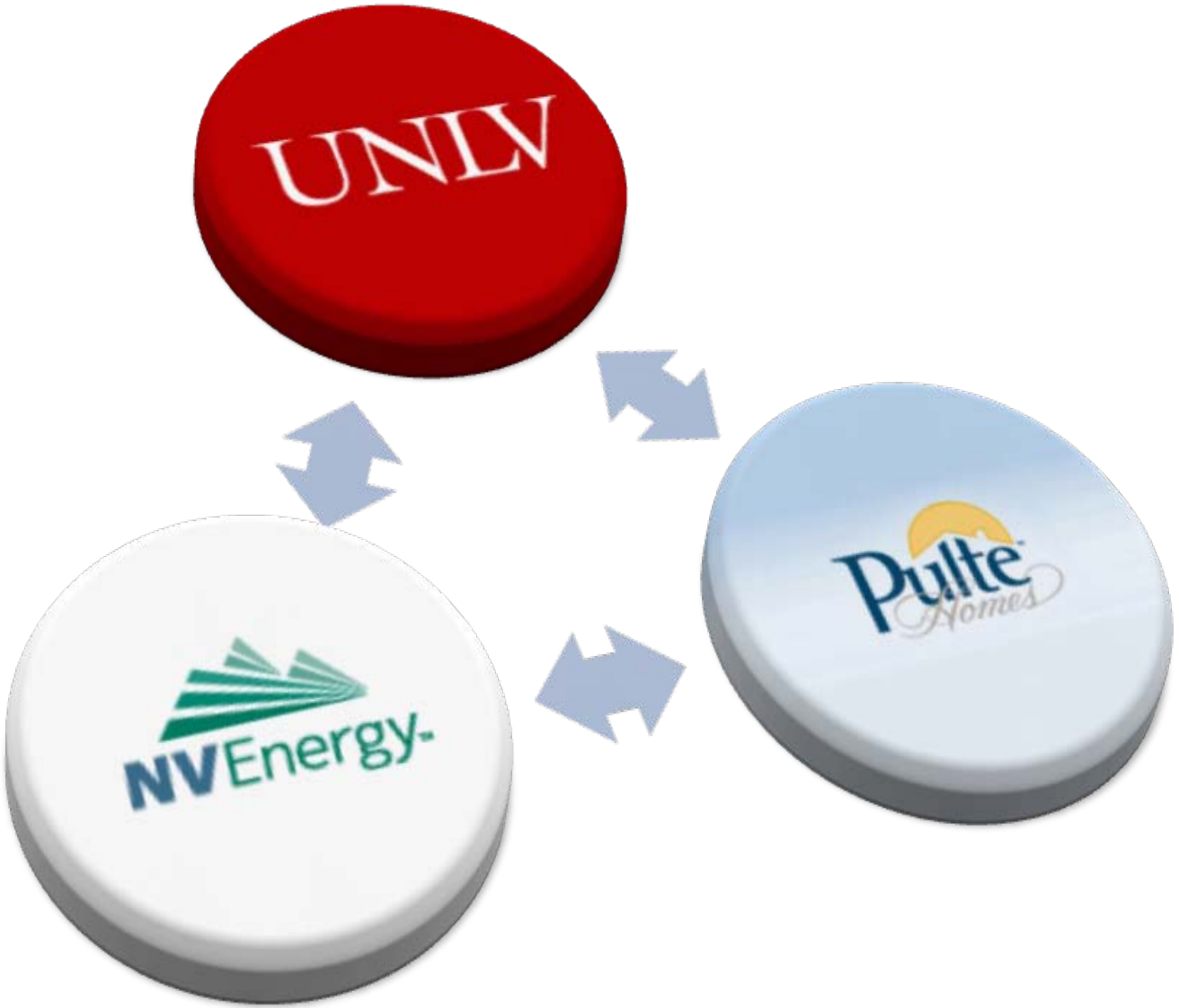


Overview

- Project description
- Subdivision energy efficiency features
- Home energy monitoring
- Demand side management
- Feeder loading
- Battery Energy Storage System
- Future Work

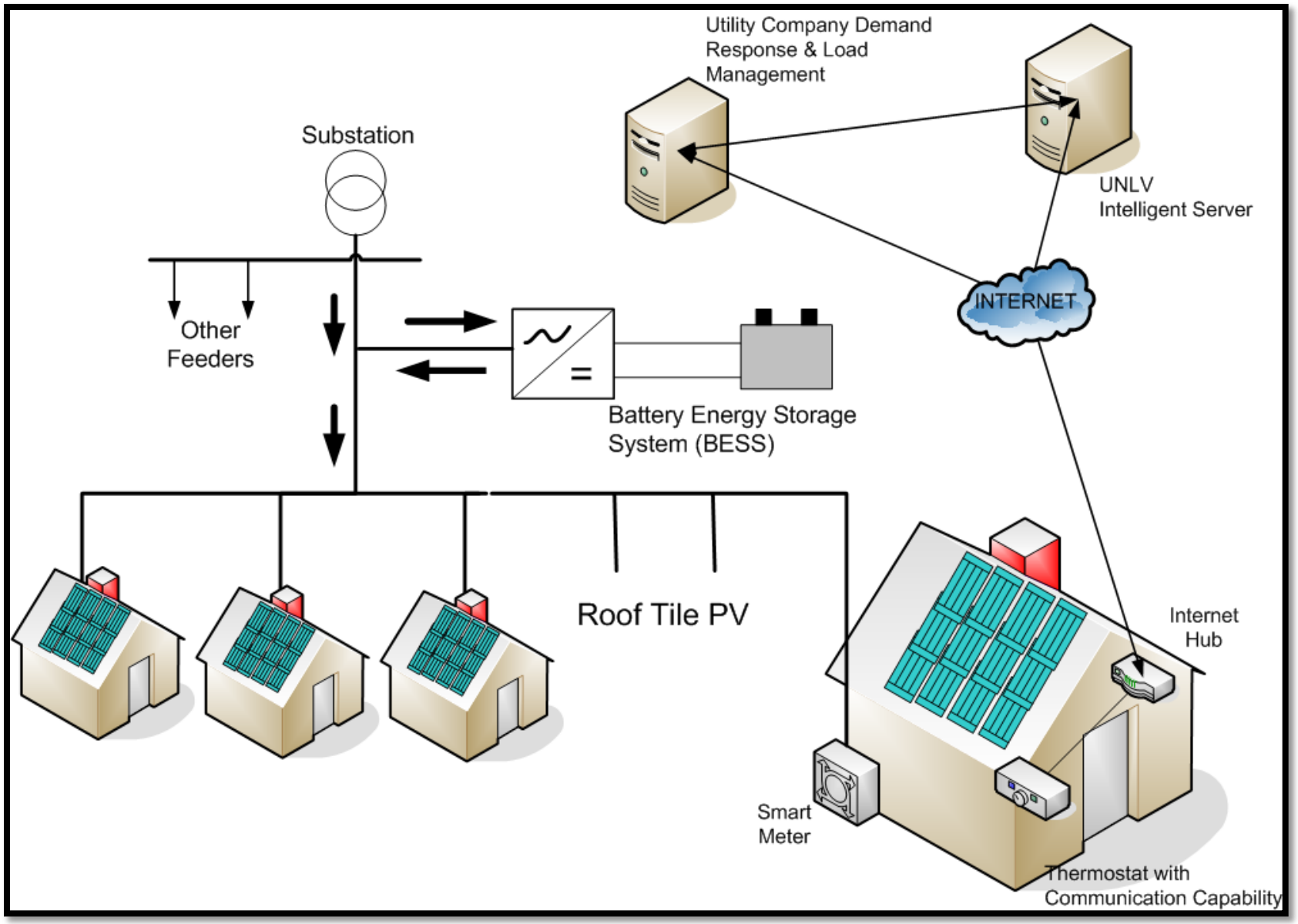
Team Members



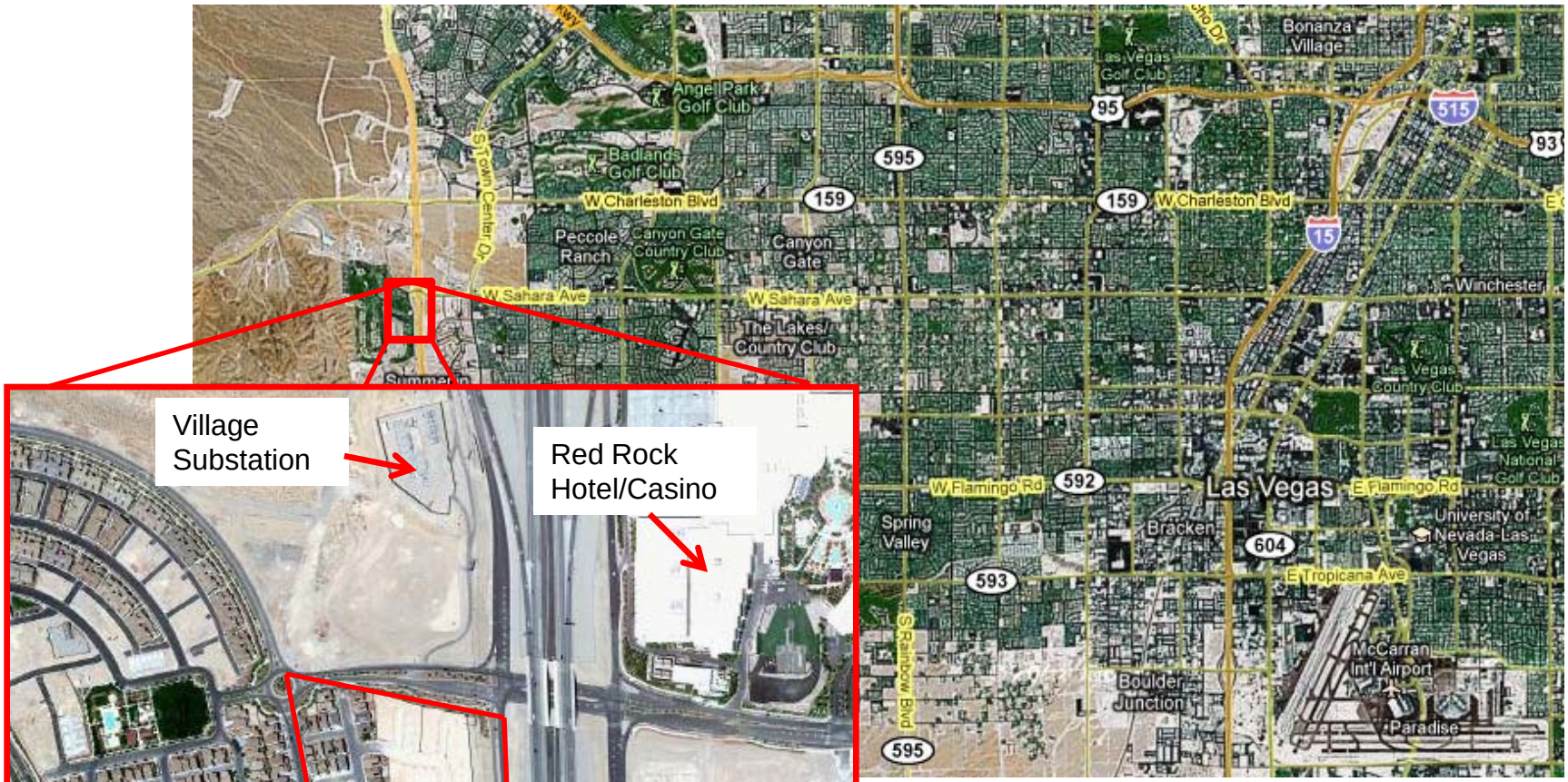
Project Objective and Methodology

- The main objective is to reduce peak power demand of a housing subdivision by 65% (compared to housing development that is built to conventional code).
- This objective will be achieved by
  - Energy efficient home construction with roof-integrated PV system
  - Demand Side Management
  - Battery Energy Storage System

Project schematic Diagram

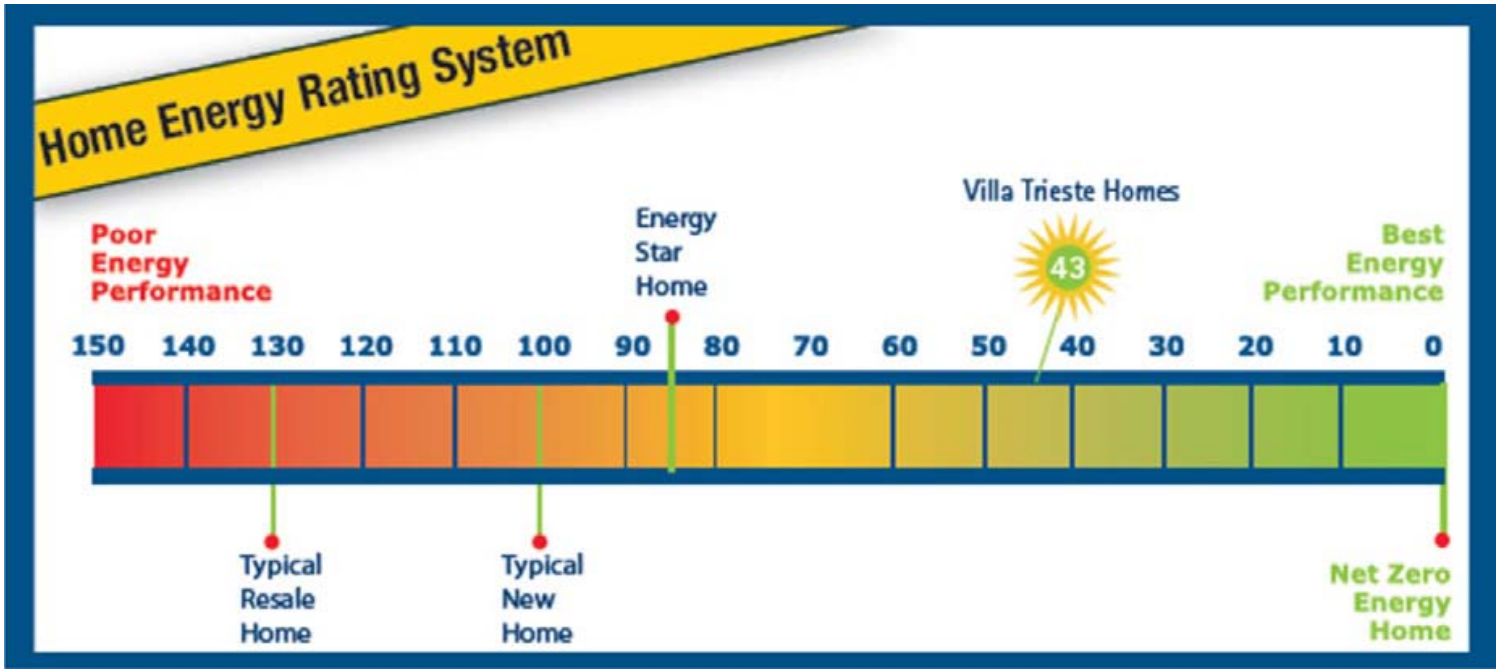


Project Physical Location: Las Vegas, NV



Villa Trieste Home Design Features

- Home Energy Rating System (HERS) index of 43
- 2 kW (avg.) photovoltaic power system
- Energy management system
- Low-E windows
- Tank-less water heater
- Leak resistant duct work
- High efficiency HVAC system
- Energy Star appliances

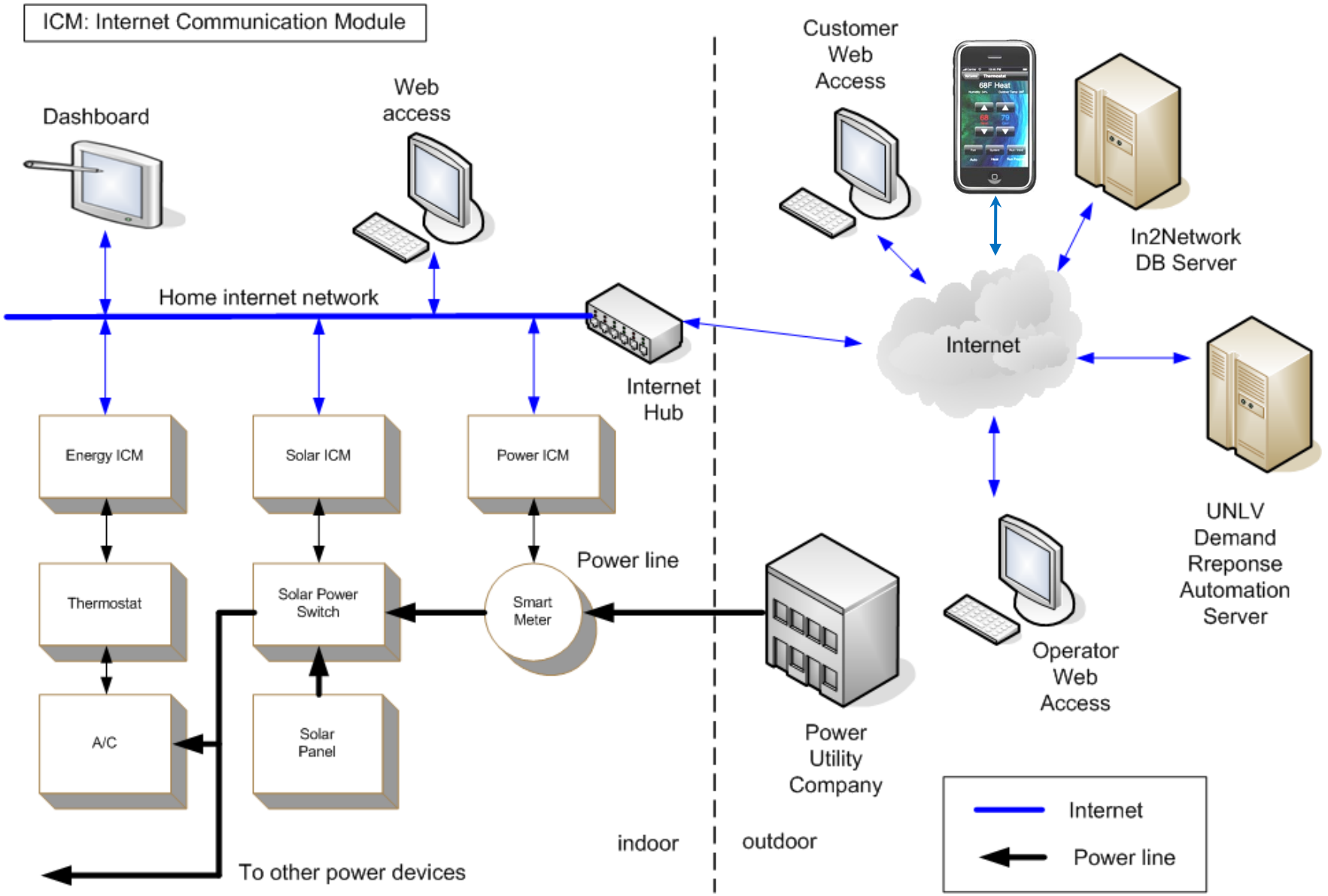


2 kW Roof-Integrated PV Systems

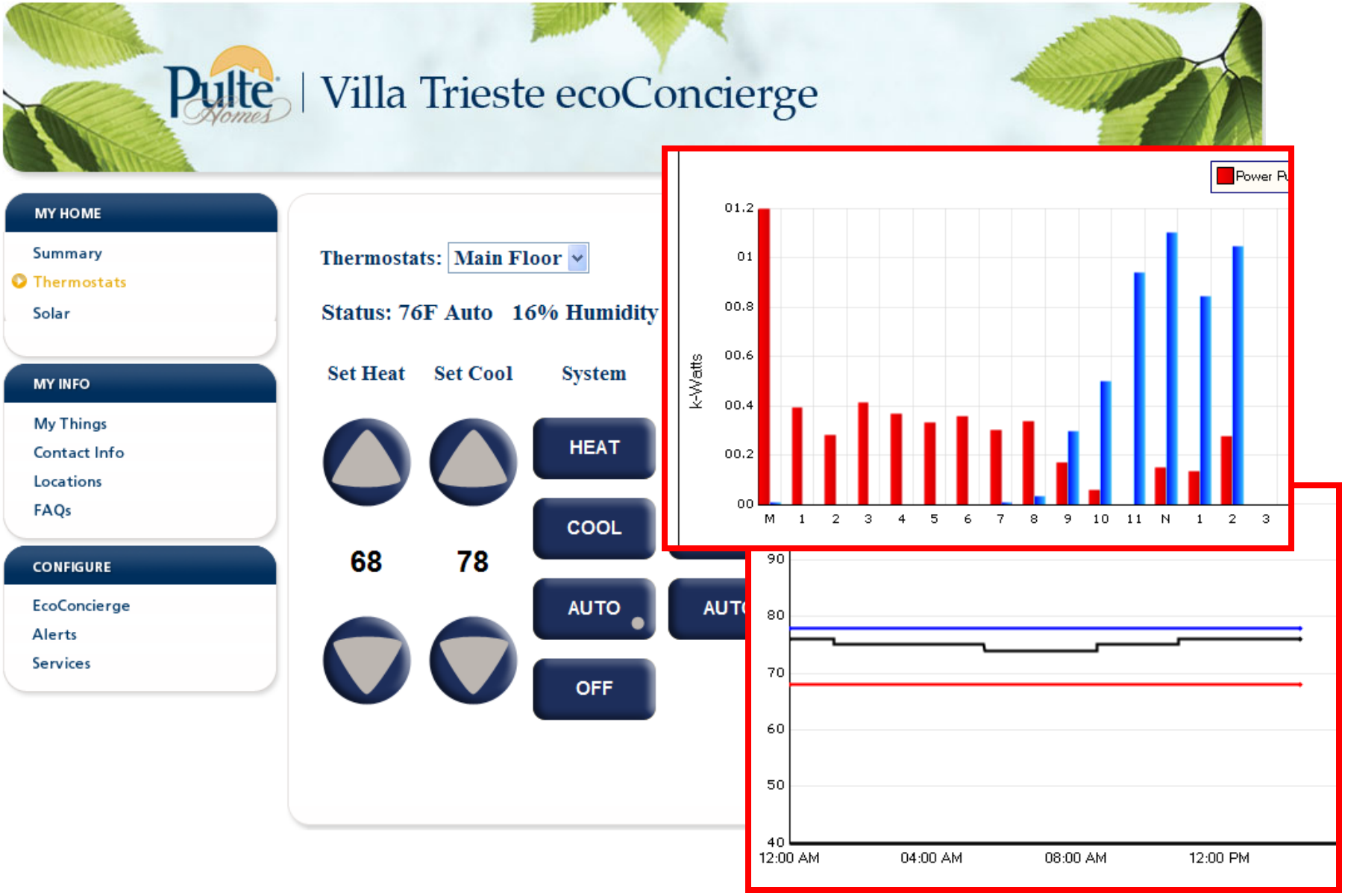
Pulte/Homeowner Involvement

- Worked with realtors and appraisers to help them understand the true value of energy efficiency and green building practices.
- implemented a “lowest utility bill contest” for the homeowners to increase awareness of energy use and encourage tem to use the tools provided.
- The FHA has agreed to start insuring the FHA Energy Efficient Mortgages. As a result, B-of-A agreed to start purchasing these from Pulte.
- Held a number of homeowner information sessions in conjunction with UNLV and NV Energy.

Home Energy Monitoring: In2Networks

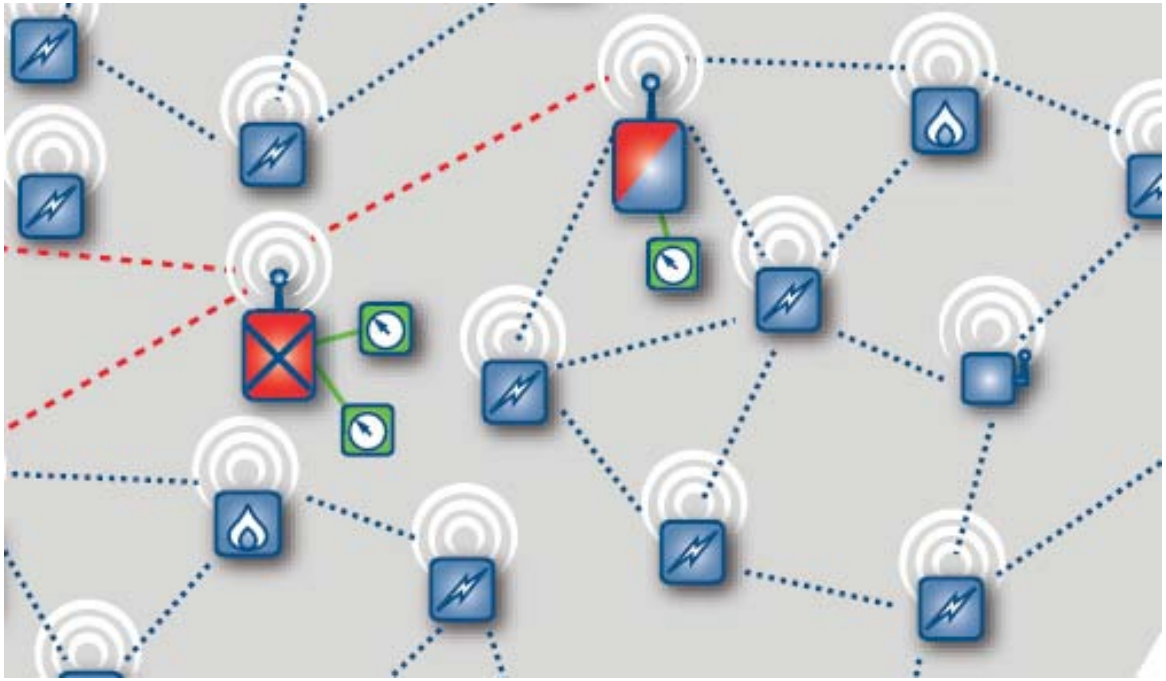


Home Energy Monitoring: In2Networks



Home Energy Monitoring: NV Energy

- Monitors PV power production and home power consumption through a Secure Mesh Neighborhood Area Network
- Secured DOE stimulus funds to place smart meters in entire service territory
- Will soon be moving to a different technology



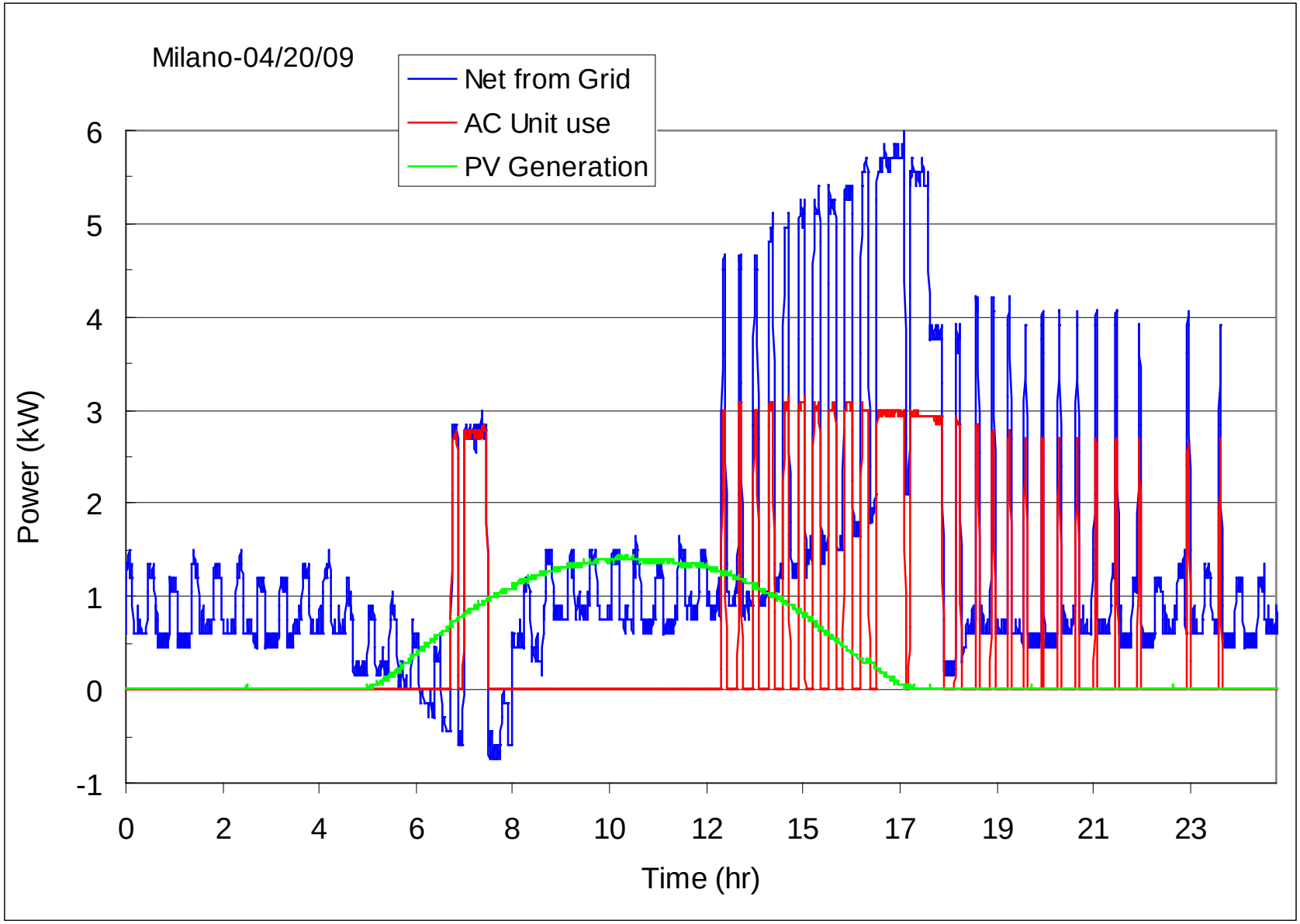
Peak Load Demand Reduction By Demand Side Management

- Demand Side action is required to reduce load when contingencies such as emergencies and congestion that threaten system reliability occur and/or when market conditions raise supply costs.
- Current utility Demand Side Management programs:
  - Direct AC Load Control (rebate)
  - Time Of Use (TOU) pricing
- Future load Management Programs:
  - Dynamic pricing pilot project is planned next year (to determine customer response). In here, the ratepayers will have the option to move their electricity use to non-peak hours, or pay higher prices for energy used during the peak hours.

Home Energy Monitoring: UNLV

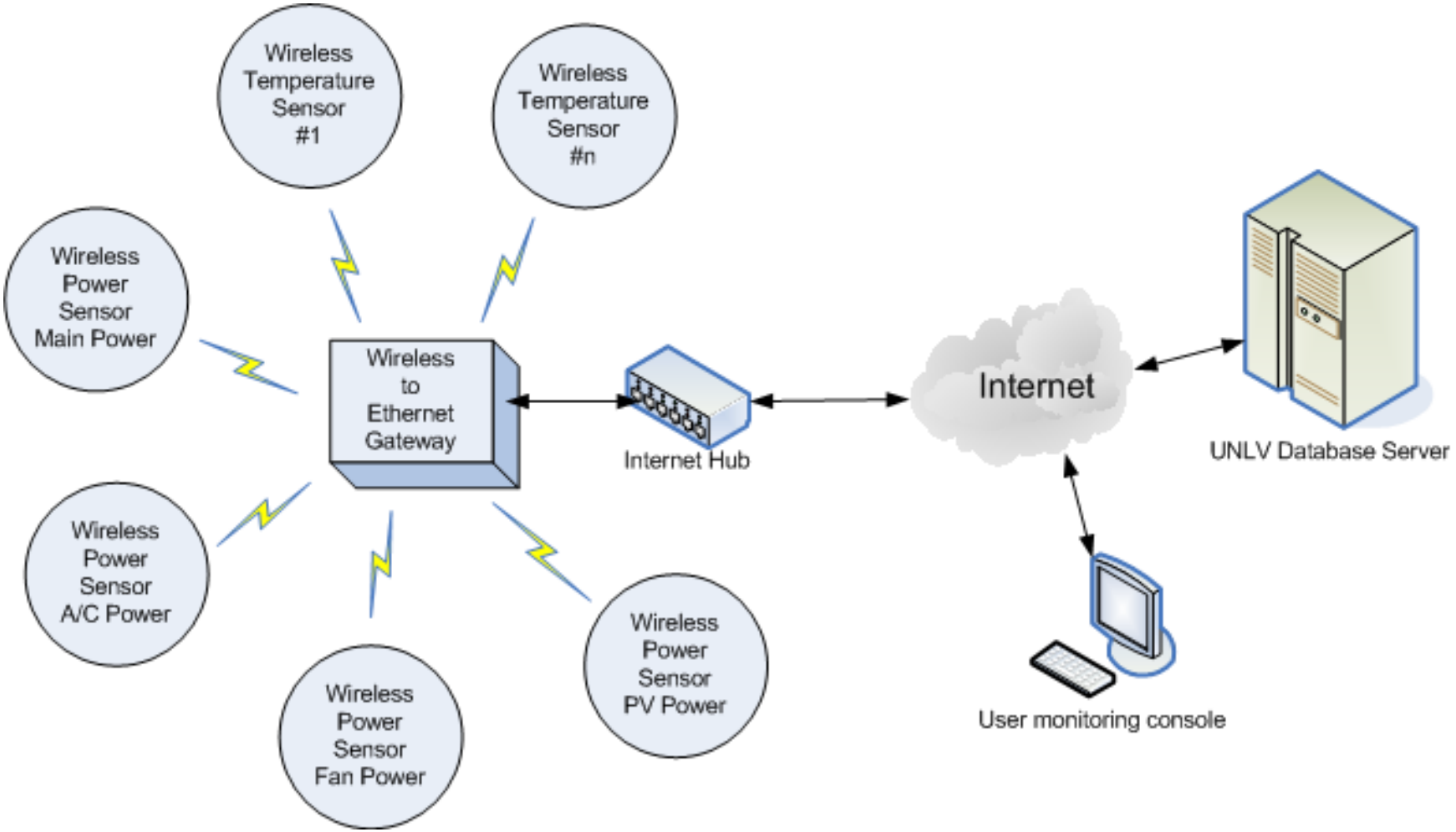
- Purpose:
  - more insight on power usage of various individual (particularly the HVAC load)
  - Weather data for evaluation of the PV systems
  - Higher resolution data
- Discovered some potential improvements for energy conservation (e.g., fan recycler)
- Collected data is used/compared to simulations (both **Energy-10** and **Energy Gauge** as simulation tools)

Sample of Instantaneous PV Power Generation, AC Load and Net Grid Power



Home Energy Monitoring: UNLV

- Developed a wireless sensor network

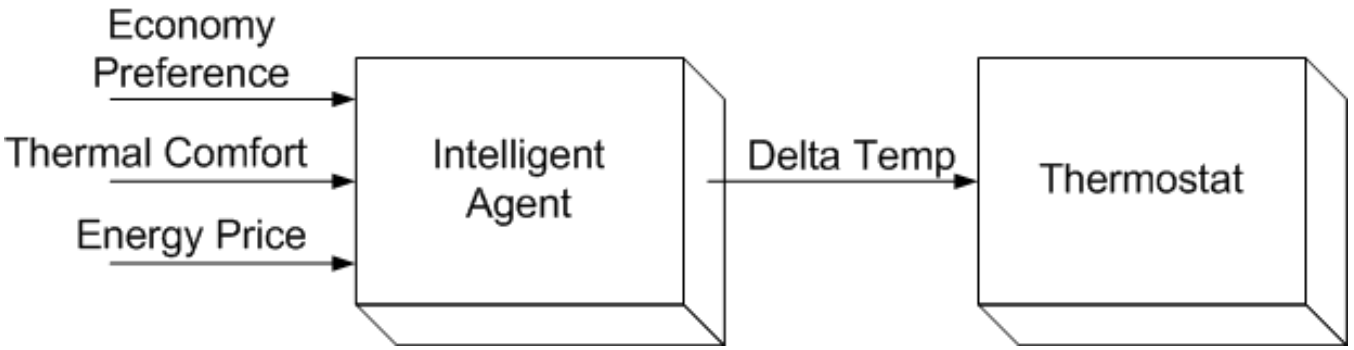


Summary of Data Collection Matrix

Provider	Resolution	Data Availability	Comm. Method	Data Type		
				Utility Power	PV Power	Other
NV Energy	5 min	Around 1 hour late via NV Energy ftp site	Mesh Network	√	√	
In2Network	2 min	Updated to In2 server every 2 minutes	LAN	√	√	Indoor temp
UNLV	1 min	Almost real-time via UNLV Database Server	Zigbee	√	√	Indoor temp Outdoor temp Weather data AC power Fan power

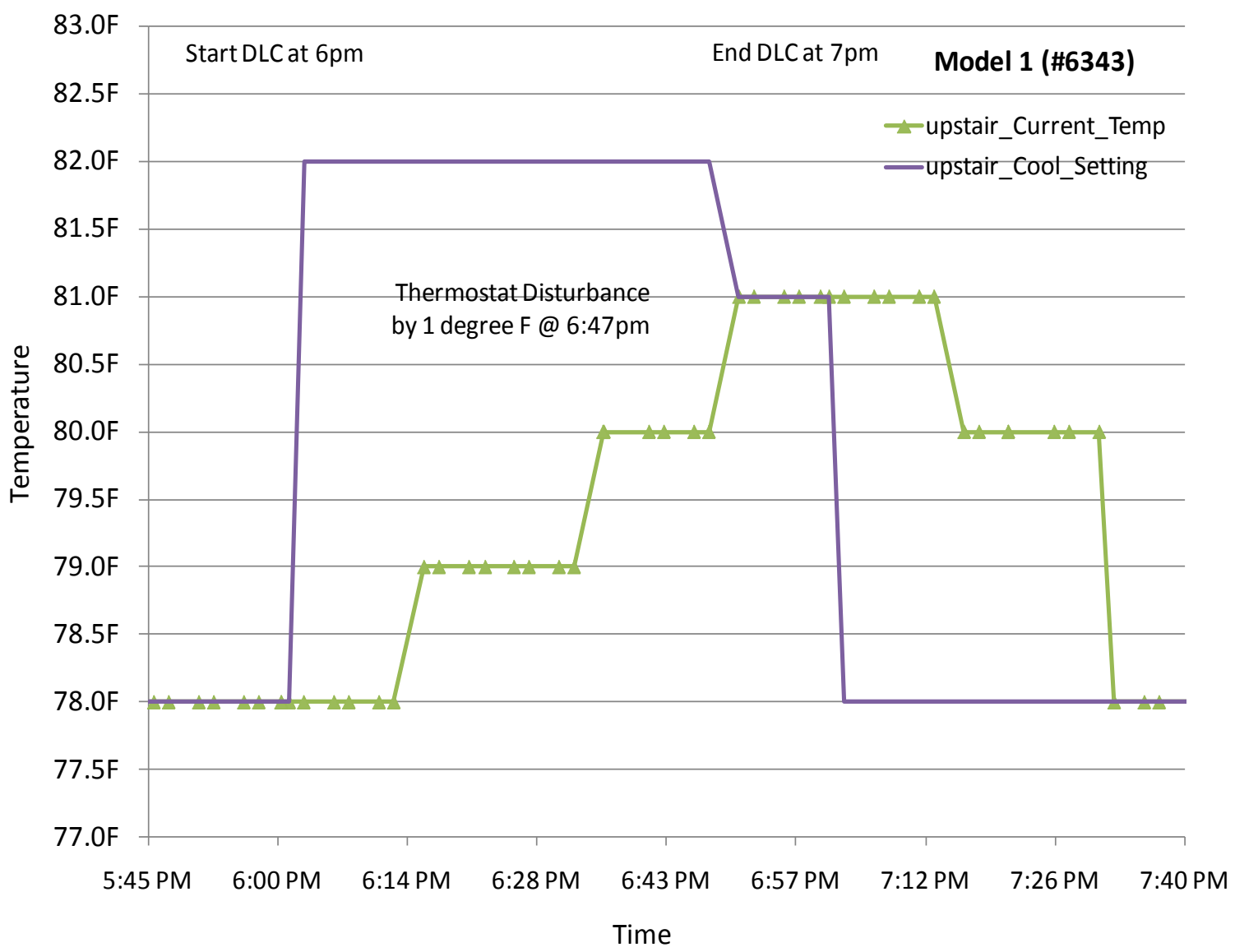
Home Energy Monitoring: UNLV

- Because most consumers don't have time to watch the price of electricity fluctuate, we are developing a dynamic price thermostat control method based on fuzzy logic.



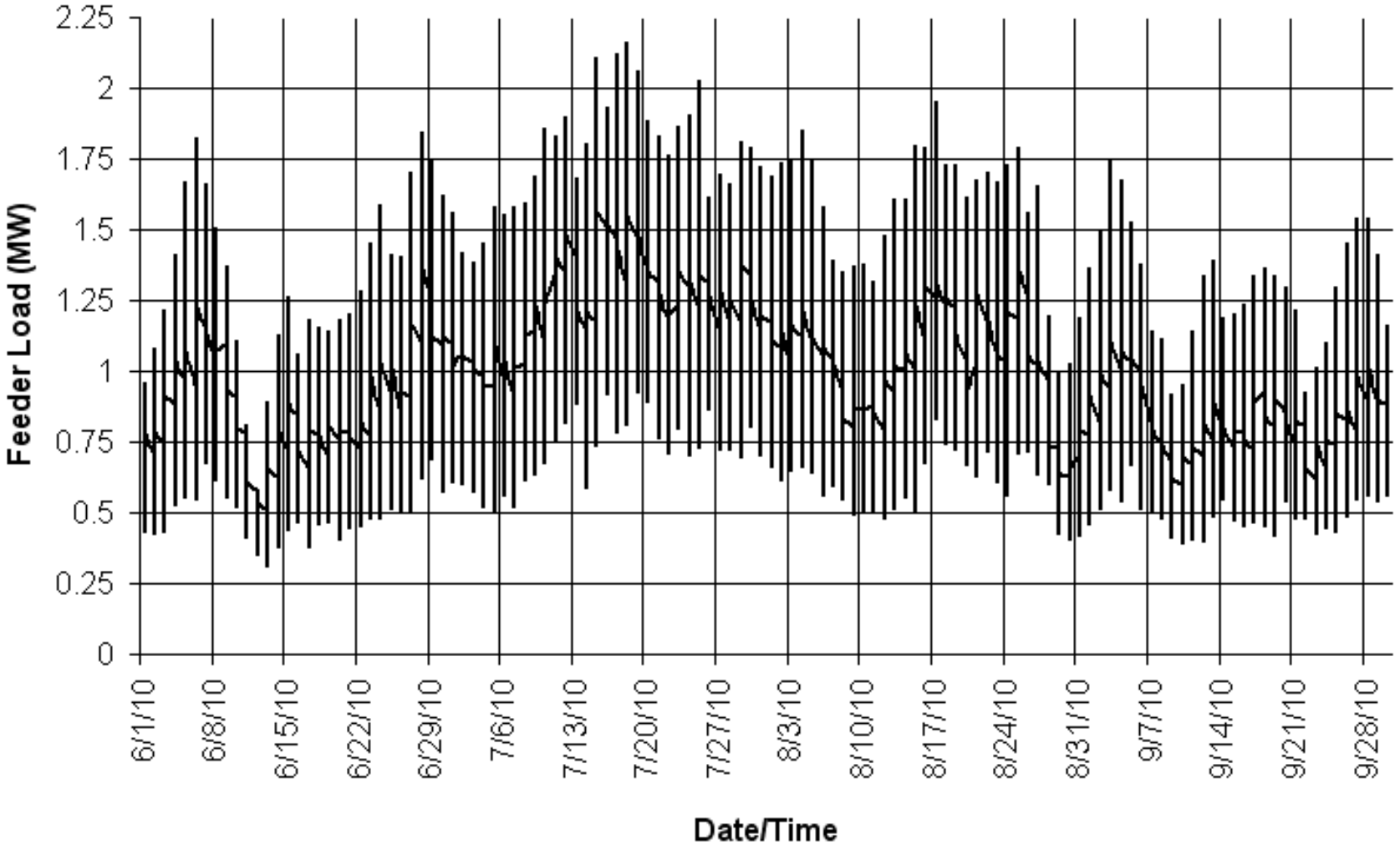
- UNLV developed a bridge server to access In2Network server in order to simulate demand response
- UNLV can now remotely control the home thermostats (with permission from the homeowners)

Sample of Direct Load Control (7/22/10)

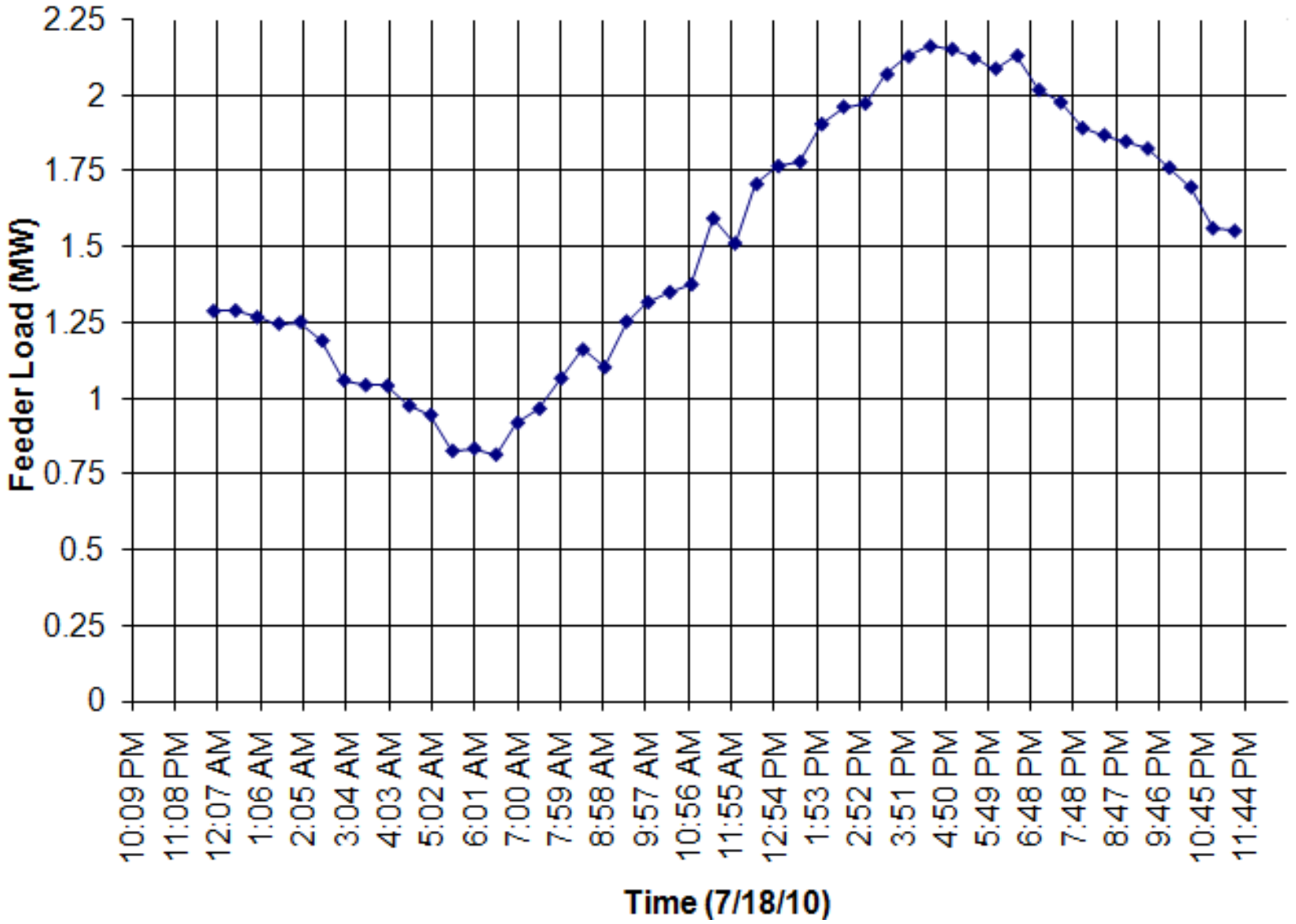


Feeder Load During Summer 2010

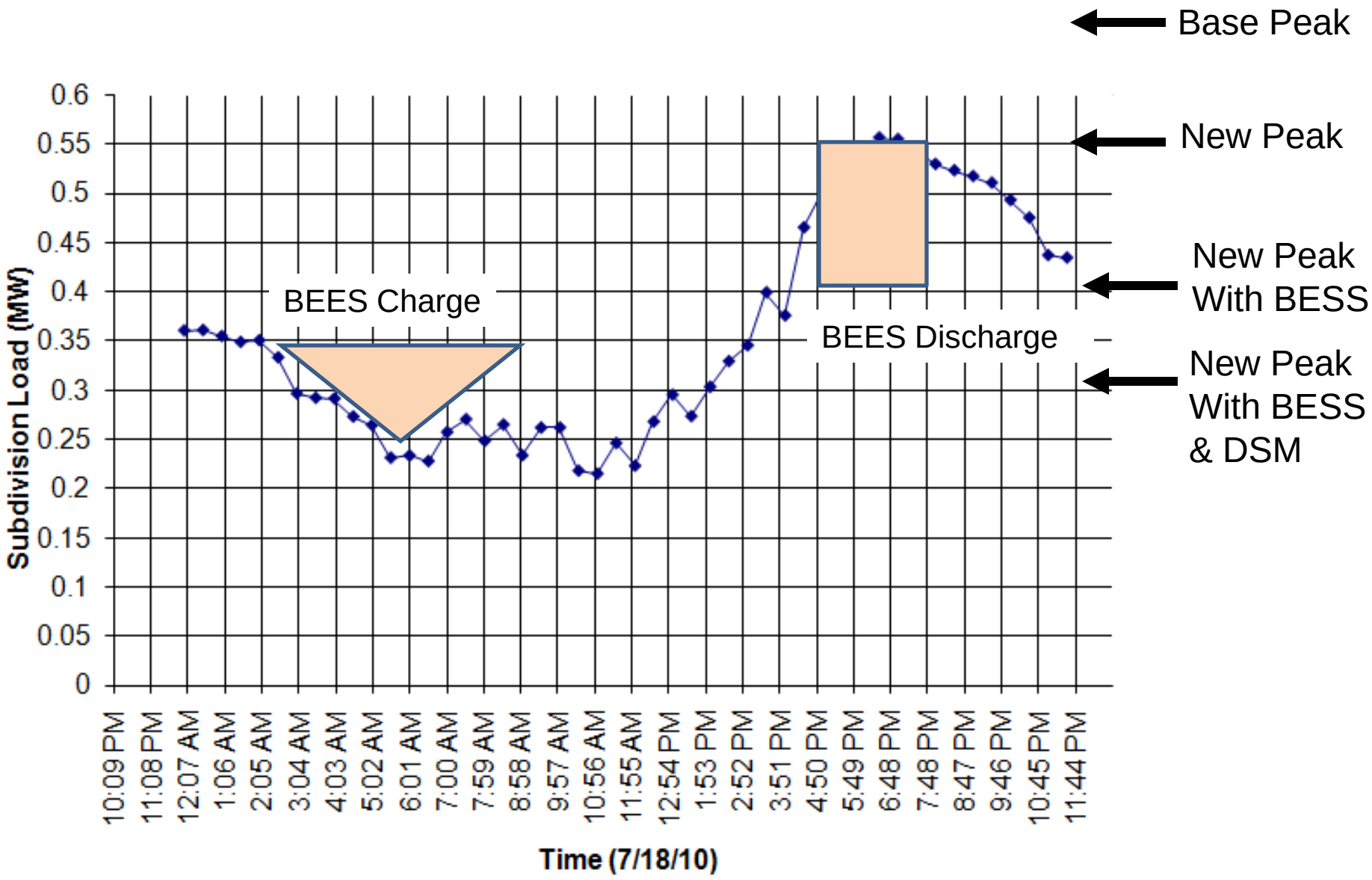
(Villa Trieste subdivision represents less than 10% of feeder load)



Feeder Load During 2010 Peak Day (July 18)



Estimated Villa Trieste subdivision Demand and Peak Load During Summer 2012



Battery Energy Storage System (BESS)

- Searched numerous technologies:
  - High temperature battery
  - Flow batteries
  - Lithium-based batteries
  - Advanced lead-acid batteries
  - Distributed energy storage
- All are too expensive for our budget.

BESS Sizing
(given budget constraint)

- 150 kW/500 kWh BESS acting alone will be able to reduce the peak demand of the subdivision by nearly 25% (see previous slide).
- Technology we can afford: conventional or maybe advanced lead acid batteries (4,500 v.s.1,500 cycles for DOD < 70%).
- Specify the power converter according to IEEE Std. 1547.
- Program battery charging according to manufacturer recommended charge cycle.

BESS Primary & Secondary Applications

- Main Application:
  - electric energy time-shift (shave peak and fill valley).
- Control method
  - Economic Dispatch through SCADA
- Possible Secondary Applications (for cost justification)
  - electric supply capacity,
  - Area frequency regulation,
  - Reserve Capacity (or spinning reserve),
  - Voltage Support,
  - Transmission congestion relief,
  - T&D upgrade deferral,
  - Substation on-site power.

Future Plan

- Complete home construction (depends on future housing market)
- Replace current Energy Management System with that NV Energy will be offering in the future.
- Complete the development of the fuzzy logic thermostat controller.
- Continue with home monitoring and simulations. Determine HVAC coincidence factor .
- Participate in dynamic pricing pilot project and evaluate performance.
- Install a battery energy storage system and conduct charge and discharge tests
- Incorporate the BESS in SCADA and work with NV Energy to develop a dispatching methodology.
- Evaluate targeted peak load reduction.