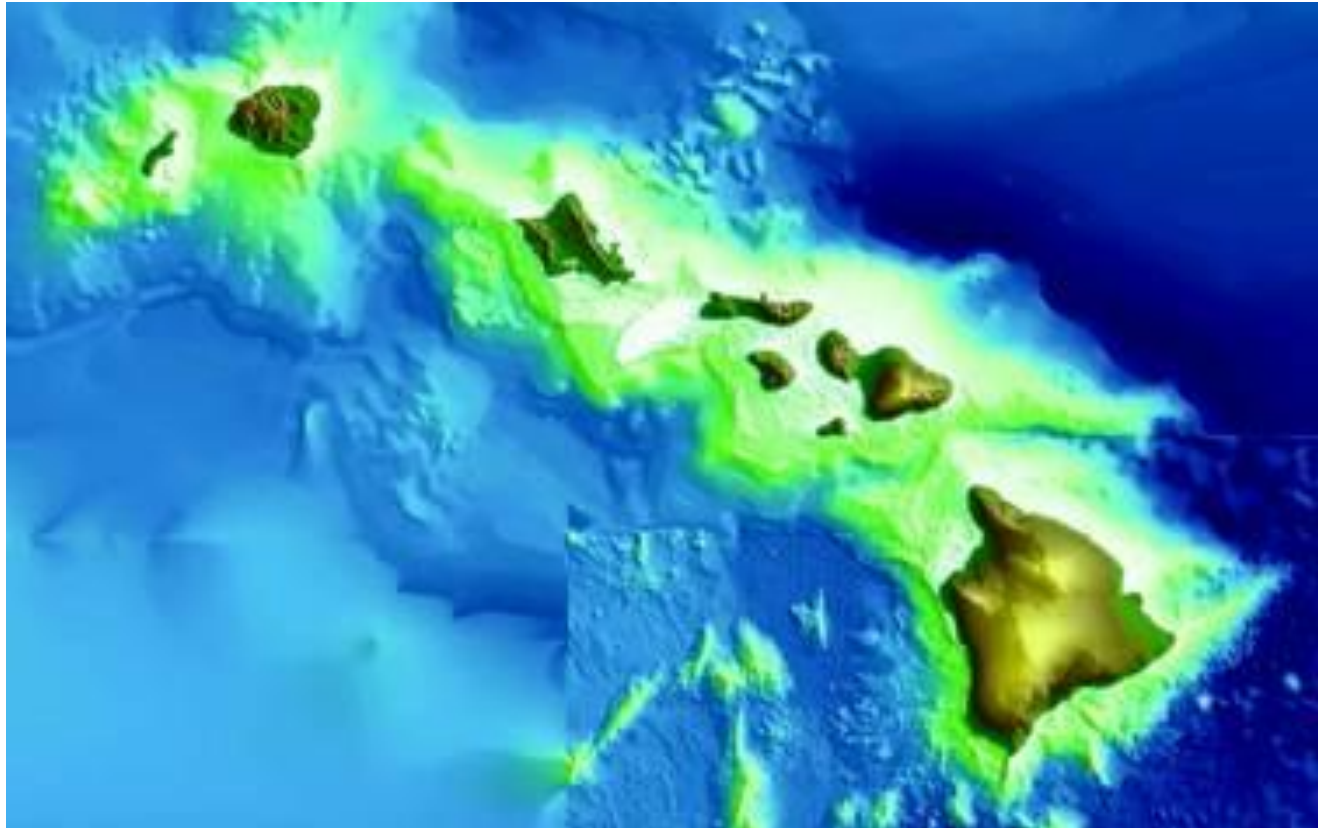


UH-HNEI PV Program



PV Program Mission – evaluate impact of ***high-penetration of Distributed PV*** on utility grid ***power quality and control issues*** under a variety of operational and environmental conditions

HNEI – PV Program Objectives

- Characterize emerging PV and smart inverter technologies in the unique micro-climates of Hawai'i to support higher penetration of PV
- Develop 1 Hz Data collection, storage, and analysis capability to support Research, Test and Evaluation (RT&E), and reporting and distribution to local utility, academia, and technology community

Data are Required to Address Grid-scale Power Management and Control Challenges

Pu'u Wa'a Wa'a PV Test Bed Commissioned July 9th, 2010



Puu' Wa'a Wa'a Ranch – Big Island, Hawai'i

UH College of Engineering (CoE) Test bed Commissioned December 9th, 2010



Mitsubishi – 3 kW

Amorphous Silicon PV array with SMA SB3000 central
inverter

CoE Test bed

Commissioned December 9th, 2010



Kyocera – 5 kW

Polycrystalline Silicon PV array with SMA SB5000 central inverter

Maui College



Kyocera – 15 kW

Polycrystalline Silicon PV array using SMA inverter technology

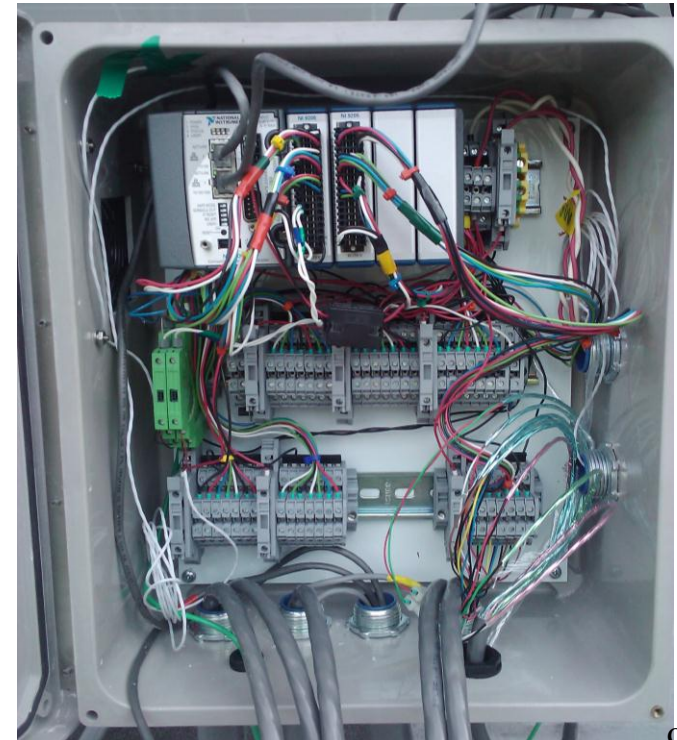
Data Analysis “Toolbox” – Develop hardware and software tools to enable data collection, storage, analysis, and distribution

Data Acquisition System (DAS)

- On-site computer “server” to manage controller and power module
 - Module-level Sensor Measurement Units
 - LabVIEW interface for remote operation
- Host computer located at UH-HNEI
 - Hosts visualization and Database SW supporting on-site operation
- On campus secure data base server

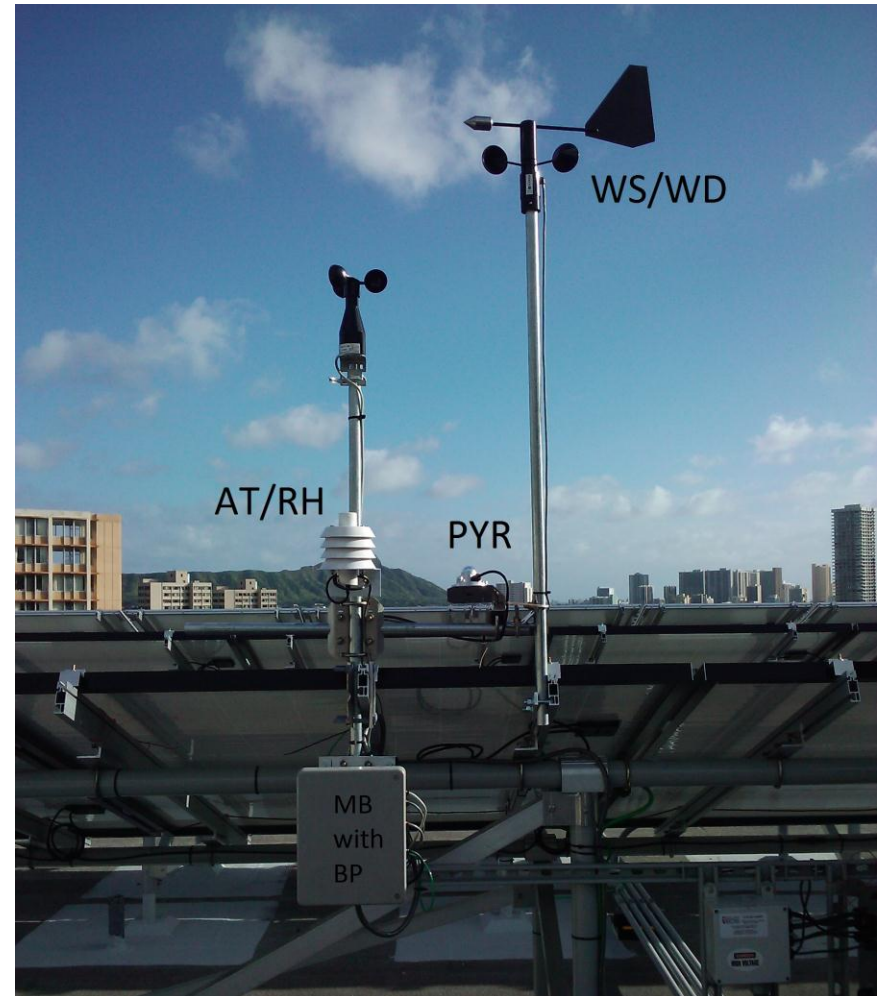


cRio-9022 embedded controller
with NI-9144 Ethernet extension
chassis



Weather Station

- Wind Speed (WS)
- Direction (WD)
- Global Solar Radiation (PYR)
- Ambient Temperature (AT)
- Relative Humidity (RH)
- Barometric Pressure (BP)

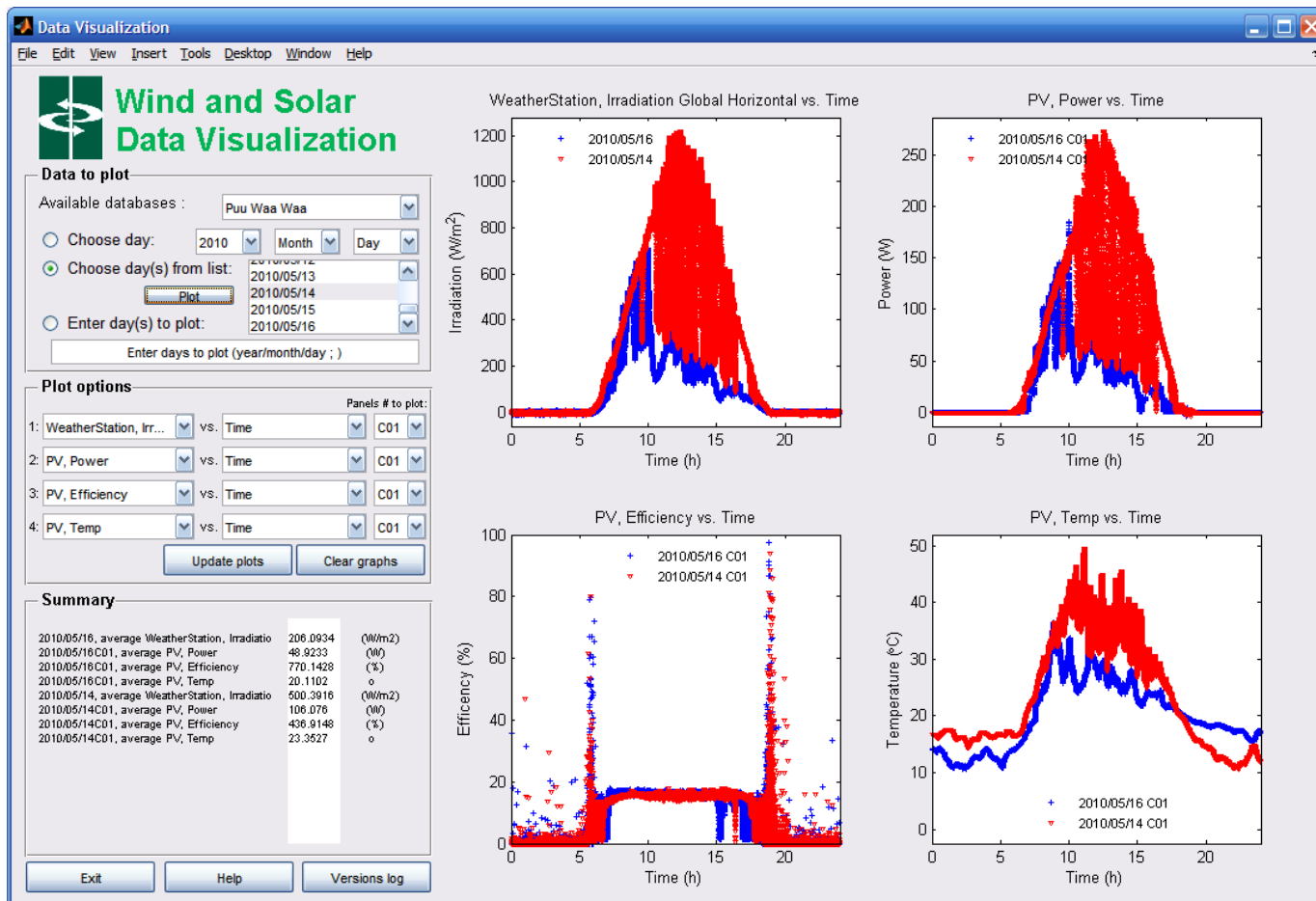


TSI 880 Sky Imager

- Automatic full-color imaging system
- Real-time processing and display of sky conditions
- Computes fractional cloud cover and sunshine duration



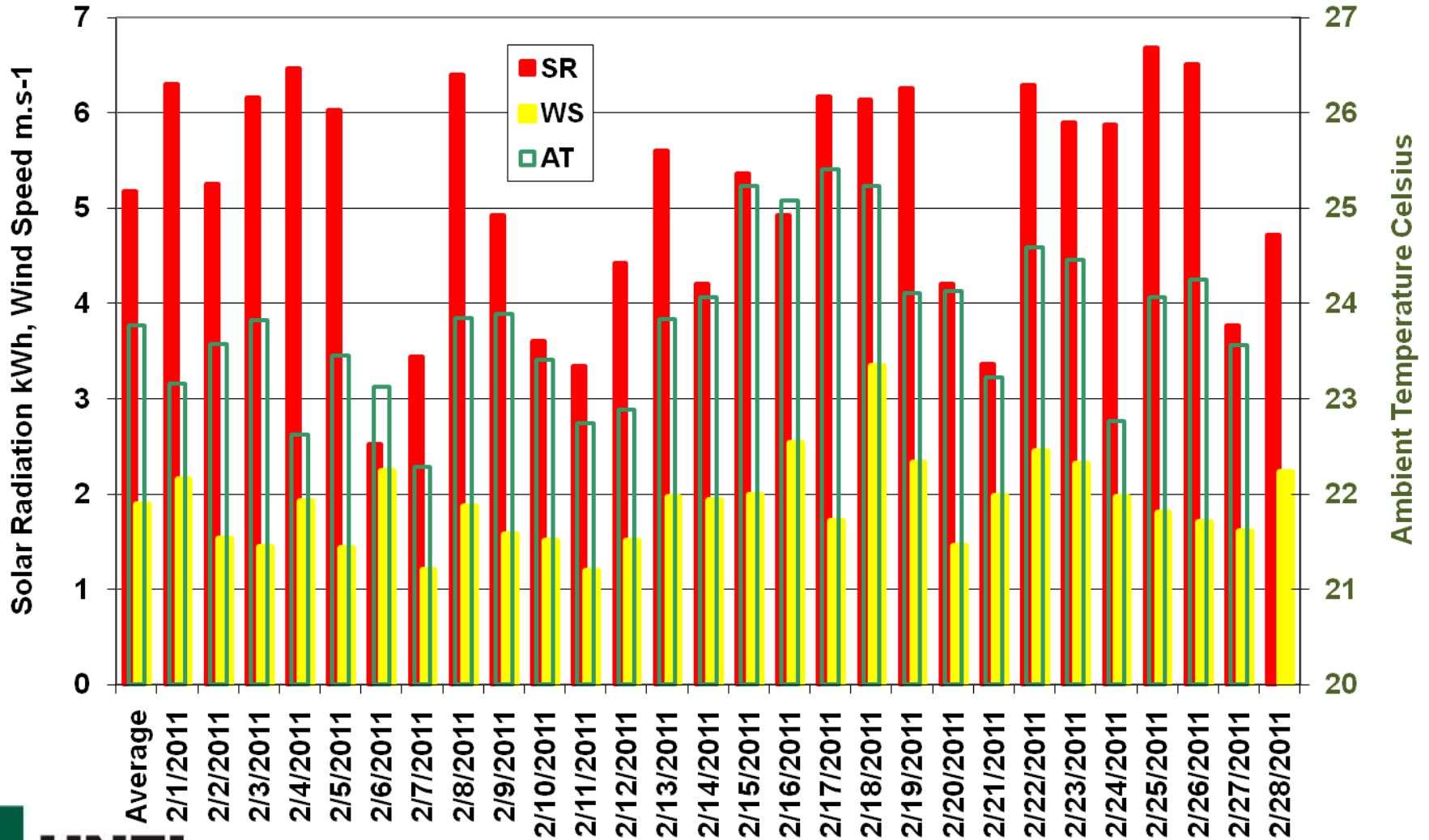
Real-time Visualization – LabVIEW



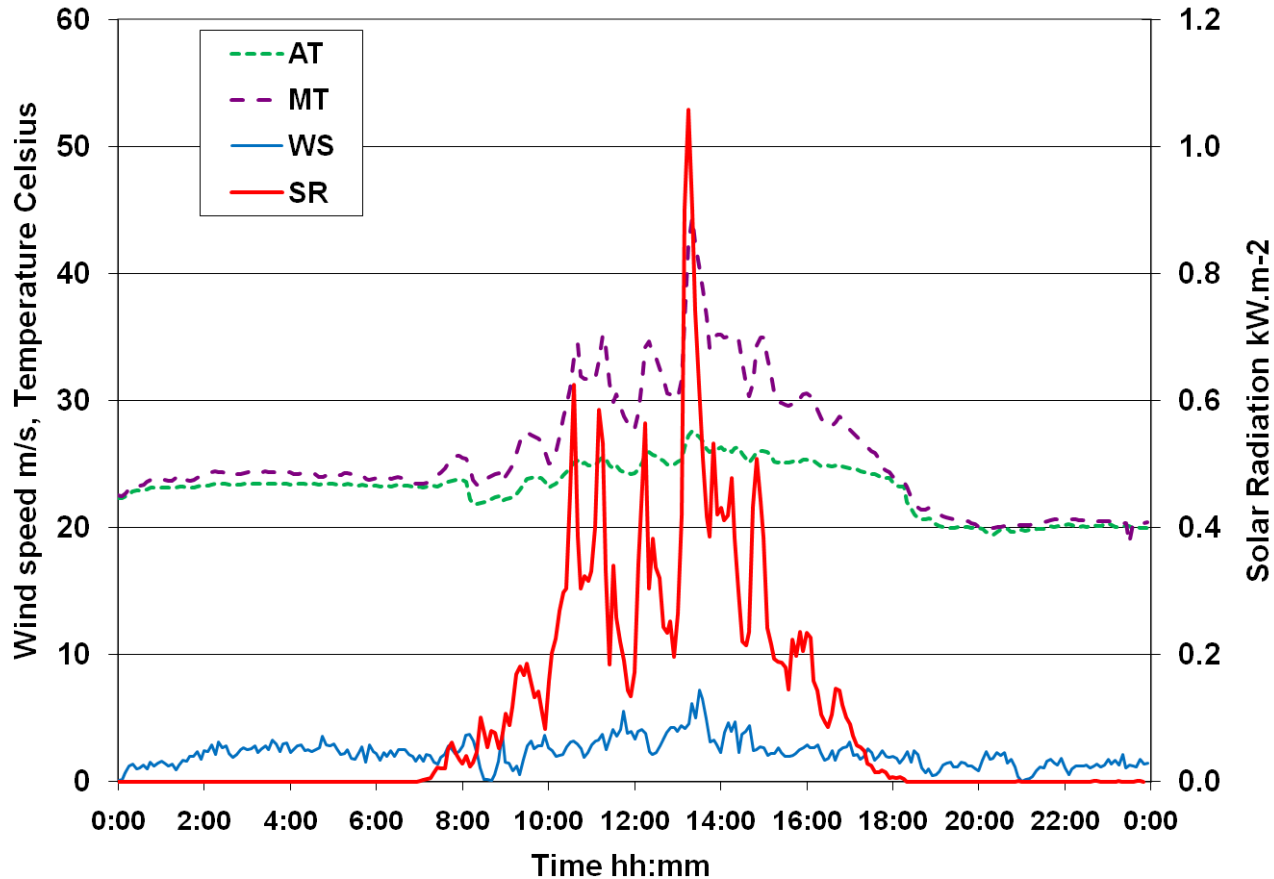
Data Visualization of Data sets from PV modules using the Matlab Data Analysis and Visualization Tool

CoE Weather Station

February 2011

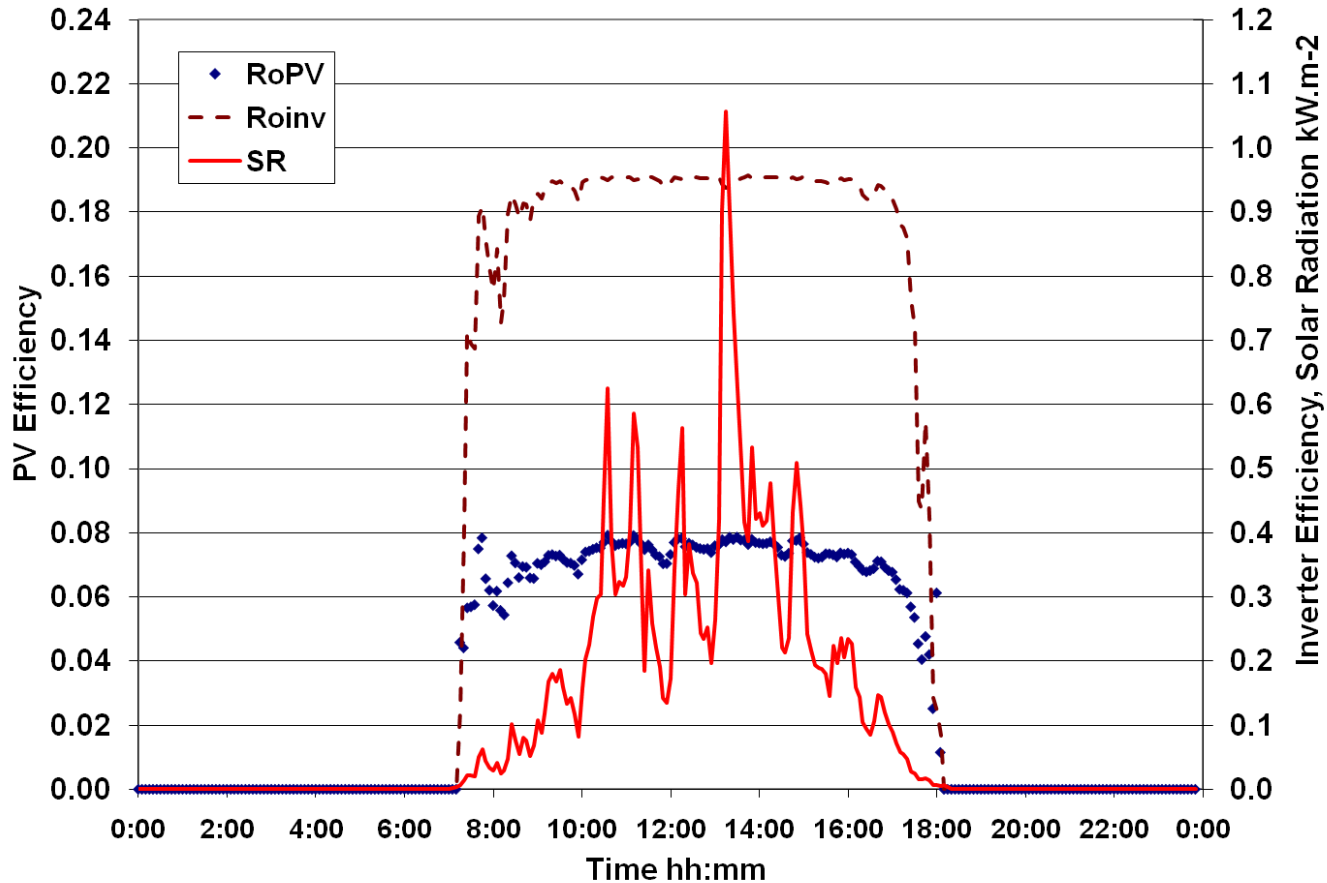


CoE Environmental Conditions



February 6th – cloudiest day of the month
SR Max=1.07kW.m-2

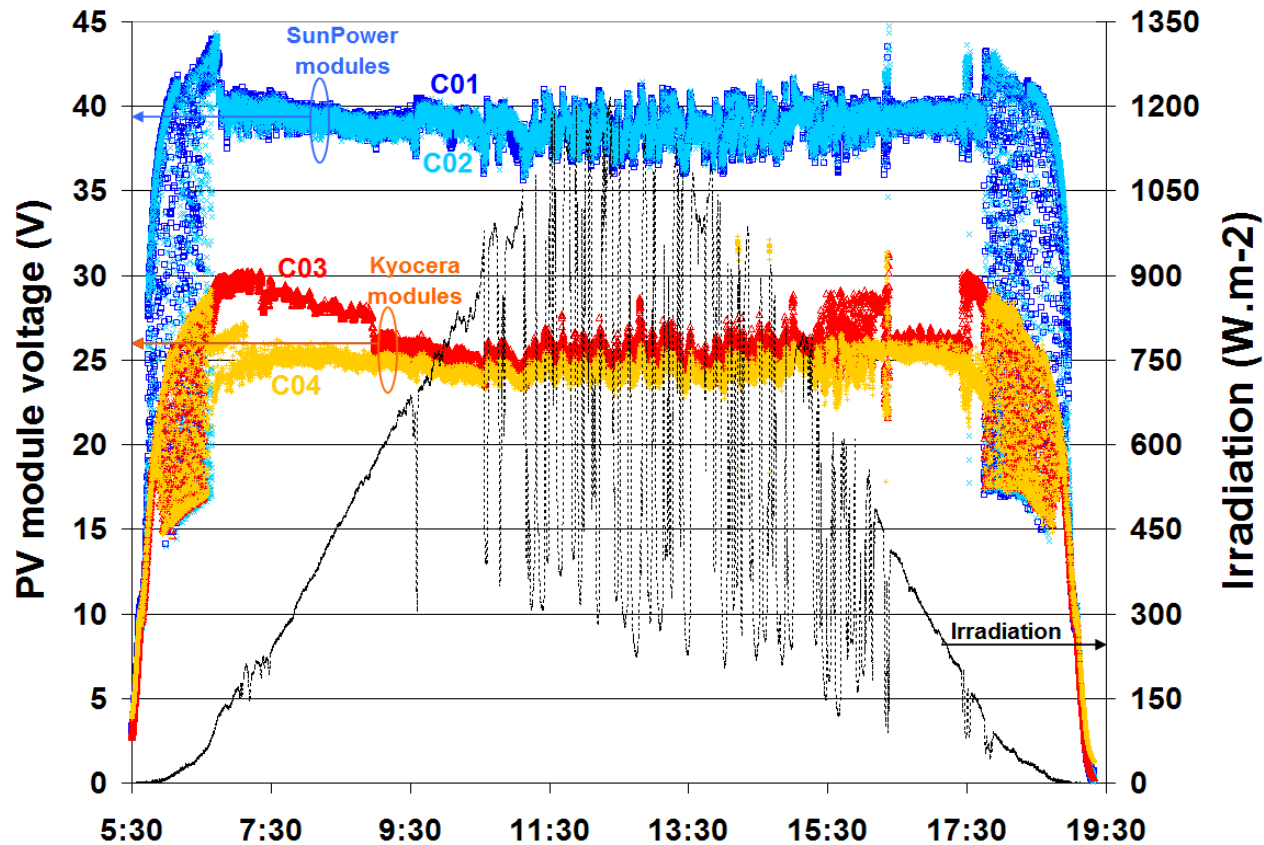
CoE PV Module Efficiency



February 6th – cloudiest day of the month

Ro PV = 7.5%

CoE PV Module Operation



DC voltage Variation versus time for 4 (four) PV modules and corresponding solar radiation during May 14th, 2010

Next Time

- 1 MW/250kWhr Grid-scale Battery Energy Storage System (BESS)
 - Frequency regulation
 - PV smoothing
 - Wind generation smoothing
 - Power quality management
 - VAR injection
 - LV Tap Changer

