

Sensing in Solar Decathlon House

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2009.09.11
Present in AIS Seminar, Fall 2009



Outline

- Introduction
- Sensing Phase I: Indoor/Outdoor Environment
- Sensing Phase II: Building Systems
- Experiences and Challenges
- Some Related Works

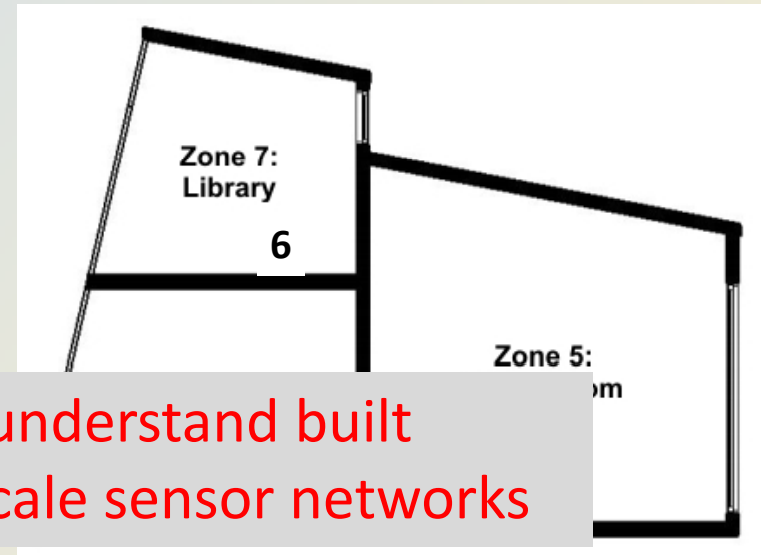
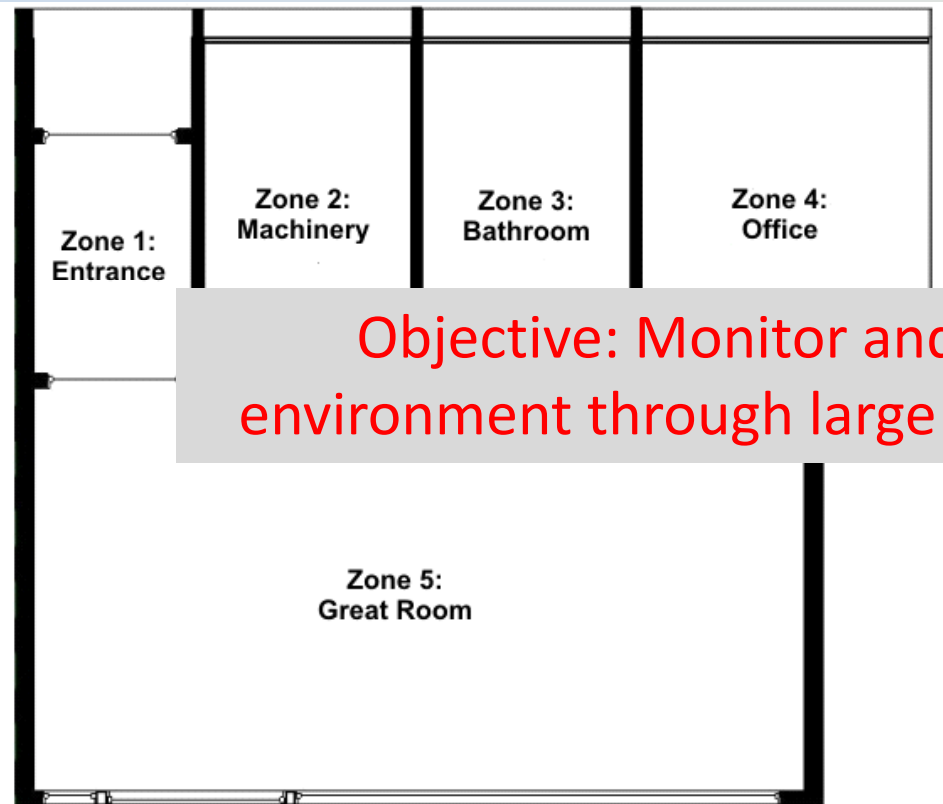


Introduction—Solar Decathlon House

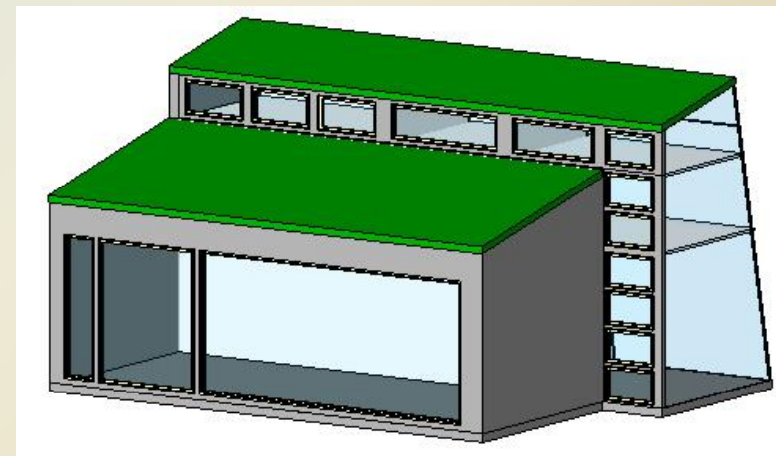
- The Solar Decathlon, a Department of Energy sponsored competition, has college participants from across the country competing for the Best Self – Sustaining Solar House.
- The Solar Decathlon 2005 entrant, the Pittsburgh Synergy, was built collaboratively by Carnegie Mellon University, the University of Pittsburgh and the Art Institute of Pittsburgh.



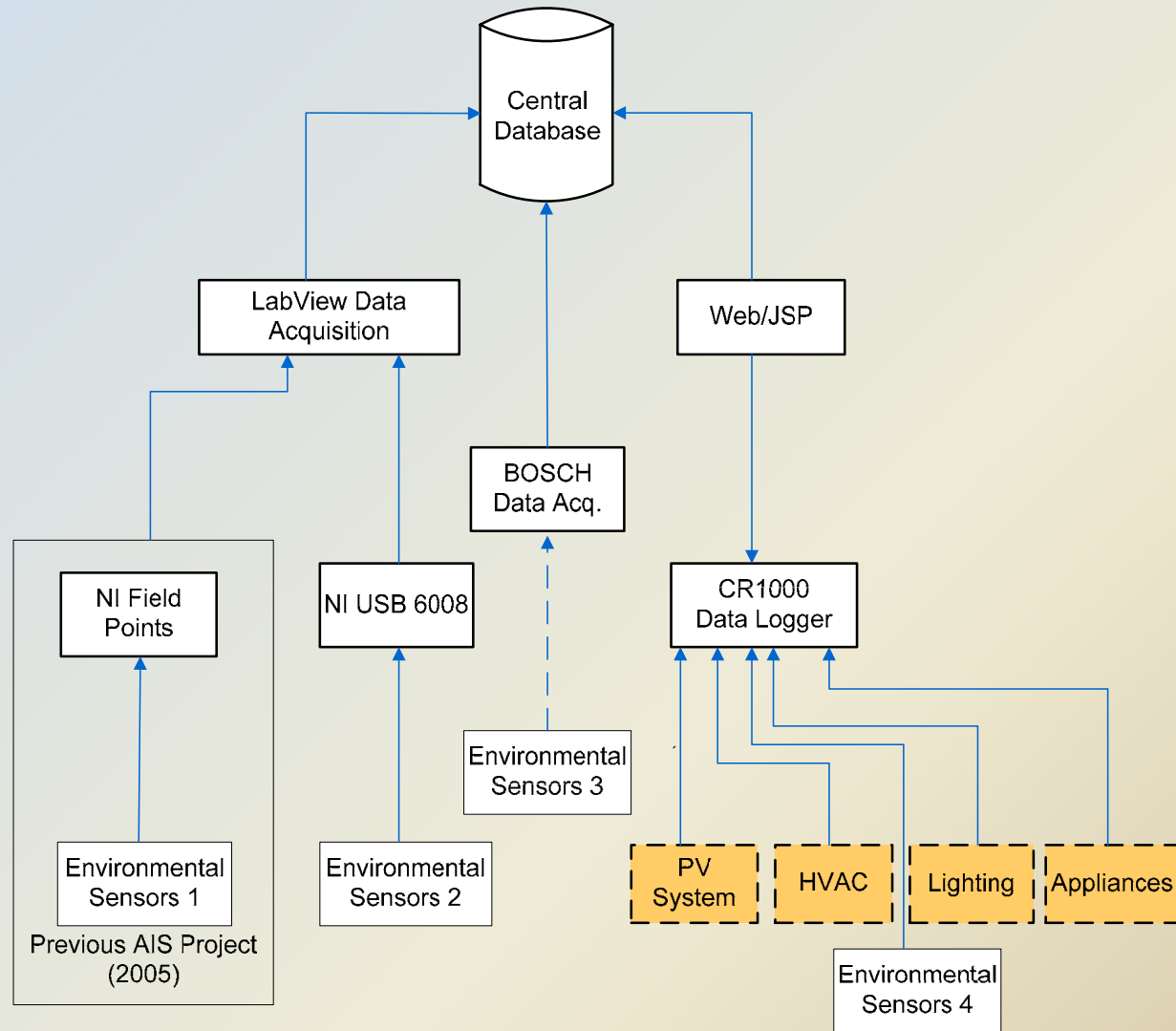
Introduction—Solar Decathlon House



Objective: Monitor and understand built environment through large scale sensor networks



Introduction—Overall Sensing Infrastructure



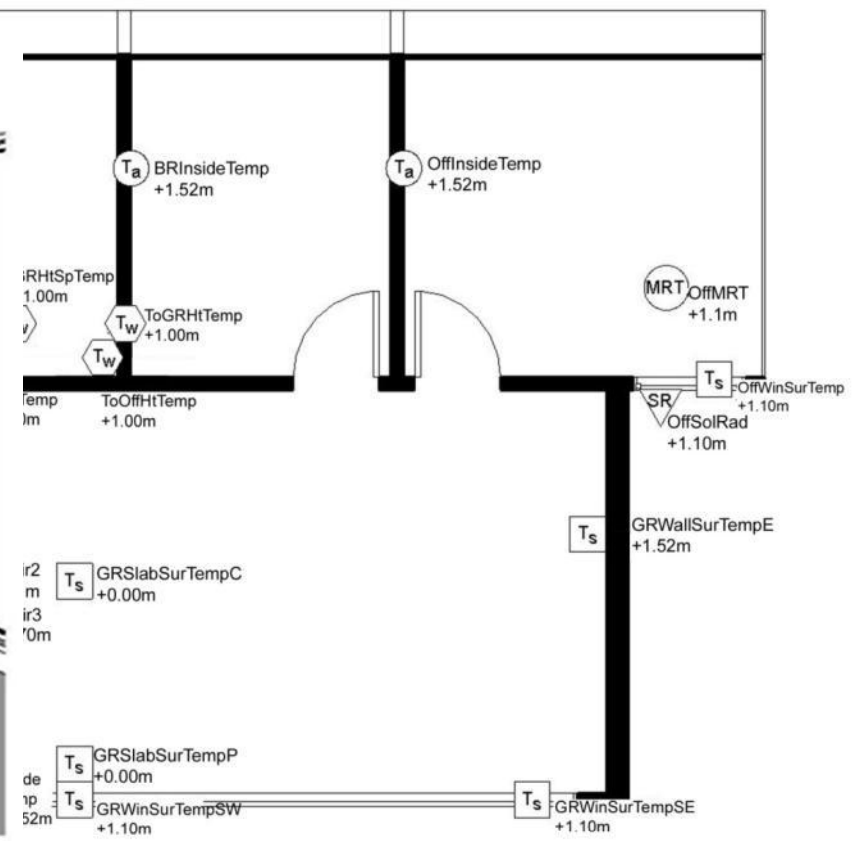
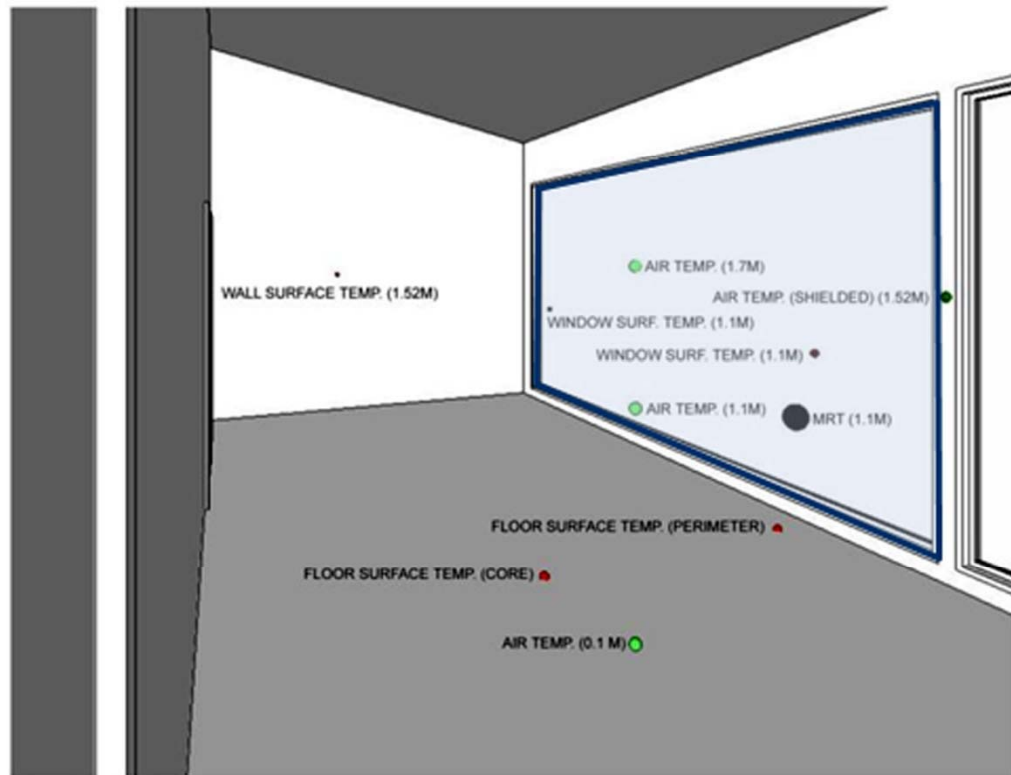
Sensing Phase I: Indoor/Outdoor Environment

- Outdoor Sensing
 - Weather station:
 - Temperature, Relative Humidity (HMP50-50, Campbell Scientific)
 - Solar Radiation (Pyranometer ,Li_COR, Li-200)
 - Wind Speed (Anemometer ,Campbell Scientific)
 - CO₂ (TelAire, Module6004a)



Sensing Phase I: Indoor/Outdoor Environment

- Indoor Sensing



Sensor Legend

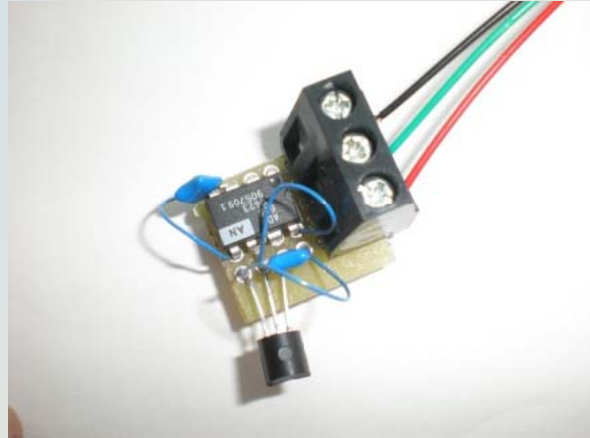
● Ambient air temperature (radiation shielded)	InsideTemp
● Ambient air temperature (unshielded)	T _{air1} / T _{air2} / T _{air3}
● Floor surface temperature	GRSlabSurTempC / GRSlabSurP
● Window/wall surface temperature	GRWinSurTempSW / GRWinSurTempSE
● Mean radiant temperature	GRMRT



Sensing Phase I: Indoor/Outdoor Environment



CO₂ Sensor



"Homemade" Temperature Sensor



RH and Temperature Probe



Floor Surface Temperature Sensor



Mean Radiant Temperature Sensor



BOSCH Wireless Mote



Sensing Phase II: Building Systems

- Overview of the building systems
 - Photovoltaic Panels (BP 5170)
 - Solar Thermal (Vitosol 300)
 - Radiant Heating Floor
 - Energy Recovery Ventilation (ER300, RenewAire)
 - Multiple Split Air Conditioning Unit (Mitsubishi, Mr.Slim)
 - Operable Windows (PPG SB60)



Sensing Phase II Building Systems

Overview of the Building Systems

Photovoltaic Panels

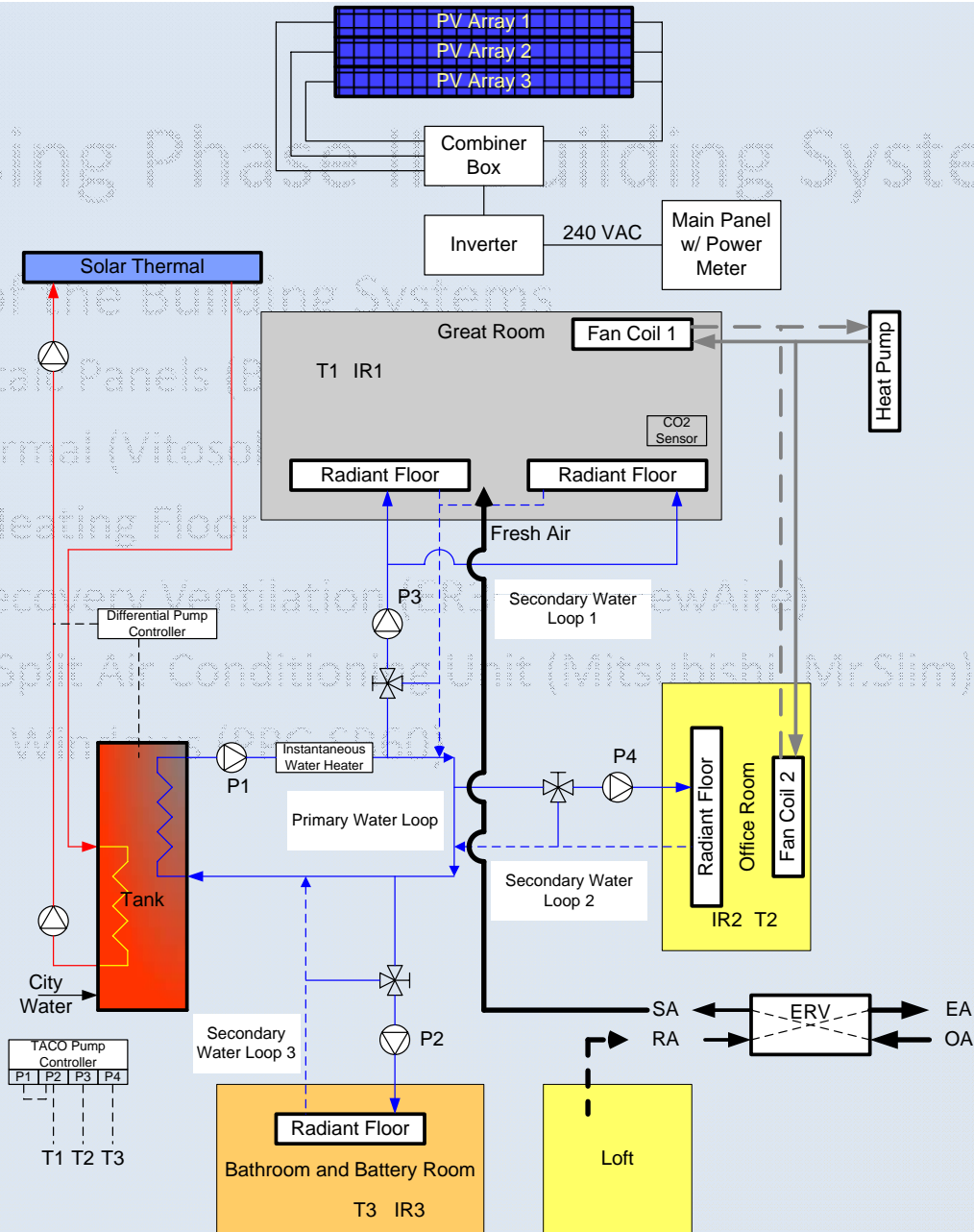
Solar Thermal/Vitocal

Radiant Heating Floor

Energy Recovery Ventilation (ERV)

Multiple Split Air Conditioning Unit (Mitsubishi Mr.Slim)

Operable Windows (OPC-650)



Sensing Phase II: Building Systems

Power Generation-- Photovoltaic Panels

PV

Manufacture: BP

Model: 5170

Modules:

Monocrystalline Photovoltaic

Total: 170W x10x3 arrays = 5.1 kW peak

Inverter

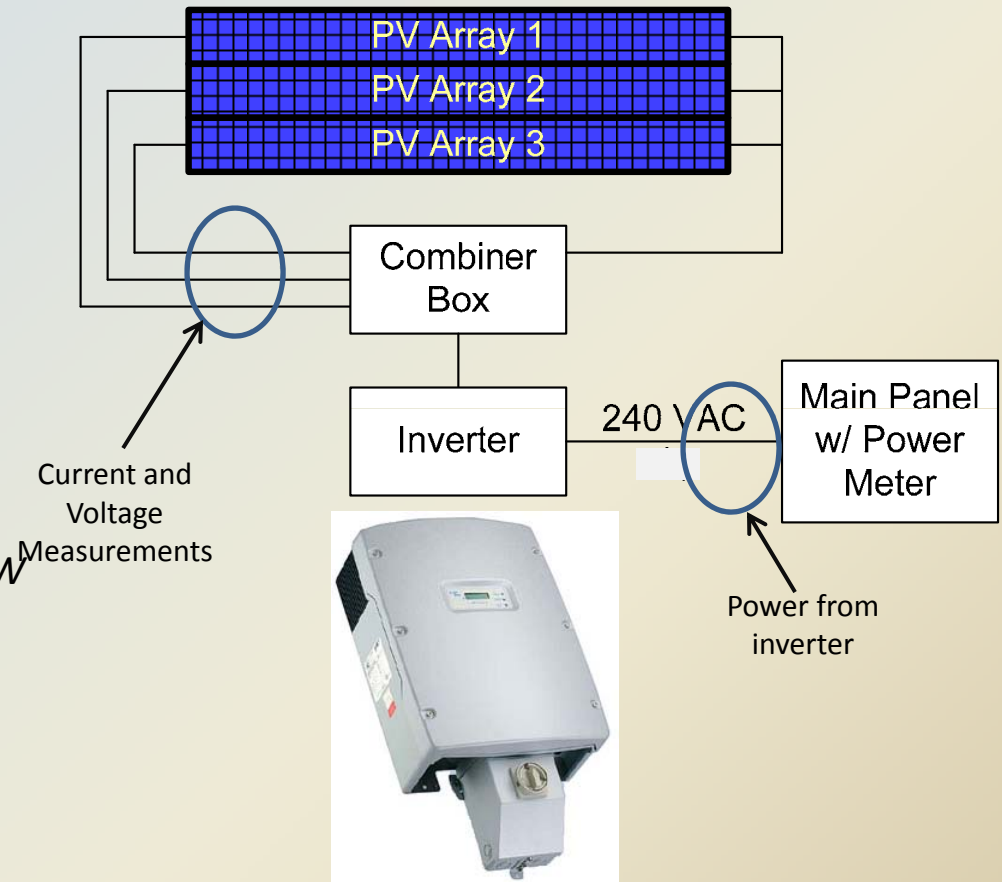
Manufacture: Sunny Boy

Model Number: SU5000

Input: Direct Current (DC), Max:6.25kW

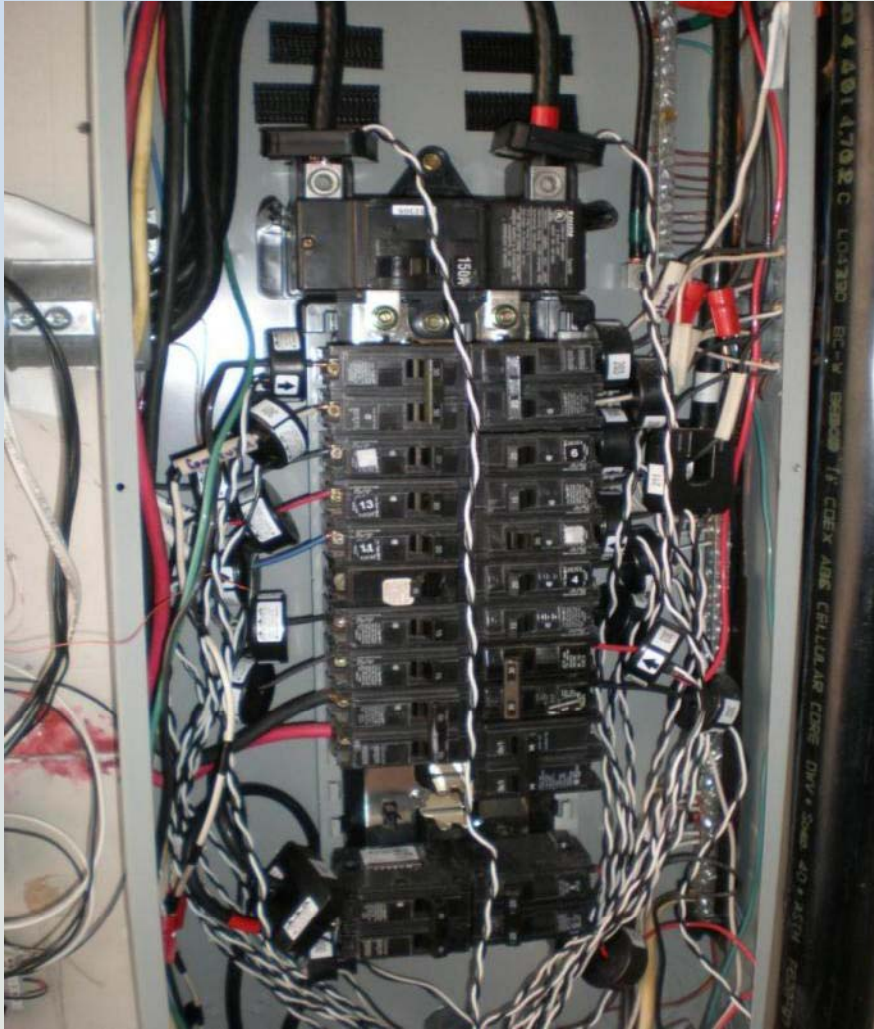
Output: Alternating Current (AC), Max,5kW

Efficiency: 96.8%



Sensing Phase II: Building Systems

Power Consumption– Whole House



CTs inside Power Distribution Board

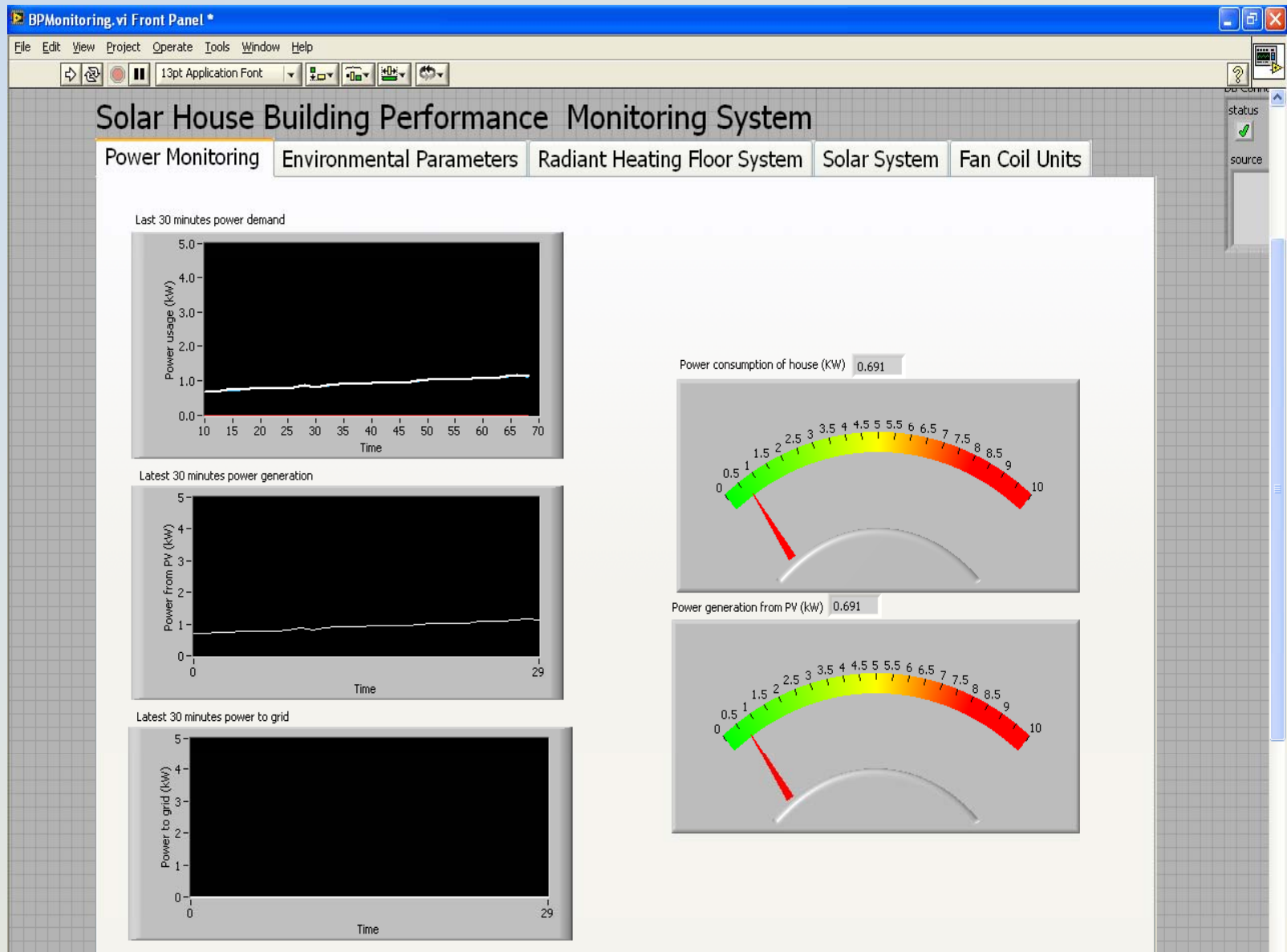


WattsNode connecting with CTs



Sensing Phase II: Building Systems

Power Monitoring



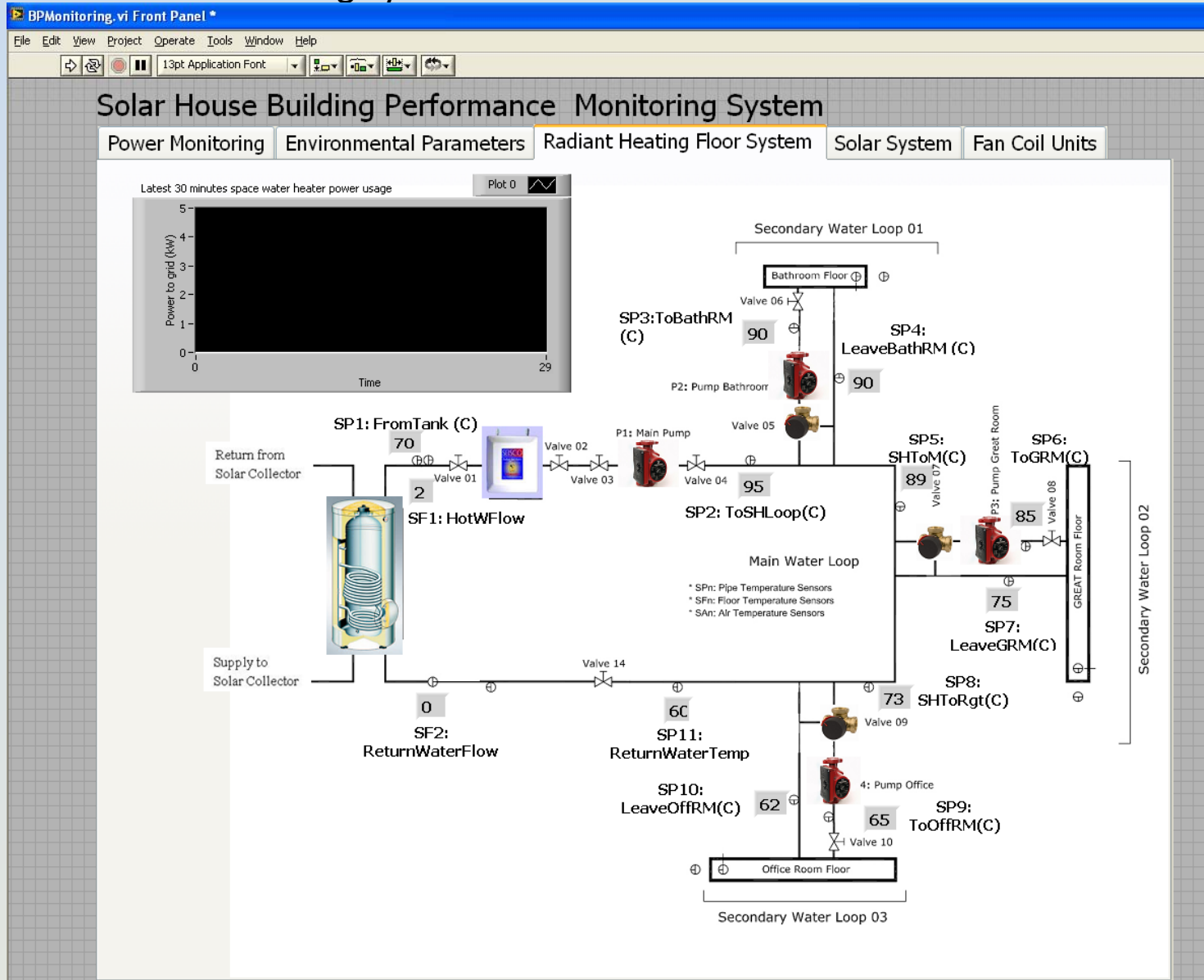
Sensing Phase II: Building Systems

Radiant Floor Heating System



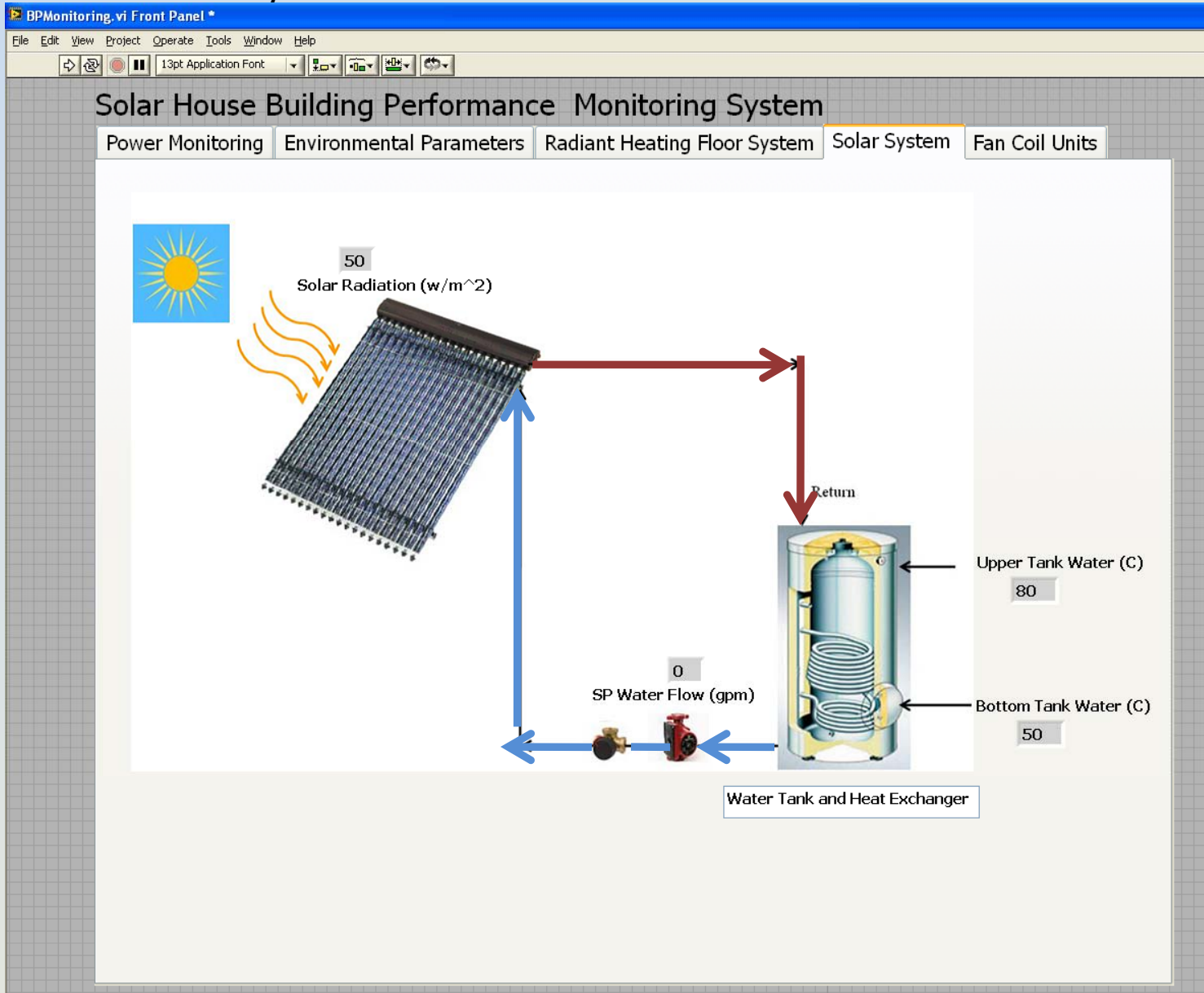
Sensing Phase II: Building Systems

Radiant Floor Heating System



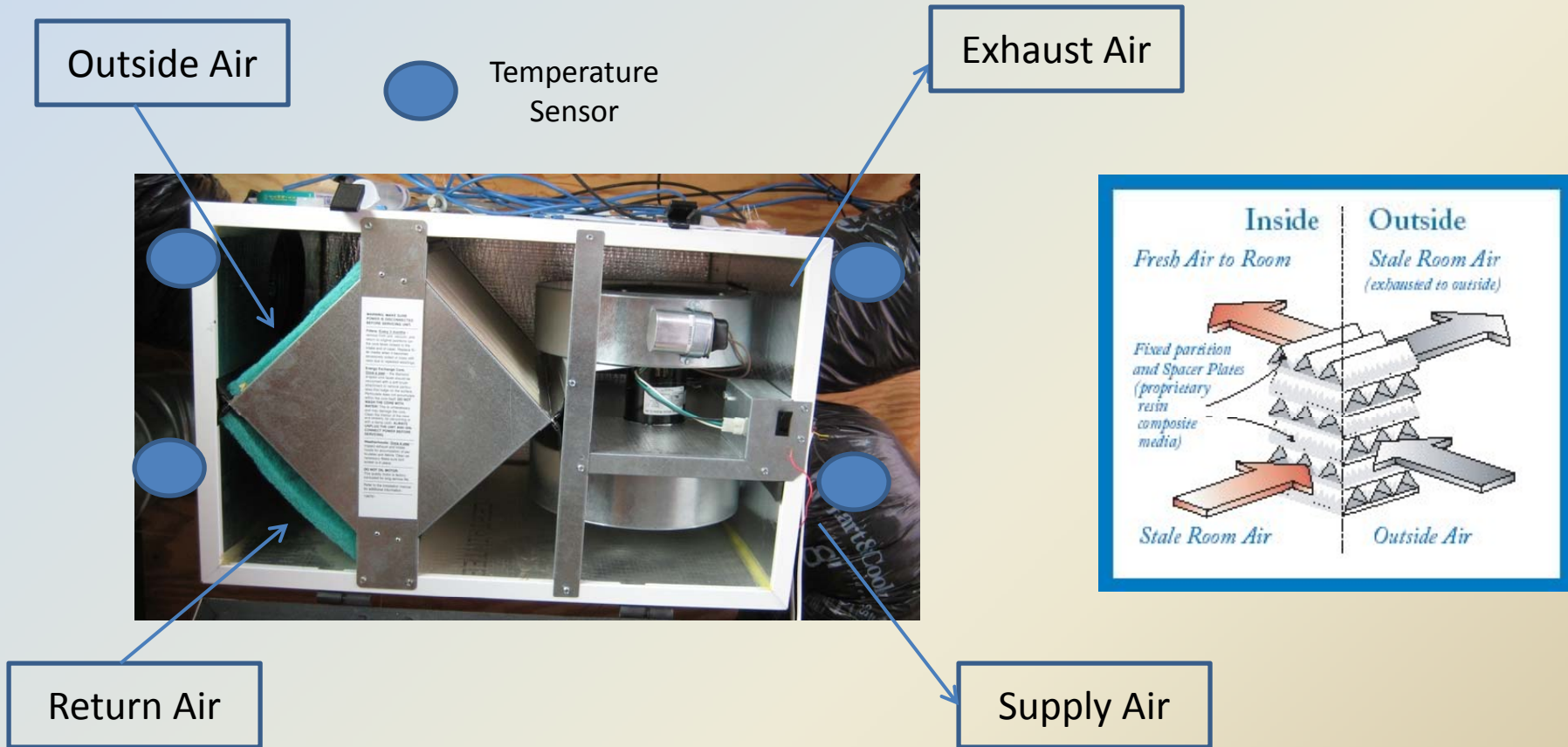
Sensing Phase II: Building Systems

Solar Thermal System



Sensing Phase II: Building Systems

- Energy Recovery Ventilation



Experiences and Challenges

- Define research objective and scope (veryⁿ important!)
- Sensor installations and calibration
- Data acquisition system
- Data visualization and analysis



Some Related Works

- Sensor data visualization
- Mobile-based energy monitoring and decision support
- Occupancy activity detection
- Model-based HVAC predictive controls
- Load prediction
- Smart grid integration

Interested?

Spring 2010, 48721: Building Controls and Diagnostics

Instructor: Bing Dong



