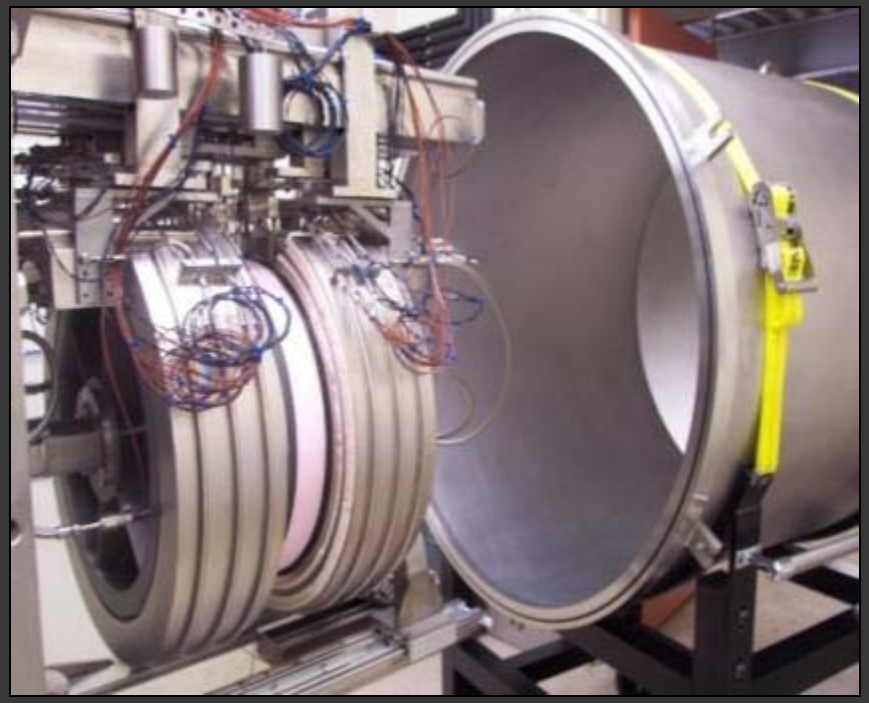
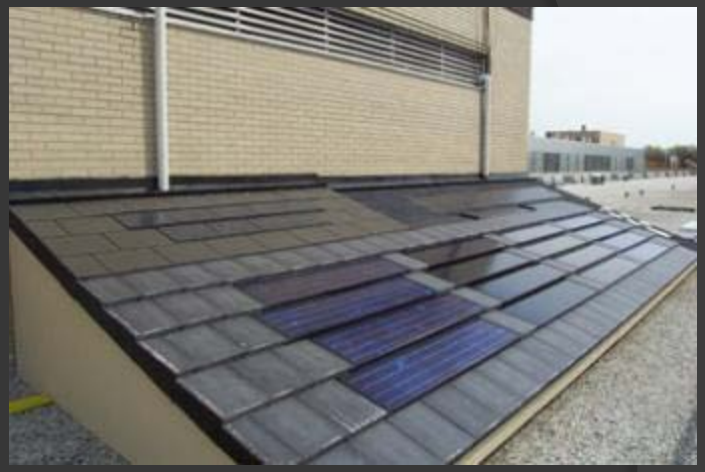
NIST's Building Energy Research Program





A. Hunter Fanney
Chief, Building Environment Division
Engineering Laboratory
National Institute of Standards and Technology

NIST's Building Energy Research Program

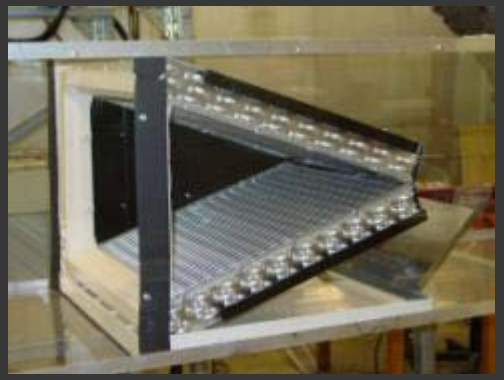
Goal: Develop the Measurement Science Needed to Enable Net-Zero Energy, High- Performance Buildings

The term ***measurement science*** includes:

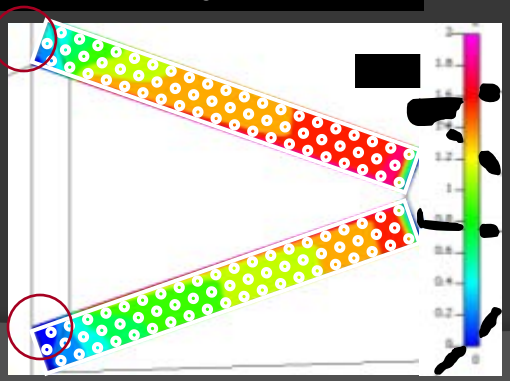
- the development of performance metrics, measurement methods, predictive tools, and protocols as well as reference materials, data, and artifacts
- the conduct of inter-comparison studies and calibrations
- the evaluation and/or assessment of technologies, systems, and practices
- the development and/or dissemination of technical guidelines and methods of test that form the basis for standards, codes, and practices—in many instances via testbeds, consortia, and/or other partnerships with the private sector

Cost Neutral HVAC Efficiency Improvements

Example: Top slab receives up to **30%** more air flow than the bottom slab

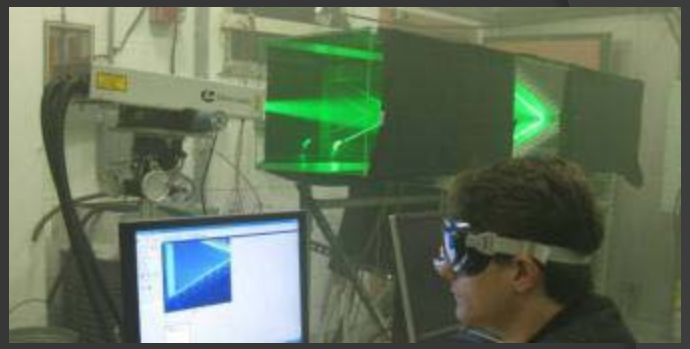


Example: Tubes in certain locations receive insignificant air flow and **hinder performance** of the heat exchanger



Investigation of air flow distributions in real life heat exchanger geometries:

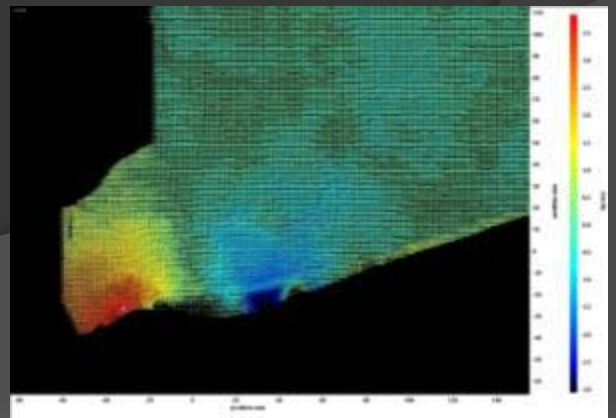
- PIV measurements
- CFD simulations



Air distribution knowledge-based heat exchanger design:

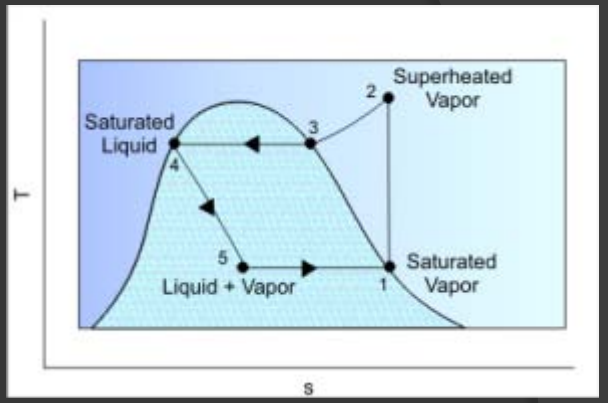
- Design for installation type
- Elimination of performance hindering sections
- Optimization of heat exchanger by evolutionary computation methods

Particle Image Velocimetry (PIV) is used to characterize the air flow distribution through finned tube heat exchangers.

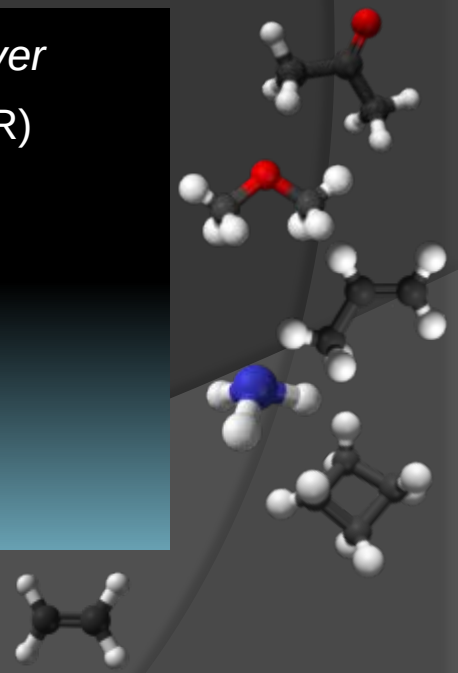


Next Generation, Low-GWP Refrigerants

- HFC refrigerants face restrictions due to high GWP
- Present options are not optimal
  - propane, isobutane: flammable
  - CO_2: high pressure, complex cycle
  - HFOs: stability?, efficiency?



- NIST will predict properties for candidate fluids, *including molecules never synthesized,* using Quantitative Structure-Property Relationships (QSPR)
- Use cycle analysis to:
  - explore what is thermodynamically possible
  - define optimum thermodynamic parameters
  - evaluate candidates
- Laboratory evaluation

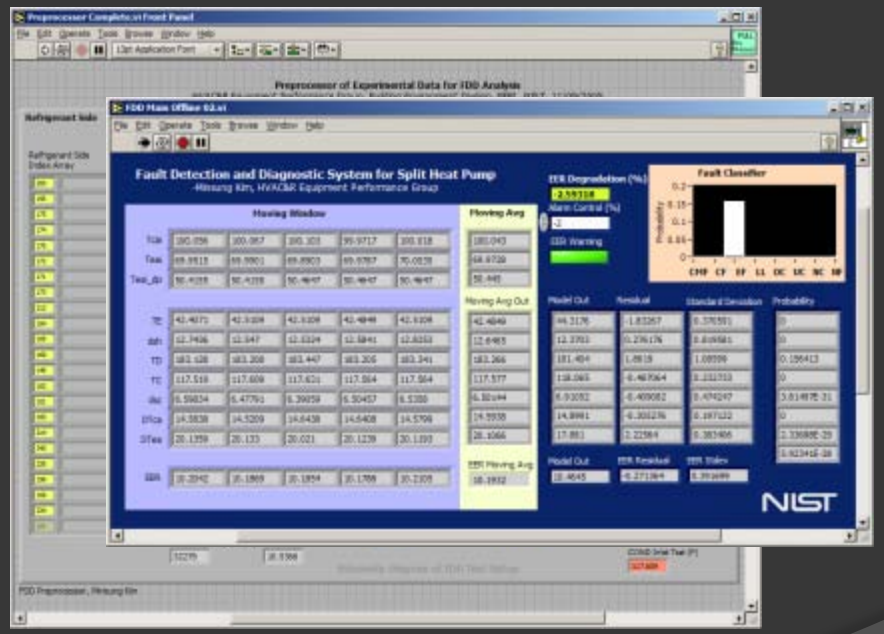


Automated Fault Detection and Diagnostics for Residential Heat Pumps

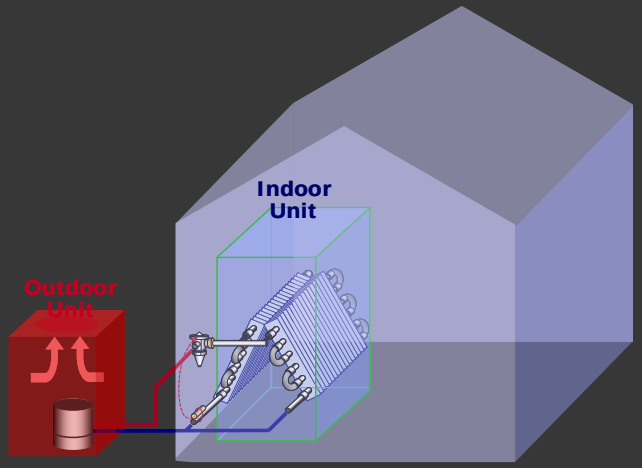
NIST is developing Fault Detection and Diagnostic methodologies for residential heat pump systems that will ensure a quality installation and sustained efficiency throughout the equipment's life span.

Goals:

- Quality initial installations
- Greater thermal comfort
- Reduced refrigerant emissions
- Increased energy efficiency
- Reduced life-cycle operating costs



System analysis and fault classifier



Residential split-system heat pump

Fuel Cell/Cogeneration Performance Ratings

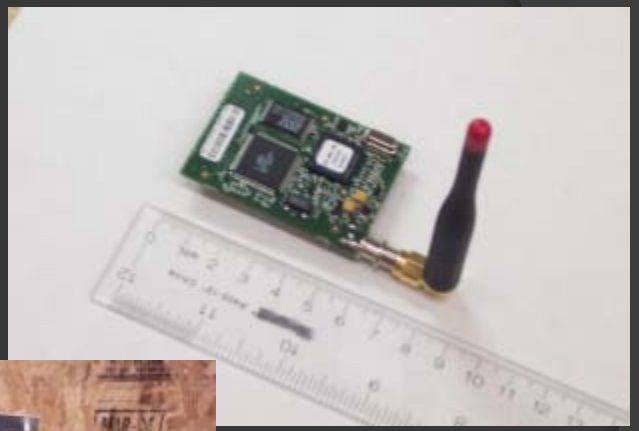
NIST is developing rating methodologies to help consumers gauge the performance of fuel cell systems and other combined heat and power (CHP) technologies for building applications .

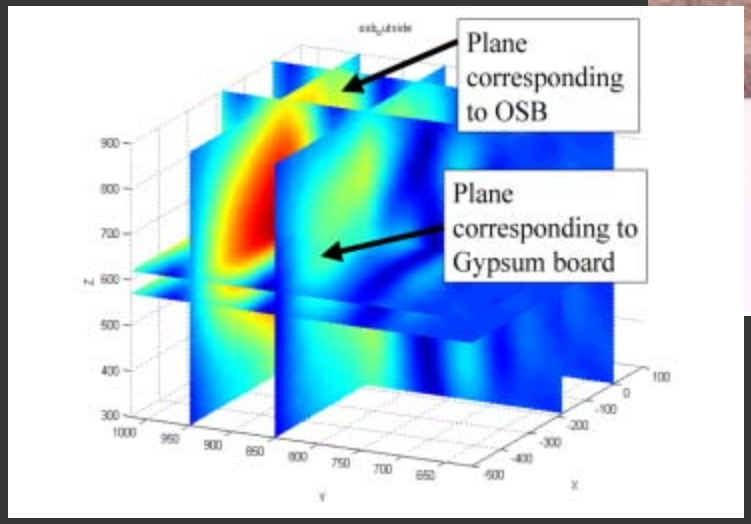
- Residential Fuel Cell Units
- Internal Combustion CHP
- Stirling Engine CHP

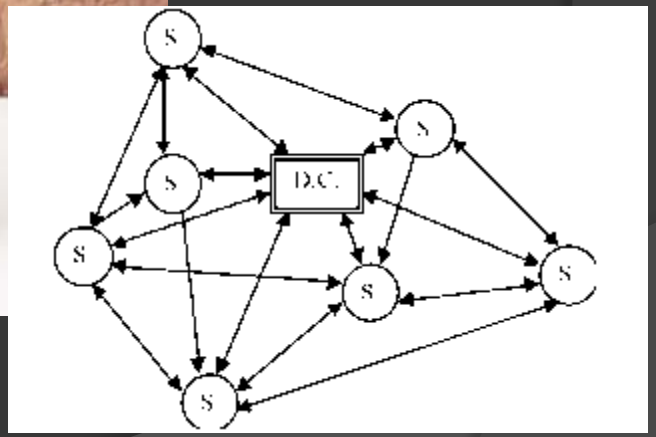
Sensors for Improved Building Monitoring

NIST is exploring novel sensor technology that could be used as part of monitoring systems to determine energy consumption in buildings:

- Non-invasive techniques to evaluate integrity of thermal envelopes
- Wireless sensors
- Energy monitoring systems

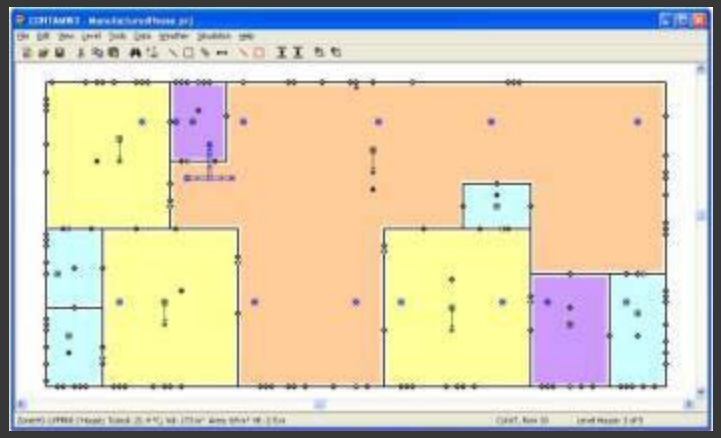




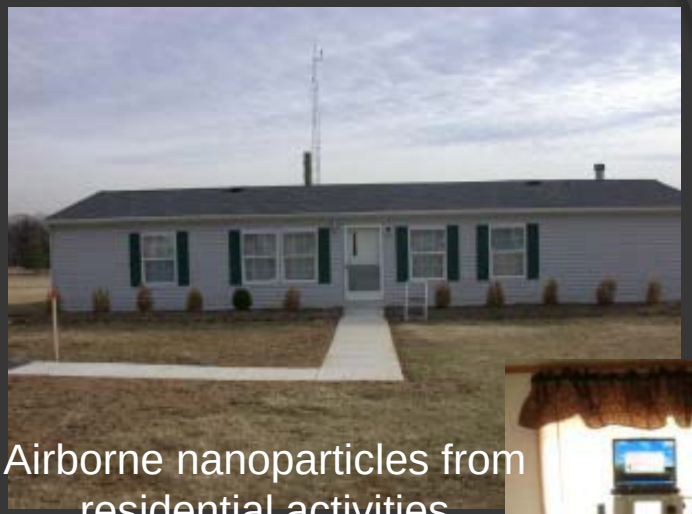


Indoor Air Quality Measurement and Modeling

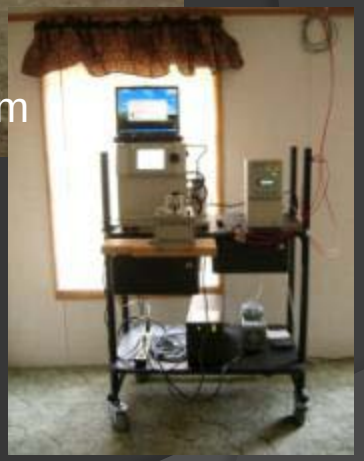
CONTAM: Multizone airflow and contaminant transport model



Research house for ventilation and IAQ studies



Airborne nanoparticles from residential activities

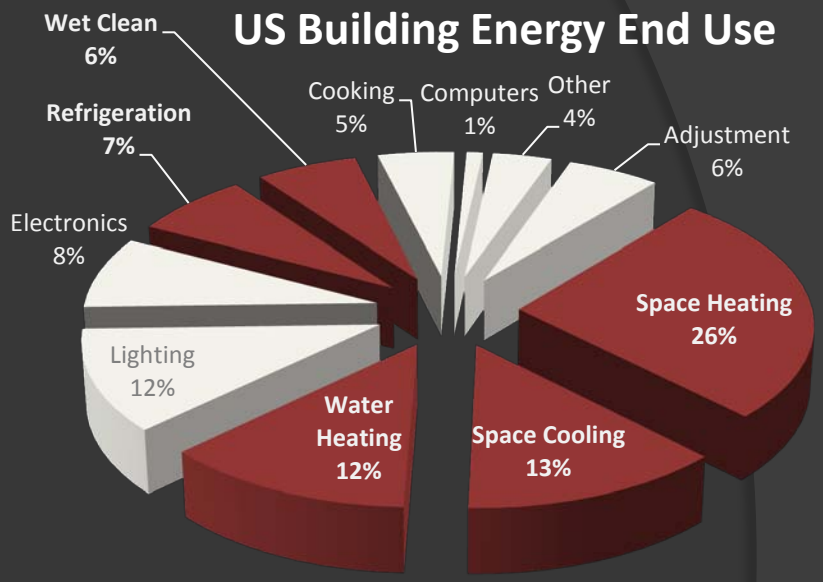


Environmental chamber for evaluating air cleaning devices

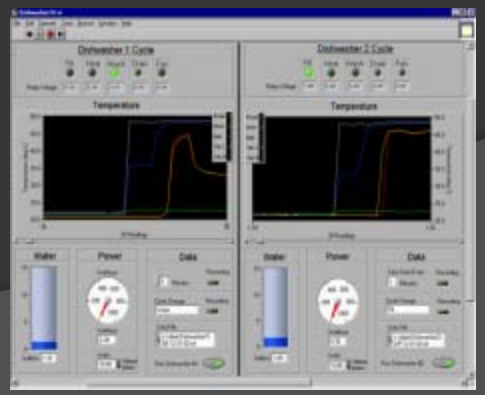
VOC emissions from building materials; developing reference material

Residential Appliance Program

- Develops **standardized test procedures** for common household appliances
- Provides the Environmental Protection Agency and the Department of Energy with information for the **Energy Star** classification
- Assists in finding data for the Federal Trade Commission's **Energy Guide** appliance rating labels



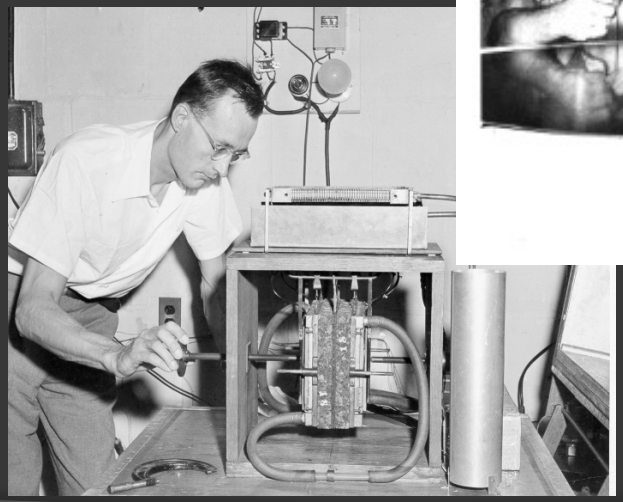
Source: 2009 Buildings Energy Data Book
2006 Residential Energy End-Use Splits, by Fuel Type

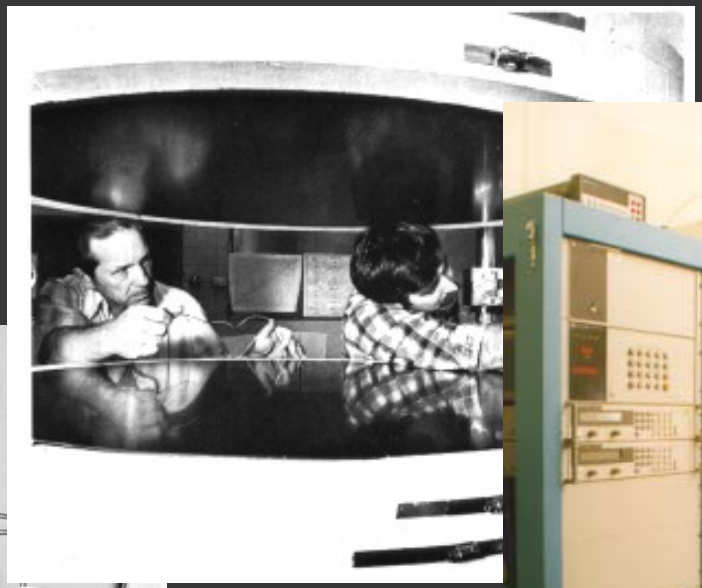


Thermal Insulation Measurements

Since 1912, NIST has provided thermal resistance measurements

- 1-m Guarded Hot Plate (GHP) Apparatus
- 0.5 m GHP designed to test from 90 K to 900 K
- Vacuum Insulation Panels tested in calorimeter
- NIST Standard Reference Database 81 (http://srdata.nist.gov/insulation/)

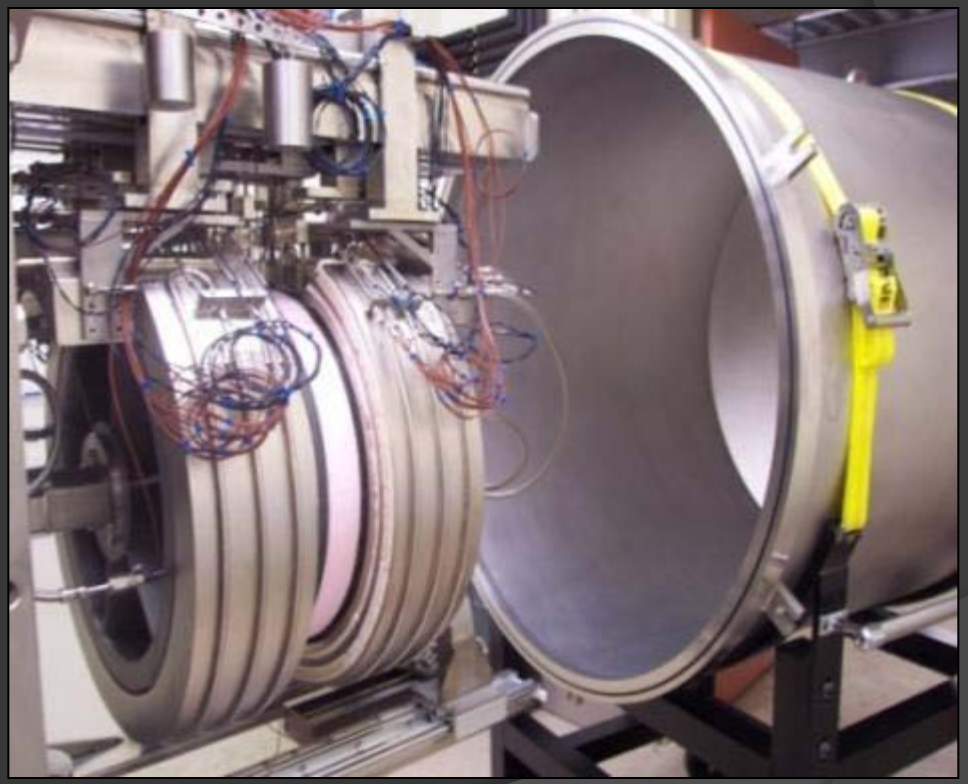




Thermal Insulation Measurements

NIST's High-Temperature Guarded-Hot-Plate Apparatus

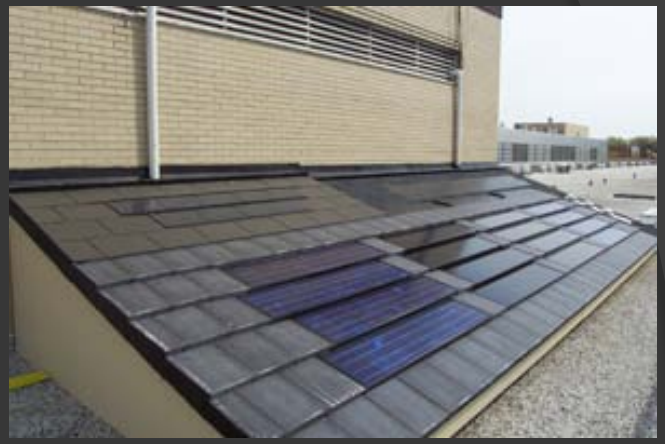
- Currently under evaluation
- Developed for industrial thermal insulation user community
- Design range:
  - 90 K to 900 K
  - 10^{-4} torr to 800 torr
- Collaboration with ASTM C16.30 Reference Materials Task Group underway to develop next the generation of high-temperature thermal insulation reference materials

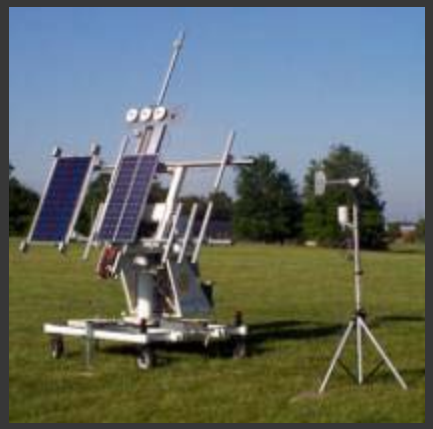


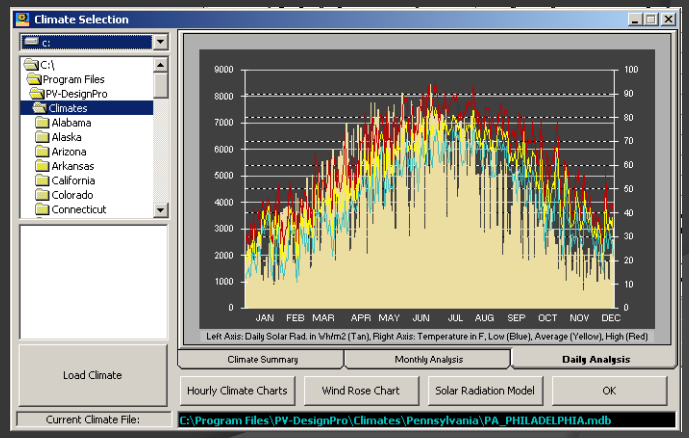
Photovoltaic Measurements and Models

NIST Provides Data for Photovoltaic

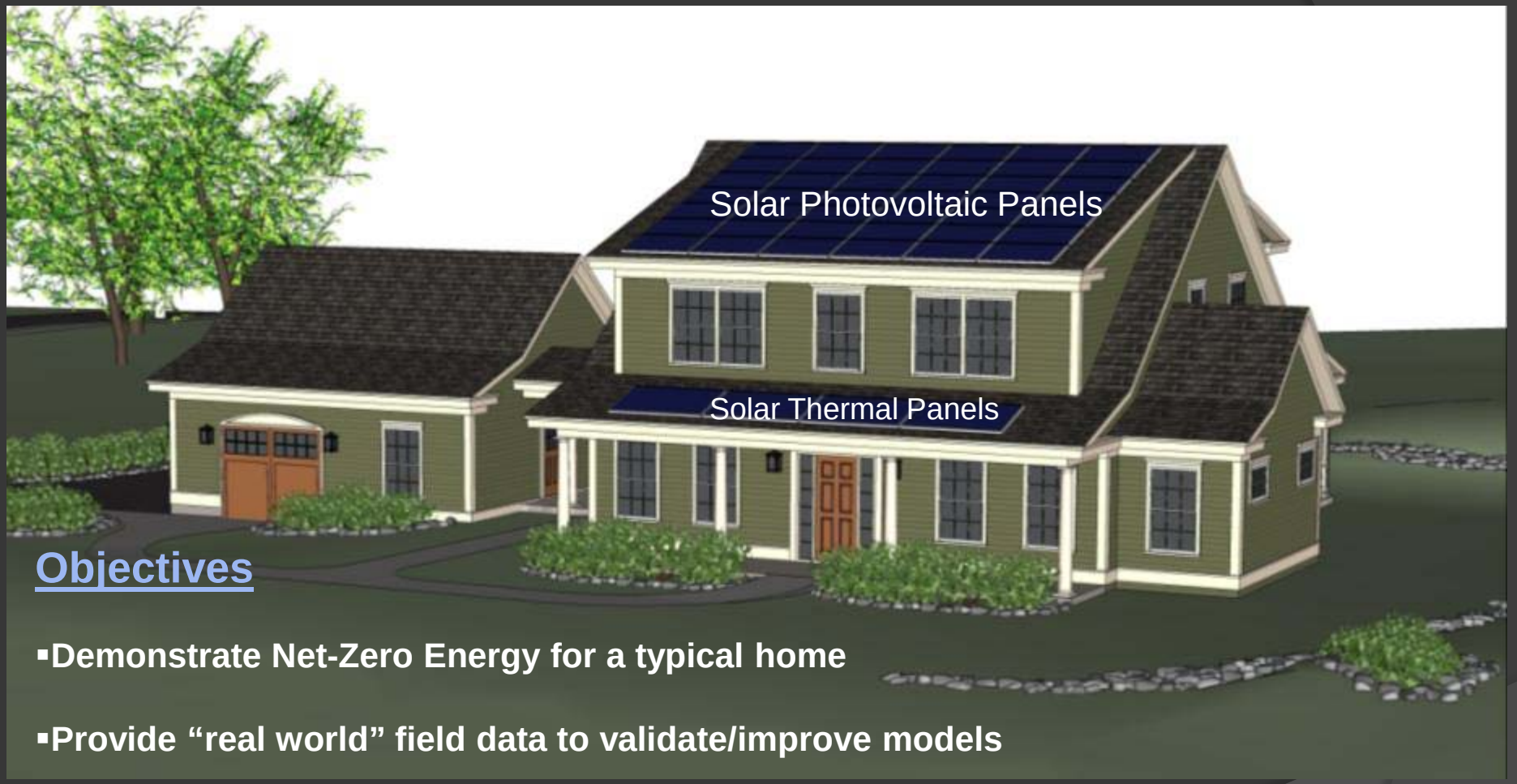
- Technology Comparisons
- Improvement/Validation of Simulation Models
- Improved Measurement Techniques







Net-Zero Energy Residential Test Facility



Objectives

- **Demonstrate Net-Zero Energy for a typical home**
- **Provide “real world” field data to validate/improve models**
- **Provide a test bed for in-situ measurements of various components and systems**
- **Improve laboratory test procedures of systems/components to give results that are representative of field performance**

Thank You!

My Dad and I after installing solar hot water system at my parents home. Provided hot water for the next 26 years!

June 1978 – Suffolk, Va.

Questions?