FLORIDA SOLAR ENERGY CENTER

A Research Institute of the University of Central Florida

Energy $mart Schools

FSEC Activities in Portable Classrooms and Industrialized Construction

March 26, 2001

Philip Fairey
Florida Solar Energy Center

Portable Classroom Retrofits

- An energy efficiency retrofit and monitoring project conducted by FSEC in 1999.
- Objective: Measure the impacts of a series of efficiency improvements in a set of Florida portable classrooms
- Purpose: To determine if the learning environment can be improved as part of a package of efficiency improvements.

Building America

- **FSEC Building America Industrialized Housing Partnership (BAIHP):** a major DOE funded project focusing on improving the energy efficiency, durability and indoor air quality in HUD Code manufactured homes.
- Team members including Cavalier Homes, Fleetwood Homes, Palm Harbor Homes, Southern Energy Homes and manufacturers in the Super Good Cents / Natural Choice program produce over 100,000 manufactured homes / yr currently.

Florida Portable Classrooms

- 25,000 portable classrooms in use in Florida
- Portables account for ~11% of the energy budget for Florida public schools annually
- Portable classrooms use approximately 10,840 kWh / year (~30 kWh / day)
- Estimate that portable energy use state-wide is 250 million kWh costing $20 million annually

BAIHP

- Technical assistance to about 30 site builders and modular home manufacturers including Habitat for Humanity affiliates throughout the nation.
- Site builders located primarily in the Gainesville, FL; Phoenix, AZ; and Reno, NV markets.
- Collaboration with additional 20 supplier and non-profit organizations.
- Charged with enhancing energy efficiency and learning environments in portable classrooms, primarily Northwestern states of WA, OR and ID.

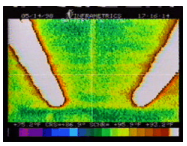
The Portable Classrooms

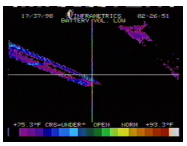
- 720 ft^2 of conditioned floor area per portable.
- ~156 ft^2 of window area per portable (22% of gross floor area).
- Portables set in an East-West orientation.

The Retrofits

- **Roof** – Composition shingle to white metal
- **Lighting** – T-12 magnetic ballast to T-8 electronic ballast
- **HVAC** – 3 Ton to 2.5 ton with enthalpy recovery ventilation (ERV) system
- **Controls** – Occupancy controls to turn off space conditioning and lighting

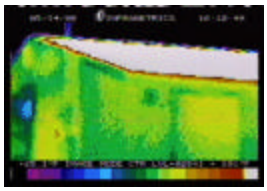
Lighting Retrofit





- Original: T12 lamps with magnetic ballasts
- Replacement: T8 lamps with electronic ballasts
- The thermographs tell the story

Conventional Shingle Roof



HVAC Retrofit

Original

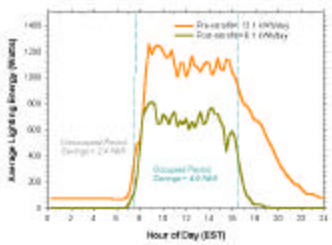
Retrofit

Roof Retrofit

- Original Roof: A frame roof with gray asphalt shingles over 3/4" plywood decking.
- Replacement Roof: Reflective white metal roof.

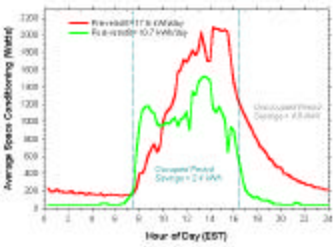
Average Lighting Demand

Average day



Average Conditioning Demand

Average Day

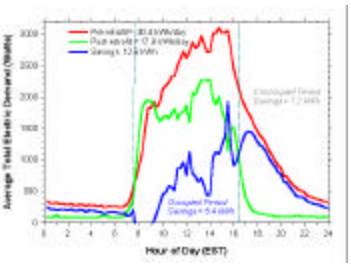


1996 Energy Survey Florida Public Schools

- @2600 surveys sent - 1298 responses (680 with matching utility data)
- General characteristics (averages)
  - 98,943 sqft conditioned area
  - 31 years old
  - 981 students
  - Built up gravel roofing
  - 32% have wall insulation
  - 64% have ceiling insulation
  - 22% have classroom buildings without windows

Total Average Energy Demand

Average Day



Respondents by school type

- Elementary schools = 755 (58%)
- Middle schools = 234 (18%)
- Senior high schools = 181 (14%)
- Vocational schools = 34 (3%)
- Combination / other = 94 (7%)

Retrofit Project Conclusions

- Annual energy reduction for the overall project is estimated to be 41% (12.6 kWh / day) – worth about $400 per year.
- The ERV added five times the ventilation air of the old unit (13 vs. 3 cfm / student), while controlling indoor humidity and saving energy.
- Energy savings for lighting upgrade and automated controls alone are greater than 30%
- If performed in all of Florida's Portables, savings would exceed $6 million annually

1996 Energy Survey Florida Public Schools

- Cooling systems: average age = 11 years
  - 57% had central chillers
  - 45% had packaged AC units
  - 52% had some window units
  - Average cfm / student: 7.9, many at 5 and others at 15

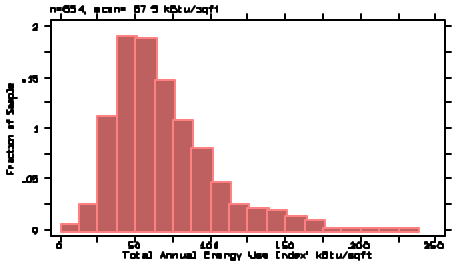
Indoor air quality problems

- 53% reported excess humidity
- 59% perceived poor indoor air quality
  - Analysis showed two are strongly linked
  - Schools with greater ventilation rate (cfm / student) show greater problems with both
  - Likely due to increased humidity from added ventilation

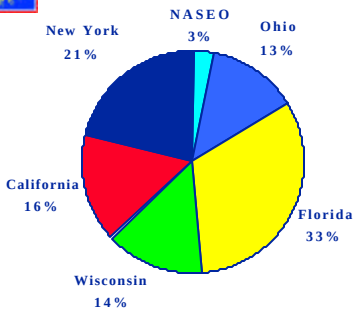
NASEO Project

- Awarded by DOE to National Association of State Energy Officials (NASEO)
- Collaborative program among multiple states: California, Florida, New York, Ohio and Wisconsin.
- Budget:
  - DOE RD&D $ 3.53 Million
  - State Matching $ 4.20 Million
  - Federal + State $ 7.73 Million

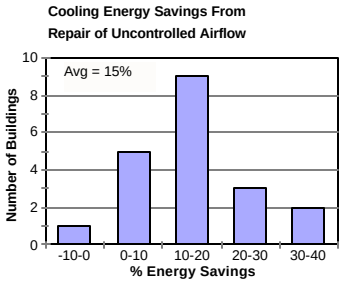
Energy Use Intensity (kBtu/ft^2)



US DOE Dollars ($3,527,296)



Duct Leakage in Schools



DOE Objectives

- Program Objectives & Milestones:
  - Increase adoption of advanced energy efficiency technologies
  - Educate/inform schools officials, A&Es and manufacturers of benefits of high quality schools nationwide
  - Improve learning environment for nation's students
  - Period of Performance is approximately 30 months (Sep 2000 to Mar 2003); effort getting underway following execution meeting

Cooperative R&D Project

- Applied Research, Field Testing and Technology Integration Program:
  - Installation and evaluation of microturbines (OH)
  - Advanced portable classroom research (FL)
  - Advanced daylighting research (WI)
  - Integrated School Building Technologies (CA)
  - Large scale study and diagnostic testing of schools & classrooms (FL)
  - Technology integration and systems approach (NY)
  - Applied engineering and design assistance (NY)

Some Related Web Sites

- Building America Industrialized Housing Partnership: ***http://baihp.org***
- Florida Solar Energy Center (FSEC): ***http://www.fsec.ucf.edu***
- FSEC Online Technical Publications: ***http://www.fsec.ucf.edu/pubs/online.htm***
- EnergyGauge® USA Software: ***http://energyGauge.com***

Energy Star Portables

- The goal is 50% energy savings
- Manufacturing partnerships
- Technical assistance and training for manufacturing design professionals
- Systems engineering design of prototypes for 4 major U.S. climates
- Measured field performance of prototypes
- Improved bulk procurement opportunities

Large-Scale Diagnostics

- National survey of school occupant satisfaction
- Field audit and testing of actual school operating conditions
- Statistical survey and audit analysis
- Retrofits in selected schools
- Re–survey and diagnostics of retrofitted schools