



U.S. Department of Energy
**Energy Efficiency
and Renewable Energy**

Bringing you a prosperous future where energy
is clean, abundant, reliable, and affordable

DOE Solar Energy Technologies Program Peer Review

Technical Track: Demonstrations

Project Name: Sustainable Buildings: Using Active Solar
Power

**Principal Investigators: Keith Sharp,
Russell Barnett**

University of Louisville

Denver, Colorado

March 9-10, 2009



Principal Investigators

- **M. Keith Sharp, ScD, PE**
 - BS, Mechanical Engineering, University of Cincinnati 1976
 - MS, Mechanical Engineering, Colorado State University 1978
 - ScD, Mechanical Engineering, MIT 1987
 - Professor, Mechanical Engineering, University of Louisville
 - Director, University of Louisville Renewable Energy Applications Laboratory
 - > 30 years experience in solar energy research & development
- **Russell A. Barnett**
 - BS, Resource Development, Michigan State University 1972
 - MS, Planning, University of Tennessee 1978
 - Director, Kentucky Institute for the Environment and Sustainable Development
 - > 35 years experience in environmental planning, research & development

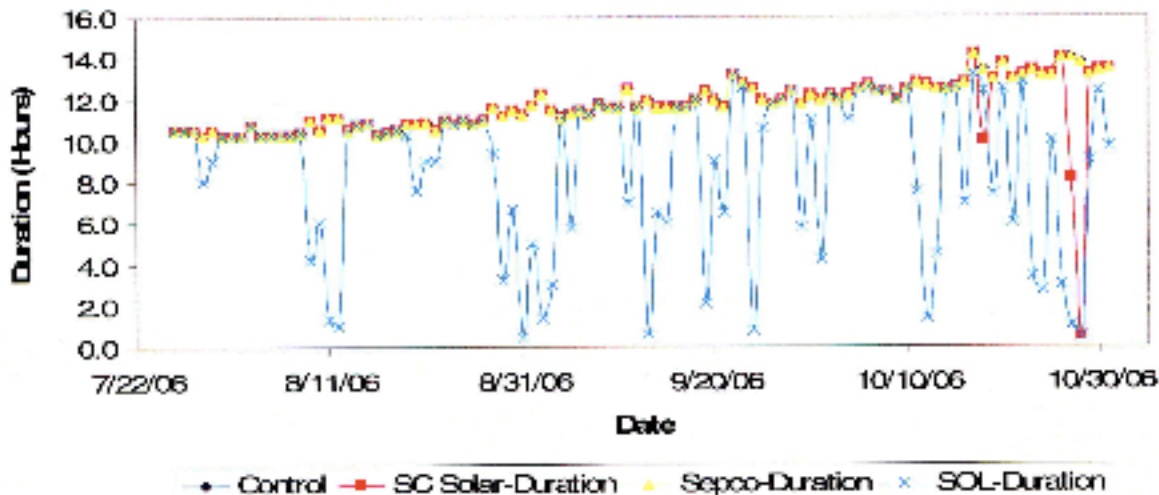


Demonstration project - Comparison of solar streetlights in downtown Louisville

- Three different lights installed & monitored during fall and spring 2006.
 - Findings
 - (1) provided light all night every night,
 - (2) After 3 days of cloudy weather light drop off,
 - The lights generated considerable publicity, and further installations are being considered, particularly for remote parking lots, canoe take-outs and along a 100-mile bike trail.



Duration Comparison





Demonstration project - Solar daylighting comparison, Shelby Middle School

- Two different light shelves & one commercial system installed in adjacent rooms & monitored during fall 2006.
 - 16" light shelf provided the greatest illumination
 - As a result of this work, similar light shelves have been installed in two Jefferson County schools, and the school district now manufacture their own shelves





Demonstration project - Solar water heating rebate program, state of Kentucky

- Program developed by UofL and Kentucky Solar Partnership (KSP), administered by KSP
- (25) applications reviewed & rebates of \$500 each distributed by early 2007
 - doubled the number of solar water heaters in the state
 - increased the number of commercial installers in the state from 1 to 7.





Demonstration project – School solar water heating

- Churchill Park, installed summer 2006
- Farmer Elementary School (w/ solar) & Aiken Road School (w/o solar) comparison, built summer 2007. Identical schools allow comparison of heating bills.
- Ramsey Middle School, installed summer 2008. In addition to hot water, light shelves, solar tubes and wind turbine installed.

- As a result of these projects, solar water heating will be used on all new Jefferson County schools





Demonstration project – 50 kW PV array

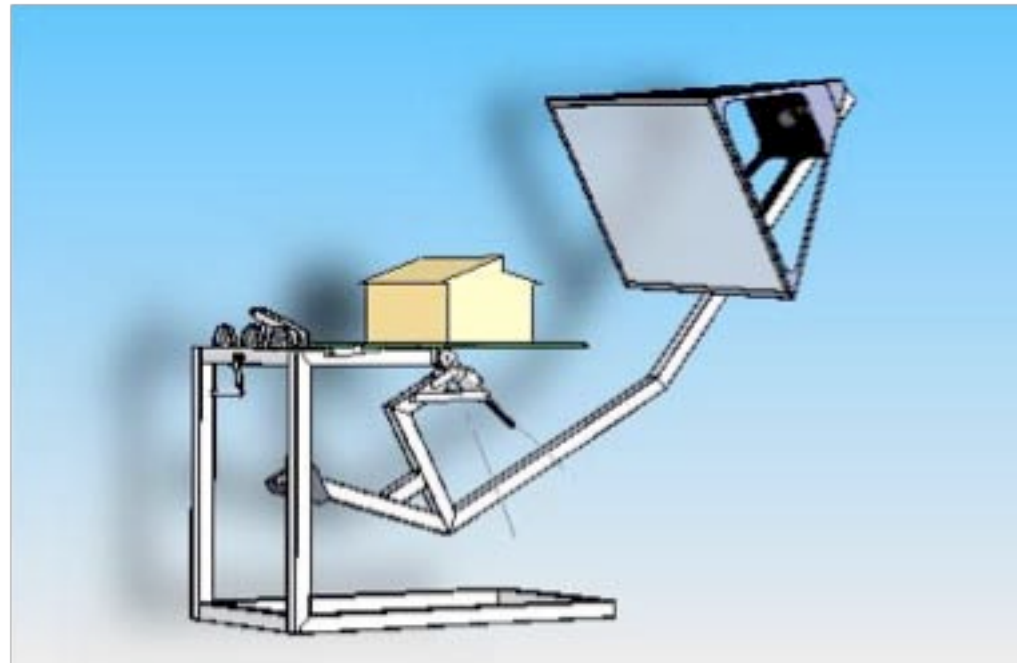
- Center for Predictive Medicine biohazard lab, Shelby campus, installed winter 2009
 - 252 GEPVp-200 modules, 13.7% efficiency, 25° slope, grid independent
 - Real-time monitor at entrance to building
 - Largest PV array in the Commonwealth





Development/Education project – A portable heliodon

- Developed by Mechanical Engineering students
- Graduated adjustments for latitude & time of year, rotates manually for time of day
 - First featured in the energy exhibit at the KY State Fair 2006
 - Used for courses ME 667 Solar Energy Applications and ME 614 Heating, Ventilating and Air Conditioning
 - Used for demonstrations for prospective students, administrators and legislators





Demonstration/Education project – Instrumented thermal/PV 2-axis tracker

- Solar hot water and grid-tied PV
 - Instrumented insolation, ambient temp, PV voltage and current, thermal collector & tank temp
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- Instructional lab experiments with varying angle of incidence, ambient temp & flow rate
 - Real-time monitor for system performance at building entrance & on webpage
 - System has been featured on local TV and print media





Education project – Solar Installers Workshops

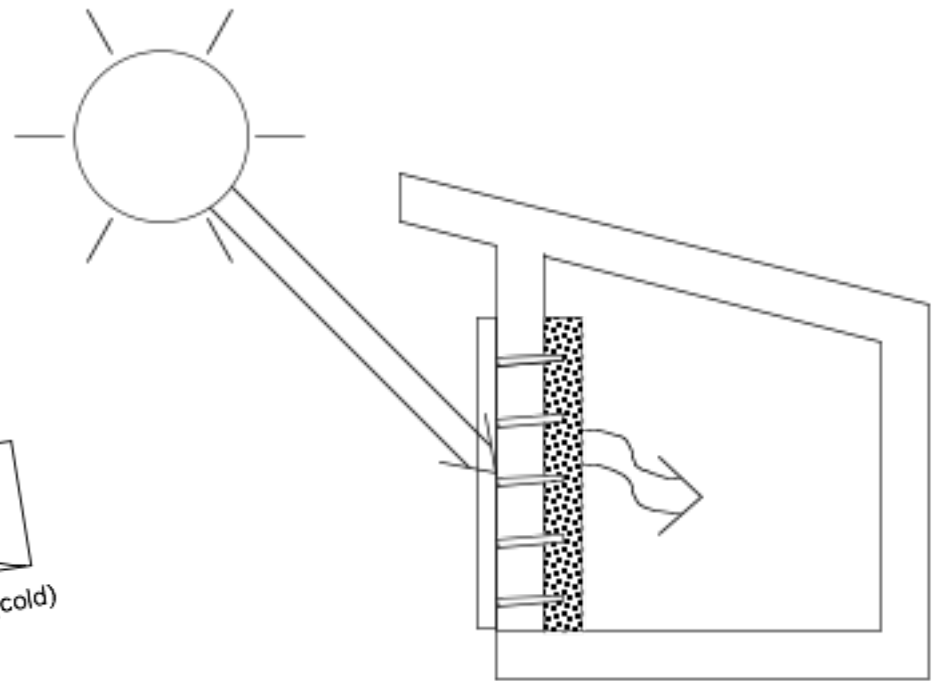
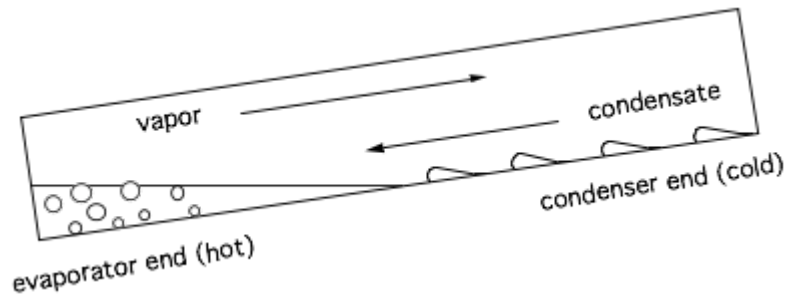
- Spring 2006 and Spring & Fall 2008
 - PV sessions for homeowners, installers and regulators
 - Hands-on instruction
 - ~ 30 participants for each workshop
 - Kentucky now has 2 certified PV installers





Research project – Passive Solar Heat Pipe System

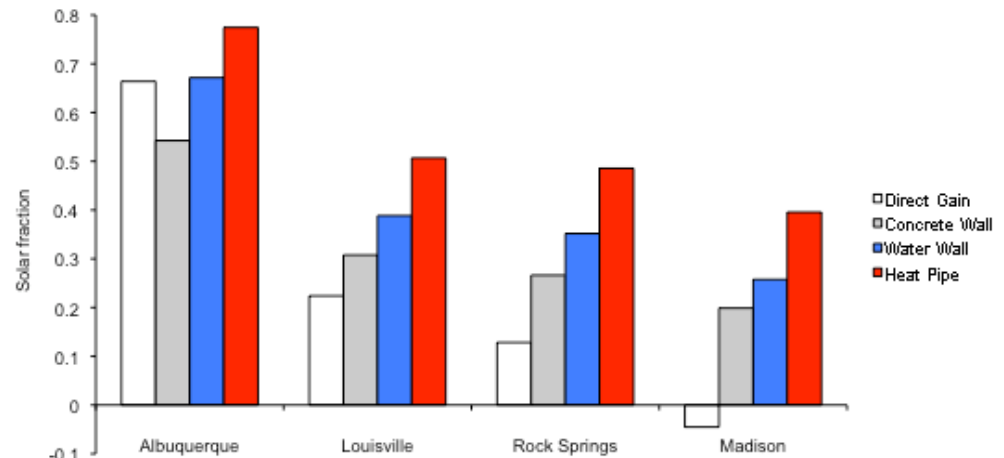
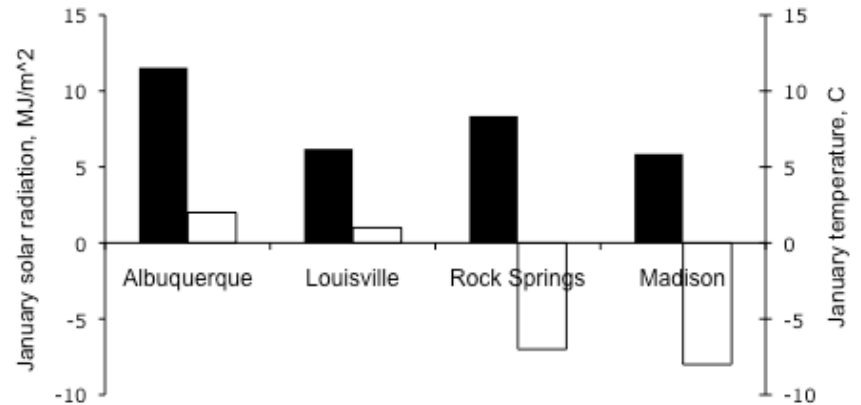
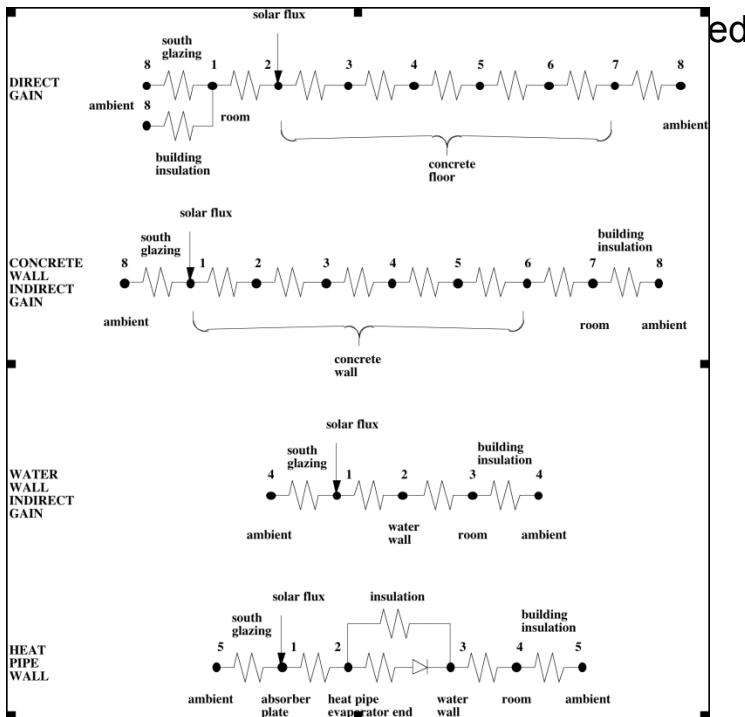
- Space conditioning comprises 40% of total US energy consumption, 70% of electricity
 - Heat pipes for space heating
 - One-way heat transfer reduces nighttime and cloudy day losses compared to conventional systems [Susheela & Sharp 2001]
 - Full-scale model to be installed April 2009 on UofL classroom/office building





Research project – Passive Solar Heat Pipe System

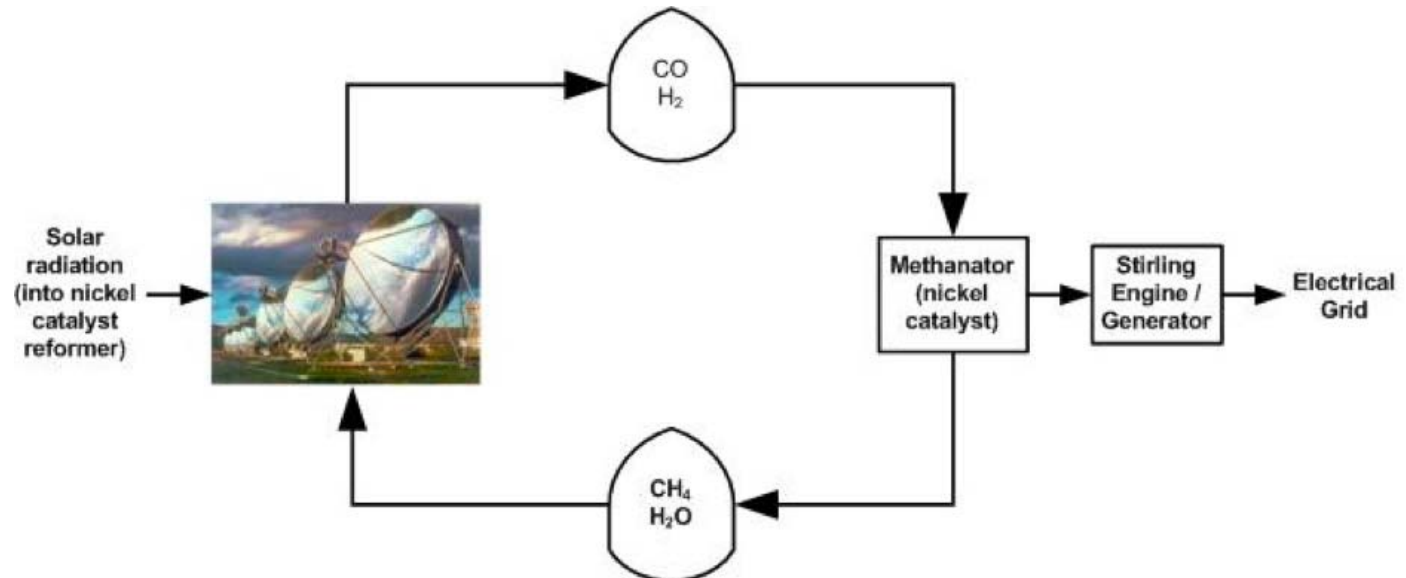
- Simulated performance compared to conventional systems in four different climates
 - Simulated heat pipe wall provided higher solar fractions in all climates, but was particularly advantageous in colder and cloudier locations
 - Bench-scale experiments have been completed





Research project – Thermochemical storage of solar energy

- Reversible reaction $\text{CH}_4 + \text{H}_2\text{O} \rightleftharpoons \text{CO} + 3\text{H}_2$ (synthesis gas)
 - TRNSYS simulated performance compared to batteries & thermal systems
- Simulation work in progress (reformer and methanator component models under development)





- **Impact of demonstration projects,**
 - UofL adopted LEED Silver for all new buildings
 - UofL committed to 15% renewable electricity
 - UofL established Conn Center for Renewable Energy and Environmental Stewardship
 - UofL conducted a campus-wide energy audit & performance contract
 - Jefferson County Public Schools will install solar hot water and daylighting on all new buildings
 - Louisville Metro Government is interested in installing more solar streetlights
 - Increased exposure & more experienced installers for solar water heating throughout the state
- **Impact of education projects,**
 - New tools for UofL courses (solar tracker, heliodon)
 - Training for PV installers, increased awareness for consumers and regulators
- **Potential impact of research projects,**
 - Substantially increased performance for passive solar systems
 - Economical long-term storage of solar energy



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Future Directions

- **Future demonstration projects,**
 - Frankfort YMCA solar pool heating system
 - Solar water heating, Burhans Hall
 - Hybrid solar lighting, Kersey building
- **Future education projects,**
 - Service learning projects with refurbished collectors
 - Development of a renewable energy instructional lab
 - A major zero energy building on campus
- **Future research projects,**
 - Experimental comparison of passive solar systems
 - Other applications of heat pipes in passive solar systems
 - Experimental trials of thermochemical storage