

## Science Afternoon at NIST with a Focus on Solar Energy and the Net-Zero Energy House Wednesday, December 14, 2011

Bill Healey and Tania Ullah of the Energy and Environment Division of the Engineering Laboratory are both involved in NIST solar energy research and the Net Zero Energy House project.



As teachers gathered to share ideas and visit, Tania and Bill joined the teachers to learn more about what's being taught in middle school in Montgomery County, MD.

Why a net-zero energy house? Uncertainty in the realized performance of green buildings is a barrier to increased adoption and investment in energy and environmental savings technologies. NIST's new Net-Zero Energy Residential Test Facility will provide a platform for comprehensive and accurate measurements that will be used to assess the in-situ performance of a net-zero energy home. This project will outfit the test facility with a full suite of high-quality monitoring equipment, measure its energy use, evaluate integrated performance metrics for net-zero energy homes, and publish a guideline for designing, operating, and monitoring net-zero energy homes.

With the increased confidence in the measurements as a result of this experiment, homeowners such as teachers and engineers can make informed choices about energy use in our own homes.



After an engaging introduction to the topic by Mary Satterfield, who is learning to implement the 5Es and practicing on the teachers, Bill began to talk about the importance of monitoring and controlling energy use in buildings. After all, residential and commercial buildings account for 40% of all energy use in the United States and consume more energy than either the industrial or transportation sectors!



Teachers were interested not only because energy use is a topic they teach, but also because they are also energy consumers. And how interesting to learn that the best savings possible with existing technologies can only provide a 30-40% savings! New technology and renewable energy is required to get to a net-zero energy state.

## Net-Zero Energy, Residential Test Facility



A net-zero energy building produces as much energy as it uses over the course of a year, according to the DOE definition. NIST is building a net-zero energy residential test facility to demonstrate net-zero energy for a home similar in nature to surrounding homes, provide a test bed for in-situ measurements of various components and systems, provide “real world” field data to validate/improve models, and to improve laboratory test procedures of systems/components to give results that are representative of field performance.

## Load Reduction

- Install more/better insulation in walls
- Ensure walls are air tight
- Minimize pollutant generation in homes to reduce need for ventilation
- Ventilate efficiently



The climate in Maryland is challenging to deal with, Bill said, since it has both hot summers and cool winters, so this house will be a good test. To get to net-zero, the load will be decreased, efficient equipment will be installed, and renewable energy sources used.



## • Floor Plan – First Floor



## • Floor Plan – Second Floor



A simulated family of four will “live” in the house: two parents, a 14-year-old and an 8-year-old. The showers will run, the lights turn on and off, and the appliances “used”. One of the challenges of setting up this simulation is figuring out how to automatically and remotely turn off and on things like the television!



As part of the renewable energy sources, geothermal is being installed. A “slinky” geothermal loop six feet underground and filled with heat transfer fluid will transfer heat from the house to the ground in the summer and from the ground to the house in the winter. This slinky is an alternative to the deep wells more traditionally used, and easier and cheaper to install.



The net-zero energy house is expected to be completed in April and measurements to begin in September. For the first year, while measurements are being made, the house will not be open to outsiders since tours affect the measurements. However, the house may be open to tours summer 2012 before experiments begin.



Solar energy is the primary renewable energy source available at a building site and NIST is involved in solar energy research in several different areas. Brian Dougherty talked to the teachers about the different kinds of solar panels and photovoltaic cells. The most efficient photovoltaic panels are now ~18-19% efficient.

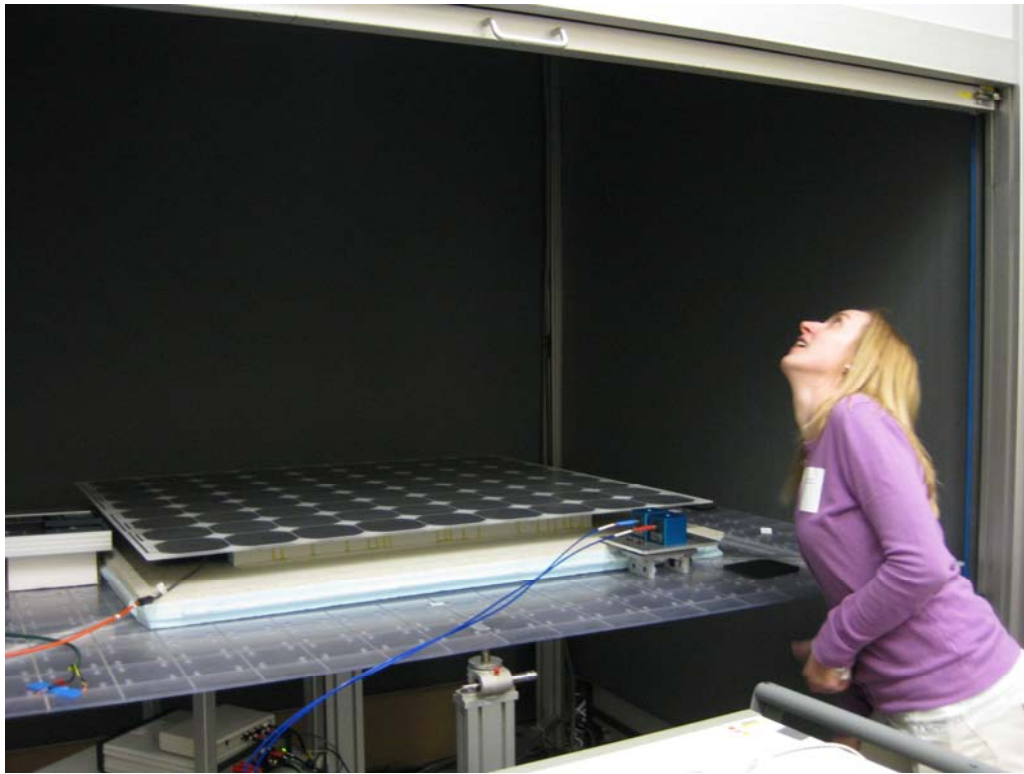




Teachers also were able to see the photovoltaic test facility – often located outside during the day loaded with different kinds of photovoltaic cells.



Different types of photovoltaic cells have differing spectral responses; some are more efficient with light in a particular band of wavelengths, others in a different area. A new idea is to combine solar photovoltaics with solar thermal and use the solar thermal to cool the photovoltaics!

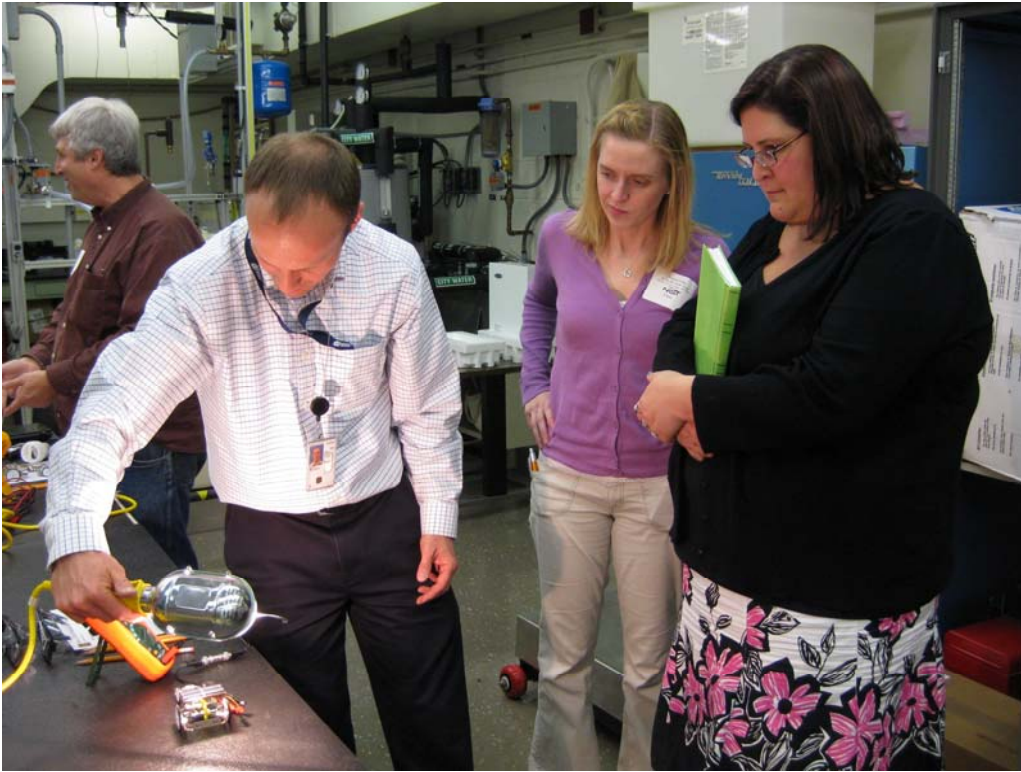


This lab has a facility to test photovoltaic cells by shining a xenon lamp on a panel for a single pulse of 36 milliseconds to measure the efficiency of energy transfer. Of course, corrections have to be made so this model better simulates the sun.



And then it was down to the basement to the lab where water heaters and dishwashers are tested – and where Tania had modified solar energy cars for activities to teach about solar energy.





Teachers had an opportunity to examine the cars and try them out with different light sources. Incandescent bulbs could make the cars move a bit; compact fluorescent, not so much. And hooking the car up to the multimeter explained why!



Tania discusses some of the modifications with the teachers and how she uses this activity with student groups who come to NIST.

All in all an interesting afternoon!



Below is information I gleaned from the Internet that may be of interest:

Links to the bios of the three presenters; their contact information is also on these pages.

Brian Dougherty: [http://www.nist.gov/el/building\\_environment/bdougherty.cfm](http://www.nist.gov/el/building_environment/bdougherty.cfm)

Tania Ullah: [http://www.nist.gov/el/building\\_environment/tullah.cfm](http://www.nist.gov/el/building_environment/tullah.cfm)

Bill Healy: [http://www.nist.gov/el/building\\_environment/whealy.cfm](http://www.nist.gov/el/building_environment/whealy.cfm)

The NIST Net-Zero Energy Residential Test Facility:

Measuring Performance of Net-Zero Energy Homes

Project: [http://www.nist.gov/el/building\\_environment/heattrans/mpnz.cfm](http://www.nist.gov/el/building_environment/heattrans/mpnz.cfm)

Net-Zero Energy High Performance Buildings

Program: [http://www.nist.gov/el/building\\_environment/heattrans/netzero.cfm](http://www.nist.gov/el/building_environment/heattrans/netzero.cfm)

Metrics and Tools for Sustainable Buildings

Project: [http://www.nist.gov/el/economics/metrics\\_for\\_sustainable\\_bldg.cfm](http://www.nist.gov/el/economics/metrics_for_sustainable_bldg.cfm)

US Dept of Energy Net-Zero Energy Buildings around the country: <http://zeb.buildinggreen.com/>

National Renewable Energy Laboratory (NREL) also has a research support facility that is net-zero energy: [http://www.nrel.gov/sustainable\\_nrel/rsf.html](http://www.nrel.gov/sustainable_nrel/rsf.html)

National Renewable Energy Laboratory: <http://www.nrel.gov/education/>

Solar Energy International: Renewable energy education for a sustainable future:

<http://www.solarenergy.org/solar-schools>

Energyteachers.org – multiple different energy-related topics including teacher workshops:  
<http://energyteachers.org>

US DOE Energy Education and Workforce Development Lesson plans, science projects, and activities: <http://www1.eere.energy.gov/education/lessonplans/>