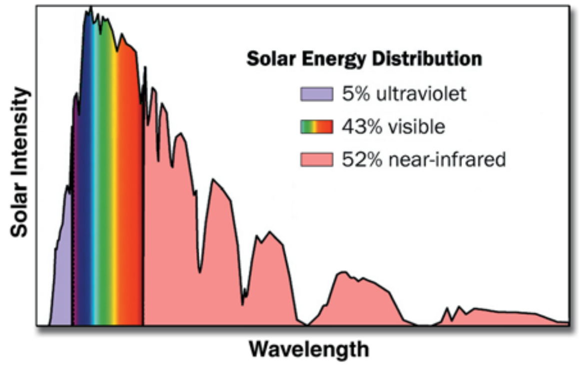
continued from p. 9

(IR) energy, but our eyes see only the visible portion. White roofs reflect most of the visible light spectrum, which mixes together to look white to our eyes, while dark roofs absorb most of the visible light, looking dark. Most solar energy, however, is in the IR region, which is not visible. CRCM roofs reflect more than 60% of the IR solar energy that strikes them.

Traditional roofing materials absorb or reflect IR light along with visible light. By reflecting the IR light independent of the visible light, the CRCMs reduce the total amount of solar energy absorbed without changing the amount of visible light reflected, hence retaining the roof color while cooling the roof. CRCMs offer other advantages over traditional roofing materials. They are available in a range of colors and resist fading better than standard materials.

Several metal roof manufacturers have successfully introduced CRCMs in their painted metal roof products. The additional cost of the CRCMs is only about 5¢ per square foot of finished product, which pays for itself within 3 years in energy savings. The architectural appeal, flexibility, and durability of CRCM-coated metal roofs are steadily increasing their market share. Historically metal roofs have held only about 3% of the residential market. From 2000 to 2002, the sales volume doubled to 6%, making metal roofs the fastest-growing residential roofing product.



Distribution of solar energy in the ultraviolet, visible, and near-infrared wavelengths.

ORNL and LBNL are collaborating with pigment manufacturers to reduce the sunlit temperatures of cedar shakes, clay and concrete tiles, and asphalt shingles, as well as metal roofing. ORNL is measuring the performance of CRCMs in the laboratory and in the field and will offer consumers information on the results. By showcasing the energy savings of CRCMs, they hope to accelerate the market penetration of these new products.

For more information, see http://coolcolors.lbl.gov/.

Contact: William Miller, 865-574-2013, millerwa1@ornl.gov

Sponsor: California Energy Commission

Attic Handbook Offers Defense Against the Elements

Proper roof, attic and ceiling configurations are essential to good thermal, structural, and moisture performance, as well as energy efficiency, in homes. Many alternatives exist to configure these components, but some are unacceptable. ORNL researchers are preparing a *Residential Attic Handbook* that will provide practical information on designing and building the roof, attic, and ceiling to ensure the best possible approaches for protecting and enhancing residences, thus reducing energy consumption.

Attics need to be properly sealed and insulated against air exchange and heat exchange between indoors and outdoors. Attic ventilation protects against ice dams.

The *Residential Attic Handbook*, written by ORNL's Building Envelope Group (BEG), will help builders, contractors and homeowners ensure that every attic built is cost-effective and energy-efficient. Attics, ceilings, and roofs are key parts of the building. The ceiling is usually the location for much of the insulation that allows acceptable thermal performance. If the attic is sealed properly against air exchange between the indoors and outdoors, problems with moisture accumulation and wasted energy should be minimal.

Ice dams can form at the edges of roofs in cold, snowy climates if the attic is warm enough to melt the snow over it. The melt water flows to the edges, where it refreezes and forms dams. Additional melt water backs up under the roof covering and may leak into the attic. A way to avoid chronic ice dams is an attic ventilation system that keeps the roof over the attic as cold as the edges, preventing the formation of ice dams.

The thermal and moisture control configuration for attics in buildings along the Canadian border is not necessarily appropriate for areas such as the very hot, humid, hurricane-prone cooling zone of the southeastern coastal states, or even for moderate climates. Consequently, the *Residential Attic Handbook* features attic configurations for all three climate zones.

The roof is a building's main defense against the elements and the loss of heating and cooling energy. Structural integrity is a prerequisite for achieving long-term good thermal and moisture performance. Roof structures frequently fail in

continued on p. 11

continued from p. 10

wind storms, often when the wind strips some of the covering off the roof and exposes joints in the decking. A failed roof allows water to penetrate the attic, damaging the building and contents. The most notorious wind damage occurs from category 1 hurricanes on the southeast and Gulf coasts and from tornadoes. Lessons learned from these catastrophic failures are incorporated in the *Handbook*.

The *Residential Attic Handbook*, to be published later in 2004, is one of at least a dozen tools produced by BEG research that offer relevant building envelope design information in a usable form. These tools reflect over 15 years of research and analysis dealing with the performance of building envelopes. They are highly regarded by the building industry because of their practicality and accuracy and the unbiased scientific method used to prepare them. They are available at www.ornl.gov/sci/roofs+walls; many are also available in print.

Contact: Tom Petrie, 865-574-9335, petrietw@ornl.gov

Sponsor: DOE/EERE Building Technologies Program

Upgrading the Grid with Superconducting Transformers

The increased load demand and reduced investment in utility power transmission systems caused by deregulation uncertainties will result in a need for many new power transformers in the near future to replace aging units. Electricity can pass through three or more transformers as it flows from the generator to the transmission line and distribution system, resulting in power losses of 7–8%. High-temperature superconducting (HTS) transformers can reduce these losses, and they promise to be smaller and lighter with lower fire and environmental hazards than conventional units. Another advantage is greater tolerance for overloads without damage.

Under a DOE Superconductivity Partnership with Industry (SPI), ORNL is collaborating with Waukesha Electric Systems (WES), SuperPower, Inc. (SP), and the Energy East (EE) utility company to develop commercial HTS power transformers. The team has developed a unique design that is cooled by compact cryocoolers rather than piped-in liquid nitrogen. The design allows operation of the windings at temperatures as low as 30 K, which greatly improves the superconductor performance. A single-phase, 1-MVA unit was successfully tested in 1998, and a three-phase, 25-kV, 5/10-MVA prototype has now been built for testing on the grid system at the WES plant. This transformer is wound with the first-generation BSCCO-2223 HTS conductor that is now commercially available.

HTS transformers can reduce distribution losses and avoid overloads.

ORNL participated in many areas of the program. The 60-cycle ac losses in small test coils provided by SP were measured to predict the cryogenic cooling power needed for a full-size transformer. High-voltage breakdown and partial-discharge tests were carried out on many different insulating materials to qualify them for operation at cryogenic temperatures. Other materials tests investigated superconductor performance and insulation heat capacities. ORNL also designed and supervised fabrication of a drop-in cooling module for the 5-MVA transformer. This module contained the cryocoolers and the heat exchangers that couple them to the superconducting coils. SP carried out design and fabrication of the HTS coils and their support system. WES was responsible for the conventional parts, including the tank, laminated steel core, and high-voltage leads and bushings; complete assembly of all components; ANSI standards electrical testing; and final installation in the WES substation.

Moving the 5/10-MVA transformer to the Waukesha Electric Systems test area.

In June 2003, the 5-MVA transformer was successfully cooled below 30 K. It took about 10 days to cool the 4-ton cold mass. Several low-voltage tests up to the full operating current were carried out. After some repairs and adjustments, it was moved on a truck while cold to the main WES plant test floor, where long-term high-voltage and high-current tests will be carried out in 2004.

Although the preliminary results for the transformer are encouraging, it has become clear that economically competitive HTS transformers will require a much less expensive conductor. The currently available conductor contains 65% silver, but second-generation conductors will use much cheaper materials and have higher current-carrying capability. Another area for further research is the development of better cryogenic dielectric materials that can operate at transmission-level voltages above 100 kV.

Contact: Bill Schwenterly, 865-574-1460, schwenterlsw@ornl.gov

Sponsor: DOE/Office of Electric Transmission and Distribution