DOE Announces Selections from Energy Efficient Building Technologies FOA

The National Energy Technology Laboratory (NETL), on behalf of the U.S. Department of Energy's Building Technologies Program, is pleased to announce the selection of thirteen (13) applications in response to Funding Opportunity Announcement (FOA) DE-FC26-04NT42114 entitled *Energy Efficient Building Technologies*. The objective of the FOA was to support projects that advance energy efficient equipment, envelope, and whole building technologies. The goal is to accelerate high-payoff technologies that, because of their risk, are unlikely to be developed in a timely manner without a partnership between industry and the Federal government. Further, these projects will contribute to the Building Technologies Program "Zero Energy Buildings" goal:

To create technologies and design approaches that enable net-zero energy buildings at low incremental cost by 2025. A net zero energy building is a residential or commercial building with greatly reduced needs for energy through efficiency gains, with the balance of energy needs supplied by renewable technologies. These efficiency gains will have application to buildings constructed before 2025 resulting in a substantial reduction in energy use throughout the sector.

The selections are summarized below (subject to negotiation):

Recipient: Davis Energy Group
Title: E-Form – A Marketable Slab Edge Insulation/Form System
Project Value: $514,015 **Applicant Cost Share:** 20% **Duration:** 24 months

Summary: Concrete slabs are the predominant foundation type for most new low-rise buildings in fast-growing residential markets throughout the western, southern, and southwestern U.S. The evolution of energy codes has significantly improved the thermal performance of walls, windows, ceilings, and floors, but slab edges are generally left uninsulated due to the lack of suitable products and the difficulty and cost of adapting existing insulating products. The objective of this project is to develop a cost-effective, easily installed stay-in-place insulated forming system that reduces slab edge energy losses by 30-50% thereby lowering heating and cooling energy use. This "E-Form" product will also provide benefits to builders and contractors by improving productivity, reduce construction waste and consumption of large timber, and add manufacturing and distribution sector jobs.
POC: Marc Hoeschele (530) 753-1100

Recipient: Advanced Energy
Title: Closed Crawl Space Performance: Proof of Concept in the Production Builder Marketplace
Project Value: $1,618,057 **Applicant Cost Share:** 20% **Duration:** 36 months
Summary: In a current Field Study of 12 identical houses, Advanced Energy has found that a properly closed crawl space can result in an average 15-18% reduction in space conditioning energy consumption (largest savings opportunity since insulation or duct air leakage sealing). In other words, initial (stages 1-4) research is providing evidence that the proper closing of crawl spaces can have beneficial moisture control AND substantial energy efficiency impacts. This building envelope system improvement with its multiple benefits hold great potential for, and is equally applicable to, both new and existing residential markets.

This proposal is to move into stage 5 research; refining prototypes, testing design features, verifying performance models and field testing of closed crawl spaces in several climate areas.

The research proposed here involves evaluating the performance of houses constructed by industry partners, with their own funds, at Marketplace Performance sites at three dispersed geographic locations. Each Marketplace Performance site would include 12 production houses, with four of the houses being control - standard construction houses and the other eight being closed crawl space construction houses (4 each of two different methods). The primary difference between the control houses and the experiment houses at each Marketplace Performance site will be that control houses will be built on traditional vented crawl spaces and experiment houses will be built on properly closed crawl spaces. Thus, any group difference in space conditioning energy consumption will be attributable to the application of closed crawl space technology.
POC: Sharon Gladwell (919) 857-9000

Recipient: University of Minnesota
Title: Advanced Energy Efficient Roof Systems
Project Value: $1,918,476 **Applicant Cost Share:** 22% **Duration:** 36 months

Summary: The University of Minnesota, Pulte Home Sciences and General Electric Advanced Materials (GEAM) are collaborating to develop and commercialize an innovative residential roof with the primary objective of creating a more energy efficient building envelope. The goal is to design, build and evaluate a one-piece modular roof panel that uses a composite material or laminated structure manufactured in a continuous process. The roof panel will be self-supporting (differentiating it from existing Structural Insulated Panels, SIPs), have an effective continuous R-value at least 20% greater than that required by the 2003 International Energy Conservation Code (IECC), reduce infiltration and moisture condensation, and in some models integrate heat recovery, photovoltaics and/or solar hot water collectors. Roof panel construction will be in an offsite facility under precisely controlled manufacturing conditions, thus ensuring superior insulation and moisture characteristics. This innovative approach to roof construction will eliminate the need for additional roof support (trusses or joists) and provide conditioned space for HVAC equipment and storage in the attic.

The project involves an integration of design, manufacturing and marketing. The initial effort entails evaluating roof concepts and selecting three "best" concepts. Each roof concept is evaluated for hygrothermal and mechanical performance, cost, manufacturability, durability, and reliability. Detailed analysis and materials evaluation will be performed for the final three concepts. A manufacturing process plan and commercialization plan will be developed for the final concepts. These final concepts will be fabricated and tested along with a conventional roof in a full-scale outdoor test facility. Test duration will be for a full calendar year.
POC: Jane Holloway Davidson (612) 626-9850

Recipient: Three Rivers Aluminum Company (TRACO)
Title: High Performance Commercial Fenestration Framing Systems
Project Value: $2,282,500 **Applicant Cost Share:** 39% **Duration:** 24 months
Summary: Aluminum framing systems are used in over 80% of commercial fenestration products (i.e. windows, curtain walls, store fronts, etc.). Aluminum framing is often required in commercial buildings because of its high structural performance, but also has lower energy performance. The objective of this project is to develop high performance, energy efficient commercial fenestration framing systems, by investigating new technologies that would improve the thermal performance of aluminum frames to the level of wood and PVC materials, while maintaining excellent structural performance.

One of the major focuses of this project will be the development of a new low emissivity coating that can be applied to both exterior and interior framing surfaces, including frame cavities. This

project will investigate new low-e coating technologies applicable for framing systems, either as part of the existing architectural paint, or as a second coating on top of the painted or anodized surface. Another major focus of this project will be to develop or improve the thermal barrier system on aluminum framing systems. The thermal barrier improvement can be anything from substituting different materials to existing designs to redesigning a hybrid frame systems. In parallel to the development of improved thermal barriers, research will be conducted with foam to fill frame cavities in order to reduce the overall U-factor.
POC: Mike Manteghi (724) 776-7050

Recipient: Universal Display Corporation
Title: Novel Smart Windows based on Transparent Phosphorescent OLEDS
Project Value: $130,000 **Applicant Cost Share:** 23% **Duration:** 12 months

Summary: In this program, Universal Display Corporation and Princeton University propose to develop novel very high efficiency transparent phosphorescent OLEDs (organic light emitting diodes) to make low cost 'TOLED smart windows', that switch rapidly (on the order of 1-10msec) from being a highly efficient solid-state light source to being a transparent window or skylight that controls the flow of heat and ultraviolet (UV) radiation into and out of buildings.

Our goal is to integrate two innovative concepts to meet the U.S. Department of Energy goals: high power efficiency TOLEDs, plus electrically controlled reflectors to produce a 'TOLED smart window.' At the completion of this 1-year program, we will demonstrate the concept of a TOLED smart window with a prototype 1" by 1" smart window with an efficiency exceeding 20 lm/W (lumens per watt) at 1,000 cd/m2 (candelas per square meter) in the 'on' state and a transparency across the visible of 75% in the 'off' state.
POC: Janice Mahon (609) 671-0980

Recipient: General Electric Company
Title: Thermotunneling Based Cooling Systems for High Efficiency Buildings
Project Value: $2,263,176 **Applicant Cost Share:** 34% **Duration:** 36 months
Summary: GE Global Research's overall objective is to develop a novel thermotunneling cooling device. The end use for these devices is the replacement of vapor cycle compression (VCC) units in residential and commercial cooling and refrigeration systems.

Thermotunneling devices offer many advantages over vapor cycle compression cooling units. These include quiet, reliable, non-moving parts operation without refrigerant gasses. Additionally theoretical calculations suggest that the efficiency of thermotunneling devices can be 1.5-2x that of VCC units. Given these attributes it can be seen that thermotunneling devices have the potential for dramatic energy savings and are environmentally friendly.

A thermotunneling device consists of two low work function electrodes separated by a sub 10 nanometer sized gap. Cooling by thermotunneling refers to the transport of hot electrons across the gap, from the object to be cooled (cathode) to the heat rejection electrode (anode), by an applied potential. GE Global Research will investigate multiple thermotunneling device architectures. Low-work-function materials (<1.0eV) for the electrodes will be developed. The low-work-function materials will be integrated it into the downselected thermotunneling architecture. Scalability of the device will be determined and integration of the device into a cooling subsystem will be completed. Commercialization of these cooling subsystems will be done through GE's Consumer and Industrial appliance division.
POC: Jeff Popielarczyk (518)387-6908

Recipient: Clarkson University
Title: Improved Design of Motors for Increased Efficiency in Residential & Commercial Buildings
Project Value: $1,084,710 **Applicant Cost Share:** 29% **Duration:** 36 months

Summary: The Objectives of this research are to:

1. Understand the scientific principles governing core losses in lamination, particularly as it relates to high frequency and nonsinusoidal excitation.
2. Develop an instrument capable of accurately measuring the core loss of motor laminations exposed to nonsinusoidal and/or high frequency excitations.
3. Measure the core losses from several lamination manufacutrers and steel mills exposed to high frequency sinusoidal and nonsinusoidal waveforms.
4. Develop design formulae for categorizing core losses as a function of frequency, lamination thickness, resistivity, peak flux density and waveshape.
5. Apply these design formulae to several prototypes and measure the improvements in efficiency.
6. Encapsulate the important findings and results in a final report and technical papers and disseminate the results through short courses.

POC: Rebecca Sutcliffe (315) 268-4402

Recipient: Davis Energy Group
Title: HyPak-MA—A Hydronic Rooftop Unit
Project Value: $1,315,059 **Applicant Cost Share:** 20% **Duration:** 28 months

Summary: The objective of this project is to develop a cost-effective, hydronic rooftop HVAC unit that reduces energy consumption 50% and delivers zero to 100% ventilation air. HyPak-MA uses the following strategies to accomplish this:

1. A water cooled condenser to increase compressor capacity and efficiency
2. A novel counterflow evaporative water cooler (CEWC) that cools water to a lower temperature and in less volume than conventional cooling towers
3. Indirect evaporative pre-cooling of ventilation air
4. Variable-speed blowers for part-load efficiency
5. 100% economizer operation bypassing aircoils for minimal blower energy
6. Heat recovery and tankless water heater coupled to a hydronic aircoil for efficient heating
7. Intelligent damper controls for maximum ventilation and minimal energy consumption

To ensure the reliability and effectiveness of these strategies, HyPak-MA will have built-in measures to maintain water quality and combat scale buildup without chemicals. Indoor air comfort and quality will improve with high ventilation rates and high-efficiency filtration. The design will emphasize isolation of conditioned air from water or moist exhaust air.

Based upon results attained in an earlier R&D project, a first generation prototype will be designed and fabricated for laboratory testing and refinement. Two second generation prototypes will be made for laboratory and field testing. An automated process will be developed for economical production of the CEWC, the key HyPak-MA component. The HyPak-MA project will yield a production-ready product ready for commercialization.

POC: Richard Bourne (530) 753-1100

Recipient: DeLima Associates
Title: High Efficiency Integrated Space Conditioning, Water Heating and Air Distribution System for HUD-Code Manufactured Housing

Project Value: $811,857 **Applicant Cost Share:** 69% **Duration:** 18 months

Summary: Manufactured homes constitute the majority of housing that is affordable by low-to-moderate income American families. Approximately 18 million people, over 7% of the U.S. population, live full-time in 7.3 million manufactured homes. Manufactured housing is the fastest growing segment of the residential housing market.

Our proposed concept combines proven HVAC components in a low-cost package that addresses space heating/cooling, air-tight air supply/return, sensible/latent temperature control, and domestic water heating. The concept includes a combination space-heating/water-heating system and an air conditioner that is supplied as an integrated, drop-in unit for manufactured homes. The integrated package uses hot water from a propane or natural gas-fired water heater to provide both domestic (potable) hot water and space heating. The appliance can be used in manufactured housing, multi-family housing, public housing, and other applications that require a small footprint.
POC: Henry DeLima (703)448-9653

Recipient: Building Solutions, Inc.
Title: Development of an Accurate Feed-Forward Temperature Control Tankless Water Heater
Project Value: $369,084 **Applicant Cost Share:** 22% **Duration:** 24 months
Summary: Tankless water heaters, sometimes called instantaneous or flow-through water heaters, offer several advantages over storage water heaters. Tankless water heaters eliminate the standby losses that waste much of the energy used by storage water heaters, since water is heated only when it is required. Tankless water heaters only account for about 1% of water heaters purchased in the United States annually, perhaps due to performance limitations of these devices, which include an inability to control outlet temperatures accurately and relatively low flow rates.

We propose to improve the performance of tankless water heaters by studying and improving the control algorithms used to heat the water. Current tankless electric water heaters, like most other devices intended to heat a fluid to a particular temperature, are normally operated by conventional feedback control. A sensor detects the temperature of the water as it leaves the heater, and transmits it to the controller. The controller compares the temperature with the desired temperature (the set-point) and adjusts the power to the heater element to eliminate any deviation. The key insight of this initiative is that better control will be achieved by measuring the temperature of the water as it enters the heater. This strategy will work better because the heat required to effect temperature change under specific conditions of water temperature and flow can be determined before the water passes through the heating element, rather than after. This will also reduce temperature fluctuations.
POC: David Yuill (402) 556-3382

Recipient: Ball State University
Title: Research and Development of a New field Enhanced Low Temperature Thermionic Cathode That Enables Fluorescent Dimming and Load Shedding without Auxiliary Cathode Heating
Project Value: $821,584 **Applicant Cost Share:** 28% **Duration:** 36 months

Summary: Dimming is a very effective way to reduce the energy consumption of fluorescent systems. It is estimated that on average an installed fluorescent dimming ballast system cuts the electricity consumption by at least 30% as compared to a compatible full-light fluorescent ballast system. However, current dimming technology suffers from high dimming ballast cost, shortened lamp life, and, to a less degree relatively low ballast efficiency. These major issues prevent broad market acceptance of the dimming technology. Currently the dimming ballast market share in the

US is only 1% of the total ballast market.

We propose research on a robust low temperature thermionic fluorescent cathode that will address all three of these problems. This cathode utilizes carbon nanotubes to induce a significant field enhanced effect in thermionic electron emissions. It can maintain the level of electron emission needed for fluorescent lamp operation at a much lower temperature, thus eliminating the need for cathode heating during dimming operation. Elimination of the need for cathode heating will cut the dimming ballast cost dramatically, and at the same time, it will improve the ballast efficiency and the lamp life significantly. In this research, we will investigate various thin film growth and deposition techniques for carbon nanotubes and oxide materials. Different cathode structures will also be explored. Prototype cathodes will be tested in typical lamp operating environment.
POC: Heather Shupp (765) 285-1560

Recipient: University of Central Florida
Title: Expand the Modeling Capabilities of DOE's EnergyPlus Building Energy Simulation Program
Project Value: $252,041 **Applicant Cost Share:** 20% **Duration:** 22 months
Summary: EnergyPlus, a building performance simulation program, has innovative simulation capabilities, including simulation time steps of less than one hour, modular systems simulation modules that are integrated with a heat balance-based zone simulation, and input and output data structures tailored to facilitate third-party interface development. The integrated systems modules/heat balance solution technique allows for evaluation of interactions between various building components and subsystems, a key deficiency in the earlier programs, but absolutely necessary to enable whole-building optimization.

While the unique capabilities of EnergyPlus have grown significantly over time, additional key features and upgrades are required to support research, design and analysis of high-performance and zero-energy buildings. Specifically, the following new features or enhancements to existing features will be implemented, tested and documented during this project:

- A model for packaged terminal heat pumps
- A model for gas engine-driven air-to-air heat pump waste heat recovery
- Proper modeling of window screens
- Modeling energy losses related to commercial building air distribution systems
- Comfort-based controls for forced-air cooling and heating systems
- An improved model for microturbine power generation with heat recovery

POC: Don Shirey (321) 638-1451

Recipient: NorthWrite, Inc.
Title: Wireless Infrastructure for Performance Monitoring, Diagnostics, and Control in Small Commercial Buildings
Project Value: $1,903,491 **Applicant Cost Share:** 22% **Duration:** 24 months

Summary: The project focuses on integrating underlying enabling technologies to create an innovative wireless technology platform for delivering services for performance monitoring, diagnostics and control of energy-using equipment and systems in small commercial buildings. The system will then be tested by applying it specifically to rooftop HVAC units and lighting systems. The platform will provide a novel mechanism for delivering facility energy management and maintenance services cost effectively to the underserved small and medium commercial building market segments by making them available via an Internet browser on the

servers of an application service provider (ASP). The proposed infrastructure integrates wireless mesh networking technology, with wireless telemetry, automated fault detection, diagnostics, and control, and the ASP delivery model.

The scope includes: 1) integrating short and long-range wireless technologies and software applications to create a cost-effective infrastructure for delivering energy-efficiency services to the small-commercial building sector via the Web, 2) adapting easy-to-install generic wireless sensor networking technology to sensing and control for small commercial buildings, 3) developing a Wireless Master Control Module (WMCM) that links on-site wireless data collection and control communication with long-distance wireless telemetry and provides on-site data processing, 4) integration and testing (laboratory and field) of the integrated infrastructure applied to two applications: i) automated monitoring and diagnostics for rooftop HVAC and ii) diagnostics and controls of equipment operation schedules.
POC: Patrick O'Neill (503) 636-0300