U.S. DEPARTMENT OF ENERGY

Small Business Innovation Research (SBIR) and
Small Business Technology Transfer (STTR) Programs

Topics

FY 2014

Phase I Release 2

Version 6, December 6, 2013

Participating DOE Research Programs

- Office of Electricity Delivery and Energy Reliability
- Office of Energy Efficiency and Renewable Energy
- Office of Fossil Energy
- Office of Fusion Energy Sciences
- Office of Nuclear Energy

Please Note: the Following Important Date(s) pertain to these Topics and the FY 2014 SBIR/STTR Phase I Release 2 Funding Opportunity Announcement (FOA).

Topics Released:	October 28, 2013
FOA Issued:	November 25, 2013
Letter of Intent Due Date:	December 16, 2013
Application Due Date:	February 4, 2014
Award Notification Date:	Late April 2014*
Start of Grant Budget Period:	Early June 2014*

*Preliminary Dates Subject to Change

	Table of Changes	
Version	Date	Change
Ver. 1	October 28, 2013	Original
Ver. 2	October 29, 2013	Page 80, Topic 22 newly added
Ver. 3	October 29, 2013	Pages 23-26, revised subtopics 6b & 6d Page 31, revised subtopic 8c
Ver. 4	November 1, 2013	Pages 59, 61, 63, 64 revised point of contact email address for Barry Sullivan to barry.sullivan@science.doe.gov
Ver. 5	November 6, 2013	Page 75, Topic 20 revised, subtopic c newly added
Ver. 6	December 6, 2013	Page 27-28, Topic 7d and 7e revised

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Technology Transfer Opportunities

Selected topic and subtopics contained in this document are designated as **Technology Transfer Opportunities** (TTOs). The questions and answers below will assist you in understanding how TTO topics and subtopics differ from our regular topics.

What is a Technology Transfer Opportunity?

A Technology Transfer Opportunity (TTO) is an opportunity to leverage technology that has been developed at participating Research Institution, such as a university or DOE National laboratory. Each TTO will be described in a particular subtopic and additional information may be obtained by using the link in the subtopic to the Research Institution that has developed the technology. Typically the technology was developed with DOE funding of either basic or applied research and is available for transfer to the private sector. The level of technology maturity will vary and applicants are encouraged to contact the appropriate Research Institution prior to submitting an application.

How would I draft an appropriate project description for a TTO?

For Phase I, you would write a project plan that describes the research or development that you would perform to establish the feasibility of the TTO for a commercial application with the intention to eventually license and commercialize the technology. The major difference from a regular subtopic is that you will be able to leverage the prior R&D carried out by the Research Institution and your project plan should reflect this.

Am I required to show I have a sub-award with the university or National Lab that developed the TTO in my grant application?

No. Your project plan should reflect the most fruitful path forward for developing the technology. In some cases, leveraging expertise or facilities of a Research Institution via a sub-award may help to accelerate the research or development effort. In those cases, the small business may wish to negotiate with the Research Institution to become a sub-awardee on the application.

Is the Research Institution required to become a sub-awardee if requested by the applicant?

No. Collaborations with a Research Institution must be negotiated between the applicant small business and the Research Institution. The ability of a Research Institution to act as a subcontractor may be affected by existing or anticipated commitments of the research staff and its facilities.

Are there patents associated with the TTO?

The TTO will be associated with one or in some cases multiple patent applications or issued patents.

If selected for award, what rights will I receive to the technology?

Those selected for award under a TTO subtopic, will be assigned rights to perform research and development of the technology during their Phase I or Phase II grants. Please note that these are NOT commercial rights which allow you to license, manufacture, or sell, but only rights to perform research and development.

In addition, TTO awardees will be provided with, at the start of their Phase I grant, a no-cost, six month option to license the technology. It will be the responsibility of the small business to demonstrate adequate progress towards commercialization and negotiate an extension to the option or convert the option to a license. A copy of an option agreement template will be available at the Research Institution which owns the TTO.

How many awards will be made to a TTO subtopic?

We anticipate making a maximum of one award per TTO subtopic. This will insure that an awardee is able to sign an option agreement that includes exclusive rights in its intended field of use. If we receive applications to a TTO that address different fields of use, it is possible that more than one award will be made per TTO.

How will applying for an SBIR or STTR grant associated with a TTO benefit me?

By leveraging prior research and patents from a participating Research Institution you will have a significant “head start” on bringing a new technology to market. To make greatest use of this advantage it will help for you to have prior knowledge of the application or market for the TTO.

Is the review and selection process for TTO topics different from other topics?

No. Your application will undergo the same review and selection process as other applications.

FAST-TRACK (COMBINED PHASE I AND PHASE II)

The following is a brief summary of Fast-Track applications. Please refer to the Funding Opportunity Announcement for more detailed information about submitting a Fast-Track application.

Fast-Track grants are opportunities to expedite the decision and award of SBIR and STTR Phase I and II funding for scientifically meritorious applications that have a high potential for commercialization. Fast-Track incorporates a submission and review process in which both Phase I and Phase II grant applications are combined into one application and submitted and reviewed together. The Project Narrative portion of a Fast-Track application must specify clear, measurable goals and milestones that should be achieved prior to initiating Phase II work. If these milestones are not met in Phase I, authorization to proceed to Phase II may not be provided and the grant will discontinue following Phase I efforts. The work proposed for Fast-Track, assuming that it proceeds, should be suitable in nature for subsequent progress to non-SBIR/STTR funding in Phase III.

For a specific R&D effort, applicants may submit either a Phase I application or a Fast-Track application, but not both. If both Phase I and Fast-Track applications are submitted, the application with the most recent submission date and time to Grants.gov will be evaluated. A project selected for Fast-Track funding which fails to meet its objectives may not later apply for Phase II funding. The topic header will clearly indicated whether SBIR or STTR Fast-Track applications will be accepted.

PROGRAM AREA OVERVIEW – OFFICE OF ELECTRICITY DELIVERY AND ENERGY RELIABILITY

The U.S. electric power sector is a critical part of our society. The electricity industry is a mix of investor-owned utilities, municipal utilities, cooperatives, and federal power utilities. In addition, electricity is also generated from non-utility power producers. The nation's electric grid must be protected from unacceptable risks, multi-regional blackouts, and natural disasters. Therefore, the mission of the Office of Electricity Delivery and Energy Reliability (OE) is to lead national efforts in applied research and development to modernize the electric grid for enhanced security and reliability. A modernized grid will significantly improve the Nation's electricity reliability, efficiency, and affordability, and contribute to economic and national security.

OE supports research and development efforts to eliminate bottlenecks, foster competitive electricity markets, and expand technology choices. For example, the risk of multi-regional blackouts and natural disasters can be reduced through the application of better visualization and controls of the electric grid, energy storage and power electronics, smart grid technology, cyber security, and advanced modeling.

For additional information regarding the Office of Electricity Delivery and Energy Reliability priorities, click here.

1. GAN-BASED HIGH DENSITY POWER CONVERSION SYSTEM FOR GRID-TIED ENERGY STORAGE SYSTEMS

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: NO	*Accepting STTR Fast-Track Applications:* NO

Grid-tied energy storage systems are a key subsystem to the electric utility infrastructure in that they provide multiple technical and economic benefits such increasing asset utilization and deferring upgrades of the grid, providing flexibility for the customer and cost control, maintaining power quality, and increasing the value of variable renewable generation from photovoltaic and wind generation systems. Such systems will ultimately improve the flexibility, reliability, security, quality, and cost effectiveness of the existing and future electric utility systems. Current energy storage systems including the power conversion system are packaged in standard shipping containers for the ease of transportability and siting. They are attractive because they have lower installation cost and less installation time to operation. This design approach provides unique technical challenges for the energy storage technology as well as the power conversion system. Due to the containerized approach, high power density and small footprint design is critical.

In the past decade or so, there has been increase interest in the utilization of wide band gap (WBG) devices such as SiC and GaN for switch mode power supply applications. These materials offer the potential for higher switching frequencies, higher blocking voltages, lower switching losses and a higher junction temperature than traditional silicon-based switches. It has been shown that WBG-based power conversion systems can result in higher power density than silicon-based system and thus an attractive approach for containerized energy storage systems.

Although a number of SiC-based power conversion have developed in recent years, GaN devices have emerged with promising characteristics such as high frequency and high density power conversion designs and are the focus of this topic. By providing low on-resistance and low gate charges due to high electron mobility, GaN devices can significantly reduce switching losses and allow for higher switching frequencies resulting in high power density power conversion designs.

Grant applications are sought in the following subtopics:

a. GaN-based High Frequency Link Converters for Grid-Tied Energy Storage Applications

Typical power conversion design for grid-tied energy storage applications involve a dc-dc converter front end followed by a dc-ac inverter back end that interconnects with the electric utility grid via a 60 Hz transformer. There is increase interest in the utilization of high frequency link approach where a high frequency transformer is integrated into the power conversion system – the goal of such system is to get rid of the bulky 60 Hz transformer while still providing galvanic isolation. The high frequency link approach will ultimately reduce the size and weight of the overall power conversion system. This type of design is very attractive for containerized energy storage units due to its strict form factor and weight limitations. Applications are being sought to apply GaN devices for a high frequency link converter design approach to improve grid-tied energy storage applications. The desired properties of a GaN-based high frequency link converter include: (a) >600V DC-link voltage, (b) >50kW power, (c) 480VAC output three phase, (d) semiconductor continuous junction temperature of >120C, (e) high frequency link frequency of >15 kHz. Proposals must show significant improvement over Si-based traditional designs.

Questions – contact: Imre Gyuk, imre.gyuk@hq.doe.gov

b. High Voltage GaN-based DC-DC Converters for Grid-Tied Energy Storage Applications

Battery based energy storage systems are inherently dc voltage sources and they usually connected to DC-link of the inverters via a bidirectional dc-dc converter. Majority of three phase energy storage systems offer designs with 480Vac output with a DC-link voltage of greater than 600Vdc. DC-DC converters are critical to the operation of energy storage systems in that they provide regulation of battery charge and discharge control and of specific DC voltage and current for the inverter. Advances in the GaN-based DC-DC converter design for battery energy storage systems are sought for grid-tied energy storage applications. Desired GaN-based DC-DC converter properties include: (a) boost output of >600Vdc link for inverter input, (b) high efficiency of >98%, (c) switching frequency of >20kHz, and (d) >2 X increase in power density. The proposal must show significant improvement of such systems compared to Si-based approaches.

Questions – contact: Imre Gyuk, imre.gyuk@hq.doe.gov

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Subtopic a:

1. Xiaolei, H., Tseng, K., Yitao, L., Shan, Y., Mengqi, Z., A High Frequency Isolated Current-Fed Bidirectional DC/AC Converter for Grid-Tied Energy Storage System, IEEE ECCE Asia, pp. 291-296, June 2013. Available from

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2. Bhattacharya, S., Zhao, T., Wang, G., Dutta, S., Baek, S., Du, Y., Parkhideh, B., Zhou, X., Huang, A., Design and Development of Generation I Silicon Based Solid State Transformer, Proc. 25th Annu., IEEE APEC, pp. 1666-1673, 2010. Available from http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5433455&url=http%3A%2F%2Fieeexplore.ieee.org%2Fxpls%2Fabs_all.jsp%3Farnumber%3D5433455.
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Subtopic b:

1. Das, J., Everts, J., Van den Keybus, J., Van Hove, M., Visalli, D., Srivastava, P., Marcon, D., Chen, K., Leys, M., Decoutere, S., Driesen, J., Borghs, G., A 96% Efficient High-Frequency DC-DC Converter Using E-Mode GaN DHFETs on Si, Electron Device Letters, IEEE, Vol. 32, Issue 10, pp. 1370-1372, 2011. Available from http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=5985468&url=http%3A%2F%2Fieeexplore.ieee.org%2Fiel5%2F55%2F6028517%2F05985468.pdf%3Farnumber%3D5985468.
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PROGRAM AREA OVERVIEW: OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY

The Office of Energy Efficiency and Renewable Energy (EERE) is at the center of creating the clean energy economy today. EERE leads the U.S. Department of Energy's efforts to develop and deliver market-driven solutions for energy-saving homes, buildings, and manufacturing; sustainable transportation; and renewable electricity generation.

The EERE mission is to strengthen America's energy security, environmental quality, and economic vitality in public-private partnerships in order to enhance energy efficiency and productivity; bring clean, reliable and affordable energy technologies to the marketplace; and make a difference in the everyday lives of Americans by enhancing their energy choices and their quality of life. EERE's role is to invest in high-risk, high-value research and development that is critical to the Nation's energy future and would not be sufficiently conducted by the private sector acting on its own.

EERE's Technology Offices all have multiyear plans, detailed implementation processes and have demonstrated impressive results. To access this information for a particular office, click here and then click on the boxes checked for it.

Program activities are conducted in partnership with the private sector, state and local governments, DOE National Laboratories, and universities. EERE also works with stakeholders to develop programs and policies to facilitate the deployment of advanced clean energy technologies and practices.

For additional information regarding the EERE priorities, click here.

2. ADVANCED MANUFACTURING

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

The Advanced Manufacturing Office (AMO) (www1.eere.energy.gov/manufacturing/) partners with industry, small business, universities, and other stakeholders to identify and invest in emerging technologies with the potential to create high-quality domestic manufacturing jobs and enhance the global competitiveness of the United States.

Grant applications are sought in the following subtopics:

a. Manufacturing Improvements of Aluminum Nitride (AlN) for Wide Bandgap Semiconductor Power Devices

Wide bandgap semiconductors (WBGS) – with bandgaps greater than 3 eV, such as silicon carbide (SiC) and gallium nitride (GaN) -- already commercialized in solid-state lighting applications — offer the opportunity for dramatic efficiency improvements in a variety of power electronic applications including industrial process and motor drives. Compared to today's silicon (Si) based technologies, devices using WBGS can operate at higher temperatures (e.g. function at ambient temperatures higher than 150^{o}C without external cooling), withstand greater voltages (>10's of kV) over time, and switch at much higher frequencies (10's of kHz to 10's of MHz). Industrial-scale motors, for example, which consume 69% of the electricity used in industry, could achieve reductions of up to 40% of consumption per motor by adoption of variable speed drive enabled by WBGS power devices.

While SiC and GaN-based power devices have matured and are now being commercialized for adoption in end-systems, the research in aluminum nitride (AlN) is still relatively recent. The wide bandgap of AlN, of ~6.1 eV, offers considerable advantages over GaN and SiC semiconductors such as higher breakdown field strength that permits higher voltage devices. AlN wafers are already available in 30 mm diameter from several sources, and AlN-based light emitting diodes (LED) with wavelengths between 200 – 300 nm are already being commercialized for water purification and other purposes. Schottky devices (for example using AlN at 10 kV) could be as much as 5x smaller than a similarly rated SiC Schottky diodes at 10-25 kV. A number of challenges, however, need to be overcome in wafer manufacturing before AlN diodes can be manufactured. These include lack of conducting substrates, doping control during the boule and epitaxial growths, relatively deep donor and acceptor levels, ion-implantation and subsequent activation of donor and acceptor impurities.

Ion-implantation of donor and acceptor impurities and subsequent thermal activation is a basic building block for any semiconductor power device, which requires high dose implants to form ohmic contacts, floating guard rings and junction termination extension (JTE) regions, and grids for junction barrier Schottky (JBS) diodes. While research reports of Cd, Ag and Si ions are available, in order to manufacture AlN epilayers on bulk AlN substrates for use by device manufacturers, more comprehensive studies are needed.

<u>An area of particular interest is: Processes for ion-implantation and activation of donor and acceptor impurities</u>

Grant applications are sought that make improvements in ion-implantation and activation of donor and acceptor impurities in AlN epilayers on bulk AlN substrates and improve formation of ohmic contacts to both n+ and p+ implanted regions. Proposed work would conduct comprehensive studies of implantation of various species at elevated temperatures followed by activation at higher temperatures using a cap layer to preserve the surface quality, measurement of temperature dependent hall mobility and carrier concentrations, donor and acceptor energy levels and residual damage especially in high dose implants.

Questions – contact: Marina Sofos, marina.sofos@hq.doe.gov.

b. Rapid Heat Treatment of Metals

A large fraction of primary metal production in the United States comes in the form of thin gauge products. For example, about two thirds of the 90 million metric tons of US steel produced annually is rolled into coils of sheet and strip. These products often require various forms of heat treatment to achieve desired mechanical properties, to homogenize coatings, or to soften the material in between successive stages of cold rolling.

Advances in heating technologies, such as induction heating, have improved the ability to heat treat thin gauge metals rapidly, with reduced levels of surface oxidation, improved energy efficiencies, and smaller systems with lower capital costs. In addition to operating cost and energy reduction benefits, rapid heating provides new opportunities to control the structure and properties of metals. In particular, rapid heat treatment processes can be exploited to control grain size, diffusion of alloying elements, precipitate sizes and distributions, and phase transformations. Such control can enable superplasticity or ultrahigh strengths in ways that were not previously obtainable.

The combination of reduction in surface oxidation, smaller systems with higher energy efficiencies and improved material performance can lead to a doubling in energy productivity –the target for SBIR projects. Embodied energy reductions include less material required, lifetime system energy use reductions due to light-weighting, and elimination of processing steps.

We seek grant applications to advance the technology of the rapid heat treatment of metals for significant reductions in embodied energy. Grant applications can focus on topics such as methods to substitute rapid heating for radiant energy technology, scale up of rapid heat treatment to larger product forms, advances in alloy compositions that exploit rapid heat treatment, and advances in processing. Embodied energy savings can include a combination of lifecycle performance, yield performance, and process energy savings. In all proposed projects the required 50% embodied energy savings shall be demonstrated through the manufacture of exemplar parts or materials, with sufficient experimental measurements and supporting calculations, to show that the savings can be achieved with practical economies of scale.

Questions – contact: David Forrest, david.forrest@hq.doe.gov

c. Desalination without Membranes

Contaminants in water can be eliminated in most cases using inexpensive, mature technologies. Removing small ions (e.g. desalination), however, requires more sophisticated processes such as reverse osmosis (RO). The RO process, however, requires the consumption of significant electrical energy in order to overcome the large osmotic pressure in saline sources using high pressures (5–8 MPa). RO membranes are also expensive and prone to fouling, especially when the feed water does not have consistent quality. In addition, the complicated machinery (e.g., high pressure pump and electricity generator) of RO processes, the maintenance of the RO membranes, and the reliance on fossil fuels complicate operations such as desalination for conventional applications, as well as for remote applications or disaster relief. Alternatives to RO membranes are sought.

An area of particular interest is:

Novel, continuous water desalination processes: Grant applications are sought to for novel, continuous water desalination processes based on directional solvent extraction (DSE) that do not use membranes and are both highly efficient and can utilize low-temperature heat sources from waste heat or solar energy to minimize or even eliminate the dependence on fossil fuels for desalination and significantly increase their self-sustainability.

Questions – contact: Bhima Sastri, bhima.sastri@ee.doe.gov

d. Critical Materials for Clean Energy Technologies

In 2008, the National Academy of Sciences Minerals, Critical Minerals and the U.S. Economy Study presented a methodology to assess material criticality based on supply risk and impact of supply restriction. The Department of Energy adapted this methodology and applied it to several clean energy technologies to determine if materials constraints could impact deployment of the clean energy technologies. Basic availability is not the only factor affecting a critical material's overall supply risk. Other factors include political or regulatory risks in countries that are major producers of critical materials; lack of diversity in producers; and a competing technology demand -- many consumer electronics like mobile phones, computers and TVs use materials essential to clean energy technologies.

After examining 16 elements across the periodic table, five rare earth metals (dysprosium, neodymium, terbium, europium, and yttrium) were assessed as critical. Dysprosium and neodymium are used in permanent magnets, important to wind turbines and electric vehicle motors. Terbium, europium and yttrium are used in energy-efficient lighting phosphors. Two other materials (lithium and tellurium) were assessed as near-critical. Lithium is used in batteries and energy storage applications and tellurium is used in photovoltaic thin-films.

The manufacturing of U.S. clean energy technologies is likely to be affected by constrained supplies. As clean energy technologies are deployed more widely in the decades ahead, their share of global consumption of rare earths is likely to grow from 7% in 2010 to 40% or more by 2025. This growth, combined with non-clean energy demand, could result in supply constraints for clean energy technologies. Economic projections suggest certain critical materials could experience supply deficits of up to 30% by 2016.

There are opportunities throughout the lifecycle to develop more efficient processes to more effectively use existing supplies, reduce use and recycle and reuse at the end-of-life. Solutions to these challenges will help enable the continued deployment of clean energy technologies. This solicitation addresses three key elements across the lifecycle of critical materials:

1. Improved separation and processing of critical rare earth elements;
2. Advances in recovery and recycling of rare earth materials from manufacturing waste and end-of-life products; and
3. Novel production methods to enable advanced manufacturing of permanent magnets.

Areas of particular interests include:

Diversifying Supply through Improved Processing and Increased Recycling: In the United States, there is a significant gap in the rare earth metal supply chain in converting ores and oxides into metal. Current processes to convert rare earth materials to metals typically utilize oxide, chloride, or fluoride intermediates, which are then reduced to metal. These methods are generally considered inefficient, environmentally unfriendly, and unsustainable. Methods to investigate other intermediates beyond oxides, chlorides, and fluorides are of interest, including methods to avoid intermediates during processing.

In recycling of rare earth materials, there are two major categories that can be considered: 1) the reduction of manufacturing loss through recovering scrap materials, and 2) end-of-life recycling for commercial and consumer products. In rare earth permanent magnet manufacturing, it is estimated that approximately 30% of the magnetic material is lost during the machining process. Developing technologies to recover the rare earth materials from the machining sludge is of interest.
Lamps containing rare earth phosphors are routinely collected by lamp recyclers for removal of mercury or recycling other lamp components. However, most of the rare earth phosphor powders from end-of-life

lamps are landfilled. Technologies that will enable downstream processing of the recovered powders are needed.

Production of metal powders for additive manufacturing: Additive manufacturing could provide a more efficient route to rare earth magnetic materials. Additive techniques would reduce the waste associated with machining (e.g. shaping and cutting) bulk magnets, decreasing the sludge and swarf produced in the process. To enable more effective additive manufacturing of rare earth magnetic materials, metal powders with narrow size distribution are needed; however, the production process usually results in waste. More efficient production methods for metal powders, such as advanced atomization techniques, that produce narrower size distributions are of interest.

Questions – contact: Michael Mckittrick, michael.mckittrick@ee.doe.gov.

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Subtopic a:

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Subtopic d:

1. National Academy of Science, "Minerals, Critical Minerals, and the U.S. Economy", (2008). Available from http://www.nap.edu/catalog.php?record_id=12034.
2. DOE Critical Materials Strategy, http://energy.gov/pi/office-policy-and-international-affairs/downloads/2011-critical-materials-strategy

3. BUILDINGS

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

DOE's Building Technologies Office (BTO) advances building energy performance through the development and promotion of efficient, affordable, and high impact technologies, systems, and practices. BTO's long-term goal is to reduce energy use by 50%, compared to a 2010 baseline. To secure these savings, research, development, demonstration, and deployment of next-generation building technologies are needed to advance building systems and components that are cost-competitive in the market. Electric lighting now consumes ~1/10 of the primary energy delivered annually in the U.S. representing ~22% of the electricity produced. The building envelope (walls, roofs, windows etc.) are often assembled on-site by labor-intensive, low-tech processes. Highly automated manufacturing processes could allow for modular building components to be shipped directly to the jobsite, reducing installation costs. Finally, BTO is dedicated to promoting the widespread and effective use of advanced whole-building energy simulation in all aspects of the building life cycle, including early-stage and detailed design for new construction, commissioning and fault detection for existing buildings, and auditing and retrofits.

Grant applications are sought in the following subtopics:

a. Integrating Energy Efficient Solid-State Lighting with Advanced Sensors, Controls and Connectivity

The DOE's Office of Building Technologies has determined that few emerging technologies represent as much potential to conserve energy and enhance the quality of our commercial, industrial and residential building inventory than does energy efficient, solid-state lighting (SSL). Electric lighting in the US domestic building inventory consumes almost 1/10 of the primary energy delivered annually in the US representing about 22% of the electricity produced. The DOE has estimated that advancing energy efficient electric lighting in US buildings could conserve more than 50% of this energy. The DOE and the General Illumination Industry in North America have begun to harvest measurable lighting energy conservation in this important end use by taking advantage of existing SSL technology. But the migration of energy efficient SSL into the remaining North American buildings inventory will take many years to accomplish. This topic seeks to identify novel and inexpensive solutions that will accelerate the adoption of this disruptive yet energy efficient and environmentally green technology into the North American building inventory.

<u>Possible areas of interest for novel solutions include:</u>

1. <u>SSL Luminaries and lamps</u> – modern manufacturing techniques can respond to small and dynamic market needs using innovative concepts such as 3-D printing, digital metal forming and many other efficient yet flexible manufacturing techniques. These proven advanced manufacturing processes may be used to create SSL luminaires and SSL lamps in ways heretofore not possible. Novel approaches to quickly, efficiently and inexpensively bring SSL technology into the American

lighting marketplace using these new methodologies in quality and useful general illumination products whose value to end users is apparent and consistent with the goals of the DOE's SSL activity are sought. Incremental advancements to existing SSL products and processes will not be considered under this FOA.

2. SSL Components, materials or constituent components – modern state-of-the art manufacturing techniques have been proven to substantially reduce product costs especially in consumer electronics and related products. While some of this technology has appeared in SSL products, most products available in the North American market today are made using discrete components and using dated, labor intensive manufacturing techniques. Fully automated assembly, advanced printing and integrated electronics designs may provide substantial opportunity to inexpensively and quickly manufacture high quality products whose value proposition is comparable to the legacy lighting products and components being replaced by SSL and modern digital electronics.

3. SSL Systems, components, sensors and software – SSL is inherently digital and easily made compatible with modern electronics, sensors and control systems, yet has failed to be fully exploited in installed systems. While certain niche products that use advanced controls, sensors or even personal device control compatibility (e.g., iPhone, Android, etc.) have achieved modest levels of consumer acceptance, such advanced systems architectures have not achieved widespread popularity, limiting the energy conservation potential thought possible using advanced controls and sensors. It is possible that imaginative and inexpensive components including sensors, control algorithms, and even applications for common digital platforms may provide control functionality to SSL products adding value to users with little or no additional cost. With the immense popularity and ease of programming interface capabilities into personal digital assistants, it is possible that creative and useful new applications can be developed at modest cost, but that provide access to the enormous and powerful computational capabilities of present and future SSL systems , components and sensors. Applications, compatible sensors or control hardware or even additional processor capability are all viable topics for this FOA provided they are inexpensive and easily integrated into SSL systems.

All proposals sought must be demonstrated with modest feasibility studies within the constraints of the Phase I grant and budget with commercial demonstration and transition to manufacturing occurring in Phase II. Successful proposals will take advantage of popular trends in manufacturing that embrace innovation and entrepreneurship by offering products or components that provide value to customers, but at greatly reduced cost or by being readily reconfigurable to meet evolving market trends. Proposals may be submitted to any one of the subtopics listed above but all applications must:

1. Whenever possible, be consistent with and have performance metrics linked to the DOE SSL Multi-Year Program Plan (MYPP) available for download directly at: http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_mypp2012_web.pdf
2. Clearly define the proposed application, the merit of the proposed innovation and the anticipated outcome of the overall effort including Phase I and Phase II;
3. Include quantitative projections for price and/or performance improvement that is tied to representative values included in the MYPP or in comparison to existing products. Projections of price or cost advantage due to manufacturing improvements; materials use or design simplification, for example, should provide references to current practices and pricing to enable informed comparison to present technologies.

4. Commercial viability should be demonstrated with a quantifiable return on DOE investment as is described in the FOA.
5. All performance claims must be fully justified with either thoughtful and justified theoretical predictions, or relevant experimental data.

Questions – contact: James Brodrick, james.brodrick@ee.doe.gov

b. Advanced Manufacturing Processes to Reduce Soft Costs of Energy-Efficient Building Envelope Technologies for Retrofitting Existing Buildings

In residential and commercial buildings, soft costs, or balance of system (BOS) costs, include factors such as labor costs, ease of installation, transportation issues, wiring, wireless, etc. In many cases, these factors dominate the installed cost. For example, the installed cost (materials + labor) of 3.5 inches of fiberglass batt insulation to an interior wall is estimated to cost $0.57/ft^2 (Kosny 2013). The labor portion of this cost is estimated to vary from $0.43/ft^2 to $0.47/ft^2 (Kosny 2013). These soft costs must be minimized to enable the adoption of next-generation energy efficient technologies.

BOS costs are particularly important for the retrofit market. Walls, roofs, and windows make up the structure of the building. They vary widely from building to building, and as a result, retrofits must be done on a case-by-case basis. This leads to long construction times, high labor costs, and energy-efficiency improvements that have negative impacts on building performance metrics, such as indoor air quality or moisture control. BOS costs dominate the total installed costs for many sealing and insulation technologies. Possible approaches to reducing these costs include low-cost, advanced thermal insulation with reduced thickness to enable quick interior retrofits that do not require typical retrofit tasks such as rearranging outlets and re-adjusting pipes, combining exterior continuous insulation with siding or roofing products, and producing an airtight and watertight envelope with automated sealing verification.

Advanced manufacturing processes are critical to reducing the soft cost of building envelope technologies. The building envelope (walls, roofs, windows etc.) are often assembled on-site by labor-intensive, low-tech processes. Highly automated manufacturing processes could allow for modular building components to be shipped directly to the jobsite, reducing installation costs. These modular components would need to be easily shipped, and attached or integrated with the existing building structure. Ultimately, the total installed cost for a proposed technology would need to show a simple payback period of less than seven years.

Questions – contact: Karma Sawyer, karma.sawyer@ee.doe.gov

c. Integrating Advanced Whole-Building Energy Simulation into End-User Workflows and Tools

BTO is dedicated to promoting the widespread and effective use of advanced whole-building energy simulation in all aspects of the building life cycle, including early-stage and detailed design for new construction, commissioning and fault detection for existing buildings, and auditing and retrofits. BTO is interested in new products and services that leverage, support, and enhance its open-source platform consisting of the EnergyPlus whole-building energy modeling engine, the Radiance lighting engine, and the OpenStudio energy/lighting modeling software development kit (SDK).

Example projects of interest for novel solutions include:

1. New end-user tools for design, retrofit analysis, commissioning/fault-detection, and auditing. Preference will be given to tools that emphasize simplicity and low-cost/effort and target small buildings and projects.
2. Plug-ins for existing commercial software including architectural and mechanical design software.
3. Plug-ins and extensions to the current platform that extend its capabilities or link it to other analyses.
4. Support and training for the platform itself or general modeling support and training incorporating the platform.

Applicants should demonstrate a clear business plan and a compelling case for the need and viability of the proposed product or service. Applicants should detail relevant experience with energy modeling, software development, training and support, as applicable.

Questions – contact: Amir Roth, amir.roth@ee.doe.gov

4. FUEL CELLS

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

The Office of Energy Efficiency and Renewable Energy Fuel Cell Technologies Office (FCTO) http://www1.eere.energy.gov/hydrogenandfuelcells works in partnership with industry (including small businesses), academia, and DOE's national laboratories to establish fuel cell and hydrogen energy technologies as economically competitive contributors to the U.S. transportation needs. Information on FCTO priorities and future directions can be found in the FY2014 Budget overview at http://www.eere.energy.gov/office_eere/pdfs/budget/fuel cells_ataglance_2014.pdf . A detailed budget request can be found at: http://energy.gov/sites/prod/files/2013/04/f0/FY%2014%20DOE%20Budget%20-%20volume3.pdf#page=179. A roadmap for development of fuel cell and hydrogen technologies that guides FCTO investments aimed at lowering the related risks and costs can be found at, http://www1.eere.energy.gov/hydrogenandfuelcells/mypp/index.html. The FCTO aims to build from other early niche market successes in applications such as fuel cell-powered lift trucks by helping the fuel cell industry succeed in another motive power application market and thus help enable a robust domestic supply base.

The conversion of high emission, low miles per gallon heavy duty trucks into completely zero-emission vehicles represents an opportunity for fuel cell technologies. For example, there are an estimated 179,000 high emission, low mpg waste hauling trucks in the U.S fleet. A typical garbage truck travels 25,000 miles annually and gets 2.8 mpg-- the lowest average fuel efficiency of any vehicle type—and consumes ~8,600 gallons of petroleum fuel. Diesel garbage trucks are a major source of air pollutants, including smog-forming compounds, particulate matter, and toxic chemical constituents. In addition, noise can be a significant concern; for example an operating diesel garbage truck generates noise up to the 100 decibel level, which is associated with serious hearing damage.

Grant applications are sought in the following subtopic:

a. Demonstration of a Prototype Fuel Cell-Battery Electric Hybrid Truck for Waste Transportation

The FCTO seeks projects that develop and demonstrate a proof of concept for a heavy-duty fuel cell-battery electric hybrid truck for waste hauling applications. The fuel cells should be those that operate on hydrogen fuel. In Phase II DOE will seek new applications for projects that demonstrate the commercial feasibility of fuel cell – battery electric plug in hybrid trucks at waste disposal and recycling centers.. The proposals should help accelerate the development and production of cost-effective on-board, fuel cell-battery electric trucks for waste hauling powered by electric drivetrains to substantially increase the zero emission driving range and reduce battery recharging times. This topic's outcome, when fully commercialized, will dramatically reduce petroleum consumption and related emissions.

The specific vehicles of interest are commercial trucks that pick up and haul waste or recycled materials to landfills or recycling centers in their daily operations. In this small business topic, the FCTO seeks technology and business solutions that will help: establish a business case, mitigate the cost of hydrogen fuel infrastructure, and demonstrate fuel cell – battery electric hybrid truck technologies. If landfill gas is used in the proposed application, technology development and analysis indicate that landfill gas can be purified and reformed economically to transportation grade (i.e. SAE J2719) hydrogen fuel. The FCTO will NOT consider applications for the development of landfill gas and bio-methane reformation technologies under this announcement.

Expected Outcomes:

Phase 1

1. A design feasibility analysis and plan describing the power system and truck designs and specifics (e.g. cost, performance requirements, etc.) using a model analysis report by Argonne National Laboratory: "The Benefits of Using a Fuel Cell Auxiliary Power Unit to Double the Range of Current Battery Electric Vehicles," as a guide for planning hydrogen fuel consumption, cost trade-offs and other impacts of using a small fuel cell to extend the driving range of a battery electric vehicle.
2. An economic assessment, including a payback analysis, concerning the use of hydrogen-fueled PEM fuel cells for fuel cell hybrid trucks used as commercial waste hauling vehicles. Intrinsic value proposition factors should be included, such as any operations or productivity gains (e.g. avoided residential community noise, energy and petroleum fuel savings, scheduled maintenance advantages, emissions reductions and other benefits).

Phase 2

1. One (1) fuel cell power system unit (approximately10 to 30 kW) delivered and installed on commercially available battery electric waste hauling truck and tested for a minimum of100 hours of real world operations.
2. Final report describing operations testing performance results and a commercialization plan.

Questions – contact: Peter Devlin, peter.devlin@ee.doe.gov

References:

1. Facts on Greening Garbage Trucks: New Technologies for Cleaner Air. (http://www.informinc.org/fact_ggt.php).

5. GEOTHERMAL

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

The heat energy from the earth represents an enormous and underutilized domestic resource. The Office of Energy Efficiency and Renewable Energy Geothermal Technologies Office (GTO) (www1.eere.energy.gov/geothermal/) works in partnership with industry (including small businesses), academia, and DOE's National Laboratories to establish geothermal energy as an economically competitive contributor to the U.S. energy supply. Technologies for electricity generation or energy utilization from marine geothermal resources will not be considered under this topic. Information on GTO priorities and future directions can be found in the FY2014 Budget overview at http://www.eere.energy.gov/office_eere/pdfs/budget/geothermal_ataglance_2014.pdf. The detailed budget request can be found at: http://energy.gov/sites/prod/files/2013/04/f0/FY%2014%20DOE%20Budget%20-%20volume3.pdf#page=179.

A roadmap for development of geothermal exploration technologies that guides GTO R&D investments aimed at lowering the risk and cost of geothermal prospect identification can be found here, http://www.eere.energy.gov/geothermal/pdfs/exploration_technical_roadmap2013.pdf. The technology roadmap that helps guide GTO investments in Enhanced Geothermal Systems (EGS) R&D can be found here, http://www.eere.energy.gov/geothermal/pdfs/stanford_egs_technical_roadmap2013.pdf

Grant applications are sought in the following subtopic:

a. Well Construction Technologies that Reduce Energy Costs

The GTO seeks well construction technologies, excluding rock reduction (both mechanical and non-mechanical), that have the potential to contribute to reducing the levelized cost of electricity from new hydrothermal development to 6¢/kWh by 2020 and Enhanced Geothermal Systems (EGS) to 6¢/ kWh by 2030. Applications should include a clear and detailed pathway to such cost reduction using the proposed technology. Applicants should consider using the Geothermal Electricity Technology Evaluation Model (GETEM) developed by GTO to model power generation costs and the potential for technology improvements to affect these costs. Information on GETEM may be found at www.eere.energy.gov/geothermal/getem.html and information on its use is at www.eere.energy.gov/geothermal/news_detail.html?news_id=17496.

In its small business topic the GTO seeks technologies, other than rock reduction technologies, that reduce the cost of geothermal well construction. Cost analysis (e.g.

www.eere.energy.gov/geothermal/pdfs/egs_well_contruction.pdf.) indicates that reducing well costs will require multiple focus areas and non-hole making well construction activities are significant cost drivers. The GTO will NOT consider applications for the development of rock reduction technologies (i.e. drill bits, cutting structures) under this announcement.

Questions – contact: Greg Stillman, greg.stillman@ee.doe.gov

6. SOLAR

Maximum Phase I Award Amount: $225,000	*Maximum Phase II Award Amount:* $1,500,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* YES
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* YES

The DOE SunShot Initiative (www.energy.gov/SunShot) aims to achieve subsidy-free, cost competitive solar power by the end of the decade. SunShot seeks proposals for the development of innovative technologies in the areas of: (a) Software Tools for PV Soft Cost Reductions and Grid Integration, (b) Analytical Modeling and Data Aggregation, (c) Supply Chain for Concentrating Solar Power and (d) Labor Efficiencies through Hardware Innovation. Applicants are encouraged to propose deliverables that demonstrate clear progress, are aggressive but achievable, and are quantitative.

Grant applications are sought in the following subtopics:

a. Software Tools for PV Soft Cost Reductions and Grid Integration

SunShot seeks innovative, transformative information technology and software solutions that can significantly reduce photovoltaic (PV) soft costs and expedite cost–effective deployment of PV generation on the power grid.

Areas of particular interest include:

1. PV Soft Cost Reductions: With global PV module prices declining rapidly, non-hardware (soft) PV costs – such as customer acquisition, permitting, installation, inspection, interconnection, operations, and maintenance – have become a major driver of installed U.S. PV system prices. Software innovations will play a critical role in achieving SunShot's installed-system soft costs targets of $0.65/W for residential systems and $0.44/W for commercial systems by 2020. Areas of interest include, but are not limited to (i) streamlining of sales and system design aspects; (ii) expediting of permitting, installation and interconnection; (iii) optimization of interfaces between project elements; (iv) next generation site assessment and bid preparation; (v) multiple-owner, multiple-tenant and crowd funded business models; (vi) standardization; and (vii) automation.

2. Grid Integration: Advanced software to interface with existing hardware systems is sought to (i) aggregate, visualize, analyze and control multiple PV generation at the distribution feeder, substation and sub-transmission level in real-time; (ii) synchronize and manage integrated PV resources at the distribution level; (iii) collect, analyze and process enormous amount of feeder, load and PV data in real-time; and (iv) expedite the utility PV interconnection technical screening

process. Proposals for advanced open source and enterprise tools to automate data exchange between PV and utility software systems and promote interoperability between existing utility legacy software and new systems are also encouraged. Emerging bulk transmission and dynamic distribution engineering analysis software combined with innovative hardware systems for data acquisition, predictive analysis, and real-time visualization, enables the utility to quickly and effectively model aggregated PV grid impacts, recommend mitigation solutions, and provide advanced capabilities for system planning and grid operations with high penetration of PV. Consequently, with these innovative tools, utility concerns about the uncertainty of PV impact on the grid are significantly decrease thereby allowing higher level of PV penetration to be integrated on the distribution system. In addition, these advanced tools can significantly reduce the expensive interconnection study fees paid by developers, reduce turnaround time for initial determination, allows more PV to pass the interconnection screens, and ultimately expedite the interconnection and cost-effective deployment of PV generation on the distribution and transmission system.

Questions – contact: solar.sbir@ee.doe.gov

b. Analytical and Numerical Modeling and Data Aggregation

The capability to efficiently collect, store, manipulate, and visualize vast, diverse, and complex streams of data can transform the operations of stakeholders throughout the solar value chain: from electric utilities managing distributed generation on their infrastructure; to solar fleet operators designing maintenance schedules; to solar sales lead generations seeking to reduce customer acquisition soft costs. The development of innovative data and simulation tools is sought under this topic area. Tools should provide actionable insights; use existing datasets or collect non-redundant datasets; and advance state-of-the-art modeling and visualization techniques. Areas of interest include, but are not limited to: (1) predictive analytics applied to solar resource forecasting, accurate technology adoption prediction, or operation and maintenance modeling; (2) advanced verification and validation tools; (3) novel techniques of and methods for capturing, aggregating, and analyzing structured or unstructured datasets; (4) aggregation and anonymization of solar performance and reliability data of residential, commercial, and utility scale installations (along with requisite metadata) to assign actionable, credible statistics for financiers; (5) consumer-facing decision-making platforms leveraging social and new media; and (6) incorporation of nearly real-time energy consumption data (e.g., applying smart meter data) . Areas not of interest include device-level modeling. Applicants must quantify the impact of the proposed research and justify the economic viability of the proposed product.

Questions – solar.sbir@ee.doe.gov

c. Supply Chain for Concentrating Solar Power

Areas of particular interest include:

1. Molten Salt Flexible and Rotating Couplings: Flexible pipe couplings suitable for molten salt heat transfer fluid (HTF) in Concentrating Solar Power (CSP) parabolic troughs are currently not commercially available for utility power generation applications. This one critical component is a key solution to enable a significant reduction in the levelized cost of electricity (LCOE) for CSP parabolic trough technology. Currently parabolic trough is the most prevalent CSP technology with

over 1 GW installed in the United States and an additional global installed capacity of almost 2 GW. This technology, as deployed today, uses oil as a heat transfer fluid which is limited to maximum temperature of approximately 400ºC. Molten salt HTF such as Sodium Nitrate / Potassium Nitrate blends has a temperature operating range between 250 to 600ºC, and lower operating temperature blends with Sodium Nitrite or Calcium Nitrate can operate between 150 to 500ºC. Numerous studies have concluded that the use of molten salt heat transfer fluid at temperatures between 450ºC to 550ºC will significantly improve efficiency and reduce the cost of thermal energy storage leading to substantial reductions in levelized cost of electricity for parabolic trough technology. This solicitation seeks applications for the development and demonstration of flexible pipe couplers suitable for a 30 year service life operation in a CSP parabolic trough plant using molten salt HTF at operating temperatures up to 550ºC.

2. <u>CSP Mirror Cleaning Systems</u>: Mirror soiling in Concentrating Solar Power (CSP) plants currently contributes to approximately a 5% loss in potential annual energy production. This translates directly to lost revenue or requires additional capital to oversize the CSP collector field capacity. Mirror cleaning maintenance costs are estimated to account for over half of the operation and maintenance (O&M) costs of a CSP facility which translates to approximately ½¢/kWh of the levelized cost of electricity (LCOE) and may account for 10% of the annual water consumption. This solicitation seeks applications for the development and demonstration of systems to improve the annual average trough and heliostat mirror reflectivity while reducing cost and water consumption of this operation. Solutions which may be considered for this solicitation may include but are not limited to intelligent sensing, soil resistant surfaces, robotic or other automated systems to remove soil from mirrors while eliminating or recapturing water. It is expected that such systems remain cost effective with a 30 year service life, 95% availability while maintaining the performance and service life of CSP collector field mirrors above 95% of their original performance.

Questions – contact: solar.sbir@ee.doe.gov

d. Labor Efficiencies through Hardware Innovation

Installing a photovoltaic (PV) system requires both electrician and non-electrician labor and includes assembling the module, racking and mounting or ballasting it, running conduit, and connecting the inverter, meter, and disconnect. In the United States, streamlining installations is complicated by the heterogeneity of installation platforms, component materials, electric systems, and utility requirements. Optimizing system performance typically requires customizing both system design and installation.

Hardware innovations are sought to reduce installation labor costs by increasing labor efficiency or reducing the process complexity required to install a PV system. <u>Installation cost reduction opportunities include</u>: (1) integrated racking, which reduces balance of system hardware; (2) module-integrated electronics, which reduces cable runs; (3) prefabrication, which streamlines installation; and (4) 1,000-volt direct current technologies, which enables more modules wired together per string. The proposed innovation must be sufficiently differentiated with respect to existing commercial products or solutions. Applicants must quantify achievable cost reductions and justify the economic viability of the proposed product assuming near term (< 5 years) industry deployment.

Achieving the SunShot price target requires a decrease in total commercial installation labor costs from $0.42/W in 2010 to $0.07/W by 2020 ($0.59/W to $0.12/W for residential systems).

Questions – contact: solar.sbir@ee.doe.gov

7. VEHICLES

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

EERE's Vehicles Technologies Offices (VTO) (www1.eere.energy.gov/vehiclesandfuels/) is focused on developing technologies to enable average new vehicle fuel economy of more than 60 miles per gallon for cars and more than 43 miles per gallon for trucks by 2025. Proposals deemed to be duplicative of research that is already in progress, or similar to proposals already reviewed this year will not be funded; therefore all submissions should clearly explain how the proposed work differs from other similar work in the field.

Grant applications are sought in the following subtopics:

a. Electric Drive Vehicle Batteries

Applicants are sought to develop electrochemical energy storage technologies which support commercialization of micro, mild, and full HEVs, PHEVs, and EVs. Some specific improvements which are of interest, but are not limited to, include: new low-cost materials, high voltage and high temperature non-carbonate electrolytes, improvements in manufacturing processes, speed or yield, improved cell/pack design minimizing inactive material, significant improvement in specific energy (Wh/kg) or energy density (Wh/L), and improved safety. Proposals must clearly demonstrate how they advance the current state of the art and address the relevant performance metrics listed at www.uscar.org/guest/article_view.php?articles_id=85.

When appropriate, evaluation of the technology should be performed in accordance with applicable test procedures or recommended practices as published by the Department of Energy (DOE) and the U.S Advanced Battery Consortium (USABC). These test procedures can be found at, www.uscar.org/guest/article_view.php?articles_id=86. Phase 1 feasibility studies must be evaluated in full cells (not half cells) greater than 200mAh in size while Phase II technologies should be demonstrated in full cells greater than 2Ah. Proposals will be deemed non-responsive if the proposed technology is prohibitive to market penetration due to high cost; requires substantial infrastructure investments or industry standardization to be commercially viable; cannot accept high power recharge pulses from regenerative breaking.

Questions – contact: Brian Cunningham, brian.cunningham@ee.doe.gov

b. Lightweight Materials

Applications are sought to develop and demonstrate unique lightweight metals and metal forming processes that support weight reduction in passenger and commercial vehicles. Applications must include metal alloys with greater than 60% Fe, Al, Mg, or Ti by weight, and must demonstrate that the proposed materials and processes can yield a weight savings of greater than 30% at a cost of less than $2.00 per pound of weight saved when compared to a standard baseline vehicle material and component. Applications should emphasize production and/or forming of metal components, but should not include joining or assembly. Traditional materials and processes are not desired - the application should clearly explain how the proposed technology differs substantially from existing light-metals and processes, or other work in the field. In particular, incremental modifications to known alloys, forming processes, or casting processes are not desired.

Questions – contact: William Joost, william.joost@ee.doe.gov

c. Electric Drive Vehicle Power Electronics Subcomponents

Power electronic inverters and converters are essential for electric drive vehicle operation, and currently add significant cost to these vehicles, therefore limiting their commercialization potential. Improvements in their performance can lead to cost reduction or better utilization of their capabilities in vehicles, as outlined in the U.S. DRIVE partnership Electrical and Electronics Technical Team Roadmap (http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/eett_roadmap_12-7-10.pdf).

Specifically, improvements are sought for magnetic materials that are used for inductors and magnetic subcomponents in vehicle power electronics such as inverters, converters, and on-board chargers. Improvements of interest are reduction in size, weight, losses, and cost relative to current state of the art used in production vehicle power electronics. Materials should be able to withstand operation in a vehicle environment, with ambient temperatures of up to 150°C and no dedicated cooling provided.

Phase I efforts should involve the development and validation of the proposed technology or material with demonstrated performance under simulated operating conditions. In Phase II, the technology should be further advanced and demonstrated through the production of prototype devices.

Questions – contact: Steven Boyd, steven.boyd@ee.doe.gov

d. Injector Spray Imaging Techniques

Gasoline direct injection engine and diesel engine fuel injector spray structures can have a significant effect on both the fuel economy and the exhaust emissions of modern vehicle engines. Advanced imaging and visualization concepts are sought that characterize both the liquid spray structures and the pre-ignition vapor phase of the fuel within internal combustion engine cylinders.

The Phase I effort should involve the development and validation of the proposed technology under in-cylinder, pre-combustion operating conditions. Characterizing the liquid and vapor at laboratory ambient temperature and pressure is sufficient for Phase I. In Phase II, the technology should be further advanced and demonstrated through the construction of a prototype system device capable of characterizing the liquid spray and vapor distribution of actual in-cylinder, pre-combustion, fuel injections from common fuel injectors, under normal operating conditions in a laboratory environment. All submissions should clearly explain how the proposed work differs from other, similar work in the field. Promising new techniques which have been used in other, non-automotive research fields are highly desirable.

Questions – contact: Leo Breton, leo.breton@ee.doe.gov

e. Advanced Ignition Concepts

Lean-burn combustion in gasoline engines introduces physical conditions that severely impede reliable ignition of fuel-air mixtures.

For Phase I advanced ignition concepts are sought that:

1. Extend the lean ignition limit to an air/fuel ratio > 20;
2. Enable reliable ignition under high in-cylinder pressures (up to 100 bar at the time of ignition) thus enabling high load operation;
3. Enable operation under high levels of exhaust gas recirculation; and
4. Lower or maintain ignitability as measured by a coefficient of variance of IMEP < 3%. Advanced ignition systems such as laser ignition, microwave ignition, plasma jet ignition, or those using advanced concepts such as pulse trains, pre-chamber spark plugs, etc. are considered typical candidates for this effort.

Questions – contact: Leo Breton, leo.breton@ee.doe.gov

f. Engine/Driveline Friction Reduction

Proposals are sought to develop innovative technologies to enable the reduction of friction in engine/driveline systems of existing vehicles through advanced lubricants. Technology must be able to be used as a drop-in or be retrofitted into existing on-road vehicles and demonstrate at least a 3% reduction in energy required to propel the vehicle. Engine lubricants, manual transmission lubricants, and axle/gear lubricants are acceptable applications. The comparison lubricant used as a baseline for demonstration/justification of the 3% fuel efficiency improvement should be commercially available, state-of-the-art technology for the intended application, e.g., GF-5 oil for gasoline engine applications or CJ-4 oil for diesel engine applications. Axle and transmission lubricants should also employ current, best-available technology as a baseline for demonstrating/justifying the proposed technology results in a 3% fuel efficiency improvement.

Applications containing the following strategies shall be considered nonresponsive to subtopic f, (Engine/Driveline Friction Reduction) and will not be reviewed:

Formulations (1) that simply lower the viscosity of the lubricant without regard for increased solid-solid contact; (2) that aren't expected to show a fuel efficiency improvement within the first 4000 miles or 50 hours of engine operation; (3) that are exclusively for use in off-road (rail, marine, construction, small engines) or motorcycle applications; (4) that are exclusively for alternative fuel applications; (5) that increase wear or reduce component durability; (6) that are not compatible with existing emissions control systems and (7) that are exclusively for automatic transmissions.

Projects focused mainly on production methods for lubricants.

Questions – contact: Steven Przesmitzki, steven.przesmitzki@ee.doe.gov

8. WIND

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

The Office of Energy Efficiency and Renewable Energy's Wind Technology Office (www.eere.energy.gov/wind/) seeks proposals for innovations that significantly advance the goal of large cost reductions in the deployment of U.S. wind power resources, including (a) Tower and Foundation Systems for Small Wind Turbine Technology and (b) Avian and Bat Monitoring Technologies and Methods For Offshore Wind Facilities and (c) US Offshore Wind O&M Vessels Personnel and Equipment Transfer System.

Grant applications are sought in the following subtopics:

a. Tower and Foundation Systems for Small Wind Turbine Technology

Increasing tower height is a means for increasing turbine performance; however, tower and foundation system design, including hardware as well as transportation and installation considerations, are significant cost drivers for small wind turbine technology. Specifically, for small wind turbine designs, as defined by AWEA 9.1-2009, self-supporting monopole towers can account for as much as 50% of total installed cost. Guyed and lattice tower designs can offer a lower cost alternative, but are typically considered to be less desirable for aesthetic reasons. A new generation of innovative, rapidly installed self-supporting monopole systems or other novel concepts that can be economically manufactured and deployed could significantly lower costs and increase deployment.

Grant applications are sought for new technologies that can provide low-cost, easily deployable tower and foundation systems for small wind turbine technology.

Grant applications must:

1. Address small wind turbines, as defined by AWEA 9.1-2009;
2. Propose to develop towers and foundations designed to IEC 61400-2 standards;
3. Propose to develop towers that reach a minimum hub height of 35 meters;
4. Provide baseline cost data for a state of the art self-supporting monopole tower and foundation design; and
5. Demonstrate a clear cost reduction from the existing state of the art.

Questions – contact: Shreyas Ananthan, shreyas.ananthan@ee.doe.gov

b. Avian and Bat Monitoring Technologies and Methods for Offshore Wind Facilities

Understanding the interactions between offshore wind facilities and sensitive wildlife will be critical for projects to obtain regulatory approval; however, monitoring the impacts of offshore wind on birds and bats poses a number of challenges associated with collecting data remotely in marine environments. While some instrumentation already exists to monitor issues such as bird and bat strike or avoidance of/attraction to wind turbines, many of these approaches are not perfected, or remain untested in the marine environment. In order to fully assess the effects of offshore wind farms on these species, improvements are needed in device automation, performance, and survivability in the marine environment, as well as in data processing techniques. Thus, innovation is required to improve the effectiveness of monitoring systems for offshore wind deployments to generate accurate, quality datasets that can be used to reduce uncertainty by effectively characterizing risk to wildlife and informing regulatory decision-making.

Grant applications are sought for new technologies that can provide low-cost, easily deployable environmental monitoring systems for offshore wind deployments to assess bird and bat interactions with offshore wind farms. Applications should focus on innovative technologies that monitor incidence of collision with wind turbines, or that improve detection of organisms to assess behavior of birds around turbines, particularly to understand whether birds are avoiding the area (macro and/or micro-avoidance), or habituating to the presence of offshore wind turbines. Advances could be made in several areas, including accuracy or range improvements for camera or radar systems, marinization of existing devices, or advancements in processing capabilities, including, but not limited to algorithm development for improved image detection, reduced post-processing time requirements, or improved system operation controls. While land-based testing may occur as part of the device development process, ultimately these devices should be designed for the offshore wind market.

Applications should include a thorough description of the current strengths and limitations of the technologies they are seeking to advance and a discussion on if and how the work proposed will affect each of these variables, including spatial and temporal resolution, data bandwidth, storage and transfer, survivability in marine environments, and data processing time and cost. Importantly, since environmental regulations are species-specific, applications should address current device ability to distinguish between species and whether and how the proposal will enhance this capability.

Applicants must demonstrate both of the following in their applications:

1. Proposed research will provide results that will substantially reduce regulatory and environmental risks to future projects facing similar issues by substantially reducing the costs and/or enhancing environmental monitoring capabilities. If the technology proposed is currently not cost competitive with alternatives, a credible pathway to cost competitiveness must be demonstrated.

2. To the extent that device testing will occur under this award, the proposed studies should actively incorporate the input of and demonstrate buy-in from relevant federal and/or state regulatory and resource management agencies, project developers, and/or any other stakeholders whose participation will be critical to the effective execution of the testing.

Specific deliverables will include a final technical report, which contains a detailed technical summary of all performed tasks. This technical report should include a section with user instructions and suggested methodology for monitoring strike at offshore wind farms.

Questions – contact: Patrick Gilman, patrick.gilman@go.doe.gov

c. US Offshore Wind O&M Vessels Personnel and Equipment Transfer System

While lessons learned from the experiences of the European offshore wind farms will help shape the US offshore wind industry, environmental conditions in each location vary. As seen in the offshore oil and gas industry, vessels may be purposefully designed for their intended area of operability. For example, although much can be learned from the vessels and experiences in the Gulf of Mexico, vessels have been specifically designed to operate in the North Sea conditions. In the National Offshore Wind Strategy, the DOE has committed to addressing supply chain development, including specialized vessels and other operations and maintenance technology. The specialized infrastructure required to operate offshore wind farms cost-effectively, such as purpose-built vessels, does not currently exist in the U.S. To support a world-leading domestic offshore wind industry, technical solutions should be optimized for the proposed site conditions.

Although operational and maintenance tasks may be similar, an optimized technical solution to transport and deliver personnel and equipment may be different. Vessels and supporting systems designed to service offshore wind farms in the North Sea may be overbuilt and more expensive than a vessel or system necessary for a US offshore wind farm. From the NREL 2013, "Installation, Operations and Maintenance Strategies to Reduce the Cost of Offshore Wind Energy" technical report, current technology in Europe restricts the operational window of O&M vessels to waves less than 1-1.5m, resulting in a wind farm accessibility of 40-60% in the North Sea. The low accessibility can reduce the wind farm availability which can lead to increased O&M costs as well as a reduction in revenue due to power losses.

Grant applications are sought for the design of a personnel and/or equipment transfer system to be retrofitted into an existing US flagged vessel or integrated into a purpose built US flagged vessel to service future US offshore wind farms. This system should result in increased accessibility of the wind farm and achieve wind farm availability of greater than 95%. Crew transfers can be made to either the service platform or the access ladder while equipment transfers should be made to the service platform. Grant applications should: 1) indicate a vessel class or type on which the technology would be installed, 2) describe the transfer system technology and its vessel integration, 3) include preliminary drawings of the proposed transfer system and vessel integration, 4) indicate the intended service area, 5) present statistical wave conditions for the intended service area, and 6) establish the environmental conditions in which the system is operable and demonstrate the increase in the wind farm's availability.

Questions – contact: Greg Matzat, greg.matzat@ee.doe.gov

9. TECHNOLOGY TRANSFER OPPORTUNITY: ENERGY EFFICIENCY AND RENEWABLE ENERGY

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $ 1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

Applicants to Technology Transfer Opportunities (TTO) should review the section describing Technology Transfer Opportunities on *page 6* *of this document prior to submitting applications.*

Grant applications are sought in the following subtopics:

a. Cost-Effective Membrane Electrode Assemblies Utilizing Novel Membranes and Non-Platinum Group Metal Catalysts for Direct Methanol Fuel Cells

Development of cost-effective membrane electrode assemblies (MEAs) lies on the critical path for the implementation of many technologies of strategic importance. Presently-available membranes are not optimal for use with fuels such as methanol or liquid fuel systems due to cross-over of organic fuel to the other electrode as well as cross-over of water and oxygen which may contaminate the liquid fuel. Poisoning of the catalysts on electrodes resulting from reaction of the organic materials on the electrodes is a major problem and the cost of presently available catalyst systems is a major obstacle to broader implementation of the technology. There exists then considerable opportunity to modify and replace existing membranes to improve performance as well as to improve the performance of the electrodes in the MEA. Improvement is defined as increasing the operating voltage and current density (power density) by: 1) modification of the electrode structure to optimize for liquid fuel behavior; 2) minimization of the catalyst loading using presently available commercial catalysts to significantly reduce cost while maintaining performance; and 3) replacement of the platinum group metal catalysts with inexpensive transition metal or organic catalysts mounted in novel electrode structures that provide the desired performance at much reduced costs.

The work that is envisioned between the SBIR/STTR grantee and LBNL would involve Technical Transfer of several LBNL IP properties - IB-3169, (http://www.lbl.gov/tt/techs/lbnl3169.html), IB-1553 and IB-1554 (http://www.lbl.gov/Tech-Transfer/techs/lbnl1553.html) and with a possible application of IB-1618 (http://www.lbl.gov/tt/techs/lbnl1618.html). The objective is to lower the cost and improve the durability and performance of direct methanol fuel cells for a range of applications including back-up power and other stationary power applications. The SBIR/STTR grantee will contribute to development of MEA manufacturing methods, scale-up and cell stack development and testing. The SBIR/STTR grantee will perform field testing, failure analysis and iterative product improvement and durability testing.

Lawrence Berkeley National Laboratory Information:
TTO tracking number: IB-1553, IB-554, IB-1618, IB-3169
Contact: Shanshan Li, 510-486-5366, shanshanli@lbl.gov

DOE Contact: Dimitrios Papageorgopoulos, dimitrios.papageorgopoulos@ee.doe.gov

b. Durable Membrane Electrode Assemblies for Polymer Electrolyte Membrane Fuel Cell Applications

Conventional polymer electrolyte membrane (PEM) fuel cell technology suffers from a lack of durability, high manufacturing costs, and rapid performance degradation. These factors overshadow the technology's potential benefits and have prevented fuel cells from entering the mainstream automobile, portable electronics, and power generation markets in which customers are price sensitive and selective in their purchases of durable goods. A revolutionary method of building a membrane electrode assembly (MEA) for PEM fuel cells has been developed by Los Alamos National Laboratory (LANL) scientists that can significantly increase durability, reduce manufacturing costs, and extend the lifetime of a fuel cell product. This method incorporates a unique polymer dispersion that can be applied to both perfluorinated sulfonic acid (PFSA) and hydrocarbon-based MEAs to produce superior electrode performance, stability, and durability during harsh fuel cell operating conditions.

The LANL-produced MEA has been evaluated and certified using an Accelerated Stress Test (AST) developed by the DOE in conjunction with car manufacturers. The AST was developed to study the durability of state of-the-art MEAs and includes challenging performance targets (e.g. voltage losses of 0.8 A/cm2 less than 30 mV after potential cycling from 0.6 to 1.0 V for 30,000 cycles at 80°C). When comparing the results of the AST from a premier manufacturer's commercially available MEA versus LANL's novel MEA, the commercially available MEA did not meet the target after 30,000 cycles. However, voltage loss of LANL's MEA still remained below 30 mV even after 70,000 cycles. Results obtained from two other commercially available PFSA dispersions also fell short of the DOE's target with 48 and 33 mV losses after 30,000 cycles. In addition the LANL MEA fabrication process utilizes a novel swelling agent that significantly lowers hot pressing temperatures and improves the interfacial stability of the MEA.

The work that is envisioned between the SBIR/STTR grantee and LANL would involve Technical Transfer of LANL IP on non-aqueous liquid compositions comprising ion exchange polymers (U.S. Patents 7981319; 8394298; 8236207) and on advanced MEAs for fuel cells (U.S. Patent No. 8227147).

Los Alamos National Laboratory Information:
TTO tracking numbers: S104819, S116252, S121243, S121863
Contact: Mariann Johnston, 505-667-4391, mjohnston@lanl.gov,

DOE Contact: Dimitrios Papageorgopoulos, dimitrios.papageorgopoulos@ee.doe.gov

PROGRAM AREA OVERVIEW – OFFICE OF FOSSIL ENERGY

Fossil fuels are projected to remain the mainstay of energy consumption (currently 80% of U.S. energy consumption) well into the next century. Consequently, the availability of these fuels, and their ability to provide clean affordable energy, is essential for global prosperity and security. As the nation strives to reduce its reliance on imported energy sources, the DOE's Office of Fossil Energy (FE) supports R&D to help ensure that new technologies and methodologies will be in place to promote the efficient and environmentally sound use of America's abundant fossil fuels. As the economy expands, and the demand for hydrocarbons increases accordingly, FE seeks to develop advanced fossil energy technologies that are reliable, efficient, environmentally sound, and economically competitive.

Particular attention will be focused on finding new ways to extract the power from coal – America's largest domestic energy resource – while simultaneously expanding environmental protection and confronting the issue of global climate change. Key R&D programs include: 1) Crosscutting research including materials, sensors, monitors, controls, computational processes, and new concepts that will be needed for these technologies to be commercially competitive; 2) Advanced energy systems including developments in advanced gasification technologies such as gas separation membranes, gas cleanup, clean fuels including hydrogen, synthetic natural gas, and ultra clean liquid fuels; advanced combustion including oxy-combustion, improved turbines and solid oxide fuel cells for future coal-based combined cycle plants; 3) Carbon capture including innovations for new and existing power plants and industrial sources such as technologies that can capture, separate, and transport greenhouse gases; 4) Carbon storage including geologic storage, monitoring and beneficial reuse and; 5) Oil and gas technologies including improvements in our ability to recover oil, natural gas, methane hydrates, and shale gas as well as environmental, safety and risk assessment studies.

Approximately two-thirds of our national petroleum reserve is "unrecoverable"; it cannot be extracted economically by conventional means. This unused resource could play a major role in supplementing the national petroleum supply if efficient approaches were developed for improved extraction. Natural gas production and utilization could also be increased through improved characterization of reserves and through better infrastructure. The most plentiful supplies of natural gas throughout the world may be the methane molecules trapped in ice-like structures called hydrates. Therefore, FE supports research to help unlock the mysteries of hydrates and develop future ways to tap their massive energy potential.

For additional information regarding the Office of Fossil Energy priorities, click here.

10. CROSSCUTTING RESEARCH

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

The Crosscutting Research Program within the DOE National Energy Technology Laboratory's (NETL) Office of Coal and Power R&D fosters the development of innovative, cost-effective technologies for improving the efficiency and environmental performance of advanced coal and power systems. In addition, Crosscutting Research (CCR) bridges the gap between fundamental research and applied development to offer technology alternatives that enable the scale-up and deployment of advanced energy systems. The CCR program encompasses three major subprograms: Sensors and Controls Innovations; High Performance Materials; and Computational Energy Sciences.

The implementation of sensors and advanced controls in power systems can provide valuable methods to improve operational efficiency, reduce emissions, and lower operating costs. These sensors and controls must provide reliable and consistent data, longevity of use, and ease of calibration. However, it has been a challenge to develop sensors and controls that are able to endure the harsh environments associated with advanced power systems. This environment includes high temperatures (800-1500°C), high pressures (500-1000 psi), and corrosion due to reactive process streams.

The high performance materials research area encompasses a range of new materials development including functional materials, coatings, and new alloys. New materials development targets mechanistic understanding and enhanced performance of the materials so that thermal, chemical, and mechanical properties of the materials support the desired operational temperatures, pressures, and reliability needed for highly efficient advanced power systems.

Computational Energy Sciences is a comprehensive program aimed at developing and applying computational tools to address issues, explore new concepts, and analyze energy options in a virtual environment with the overall goal of reducing the time from concept to application and lowering the risk and cost associated with scale-up of novel concepts.

Grant applications are sought in the following subtopics:

a. New Alloy Development

New alloy development is sought to enable advanced power systems to operate with increased efficiencies. The need for alloys is driven by the hostile conditions created when fossil fuels are converted to energy. These conditions include high temperatures, elevated pressures, and corrosive environments (reducing conditions, gaseous alkali). Examples of advanced power cycles where new alloys are needed include:

1. Advanced Ultra-Super Critical (AUSC) steam power plant cycles operating at steam conditions of 760°C and 5000 psi.
2. Oxy-fueled combustion systems where components will be exposed to high concentrations of CO_2 and steam.

Grant applications are sought for the development of new alloys that will enable the deployment of the aforementioned advanced power generation technologies in the next 5 – 20 years. Research in the following areas is specifically solicited:

1. Development of high chromium, low nickel ferritic alloys with high creep resistance at 700 to 760°C. These alloys would be low cost alternatives to nickel superalloys and the high end stainless steels.
2. Development of more efficient, accurate, and user friendly computational methods for the long term (to 300,000 hrs. operating life) prediction of materials behavior (e.g. base alloys and weldments) in the fossil energy systems described above.

Questions – contact: Richard Dunst, richard.dunst@netl.doe.gov

b. Fabrication of High Temperature Materials

New processing methods and other materials technologies are required to enable the development of new fossil energy power generation systems with increased efficiencies. The Fossil Energy Materials Program conducts research and development on high-performance materials for longer-term fossil energy applications. The program is concerned with operation in the hostile conditions created when fossil fuels are converted to energy. These conditions include high temperatures, elevated pressures, and corrosive environments (reducing and oxidizing conditions, steam, acid gases and gaseous alkali salts). Examples of such environments are:

1. Advanced Ultra-Super Critical (AUSC) steam power plant cycles operating at steam conditions of 760°C and 5000 psi.
2. Oxy-fueled combustion systems where components will be exposed to high concentrations of CO2 and steam.

Grant applications are sought for the development of manufacturing technologies that will enable the deployment of the aforementioned fossil energy power generation technologies in the next 5 – 20 years. Research in the following areas is specifically solicited:

1. Methods of economically producing Oxide Dispersion Strengthened (ODS) alloy components for advanced high temperature fossil energy systems.
2. Production of boiler tubing with durable protective coatings. Both fireside (outside of the tube) and steamside (inside the pipe) coatings for operation at 760°C are of interest.
3. New or improved joining and welding methods for high temperature creep resistant steels (such as T/P23 and 24, T/P91 and 92) that will reduce the current cost of welding and post weld heat treatment these alloys, and reduce or eliminate the occurrence of premature weld failures (e.g., Type IV cracking of P91 steel weldments) that occurs in fossil energy power generation systems, such as coal fired boilers.

Questions – contact: Richard Dunst, richard.dunst@netl.doe.gov

c. High Temperature Solids Circulation Rate Measurements

Devices to accurately measure the solid flow rate of an operating gas-solid system, particularly at high temperature, are limited. Applications are sought for the development and demonstration of a sensor for measuring solid circulation rates in typical power generation multiphase flow processes at high temperature (>750°C). The knowledge of this parameter at sufficient sampling rates (1Hz) and at accuracies of +/- 5% or less will significantly help in optimization and control of multiphase systems including, but not limited to, Circulating Fluidized Bed combustors and gasifiers.

The ability to quantify the uncertainty of the measurement being made must be described within the application. Approaches that infer solid circulation rates based upon measured pressure drops across a given volume are not of interest under this subtopic. Both the development of new devices and refinement to existing devices that show improvement in accuracy, operating temperature range, or reduced cost over existing technologies are desired. This project should produce an end user product. The demonstration of a laboratory scale prototype should be the minimum end goal of any proposed project.

Questions – contact: Robie Lewis, robie.lewis@netl.doe.gov

d. Physics-based Computational Models for Multi-Phase Flows

Multiphase flow is prevalent in fossil fuel processes, appearing in processes such as coal gasifiers, reactors used for post- and pre-combustion CO_2 capture, and emerging technologies such as chemical looping combustion that help efficient CO_2 separation. It is necessary to reduce the cost and time required to scale-up such reactors, and physics-based or computational fluid dynamic (CFD) models are sought to help with the scale-up. The flows in multiphase reactors invariably span multiple time and length scales and pose enormous computational and experimental challenges. For example, the granular flow in a fluidized bed may range from incompressible to hypersonic, while the granular media may undergo a phase change similar to a gas-to-solid transition, all within the same reactor. The volume fraction, stress, and energy typically fluctuate spatially and temporally with amplitudes comparable to the mean. The interaction of the phases with boundaries is often complex and poorly understood. Because multiphase flows may not exhibit a clear separation among the spatial and temporal micro-, meso-, and macro- scales, advanced multi-scale theories may be needed to analyze them. Therefore, it is a critical to understand and be able to model multiphase devices for building highly efficient, near-zero emission fossil energy plants (Refer to the 2006 Workshop Report1). A number of commercial and open-source CFD software is available for modeling multiphase flows. Yet there remains a gap in the software available for conducting fast simulations, required for the conceptual design of devices. The speed is achieved with physics-based model reduction approaches.

Applications are sought for developing such software that will accelerate the speed of simulations with the help of physics-based reduced order models, hybridization of models, or improvements in numerical algorithms that exploit the physics. Hybridization includes, but is not limited to, the use of two-fluid models (TFM) with discrete element models (DEM); that is, use a TFM approach wherever TFM can be used, but switch to a DEM description of solids wherever TFM fails to provide the desired accuracy. A preliminary implementation of this method is available in the open-source code MFIX (http://mfix.netl.doe.gov). These models must demonstrate at least a 10x speed up from conventional CFD software. It will be necessary to be able to estimate the reduction in accuracy, if any, resulting from model reduction. Applications must also demonstrate the ability to model flow densities and characteristics comparable to typical fluid bed reactors found in power systems. Applications that implement data-based reduced order models are not sought, and will be discounted.

Questions – contact: Steven Seachman, steven.seachman@netl.doe.gov

e. Other

In addition to the specific subtopics listed above, the Department invites grant applications in other areas that fall within the scope of the topic description above.

Questions – contact: Robie Lewis, robie.lewis@netl.doe.gov

References:

Subtopics a and b:

1. Romanosky, R., 26th Annual Conference on Fossil Energy Materials. 2012. (http://www.netl.doe.gov/publications/proceedings/12/fossil_energy_materials/pdf/Tue/Romanosky.%2026th%20Annual%20Fossil%20Energy%20Materials%20Conference_Fi.pdf).
2. Conrad, R., 26th Annual Conference on Fossil Energy Materials. 2012. (http://www.netl.doe.gov/publications/proceedings/12/fossil_energy_materials/pdf/Thu/Conrad.FE%20Presentation%20for%20Materials%20Conference%20Apr%202012.pdf).
3. National Research Council report, "Integrated Computational Materials Engineering: A Transformational Discipline for Improved Competitiveness and National Security", National Academies Press. 2008. Available from http://www.nap.edu/catalog.php?record_id=12199.
4. Panchal, J.H. et al, "Key Computational Modeling Issues in Integrated Computational Materials Engineering", Computer Aided Design. 2013. Vol. 45, pp. 4-25. Available from http://www.sciencedirect.com/science/article/pii/S0010448512001352.
5. Parker, Jonathan, "Factors Affecting Type IV Creep Damage in Grade 91 Steel Welds", Materials Science & Engineering A. 2013. Vol. 578, pp. 430-437. Available from http://www.sciencedirect.com/science/article/pii/S0921509313004279.

Subtopic c:

1. "Use of piezoelectric pressure transducers to determine local solids mass flux in the riser of a cold flow circulating fluidized bed." October 2010. Available from http://www.sciencedirect.com/science/article/pii/S0032591010001592.
2. "Improvement of continuous solid circulation rate measurement in a cold flow circulating fluidized bed." March 2008. Available from http://www.sciencedirect.com/science/article/pii/S0032591007003312.

Subtopic d:

1. "Report on Workshop on Multiphase Flow Research, Morgantown, WV, June 6-7, 2006," ed. M. Syamlal. DOE/NETL-2007/1259. December 2006. Available from http://www.netl.doe.gov/events/06conferences/mfr_workshop/Multiphase%20Workshop%20Report%206.pdf.

11. ADVANCED ENERGY SYSTEMS

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

The U.S. DOE Office of Fossil Energy's Advanced Energy Systems Program (AES) is developing a new generation of clean coal-fueled energy conversion systems capable of producing competitively priced electric power while reducing carbon dioxide (CO_2) emissions, with a focus on improving efficiency, increasing plant availability, reducing cooling water requirements, and achieving ultra-low emissions of traditional pollutants. A key aspect of this area of research is targeted at improving overall system thermal efficiency, reducing capital and operating costs, and enabling affordable CO_2 capture. Key technology areas of AES are:

1. The Gasification technology area is focused on converting coal into clean synthesis gas (syngas) that can in turn be converted into electricity, chemicals, hydrogen, and liquid fuels to suit market needs.
2. The Hydrogen Turbines technology area is focused on developing advanced technology for the hydrogen-fueled gas turbine component in Integrated Gasification Combined Cycle (IGCC) plants configured for carbon capture.
3. The Solid Oxide Fuel Cells technology area is focused on developing low-cost, reliable SOFC technology suitable for deployment in advanced Integrated Gasification Fuel Cell (IGFC) systems configured for carbon capture.
4. The Advanced Combustion technology area is focused on new high-temperature materials and the continued development of high-efficiency oxy-combustion technologies amenable to lower cost carbon capture.

Grant applications are sought in the following subtopics: (one for each AES technology area noted above)

a. Advanced Oxygen Separation Technology for Power and Fuels Production and Co-Production Applications

Applications are invited for novel technologies to produce oxygen beyond the current benchmarks of performance and cost of existing commercial technologies. Proposed technologies must be suitable for use in co-production configurations. The target oxygen production rate must be sufficient to support oxygen-intensive industrial applications, such as energy production, steel, cement, glass, etc. DOE is interested in projects that will conduct physical experiments to develop and test the proposed technology, along with economic analyses to validate the technology's potential economic benefits. Examples of air separation technologies that may be of interest include, but are not limited to: diffusion membranes, sorbents, magnetic gradients, redox swing, or bio-mimetic processes (such as mimicking hemoglobin). Technology ideas to augment cryogenic air separation technology, along with potential integration schemes with commercial cryogenic air separation units, are highly desirable.

Questions – contact: Arun Bose, arun.bose@netl.doe.gov

b. Development of Affordable Heat Exchangers for Supercritical CO_2 Power Cycles

The supercritical carbon dioxide (SCO_2) recompression Brayton (RCB) cycle is gaining significant interest for numerous power generation applications, including fossil fuel, nuclear, and concentrated solar. The SCO_2 RCB cycle employs high- and low-temperature recuperators (SCO_2 to SCO_2 heat exchangers) to achieve attractive efficiencies relative to steam-based Rankine cycles at similar turbine inlet temperatures. A significant barrier to the full-scale demonstration and economic viability of SCO_2 RCB cycle technology is the performance and cost of these recuperators.

Grant applications are sought for the research and development of innovative designs, materials and manufacturing methods to produce cost-effective recuperators suitable for deployment in large-scale SCO_2

RCB cycle applications. The high-temperature recuperator should be capable of operating at temperatures approaching 1100 F on the hot side and pressures as high as 3500 psi on the cold side. Designs and manufacturing methods must be scalable – total recuperator thermal duty for a 500 MWelectic SCO_2 RCB plant is approximately 660 MWthermal. To meet the temperature and pressure requirements stated above, the literature indicates that multiple heat exchanger types could be applicable (e.g. plate matrix, printed circuit, shell and tube, coil wound, and bonded plate fin). High heat exchanger effectiveness while minimizing overall size and weight is critical to achieving high system efficiency at an acceptable capital cost. Modular concepts and/or strategies that are capable of addressing the range in size and temperature anticipated for the various SCO_2 RCB cycle applications are of particular interest.

Grant applications should baseline the proposed concept(s) with respect to the current state-of-the-art, and address the capital costs in the context of full-scale SCO_2 power systems.

Questions – contact: Robin Ames, robin.ames@netl.doe.gov

c. Surface-Functionalized Powders for Solid Oxide Fuel Cell Cathodes

Research has shown that controlling the surface morphology of Solid Oxide Fuel Cell (SOFC) cathodes can improve their electrochemical performance and stability. This has been demonstrated by infiltrating materials into porous cathodes followed by thermal treatments. It may be possible to bypass the infiltration step and synthesize electrode powders that, when sintered, form a similar, surface-tailored architecture directly. As an example, it has been shown repeatedly that alkaline-earth elements surface segregate in most of the state-of-the-art cathode materials. These elements are initially in solid solution, as synthesized, and then naturally surface segregate during fabrication and/or operation conditions. Similarly, core-shell particles have been designed for other catalytic applications to have a stable bulk “core” with an active surface “shell.” While it is recognized that the ideal surface termination has yet to be identified, many materials have shown substantial promise - such a processing innovation would enable materials currently under investigation to be seamlessly integrated with industrial manufacturing routes. Promising surface materials include, but are not limited to, the following: Lanthanum Strontium Manganese oxide (LSM), Lanthanum Strontium Cobalt oxide (LSC), and doped cerium oxide.

Research and development is sought to develop cathode powders that can be used as a drop-in replacement for current materials in state-of-the-art cathode fabrication processes yet result in high-performance surface-tailored electrode microstructures. The powder technology should be amenable of replacing or augmenting SOFCs based on composites LSM + Yittria-stabilized Zirconia (YSZ) and Lanthanum Strontium Iron Cobalt Oxide (LSCF) + doped cerium oxide. These structures and their electrochemical performance must be stable for greater than 40,000 hrs, under load, at typical SOFC operating temperatures (650 – 800C). Grant applications should include a description of how an anticipated structure will lead to enhanced performance and have sufficient analysis of the proposed manufacturing process to evaluate potential cost and complexity. In particular, evaluations of structural and performance stability over extended periods of time are encouraged.

Questions – contact: Briggs White, briggs.white@netl.doe.gov

d. Advanced Oxy-Combustion Technology

The combustion of coal directly with oxygen, rather than air, presents an opportunity to simplify CO_2 capture in power generation applications. In a chemical looping system, oxygen for combustion is produced internal to the process via oxidation-reduction cycling of an oxygen carrier - typically a solid metal-based compound.
Researchers are investigating several solid oxides for use as the oxygen carrier, including oxides of calcium, iron, nickel, copper, and manganese. Of interest is the evaluation of the attrition resistance of candidate oxygen carriers, as the particles must be robust to survive the rigorous stresses encountered in coal-based chemical looping processes. Although some test protocols and procedures exist to evaluate attrition resistance, it is not established that they accurately reflect the unique conditions of chemical looping processes.

Grant applications are sought to develop a protocol for the evaluation of oxygen carriers that broadly accounts for the process requirements of coal-based chemical looping systems. Also of interest are applications that can demonstrate the appropriate application of existing attrition evaluation methodologies for similar processes while accounting for unique process requirements of coal-based chemical looping systems.

In responding to this subtopic, applicants must demonstrate a thorough knowledge and understanding of existing attrition evaluation methodologies and of the various coal-based chemical looping processes under development. The applicant should explain how their methodology addresses the unique aspects of chemical looping and how it is an improvement over existing protocols.

Questions – contact: Steve Richardson, steven.richardson@netl.doe.gov

e. Other

In addition to the specific subtopics listed above, the Department invites grant applications in other areas that fall within the scope of the topic description above.

Questions – contact: Travis Shultz, travis.shultz@netl.doe.gov

References:

Subtopic a:

1. "Cryogenic Air Separation, History and Technological Process," The Linde Group. Available from http://www.linde-engineering.com/internet.global.lindeengineering.global/en/images/L_2_1_e_10_150dpi19_4353.pdf.
2. A.R. Smith, J. Klosek, "A review of air separation technologies and their integration with energy conversion processes," Fuel Processing Technology. 2001. Vol 70, pp. 115–134. Available from http://www.airproducts.com/~/media/downloads/white-papers/A/en-a-review-of-air-separation-technologies-whitepaper.pdf
3. Final Public Design Report, Technical Progess Report. July 1996. (http://www.netl.doe.gov/technologies/coalpower/cctc/cctdp/bibliography/demonstration/pdfs/tampa/M98054582.pdf).

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12. CARBON CAPTURE TECHNOLOGIES

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

Coal-fired utility boilers generate approximately 37.4% of the electricity in the United States. The DOE Energy Information Administration (EIA) projects that the 314 GW of coal-fired electricity generating capacity currently in operation will decline to 278 GW by 2040. For the foreseeable future, coal will continue to play a critical role in powering the Nation's electricity generation, especially for base-load power plants1.

Coal-fired power plants have made significant progress in reducing emissions of sulfur dioxide (SO_2), nitrogen oxide (NOx), particulate matter (PM), and recently mercury (Hg), since the passage of the Clean Air Act. Recently proposed limits on CO_2 emissions from new electric generating units will require carbon capture on any new coal-fired power plant. In addition, CO_2 emission reductions from existing generating units are expected to be proposed in 2014. Greenhouse gases such as CO_2 have increased over the past century and have been linked to climate changes. The amount of CO_2 produced from the combustion of fossil fuels in the United States was measured at 5.5 billion metric tons in 2011 according to the EIA1. This topic is specifically focused on developing technologies for carbon capture that can be integrated with new or existing coal-fired power plants. This is driven by the fact that coal is an extremely abundant resource with an existing infrastructure that produces a large fraction of the current CO_2 emissions from all fossil-fuel-based sources. The recently proposed climate change regulations will target a reduction in CO_2 emissions from new coal-fired sources. To prepare for these proposed regulations, significant research and development is currently being pursued for new technologies to capture carbon from flue gas streams produced by coal-fired electric generating power plants. Aqueous amine absorption is currently the state of-the-art technology for carbon capture from flue gas. However, amine absorption has a number of drawbacks, including significant capital and operating costs.

The Carbon Capture program area is pursuing three categories of technologies referred to as 1st-Generation, 2nd-Generation, and Transformational. 1st Generation Technologies include technology components that are being demonstrated or that are commercially available. 2nd Generation Technologies include technology components currently in R&D that will be ready for demonstration in the 2020–2025 timeframe. Transformational Technologies include technology components that are either conceptual or are in the early stage of development and offer the potential for significant improvements in cost and performance beyond those expected from 2nd-Generation technologies. The development and scale-up of these “transformational” technologies are expected to occur in the 2016–2030 timeframe, and demonstration projects are expected to be initiated in the 2030–2035 time period 2.

Applications are being sought for research, development, and testing of transformational carbon capture technologies. Transformational carbon capture technologies, for the purposes of this announcement, are defined as the following: absorption/adsorption/separation materials that have not been tested in a simulated flue gas environment; system integration that has not developed past the point of a working prototype; and the scale of the technology has not developed past the bench scale level. Technologies shall be capable of 90% or greater capture of CO_2 emissions and when technologies mature, result in a cost to capture CO_2 less than $40/tonne.

Applications that address oxy-combustion, chemical looping combustion, carbon dioxide capture from air, carbon dioxide capture from mobile emission sources (i.e. vehicles), and non-transformational carbon capture technologies (as defined above) will be considered non-responsive to the topic area.

Grant applications are sought in the following subtopics:

a. Electrochemical-Based Capture of Carbon Dioxide

Absorption employing liquid solvents, adsorption employing solid sorbents, and gas-separation membranes has been the focus of intense research to develop cost-effective, energy-efficient CO_2 capture systems. One area that has received much less attention is the application of electrochemical-based approaches to CO_2 capture.

Current commercial technologies based on chemical solvents, such as aqueous amine solutions, can absorb CO_2 from flue gas with high recoveries (> 90%) and purities (>>95%). However, in addition to electrical auxiliary load, they also require significant amounts of steam to be re-directed from power generation to thermally regenerate the solvent. There are similar issues with sorbent-based CO_2 capture. These technologies are also expensive and often require extensive compression in order to transport and inject CO_2 for geological storage (>150 bar).

Electrochemical-based separation is not reliant on the significant temperature and pressure swings that most currently proposed technologies must employ. However, chemical potential differences must be generated and/or overcome in this approach in order for separation to occur; this is not as well understood as solvent, sorbent and membrane mechanisms are in the context of carbon capture. Further development of electrochemical capture technologies is needed to establish their efficacy for CO_2 capture applications. Examples of areas of interest under this sub-topic are absorption/adsorption capture systems utilizing electrochemical regeneration and gas separation utilizing electrochemical membrane systems. Applications for proposed technologies should clearly show potential to significantly lower costs, reduce parasitic energy requirements, and reduce overall equipment footprint for CO_2 capture, relative to current technologies.

Questions – contact: Isaac Aurelio, isaac.aurelio@netl.doe.gov

b. Development of Advanced Solvents for CO_2 Capture

Solvent-based CO_2 capture involves chemical or physical absorption of CO_2 from flue gas into a liquid carrier. The absorption liquid is regenerated by increasing its temperature or reducing its pressure. Recent developments in this technology have been focused on the development of low-cost, non-corrosive solvents that have a high CO_2 loading capacity, improved reaction kinetics, low regeneration energy, and resistance to degradation. In addition, considerable effort is being applied to development of process design and integration that leads to decreased capital and operating costs, and enhanced performance2. An existing area of interest to the FE Carbon Capture R&D Program is the development of advanced solvents. Advanced solvents and their mixtures exhibit potential for the ability to achieve extremely-high CO_2 loadings and efficient separation through crystallization, phase change phenomena, or other novel absorption mechanisms. Increased loadings allow for a reduction in solvent circulation rate, leading to decreased energy use and potentially smaller equipment.

The focus of this sub-topic area is on the development and application of novel technologies applicable to advanced solvent absorption systems. Key technologies of interest include advanced solvent development or high-throughput solvent characterization for advanced solvents and or solvent mixtures. Development of aqueous amine-based solvent technology will be deemed non-responsive to this topic.

Questions – contact: Isaac Aurelio, isaac.aurelio@netl.doe.gov

c. Capture Systems Employing CO_2 Condensation

Cooling and condensation can be used as a means of separating CO_2 and other flue-gas components from N2. In a mixture, these gases will condense out as mixtures over a range of temperatures; however, fractionation schemes can be designed that result in the recovery of gas components as nearly pure streams. Solid-liquid-vapor thermodynamic equilibrium data and models can be used to establish design pressures and temperatures to achieve this separation. There are a number of means of cooling gas to near-cryogenic temperatures; multiple process options are possible for separating the condensed solid or liquid CO_2 from the gaseous N2. Desirable characteristics of this approach to separating and recovering

CO_2 are: (1) the resulting high-purity CO_2 stream may be pumped up to the required sequestration pressure (2,200 psig) as a liquid, which requires substantially less energy than systems employing CO_2 gas compression only, and (2) the need to deliver the CO_2 for transportation at very high-pressure enables synergistic opportunities for integrating compression and expansion systems to minimize parasitic energy requirements.

Applications are being sought to address key technical challenges to CO_2 condensed-phase capture, which include: (1) minimizing compression requirements for flue gas prior to CO_2 capture; (2) maximizing recovery of energy from refrigeration and cooling; (3) minimizing effects of acid gases (corrosion) and flue gas moisture (icing) and;(4) effectively separating solid and/or liquid phases from the continuous gas phase.

Questions – contact: Isaac Aurelio, isaac.aurelio@netl.doe.gov

d. Application of Nano-engineered Material to Carbon Capture Systems

Developments in the field of nano-engineering have resulted in the discovery of a number of new and novel materials which may have beneficial applications for CO_2 capture. Nano-materials can possess precise dimensions which are the same order of magnitude as gas molecules found in process streams being targeted for CO_2 capture. Therefore, they can be used as materials in the manufacture of size-selective, gas-separation membranes with extremely-high permeance, solid sorbents with extremely-high volumetric capacities, heat and mass transfer media with extremely-high surface areas and transfer rates, and catalysts with extremely-high rates of reaction. In addition, these materials may be chemically functionalized to enhance their selectivity to various other gas molecules found in the process stream; enabling or excluding a given molecule from entering a nano-pore of a surface or particle.

Focus of the proposed research should be on application of these types of materials to gas separation for CO_2 capture and improved heat and mass transfer in CO_2 capture systems. Proposed projects should include material synthesis and bench-scale testing of materials to establish material performance parameters in a simulated flue gas environment.

Questions – contact: Isaac Aurelio, isaac.aurelio@netl.doe.gov

e. Application of Process Intensification to Carbon Capture Systems

Processes being developed for CO_2 capture employ a number of standard unit operations, such as gas-liquid contactors (e.g., gas absorbers and strippers), gas-solid contactors (e.g., packed and moving beds), gas-separation membranes, heat exchangers, pumps, and compressors; all of which may be suitable for process intensification, by integrating two or more of these operations within a single piece of equipment. Example combinations include absorption/desorption, adsorption/desorption, compression/gas separation, and membrane reactors.

DOE has on-going projects for CO_2 capture focused on the development of absorption systems employing liquid solvents, adsorption systems employing solid sorbents, and gas-separation membrane systems3. Applicants are encouraged to address their proposals toward development and/or testing of optimized hybrid and/or integrated approaches that synergistically complement each other to significantly improve the performance and lower the costs of carbon capture. New solvent, sorbent, or membrane materials development should not be a part of any proposal submitted and will be considered non-responsive to the sub-topic.

Questions – contact: Isaac Aurelio, isaac.aurelio@netl.doe.gov

f. Other

In addition to the specific subtopics listed above, the Department invites grant applications in other areas that fall within the scope of the topic description above.

Questions – contact: Isaac Aurelio, isaac.aurelio@netl.doe.gov

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13. CARBON STORAGE TECHNOLOGIES

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

Coal is predicted to continue to dominate power generation for the next 25 years, and since power generation from coal is a significant source of carbon dioxide (CO_2) emissions, the reduction of these emissions is a critical research need. The United States has made a commitment to work toward the long-term reduction of CO_2 emissions, which in the USA originate mainly from the combustion of fossil fuels for energy production, transportation, and industrial processes, with about one third of US anthropogenic CO_2 emissions coming from power plants. The DOE continues to make progress toward the goals of lowering the cost of CO_2 capture and ensuring that CO_2 can be safely and permanently stored in geologic formations in a process known as carbon capture, and storage (CCS). Additionally, as carbon capture technology has advanced, the concept of CO_2 utilization has attracted more interest due to its potential not only to reduce emissions but also as a means to generate revenue to possibly offset a portion of the cost of capture. To assist in accelerating the implementation of CCS at commercial scale, DOE seeks innovative technologies and methods that (1) detect and mitigate releases from wellbores and geologic reservoirs used for geologic CO_2 storage; (2) reduce the cost and improve the accuracy of field monitoring instrumentation to detect supercritical CO_2 in the deep subsurface environment; and (3) promote the use of CO_2 as a raw material in processes that will be economically feasible and provide a significant reduction in atmospheric concentrations of CO_2.

Important Note: other DOE programs are supporting R&D efforts to develop technologies that use CO_2 for CO_2-Enhanced Oil Recovery (EOR), CO_2-Enhanced Coalbed Methane (ECBM) production, CO_2-Enhanced Gas Recovery (EGR), CO_2-Enhanced Geothermal Systems (EGS), and microorganism cultivation, as well as CO_2 conversion to fuels, biofuels, fuel precursors or additives, syngas, hydrogen and carbon monoxide. Therefore these approaches are not of interest for this topic, and proposals based on these approaches will not be responsive to the topic. For this release, conversion of CO_2 to chemicals is also not of interest.

Grant applications are sought in the following subtopics:

a. Advanced Geologic Storage Technologies

DOE is the lead agency supporting research and development of technologies to ensure that greater than 99% of injected CO_2 remains permanently stored in deep geologic formations. Mitigation may be needed on injection, abandoned, and monitor wells that are structurally unsound and leaking reservoirs to ensure that this goal is met. Operating permits under the Environmental Protection Agency (EPAs) Safe Drinking Water Act and Clean Air Act requires that CO_2 be stored in a manner to ensure that potable groundwater sources and sensitive ecosystems are protected. The EPA has developed a Class VI injection permit for CO_2 geologic storage. A Corrective Action Plan and Emergency and Remedial Response Plan for leaking wellbores would be included in a Class VI permit application. These plans would describe proposed leak detection methods and any chemicals, enhanced biological processes, materials, and equipment that will be deployed to ensure that CO_2 remains in the injection zone.

Grant applications are sought for cost effective chemicals, enhanced biological processes, materials, and/or equipment that may be used to detect and mitigate CO_2 leakage from storage reservoirs. Any technology, chemical, enhanced biological processes, materials, or equipment should be compatible with the subsurface environment (geology, pressure, temperature, CO_2, saline waters, and petroleum hydrocarbons) at depths greater than 3,000 feet. It is envisioned that detection technologies may be utilized both pre-injection and post-injection. The mitigation technologies would be used to seal any pre-injection potential leakage pathways and post-injection in the unlikely event that CO_2 migrates out of the injection zone through leakage pathways such as faults, fractures, and/or leaking wellbores. Proposals are sought that focus on developing new, or enhancing existing, chemicals, biological processes, materials, and equipment to detect and mitigate CO_2 leakage in both the reservoirs and wellbores to help ensure greater than 99% permanence. Preference will be given to technologies that demonstrate enhanced performance and permanence at reduced cost.

Questions – contact: Brian Dressel, brian.dressel@netl.doe.gov

b. Advanced Monitoring Technologies

A "Monitoring Verification and Accounting (MVA)" program is designed to confirm permanent storage of carbon dioxide (CO_2) in geologic formations through monitoring capabilities that are reliable and cost effective. Monitoring is an important aspect of CO_2 injection, since it serves to confirm storage permanence. Monitoring technologies can be developed to ensure that injection, abandoned, and monitoring wells are structurally sound and that CO_2 will remain within the injection formation. Operating permits under the Safe Drinking Water Act and Clean Air Act for geologic storage projects require monitoring to account for CO_2 that has been stored underground to ensure that potable groundwater sources and sensitive ecosystems are protected and to account for the CO_2.

Grant applications are sought for technologies involving field-based MVA hardware that quantify CO_2 emissions from geologic storage fields in the unlikely event that CO_2 migrates out of the injection zone. Proposals are sought that focus on developing new, or enhancing existing, MVA tools for monitoring supercritical CO_2 in the deep subsurface environment that can cover a large area with improved accuracy, continuous (real-time) monitoring capabilities, and/or reduced cost. Preference will be given to technologies that demonstrate enhanced performance at reduced cost.

Approaches in developing new or enhancing existing modeling technologies are not of interest for this subtopic. Grant applications using these approaches will not be responsive to the topic.

Questions – contact: Joshua Hull, joshua.hull@netl.doe.gov

c. CO_2 Use and Reuse

As CCS technologies have advanced, the concept of CO_2 utilization has attracted more interest due to the potential of CO_2 as a useful commodity chemical. In a future carbon-constrained economy it is anticipated that large volumes of CO_2 will be available from fossil fuel–based power plants and other CO_2-emitting industrial plants equipped with CO_2 emissions control technologies. While DOE is supporting efforts to demonstrate the safe and permanent storage of captured CO_2, a large surplus of captured CO_2 presents an opportunity to use it as an inexpensive raw material.

To explore this concept, the DOE has created a CO_2 Utilization Core Research Focus Area as part of its Carbon Storage Program. The goals of the CO_2 Utilization focus area are to identify and develop a suite of technologies that can increase the value and demand for CO_2 and contribute to reducing CO_2 emissions. Grant applications are sought for the development or enhancement of novel technologies that support these goals. For this release, the approach of interest is for technologies that use CO_2 as a feedstock in the production of cementatious construction materials. Preference will be given to proposals that attempt to maximize the unit weight CO_2 consumed per unit weight product. Additionally, the proposal should include a preliminary, high level life cycle analysis to demonstrate that the proposed technology will not create more CO_2 than is utilized.

DOE is currently supporting multiple small- and large-scale R&D projects to demonstrate the technical and economic feasibility of CCS. While advances have been made to reduce the cost of implementation, cost remains a primary concern. Recent studies support the approach that CO_2 utilization should focus on identifying technologies and opportunities that assist in reducing CO_2 capture costs as a means to accelerate industrial-scale implementation of geologic storage. Consequently, technologies that support this approach are of particular interest.

Questions – contact: Darin Damiani, darin.damiani@netl.doe.gov

d. Other

In addition to the specific subtopics listed above, the Department invites grant applications in other areas that fall within the scope of the topic description above.

Questions – contact: Andrea Dunn, andrea.dunn@netl.doe.gov

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Subtopic a:

1. "Best Practices for Carbon Storage Systems and Well Management Activities", U.S. DOE National Energy Technology Laboratory (NETL). April 2012. (http://www.netl.doe.gov/technologies/carbon_seq/refshelf/BPM-Carbon-Storage-Systems-and-Well-Mgt.pdf).
2. "DOE/NETL Carbon Dioxide Capture and Storage RD&D Roadmap," U.S. DOE National Energy Technology Laboratory (NETL). December 2010. (http://www.netl.doe.gov/technologies/carbon_seq/refshelf/CCSRoadmap.pdf).
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5. The Clean Air Act, U.S. Environmental Protection Agency, 2011. (http://www.epa.gov/ghgreporting/reporters/subpart/index.html).

Subtopic b:

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4. "Carbon Sequestration Program: Technology Program Plan," U.S. DOE National Energy Technology Laboratory (NETL). February 2011. (http://www.netl.doe.gov/technologies/carbon_seq/refshelf/2011_Sequestration_Program_Plan.pdf)
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2. DOE/NETL Carbon Dioxide Capture and Storage RD&D Roadmap, U.S. DOE National Energy Technology Laboratory (NETL), December 2010. Available from http://www.netl.doe.gov/technologies/carbon_seq/refshelf/CCSRoadmap.pdf.
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14. OIL AND GAS TECHNOLOGIES

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

A huge residual oil resource remains left behind in the Nation's conventional oil reservoirs. Recovery of much of this oil will depend on the development and application of cost effective enhanced oil recovery (EOR) techniques that employ carbon dioxide injection.

At the same time, while crude oil and condensate production from shale formations is increasing rapidly in the U.S., operators are recognizing that the percentage of oil-in-place that will ultimately be recovered from these unique reservoirs will likely be significantly less than the recoveries historically achieved from more conventional reservoirs. The same appears to be true for shale gas plays being developed via horizontal wellbores with multiple hydraulic fracture treatments, where recoveries of perhaps 25% or less of the gas originally in place are being forecast.

DOE is interested in catalyzing the development of novel technologies that will improve the ultimate recovery of domestic oil and natural gas resources in an environmentally safe manner. Specifically, DOE is interested in funding the development of technologies that are focused on increasing the percentage of oil-in-place recovered from either conventional or shale reservoirs, or the percentage of gas-in-place recovered from shale reservoirs.

In addition, DOE is interested in funding research that reduces emissions of hydrocarbons to the atmosphere during all phases of the drilling, completion and production process. Cost effective methods for reducing these emissions will enable operators to meet regulatory standards and thus permit wider and more rapid development of the shale gas resource.

Beyond-state-of-the-art research that can have (or lead to) "game-changing" impacts on recovery or emissions reduction will be considered more responsive to this solicitation than research that proposes small, incremental advances.

This topic focuses on three areas: (1) increasing the portion of hydrocarbon liquids-in-place (crude oil, condensate) in both conventional and shale reservoirs that can be economically produced, (2) increasing the portion of natural gas-in-place in shale reservoirs that can be economically produced via horizontal, hydraulically fractured wells, and (3) reducing the volume of fugitive methane and VOC emissions during drilling, completion and production operations.
Proposals to fund the development of new (or modification of existing) hydraulic fracturing or reservoir simulation models will be considered less responsive to the priorities of this solicitation than proposals to fund the development of tools or the demonstration of operating technologies.

It should be noted that DOE is not interested at this time in grant applications related to research focused on oil shale deposits (i.e Green River formation) or oil sands deposits, but rather research related to shale oil (crude oil or condensate found in shale formations similar to but not limited to the Bakken, Eagle Ford, and the Niobrara).

Grant applications must include a succinct discussion of the potential technical and economic advantages of the proposed technology, as compared to existing state-of-the-art systems.

Grant applications are sought in the following subtopics:

a. Improving Hydrocarbon Liquids Recovery Efficiency from Shales and via Carbon Dioxide Flooding of Conventional Reservoirs:

For this subtopic, the focus of interest lies in the following aspects:

1. Tools or methods for maximizing liquids recovery from shale reservoirs through improved well completion designs, operating procedures or field development practices.
2. Technologies for significantly increasing the recovery of residual oil from conventional oil reservoirs via advanced carbon dioxide flooding (e.g., improving sweep efficiency through advanced carbon dioxide mobility control).
3. Technologies that can help to dramatically reduce the cost of applying advanced carbon dioxide EOR methods, permitting their wider application.

Questions – contact: Albert Yost, albert.yost@netl.doe.gov

b. Improving Natural Gas Recovery from Shale Gas Reservoirs:

For this subtopic, the focus of interest lies in the following aspects:

1. Tools or methods for maximizing natural gas recovery from shale reservoirs through improved well completion designs, operating procedures or field development practices. (e.g., EQT, see references below).
2. Methods that advance the economic application of non-water-based fracturing fluids (e.g., LPG, LNG, natural gas or other novel fluids) in ways that serve to increase ultimate recovery of natural gas from shale reservoirs (e.g. GASFRAC, see reference below).
3. Advanced formation evaluation tools or techniques or perforation selection strategies that increase the efficiency of recovery on a per well basis and reduce the volume of fresh water required to produce a unit volume of natural gas. (e.g., AOGR article, Schlumberger paper, see references below).

Questions – contact: Albert Yost, albert.yost@netl.doe.gov

c. Reducing Methane and VOCs Emissions during Oil and Natural Gas Production:

For this subtopic, the focus of interest lies in the following aspects:

1. Innovative, lower cost alternative technologies for reducing VOC emissions from condensate tanks and other production equipment.
2. Innovative, lower cost technologies for reducing methane emissions during drilling, well completion or production operations (e.g., improved "green completion equipment," low emission valve operating systems).
3. Innovative, lower cost alternative technologies for capturing and monetizing natural gas from flaring operations during oil production.

Questions – contact: Albert Yost, albert.yost@netl.doe.gov

d. Other

In addition to the specific subtopics listed, the Department invites grant applications in other areas that fall within the scope of the higher level topic description provided above.

Grant applications must include a succinct discussion of the potential technical and economic advantages of the proposed technology, as compared to existing state-of-the-art systems.

Questions – contact: Albert Yost, albert.yost@netl.doe.gov

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1. NETL's Oil and Natural Gas Program. (http://www.netl.doe.gov/technologies/oil-gas/index.html).
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4. GASFRAC application by BlackBrush Oil and Gas LP. (http://www.houstonchronicle.com/news/houston-texas/houston/article/Hold-the-water-Some-firms-fracking-without-it-4760389.php).
5. AOGR article on geomechanics in Marcellus wells. (http://www.slb.com/~/media/Files/stimulation/industry_articles/201303_og_geomechanics.pdf).
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PROGRAM AREA OVERVIEW – OFFICE OF FUSION ENERGY SCIENCES

The Department of Energy sponsors fusion science and technology research as a valuable investment in the clean energy future of the nation and the world, as well as to sustain a field of scientific research - plasma physics - that is important in its own right and has produced insights and techniques applicable in other fields of science and industry. The Fusion Energy Sciences (FES) mission is to expand the fundamental understanding of matter at very high temperatures and densities and to build the scientific foundation needed to develop a fusion energy source. This is accomplished by studying plasma and its interactions with its surroundings across wide ranges of temperature and density, developing advanced diagnostics to make detailed measurements of its properties and dynamics, and creating theoretical and computational models to resolve the essential physics principles. FES has four strategic goals:

1. Advance the fundamental science of magnetically confined plasmas to develop the predictive capability needed for a sustainable fusion energy source;
2. Support the development of the scientific understanding required to design and deploy the materials needed to support a burning plasma environment;
3. Pursue scientific opportunities and grand challenges in high energy density plasma science to explore the feasibility of the inertial confinement approach as a fusion energy source, to better understand our universe, and to enhance national security and economic competitiveness, and;
4. Increase the fundamental understanding of basic plasma science, including both burning plasma and low temperature plasma science and engineering, to enhance economic competiveness and to create opportunities for a broader range of science-based applications.

This is a time of important progress and discovery in fusion research. The U.S. has joined an international consortium (consisting of the European Union, Japan, China, Russia, Korea, and India) to fabricate and operate the next major step in the fusion energy sciences research program, a facility called "ITER. The purpose of ITER is to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes. Experimental operations are planned to begin in approximately 10 years and are expected to continue for 20 years, demonstrating production of at least 10 times the power used to heat the fusion fuel and providing a platform to validate proposed commercial-grade technologies needed for power production. The FES program is making great progress in understanding turbulent losses of particles and energy across magnetic field lines used to confine fusion fuels, identifying and exploring innovative approaches to fusion power that may lead to more economical power plants and encouraging private sector interests to apply concepts developed in the fusion research program. The following topics are restricted to advanced technologies and materials for fusion energy systems, fusion science, and technology relevant to magnetically confined plasmas, high energy density plasmas and inertial fusion energy, and low-temperature plasmas, as described below.

For additional information regarding the Office of Fusion Energy Sciences priorities, click here.

15. ADVANCED TECHNOLOGIES AND MATERIALS FOR FUSION ENERGY SYSTEMS

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

An attractive fusion energy source will require the development of superconducting magnets and materials as well as technologies that can withstand the high levels of surface heat flux and neutron wall loads expected for the in-vessel components of future fusion energy systems. These technologies and materials will need to be substantially advanced relative to today's capabilities in order to achieve safe, reliable, economic, and environmentally-benign operation of fusion energy systems. Further information about research funded by the Office of Fusion Energy Sciences (FES) can be found at the FES Website, www.science.energy.gov/fes/.

Grant applications are sought in the following subtopics:

a. Plasma Facing Components

The plasma facing components (PFCs) in energy producing fusion devices will experience 5-15 MW/m2 surface heat flux under normal operation (steady-state) and off-normal energy deposition up to 1 MJ/m2 within 0.1 to 1.0 ms. Refractory solid surfaces represent one type of PFC option. These PFCs are envisioned to have a refractory metal heat sink, cooled by helium gas, and a plasma facing surface, consisting of an engineered refractory metal surface or a thin coating of refractory material that minimizes thermal stresses. The materials being considered include tungsten alloys. Grant applications are sought to develop: (1) innovative tungsten alloys having good thermal conductivity , resistance to recrystallization and grain growth, good mechanical properties (e.g., strength and ductility), and resistance to thermal fatigue; (2) coatings or bulk specialized low-Z materials for improved plasma performance; (3) innovative refractory-metal heat sink designs for enhanced helium gas cooling; (4) efficient fabrication methods for engineered surfaces that mitigate the stresses due to high heat flux; and (5) joining methods, for attaching the plasma facing material to the heat sink, that are reliable, efficient to manufacture, and capable of high heat transfer – these new joining techniques may be applicable to either advanced, helium-cooled, refractory heat sinks or present-day, water-cooled, copper-alloy heat sinks.

Another PFC option is to use a flowing liquid metal surface as a plasma facing component, an approach which will require the production and control of thin, fast flowing, renewable films of liquid lithium, gallium, or tin for particle control at diverters. Grant applications are sought to develop: (1) techniques for the production, control, and removal of flowing (velocity 0.01 to 10 m/s) liquid metal films (0.5-5 mm thick) over a temperature controlled substrate; (2) advances in materials that are wetted by liquid metals at temperatures near the respective metal melting point and that are conducive to the production of uniform well-adhered films; (3) techniques for active control of liquid metal flow and stabilization in the presence of plasma instabilities (time and space varying magnetic field); and (4) computational tools that model the flow and magnetohydrodynamic response of flowing liquid metals.

Questions – contact: Pete Pappano, peter.pappano@science.doe.gov

b. Blanket Materials and Systems

Blanket systems including an integrated first wall facing the plasma are complex, multi-function, multi-material components that capture neutrons emitted from the burning plasma to both produce tritium via nuclear reactions with lithium, and extract the energy for efficient power conversion. Associated with the blanket are complex systems (structure, breeder, multiplier, coolant, insulator, tritium processing), all of which have scientific and technological issues in need of resolution. Proposals that address these issues in areas such as:

1. Thermofluid and thermomechanical simulation of coolant flows and structural responses under surface and volumetric heat loads of all blanket materials (structure, breeder, multiplier, coolant, insulator, etc);
2. Mass transport (corrosion and tritium) modeling development and simulations;
3. Ceramic breeder and beryllium pebbles material fabrication, characterization, and thermo mechanics;
4. Lattice structured breeding materials with integral He cooling flow channels;
5. SiC or alternate insulators for electric current and thermal heat;
6. Simulation and analysis of blanket material and component responses to both steady-state and dynamic surface heat and particle flux in combination with bulk material neutron irradiation effects (14 MeV source);
7. Tritium permeation barriers and permeator windows, corrosion barriers, etc.;
8. Chemistry and impurity control in coolants (helium, liquid metals, etc.);
9. Flow and other diagnostic sensors compatible with fusion environment; or any blanket and tritium system relevant development issue;
10. Neutronic simulation and analysis tools for determining radiation induced material damage, tritium breeding efficiency, and worker radiation exposure conditions.

Several areas of particular interest are described in more detail below.

A new form of solid breeder morphology is required that holds the promise for increased breeding ratios – dictated by increased breeder material density; long term structural reliability; and enhanced operational control – compared to packed beds.

Grant applications are sought for new solid breeder material concepts that include: (1) increased breeder material densities (up to~80%); (2) higher thermal conductivities (provided by a fully interconnected structure, as opposed to point contacts between pebbles); (3) better thermal contact, such as reliable bonded contact, with cooling structures (instead of point contacts between pebbles and wall); (4) the absence of major geometry changes between beginning-of-life and end-of life (such as sintering in pebble beds) in the presence of high neutron fluence; and (5) structural integrity in freestanding and self-supporting structures with significant thermo-mechanical flexibility.

There is a strong need to understand and predict in greater detail both the corrosion, transport and redeposition of materials, and the generation, bubble formation, transport permeation and uptake of tritium in the fusion relevant blanket wall, coolant, and breeder materials. Both numerical predictive tools and increased database from experimental studies are needed to better characterize the corrosion and tritium transport behavior in breeder materials under fusion relevant conditions that include operation at 400-700C and the presences of strong magnetic fields in contact with various materials such as Reduced Activation Ferritic/Martensitic (RAFM) steels, silicon-carbide, and other proposed tritium or corrosion barrier or permeator materials for tritium extraction.

Solutions are sought that address challenges with pebble-bed solid breeders such as: thermo-mechanical uncertainties caused by pebble-bed wall interaction, potential sintering and subsequent macro-cracking, and low pebble-bed thermal conductivity.

Flow channel inserts (FCIs) act as magnetohydrodynamic and thermal insulators in ferritic steel channels containing, tritium breeders such as a molten Pb-Li alloy. Target FCI materials have a low electrical conductivity (1 to 50 Ω-1m-1). FCI structural loading is low, but they must be able to withstand thermal stresses from through-surface temperature differences in the range of 150-300K, over a thickness of 3 to 15 mm depending on designs. Grant applications are sought to develop manufacturing techniques for radiation resistant, low thermal/electrical conductivity materials that would make for effective FCIs as a homogenous material or one with layers of insulating materials. Experimental techniques are also sought for determining: (1) the compatibility between the FCI and breeder materials, and (2) the insert integrity under cyclic thermal loading and other in-service conditions.

Grant applications are sought for developing neutronic simulation and analysis tools for determining radiation-induced material damage, tritium breeding efficiency, and worker radiation exposure conditions under a fusion environment with a peak 14 MeV neutron source. The fusion neutronic environment is different, and harsher than the fission environment. Simulation and analysis tools that advance the state of the art to enable effective prediction of the fusion Tritium Breeding Ratio (TBR), material damage effects, such as swelling and creep, and prediction of the effectiveness of fusion radiation shields and barriers designed to limit worker and remote handling equipment exposure to the radiation environment, are critical to the safe adoption of fusion power. Ideally these tools are plug-ins, or compatible modules within existing commercial design software codes for structural, thermal, fatigue, or fluid flow, such as Ansys®, Fluent®, Nastran®, LS-DYNA®, to enhance the integration, validation and adoption of the tools.

Questions – contact: Edward Stevens, edward.stevens@science.doe.gov

c. Superconducting Magnets and Materials

New or advanced superconducting magnet concepts are needed for plasma fusion confinement systems. Of particular interest are magnet components, superconducting, structural and insulating materials, or diagnostic systems that lead to magnetic confinement devices which operate at higher magnetic fields (14T-20T), in higher nuclear irradiation environments, provide improved access/maintenance or allow for wider operating ranges in temperature or pulsed magnetic fields.

Grant applications are sought for:

1. Innovative and advanced superconducting materials and manufacturing processes that have a high potential for improved conductor performance and low fabrication costs. Of specific interest are materials such as YBCO conductors that are easily adaptable to bundling into high current cables carrying 30-60 kA. Desirable characteristics include high critical currents at temperatures from 4.5 K to 50 K, magnetic fields in the range 5 T to 20 T, higher copper fractions, low transient losses, low sensitivity to strain degradation effects, high radiation resistance, and improved methods for cabling tape conductors taking into account twisting and other methods of transposition to ensure uniform current distribution.

2. Novel methods for joining coil sections for manufacture of demountable magnets that allow for highly reliable, re-makeable joints that exhibit excellent structural integrity, low electrical resistance, low ac losses, and high stability in high magnetic field and in pulsed applications. These include

conventional lap and butt joints, as well as very high current plate-to-plate joints. Reliable sliding joints can be considered.

3. Innovative structural support methods and materials, and magnet cooling and quench protection methods suitable for operation in a fusion radiation environment that results in high overall current density magnets.

4. Novel, advanced sensors and instrumentation for monitoring magnet and helium parameters (e.g., pressure, temperature, voltage, mass flow, quench, etc.); of specific interest are fiber optic based devices and systems that allow for electromagnetic noise-immune interrogation of these parameters as well as positional information of the measured parameter within the coil winding pack. A specific use of fiber sensors is for rapid and redundant quench detection. Novel fiber optic sensors may also be used for precision measurement of distributed and local temperature or strain for diagnostic and scientific studies of conductor behavior and code calibration.

5. Radiation-resistant electrical insulators, e.g., wrap able inorganic insulators and low viscosity organic insulators that exhibit low gas generation under irradiation, less expensive resins and higher pot life; and insulation systems with high bond and higher strength and flexibility in shear.

Questions – contact: Barry Sullivan, barry.sullivan@science.doe.gov

d. Structural Materials and Coatings

Fusion materials and structures must function for a long time in a uniquely hostile environment that includes combinations of high temperatures, reactive chemicals, high stresses, and intense damaging radiation. The goal is to establish the feasibility of designing, constructing and operating a fusion power plant with materials and components that meet demanding objectives for safety, performance, and minimal environmental impact.

Grant applications are sought for:

1. Development of innovative methods for joining beryllium (~2 mm thick layer) to RAFM steels. The resulting bonds must be resistant to the effects of neutron irradiation, exhibit sufficient thermal fatigue resistance, and minimize or prevent the formation of brittle intermetallic phases that could result in coating debonding.

2. Development of fabrication techniques for typical component geometries envisioned for use in test blanket modules for operation in ITER using current generation RAFM steels. Such fabrication techniques could include but are not limited to appropriate welding, hot-isostatic pressing, hydroforming, and investment casting methods as well as effective post joining heat treatment techniques and procedures. Appropriate fabrication technologies must produce components within dimensional tolerances, while meeting minimum requirements on mechanical and physical properties.

3. Development of oxide dispersion strengthened (ODS) ferritic steels. Approaches of interest include the development of low cost production techniques, improved isotropy of mechanical properties, development of joining methods that maintain the properties of the ODS steel, and

development of improved ODS steels with the capability of operating up to ~800˚C, while maintaining adequate fracture toughness at room temperature and above.

4. Development of functional coatings for the RAFM/Pb-Li blanket concept. Coatings are needed for functions that include (1) compatibility: minimizing dissolution of RAFM in Pb-Li at 700°C, (2) permeation: reducing tritium permeation (hydrogen for demonstration) by a factor of >100 and (3) electrically insulating: reducing the pressure drop due to the magneto-hydrodynamic (MHD) effect. Proposed approaches must: (1) account for compatibility with both the coated structural alloy and liquid metal coolant for long-time operation at 500-700˚C (2) address the potential application of candidate coatings on large-scale system components; and (3) demonstrate that the permeation and MHD coatings are functional during or after exposure to Pb-Li.

Priority will be given to innovative methods or experimental approaches that enhance the ability to obtain key mechanical or physical property data on miniaturized specimens, and to the micromechanics evaluation of deformation and fracture processes.

Questions – contact: Pete Pappano, peter.pappano@science.doe.gov

e. Other

In addition to the specific subtopics listed above, the Department invites grant applications in other areas that fall within the scope of the topic description above.

Questions – contact: Barry Sullivan, barry.sullivan@science.doe.gov

References:

Subtopic a:

1. U.S. Department of Energy Office of Fusion Energy Sciences. (2009). Research Needs for Magnetic Fusion Energy Sciences. Report of the Research Needs Workshop (ReNeW). Bethesda, Maryland. June 8-12, 2009. Available from http://science.energy.gov/~/media/fes/pdf/workshop-reports/Res_needs_mag_fusion_report_june_2009.pdf.
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http://science.energy.gov/~/media/fes/pdf/workshop-reports/Res_needs_mag_fusion_report_june_2009.pdf.
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16. FUSION SCIENCE AND TECHNOLOGY

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

The Fusion Energy Sciences program currently supports several fusion-related experiments with many common objectives. These include expanding the scientific understanding of plasma behavior and improving the performance of high temperature plasma for eventual energy production. The goals of this topic are to develop and demonstrate innovative techniques, instrumentation, and concepts for (a) measuring magnetized-plasma parameters, (b) for low-temperature and multi-phase plasmas, (c) for magnetized-plasma simulation, control, and data analysis, and (d) for overcoming deleterious plasma effects during discharges. It is also intended that concepts developed as part of the fusion research program will have application to industries in the private sector. Further information about research funded by the Office of Fusion Energy Sciences (FES) can be found in the FES website at http://www.science.doe.gov/ofes/.

Grant applications are sought in the following subtopics:

a. Diagnostics

Diagnostic systems are critical to the success of any experimental campaign. In order to ensure continued progress in plasma experiments in pursuit of magnetic fusion energy, applications are sought for the development of diagnostic techniques to measure plasma parameters not previously accessible, or at a level of detail greater than previously possible, or at a substantially reduced cost or complexity. Preference will be given to research and development of advanced and innovative diagnostics that will advance our scientific understanding and predictive capability of magnetic fusion devices. Proposals addressing diagnostic needs of research on long-pulse facilities are also encouraged. Proposals addressing a specific milestone or a critical step towards the development of a major advanced and innovative diagnostic are welcome, including the development of subsystems, components, or methodologies for extending the capability of an advanced diagnostic technique being developed in the regular FES advanced Diagnostics program. Requests seeking funding for the routine application or operation of proven and matured diagnostic techniques at the major fusion facilities will not be considered under this subtopic. Such diagnostic applications are typically funded via separate solicitations as part of experimental facilities, based on their own research program priorities.

Questions – contact: Francis Thio, francis.thio@science.doe.gov

b. Components for Heating and Fueling of Fusion Plasmas

Grant applications are sought to develop components related to the generation, transmission, and launching of high power electromagnetic waves in the frequency ranges of Ion Cyclotron Resonance Heating (ICRH, 50 to 300 MHz), Lower Hybrid Heating (LHH, 2 to 10 GHz), and Electron Cyclotron Resonance (or Electron Bernstein Wave) Heating (ECRH / EBW, 28 to 300 GHz). These improved components are sought for the microwave heating systems of the fusion facilities in the United States and facilities under construction including ITER. Components of interest include power supplies, high power microwave sources or generators, fault protection devices, transmission line components, and antenna and launching systems. Specific examples of some of the components that are needed include tuning and matching systems, unidirectional couplers, circulators, mode convertors, windows, output couplers, loads, energy extraction systems from spent electron beams and particle accelerators, and diagnostics to evaluate the performance of these components. Of particular interest are components that can safely handle a range of frequencies and increased power levels.

For the ITER project, the United States will be supplying the transmission lines for both the ECRH (2 MW/line) system, at a frequency of 170 GHz, and for the ICRH system (6 MW/line), operating in the range of 40 – 60 MHz.. For this project, grant applications are needed for advanced components that are capable of improving the efficiency and power handling capability of the transmission lines, in order to reduce losses and protect the system from overheating, arcing, damage or failure during the required long pulse operation (~3000s). Examples of components needed for the ECRH transmission line include high power loads, low loss miter bends, polarizers, power samplers, windows, switches, and dielectric breaks. Examples of components needed for the ICRH transmission line include high power loads, tuning stubs, phase shifters, switches, arc localization methods, and in line dielectric breaks. For the ECRH and ICRH ITER transmission lines, improved techniques are needed for the mass production of components, in order to reduce cost. Lastly, advanced computer codes are needed to simulate the radiofrequency, microwave, thermal, and mechanical components of the transmission lines.

Questions – contact: Barry Sullivan, barry.sullivan@science.doe.gov

c. Simulation and Data Analysis Tools for Magnetically Confined Plasmas

The predictive simulation of magnetically confined fusion plasmas is important for the design and evaluation of plasma discharge feedback and control systems; the design, operation, and performance assessment of existing and proposed fusion experiments; the planning of experiments on existing devices; and the interpretation of the experimental data obtained from these experiments. Developing a predictive simulation capability for magnetically confined fusion plasmas is very challenging because of the enormous range of overlapping temporal and spatial scales; the multitude of strongly coupled physical processes governing the behavior of these plasmas; and the extreme anisotropies, high dimensionalities, complex geometries, and magnetic topologies characterizing most magnetic confinement configurations.

Although considerable progress has been made in recent years toward the understanding of these processes in isolation, there remains a critical need to integrate them in order to develop an experimentally validated integrated predictive simulation capability for magnetically confined plasmas. In addition, the increase in the fidelity and level of integration of fusion simulations enabled by advances in high performance computing hardware and associated progress in computational algorithms has been accompanied by orders of magnitude increases in the volume of generated data. In parallel, the volume of experimental data is also expected to increase considerably, as U.S. scientists plan to collaborate on a new generation of overseas long-pulse superconducting fusion experiments. Accordingly, a critical need exists for developing data analysis tools addressing big data challenges associated with computational and experimental research in fusion energy science.

Grant applications are sought to develop simulation and data analysis tools for magnetic fusion energy science addressing the challenges described above. Areas of interest include, but are not limited to: (1) algorithms incorporating advanced mathematical techniques; (2) algorithms targeting novel computing architectures, including Graphics Processing Unit (GPU), manycore, and heterogeneous computing platforms; (3) verification and validation tools, including efficient methods for facilitating comparison of simulation results with experimental data; (4) data management, visualization, and analysis tools for local and remote multi-dimensional time-dependent datasets resulting from large scale simulations or experiments; (5) techniques for coupling simulation codes, including coupling across different computer platforms and through high speed networks; (6) methodologies for building highly configurable and modular scientific codes and flexible user-friendly interfaces; and (7) remote collaboration tools that enhance the ability of geographically distributed groups of scientists to interact and collaborate in real-time.

The simulation and data analysis tools should be developed using modern software techniques, should be capable of exploiting the potential of next generation high performance computational systems, and should be based on high fidelity physics models. The applications submitted in response to this call should have a strong potential for commercialization and should not propose work that is normally funded by program funds. Although applications submitted to this topical area should primarily address the simulation and data analysis needs of magnetic fusion energy science, applications proposing the development of tools and methodologies which have a broader applicability, and hence increased commercialization potential, are encouraged.

Questions – contact: John Mandrekas, john.mandrekas@science.doe.gov

d. Components and Modeling Support for Validation Platforms for Fusion Science

The FES Experimental Plasma Research program has the long-term performance measure of demonstrating enhanced fundamental understanding of magnetic confinement and improving the basis for future burning plasma experiments. This can be accomplished through investigations and validations of the linkage between prediction and measurement for scientific leverage in testing the theories and scaling the phenomena that are relevant to future burning plasma systems. This research includes investigations in a variety of concepts such as stellarators, spherical tori, and reversed field pinches. Key program issues include initiation and increase of plasma current; dissipation of plasma exhaust power; symmetric-torus confinement prediction; stability, continuity, and profile control of low-aspect-ratio symmetric tori; quasi-symmetric and three-dimensional shaping benefits to toroidal confinement performance; divertor design for three-dimensional magnetic confinement configurations, and the plasma-materials interface. Grant applications are sought for scientific and engineering developments, including computational modeling, in support of current experiments in these research activities, in particular for the small-scale concept exploration experiments. The proposed work should have a strong potential for commercialization. Overall, support of research that can best help deepen the scientific foundations of understanding and improve the tokamak concept is an important focus area for grant applications.

Questions – contact: Sam Barish, sam.barish@science.doe.gov

e. Other

In addition to the specific subtopics listed above, the Department invites grant applications in other areas that fall within the scope of the topic description above.

Questions contact Barry Sullivan, barry.sullivan@science.doe.gov

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17. HIGH ENERGY DENSITY PLASMAS AND INERTIAL FUSION ENERGY

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

High-energy-density laboratory plasma (HEDLP) physics is the study of ionized matter at extremely high density and temperature, specifically when matter is heated and compressed to a point that the stored energy in the matter reaches approximately 100 billion Joules per cubic meter (the energy density of a hydrogen molecule). This corresponds to a pressure of approximately 1 million atmospheres or 1 Mbar. Research in HEDLP forms the scientific foundation for developing scenarios that could facilitate the transition from laboratory inertial confinement fusion (ICF) to inertial fusion energy (IFE).

While substantial scientific and technical progress in inertial confinement fusion has been made during the past decade, many of the technologies required for an integrated inertial fusion energy system are still at an early stage of technological maturity. This relative immaturity ensures that commercially viable IFE remains a long-term (>15 years) objective. Research and development activities are sought which address specific technology needs (specified below), necessary to both assess and advance IFE. Given the long-term prospects for IFE, applications submitted under this topical area must also clearly describe their potential/plans for short-term (2-10 years) commercialization in other commercial industries such as telecommunications, biomedical, etc.

Grant applications are sought in the following subtopics:

a. Driver Technologies

Inertial fusion energy hinges on the ability to compress an ICF target in tens of nanoseconds and repeat this process tens of times per second. Thus, the development of technologies is needed to build a driver (e.g., lasers, heavy-ions, pulsed power) that can meet the IFE requirements for energy on target, efficiency, repetition rate, durability, and cost. Specific areas of interest include but are not limited to: wavelength and beam quality for lasers, brightness for lasers and heavy ions, and pulse shaping and power.

Questions – contact: Ann Satsangi, ann.satsangi@science.doe.gov

b. Driver Delivery Systems

The development of final focusing elements capable of focusing the driver energy onto target with the required precision fidelity, damage threshold, and repetition rate is sought. These elements should be resistant to damage from both the target emissions and the driver energy. Specific examples include but are not limited to: optics, magnets, and electrical transmission lines.

Questions – contact: Ann Satsangi, ann.satsangi@science.doe.gov

c. Ultrafast Diagnostics

The development of ultrafast diagnostics is needed to assess driver and plasma conditions on sub-picosecond time scales. This technology has the potential to enable the development and deployment of feedback systems capable of ensuring the necessary reliability required for commercially viable IFE.

Specific areas of interest include but are not limited to the generation, detection, and control of nonlinear optical processes in plasmas.

Questions – contact: Ann Satsangi, ann.satsangi@science.doe.gov

d. Other

In addition to the specific subtopics listed above, the Department invites grant applications in other areas that fall within the scope of the topic description above.

Questions – contact: Ann Satsangi, ann.satsangi@science.doe.gov

References:

1. Advancing the Science of High Energy Density Laboratory Plasmas. Report of the High Energy Density Laboratory Plasmas Panel of the Fusion Energy Sciences Advisory Committee. January 2009. Available from http://science.energy.gov/~/media/fes/pdf/workshop-reports/Res_needs_mag_fusion_report_june_2009.pdf

18. LOW TEMPERATURE PLASMAS

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* NO

Low-temperature plasma science and engineering addresses research and development in partially ionized gases with electron temperatures typically below 10 eV. This is a field that accounts for an enormous range of practical applications, from light sources and lasers to surgery and making computer chips, among many others. The commercial and technical value of low temperature plasma (LTP) is well established where much of this benefit has resulted from empirical development. As the technology becomes more complex and addresses new fields, such as energy and biotechnology, empiricism rapidly becomes inadequate to advance the state of the art. Predictive capability and improved understanding of the plasma state becomes crucial to address many of the intellectually exciting scientific challenges of this field.

Building upon fundamental plasma science, further developments are sought in plasma sources, plasma surface interactions, and plasma control science that can enable new plasma technologies or marketable product and impact in other areas or disciplines leading to even greater societal benefit. The focus is on utilizing fundamental plasma science knowledge and turning it into new applications.

Use of readily available LTPs involving very little plasma science in a direct application of another field will not be considered. All research proposals must have a strong commercialization potential.

Grant applications are sought in the following subtopics:

a. Low-Temperature Plasma Science and Technology for Biology and Biomedicine

One of the current challenges identified in the areas of biological and medical applications of low-temperature plasmas is improving our current understanding and scientific knowledge in the area of plasma-biomatter interactions. Specific examples include but are not limited to: plasma-based bacterial inactivation, cancer cell modification, etc.

Questions – contact: Nirmol Podder, nirmol.podder@science.doe.gov

b. Low-Temperature Plasma Science and Engineering for Plasma Nanotechnology

Another current challenge has been identified in plasma assisted material synthesis for improving our current understanding and scientific knowledge in the area of plasma nanotechnology. Specific examples include but are not limited to: plasma-based nanotubes, submicron matters, etc.

Questions – contact: Nirmol Podder, nirmol.podder@science.doe.gov

c. Other

In addition to the specific subtopics listed above, the Department invites grant applications in other areas relevant to this Topic.

Questions – contact: Nirmol Podder, nirmol.podder@science.doe.gov

References:

1. Low-Temperature Plasma Science Workshop: Not Only the Fourth State of Matter but All of Them. (2008). Report of the U.S. Department of Energy Office of Fusion Energy Sciences Workshop on Low Temperature Plasmas. March 25-27, 2008. Available from http://science.energy.gov/fes/about/~/media/fes/pdf/about/Low_temp_plasma_report_march_2008.pdf.
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PROGRAM AREA OVERVIEW – OFFICE OF NUCLEAR ENERGY

Continued use of nuclear power is an important part of the Department's strategy to provide for the Nation's energy security, as well as to be responsible stewards of the environment. Nuclear energy currently provides approximately 20 percent of the U.S. electricity generation and will continue to provide a significant portion of U.S. electrical energy production for many years to come. Also, nuclear power in the U.S. makes a significant contribution to lowering the emission of gases associated with global climate change and air pollution.

The primary mission of the Office of Nuclear Energy (NE) is to advance nuclear power as a resource capable of meeting the Nation's energy, environmental, and national security needs by resolving technical, cost, safety, nonproliferation, and security barriers through research, development, and demonstration as appropriate [1].

For additional information regarding the Office of Nuclear Energy priorities see, http://nuclear.energy.gov/

19. ADVANCED TECHNOLOGIES FOR NUCLEAR ENERGY

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* YES
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* YES

New methods and technologies are needed to address key challenges affecting the future deployment of nuclear energy and to preserve U.S. leadership in nuclear science and engineering, while reducing the risk of nuclear proliferation. This topic addresses several key areas that support the development of crosscutting and specific reactor and fuel cycle technologies.

Grant applications are sought in the following subtopics:

a. Advanced Sensors and Instrumentation

Improvements and advances are needed in the technical area of Advanced Sensors and Instrumentation technologies to enhance economic competitiveness for nuclear power plants and promote a high level of nuclear safety. Grant applications are sought for: (1) Advanced Sensors that can withstand harsh environments (such as under accident conditions, in reactor applications, or during in-pile irradiation for fuel testing) to detect and monitor behavior of reactor or fuel cycle systems to achieve needed accuracy/resolution and minimize measurement uncertainty (2) Digital Monitoring and Control systems that increase nuclear plant system reliability, availability, and resilience by detecting and managing faults and failures of either instrumentation and control (I&C) systems or plant components; (3) Nuclear Plant Communication technologies that securely and reliably support greater data generation and transmission demands expected to accompany advancements in digital sensor, measurement, and control technologies; and (4) Innovative human-system interactions approaches and human-machine interface technologies to enable Advanced Concepts of Operation for future nuclear energy systems based on more highly automated control and unconventional roles and responsibilities for both human and system.

Successful applications will describe truly innovative sensors and instrumentation that offer the potential for revolutionary gains in reactor and fuel cycle performance and that can be applied to multiple reactor designs and fuel cycle concepts.

Grant applications that address the following areas are NOT of interest and will not be responsive to the topic: nuclear power plant security, homeland defense or security, or reactor building/containment enhancements; radiation health physics dosimeters (e.g., neutron or gamma detectors), and radiation/contamination monitoring devices; U. S. Nuclear Regulatory Commission probabilistic risk assessments or reactor safety experiments, testing, licensing, and site permit issues.

Questions – contact: Suibel Schuppner, suibel.schuppner@nuclear.energy.gov

b. Advanced Technologies for the Fabrication, Characterization of Nuclear Reactor Fuel

Improvements and advances are needed for the fabrication, characterization, and examination of nuclear reactor fuel. Advanced technologies are desired for advanced light water reactor fuels and materials and for particulate based TRISO fuels for Advanced Gas-Cooled Reactors/NGNP applications [2, 3, 5, 6]. In the area of light water reactors, specific technologies that improve the safety, reliability, and performance in normal operation as well as in accident conditions are desired.

1. Provide new innovative LWR fuel concepts, to include fuel and/or cladding, with a focus on improved performance (especially under accident scenarios), develop radiation-tolerant electronics for characterization instrumentation for use in hot cell fuel/cladding property measurements or characterization. Improvements to LWR fuel and cladding may include but not be limited to fabrication techniques or characterization techniques to improve the overall performance or understanding of performance of the nuclear fuel system.

2. Develop advanced automated, accurate, continuous vs. batch mode process techniques to improve TRISO particle fuel and compacts to include: (a) fabrication methods for particles and compacts, automated fabrication and characterization methods replace manual manufacturing techniques, and (b) advanced methods for non-destructive evaluation testing of TRISO particles and compacts for demonstration.

Grant applications may use non-fueled surrogate materials to simulate uranium, plutonium, and minor actinide bearing fuel pellets or TRISO particles for demonstration. Actual nuclear fuel fabrication and handling applications which require use of the INL ATR National Scientific User Facility [4], and its hot cells and fuel fabrication laboratories, or the Oak Ridge National Laboratory Advanced Gas Reactor TRISO fuels laboratory facilities [5, 6] to demonstrate the techniques and equipment developed may be proposed. Actual nuclear fuel specimens may be considered for ATR or ORNL High Flux Irradiation Reactor (HFIR) but will need to prove technical feasibility prior to their insertion into the ATR or HFIR for irradiation testing. Access to the aforementioned facilities is not guaranteed as part of this solicitation and must be obtained independent of an SBIR/STTR award.

Grant applications that address the following areas are NOT of interest and will not be responsive to the topic: thorium based fuels, molten salt based fuels, spent fuel separations technologies used in the Fuel Cycle Research and Development Program [3] and applications that seek to develop new glove boxes or sealed enclosure designs.

Questions – contact: Frank Goldner, frank.goldner@nuclear.energy.gov

c. Materials Protection Accounting and Control for Domestic Fuel Cycles

Improvements and advances are needed for the development, design and testing of new sensor materials and measurement techniques for nuclear materials control and accountability (including process monitoring) that increase accuracy, resolution, radiation hardness, while decreasing intrusiveness on operations and the cost to manufacture. Specifically, concepts and integration of safeguards features into design and operation of Used Fuel storage facilities and Electrochemical Recycling facilities are being sought. Grant applications are sought for: (1) Sensors based on radiation detection;(2) Imaging and identification technology for used fuel casks; (3) New active interrogation methods, including basic nuclear data (neutron and photo fission, nuclear resonance fluorescence); (4) Non-radiation based (stimulated Raman, laser-induced breakdown spectroscopy, fluorescence, etc.); and (5) Safeguards and security by design concepts. Grant applications are also sought for the development of new methods for data validation and security, data integration, and real time analysis with defense-in-depth and knowledge development of facility state during design.

Detectors that may indicate unauthorized materials diversion can be equally useful in identifying system upsets and the need for control changes. Grant applications are sought for the development of dual-use as well as single purpose instruments and detectors. Proposed concepts used exclusively for separations process control should be submitted under subtopic g.

Grant applications that address border security or remote monitoring are NOT sought.

Questions – contact: Daniel Vega, daniel.vega@nuclear.energy.gov

d. Modeling and Simulation

Computational modeling of nuclear reactors is critical for their design and operation. Nuclear engineering simulations are increasingly predictive and able to leverage high performance computing architectures. Writing software which works on leadership class facilities and is able to be used by nuclear engineers in industry presents many challenges. Grant applications are sought that:

Can provide supporting software for nuclear engineering analyses, such as advanced meshing tools (e.g., for generation of reactor spacer grid fluid flow or structural mechanics simulations), advanced visualization tools (e.g., for projecting 1-D network flow simulation results as color maps onto 2-D graphical icons created by the user), and data exchange capability between codes (e.g., for duplication of a large mesh-based data set onto an array of similar, coarser meshes); and can integrate the resultant tools and codes into a web services framework, with emphasis on the ability to connect to an open science computing framework like the open science grid.

Questions – contact: Dan Funk, dan.funk@nuclear.energy.gov

e. Component Technology Development for Advanced Small Modular Reactor Systems

The development of advanced components (e.g. sensors, valves, instrumentation, etc.) for nuclear systems can enable Advanced Small Modular Reactors (AdvSMRs) to achieve greater levels of safety, sustainability, and operational affordability. AdvSMRs differ from large plants in their fundamental design features requiring implementation of new advanced components for nuclear systems. Grants are sought for the development of new and innovative components to provide increased levels of safety and robustness, offer new functionalities, and maintain or improve the performance of AdvSMR systems.

Questions – contact: Brian Robinson, brian.robinson@nuclear.energy.gov

f. Advanced Methods for Manufacturing

A strong manufacturing base is essential to the success of U.S. reactor designs currently competing in global markets, but the success of the Small Modular Reactor (SMR) Initiative depends heavily on the ability of the U.S. to deliver on the SMR's expected advantages – the capability to manufacture them in a factory setting, dramatically reducing the need for costly on-site construction – thereby enabling these smaller designs to be economically competitive. The following areas are of specific interest.
Data and resource management programs are currently being considered by reactor vendors and their EPC contractors for the construction of new nuclear power plants. New nuclear plant owners will be required to manage and control the configuration of the nuclear plant through the complete nuclear plant lifetime. Significant project cost and schedule advantage can be achieved by effectively managing and maintaining configuration management (CM) of plant data beginning in the design and construction phases of the nuclear plant. Advanced methods are needed to acquire process and compare construction as-built configurations against the design. Grant applications are sought for (1) methods and technology improvements in laser, GPS and photometric systems to assure the as-built configuration matches the design, and (2) improvements in radiofrequency (RF) tags and similar devices to assure correct materials, placement, test criteria, and spare parts inventories.

Advanced fabrication and manufacturing methods will require advances in welding processes and inspection methods that can maintain production speed and efficiency with the manufacturing processes. Component manufacturing technologies will be required that take full advantage of the new 3-D printing methods employed by Additive manufacturing technologies. These manufacturing methods must be capable of producing components or sub components on a limited production basis and with nuclear quality. Grant applications are sought for (1) methods to improve the process, speed, quality and cost of welding and the required in-process and post welding inspections and (2) methods and processes to fabricate components using advanced technologies like 3D printing forms of Additive manufacturing processes that can eventually produce nuclear quality components. Grant applications are also sought for methods that can improve the manufacturing processes required for nuclear components using "Just in time" manufacturing methods adapted from other industries.

Questions – contact: Alison Hahn, alison.hahn@nuclear.energy.gov

g. Material Recovery and Waste Forms for Advanced Domestic Fuel Cycles

Material Recovery and waste forms play critical roles in both current and future nuclear fuel cycles. Currently, research reactor fuels are being processed in the U.S. for their stabilization while large nuclear waste treatment processing plants are in operation and are being constructed to convert cold war liquid waste into safely storable solid waste forms. An additional plant is being built to convert weapons-grade plutonium into commercial nuclear fuel. In the future, chemical processing plants may be constructed in the U.S. to recycle used nuclear fuel for improved resource utilization and reduced environmental impact. In all cases, modest improvements in chemical processing technologies can effect significant cost reductions.

In addition to the use of advanced sensors and measurement technologies for materials protection, accounting and control (as outlined in subtopic c), grants are sought for the development of related systems useful for separations process control. For example, detectors that may indicate unauthorized materials diversion can be equally useful in identifying system upsets and the need for control changes. Grant applications are sought for the development of dual-use as well as single purpose instruments and detectors used exclusively for process control. However, proposals that are focused on materials protection, accounting and control related applications are more appropriate for subtopic c and should be submitted there.

Most liquid high-level nuclear waste in the world is being converted to a solid form as a borosilicate glass. Such waste forms, while extremely durable, generally contain low concentrations of radioactive materials. Several approaches are under investigation to increase radioactivity concentrations and thus to decrease the total waste mass and volume for storage and disposal. Examples include the possible use of metal alloys and ceramics as advanced waste forms. Innovations are needed in waste forms chemistry and crystallinity to increase waste concentrations without the sacrifice of glass durability. Acceptability of such new waste forms as alternatives to borosilicate glass will depend upon sufficient knowledge of their degradation processes to be able to predict their performance over geologic time periods. Collaboration with national laboratory scientists involved in related studies is encouraged.

Questions – contact: James Bresee, james.bresee@nuclear.energy.gov

h. Other

In addition to the specific subtopics listed above, the Department invites grant applications in other areas that fall within the scope of the topic description above.

Questions – contact: Bradley Williams, bradley.williams@nuclear.energy.gov

References:

1. U.S. DOE Office of Nuclear Energy, Home Page. (http://www.nuclear.gov).
2. U.S. DOE Office of Nuclear Energy, “Nuclear Energy Research and Development Roadmap, Report to Congress,” April 2010. (http://energy.gov/ne/downloads/nuclear-energy-research-and-development-roadmap).
3. U. S. Department of Energy, Fuel Cycle Research and Development Program. (http://energy.gov/ne/fuel-cycle-technologies/fuel-cycle-research-development).
4. Idaho National Laboratory Advanced Test Reactor National Scientific User Facility: (http://nuclear.inl.gov/atr/).
5. “Technical Program Plan for the Next Generation Nuclear Plant/Advanced Gas Reactor Fuel Development and Qualification Program,” Idaho National Laboratory, Rev. 3, INL/EXT-05-00465. August 2010. Available from https://inlportal.inl.gov/portal/server.pt/community/ngnp_public_documents/452/home.

6. Petti, D. et al., "The DOE Advanced Gas Reactor (AGR) Fuel Development and Qualification Program," 2005 International Congress on Advances in Nuclear Power Plants, INEEL/CON-04-02416. Available from http://www.inl.gov/technicalpublications/Documents/3169816.pdf.

20. TRANSIENT TESTING R&D

Maximum Phase I Award Amount: $225,000	*Maximum Phase II Award Amount:* $1,500,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* YES
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* YES

Transient testing involves placing fuel or material into the core of a reactor and subjecting it to short bursts of intense high-power radiation. Development and qualification of new nuclear fuels and materials requires an understanding of behavior under such transient conditions. In fact, this is a required step in licensing new nuclear fuels for use in existing and future U.S. nuclear power plants. Additionally, fuel development increasingly relies on advanced modeling and simulation tools which must be validated with specific data sets. In order to meet these needs and fully realize the potential of transient testing, development and demonstration of specific technologies to support transient testing are desired.

Grant applications are sought in the following subtopics:

a. Non-Destructive Examination Systems

Designs of advanced non-destructive examination systems and reconstruction software to evaluate the geometric and compositional characteristics of fuel tests that include disrupted fuel (e.g. failed cladding and fragmented fuel pellets) prior to disassembly are desired. Specific interests include, but are not limited to, fuel burn-up distribution, fuel location identification, and non-fuel component geometry. Potential detector systems must withstand high-radiation environments and accommodate highly-radioactive specimens. Neutron radiography is an area of particular interest and new detectors are sought that can appropriately balance spatial and time resolution. Computational software to support (neutron) tomography is also of interest. Currently available technology requires many radiographs and manual image processing to produce a single reconstruction. Tomosynthesis, for example, could reduce the number of shots required and associated costs. The combination of advanced x-ray and neutron imaging may also offer promise. X-ray radiography software packages currently exist and the addition of similar neutron radiography capabilities are of particular interest.

Questions – contact: Bradley Williams, bradley.williams@nuclear.energy.gov

b. Other

In addition to the specific subtopics listed above, the Department invites grant applications in other areas that fall within the scope of the topic description above.

Questions – contact: Bradley Williams, bradley.williams@nuclear.energy.gov

c. Flowing Loop Pump Development

Design of irradiation test vehicles for use in transient testing, including cartridge type pressurized water loops to apply representative reactor coolant boundary conditions for fuel pin (or small bundle) experiments will play an important role in future transient tests. Cartridge type loops offer the advantage of being loaded and sealed with irradiated fuel samples remotely, while remaining hermetically sealed throughout transportation and irradiation at the test facility. Pump design will be a key constraint in package-type water loop designs, especially if larger-scale tests are needed. Small pumps (less than 10 inches in diameter) are sought for incorporation into the aforementioned loop designs. These pumps should be able to achieve high-temperature (~300 °C), high-pressure (~2300 psi) and low flow rates (~35 gpm) prototypic of pressurized water reactor conditions, while being fully contained within the sealed loop.

Questions – contact: Bradley Williams, bradley.williams@nuclear.energy.gov

21. ADVANCED TECHNOLOGIES FOR NUCLEAR WASTE

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* YES
Accepting STTR Phase I Applications: YES	*Accepting STTR Fast-Track Applications:* YES

With the need to store used nuclear fuel for prolonged periods of time (in excess of 100 years), it becomes necessary to address technical performance issues of the nuclear materials with time. Improvements and advances are needed for the development, design, and testing of new sensors, transmitters, and measurement techniques for used nuclear fuel stored in dry storage systems for long periods of time. While long-term material performance studies are planned within the Used Fuel Disposition (UFD) program, there are limited opportunities to perform reliable real-time monitoring of the material condition in a sealed container or a dry storage cask. There are several monitoring devices that can be used for conventional non-destructive examinations. However, the current monitoring devices only provide limited information and the long-term reliability of the data could be questionable. Of interest to the UFD program are grant applications that propose new devices based on the long-term material behavior characteristics and/or propose new data collection and advance analyses methods that can support reliability of long-term storage options.

Grant applications are sought only in the following subtopics.

a. Used Fuel Disposition, Generic Repository Research-development: Deep Boreholes

New methods and technologies are needed to address key issues that affect the future of nuclear energy, in particular, resolution of materials disposition associated with the back-end of the nuclear fuel cycle. Disposition of defense program high-level nuclear waste products and used nuclear fuel from civilian reactors remains a significant national challenge. The U.S. DOE Office of Nuclear Energy, Office of Fuel Cycle Technologies, Office of Used Nuclear Fuel Disposition R&D [1,2, 3] is currently investigating generic repository disposal systems in crystalline/granite, shale, salt, and deep borehole environments.

Proposals are sought in the following general areas:

Improvements and advances in drilling and testing technologies, and understanding of generic deep borehole environments (drilled to 5 km depth into "crystalline basement" rock) are sought; consideration should be given to examination of the feasibility of using existing drilling and testing systems and component technologies and innovative techniques to provide information to be used in the design, construction, testing, characterization, and performance assessment modeling of the deep geologic system borehole environment (chemical, hydrologic, mechanical, thermal).
Deep borehole (3-5km depth, crystalline basement rock) disposal of nuclear waste [4-19] has been considered by several nations. Research-development challenges abound and provide opportunities for contribution to the USA's ongoing efforts in this area including but not limited to:

1. Seal integrity studies,
2. Canister design and prototyping,
3. Drill rig design specifications / modification for emplacement,
4. Bentonite and cement degradation evaluation,
5. Borehole, casing, and liner design and emplacement operations,
6. Waste form degradation studies at expected environmental conditions,
7. Selected radionuclide (I129, Tc99, Cl36) characterization at expected environmental conditions,
8. Studies of I129 sorbent additive in seal zone: system modeling investigations to examine long-term (up to 1 million years) changes in system processes and performance for deep basement rock environments
9. Age dating methods and reliability for very old groundwater (millions to billion years); including test specifications, materials, hardware requirements, test methods, distinguishing age of pore waters and fracture waters or determination of hydrologic system character and formation water residence time [19-23].

Proposals are sought to evaluate, improve, and or optimize the reliability, accuracy, and/or performance of drilling technologies and instrumentation, testing methods and applications, and modeling or analysis of deep borehole systems. Predictive and post-testing computational component, process, and system modeling and simulations are important for confidence building; it may also be advantageous to leverage high performance computing architectures and capabilities. Of particular interest are applications that propose the use of cooperative research efforts (e.g., with the national laboratories, other research institutions) in examination of the deep borehole disposal option; proposals are invited in other areas that fall within the scope of the topics described above.

Questions – contact: Mark Tynan, mark.tynan@nv.doe.gov

b. New Technology for Devices for Evaluating Internal Conditions of Nuclear Waste Storage Casks Non-Destructively

Grant applications are sought: (1) to improve and optimize instrumentation devices using advanced techniques that relate to the fundamental properties of degrading nuclear materials, Develop a monitoring system for internal conditions in used fuel dry storage systems to identify or predict fuel cladding failure and fuel assembly structural degradation/corrosion [1, 2, 3, 4]. The attributes to be monitored might include radiation levels, temperatures, pressures, detection of certain gasses including corrosion products and radioactive decay elements, etc. (2) Develop remote and long-term monitoring of nuclear waste casks in a passive manner. The monitoring sensors might be located inside the containment canister or externally, depending on the proposed measurement technique. If internal, there shall be no penetrations through the canister; they would have to be powered without direct connections and the signals would have to be transmitted without direct connection (through thick steel shells and, possibly, concrete over-packs). The sensors and transmitters would have to sustain harsh environments (including high radiation, high temperatures, and vibration) for long periods of time (centuries) without accessibility for maintenance or calibration. The sensors and transmitters would have to sustain reorientation and vibration associated with loading and shipping the used fuel canisters from the reactors to the storage facilities. There might be several ways to solve each of these requirements. (3) Develop sensing technology to record and warn operators of events exceeding threshold of preset damage values for internals of a waste containing casks.

Questions – contact: John Orchard, john.orchard@nv.doe.gov or Prasad Nair, prasad.nair@nv.doe.gov

c. Advanced Data Analyses Methodology for Nuclear Waste Containers/Casks Currently in Use

There are several monitoring devices that provide data based on interpretation of physics, chemistry, or radiological aspects of the material/structure performance. These data very often get filtered or amplified for purposes of identifying a phenomenon under consideration. However the raw data may contain additional information that could be valuable, if one is able to perform detailed or new analyses of these data. Grant applications are sought: (1) to develop methodology to extract more usable information from current monitoring devices for material degradation processes, and (2) develop and demonstrate advanced data analysis schemes with the use of multiple devices of various kinds.

Questions – contact: John Orchard, john.orchard@nv.doe.gov or Prasad Nair, prasad.nair@nv.doe.gov

d. Other

In addition to the specific subtopics listed above, the Department invites grant applications in other areas that fall within the scope of the topic description above.

Questions – contact: Joe Price, joe.price@doe.gov

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Subtopics b and c:

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2. 10 CFR 72.128, Licensing Requirements For The Independent Storage Of Spent Nuclear Fuel, High-Level Radioactive Waste, And Reactor- Related Greater Than Class C Waste, General Design Criteria. Criteria for spent fuel, high-level radioactive waste, and other radioactive waste storage and handling.
3. US Department of Energy, FCRD-USED-2011-000136 Rev. 0, Used Fuel Disposition Campaign Gap Analysis to Support Extended Storage of Used Nuclear Fuel Rev. 0, JANUARY 31, 2012, Section 4.6 Monitoring. Available from http://energy.gov/sites/prod/files/Gap%20Analysis%20Rev%200%20Final.pdf.
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PROGRAM AREA OVERVIEW – OFFICE OF ELECTRICITY DELIVERY AND ENERGY RELIABILITY

The U.S. electric power sector is a critical part of our society. The electricity industry is a mix of investor-owned utilities, municipal utilities, cooperatives, and federal power utilities. In addition, electricity is also generated from non-utility power producers. The nation's electric grid must be protected from unacceptable risks, multi-regional blackouts, and natural disasters. Therefore, the mission of the Office of Electricity Delivery and Energy Reliability (OE) is to lead national efforts in applied research and development to modernize the electric grid for enhanced security and reliability. A modernized grid will significantly improve the Nation's electricity reliability, efficiency, and affordability, and contribute to economic and national security.

OE supports research and development efforts to eliminate bottlenecks, foster competitive electricity markets, and expand technology choices. For example, the risk of multi-regional blackouts and natural disasters can be reduced through the application of better visualization and controls of the electric grid, energy storage and power electronics, smart grid technology, cyber security, and advanced modeling.

For additional information regarding the Office of Electricity Delivery and Energy Reliability priorities, click here.

22. ADVANCED DIAGNOSTIC TECHNIQUES FOR ELECTRIC POWER SYSTEMS – FAULT DETECTION

Maximum Phase I Award Amount: $150,000	*Maximum Phase II Award Amount:* $1,000,000
Accepting SBIR Phase I Applications: YES	*Accepting SBIR Fast-Track Applications:* NO
Accepting STTR Phase I Applications: NO	*Accepting STTR Fast-Track Applications:* NO

Locating faults in a utility network presents unique problems. An outage area might be defined only by calls from dropped customers and/or by a breaker trip indication at a control center. The exact location of the fault can only be determined by service crews driving around the known outage area, a time consuming and labor intensive process. Incipient faults, such as partial discharge, that do not result in an immediate outage can be caused by arcing on insulators and other fixtures. Such arcing causes a slow degradation of the insulating material. This may continue for some time before the degradation results in a point of failure and an outage.

Grant applications are sought in the following subtopics:

a. Development of Advanced Diagnostic Techniques for Fault Location

Existing methods for precisely locating incipient faults apply only to partial discharge. These generally entail driving around the utilities' service area using a special receiver and a directional antenna. The antenna can be used to determine the direction of a suspected partial discharge fault but not the distance. One must drive in the direction of the fault signal and stop, take a reading, and repeat the process. Only when you are at the fault can you be sure of its location. This is a time and labor intensive process that cannot be automated. Further, it is only applicable to partial discharge events and not an outage.

Although underground cable installations address environmental and aesthetic concerns, their added installation costs, and associated O&M costs have nonetheless been a major barrier. For example, the length of time required to locate faults and restore power is typically longer for underground cables than for overhead conductors. Therefore, grant applications are sought to develop advanced diagnostic techniques for real-time prognosis and diagnosis of overhead conductor and underground cable conditions, in order to support predictive and condition-based monitoring, maintenance, and operations. Proposed solutions should meet the following requirements:

1. Low cost to allow for large-scale deployment.
2. Self-powered to operate through power failures.
3. Ability to monitor for continuous operation, preferably over the conductor's length.
4. Ability to report events automatically in real time and over a wide area.
5. Ability to be easily installed.
6. Ability to locate events within seconds.

Proposed approaches should seek to avoid the problems associated with existing techniques for fault and incipient fault detection which are generally not in continuous operation, require isolation of cables for test, and require a methodical search to report the location of fault events.
Conventional methods for fault monitoring techniques experience various problems related to fault location [1], the need to "estimate" fault location [2], and general issues related to fault location in underground cables [3].

Questions – contact: Philip Overholt, philip.overholt@hq.doe.gov

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