U.S. Department of Energy

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

Topics

FY 2015
Phase I
Release 2

Participating DOE Research Programs

- Office of Defense Nuclear Nonproliferation
- 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 High Energy Physics
- Office of Nuclear Energy

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 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 Technology Office efforts directly support the President's Climate Action Plan goals of doubling renewable electricity generation by 2020 and doubling energy productivity by 2030. On September 17, 2014, U.S. Secretary of Energy Moniz announced a partnership with the Council on Competitiveness and the Alliance to Save Energy to launch Accelerate Energy Productivity 2030 to grow our economy while reducing our energy costs.

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. Program activities are conducted in partnership with the private sector (including small businesses), 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. EERE's fiscal year 2015 budget request can be found here: http://energy.gov/sites/prod/files/2014/04/f14/Volume%203.pdf.

For additional information regarding EERE's priorities, click here.

11. 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. Wide bandgap (WBG)-based power electronics and light-emitting diodes (LEDs) promise to be more efficient, powerful, and less costly than conventional electronics. The use of domestic natural gas for feedstock and fuel substitution enables more energy-efficient manufacturing than today's state-of-the-art. Innovative systems for the production of carbon fiber and for synthesizing novel atomically precise catalysts represent critical platform materials for a wide variety of clean energy applications. New technologies now can cost-effectively recover previously inaccessible low grade industrial waste heat and use it to reduce industrial fuel use.

All applications to this topic must:

- Be consistent with and have performance metrics (whenever possible) linked to published, authoritative analyses in your technology space.
- Clearly define the proposed application, the merit of the proposed innovation compared to competing approaches, and the anticipated outcome with a special emphasis on the commercialization potential of the overall effort including Phase I and Phase II.
- Applications should provide a path to scale up in potential Phase II follow on work.
- Include quantitative projections for price and/or performance improvement that are tied to representative values included in authoritative publications or in comparison to existing products. For example, projections of price or cost advantage due to manufacturing improvements, materials use, or design simplification should provide references to current practices and pricing to enable informed comparison to present technologies.
- Demonstrate commercial viability with a quantifiable return on DOE investment as described elsewhere in this FOA.
- Fully justify all performance claims with thoughtful theoretical predictions and experimental data.

Grant applications are sought in the following subtopics:

a. Wide Bandgap Semiconductors for Energy Efficiency and Renewable Energy

Wide bandgap (WBG) semiconductor-based devices — with bandgaps significantly greater than 1.7 eV — operate at much higher voltages, frequencies, and temperature than conventional semiconductor-based devices.[1-3] DOE has made significant R&D investments in WBG semiconductors. [4] WBGs--including silicon carbide (SiC), gallium nitride (GaN), zinc oxide (ZnO), aluminum nitride (AlN) and diamond (C) offer dramatic improvements in a variety of applications such as power electronics, solid-state lighting, fuel cells, photovoltaics, and sensing in harsh environments.

Compared to today's Si-based technologies, devices using WBGs can operate at higher temperatures, operate at greater voltages over time, and switch at much higher frequencies than those based on non-WBG substrates. Depending on current density, power dissipation, and reverse breakdown voltage requirements, semiconductor devices are structured as either vertical or lateral structures. While vertical SiC and lateral GaN/(SiC, Si, Sapphire)-based semiconductor devices are commercial, vertical GaN devices (LEDs and power devices) built on GaN substrates and vertical AlN or AlGaN devices (UV-C LEDs and power devices) built on AlN substrates are not. Making commercial vertical LEDs on GaN and AlN or AlGaN substrates would have major power and efficiency advantages including: greater brightness (2-3x); higher current tolerance; and smaller and less expensive chips due to improved geometry compared with LEDs on other substrates such as Sapphire. To develop these applications, the substrates must be conducting, and LED substrates also must be transparent. These properties are controlled by point defects in the substrates, so identifying and eliminating these point defects is a key research goal.

Research areas below are important for the fabrication of conducting and transparent(e.g. LED) substrates; for improved doping control during boule and epi-growths; and for increasing scientific understanding of relatively deep donor and acceptor levels, ion-implantation, and subsequent activation of donor and acceptor impurities. [5]

Areas of particular interests include:

Substrate Forming from Bulk GaN Crystals: While much R&D has been conducted on the methods for growing low defect, low-optical-absorption bulk GaN crystals, significant advances are still required to make epi-ready substrates. GaN has similar mechanical properties to SiC [6], and many mechanical forming methods such as slicing, grinding, and mechanical polishing can be adapted from SiC. As each step in the epi-ready substrate formation process is highly dependent on the preceding step, it is important to adapt these operations in a concurrent, balanced manner.

Mechanical shaping steps must be cost effective and minimize subsurface damage; achieve reasonable wafer shape (as measured by bow, warp, and total thickness variation and local thickness variation); and consider requirements for scaling diameter and volume. After mechanical polishing, final surface preparation with chemo-mechanical polishing (CMP) steps are required to remove surface and subsurface damage and present a high quality surface to grow low-defect epitaxial films. Developing a commercially viable CMP process with a reasonable removal rate requires a thorough study of chemistries and mechanical (down) forces with careful control of all interacting parameters such as chemistry, temperature, down-force, linear abrasion speed, viscosity, slurry flow rates and concentrations. The difficulty with CMP on relatively hard crystals such as GaN and SiC is in achieving a viable removal rate while balancing all process parameters to create a smooth surface. Removal rates can also be heavily influenced by crystallographic orientation, defect density, defect size, defect type, and doping / impurity type and concentration. The final steps required include non-destructive surface characterization techniques that can be performed with high speed and accuracy at low cost. Of particular interest is the ability to measure sub-surface damage, which is currently impossible using optical microscopy.

Doping Control and Producing Shallow Donors in AlN Substrates and Epilayers: Improving control of dopant incorporation and production of shallow donors is critical during boule and epi growth. Applications are sought that show a path to the controlled incorporation of shallow donors (<100 meV) in AlN substrates and/or thick (>10 µm) epilayers grown on AlN or other suitable WBG substrates. AlN substrates with thick epilayers and n-type (vertical) conduction are needed for a wider array of devices including both LEDs and power devices. While AlN-based LEDs producing light at between 200-300 nm are already being commercialized for water purification, it is still difficult to obtain n-type conduction for AlN substrates and epilayers [7, 8, 9, and 10]. An understanding of the doping mechanism and of controlled and reproducible doping in AlN is needed to manufacture these vertical structures. A Si concentration of $3x10^{19}$ cm^{-3} is the upper doping limit for achieving n-type conductive Si-doped AlN. At that limit, the highest electron concentration of $9.5x10^{16}$ cm^{-3} has been obtained [11].

Questions - contact anant.agarwal@ee.doe.gov

b. Natural Gas Feedstock and Fuel Substitution for Energy Efficient Manufacturing

The recent emergence of new supplies of natural gas in the United States, along with the use of more energy efficient technologies, has the potential to increase competitiveness in American manufacturing [1, 2]. Point-of-use, on-demand production systems in miniaturized chemical processing systems could offer improved environmental and safety benefits [3]. The realization of these benefits depends on the availability of low cost, modular process technologies that overcome low economy of scale issues and mitigate demonstration risks [4]. Plasma reforming of natural gas offers the opportunity for process intensification [5]. Applications are sought to develop novel thermal and non-equilibrium (also called cold plasma) reactors for manufacturing valuable products from natural gas. Selective conversion is sought to produce useful products such as acetylene, carbon black, or high performance carbon materials. As this subtopic focuses on reactor development, proposals should clearly demonstrate existing pathways to integration of any necessary catalysts. Novel processes must show improvements to yield, selectivity, and economics compared to state-of-the art technology.

Questions - contact stephen.sikirica@ee.doe.gov

c. Carbon Fiber Production Processes

Due to their high strength-to-weight ratio, stiffness, and outstanding corrosion resistance properties, carbon fiber composites can be used to lightweight: vehicles, next generation blades for wind and other turbine technologies, and high pressure storage tanks for natural gas and hydrogen. Several challenges remain for carbon fiber composites to achieve widespread adoption. Current carbon fiber technology relies primarily on polyacrylonitrile (PAN) precursors, a polymer of acrylonitrile (ACN). ACN in turn is made from petroleum (propylene) and natural gas (ammonia) feedstocks. The precursor PAN-based material is subject to convection heating in an oxidation oven and subsequent high-temperature carbonization. These processes are energy-intensive and generate high levels of off-gases that must be treated before being released. To reduce these problems, EERE has supported potentially lower-energy methods of converting precursor material to the final fiber form such as the development of atmospheric plasma technologies and microwave assisted plasma-based technologies. [1]

Areas of particular interest include

<u>Low Energy Conversion of Polyacrylonitrile to Carbon Fiber:</u>

EERE is seeking innovative and novel processes that are less energy- and carbon- intensive compared to the standard oxidation and carbonization steps used to convert PAN-based precursors to carbon fiber. The deliverable for this area should demonstrate a minimum of 25% reduction in energy intensity over fiber production in current commercial practice. The deliverable must show, through the synthesis of carbon fiber, with sufficient experimental measurements and supporting calculations, that cost-competitive energy savings can be achieved with practical economies of scale. Applications should provide a path to scale up in potential Phase II follow on work. Applications involving the use of atmospheric plasma or microwave assisted plasma technologies are outside the scope of this topic area.

Novel Catalytic Routes to Direct Synthesis of Carbon Fiber from Gas or Solution Phase
Advances in the design and synthesis of solid atomically-precise enzyme-like catalytic structures offer the potential for direct conversion of low-cost chemicals to solid products [2-5]. AMO seeks to advance solid catalyst technology for the production of carbon fiber from low cost chemicals in a commercially competitive and scalable processing approach. The subtopic deliverable should demonstrate a minimum of 25% reduction in energy intensity over fiber production in current commercial practice. The deliverable must show, through the physics-based design and synthesis of atomically precise solid catalysts, (with sufficient experimental measurements and supporting calculations), that the technology could feasibly synthesize carbon fiber. It also must show that cost-competitive energy savings can be achieved with practical economies of scale. Applications should provide a path to demonstration of carbon fiber synthesis (if not actual synthesis), and to process scale up in potential Phase II follow on work.

Questions - contact kelly.visconti@ee.doe.gov

d. Novel Low Cost Recovery from Low Temperature Industrial Waste Heat

The industrial sector accounts for about 31 Quads [1] of energy consumption, more than any other sector in the American economy. An estimated 20-50% [2] of this energy consumption is lost as waste heat. While some of this waste heat is at high temperatures, and is easily recovered using conventional recovery technologies, a substantial portion - as much as 60% [3] - is at temperatures below 450ºF, often in highly diffuse form. While thermo-electric (TE) technologies can be used to convert this heat directly into electricity, their low efficiencies (<10%) and high costs (>3$/watt) make them unattractive options. Advances in nanotechnology and nanofabrication have enabled new direct conversion (heat to electricity) technologies that have the potential to surpass the performance of TE systems. Some illustrative examples include plasmonics [4], thermionic emission [5], and vibration energy harvesting [6].

Applications are sought for novel low-cost approaches to direct energy conversion for low temperature (<450ºF) industrial waste heat streams that could significantly improve the energy efficiency of the industrial sector. Responses outside of the examples above are welcome, as they are for illustrative purposes only. Performance targets include a conversion efficiency >30% [7] with a manufacturing cost <$1/W. The proposed technology must have adequate robustness for utilization in challenging industrial operations. Applications must show a credible path from early stage development through potential Phase II follow on work, to ultimate commercialization.

Questions - contact bob.gemmer@ee.doe.gov

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Subtopic a

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Subtopic b

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2. *Fueling the Future with Natural Gas: Bringing It Home.* (2014). IHS CERA. http://www.fuelingthefuture.org/assets/content/AGF-Fueling-the-Future-Study.pdf

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Subtopic c

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5. Center for Molecular Electrocatalysis. Pacific Northwest National Laboratory. http://efrc.pnnl.gov/

Subtopic d

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12. BIOENERGY

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**

Biomass is a clean, renewable energy source that can significantly diversify transportation fuels in the United States. The U.S. Department of Energy's Bioenergy Technologies Office (BETO) (http://energy.gov/eere/bioenergy) is helping to transform the nation's renewable and abundant biomass resources into cost-competitive, high-performance biofuels, bioproducts, and biopower. BETO is focused on forming partnerships with key stakeholders to develop, demonstrate, and deploy technologies for advanced biofuels production from lignocellulosic and algal biomass.

All applications to this topic must:

- Be consistent with and have performance metrics (whenever possible) linked to BETO's recently updated Multi-Year Program Plan (MYPP) that is available for download directly at: http://energy.gov/eere/bioenergy/downloads/bioenergy-technologies-office-multi-year-program-plan-july-2014-update
- Clearly define the proposed application, the merit of the proposed innovation, and the anticipated outcome with a special emphasis on the commercialization potential of the overall effort including Phase I and Phase II;
- Applications should provide a path to scale up in potential Phase II follow on work.
- Include quantitative projections for price and/or performance improvement that are tied to representative values included in the MYPP or in comparison to existing products. For example, projections of price or cost advantage due to manufacturing improvements, materials use, or design simplification should provide references to current practices and pricing to enable informed comparison to present technologies.
- Demonstrate commercial viability with a quantifiable return on DOE investment as described elsewhere in this FOA.
- Fully justify all performance claims with thoughtful theoretical predictions or experimental data.

a. Design and Fabrication of Solids Handling for Biomass Conversion Systems

Lack of continuous solids handling is one of the main barriers to continuous operation of biomass conversion systems. Robust handlers are needed to continuously move biomass feedstock from ambient conditions into a controlled reactor environment. Grant applications are sought for designs, prototype equipment, and procedures that enable continuous biomass solids handling at 10% lower cost than currently available. The continuous handling into a controlled reactor environment must meet the in-feed specifications of the conversion technology Examples of in-feed specifications are located in two design reports (PNNL-23053/NREL/TP-5100-61178; NREL/TP-6A2-46588) that are available electronically at http://www.osti.gov/bridge. Consideration will be given to ideas that allow for multiple feedstocks, easy manufacturability (including use of non-specialized construction materials), or other features that would enable feedstock from ambient conditions to be continuously moved into the reactor environment used by multiple conversion technology providers.

Questions - contact Mark Elless, mark.elless@ee.doe.gov

b. Low-Cost Coatings for Advanced Thermal Processes in Metal Combustors

As the use of biomass increases for power, products and fuels, one challenge is the reliability of the combustors in the harsh conditions in the reacting zone (high-temperature typically >600°C, with some local hot spots up to ~800 to 900°C). One of the most challenging components at the higher temperatures is the combustor made from lower-cost metal alloys. In addition to surviving the high-temperatures, the combustor must endure a corrosion/materials challenge due to the presence of both aggressive chemicals such as halide salts (e.g. NaCl, KCl, etc.) and water vapor released from the biomass fuel (e.g. grass, wood, charcoal, agricultural residue). When the need for low-cost alloys to permit widespread adoption of sustainable feedstocks is also considered, these conditions pose a major durability/cost challenge.

Grant applications are sought for the development of low-cost protective coatings for metal combustors. Coating approaches potentially of interest may include, but are not limited to: ceramic coatings, alloy coatings, aluminizing treatments, surface modifications/reactive surface treatments, thermal spray, wash coats, vapor deposition or sputtering (if sufficiently low cost), plating, and porcelains/enamels.

For this application's intended end-user market, the metal combustor component design must be produced for $5-10 (assume generic 0.5–1.0mm thick substrate alloy as a cylinder with a 15cm diameter and 30cm height), offer hot use lifetimes of several years (minimum of ~1000 hours per year) and comply with all federal, state and local emissions regulations. The candidate coatings should resist high-temperature corrosion, be compatible with lower-cost ferritic and/or austenitic substrate alloys (e.g. steels, 9Cr steels, lower alloyed 200 or 300 series stainless steels, FeCrAls), and be able to coat the (typically) curved inner surfaces of the combustor. Applicants must include a coating cost estimate task in the Phase I work plan This plan must include both coating raw material and processing for a simplified cylindrical wall inner surface (15 X 30 cm) that is projected for high volume production. The Phase I work plan should also include high-temperature corrosion screening assessments of the candidate coatings (small test sample form is acceptable) relative to the uncoated substrate alloy and/or a benchmark uncoated alloy such as a 300 series stainless steel or FeCrAl. The test conditions must be relevant to biomass, i.e. ≥ 600°C. Either lab furnace simulations or direct exposure are acceptable for Phase I work. The use of a salt or other relevant corrosive species in the high-temperature corrosion testing is encouraged but not required.

Questions - contact Neil Rossmeissl, neil.rossmeissl@ee.doe.gov.

c. Solid-Liquid Separations for Algal Systems

The recent growth in bioenergy R&D focus on algal systems is due in part to their high growth rate and high oil content. However, cost reduction is required for algal energy to become widespread. The cost of solid-liquid separation, including algae concentration and dewatering, is a critical driver for initial capital, energy and resource costs of algal fuel and products. Algae grown in open ponds and photobioreactors are dilute (0.1–0.5 grams per liter) and currently require multiple concentration steps. Multiple separation technologies might substitute for these multiple process steps, but only if these technologies are integrated in an optimal (unit operation) fashion. The purpose of this subtopic is to support such integration. Specifically it seeks commercial processing technologies that as a unit operation produces slurry with 20–30% solids from a dilute 0.5 grams/liter algal feed. The applicant should consider as a minimum the following technology options [1] for integration:

- Vacuum Filters
- Pressure Filters
- Hydroclones
- Screens and or sieving, and
- Gravity tables

Other technologies, such as flocculation, may be considered, provided the evaluations in the application consider the cost of the chemicals. For the required comparison of energy and cost parameters, the applicant must use – as a baseline – the integration of dissolved air floatation with centrifuges to achieve the desired solids concentration. Applications must show a final 25–30% reduction in capital cost [2], a 20% reduction in energy demand, and a solids concentration of at least 20%.

Questions - contact Neil Rossmeissl, neil.rossmeissl@ee.doe.gov

References:
Subtopic c

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13. 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 buildings' energy use by 50%, compared to a 2010 baseline. To secure these savings, research, development, demonstration, and deployment of next-generation building technologies in both the commercial and residential buildings sector are needed to advance building systems and components that are cost-competitive in the market. Energy efficient lighting has enormous potential to conserve energy and enhance the quality of our commercial, industrial and residential building inventory. Electric lighting now consumes ~1/10th of the primary energy delivered annually in the U.S., representing ~22% of the electricity produced. Energy storage and distributed generation technologies are used increasingly for base or peak load generation. BTO is dedicated to promoting the widespread and effective use of these technologies to meet its long term goal.

Grant applications are sought in the following subtopics:

a. Energy Efficient Solid-State Lighting Luminaires, Products, and Systems

The DOE has estimated that advancing energy efficient electric lighting in U.S. buildings could conserve more than 50% of lighting energy with corresponding savings in electricity costs to building operators. These technologies also could reduce costs with reductions in power generation load – especially during peak consumption. Although the DOE and the general illumination industry in North America have already realized substantial energy conservation in this end use, even more energy conservation is possible using advanced luminaire designs, constituent products and systems that take full advantage of the unique performance capabilities of Solid-State Lighting (SSL). This subtopic aims specifically at identifying and stimulating the commercial introduction of advanced and energy efficient SSL luminaires, SSL components and SSL systems in the three broadly defined categories below.
All applications to this subtopic must:

- Be consistent with and have performance metrics (whenever possible) linked to either the recently updated 2014 DOE SSL Multi-Year Program Plan (MYPP) [1] that is available for download directly at: http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_mypp2014_web.pdf or the DOE SSL Manufacturing Roadmap [2] available for download at: http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_mfg_roadmap_aug2014.pdf
- Clearly define the proposed application, the merit of the proposed innovation, and the anticipated outcome with a special emphasis on the commercialization potential of the overall effort including Phase I and Phase II;

- Include quantitative projections for price and/or performance improvement that are tied to representative values included in the MYPP or in comparison to existing products [3]. For example, projections of price or cost advantage due to manufacturing improvements, materials use, or design simplification should provide references to current practices and pricing to enable informed comparison to present technologies.
- Demonstrate commercial viability with a quantifiable return on DOE investment as described elsewhere in this FOA.
- Fully justify all performance claims with thoughtful theoretical predictions or experimental data.

<u>SSL Luminaires and Lamps</u> -- Today, SSL luminaires are widely available in an array of direct traditional source replacements and in common lamp replacements such as A-line lamps, PAR lamps, and small linear fluorescent lamps or compact fluorescent lamps. Luminaire designs are available with integrated SSL sources in flat panel architectures that directly replace wall sconces, decorative and safety lighting products and in suspended ceiling luminaires. New, novel and highly energy efficient designs are sought in any of these product areas that build on the unique performance attributes of the SSL source to achieve significant improvements in overall luminaires or lamp performance. Applications are sought for designs that are revolutionary, imaginative, impactful, and that could have a significant impact on introducing SSL in important general illumination markets. Designs that are already under development or that represent incremental or evolutionary improvements over current products are not of interest under this topic.

<u>SSL Components, contributing materials, constituents or integral products</u> – Many individual components and materials (for advanced optoelectronic device packaging/manufacturing) are used in the manufacture of SSL including highly-engineered intermediate products. These components include power supplies, current spreading devices, out coupling enhancement lenses, and specialty materials such as index matching silicones and epoxies [1]. Applications are sought for replacements or alternatives to these intermediate components, materials, or constituents that could significantly advance the performance of SSL products while simultaneously reducing cost or manufacturing complexity. Such intermediate dedicated products might be part of a thermal management solution, optical delivery and management architecture, power supply, or some other aspect of a modern, energy efficient SSL design. Successful applications should represent innovative, high performance and cost-competitive alternatives. Incremental or evolutionary advancements to existing materials, constituents, or intermediate products are not of interest.

<u>SSL Systems</u> – One of the most important performance attributes of SSL is their direct current (DC) operation, which makes them inherently compatible with digital controls, sensors (e.g. motion sensors, occupancy sensors, ambient light intensity and quality sensors) and DC renewable energy sources such as solar cells.

This attribute, however is not typically a featured element or capability of commercial SSL products. If this traditionally unused attribute were incorporated into SSL product design, their inherent power compatibility with other digital peripherals (due to avoided DC to AC to DC conversion) could lead significant energy conservation. Self-commissioning lighting control systems that easily accommodate variations in interior décor or seasonal adjustments in lighting quality are an example of how novel integration and digital controls may be able to conserve lighting energy much more easily with SSL than with most traditional light sources. It is also possible that advanced controls and digital features could accelerate the market penetration of various SSL luminaires or lamps by adding valued features not presently available with traditional sources. BTO therefore seeks novel system designs or integrated product concepts that represent both novelty and innovation in concept as well as demonstrable lighting energy conservation potential.

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

b. Integrated Storage and Distributed Generation for Buildings

DOE's BTO seeks to identify energy storage and distributed generation technologies not for emergency generation, but for base or peak load electricity generation in commercial and residential building stock. Applications must specify the intended market(s) for the technology and justify the improved performance relative to a representative building within that market. Preference will be given to technology solutions that are applicable to the existing building stock. Applicants are expected to provide quantitative analysis, with all assumptions clearly stated, that supports the performance and economic targets for the proposed technology.

Areas of interest include:

1) Integrated thermal and/or electrical energy storage systems for buildings that could reduce carbon emissions from the building sector by a minimum of 25% with the baseline defined by EIA [3].

Applications must meet the following requirements:

Performance: Reduction in operating carbon emissions (not embodied)
Minimum of 25% compared to an existing building (for retrofits) or a new building built to existing code. Greater carbon emissions reductions are anticipated for commercial buildings than residential buildings.

Economics: Simple payback including a full balance-of-system (with installation and any complementary distributed generation technology).The simple payback can take into account time-of-use and/or demand response utility rates, if applicable. Detailed justification that the calculated payback is acceptable for the intended market(s)

2) Building-Integrated Solar Electricity Generator (SEG) technologies to offset fossil-fuel primary energy consumption by 10% and 5%, respectively, for residential and commercial buildings. This subtopic is not focused on developing new solar electricity generators (SEG), but rather seeks to integrate SEGs with building materials.

Applications must meet the following requirements:

- Performance
- System integration (Inverter, storage, etc.)
- Reliability, aesthetics etc.
- Long-term durability relative to existing fire, structure, moisture, and acoustic codes; applications should illustrate that the proposed technology will not have detrimental impacts on the building structure or thermal performance
- Economics
- Cost of the integrated building material and SEG system
- Calculation of simple payback (the replacement building materials could be used as baseline); detailed justification that the calculated payback is acceptable for the intended market(s)
- Minimum added installation costs compared to replacement building materials

All applications for this subtopic should include modest feasibility studies in Phase I, and transition to manufacturing in Phase II. BTO strongly encourages applicants to include a strategy for obtaining partners in the building material industry by the end of Phase 1 as a part of their commercialization plan. Successful applications will offer products or components that provide value to customers at a greatly reduced cost (compared to the state-of-the art) or by being readily reconfigured to meet evolving market trends.

All applications to this subtopic must:

Clearly define the proposed application of the technology, the merit of the proposed innovation, and the anticipated outcome of the overall effort including Phase I and Phase II; and

Demonstrate commercial viability with a quantifiable return-on-DOE-investment as described elsewhere in this FOA.

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

References:
Subtopic a

1. *Solid-state Lighting Research and Development.* (2014). United States Department of Energy Energy Efficiency and Renewable Energy. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_mypp2014_web.pdf

2. *Solid-state Lighting Research and Development Manufacturing Roadmap*. United States Department of Energy Energy Efficiency and Renewable Energy. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/ssl_mfg_roadmap_aug2014.pdf

3. *Annual Energy Outlook 2014. (2014).* United States Energy Information Administration. http://www.eia.gov/forecasts/aeo/

Subtopic b

1. Overall Sector Wide Emissions.
http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2014&subject=13-AEO2014&table=17-AEO2014&region=1-0&cases=ref2014-d102413a

2. Overall Sector Wide Energy Consumption.
http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2014&subject=13-AEO2014&table=2-AEO2014&region=1-0&cases=ref2014-d102413a

3. Alternatively, applicants may use one number per state using the following table; however, they are expected to show the technologies' performance at a national level
http://www.eia.gov/environment/emissions/state/analysis/pdf/table7.pdf

14. 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's 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 U.S. transportation needs. A roadmap for the development of fuel cell and hydrogen technologies that guides FCTO investments aimed at lowering the related risks and costs can be found here: http://energy.gov/eere/fuelcells/fuel-cell-technologies-office-multi-year-research-development-and-demonstration-plan.

The FCTO aims to build on other early niche market successes in applications such as fuel cell-powered lift trucks by helping industry initiate another market in motive power applications and enable a robust domestic supply base. The FCTO Market Transformation subprogram helps drive down costs, develops a supply base, and provides a strategic pathway to high volume manufacturing as part of establishing an industry in transportation applications. This subprogram is a key component that moves technologies from the laboratory to self-sustaining commercialization in the marketplace. The subprogram's market-acceleration strategy evaluates and aids deployment of commercially ready fuel cell technology applications. The primary goal of the Market Transformation subprogram is to increase penetration of hydrogen and fuel cell technologies in key early markets by developing business cases for emerging commercial applications.

Grant applications are sought in the following subtopics:

a. Fuel Cell-Battery Electric Hybrid for Utility or Municipal MD or HD Bucket Trucks

Medium duty (MD) and heavy duty (HD) vehicles (Classes 3-8) consume 22% of the petroleum used annually by the United States vehicle fleet. This oil usage is driven primarily by the size of the vehicle fleet—about 11.9 million vehicles—and the age of the vehicle fleet, with about 4.2 million pre-2000 vehicles in operation. Low fuel economies and a slow turnover rate, with new vehicle sales averaging about 600,000 units annually, have resulted in continued high oil usage in class 3-8 vehicles. While diesel engines now dominate new vehicle sales of class 3-8 vehicles [1], the diesel share is declining. This decline is partly due to an increase in other types of vehicles including those based on gasoline engines; flex fuel engines, and alternative fuel engines, such as compressed natural gas engines and plug-in hybrid electric (PHEV) engines.

Vehicle electrification is underway for MD and HD bucket trucks, which are used by line crews employed by electric utilities, natural gas utilities, telecommunications companies, and municipalities. These trucks typically spend a significant amount of time (and diesel fuel) idling at the work site to power the truck's hydraulic boom, lights, auxiliary equipment, and cabin heating and cooling. Work crews also use emergency generators to supplement the power provided by the bucket trucks' internal combustion engines. Electric Power Take-off (ePTO) systems have been commercially introduced as a clean technology alternative to combustion engine idling to provide remote power to work crews [2]. The ePTO systems use batteries that are integrated into the bucket trucks, both with and without drivetrain integration. These batteries are either charged by the grid or while driving between work sites.

The FCTO seeks applications with projects that develop and demonstrate polymer electrolyte membrane (PEM) fuel cell-battery electric hybrid trucks for MD or HD bucket trucks with drivetrain-integrated ePTO systems. Low temperature PEM fuel cells operate on hydrogen fuel at relatively low temperature and are well-suited to both motive and stationary operation. PEMFCs are considered a key electric energy-conversion technology for this application. EPTO systems have an onboard inverter and a transfer switch breaker to enable the vehicle to serve as a portable backup power unit to support critical loads during power outages, thus eliminating the need for engine idling or use of remote generators including during emergencies, such as extended power outages. Utility and municipal fleets are a critical first market on the path to mainstream electrification. This subtopic aims to accelerate the development and production of cost-effective on-board, fuel cell-battery electric drivetrains that substantially increase the electric driving range and remote exportable power capabilities of bucket trucks used by utilities and municipalities.

Applications are sought for technology and business solutions that will help: establish a business case, mitigate the cost of hydrogen fuel infrastructure, supplement utility industry evaluations of introducing hydrogen generation on their grids, and demonstrate fuel cell-battery electric hybrid truck technologies.

<u>Expected Outcomes</u>

Phase I

- A design feasibility analysis and plan describing the power system and truck designs and specifics (e.g. cost, performance requirements). Plans should use well established references, including a model analysis report [3] by Argonne National Laboratory: "The Benefits of Using a Fuel Cell Auxiliary Power Unit to Double the Range of Current Battery Electric Vehicles," as guides 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.
- An economic assessment, including a payback analysis, concerning the use of hydrogen-fueled PEM fuel cells for fuel cell hybrid trucks used as MD or HD bucket trucks with drivetrain-integrated ePTO systems. Assessments should include intrinsic value proposition factors such as any operations or productivity gains (e.g. avoided residential community noise, energy and petroleum fuel savings, scheduled maintenance advantages, emissions reductions, availability of remote power during extended outages or remote service calls, and other benefits).

Phase II

- One (1) fuel cell power system unit (approximately10 to 30 kW) delivered and installed on commercially available MD or HD bucket truck with drivetrain-integrated ePTO system and tested for a minimum of 200 hours of real world operations.
- Final report describing operations testing performance results and a commercialization plan.

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

b. TECHNOLOGY TRANSFER OPPORTUNITY: In-line Quality Control Devices Applicable to PEM Fuel Cell MEA Materials

The FCTO has supported Manufacturing R&D to address industry-identified technical barriers to the scale-up of PEMFCs for mobile, stationary, and portable applications. One barrier to scale-up is the lack of in-line quality control techniques developed and validated for the continuous (roll-to-roll) production of membrane-electrode-assembly (MEA) components. FCTO supports the development and validation of in-line quality control techniques for MEA components production. The FCTO has funded the National Renewable Energy Laboratory (NREL) to develop non-destructive techniques with the resolution, sensitivity, and measurement rate to tackle this barrier. NREL has developed a suite of techniques applicable across all of the MEA components and has begun validating these techniques with state-of-the-art MEA materials. For example, NREL has used a direct current excitation/infrared detection diagnostic to map out material defects in moving gas diffusion media and catalyst-coated membrane sheets on a manufacturing webline. The thermal response from the fuel cell material (or absence of signal from a defect) is captured by an infrared camera. In addition, NREL has used an optical reflectance diagnostic to map material thickness and defects in moving membrane sheets on a manufacturing web-line. The reflectance signal from the fuel cell material (or absence of signal from a defect) is captured by an array detector. To encourage industry's uptake of these technologies, DOE seeks small businesses to design and develop commercially viable Quality Control (QC) devices for ultimate implementation by fuel cell and fuel cell component manufacturers. DOE expects that these devices could be applicable to a wide variety of industries and material sets beyond PEM fuel cell MEA components.

Applications are sought that meet the critical need for in-line quality control devices for PEM fuel cell MEA component manufacturing processes. Awardees must design and fabricate a QC device that is readily implementable in a roll-to-roll production line for the production of one or more MEA component materials. It is expected that the successful applicant will, using their own expertise in developing similar techniques, work to improve the resolution, sensitivity, measurement speed, or other critical parameters of the device. Awardees must develop a marketing plan for the device that would include but not be limited to the PEMFC industry, based on existing, emerging, and expected markets.

The work that is envisioned must involve Technical Transfer of NREL IP on optical techniques for monitoring continuous manufacturing of proton exchange membrane fuel cell components (U.S. Patent Application US13/405,129).

Licensing Information:
National Renewable Energy Laboratory
Contact: Anne Miller (anne.miller@nrel.gov; 303-384-7353); Ty Ferretti (ty.ferretti@nrel.gov; 303-275-4353)
Patent Status: U.S. PatentApplication: US13/405,129
USPTO Link: http://appft1.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PG01&p=1&u=/netahtml/PTO/srchnum.html&r=1&f=G&l=50&s1=20130226330.PGNR.

DOE Contact: Nancy Garland, nancy.garland@ee.doe.gov

References:
Subtopic a

1. Reference for diesel with a 77.5% share at the end of March 2014.

2. Edison Electric Institute. (2014). *Transportation Electrification: Utility Fleets Leading the Charge*. June 2014. www.eei.org/issuesandpolicy/electrictransportation/FleetVehicles/Documents/EEI_UtilityFleetsLeadingTheCharge.pdf

3. P. Sharer & A. Rousseau. (2013). *Fuel Cells as Range Extenders for Battery Electric Vehicles.* Department of Energy Hydrogen Program and Vehicle Technologies Annual Merit Review. Project ID Number MT012. May 15, 2013. Available at http://www.hydrogen.energy.gov/pdfs/review13/mt012_rousseau_2013_o.pdf

Subtopic b

1) http://www.hydrogen.energy.gov/pdfs/review14/mn001_ulsh_2014_o.pdf
2) http://www.hydrogen.energy.gov/pdfs/progress13/vi_1_ulsh_2013.pdf

15. 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's 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. Information on GTO priorities and future directions can be found in the fiscal year 2015 Budget overview at http://energy.gov/sites/prod/files/2014/03/f9/fy15_at-a-glance_gto.pdf.

In 2013, GTO outlined the underlying technology needs that will guide research and ultimately determine commercial success for geothermal energy production. Two strategic roadmaps trace the Energy Department's investments, past and present, and tie them to these needs to guide future GTO research. The report for geothermal exploration technologies can be found here: http://www.eere.energy.gov/geothermal/pdfs/exploration_technical_roadmap2013.pdf, and the report for Enhanced Geothermal Systems (EGS) can be found here: http://www.eere.energy.gov/geothermal/pdfs/stanford_egs_technical_roadmap2013.pdf.

GTO also conducts research, development, and demonstration projects throughout the United States on low-temperature and coproduced geothermal and geopressured resources. Recent funding opportunities have enabled GTO to support work that extends into sedimentary basins, including geothermal resources colocated within oil and natural gas fields. GTO strives to demonstrate innovative technologies that will lead to advanced geothermal and geopressured energy use and electricity production in these currently underutilized resource areas.

All applications to this topic must include:

- Specific performance metrics that, whenever possible, are consistent with and linked directly to the GTO roadmaps and priorities as described above,
- a description of the merit of the proposed innovation,
- anticipated outcomes of Phase I and Phase II,
- a path to phase up to potential Phase II follow on work, and a
- full justification for all performance claims based on thoughtful theoretical predictions or experimental data.

Grant applications are sought in the following subtopics:

a. **Innovative Products or Technologies that Develop New Markets/Revenue Streams for Geothermal Energy**

GTO seeks to fund the development and commercialization of innovative products or technologies that will expand current markets utilizing geothermal energy for electricity production or direct use applications. A major hindrance to the wider development and use of geothermal energy is high capital costs, modest market size, and limited technology penetration, which contribute to a lag in creating needed economies of scale. In the context of this subtopic, we define geothermal energy as any useful application of naturally occurring heat from beneath the earth's surface; however, GTO specifically excludes from this subtopic products or technologies that are solely improvements to geothermal ground source heat pumps. Expanding market accessibility to geothermal energy and technologies directly supports the President's Climate Action Plan goals of doubling renewable electricity generation by 2020 and doubling energy productivity by 2030.

As part of a response to this subtopic, applicants must clearly define their target market, describe why geothermal energy has either not been developed or has been under-utilized within that market, and describe how their proposed product or technology will increase wider penetration of geothermal energy. These markets can be geographic (i.e. eastern United States), new technological applications (i.e. power storage or other ancillary services), new revenue streams (i.e. cascading direct use), or others. GTO welcomes all innovations, whether they are high definition subsurface imaging or a waste heat bottoming cycle, so long as the applications include a detailed explanation of how the proposed product or technology could expand market availability to the geothermal energy sector. The applicant also must show how the proposed innovation will lead to a reduction in the risks and/or cost of geothermal energy technology development leading to new market commercialization.

Questions - Contact: Josh Mengers, joshua.mengers@ee.doe.gov

Applicants to Technology Transfer Opportunity (TTO) subtopic below should review the section describing Technology Transfer Opportunities on page 5 of this document prior to submitting applications.

b. **TECHNOLOGY TRANSFER OPPORTUNITY: Enabling Geothermal Co-produced Applications by Employing Electromagnetic Manipulation of Magnetizable Oil**

Coproduced resources use heat and/or pressure in fluids produced from oil, gas, and other material harvesting processes to generate electricity as well as in direct use applications. While the quality of the resource depends on water volume and temperature, these technologies have the potential to add value streams to existing operations. Applications for low-temperature geothermal energy beyond power generation (including material extraction, industrial processes, space heating and cooling, aquaculture, agricultural drying, water purification, and radiant heating) continue to gain ground in the United States.

Improving current oil/gas/water separation technologies has the potential to enable wider use of coproduced geothermal resources. GTO seeks to fund the further development and commercialization

of the electromagnetic manipulation of magnetizable oil (U.S. Patent No. 8795519-Fermi National Accelerator Laboratory) to create a product that separates hydrocarbons from other produced fluids to enable geothermal coproduced applications. For example, the technology can be used as part of a water purification system or a mineral recovery system. The application should make clear how the technology could reduce the costs of operation/waste disposal or add value by the recovery of a useful resource. In order to be selected, the proposed technology must incorporate the use of geothermal resources, which can be accomplished either by using the coproduced resource to power the operation of the technology or by clearly showing how the byproduct streams enable the coproduced resource to be further developed economically. The proposed technology also must be able to operate at commercial flow rates of a minimum of 10,000 barrels per day total volume, with the ability to accommodate larger volumetric flow rates preferred. The proposed technology should offer an improvement over current state of the art for the removal of dispersed oil, which consists of small droplets suspended in the aqueous phase that are typically 4-6 microns in size. Current treatment systems typically cannot remove droplets smaller than 10 microns. An ancillary goal of this project is to treat produced waters to the EPA limit of oil and grease (O&G) which is 42 mg/L daily maximum.
Fermi National Accelerator Laboratory Information:

Licensing Information:
Fermi National Accelerator Laboratory
Contact: Cherri Schmidt (cherri@fnal.gov; 630-840-5178)
TTO Tracking number: FAA-815
Patent Status: U.S. Patent 8,795,519 Issued 5 August 2014
USPTO Link: http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO2&Sect2=HITOFF&p=1&u=%2Fnetahtml%2FPTO%2Fsearch-bool.html&r=1&f=G&l=50&co1=AND&d=PTXT&s1=%22electromagnetic+boom%22&OS=

DOE Contact: Josh Mengers, joshua.mengers@ee.doe.gov

References:
Subtopic b

1. J. Veil, et al. (2004). *A White Paper Describing Produced Water from Production of Crude Oil, Natural Gas, and Coal Bed Methane*. Prepared by Argonne National Laboratory for the United States Department of Energy, National Energy Technology Laboratory. http://seca.doe.gov/technologies/oil-gas/publications/oil_pubs/prodwaterpaper.pdf

2. A. Fakhru'l-Razi, et al. (2009). *Review of Technologies for Oil and Gas Produced Water Treatment*. Journal of Hazardous Materials. Volume 170 Issues 2-3. pp. 530-551. Available at http://www.sciencedirect.com/science/article/pii/S030438940900778X

3. Balch, Robert, et al. (2012). *Cost-Effective Treatment of Produced Water Using Co-Produced Energy Sources for Small Producers*. RPSEA Small Producer Program Final Report. Available at http://www.rpsea.org/projects/07123-05/

16. 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:* **NO**
Accepting STTR Phase I Applications: **YES**	*Accepting STTR Fast-Track Applications:* **NO**

The Office of Energy Efficiency and Renewable Energy's SunShot Initiative (SunShot) (http://energy.gov/eere/sunshot/sunshot-initiative) is working in partnership with industry, academia, national laboratories, and other stakeholders to achieve subsidy-free, cost-competitive solar power by 2020. The potential pathways, barriers, and implications of achieving the SunShot Initiative price reduction targets and resulting market penetration levels are examined in the SunShot Vision Study (http://www1.eere.energy.gov/solar/sunshot/vision_study.html).

In this topic, SunShot seeks applications for the development of innovative and impactful technologies in the areas of:

(a) Analytical and Numerical Modeling and Data Aggregation
(b) Concentrating Solar Power: Novel Solar Collectors
(c) Concentrating Solar Thermal Desalination
(d) Grid Performance and Reliability
(e) Labor Efficiencies through Hardware Innovation

Applications may be submitted to any one of the subtopics listed above but all applications must: Propose a tightly structured program which includes technical milestones that demonstrate clear progress, are aggressive but achievable, and are quantitative;

Include projections for price and/or performance improvements that are tied to a baseline (i.e. SunShot targets and/or state of the art products or practices);

Explicitly and thoroughly differentiate the proposed innovation with respect to existing commercially available products or solutions;

Include a preliminary cost analysis;

Justify all performance claims with theoretical predictions and/or relevant experimental data

Grant applications are sought in the following subtopics:

a. 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.

Applications are sought for the development of innovative data and simulation tools. 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 performance 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 from residential, commercial, and utility scale installations to assign actionable, credible statistics for financing and underwriting; (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.

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

b. Concentrating Solar Power: Novel Solar Collectors

Concentrating solar power (CSP) collectors capture the solar flux and direct the photons to a receiver, where they are converted to heat. The heat is then typically absorbed by a fluid and transferred to a thermal energy storage unit or to a power block, where it is used to generate electricity. Collectors can be categorized as (i) non-tracking, (ii) single-axis tracking and (iii) dual-axis tracking. The greater the tracking control, the smaller the cosine losses. But this improved performance typically is at the expense of higher tracking costs. Well-established, commercial CSP collector designs include parabolic troughs and heliostats. Linear Fresnel and parabolic dish collectors have also been demonstrated, albeit at a smaller scale. CSP collector costs (including direct, indirect and O&M costs) were estimated in 2013 to account for approximately 40% of the levelized cost of electricity (LCOE) of a CSP power tower plant.

This subtopic seeks applications that demonstrate novel collector designs that could significantly reduce the contribution of solar collectors to CSP plant cost and surpass the 2020 SunShot CSP cost targets. Such collector designs may include optical waveguides with minimal-to-no tracking and microfluidics. (Note that low cost CS collector designs are also of interest in the subtopic "Concentrating Solar Thermal Desalination".)

The performance of CSP collectors is intimately coupled to the type of thermal receiver and heat transfer fluid. Successful applicants must demonstrate ability to meet the 2020 SunShot technical and cost targets for the solar collector subsystem (http://energy.gov/eere/sunshot/collectors-rd-csp-systems) in concert with the thermal receiver targets (http://energy.gov/eere/sunshot/receiver-rd-csp-systems) and the heat transfer fluid targets (http://energy.gov/eere/sunshot/multidisciplinary-university-research-initiative-high-operating-temperature-fluids).

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

c. Concentrating Solar Thermal Desalination

Competing demands for fresh water — among ecosystems, agriculture, municipalities, and industries — are affecting the value and availability of the critical fresh water resource. Three salt water desalination techniques are currently in use globally to produce fresh water from salt water at the industrial scale: reverse osmosis (RO), multi-stage flash distillation (MSF), and multi-effect distillation (MED). RO, the most widely deployed technique, filters water using a membrane to remove particulates. The major energy requirement is electricity to pump and pressurize the feed water. MSF thermally vaporizes salt water in a low-pressure chamber and directs the resultant steam into a collection reservoir where it is condensed. MSF plants require heat for creating the steam and electricity for pumping. MED is similar to MSF, but rather than a single low-pressure chamber, a series of chambers is utilized, each with a lower pressure than the preceding chamber. As with MSF, MED requires both thermal and electrical energy, but MSF has the advantage of being able to operate at a lower brine water temperature.

The industrial-scale and heat requirements of MSF and MED make concentrating solar thermal desalination a potentially value-adding, cost-reducing alternative to conventional sources of thermal energy for desalination. In addition, concentrating solar thermal MSF and MED systems use lower-cost renewable energy; have lower sensitivity to water salinity; can more easily operate off-grid; have reduced demand for high-value electricity; and produce less chemical waste than RO systems. However, large-scale solar thermal MSF and MED are approximately four times more expensive than RO (given a cost of nearly $2.00/m^3 of fresh water).

This subtopic seeks to identify and invest in concentrating solar thermal MSF and MED technologies that can meet and beat RO desalination costs (~$0.50/m^3 fresh water) by reducing the levelized cost of solar thermal energy (in terms of $/kWh$_{th}$). By targeting a relatively low temperature output (<150°C for thermal desalination vs. >650°C for cost-effective solar electric power generation), ultra-low cost solar thermal collection strategies can reduce energy costs. Use of non-tracking collectors (to eliminate expensive drive/control mechanisms), low-cost materials (e.g. polymers), reduced site preparation (to enable rapid field construction), and integration with low-cost, low-temperature thermal energy storage, in addition to other innovations, could lower the cost of the heat input such that concentrating solar desalination can compete with RO desalination.

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

d. Grid Performance and Reliability

The SunShot Systems Integration (SI) Grid Performance and Reliability activity area focuses on achieving high penetration of solar generation at both the transmission and distribution levels in a cost-effective manner, while ensuring safety and reliability of the grid. It is SunShot's intent to not only preserve but also enhance the performance and reliability of the entire power system operating with high penetration of solar generation. SunShot SI target metrics are as follows:

- High penetration of solar generation at levels greater than 100% of today's peak load
- Reduced interconnection approval time for solar projects to less than 1 week on average
- Reduced interconnection costs for solar projects to less than USD $1,000 on average
- Exceeding present and future ANSI, IEEE and NERC grid performance standards (http://grouper.ieee.org/groups/scc21/1547/1547_index.html)

Applications are sought for advanced methodology and software that will interface with existing utility legacy software and hardware systems to (i) aggregate, visualize, analyze and control multiple photovoltaic (PV) generation installations at the distribution feeder, substation and sub-transmission level in real-time; (ii) collect, analyze and process enormous and complex amount of feeder, load and PV data in real-time; (iii) quantify and analyze both positive and negative impacts of PV on the four distribution reliability metrics (System Average Interruption Duration Index (SAIDI),System Average Interruption Frequency Index (SAIFI), Customer Average Interruption Duration Index (CAIDI) and Average Service Availability Index (ASAI)) that are based on economic, technical and time series analysis; (iv) create engineering analysis tools for distribution planning and operation to pro-actively mitigate before a perturbation occurs, potential high PV penetration grid impacts; (v) provide a cloud-based "hub" for electric utilities to access the various advanced PV tools, PV engineering analysis best-practices, technical resources and reliability benchmarking; and (v) expedite the utility PV interconnection technical screening process and lower interconnection costs.

Applications are also sought for advanced open source tools that automate data exchange between PV and utility software systems and promote interoperability between existing utility legacy software and new systems. Emerging bulk transmission and dynamic open source 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 potential high PV grid impacts, recommend mitigation solutions, and provide advanced capabilities for system planning and grid operations with high penetration of PV. With these innovative tools, utilities' concerns about the uncertainty of PV impact on the grid are significantly decreased, thereby allowing higher level of PV penetration to be integrated on the distribution system. In addition, these advanced tools can significantly enhance the utility distribution planning and operational capability, reduce the expensive interconnection study fees paid by developers, reduce turnaround time for initial determination, allow more PV installations to pass the interconnection screens, and ultimately expedite cost-effective deployment of PV generation on distribution and transmission systems.

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

e. Labor Efficiencies through Hardware Innovations

Installing a photovoltaic (PV) system requires both electrician and non-electrician labor such as assembling the module, racking and mounting or ballasting it, running conduit, and connecting the inverter, meter, and disconnect. In the United States, PV installation is complicated by the heterogeneity of installation platforms, component materials, electric systems, and utility requirements making streamlining efforts more difficult. Optimizing system performance typically requires both a custom system design and a custom installation—each with added costs.

Applications are sought for hardware innovations that reduce installation labor costs** by increasing labor efficiency or reducing the process complexity required to install a PV system. Installation cost reduction opportunities include: (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. Successful applicants must quantify the achievable cost reductions and justify the economic viability of the proposed product assuming near term (<5 years) industry deployment. (**The SunShot Initiative targets a reduction in total commercial installation labor costs from $0.42/W in 2010 to $0.07/W by 2020; for residential systems, $0.59/W to $0.12/W, respectively).

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

17. 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 Vehicle Technologies Office (VTO) (www1.eere.energy.gov/vehiclesandfuels/) focuses on reducing the cost and improving the performance of vehicle technologies that can reduce petroleum dependency, including advanced batteries, electric traction drive systems, lightweight materials, advanced combustion engines, and advanced fuels and lubricants. VTO supports the development and deployment of advanced vehicle technologies, including advances in electric vehicles, engine efficiency, and lightweight materials. Since 2008, the Department of Energy has reduced the costs of producing electric vehicle batteries by more than 35%. DOE has also pioneered better combustion engines that have saved billions of gallons of petroleum fuel, while making diesel vehicles as clean as gasoline-fueled vehicles.

Applications that duplicate research already in progress or that are similar to applications already reviewed by DOE this year will not be funded; all submissions therefore should clearly explain how the proposed work differs from other work in the field.

Grant applications are sought in the following subtopics:

a. Electric Drive Vehicle Batteries

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

When appropriate, technology should be evaluated 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 I 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. Applications will be deemed non-responsive if the proposed technology is high cost; requires substantial infrastructure investments or industry standardization to be commercially viable; and/or cannot accept high power recharge pulses from regenerative breaking or has other characteristics that prohibit market penetration. Applications deemed to be duplicative of research that is already in progress or similar to applications already reviewed this year will not be funded; therefore, all submissions should clearly explain how the proposed work differs from other work in the field.

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

b. SiC Schottky Diodes for Electric Drive Vehicle Power Electronics

Power electronic inverters are essential for electric drive vehicle operation. DOE R&D targets and research pathways for inverters are described in both the U.S. DRIVE Partnership Electrical and Electronics Technical Team Roadmap [1] (http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/eett_roadmap_june2013.pdf) and EV Everywhere Blueprint [2] (http://energy.gov/sites/prod/files/2014/02/f8/eveverywhere_blueprint.pdf). These documents discuss both performance benefits of and the barriers (including high cost) — to high volume automotive adoption of wide bandgap (WBG) semiconductors. With large area (>150 mm, or 6") SiC epiwafer is available from a large number of qualified suppliers. The SiC device industry is approaching the same cost-competitiveness as the silicon power device industry, where the cost of fabrication is the primary driver of device costs, and high device yield enables low overall device costs.

The devices that are best positioned to be an early adopter of these SiC epiwafers are SiC Schottky diodes, which offer 100X smaller on-state resistance as compared to Si and GaAs diodes and enable very high power density inverters for use in electric drive vehicles. The high switching speed of SiC diodes also provides significantly increased efficiencies for power inverter applications. While lower current (<50A) SiC Schottky diodes offered by a few SiC device suppliers have already penetrated solar and computer power supply manufacturers, higher, >100 A current remains a key threshold for automotive applications.

VTO seeks applicants to overcome this SiC device current threshold barrier by demonstrating production of >100A, >600V rated diodes suitable for use in electric-drive vehicle traction motor inverters. Specifically, devices produced should show automotive application readiness by passing qualification specifications or standards while achieving high yields. Where possible, applicants should show a relationship to, and demonstrate an understanding of automotive application requirements and environments. Example approaches for applicants include surface and/or substrate treatments and processing and compatibility with existing wire bond power module processing. Applications should also describe the cost of manufacturing SiC diodes compared to competing silicon diodes, including details such as costs and availability of commercial SiC substrates, epilayers, and additional equipment needed. Applications should link these costs to a commercially viable business model for scale up and increased production that could be executed in Phase II.

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

c. Onboard Fuel Separator or Reformer

On-board fuel separation or reformation has the potential to overcome infrastructure (e.g. pipeline, dispenser material compatibility) and consumer challenges associated with introducing fuel streams with specific desirable characteristics, such as very high-octane or evaporative cooling capability, during vehicle operation. After overcoming such challenges, these fuel streams would be able to positively affect the combustion process and result in increased efficiency for automotive vehicles. On-board separation/reformation technologies, if successful, could accelerate the deployment of vehicles with more efficient combustion designs that require specific fuel streams characteristics during some driving modes.

The technology developed under this subtopic must be capable of separating or reforming convention fuels and be packaged on conventional light or heavy duty vehicles without disrupting the existing system. The developed prototype must be capable of demonstrating a net 10% fuel economy improvement, and cost to manufacture on a production basis must not exceed $200/unit.

Questions - Contact: Roland Gravel, roland.gravel@ee.doe.gov

d. Alternative Crank Mechanisms for Internal Combustion Engines Leading to Improved Energy Efficiency

Reciprocating internal combustion (e.g. gasoline or diesel) engines for automotive applications use slider/crank mechanisms to create torque on an engine's output shaft from forces applied to pistons as a result of the pressure created by the combustion of fuel. While direct mechanical losses of traditional slider/crank mechanisms are small, there is another indirect loss as a consequence of slider/crank use. Early in an engine's power stroke, cylinder temperatures—and therefore convective and radiative heat losses—all peak. The engine’s rate of performing work is still very low reducing energy efficiency. The net effect may be that slider/crank mechanisms indirectly lead to preventable energy losses and reduced energy efficiency.

Applications must propose the development of a functioning prototype of a mass-produced, commercially available reciprocating engine, modified with an alternative mechanical mechanism linking the piston to the engine's output shaft is desired. Reporting must include fuel consumption test results over the entire engine map of the prototype compared with a second, unmodified, otherwise identical engine. All fuel consumption testing must be conducted according to engine industry norms. Statistically valid fuel economy improvements (95% confidence level) of at least 5.0% are desired.

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

e. Advanced Ignition System for Internal Combustion Engines Enabling Lean-Burn and Dilute Gasoline Ignition

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

For Phase I, prototype ignition systems 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%.

Typical candidates for this effort are advanced ignition systems such as laser ignition, microwave ignition, and plasma jet ignition. Prechamber combustion systems are not of interest for this subtopic. Questions – contact: Leo Breton, leo.breton@ee.doe.gov

References:
Subtopic b

1. *Electrical and Electronics Technical Team Roadmap.* (2013). U.S. DRIVE Partnership. http://www1.eere.energy.gov/vehiclesandfuels/pdfs/program/eett_roadmap_june2013.pdf

2. *EV Everywhere Grand Challenge Blueprint. (2013).* United States Department of Energy. http://energy.gov/sites/prod/files/2014/02/f8/eveverywhere_blueprint.pdf

18. WATER

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 and Water Technology Office's Water Program seeks applications for innovation in small hydropower, marine, and hydrokinetic (MHK) technologies. The Water program (http://energy.gov/eere/water/water-power-program) researches, tests, evaluates, and develops innovative technologies capable of generating renewable, environmentally responsible, and cost-effective electricity from water resources. This includes hydropower, as well as marine and hydrokinetic energy technologies, which capture energy from waves as well as riverine, tidal, and ocean currents.

Grant applications are sought in the following subtopics:

a. Innovative Small, Low-head Hydropower Turbines

Almost 40GW of the undeveloped hydropower stream-reach resource potential identified by the Oak Ridge National Laboratory (http://nhaap.ornl.gov/sites/default/files/ORNL_NSD_FY14_Final_Report.pdf) may require turbine-generator units operating at less than 25 feet of head to be used. Applications are sought for innovative small hydraulic turbine prototypes or integrated small hydropower turbine-generator unit prototypes that can generate from 50kW to 5MW power at heads less than 25 feet. Key areas of interest include advanced materials and manufacturing for powertrain components, innovative hydrodynamic and mechanical concepts to reduce machinery size, favorable efficiency over a range of head and flow rates, low initial cost, durability and ease of replacement. Proposed innovations should be amenable to scaling in the amount of head, flow, and power.

Questions – contact: Rajesh Dham, rajesh.dham@ee.doe.gov

b. Prognostic & Health Monitoring of MHK devices

Commercial-scale marine and hydrokinetic (MHK) energy converters are large, often highly dynamic devices operating in a harsh marine environment. Servicing these devices at sea is a difficult and costly operation. As such, minimizing the maintenance frequency and failure frequency of these devices has the potential to reduce the MHK levelized cost of energy. Prognostic and health monitoring (PHM) systems anticipate and identify relevant changes to device health, informing optimal maintenance schedules and issuing warnings and alarms which may then inform human operators, initiate alternate device dynamic control sequences, and/or initiate the device survival mode; mitigating damage to the devices and maximizing availability.

Grant applications are sought for innovative PHM systems optimized for use in tidal, current, wave, and/or ocean thermal energy converters. Successful applications must propose methods and technologies to identify and monitor modes of fault/failure specific to an archetypal MHK device (e.g. point absorber, axial flow turbine), specify the anticipated interaction of the PHM system with the control and survivability modes of the device, and outline plans to assess the market potential of the system. PHM methods and technologies which are broadly applicable across MHK energy converters are strongly encouraged.

Questions – contact: Rajesh Dham, rajesh.dham@ee.doe.gov

References:
Subtopic a

1. S. Kao, et al. (2014). *New Stream-reach Development: A Comprehensive Assessment of Hydropower Energy Potential in the United States.* Prepared by Oak Ridge National Laboratory for the United States Department of Energy Wind & Water Power Technologies Office. http://nhaap.ornl.gov/sites/default/files/ORNL_NSD_FY14_Final_Report.pdf

19. 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 Program, part of the Wind and Water Power Technologies Office (www.eere.energy.gov/wind/), seeks applications for innovations that significantly advance the goal of large cost reductions in the deployment of U.S. wind power resources by exploring technologies that enable the production of larger wind turbine rotors through active load alleviation.

Grant applications are sought in the following subtopic:

a. Active Load Alleviation Strategies for Wind Turbine Blades

There has been an increasing trend among wind turbine Original Equipment Manufacturers (OEMs) to increase the length of the rotor blades to allow wind plants to operate economically in the low wind speed sites around the world. While a larger rotor for a given MW rating can increase the capacity factor of the plant, the design of such a rotor is challenging. To keep costs down, transportation logistics, manufacturing constraints, and turbine design load constraints must all be addressed effectively. Recently, turbine designers have adopted passive load alleviation strategies that allow them to increase the length of the blades without incurring severe weight penalties.
The Wind program, strategy, in this topic, is to focus on *active* control strategies to manage and mitigate loads experienced by the turbine within its design envelope. While active load alleviation holds the promise of being more versatile than passive strategies, it is also inherently more risky. Significant R&D issues such as fatigue leading to increased maintenance/repair and reduced reliability, must be addressed before these technologies will be accepted by turbine manufacturers and integrated into the next generation of large wind turbine blades to become part of their product offering.

A new generation of active load control strategies that can be economically manufactured and integrated into turbine blades could significantly increase wind deployment at low wind speed sites. Grant applications are sought for innovative active wind turbine blade load alleviation concepts with the potential to serve as competitive alternatives to current passive load alleviation strategies. Successful applications must develop, mature, and de-risk the technology to the point that it is ready to be integrated into a turbine blade design. Applicants must identify and solve problems related to manufacturing, integration into the blade manufacturing process, reliability of the technology, routine maintenance and repair.

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