



NASA STTR 2017 Phase I Solicitation

T3.01 Energy Harvesting, Transformation and Multifunctional Power Dissemination

Lead Center: SSC

Participating Center(s): GRC, JSC, KSC, MSFC

Technology Area: TA3 Space Power and Energy Storage

The NRC has identified a NASA Top Technical Challenge as the need to "Increase Available Power". Additionally, a NASA Grand Challenge is "Affordable and Abundant Power" for NASA mission activities. As such, novel energy harvesting technologies are critical toward supporting future power generation systems to begin to meet these challenges. This subtopic addresses the potential for deriving power from waste engine heat, warm soil, liquids, kinetic motion, piezoelectric materials or other naturally occurring energy sources, etc. Development of energy harvesting (both capture and conversion) technologies would also address the national need for novel new energy systems and alternatives to reduce energy consumption. Conversion and transformation technologies for gathering energy naturally occurring in conjunction with induced energies are being pursued, and novel technologies capable of artificially saturating an environment with energy for storage and power dissemination along with non-conventional transmission via the surrounding environments such as wireless power are also applicable. Energy gathering is limited by the quantity of energy available within a system's immediate environment, and often the environment's energy contains prolonged periods of lulls in harvestable energy. Technologically bridging power from a distance would fundamentally alleviate issues with low energy environments by allowing energy to be supplementally broadcast through preexisting structures and environments while simultaneously reducing docking and interfacing for power transfer.

Technology development should support powering small remotely located equipment such as wireless instrumentation, or support power gathering for independently providing supplementary power to centralized equipment such as control consoles. Distributed Nano energy generating technologies are applicable for gathering scattered environmental energies into significant amounts of accumulated power along with supplementation for long-duration power utilization. This kind of distributed power should also be able to recover waste energy from rocket, nuclear, fission, and electrical propulsion devices while providing enhanced protection from energies contained within the work environment through transformation and consumption. Transforming harmful radiation, elevated temperatures, unwanted vibrations etc. into usable energy will support increased scope and duration of missions while enhancing protection from the waste energies (mitigation by transformation and consumption). Waste energies from warm soil, liquids (water, oils, hydraulic fluids), kinetic motion, piezoelectric materials, or various naturally occurring energy sources, etc. should also be transformable.

Areas of special focus for this subtopic include consideration of:

- Innovative technologies for the efficient broadcast, capture, regulation, storage and/or transformation of acoustic, kinetic, radiant (including radiation), electric, magnetic, radio frequencies and thermal energy types.
- Technologies which can work either under typical ambient environments for the above energy types and/or

under high intensity energy environments for the above energy types as might be found in propulsion testing and launch facilities.

- As above, energy capture, transmission and transformation technologies that can work in very harsh environments such as those which are very hot and/or ablative (e.g., in the proximity of rocket exhaust) and/or very cold (e.g., temperatures associated cryogenic propellants) may be of interest.
- Innovations in miniaturization and suitability for manufacturing of energy capture, transmission and transformation systems so as to be used towards eventual powering of assorted sensors and IT systems on vehicles and infrastructures.
- High efficiency and reliability for use in environments that may be remote and/or hazardous and having low maintenance requirements.
- Employ green technology considerations to minimize impact on the environment and other resource usage.

- Reliable nano-engineered concept designs for generating charge and charge storage devices powering miniature (or “nano”) devices, such as members of a “swarm” are needed for exploration purposes. Designs should be capable of easy integration to miniaturize systems, subsystems, satellites, or “swarm” elements without compromising capability.
- Designs should maximize high energy density for charge storage with very low mass.

Rocket propulsion test facilities within NASA provide excellent test beds for testing and using the innovative technologies discussed above because they offer a wide spectrum of energy types and energy intensities for capture and transformation. Additional Federal mandates require the optimization of current energy use and development of alternative energy sources to conserve on energy and to enhance the sustainability of these and other facilities. Specific emphasis is on technologies which can be demonstrated in a ground test environment and have the ability/intention to be extrapolated for in-space applications such as on space vehicles, platforms or habitats. Energy transformation technologies to generate higher power output than what is presently on the market are a highly desired to an expected outcome from this subtopic.

Phase I will develop feasibility studies and demonstrate through proof-of-concept demonstrations. Phase II will develop prototypical hardware and demonstrate infusion readiness to be incorporated into other products.