NASA SBIR 2005 Phase I Solicitation

X3.01 Power Generation & Transmission

Lead Center: GRC

Participating Center(s): JPL, MSFC

All innovative technologies for power generation and conversion are highly encouraged under this subtopic. Proposals addressing technologies, including solar photovoltaic conversion, thermo-photovoltaic conversion, thermoelectric conversion, and thermodynamic conversion (heat engines), etc., are encouraged. In addition, research and technology development in topics related to advanced power cabling and power management are also needed.

Significant improvements in photovoltaic systems are required to enable future exploration missions. Dramatic increases in array mass specific power (>1000 W/kg), reductions in stowed volume, increases in operational voltages to 1000V, increases in radiation hardness enabling reliable operation in high-radiation environments, increases in survivability over wide temperature extremes, as exists on a lunar surface, and developments of automated deployment systems for surface power applications. Developments are sought for photovoltaic cells on flexible, ultra-lightweight substrates, array technologies that maintains the high mass specific power of these cells, nanostructures incorporated to enhance the performances of thin-film, organic/inorganic, or single-crystal photovoltaic cells and thermo-photovoltaic cells. Demonstrations of high efficiency, lightweight, concentrator cell and supporting array techniques, multi-quantum well and multi-quantum dot devices, and advanced multi-band gap devices are also of interest. Advanced photovoltaic areas of emphasis include high-efficiency quantum well technology. Nano-engineered materials are an area of emphasis for all of these applications.

High power solar dynamic power conversion systems, including Brayton and Stirling, support the development of solar-electric propulsion and power systems requiring low overall system specific mass (kg/kW). The objectives for solar dynamic systems, with power output capacities ranging from 100W to >100kW, require demonstrating thermal efficiencies greater than 30% over a range of cycle temperature ratios and heat rejection temperatures. A system specific mass of

Technological advances are needed for large deployable solar concentrators and secondary concentrators, high temperature heat receivers with thermal energy storage capability, and advanced lightweight heat rejection sub-systems. For Brayton power, advances are needed in ceramic high temperature turbine technology, high efficiency compressors matched to turbine performance, high efficiency alternators, lightweight carbon composite heat exchangers and recuperators.

For Stirling, advances required are: high frequency, low inductance linear alternators, low mass displacer, hot-end materials and structures, efficient cold-end thermal integration with lightweight radiators, high efficiency low mass controllers, and regenerators.

For power management and distribution systems, areas of emphasis include: high reliability, light weight, radiation-hardened power electronic components (semiconductor switches, diodes, capacitors, and transformers); high voltage switching contactors (>100Vdc) tolerant to corona discharge; and high efficiency (>95%) modular DC converters for boost and buck conversion. Concepts for monitoring power system status, fault tolerance, redundancy, and energy management. Advanced power cabling including high voltage, superconductors, carbon
nanotube, and cable embedded with structural elements. Also of importance are intelligent and modular distribution switchgear and power management that can autonomously reconfigure in response to faults and changing loads.

Research for Wireless Power Transmission (WPT) technology development, to reduce the cost of electrical power and to provide a stepping stone to NASA for delivery of power between objects in space, between space, and surface sites, between ground and space, and between ground and air-platform vehicles. WPT can involve lasers or microwaves along with the associated power interfaces. Microwave and laser transmission techniques have been studied with several promising approaches to safe and efficient WPT identified. These investigations have included microwave phased array transmitters, as well as visible light laser transmission, and associated optics. There is a need to produce "proof-of-concept" validation of critical WPT technologies for both the near-term as well as far-term applications. These investments will be harvested in near-term, beam-safe demonstrations of commercial WPT applications. Proposals are sought that include such activities as the technology elements, architecture, and demonstration programs for wireless transmission of power. Receiving sites (users) include ground-based stations for terrestrial electrical power, orbital sites to provide power for satellites and other platforms, future space elevator systems, and space-based sites for spacecraft and space vehicle propulsion.