Work Began on Contracts for Radioisotope Power Conversion Technology Research and Development

NASA has had a history of successful space flight missions that depended on radioisotope-fueled power systems. These Radioisotope Power Systems (RPSs) converted the heat generated from the decay of radioisotope material into useful electrical power. An RPS is most attractive in applications where photovoltaics are not optimal, such as deep-space applications where the solar flux is too low or extended applications on planets such as Mars where the day/night cycle, settling of dust, and life requirements limit the usefulness of photovoltaics. NASA's Radioisotope Power Conversion Technology (RPCT) Program is developing next-generation power-conversion technologies that will enable future missions that have requirements that cannot be met by the two RPS flight systems currently being developed by the Department of Energy for NASA: the Multi-Mission Radioisotope Thermoelectric Generator and the Stirling Radioisotope Generator (SRG).

RPCT performance goals include improvement over the state-of-practice General Purpose Heat Source/Radioisotope Thermoelectric Generator (GPHS-RTG, 7-percent efficiency and 5 W/kg at the beginning of the mission) by providing significantly higher efficiency to reduce the number of radioisotope fuel modules and to increase specific power (watts/kilogram). Other general RPCT goals include safety, long-life (14 years, with well-understood degradation), reliability, scalability, multimission capability (in vacuum and atmosphere), resistance to radiation (from the GPHS-RTG or potential mission environments), and minimal interference with the scientific payload.

The RPCT Program has awarded five development contracts using more mature technologies (technology readiness levels (TRLs) 3 to 5) and five research contracts using less mature technologies (TRLs 1 to 3). The selections include a broad range of conversion technologies including dynamic technologies (free-piston Stirling and turbo-Brayton), and static technologies (thermoelectric and thermophotovoltaic). Most of the contracts are developing technologies applicable to a nominal 100-W-class RPS, but two of the research contracts using thermoelectrics are specific to a low-power RPS (milliwatt to multiwatt class). Each contract has a performance period of 3 years and will be divided into three 1-year phases, with options to continue the following phase after the conclusion of each phase.

The five higher TRL development contracts, along with the contractor's performance estimates at the end of phase I, are shown in the following table:

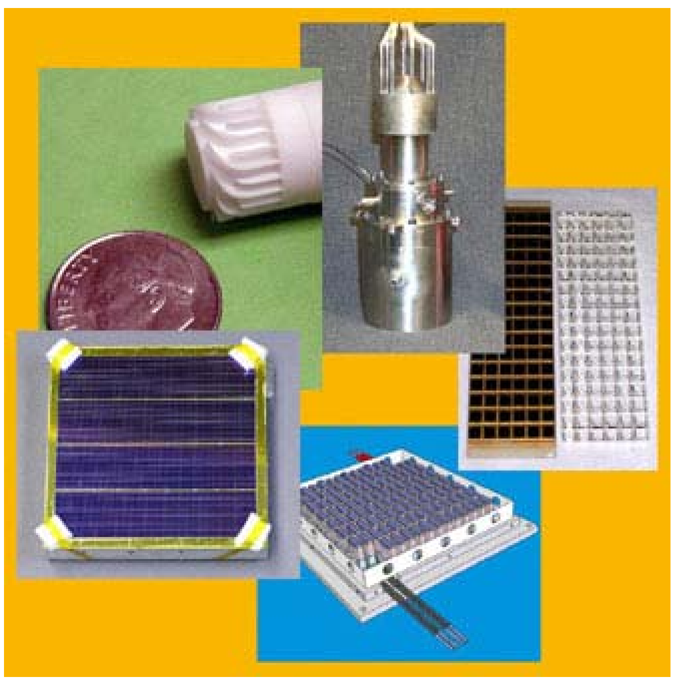
Company	Technology	Direct-current power, We	Efficiency, percent	Specific power, W/kg
Creare, Inc.	Precision fabricated miniature-rotor turbo-Brayton power converter	60	25	9
Creare, Inc.	Thermophotovoltaic converter using InGaAs cells[a]	85	>15	10
Edtek, Inc.	Thermophotovoltaic converter using GaSb cells[b]	80	16	14
Sunpower, Inc.	Advanced free-piston Stirling convertor	82	37	10
Teledyne Energy Systems, Inc.	Segmented thermoelectrics using Bi-Te with PbTe, and PbSnTe/TAGS[c]	24	10	3.2
[a]InGaAs, indium gallium arsenide.				
[b]GaSb, gallium antimony.				
[c]Bi-Te, bismuth-tellurium; PbTe, lead-tellurium; PbSnTe/TAGS, lead-tin-tellurium/tellurium-antimony-germanium-silver.				

The five lower TRL research contracts, which may only deal with components, are summarized in the final table:

Company	Technology	Power	Efficiency, percent
Cleveland State University	Microfabrication Stirling regenerator	6- to 9-percent gain for Stirling convertor	--------
Essential Research, Inc.	Dot-junction InGaAs-on-InP cell for thermophotovoltaics[a]	--------------------	30
Hi-Z, Inc.	Multiwatt quantum well Si-Ge thermoelectrics[b]	--------------------	30
Massachusetts Institute of Technology	Nanostructure Si-Ge thermoelectricsb	--------------------	12 to 14
Teledyne Energy	Cascaded superlattice	50- to 100-	>8

Systems, Inc.	PbTe/TAGS BiTe Thermoelectric[c]	mW module	
[a]InGaAs-on-InP, indium gallium arsenide on indium phosphide.			
[b]SiGe, silicon germanium.			
[c]PbTe/TAGS, lead tellurium/tellurium-antimony-germanium-silver; BiTe, bismuth tellurium.			

A Government-led Advanced RPS Systems Assessment Team was formed, with members from the NASA Glenn Research Center (lead), the Jet Propulsion Laboratory, the Department of Energy, and Orbital Sciences Corporation. The team's function is to review the technologies being developed under the 10 RPCT contracts, assess their relevance to NASA's future missions, and provide recommendations to the RPS program with regard to status of the technology, technology development options, phase-to-phase funding, and potential down-selection. The team also is responsible for using the RPCT technologies to develop conceptual RPS designs and for projecting system-level performance.



Collage of hardware and designs developed during the RPCT phase-I development contracts, representing Brayton, Stirling, thermoelectric, and thermophotovoltaic technology.

Find out more about this research at http://www.grc.nasa.gov/WWW/tmsb/

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