Sources Sought Notice
Next-Generation Radioisotope Thermoelectric Generator (RTG) Systems for Space Power Generation

General Information:

Solicitation Number:	INL-18-012
Posted Date:	June 21, 2018
Proposal Due Date:	August 6, 2018
Recovery and Reinvestment Act Action:	No
Classification Code:	A - Research and Development
Issued By:	Battelle Energy Alliance, LLC
NAICS Code:	541715
CFDA Number:	43.001 Science

Battelle Energy Alliance, LLC (BEA), the Management and Operating Contractor of the Idaho National Laboratory (INL) for the Department of Energy (DOE), in partnership with the National Aeronautics and Space Administration (NASA) Glenn Research Center (GRC), releases this Sources Sought Notice (SSN) for capabilities, ideas and information that could lead to a potential industry/Government contract for development of a vacuum rated Radioisotope Thermoelectric Generator (RTG) system to support science missions. It is the intent of the BEA and GRC to use this information for market research and program planning purposes, with the goal of promoting competition where possible.

SSN respondents are requested to complete and submit the Next-Generation RTG Power Technology Questionnaire (Appendix A) of this SSN by the requested deadline. Respondents will not be notified of the results of the SSN. This is not a request for proposals, quotations, or bids. Responses to this SSN will not be returned. If a formal solicitation is released, it will be made available to potential offerors qualified based on their SSN submission. The formal solicitation would be released via the BEA contracting office. All offerors who provide goods or services to BEA and the Government must be registered in the System for Award Management (SAM) located at https://www.sam.gov.

This SSN is open to responses from U.S. companies only, however this does not prohibit the U.S. company from using foreign services/products. BEA will not pay for the provision of any information received in response to this SSN, nor will it compensate any respondents for the development of any such information.

Introduction:

NASA's Radioisotope Power System (RPS) Program under the Planetary Science Division within the Science Mission Directorate, and DOE's Office of Space and Defense Power Systems, seeks to identify radioisotope power system providers that could develop a vacuum rated next generation RTG. The goals are to develop a system that is more efficient than the General Purpose Heat Source (GPHS)-RTG, is modular, has a long life (17 or more years after fueling) and has a comparable degradation rate. If all of these goals are met the system would produce up to 500 W_e at Beginning of Mission (BOM) using up to 16 GPHS modules. Modularity is to enable a mission to choose a RPS size that best meets the mission power need maintaining a common voltage. Thus, it is desired that the RPS can be built using GPHS increments up to 16 GPHS modules, for the full size integrated systemsy, that would provide power as high as 500 W_e. The mass goal of a 16 GPHS next generation RTG is 60 kg. The End of Design Life goal (at 17 years after BOM) is 290 We.

In addition to understanding system provider capabilities to develop a higher efficiency system, the RPS Program would like to understand potential risk mitigation activities that consider the ability to 1) build a GPHS-RTG from parts that the government owns, 2) build a GPHS-RTG "to print" from the government owned design, and 3) re-design the system and upgrade the SiGe couple using 21st century manufacturing and technology. As a risk mitigation option, it is understood and accepted that a lower power output may result.

This SSN will provide the RPSP with data on possible Next-Generation RTG designs for deep-space missions of around 14 years after up to three years of storage. These missions will operate in vacuum environments.

These Next-Generation RTG systems will be operating under the following draft requirements:

Internal device Hot junction temperature:	less than 1100°C
Sink temperature:	-269°C
Fueled System Mass:	less than 60kg
GPHS Module BOL Power:	250 W_{th} (thermal)
Allowable Flight Envelopes:	
Voltage:	22-34 VDC
Flight Fin Root Temperature:	50-200°C
Primary Modal Frequency:	greater than 50 Hz
Quasi-static acceleration (Q/FA):	NA/25 g
Random Vibration - GRMS (Q/FA):	7.44/4.79 g
Acoustic Sound Pressure (Overall) (db) (Q/FA):	147/143 db
Pyrotechnic shock load (Q/FA):	6000/6000 g

NASA's goal is to develop this system within the next decade or sooner so that it can be utilized for planetary science missions. Future NASA goals may include human spaceflight applications. To that end, this SSN seeks responses to understand the state-of-the-art in the thermoelectric field. Information regarding piece parts of the key auxillary thermoelectric technologies such as packaging, brazing, and insulation are also sought as they relate to key technology challanges.

Understanding and minimizing the technology maturation key challenges are desirable. Performance trades that reduce development risk or aid in manufacturing should be considered. SSN responses are requested from industry suppliers and manufacturers capable of designing, building and operating high temperature Thermoelectric Generators (TEGs). Industry sources that have demonstrated capabilities for producing thermoelectric materials and manufacturing robust thermoelectric devices and long-lived converters, but have limited space flight hardware or system level background, should consider partnering in responding to this SSN.

It should be noted that NASA has been investing in related technologies. For more information see https://rps.nasa.gov/resources/73/next-generation-rtg-study-final-report/?category=reports to obtain a copy of the Next-Generation RTG Study Final Report. This report provides concepts and thermoelectric devices that could be considered in designing the next generation RTG. Additional reference information can be seen at https://rps.nasa.gov/.

The RPS Program has formed a Government assessment team comprised of subject matter experts to perform the industry assessment, including this SSN. This team will engage the industrial community to seek inputs on industry capabilities, thermoelectric technology design options, and system implementation strategies. A Government-Industry Technical

Interchange Meeting (TIM) may be held in July 2018. Further information will be posted on FedBizOpps. This meeting, if held, will be in Cleveland, Ohio. The agenda will include a review of Government plans and time for individual "Government to industry" discussions. Following the collection of the data from this SSN, BEA/NASA may request site visits with the respondents.

This SSN could be a precursor to a potential, future BEA-issued Request for Information/Proposal (RFI/RFP) for concept development and thermoelectric technology maturation leading to the development of a flight-ready Next Generation RTG for a potential future NASA mission application. Should BEA proceed with a solicitation, only firms evaluated under this SSN to be potentially qualified to perform the work will be solicited. No other public announcements will be made should a solicitation be issued.

This SSN does not constitute a commitment, implied or otherwise, that BEA or the Government will take procurement action in this matter, nor does it prohibit BEA or the Government from taking action. Further, neither BEA nor the Government will be responsible for any costs incurred in furnishing this information.

In accordance with Federal Acquisition Regulation (FAR), responses to this SSN are not offers and cannot be accepted by BEA or the Government to form a binding contract. BEA or the Government are under no obligation to issue a solicitation or to award any contract on the basis of this SSN. The specific information provided in responses to this SSN will not be made public in an effort to protect any propriety company information. The SSN evaluation team will use the submitted information to complete the assessment. Respondents to the **Next-Generation RTG Power Technology Questionnaire (Appendix A)** shall clearly and properly mark any propriety or restricted data contained within their submission so it can be identified and protected. Respondents are solely responsible for all expenses associated with responding to this SSN. Responses to this SSN will not be returned and respondents may not be notified of the result of the review.

Notification is provided that multiple entities, including NASA, DOE, other interested Government agencies, federally-funded research and development centers, as well as support contractors working on behalf of the Government, e.g., BEA, may review the information received unless other arrangements are made. All responses will be treated as sensitive competitive information and will only be disclosed for response evaluation purposes. Potential respondents should only submit information that can be made available to those entities (properly marked) and should note by submitting information to this SSN, the above entities will be able to review each respondent's information.

The questions in the **Next-Generation RTG Power Technology Questionnaire (Appendix A)** are posed to gain understanding about potential company/team respondent capabilities, product attributes, design features and constraints, performance parameters, operating experience, testing scenarios and results, manufacturing history, reliability, and scalability. Additionally, this SSN requests industry perspective on potential industry partnership opportunities, integration strategies, cost or time saving measures, and technology development risks. **Next-Generation RTG Technology Assessment Process:**

Initial SSN response:

- Respond to POC within 1st week of posting with a statement of interest and interest in attending the TIM (email, one line). Not responding with a statement of interest does not preclude submitting a response on, or before, the SSN deadline.

SSN responses shall include:

- Name of the primary point of contact for the response and business title
- Institution or organization affiliation
- Postal address, e-mail address, and phone number
- Identification of other key individuals who collaborated on the SSN response
- Responses to **Next-Generation RTG Power Technology Questionnaire (Appendix A)** of this SSN.

SSN Response Requirements:

- The SSN response time has been set for **Forty-Six (46) Days**. Responses to this SSN shall be submitted no later than 11: 59 PM Mountain Time on the deadline date. SSN responses shall be submitted and accepted as e-mail attachments only. All SSN responses shall be sent to the attention of Steven Gihring, the cognizant BEA Contract Representative, at steven.gihring@inl.gov, with "Next-Generation RTG Technology SSN Response from [Company Name]" in the subject line.

- All files with confidential or proprietary information shall be sent via secure file transfer, with passwords provided. If a secure file transfer system is not available, please contact Steven Gihring at (208) 526-7706 for assistance.

- Responses shall be limited to 20 pages total including figures and references as appropriate. Use single-spaced, 12-point, Times New Roman font. Requested file formats are: Microsoft Word (.docx) or Portable Document Format (PDF). Where possible, provide figures in "native file" format to allow for review in greater detail.

- An e-mail confirmation of SSN response receipt will be sent from BEA to respondents within a one-week period to the respondent's designated point of contact.

SSN Primary Point of Contact:

Steven Gihring, Lead Contract Specialist
Battelle Energy Alliance, LLC
steven.gihring@inl.gov
(208) 526-7706

SSN Alternate Point of Contact:

Roger Chunn, Contract Specialist
Battelle Energy Alliance, LLC
roger.chunn@inl.gov
(208) 526-2085

SSN Alternate Point of Contact:

Jennifer Rock, Project Manager
NASA Glenn Research Center
jennifer.l.rock@nasa.gov
(216)433-3354

Acronyms:

BOL – Beginning of Life
BOM – Beginning of Mission
DOE – Department of Energy
FA – Flight Acceptance
GPHS – General-Purpose Heat Source
GRC – Glenn Research Center
G_{RMS} - Root mean square acceleration
NAICS - North American Industry Classification System
NG – Next-Generation or Next-Gen
PSD – Planetary Sciences Division
Q - Qualification
RFI – Request For Information
RPS – Radioisotope Power Systems
RPSP – Radioisotope Power Systems Program
RTG – Radioisotope Thermoelectric Generator
SAM - System for Award Management
TE - Thermoelectric
TEG – Thermoelectric Generator
TRL – Technology Readiness Level
W_e – Watts electric
W_{th} – Watts thermal

Appendix A

Next-Generation RTG Power Technology Questionnaire

Please respond to the following questions regarding your capabilities, hardware products, and strategies for developing a robust and reliable vacuum rated Next-Generation RTG systems minimizing technology maturation risks. Please use consistent units of measure throughout your responses (all metric or all English). You may respond to any or all questions.

1. Does your company/team have existing high temperature (greater than 500C) TEG technologies (materials, components, devices, converters) that are relevant for use in generating up to 500 W_e using 4000 W_{th} BOM Radioisotope Thermoelectric Generators? If so, how are they currently used? Please describe the current technology maturity level. (NASA uses Technology Readiness Levels (TRLs)) For TRL definitions see: https://www.nasa.gov/pdf/458490main_TRL_Definitions.pdf.

2. How would your company/team mature thermoelectric technology if not currently available? Has your company/team matured prior thermoelectric technology? If so please provide details, and the risks to completing the technology development?

3. How does your thermoelectric (TE) device and/or converter work? What are the configurations and operational environments? What are the key performance parameters including power output and lifetime? How many units have been produced? Do the units show repeatable performance? If long duration operational data is not available, what are the key risks that must be overcome to achieve > 14 year operating life? Please provide any data showing performance and key TE parameters over time, stating the testing environment(s).

4. The government team has invested in potential thermoelectric materials, elements and potential thermoelectric devices that could be considered for use in the Next Generation RTG. Would your company/team be interested in using these potential technologies? If so, how would your company/team propose to interact with the government to establish your own technology capability from the government investment?

5. What experience, personnel, capabilities, and production experience does your company/team have in fabricating TE devices and/or thermoelectric power systems?

6. What is your production strategy for delivering a vacuum-rated Next-Generation RTG? What partnerships and teaming arrangements could be leveraged?

7. What experience does your company/team have in building space flight hardware, materials, components, devices, converters, processes, Integration and test, Quality Assurance and in developing nuclear power systems?

8. What current company/team assets and expertise could be utilized in developing a space-rated RTG system?

9. What options exist to sustain your company/team's Next-Generation RTG design and production capabilities during periods of inactive use by the government team?

10. Considering the current development level of your thermoelectric device technology/system, what information do you expect to be provided from the government team for your company to initiate thermoelectric device and/or power systems production?

Risk Mitigation Questions

11. Identify what is necessary, and if your company/team would be interested in building a GPHS-RTG from parts that the government team owns.

12. Identify what is necessary, and if your company/team would be interested in building a GPHS-RTG "to print" from the government team owned design,

13. Identify what is necessary, the starting TRL and potential risks in re-designing the system and upgrading the SiGe couple using 21st century manufacturing and technology. Please state the projected BOM power and degradation rate of the system.

Other Questions

14. How long is necessary to develop a credible, detailed proposal, if the government team chooses to move forward with a solicitation for a concept, technology maturation and system development?

15. Is there any other information that you would like to share about your company/team or your products that would be beneficial to the objective of this SSN?