



# BIG IDEA CHALLENGE



## 2018 Call for Proposals

The BIG Idea Challenge is a university-level design competition sponsored by NASA's Space Technology Mission Directorate and managed by the NIA. **To participate, university teams of 3-5 students will submit proposals on ideas/concepts for the design, installation, and sustainable operation of a large solar power system on the surface of Mars.** Selected teams will be invited to present their concept to a panel of NASA and industry judges at the 2018 BIG Idea Forum in March at either the NASA Langley Research Center in Hampton, VA, or the NASA Glenn Research Center in Cleveland, OH.

### Breakthrough, Innovative & Game-changing Idea Challenge

#### Background Info for the 2018 BIG Idea Challenge Theme

Potential human missions to the Mars surface in the 2030s may use large photovoltaic (PV) solar arrays to generate electric power for landers, habitats, In-Situ Resource Utilization (ISRU) plants, science laboratories, and to charge energy storage systems for night power. Preliminary human Mars surface power requirements are projected to be approximately 40 kilowatts, day and night. Because of the critical nature of electrical power, this equipment may be prepositioned and validated prior to human landings. A promising approach is to deliver stowed PV arrays on Mars cargo landers and deploy them using the lander deck for support. The total power requirement may be satisfied using multiple landers that arrive on Mars over a series of missions. Each lander might include multiple modular solar array wings that form an integrated system, or a single monolithic structure that supports the PV blankets. Regardless of the configuration, autonomous deployment is anticipated with no on-site human intervention to assist in the installation. Preliminary NASA estimates indicate the need for deployed PV surface areas of at least 1000 m<sup>2</sup> per lander. The power produced will depend on the landing site (Mars latitude), season/distance from the sun (Mars orbital position), time of day (sun angle relative to array), and the extent of dust blockage (either on the array surface or suspended in the atmosphere), as well as any PV cell degradation that occurs over time in the Mars environment.

#### 2018 BIG Idea Design Guidelines and Constraints

**This solicitation seeks innovations in the design, installation, and sustainable operation of a large solar power system on the surface of Mars.** The design aspects should consider lightweight structures, compact stowage, and high PV efficiency. The installation aspects should consider lander integration, robust deployment/retraction mechanisms, and fast/reliable deployment. The sustainable operation aspects should consider array performance under varying Mars environmental conditions including solar flux changes due to daily sun angle, season, and landing site latitude as well as impacts of extended dust storms on array power output. A key objective is to identify practical methods to prevent dust accumulation on the array surface or methods to remove dust once it has collected. These solar array systems are expected to supply reliable electric power for multiple crew campaigns that may span 10 years or more. Successful proposals will include appropriate levels of engineering design and power system analysis to validate the concept.



#### Important Dates

- Notice of Intent Deadline: Oct. 1, 2017
- Proposal Deadline: Nov. 30, 2017
- Selection Notifications: Dec. 15, 2017
- Technical Paper Deadline: Feb. 20, 2018
- 2018 BIG Idea Forum: March 5-6, 2018

#### Eligibility

Undergraduate and graduate students studying in fields applicable to human space exploration at an accredited U.S.-based university (3-5 people per team). **Please carefully review the foreign national restriction policy under "Eligibility" on the BIG Idea website for full details.**

#### Stipends/Awards

Qualifying teams will receive up to a \$6,000 stipend to participate in the 2018 BIG Idea Forum. The winning team will be awarded with NASA internship offers.

The 2018 BIG Idea Challenge seeks novel concepts that emphasize innovative mechanical design, low mass and high efficiency, with viable operational approaches that assure sustained power generation on the Mars surface over the Martian year and during extended dust storms. Since the cargo landers will have limited battery power after touchdown, the solar arrays must be deployed and producing power soon after landing. The deployment analysis should include estimates of required power and the time duration for the array deployment. If solar tracking is proposed, arguments should be provided to justify why this approach is superior to fixed solar arrays based on performance, cost, and risk. Of special interest are modular array designs that are self-supporting in 1-g and can be autonomously deployed, and optionally retracted, relocated, and interfaced with other power sources on the Mars surface. The overall Concept of Operations (ConOps) should be clearly described including all design assumptions.

This solicitation seeks innovations in the following areas for Mars solar arrays:

- Novel packaging, deployment, retraction, and dust-abatement concepts
- Lightweight, compact components including booms, ribs, substrates, and mechanisms
- Optimized use of advanced ultra-lightweight materials and high efficiency solar cells
- Validated modeling, analysis, and simulation techniques
- High-fidelity, functioning laboratory models and test methods



### Specific Guidelines and Constraints

NASA has developed a preliminary set of design guidelines for autonomously deployed Mars solar arrays that could be delivered on a single cargo lander, as follows:

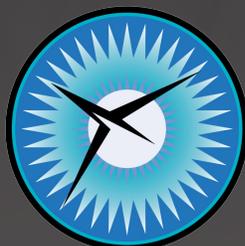
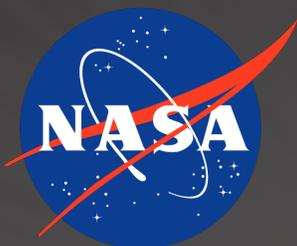
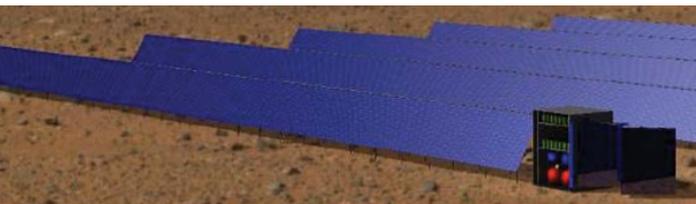
- At least 1000 m<sup>2</sup> total PV cell area per lander.
- Less than 1500 kg total array mass including all mechanical and electrical components and less than 10 m<sup>3</sup> total launch volume.
- Launch Loads of 5 g axial, 2 g lateral, and 145 dB Overall Sound Pressure Level (OASPL).
- Up to 50 m/s Mars surface winds. Ideally greater than 1-g deployed strength to allow unconstrained Earth deployment qualification.
- Deployment/retraction at -50 deg C on terrain with up to 0.5 m obstacles and 15 deg slopes.
- Operating height greater than 0.5 m to avoid wind-blown sand collection.
- Positive power output within 1 Martian Sol of landing.
- Integrated dust mitigation and abatement methods. (Dust accumulation is the #1 design risk issue for sustained PV power production on Mars.)
- Tolerant of daily thermal cycling from -100 C to 25 C over a lifetime of 10 years.

All BIG Idea Projects should give special attention to:

- Innovative design
- Creative operational approaches
- Use of technologies that could be ready for use on Mars in the early 2030s
- Effective packaging for launch and Mars landing
- Viable lander-based deployment methods
- Reliable, long-term power generation in the Mars environment

*The Game Changing Development Program is a part of NASA's Space Technology Mission Directorate. The Program advances space technologies that may lead to entirely new approaches for the Agency's future space missions and provide solutions to significant national needs. The program will focus efforts in the mid Technology Readiness Level (TRL) range of (3-5/6) generally taking technologies from proof of concept through component or breadboard testing in a relevant environment. The program employs a balanced approach of guided technology development efforts and competitively selected efforts from across academia, industry, NASA, and other government agencies. The program strives to develop the best ideas and capabilities irrespective of their source.*

[gameon.nasa.gov](http://gameon.nasa.gov)



For more information, visit

<http://BIGidea.nianet.org>