

NASA SBIR/STTR Technologies

H3.02-9680 - Solar Plant Growth System for Food Production in Space Exploration Missions



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Identification and Significance of Innovation

Physical Sciences Inc. (PSI) proposes to develop a Solar Plant Growth System for Food Production in Space Exploration Missions. In this system solar light is collected by the reflector optics and only the photosynthetically active radiation (PAR) spectra (PAR: $400 \text{ nm} < \lambda < 700 \text{ nm}$) are transmitted to the plant growth chamber. The PAR spectra transmitted to the plant growth chamber are distributed over the plant growth area at optimum intensities for plant growth. The non-plant growing spectra (non-PAR) are transmitted to energy conversion devices such as low-bandgap photovoltaic (PV) cells for electric power generation.

The proposed solar plant growth system will be significantly more efficient than the electric plant lighting system. The solar plant growth system based has potential capabilities to produce food, not just a small quantity of salad greens, but a large quantity of edible plants to meet human needs and to contribute to CO₂ remediation and O₂ generation.

Estimated TRL at beginning and end of contract: (Begin: 2 End: 4)

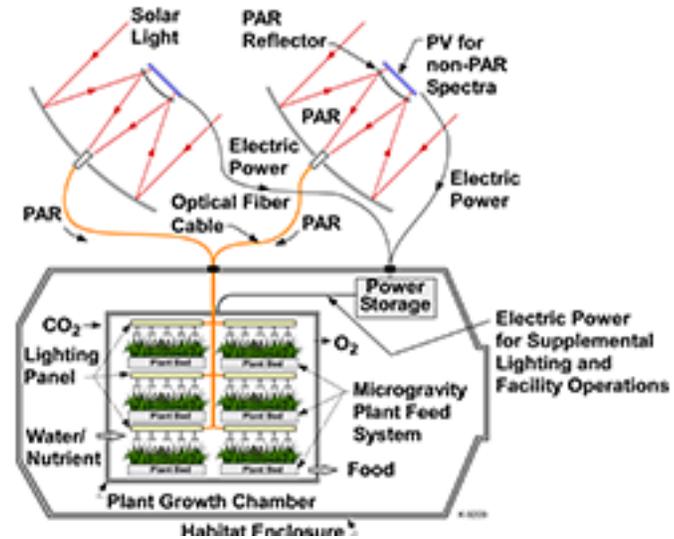
Technical Objectives and Work Plan

In the proposed program we will develop a ground-based prototype system by integrating (i) the solar plant lighting technology developed by Physical Sciences Inc. (PSI) with (ii) state of the art plant growth technologies for food production in space. Specific technical objectives of the Phase I program are:

1. Develop and evaluate a laboratory prototype solar plant growth system;
2. Study effect of the solar lighting of plants in the space mission environment; and
3. Develop an optimum system architecture for the space-based Solar Plant Growth System and identify key technology issues to be addressed in Phase II.

The work plan for the proposed program includes the following tasks.

- Task 1: Develop key components for the Optical Waveguide (OW) Solar Plant Lighting System;
- Task 2: Prepare a plant growth system with a plant feed module;
- Task 3: Integrate the plant lighting system and the plant growth system to form a laboratory prototype Solar Plant Growth System and test its functionality and performance;
- Task 4: Conduct a series of plant growth experiments with simulated AM0 solar spectra to characterize plant growth in space missions; and
- Task 5: Develop the optimum system architecture for the space-based Solar



NASA Applications

The Solar Plant Growth System for Food Production is for application to: 1) onboard a crewed spacecraft such as such as the Deep Space Habitat or ISS where compact and efficient photosynthetic life support is required, and ISS; and 2) a Lunar, NEO or Mars base where large scale food production and life support are implemented. The solar plant growth system can also be utilized to supply lighting to the spacecraft or habitat.

Non-NASA Applications

The solar lighting system discussed in this proposal can be used for household, commercial or industrial lighting. In addition, industry and educational institutions that are currently using electric lamps for plant lighting will likely deploy the proposed system. The solar lighting system discussed in this proposal can be applied to specialty farming such as "Vertical Farming."

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NON-PROPRIETARY DATA