Team SUNSPOT™ Technical Assistance Request

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Objective

Develop and test prototype of SUNSPOT Solar Electric Cooking Appliance. There are three main technical issues which need to be addressed at this stage:

- Integration of the three power/control functions – MPPT charge controller, DC boost converter to drive loads, and integrated controller incorporating system management, data collection system and PAYG capability – into a single working board, with heavy emphasis on reducing cost.
- Development of an alternative to lead-carbon batteries for energy storage with emphasis is on low cost and high performance.

In addition, we are looking to use the Connector Network to assist us in fabrication of the prototype, include board fabrication and design / fabrication of the system enclosure.

1 – Circuit Integration

In the ready phase, we have validated (through testing) that commercial induction cooktops and multi-function electric pressure cookers can be run using 120V DC with little or no modifications to the commercial appliances. We have developed a detailed design for the DC/DC boost converter required to run these cooking appliances.

The second function – MPPT charge controller – is a well understood technology and dedicated chips such as the TI MSP430F5132 MCU can be used to implement this stage. The primary design goal here is to develop a dedicated (rather than general purpose) MPPT controller sized for this application.

The third function covers system control and monitoring, data acquisition, and Pay-As-You-Go (PAYG) capabilities. We will be working with Angaza to implement the PAYG technology, including integration onto the main appliance board.

We confident in our design, but are looking for input concerning emerging technologies that we can incorporate into our roadmap, and on evaluation of the design to meet UL and CEC standards.

2 – Find better batteries

Our present designs use Firefly lead-carbon batteries, which we have chosen as the best technology at the present both in cost (comparable to a high quality VRLA battery) and in performance (up to 2400 cycles to 65% depth-of-discharge). However, we recognize that battery technology is rapidly improving and costs are being reduced so we anticipate moving to a new battery technology within a few years.

At present we are uncomfortable with Lithium NMC and similar cells due to fire safety issues. LiFePO4 technologies appear to be more suitable but are still too expensive. We would like to explore upcoming technologies to help develop our roadmap for future product development.

3 – Prototype Fabrication

We are looking for assistance in tow main elements of the prototype: circuit board assembly and fabrication tasks associated with the plastic enclosure with cutouts, internal aluminum panel, and wooden cooktop. These requirements can be supplied through a maker space such Nova Labs in Virginia or ETI in Arkansas.

Proposed Tasks for Connectors / Partners

Task	Description	Connector
1	Review the functional specifications for the SUNSPOT appliance, especially the controller software specs. Review the designs for the two power stages and make technical suggestions based on upcoming technologies such as WBG transistors. Also review of full system design, including code compliance and suggestions for cost reductions.	Sandia
2	Assistance with specification and selection of cost-effective alternative to energy storage, especially with emerging technologies such as next-generation lithium batteries.	Sandia
3	Integrated SUNSPOT Appliance circuit board layout, fabrication and programming.	Private Partner (selected from connectors)
4	Design and fabrication of custom low-cost enclosure – emphasis on manufacturability in target countries (work to be completed at). This will include the outer enclosure, top work surface, internal frames, wiring harnesses, and user access panels.	ETI, LLC (Arkansas) or NOVA labs (VA) or equivalent private connector