The Heat Wave Controller

Managing Water Heating as Thermal Batteries

TECHNICAL ASSISTANCE REQUEST

We are building the Heat Wave Controller as a low cost, energy efficient approach to home water heating. The Heat Wave Controller accepts DC current directly from a small, dedicated PV panel array and outputs a Pulse-width modulated (PWM) AC signal. This signal is capable of powering all standard electric water heater resistive element, avoiding the conversion loss of a typical DC to standard-AC inverter, and without needing to tie into the grid. The energy converted from The Heat Wave Controller is stored as heat in the water heater tank, transforming what is typically an energy drain into a thermal energy battery. This directly addresses one of the duck curve's primary issues, energy power storage collected during the peak of the day.

The primary need for technical assistance during the American Made Challenge is the need to meet the required codes and regulations so that the final commercial product can reach the hands of the consumer. The prize money from the *Ready!* stage will let us continue developing the initial prototype which would give us a product to work with during the *Set!* and *Go!* stages. Several codes and standards exist that are relevant to the product being developed within this submission of the challenge. Other technical assistance needed is in the form of product lifetime testing and validation by independent laboratories. The DOE labs could also assist in integration of smart (controller) water heater into the Internet of Things (IoT), where time-of-use can be coordinated between dish washers, washing machines and showering.

The use of standards and codes that validate products is to ensure their safety, functionality, and that best practices were used during the design of the product. Firstly, because it is an electrical consumer product, we will want it to be approved by the Underwriters Laboratory (UL) and meet standards requirements by the National Electrical Code (NEC). Having these codes will allow equipment installers to get the building permits needed for home installs. The second primary certification to aim for is the Solar Rating and Certification Corporation (SRCC) OG-300, which is specific to solar water heating systems. While the SRCC OG-300 is not required for building, in some states it is necessary for incentive programs, and is becoming the adopted standard for meeting other building codes.

For a small business, getting these standards completed is a time-consuming and very expensive task, upwards of $60,000 per certification. Without the vouchers to help cover these certification costs, we could not afford them. The benefit of the standards having similar requirements is that certain tests can be completed once and applied to the relevant standard going for, whether that is UL, NEC, SRCC OG-300, or even the Consumer Electronics (CE) marking. The vouchers would go towards testing facilities such as LabTest Certification, Inc in Nevada or Intertek Testing Services in Texas. Prior to having the tests completed, a voucher for consulting could be used with an American-Made Solar Prize sponsored company, Direct Gain Consulting.

The vouchers will really help with smart connection to the IoT, or in this case the Internet-of-Appliances that use hot water. Ideally the National Lab can help evaluate further optimization of managing hot water heaters as thermal batteries. This assistance should include modeling the most

efficient water storage temperature, tank size, insulation, and the use of hot water mixing valves for even higher temperature water storage. The more of these water heater controllers that are on the market, the more beneficial their use is to the power grid in whole. Due to DSSP's location on the west coast, Lawrence Livermore National Lab would be ideal to work with since they are directly affected by PG& E power outages. LLNL Energy Infrastructure Group, is already examining electric grid modernization and load shifting. The National Labs will have the knowledge and data sets into what kind of power savings is capable to the power grid. By attaching these products to the IoT we can leverage these data sets to lessen the impact to the power grid due to spikes caused by water heaters.

The average household uses their heated water near the same time every day, and because the current water heater systems out there are not controlled as a whole, there is a large spike in energy used across an entire geographical area. By allowing these water heater systems to be controlled together, they can heat the water throughout the day when the heated water is not being used, thereby lessening the load to power companies, in turn reducing overall power costs to each user. This capability would only be achievable in a short time span by using the data sets and computer technology that is available at these national labs. They also would have the expertise and the best practices in applying current IoT technology. Likely components would be current and voltage monitoring that can be fed to a WiFi signal for analysis in the cloud, all aspects that our team is only slightly familiar with and could use the professional help from a national lab. By applying the datasets, grid analysis, and IoT capability of our devices, the water heater controllers could be a real game changer to the power grid industry.

Technical assistance in vouchers could also be used for prototype and final product development to optimize performance. These national labs or other private firms could help us characterize the product in order to know levels of operation and product lifetime. Having a bell curve of use versus lifetime will give us the ability to give the consumer a confident product warranty. This would also let us develop the product in a way to ensure the product will benefit the consumer by not having to be replaced often.

Another use for technical assistance would come be for manufacturing the product on a much larger scale than we are currently capable of. Because our product is a device, it has manufacturable components that are within it. Vouchers could be given directly to the manufactures and assemblers of these components. These vouchers would be given to American Companies to truly have this product be *American-Made.* The device consists of a circuit board, switches, cooling plates and an enclosure to house it all. For the circuit board we will be using a local company for the assembly, Vital Systems, which has all of their assembly a few blocks away in Reno, NV. The switches will be made at US-based company in California, Control Switches International. The enclosure and final assembly are still something to be sourced. Many options exist in the American-Made Challenge sponsored company list that we can use for those last two tasks in the final production of the product.

With all of the technical assistance described, we fully believe that we can achieve a final product in the later stages of the American-Made Solar Challenge, and the vouchers available would help greatly. The prize money for the *Ready!* stage of the challenge will help with initial prototype development. The costs associated with increasing in scales from prototypes to the thousands and hopefully tens of thousands will need a massive amount of capital, something we are looking forward to in getting the aid from the American-Made Solar Challenge.