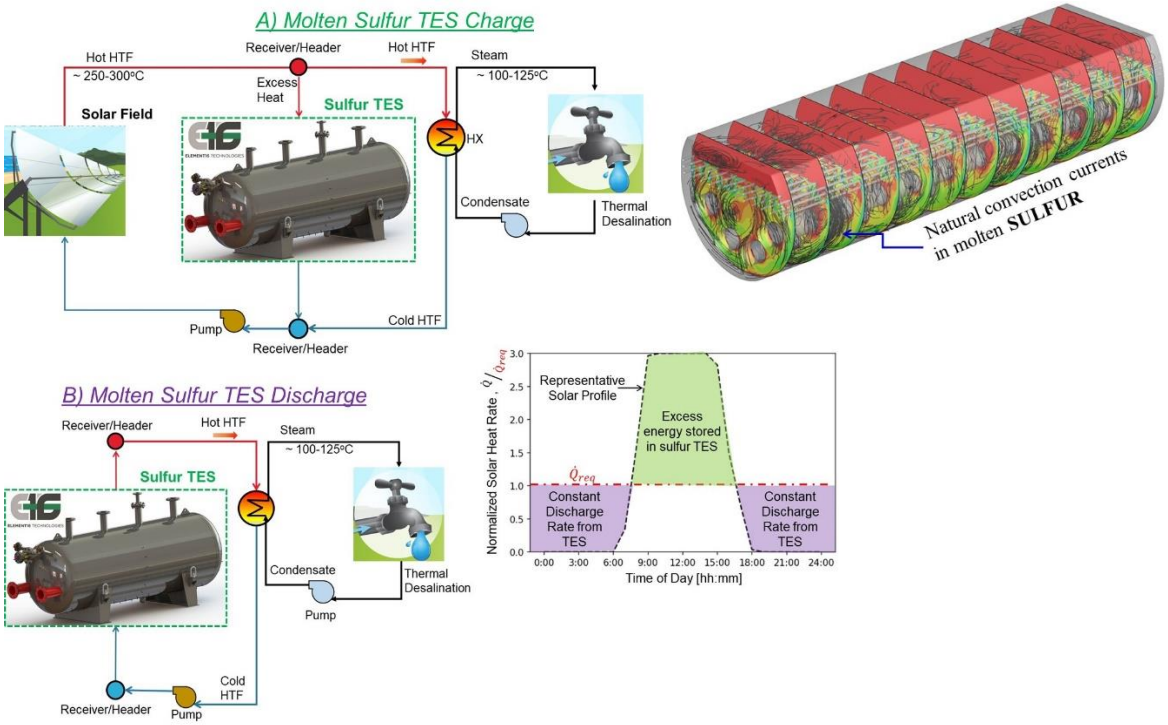
Technical Assistance Request
Element 16 Technologies, Inc.
American-Made Challenge Solar Desalination Prize

Element 16 is a thermal energy storage startup. Our team of engineers are the leading experimental, analytical, and demonstration experts of sulfur thermal energy storage (TES). Element 16 is a recipient of multiple California Energy Commission awards, was recently selected for two Department of Energy award negotiations, and is a graduate of the Techstars Accelerator, NSF i-Corps, Creative Destruction Lab Energy, and SparkLabs Energy. Element 16's sulfur design configuration involves heat transfer fluid (HTF) tubes located within molten sulfur stored in a pressure vessel. The heat transfer physics is governed by the combination of the forced convection dynamics in HTF and natural convection heat transfer dynamics in molten sulfur (for medium temperature applications) and solid-liquid phase change dynamics (for low temperature applications < 115 °C)[2-4]. The product design must be co-optimized for both performance (high exergetic efficiency, utilization) and lifetime cost.



Molten sulfur thermal storage concept for solar thermal desalination.

As part of the American-Made Challenge Solar Desalination Prize, Element 16 is seeking the following areas for technical assistance: high performance computing expertise and support, material compatibility expert review, thermal energy storage system design expert review, and thermal energy storage technoeconomic model review.

High Performance Computing

Element 16 requires detailed computational modeling of the conjugate transient heat transfer and fluid flow phenomena at multiple scales to provide a scientific basis for engineering, and

optimizing the sulfur TES design, and bridge the modeling continuum from the prototype scale to the real-world conditions for seamless scale-up of sulfur TES product. To date, Element 16's simulations of heat transfer in TES have been limited by the computational expense of fully simulating (1) the complex three-dimensional geometry at the appropriate length scales, requiring 2 million or more elements, (2) the non-linear properties of multi-phase sulfur, and (3) the turbulent flow within the system. This type of computational modeling can be accomplished through high performance computing capabilities of a national lab or through further computing time on commercially available options like Amazon Web Services.

Material Compatibility Expert Review

Element 16 continues to pursue further cost saving opportunities by investigating sulfur compatibility in the solar desalination-relevant temperature range. We request material compatibility experts to support our ongoing efforts to identify low-cost materials and/or coatings that are compatible with sulfur for 25+ year lifetime and determine the required corrosion allowance. We seek experts who can both verify existing plans and develop new ones. Extensive testing of the thermal endurance and corrosion rates of the different material samples will be conducted through (a) isothermal testing at the solar topping temperature and (b) rapid thermal cycling tests for different time and heating/cooling rates relevant to solar thermal process heat. The materials will be examined in scanning electron microscope (SEM) after exposure and composition measured using energy dispersive spectrometer (EDS). This type of material compatibility expertise and services can be found in national labs or private companies, like Intertek.

Thermal Energy Storage System Design Feedback

External reviews by industry experts have always been a key aspect of Element 16's engineering process. Due to our small team size, we are always seeking experts from other entities that can provide fresh perspectives on our technology and product design. This often takes the form of a Technical Advisory Committee for holistic reviews and design review meetings for deep dives into particular aspects or components of a project. We seek experts with significant thermal energy storage experience from technologies such as molten salt TES, thermal oil TES and heat transfer fluid, sulfur production facilities, and solar thermal project development. Third party feedback by relevant industry experts will improve Element 16's work and can provide our project partners further peace of mind.

Solar Desalination with Storage Technoeconomic Model Feedback

Similar to the Thermal Energy Storage System Design Feedback request, a technoeconomic review of the entire solar desalination system with storage by industry experts can provide fresh inputs to our ongoing work. For this effort, we seek experts in technoeconomic modeling with insights into industry methodologies and costs. As our technology moves into market competition, Element 16 is keen to ensure that all technoeconomic modeling is accurate with the true price of heat and freshwater, including upfront equipment and fabrication costs, installation costs, operations and maintenance costs, and end-of-life costs. In our team's experience developing these technoeconomic models, we find that expert feedback is invaluable.