FLORIDA STATE UNIVERSITY
Multi-Generation Capable Solar Thermal Technologies

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Description: The objective of the proposed research is to develop and demonstrate small-scale solar thermal technologies that can be used separately, in conjunction with one another, or with existing waste heat producers, thus improving the overall system efficiency.

The development of an indoor solar simulator capable of providing and sustaining 1 kW/m2 over an area of 10 m2

The development of a Rankine cycle-based solar concentrating system that is capable of producing at least 2 kW of electricity adaptation and integration of small-scale absorption-based refrigeration systems that can employ the waste heat from the aforementioned Rankine system.

Integration of existing membrane distillation technology for waste heat recovery from either, or both, of the above-mentioned technologies. Demonstration of a multi-generation system that combines all of the above-mentioned technologies.

Budget: $544,226

Progress Summary

Task 1: Develop an indoor solar simulator
Testing of the solar simulator components has begun (Figure 1). The results from two of the test configurations are shown in Figure 2. It can be seen that there is uniform light distribution without the reflector but it is only 40% of the desired intensity. With the reflector the maximum intensity rises to 80% of the desired value but it is concentrated over an unacceptably small area. A number of configurations will be tested in an attempt to address these issues.

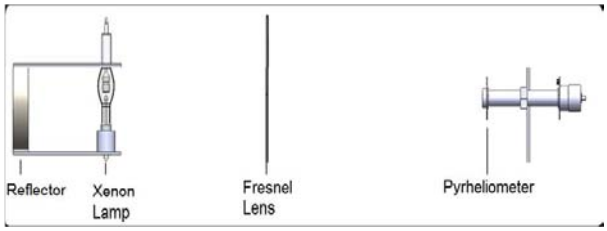

Figure 1. Experimental setup for solar simulator design development.

A low-cost pyreheliometer is under development at ESC for use with the simulator and other outdoor activities requiring direct beam radiation (Figure 2). Work on the tracking system for the low-cost unit is currently underway. Cost for pyrheliometer and tracking system ~$500

Figure 2. Pyreheliomoeter

A first generation solar generator has been built to verify the basic design principles of solar steam generation using dish system. Figure 3 is the system installation picture on the FSU at ESC. The results of this work is described in a recent M.S thesis (John Dascomb, August 2009)

Arrangements have been made to have a 15-foot diameter commercial concentrating dish donated by Infinia Inc. to ESC for use in the development of a small-scale cavity type steam boiler.

Task 5: Integration of existing membrane distillation technology for use with the waste heat from the Rankine cycle and the refrigeration system (unfunded). Because of the importance of efficiency improvement in solar thermal systems, ESC has been developing waste heat recovery methods with particular emphasis on a novel water purification system. This work is carried out in collaboration with the Royal Institute of Technology (KTH) in Sweden. A typical multi-generation solar power system is shown schematically below. Such systems are being studied currently with a goal of building a demonstration system during the second year of the program.

Figure 3. ESC 14 m2 parabolic dish concentrator with a steam boiler - solar steam generator.

Figure 4. Infinia 3 kW dish-Stirling system.(The dish is being donated to ESC for the steam generation project)

A multi-generation solar thermal system. MD: membrane distillation unit; ORC: Organic Rankine Cycle.

A membrane distillation (MD) unit for water purification has been purchased.This unit is capable of utilizing waste heat to operate and understanding of itsoperation will allow for an optimal solar thermal system design.