UNIVERSITY OF SOUTH FLORIDA

Design, Construction and Operation of CSP Solar Thermal Power Plants in Florida

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Description: Florida utilities are mandated to achieve 20% renewable energy contribution to their generation mix by 2020. While technologically feasible with solar energy, the capital costs are high – presently, capital costs range from $6,000-$7,000/kW for PV and $3,500-$4,000/kW for concentrating solar thermal power. This project targets the development of solar thermal power technology for bulk power and distributed generation, which will diversify energy resources in Florida and reduce greenhouse emissions by utilizing renewable sources. Also, there will be economic impacts with the establishment of new power industry in Florida, which will help the electrical utilities of the state to meet the renewable portfolio standards. The project has three main tasks; the first one is to develop design methodologies and standards for the proven solar thermal power technologies in combination with bio or fossil fuels based on Florida conditions and resources. Secondly, the project aims to set up demonstration and test facilities for these technologies for optimization for Florida conditions, and the final task is to develop and commercialize innovative technologies based on new thermodynamic cycles.

Budget: $882,000
Universities: USF, UF, UCF
External Collaborators: Calnetix Power Solutions

Progress Summary

Summary of Progress: The main research objectives for the current reporting period include the development of a test facility and pilot demonstration systems based on parabolic trough technology.

Progress Made Toward Objectives During Reporting Period: Daily integration (DI) approach was used to obtain the average direct normal solar radiation for the location of the pilot demonstration solar plant (USF, Tampa, Fl). The direct normal solar radiation obtained for Tampa is shown in Fig. 1. The annual average for this location is 4.6 kWh/m^2-day. These solar radiation values and the solar shading analysis for solar collector rows were used for the solar field calculation. The solar field layout proposed for 50 kW_e is shown is Fig. 2. The Soponova 4.0 (Sopogy Inc.) parabolic trough collectors will be used in the solar field for providing 430 W/m^2 of thermal energy after losses. The solar field is being designed to work in conjunction with a thermal energy storage system, which will use phase change material (PCM) as a storage material.

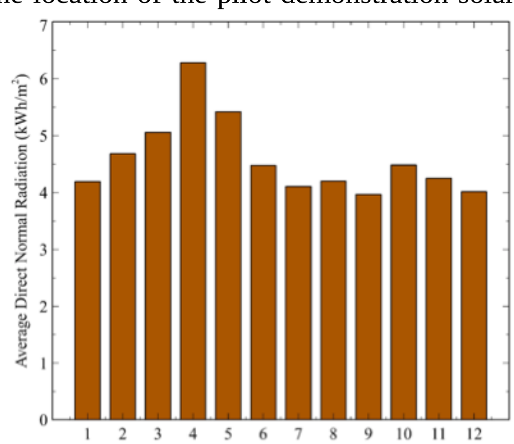

FIGURE 1: DIRECT NORMAL RADIATION FOR TAMPA

The remaining thermal energy will be provided by a natural gas boiler, which will work in series with the solar field and supply thermal energy to the power block when the solar energy is not available.

The power block that will convert the thermal energy to electricity is based on Organic Rankine Cycle. This power block will have a nominal capacity of 120 kW_e. A preliminary study on condensation methods for solar thermal plants is also conducted and more research will be devoted to the development of cost effective dry cooling technology.

Research activities for the next reporting period will focus on the modeling of heat transfer losses through the solar receiver and field piping, pressure drops pumping requirement and thermal energy storage system design.

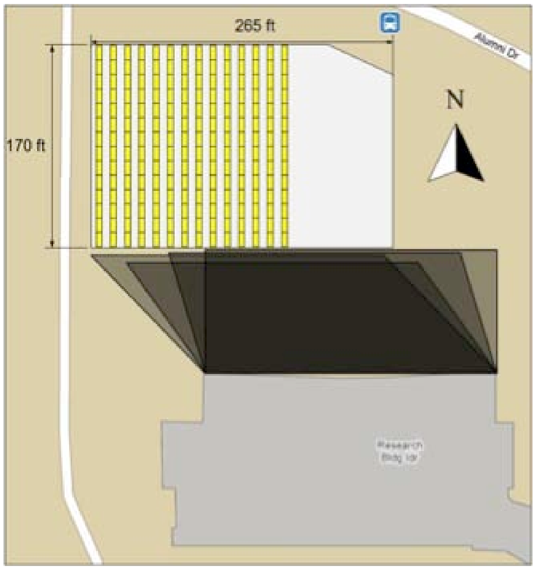

FIGURE 2: SOLAR FIELD LAYOUT