Multimegawatt Dish-Based Solar Thermal Electricity Generating Plant with Optional Co-generation

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Abstract

Development of the Mark 2 and Mark 3 versions of the 400 m^2 'Power Dish' series of point focus collectors, provides means for enhancing economic viability of solar thermal power systems in sizes from small to very large, with the potential to compete with traditional fossil-fuelled power.

This has been recognized by the provision of financial support from the Australian Greenhouse Office of the Federal Government to assist establishment of a solar array of 20 dishes providing direct steam input to an existing steam turbine in a coal-fired Utility Power Plant. Larger systems of wider applicability are currently being investigated, including a Study supported by Government and Industry comprising a 200 Power Dish system for electricity generation with waste-heat-driven desalination of sea water. Both systems are considered fore-runners of larger solar powered plant which can take many forms. A helpful feature of the Power Dishes which facilitates their application to systems large and small, is their capability to generate steam at temperatures and pressures to match the direct inlet requirements of any steam turbine and their capability to work in conjunction with fossil fuelled systems.

While the specific aspects of the systems are discussed, since the technology can be employed to provide many options and characteristics, technological and economic information with respect to each system is provided in generic terms. Functional diagrams are presented for various configurations, with technological and economic performance characteristics illustrated graphically for a wide range of solar resources. This approach allows the value of the technology to be considered and identified under different climatic conditions. Although sizes of the systems (~ 2.5 and 25 MWe respectively) are not sufficiently large to demonstrate the best attainable economic values for more appropriate comparison with large fossil-based power systems, they nevertheless indicate good performance and show the trends determined by the economy of size of system and the dependence of technological performance and economics on solar resources and on the installed cost of collectors.

In relation to the retrofitted solar array, the many factors affecting the successful connection and operation of a dish-based solar array to an existing steam turbine are discussed in relation to hardware requirements, means of connection, functional operation and effectiveness with which solar

supplementary steam can be provided, together with the operational, control and optimization aspects which require to be addressed and resolved for both steady state and transient operation; especially operation during intermittent cloud. The overall effects of size of turbine and relative size of solar array are considered in relation to economic performance and implications on the design of complete new systems are drawn, together with the advantages of larger size systems

Dish-based systems providing combined electricity and potable water output are illustrated, indicating how the use of waste heat enhances overall economics by appropriate configuration and design. Also illustrated is the ability to employ solar arrays with gas turbine combined cycle systems and to gain economic advantage by doing so, given appropriate system size.

Finally, means for reducing overall system costs and improving performance are considered and prospects for further substantial developments are discussed.