IMPROVING THE PERFORMANCE OF COMBINED CYCLES WITH SOLAR THERMAL ENERGY

Wesley Stein

E-mail: **wstein@ozemail.com.au**
Phone: **02 46557256**

A comprehensive study has been undertaken into the optimised integration of solar thermal steam into combined cycles and conventional fossil-fuelled cycles.

The high capital cost and zero fuel costs associated with renewable energy plants makes the hybridisation of solar steam into large power blocks a very attractive option. A detailed model has been developed to analyse such hybrid plants on the basis of actual industrial performance.

The paper considers a number of configurational options for integration, including solar superheating, solar evaporation, and solar preheat+evaporation. In concert with these configurations are the various operational modes and conditions which can be used, including solar topping, gas turbine throttling, supplementary firing and exhaust gas bypassing. Each case is analysed on an annual average basis for efficiency, capacity, specific CO_2 emissions and levelised cost of electricity.

Conclusions for the solar thermal combined cycle hybrid are that solar evaporation is the best performing form of solar integration. Supplementary firing offers the cheapest operational mode, but little improvement in specific CO_2 emissions. GT throttling offers the best performance improvement, but at a higher cost. Solar evaporation with solar topping offers all-round benefits.

The major premise of the study had been the identification of the potential for improving the inherent exergetic losses in the heat recovery boiler of a combined cycle plant. The study determined that solar thermal was one of the only available technologies that could provide evaporation external to the heat recovery boiler in such a way that both heat recovery boiler and steam cycle efficiency were simultaneously improved. Thus solar thermal energy not only generated renewable energy but also improved the efficiency with which the fossil fuel was used.

Limitations to the extent of integration were examined. Steam turbine exhaust wetness at high levels of solar proved the major limitation. It was determined that peak solar evaporation could improve the steam cycle efficiency by up to 10%, with solar energy to net electrical energy efficiency of 36%.

Overall, the integration of the solar thermal pushed plant levelised electricity costs up by approximately 10%.

From a business point of view, the integration of solar with combined cycle yields two marketable products. The solar electricity itself can be sold on the “green market”, but in addition the owner of the plant would have less exposure in a tradeable emissions market.