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Techno-economic performance evaluation of a solar industrial process heating system in Cairo–Egypt

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The demand for industrial process heating in Egypt is increasing at a very high rate while fuel costs are also increasing, representing an emerging challenge for the development in both industrial and commercial sectors. This paper introduces a techno-economic analysis and evaluation of a solar-driven hot water/steam production system for industrial and commercial applications. The system is composed of two full-scale parabolic trough solar thermal collector modules, thermal oil storage tank and a shell-and-tube heat exchanger (thermal oil-to-water). The system is sized to meet thermal loads up to 100 kWth. Experimental solar irradiance and meteorological databases available from the weather monitoring station at the Solar Energy Conversion Laboratory–Cairo University – permit accurate prediction of the collector system performance. A quasi-dynamic mathematical model is developed under MATLAB-Simulink environment and the system performance is analyzed and evaluated under typical days during the year (equinoxes, summer and winter solstices). Validation against experimental performance data provided by manufacturers' datasheets of system components enhance the accuracy of the mathematical model. Annual fuel and emission savings as well as economic effectiveness evaluation of the system are assessed through a retrofit study of replacing natural gas heating with the proposed solar system for thermal energy supply.

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