

Article title: Solar Energy for Process Heating: a Case Study of Select Indian Industries

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Abstract:

The annual consumption of petroleum products in India was about 221 million metric tons in 2015. Of this, 84% was imported. The Indian industrial sector accounts for about 16%–20% of the total fuel consumption for thermal energy for different heating applications in the temperature range of 50°C–250°C. Solar collectors can meet these temperature requirements and offer the possibility to mitigate the consumption of oil. This study highlights the fact that conversion efficiency from solar energy is much higher for process heating than for electricity generation and that process heating applications constitute a significant share of industrial energy consumption. In this paper, a methodology has been developed to estimate the potential for integration of solar collectors for process heating. The methodology employs process operating temperatures to select the type of solar collectors. The size of the solar field is estimated taking into account the thermal heat loads, working fluid and temperatures of these processes, the efficiency of the chosen solar collectors, location-based solar irradiance and capacity utilization of the solar collectors. The proposed methodology has been validated with a software tool called System Advisor Model (SAM). The techno-economic analysis will indicate the viability of solar systems for integration in industries. Therefore, the consociated parameters on economic (capital cost, fuel oil savings, monetary benefits), financial (Payback periods, Rates of Returns) and environmental (Carbon savings) are estimated. Further, the methodology has been applied to select Indian industries to verify its potential quantitatively. The industries selected include Textile, Pulp & Paper, Dairy, Leather and Automobile. Process-wise energy demands are considered while estimating the potential as the fuel requirement offset by solar energy in terms of absolute fuel oil savings, monetary benefits and carbon savings. The other economic and financial parameters mentioned above were estimated to verify the capability and present the market position of solar systems. Further, sensitivity analyses have been performed with respect to solar energy penetration and fuel oil prices to address the viability of integration of solar energy for process heating.