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Techno-economic assessment of a solar powered absorption chiller coupled with shallow-geothermal ground loop

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Abstract: Almost 65% of the energy consumed by the building sector in the Kingdom of Saudi Arabia (KSA) goes to air conditioning systems [7]. This high electricity demand can be greatly reduced if a clean energy resource is adopted. This study suggests that replacing conventional components of vapor compression chillers in commercial HVAC systems with renewable resources is technically applicable, economically viable, and environmentally sustainable. It presents a thermo-economic assessment of a solar-driven absorption chiller coupled with geothermal loop simulated for Saudi Arabian weather condition. In this system, solar thermal collectors along with a thermal energy storage tank are used to provide sufficient heat input for the absorption chiller over the course of the day while the geothermal loop operates in the system as a heat sink. The solar collectors and geothermal loop replace furnaces and cooling towers, respectively, in absorption chillers. A computer-based software was employed to simulate the 20-year thermal behavior of the suggested system. The model shows that a 3.5- ton absorption chiller coupled with a 23m^2 evacuated tube thermal collector and 23 boreholes is able to meet the cooling load of a small-size commercial building located in Riyadh, Saudi Arabia. This system can reduce the annual electricity consumption of the building by up to 51% and reduce the annual CO2 emissions by 9.2 metric tons. Despite its technical viability and environmental benefits, the economic analysis shows that the solar-driven absorption chiller coupled with geothermal loop is not economically feasible due to the high initial cost of the drilling. However, when a conventional cooling tower is used instead of the geothermal loop, a payback period of 10.5 years can be achieved.