Design Guidelines for Solar Cooling Applications

The widespread adoption of solar cooling technology in the market is not solely driven by the system's technical and economic aspects. Equally important is having a systematic approach for designing and installing systems in different climates and technology that can be easily managed by professionals who are not experts on the specific technology. It is for this reason, IEA SHC Task 65 on Solar Cooling for the Sunbelt Regions has published "Design Guidelines."

Design Guidelines, is a summary of case studies (practical or theoretical) that demonstrate novel and updated system concepts for solar thermal and PV cooling applications.

The method involved collecting information through questionnaires and analyzing the case studies received. A comprehensive questionnaire detailing various solar cooling components, design, sizing, and other sub-systems, such as heat rejection units and cold distribution systems, was sent to 74 Task 65 experts. The report presents the collection of design and system integration guidelines for solar cooling projects. Data from 10 case studies show the performance of solar cooling systems under different boundary conditions. The report covers three additional case studies, each with its own scope and unique characteristics.

The report's main findings are:

- **Industrial cooling** offers significant opportunities for solar thermal cooling applications. These systems can achieve a high solar fraction, leading to substantial reductions in CO_2 emissions compared to conventional electricity-powered chillers. Overall, the simulated system results of a solar field with a parabolic trough collector (PTC) area of 150,040 m^2 (27,280 PTCs, each 5.5 m^2), a cold storage volume of 35,000 m^3 (6 tanks, each 5,840 m^3) and double-effect water-LiBr absorption chillers (110 MW) can save nearly 25,000 tons of CO_2 annually compared to the base case. This equates to a 53% reduction in annual CO_2 emissions.
- **Integrating solar PV with vapor compression chillers** is an emerging solution for decarbonizing cooling systems. A comparative analysis of different load and weather profiles suggests that solar PV cooling can result in lower levelized costs of cooling compared to solar thermal cooling. As highlighted by this study, solar cooling using parabolic trough collectors and double-effect absorption chillers is less competitive than retrofitting a modern vapor compression chiller with a high coefficient of performance (COP) with a photovoltaic system. Absorption chillers with solar thermal are useful for replacing low COP compression chillers (see Figure 1).
- **Hybrid chillers emphasize the potential of combining electrical and thermal chillers.** Both simulation and practical results indicate a significant reduction in power consumption when using the topping cycle of an adsorption chiller. The results show that lowering the heat source temperature from 85°C to 70°C reduces the chiller's performance from 6% to 10% for the Energy Efficiency Ratio (EER) and cooling capacity. Such a reduction of cooling capacity and EER with the temperature is slightly higher for higher evaporation temperatures (around 15% for chilled water temperature of 0°C and above). The adsorption

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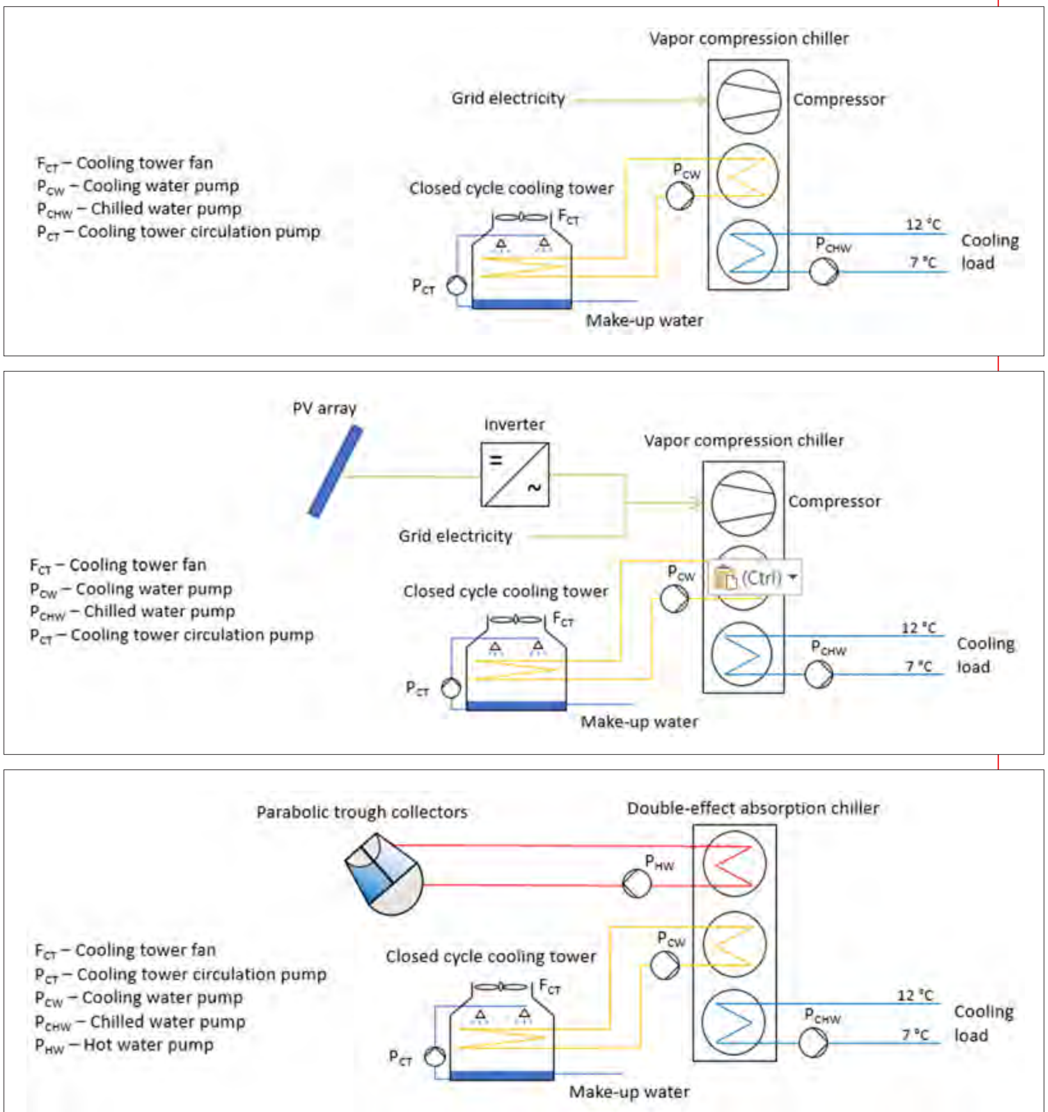

Figure 1. The most important components are 1) a reference cooling system (top), 2) a PV cooling system (middle), and 3) a solar thermal cooling system (bottom).
Source: Absolicon

chiller uses silica gel/water for the sorption cycle and a low Global Warming Potential (GWP) refrigerant, propene, for the compression cycle. It has been found that electricity energy savings from 15% to 25% can be achieved when using a hybrid system over a compression one with the same cooling capacity.

These case studies collectively demonstrate the transformative potential of cooling solutions in shaping a greener and more energy efficient cooling future to support the Global Cooling Pledge, launched at COP28.

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