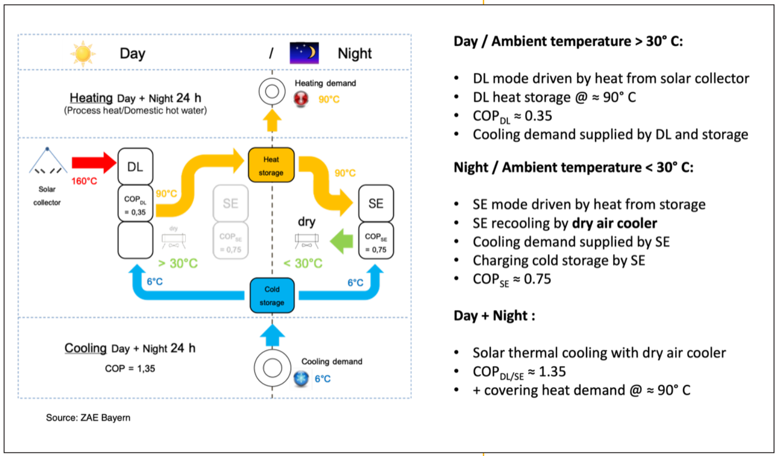
Future Potential of Solar Cooling

The energy demand for air-conditioning is growing faster than any other energy consumption in buildings. The main share of the projected growth for space cooling comes from emerging economies and will more than triple by 2050 to 6,000 TWh/a globally. What could be the contribution of PV and solar thermal cooling to meet this increasing demand in the next decade? This was the key question that Dr. Uli Jakob, Task Manager of SHC Task 65 on Solar Cooling for the Sunbelt Region, elaborated on in his keynote presentation, The Future of Solar Cooling, at EuroSun 2022.

The challenge faced by many solar thermal cooling systems in the sunbelt region is the need for recooling the heat-transfer medium. In areas with high ambient temperatures above 30 °C wet cooling towers are necessary, which causes costs and water requirements. In the SunBeltChiller project, scientists have developed a new system configuration for a solar thermal cooling system that works without a wet recooler so it can be operated in dry and water-poor areas.



▲ **Figure 1. The SunBeltChiller system combines the double-lift (DL) operation of a high-temperature heat pump with a single-effect absorption chiller to avoid a wet recooler.** Source: ZAE Bayern

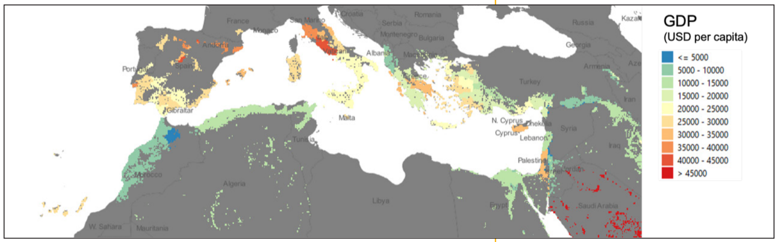
There are three special features of this concept, which are shown in Figure 1:

- Double lift (DL): Uses concentrating collectors as the heat source of around 160 °C for a high-temperature heat pump.
- Single effect (SE): The waste heat from the double lift process at around 90 °C is stored and used in a single-effect absorption chiller at night.
- Cooling storage is connected to the single-effect chiller to make the cold produced at night available during the day.

"The big advantage of the SunBeltChiller concept is that only the single-effect cooling process needs recooling. This is done at moderate temperatures during the night because of the storage, which allows the use of dry recoolers," explains Richard Gurtner, Head of the SunBeltChiller project and researcher at the German ZAE Bayern research institute.

A newly developed tool within the German project SunBeltChiller allows the assessment of the future

▶ **Figure 2. Potential customers for SunBeltChiller systems around the Mediterranean. Inhabitants live in areas with a DNI higher than 1,500 kWh/a and water scarcity. The colors show the GDP, with green representing low-income groups and red indicating well-off population groups.** Source: ZAE



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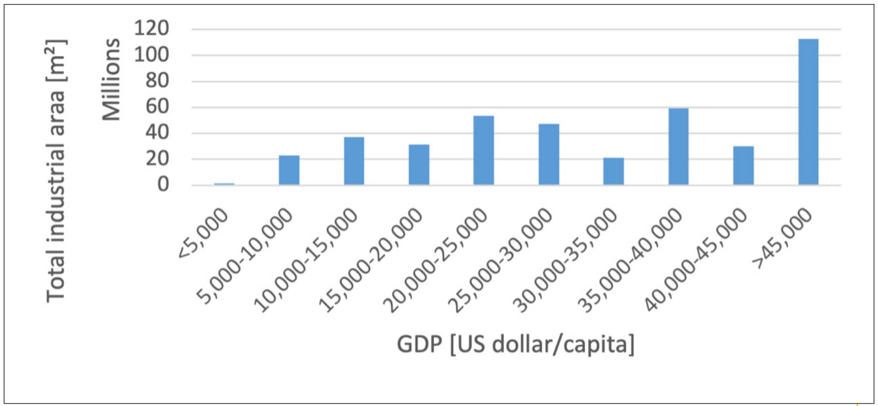

Figure 3. The global potential for SunBeltChiller systems for industrial cooling. How to read this chart: The tool identified industrial areas totaling 110 million m2 across the globe where the GDP is above USD 45,000 (column on the right). Photo: ZAE

potential of solar cooling based on specific geographical data on irradiation, population density, industrial areas, and water availability. To determine which areas of the sunbelt region have the potential for this concept, the team defined a DNI of at least 1,500 kWh/m^2 annually as the necessary condition for the concentrating collectors. They also wanted to find arid regions where the dry cooling advantage of the SunBeltChiller concept has a unique advantage.

ZAE used geographical information system software (QGIS). They also collected data from publicly available sources, such as climate zones, irradiation potential, gross domestic product, population density, industrial areas, and water availability. They then adapted it to a uniform grid structure. The tool covers the whole world with a grid of one square kilometer fields. The tool can check the available data in all these squares and aggregate the results if a set filter is met.

Two filters are crucial as key indicators for market size. The GDP level is an indication of the market volume for building air conditioning because homeowners need a certain income to buy solar cooling systems. Industrial areas, on the other hand, are the indicator for the market size of industrial cooling demand. The result can then be displayed graphically (see Figure 2) or as a chart (Figure 3).

Currently, the QGIS tool is being used on a global level only. But Gurtner and his team want to identify potential demand for solar cooling systems in buildings and industry at the country level.

This article was contributed by Bärbel Epp, editor-in-chief of solarthermalworld.org.

"The QGIS-based software is a great tool to identify potential solar thermal cooling demand," summarized Uli Jakob. "It is all about how to use the solar resource on-site for particular applications."