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# MARKET READY SMALL-SCALE SOLAR COOLING SYSTEMS

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## 1 Abstract

Worldwide the energy consumption for cold and air-conditioning is rising rapidly. Usual electrically driven compressor chillers (split-units) have maximal energy consumptions in peak-load period during the summer. In the last few years even in Europe this regularly leads to overloaded electricity grids. The refrigerants that are currently used in the split-units do not have an ozone depletion potential (ODP) anymore, but they have a considerable global warming potential (GWP), because of leakages of the chiller in the area of 5 to 15 % per year. Particularly the sale figures of split-units with a cooling capacity range up to 5 kW are rising rapidly. In USA the number of sold units has risen about 32% from 12.9 million in 2004 to predicted 17.0 million in 2007 (cci, 2007). The Japan Refrigeration and Air Conditioning Industry Association (JRAIA) has expected a worldwide sales of 74.4 million units in 2007.

Thermal cooling by solar energy or district heating or waste heat from CHP units could be lead to a considerable reduction of energy consumption. The sorption chillers use environmentally friendly refrigerants and have only very low electricity demand. Therefore the operating costs of these chillers are very low and the CO<sub>2</sub> balance compared to split-units is considerably better. The main advantage of solar cooling is the coincidence of solar irradiation and cooling demand. In case active cooling being necessary, the long running times of the chillers are the key for economic efficiency of solar cooling. For domestic buildings in Central Europe only about 50 to 200 cooling hours occur, whereas in the southern Mediterranean area as well as for some industrial and office buildings approximately 1,000 full load hours are necessary. In the small scale capacity range up to 30 kW several water/lithium bromide absorption chillers, one ammonia/water absorber as well as three water/silica gel adsorption chillers are market-ready available in Europe (Jakob, 2008). The market potential for solar cooling is very large, so that different European companies like CitrinSolar, Enus, Schüco, SolarNext and Solution have developed small scale solar cooling systems for the product business. These solar cooling systems basically include solar thermal collectors with attachments, hot water storage, pump-set, chiller, re-cooler and partly cold water storage and system control. The specific total costs of installed solar cooling systems in Europe are so far between 5,000 and 8,000 EUR/kW (26,250 and 42,000 US\$/RT). For 2008 system prices of 4,500 EUR/kW (23,625 US\$/RT) are reached, in the next two years 3,000 EUR/kW (15,750 US\$/RT) are expected for small scale solar cooling systems. An all-season use of renewable energy sources for hot water, space heating and solar cooling is here indispensable. The solar fraction for the solar cooling system should be more than 70%. Therefore the latest small scale sorption chillers and solar cooling systems as well as first installations are presented.

cci (2007), 71 Mio. Klimageräte - neuer Weltrekord, *cci*, No. 9, pp. 30

Jakob, U. (2008), Cool climate from the scorching sun, *Sun & Wind Energy*, No. 2, pp. 64-72