SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

Task38
Solar Air-Conditioning and Refrigeration

Executive Summary:
Solar Cooling Position Paper

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This document summarises the Position Paper on Solar Cooling developed by IEA SHC project "Solar Air-Conditioning and Refrigeration (Task38)". The full document (PDF, 20 pages) can be downloaded from the IEA SHC website.

Introduction to Solar Cooling

The fast growing demand for cooling and air conditioning has led to a dramatic increase in peak electricity demand in many countries. Blackouts and brownouts in summer have frequently been attributed to the large number of conventional air conditioning systems running on electric energy. The increasing use of vapour compression cooling machines furthermore leads to increased emissions of greenhouse gas emissions, such as HFCs, which are used as refrigerants.

An obvious possibility to counter this trend is to use the same energy for generation of cooling that contributes to creating the cooling demand—solar energy. The distinct advantage of cooling based on solar energy is the high coincidence of solar irradiation and cooling demand—the use of air conditioning is highest when sunlight is abundantly available. This coincidence leads to a low need for energy storage, as the cooling produced from solar energy is almost immediately used.

While many professionals such as architects and installers think of photovoltaic systems in combination with conventional vapour compression cooling machines as the most obvious solar option, the alternative option of using solar thermal systems in combination with thermally driven chillers is now a market ready technology.

The Solar Cooling Position Paper developed by the International Energy Agency's Solar Heating and Cooling Programme (IEA SHC) provides an overview of the state-of-the-art of technology and markets. And, it identifies remaining shortcomings and how to overcome them.

Technology

Thermally-driven chillers have been available for over 100 years. However, they were designed for rather large cooling capacities (>100kW) and high temperatures (>100°C). Thus, their main use was in industrial applications, especially in using excess heat from other processes (including CHP plants). These large cooling machines were not suitable for use with low-temperature heat from typical solar thermal collectors, and they did not work well with the fluctuating temperatures provided by solar thermal systems. In recent years, numerous thermally-driven chillers have entered the market to work at lower temperatures and cooling capacities and system design was adapted to maximize the use of solar energy in combination with these thermally driven chillers.

Markets

More than 1,000 cooling systems based on solar thermal collectors and thermally-driven chillers have been installed in recent years. And the interest in these products continues to increase. This is most evident where solar thermal collectors can be used for cooling in summer and for heating in winter. As high prices for (peak) electricity and more frequent electricity outages occur the attractiveness of solar thermally driven cooling systems will continue to grow.

Technical barriers

The components for solar thermally driven cooling have reached a sufficient level of maturity and the main technical problems today lie at the system level—proper design and energy management of the systems. In many cases, earlier systems were designed too complex thus creating non-optimal control and high maintenance needs.

At the component level, further R&D could lead to higher efficiencies and lower costs. Of particular interest are:

- cooling machines that can be integrated in the solar collectors, thus reducing system complexity and energy losses,
- double-effect absorption chillers to achieve higher efficiencies at higher temperatures,
- single-axis tracking solar thermal collectors for temperatures between 150 and 250°C to drive double- and triple-effect chillers, and
- standard (non-tracking) solar thermal collectors to have higher efficiencies at temperatures between 80 and 150°C and reduced costs.

Non-technical barriers

As for most renewable energy options, the initial investment costs are significantly higher than those of conventional cooling solutions. Even where the investments pay off in just a few years, many consumers and decision makers chose the conventional option and its lower investment costs. Furthermore, the awareness and know-how of involved professionals (planners, installers) remains insufficient. Most of them have no experience and no training in solar thermally driven cooling systems thus creating a barrier for growth of this technology either by not actively marketing the technology or by poor quality planning or installations, thus reducing system efficiencies and increasing cost to the consumers.

Solutions & recommendations

Both, public and private R&D efforts are needed to further improve solar thermally driven cooling at the system level. Research and development should focus on pre-engineered systems for the smaller capacity range, which minimize planning efforts and the risk of installation errors. In solar heating systems, such pre-assembly has already led to better quality installations and is contributing to efforts leading to overall lower installation costs. Furthermore, a focus on quality procedures for design, commissioning, monitoring and maintaining solar cooling systems is needed to develop a sustainable market for solar thermally driven cooling technologies. Developing guidelines and planning tools as well as offering training courses to involved professionals are concrete examples of steps to be taken.

Solar cooling helps shave costly peak loads in the electricity grid, reduce conventional energy consumption, and avoid GHG emissions from vapour compression cooling machines. Therefore, governments should help solar cooling enter the market with financial support. Regardless of the concrete support scheme (e.g., direct grants, tax incentives), it is most important to avoid stop-and-go support, which usually hurts the market more than it helps. Stability of the support framework should have a high priority and it thus makes sense to seek funding sources outside of public budgets.

Building regulations prescribing minimum energy efficiencies should cover not only heating, but also cooling. Cooling solutions based on renewable energies, such as solar cooling, is then an option to achieve the required overall efficiency targets.

More information on the topic

- Full Solar Cooling Position Paper (PDF, 20 pages)
- Project's website: http://task38.iea-shc.org/
- See also: http://task48.iea-shc.org/

About the International Energy Agency's Solar Heating and Cooling Programme (IEA SHC):

- The Programme was established in 1977.
- Its objectives are co-operative research, development, demonstration and exchange of information regarding solar heating and cooling systems.
- 21 countries and the European Union are IEA SHC members.
- The research topics of the current 12 projects range from general topics, such as "Solar Resource Assessment and Forecasting" and system and materials research, such as "Large Solar Thermal Systems" and "Polymeric Materials for Solar Thermal Applications" to market support topics such as "Solar Rating and Certification".
- Additional information: www.iea-shc.org