Solar thermal cooling - South Africa

INTRODUCTION

South Africa is an energy-intensive economy with a high greenhouse gas (GHG) emission factor. More than 90% of the country's electricity is still generated from coal. As a developing nation with a population estimated at around 54 million and an economy boasting significant heavy-industrial and extractive-industrial activities, the demand for energy from the building, industrial and mining sectors is substantial. As these sectors account for 93% of South Africa's demand for electricity, there is a significant energy savings potential. One of the biggest drivers for growth in this demand is cooling. Electricity consumption for cooling in South Africa was estimated to account for 24 TWh in 2009, corresponding to the emission of 23.5 million tCO_2e.

A range of relevant technologies is envisaged to reduce demand for electricity for cooling, including solar absorption cooling and PV powered hardware. The distinct advantage of cooling based on solar energy is the high coincidence of solar irradiation and cooling demand in South Africa (i.e., the use of air conditioning is highest when sunlight is abundantly available). This correlation reduces the need for energy storage, as the cooling produced from solar energy is almost immediately used. While PV-powered 'traditional' airconditioning technology has become a more realistic option, solar thermal cooling technology, being a new technology, has also moved closer to market and has significant potential to scale up in South Africa. South Africa has an excellent solar irradiation, with up to 3000 kWh/m^2 annual radiation, and estimates from the International Energy Agency (IEA) show that solar thermal systems could meet about 70 – 80% of the region's low temperature heating and cooling demand (IEA, 2014).

PROJECT OBJECTIVE

This project focused on an innovative and promising technology and was largely exploratory, aiming to understand the status of the market for solar cooling technology in South Africa, and what can be done to further develop it. As such, activities and outputs of the ADMIRE project in South Africa were designed in parternship with the South African National Energy Development Institute (SANEDI) and divided into two stages: market analysis and the development of a technology-support mechanism. However, approval for the second stage was contingent upon the conclusions of the first stage.

RESULTS & NEXT STEPS

The market analysis clearly indicated that despite a relatively high cooling demand, there has not been a significant penetration of commercially available solar cooling systems into South Africa. The technology is still emerging, and currently in demonstration phase, not too far from being competitive on the market. Indeed, if the historical technology cost curve reductions continue at the same pace, solar thermal cooling technologies are likely to be competitive with conventional electrical cooling technology by as early as 2020, especially as electricity prices are projected to increase. However, a range of financial and non-financial barriers exist, including a lack of awareness about the technical potential and commercial opportunities surrounding the uptake of solar thermal cooling technology. Given the current state of the market and the barriers, solar cooling technology was not deemed feasible, at this stage, for support under ADMIRE. The second phase of the project was thus not initiated, and the project was terminated.

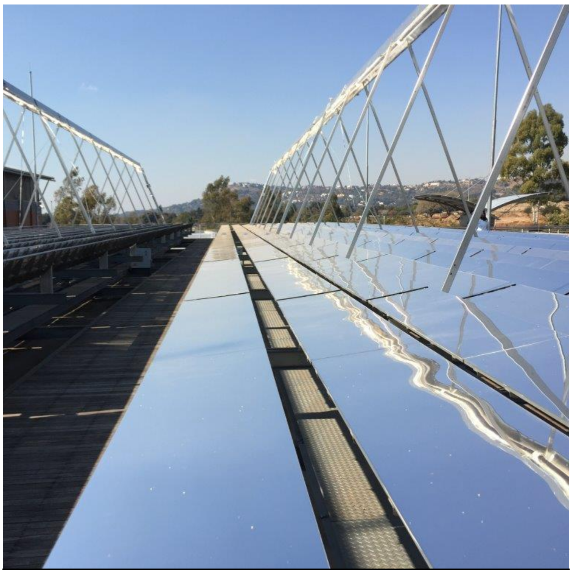
Nevertheless, the technology has huge potential in South Africa, and this justifies interventions in the form of "learning by doing" research, development, demonstration and deployment (RDD&D). The study concludes that government and industry must pursue energy technology innovation through a number of parallel and interrelated pathways sympathetic to both the "push" of RD&D and the "pull" of market deployment; however, such interventions were outside of the scope of the ADMIRE project.

SUSTAINABLE DEVELOPMENT GOALS

7 AFFORDABLE AND CLEAN ENERGY	8 DECENT WORK AND ECONOMIC GROWTH	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	13 CLIMATE ACTION
Increased access to cleaner energy technologies in a country with a high dependence on fossil fuel for power generation	Solar thermal cooling technology can play a central role in driving South Africa along a path of 'Green Growth'	Making the technology available to all and thus enabling scaling of the production system over time	Widespread use of solar thermal cooling technology will contribute towards greenhouse gas emission reduction in South Africa

THE TECHNOLOGY - SOLAR THERMAL COOLING

Solar thermal cooling works by using heat generated by solar thermal collectors and converting this into cooling using thermally driven refrigeration or air-conditioning technologies. There are various types of solar thermal cooling technologies, absorption cooling driven by solar thermal collectors are the most mature, proven technologies. These systems are typically utilised in instances where waste heat is available, which is the case in many industries in South Africa, such as cement manufacturing, electricity generation, smelters, just to mention a few. Absorption cooling technologies are also available at smaller scales, appropriate for domestic cooling needs, which accounts for the vast majority of energy demand for cooling in South Africa. The potential for scaling up the application of smaller-scale solar thermal cooling units to the domestic market was included as a focus of the study.



330kW Linear Fresnel solar thermal cooling installation at MTN Data Centre, Roodepoort, Johannesburg (2015)

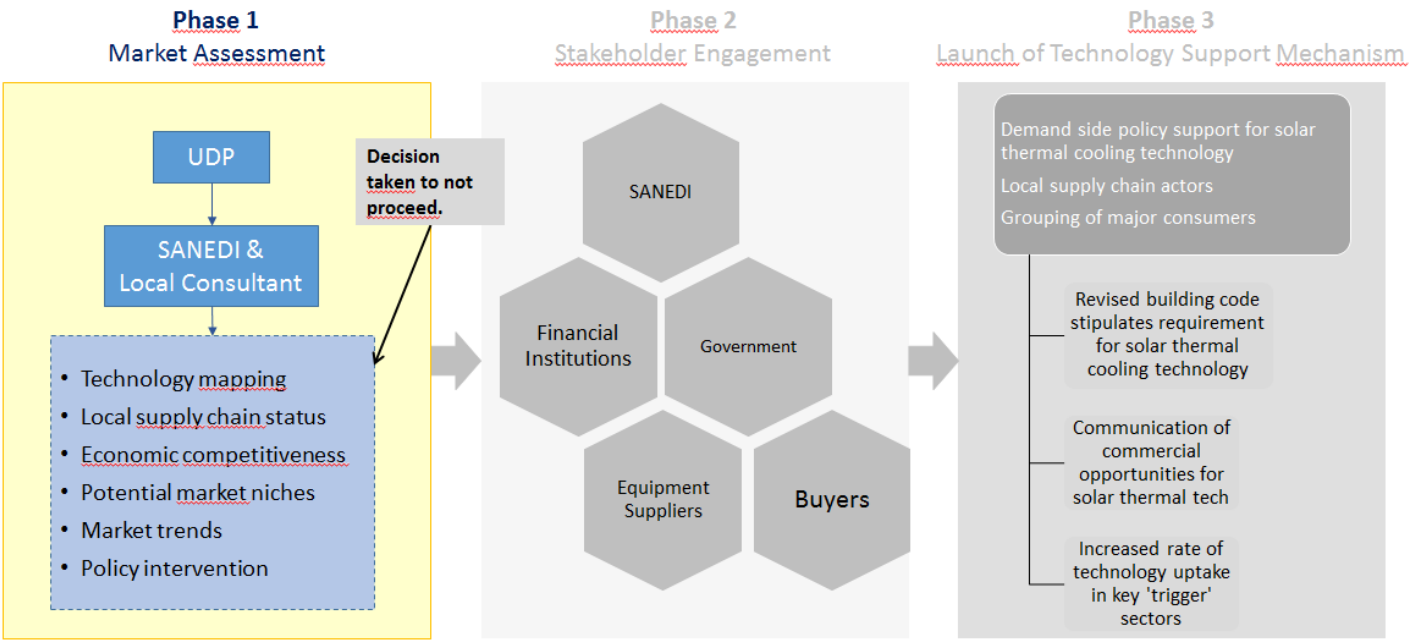
Improving the economic feasibility of solar thermal cooling technology depends on performance improvements of thermally driven chillers. A combination of small capacity chillers with existing solar combined systems for space heating and domestic hot water preparation is gaining a share of the global market and is expected to open new market segments in the coming years. The application of small thermally driven chillers in such systems would enable solar collectors to be fully exploited during summer days. Such systems are especially suitable for climates with mild winters and sunny summers such as in South Africa.

THE BUSINESS CASE FOR CLIMATE ACTION

As with many renewable energy technologies, the upfront (capital) costs of solar thermal cooling technologies are relatively high, compared with conventional electric cooling technology, while the fuel costs are zero if energy storage is included in the Capex. Therefore, in a country such as South Africa that has low but rapidly increasing electricity prices, solar thermal technologies will inevitably become cost competitive, compared with electric chiller technologies. A study conducted by Joseph (2012) calculated a payback period of 14 months for solar thermal absorption technology, when a 10% escalation rate for electricity was applied.

The low uptake reflects a general lack of awareness of solar thermal technology among consumers, government and business as well as the underlying financial cost of the technology. This has manifested in a lack of experience with the technology among designers, installers (to a lesser degree as some experience gained from Solar Water Heating Programmes e.g. NSWHP and SOLTRAIN) and suppliers, which will be a significant barrier to industry expansion in the short term. To address this limited industry experience and increase awareness of the technology among consumers, government support for the development of the solar cooling industry should emphasise high-quality demonstration projects, development or adaption of current HVAC standards, and training programs. It was recommended that current application of local building codes (SANS 10400-XA) should also look at specific measures to address solar cooling technologies.

PROJECT INTERVENTION



RESOURCES

Joseph, J., (2012) *Study of a Solar Assisted Air Conditioning System for South Africa.* Durban: School of Engineering, University of KwaZulu-Natal.

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IEA (2014) *Solar Heat Worldwide*

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