Third Update on Activity C1 Design Tools and Models, Task 65 Solar Cooling Sunbelt Regions

Lu Aye[1]*, Nayrana Daborer-Prado[2], Daniel Neyer[3,4], and Uli Jakob[5]

[1]*Renewable Energy and Energy Efficiency Group, Department of Infrastructure Engineering, Faculty of Engineering and Information Technology, The University of Melbourne, Victoria 3010, Australia*

[2]*University of Applied Sciences Upper Austria Campus, Energy Research Group ASIC, Stelzhamerstraße 23, 4600 Wels, Austria*

[3]*Neyer Brainworks GmbH, Oberradin 50, 6700 Bludenz, Austria*

[4]*University of Innsbruck, Innrain 52, 6020 Innsbruck, Austria*

[5]*dr. Jakob energy research GmbH & Co. KG, Pestalozzistraße 3, 71384 Weinstadt, Germany*

**Corresponding Author. E-mail address: lua@unimelb.edu.au (Lu Aye).*

Abstract

This document reports about IEA Solar Heating and Cooling (SHC) Task 65 and Australia's engagement within the task. Australia has been contributing to Subtask C: Assessment and Tools. The findings from the interviews/questionnaires and interactive questionnaires on solar cooling system design tools and models are presented.

Keywords: IEA; Sunbelt region; solar cooling; assessment; design tool; interview

Introduction

IEA SHC Task 65 focuses on innovations for affordable, safe and reliable solar cooling systems (the configurations may be found in Table 1 and 2). It is organised into four main activities/subtasks; the details may be found in Neyer and Jakob (2020). One of the issues identified is that commonly accepted appropriate methods and tools for benchmarking, assessment, and design for the Sunbelt region (sunny and hot, and humid climates, between the 20th and 40th degrees of latitude in the northern and southern hemisphere) are lacking. To address this issue, the main objectives of Activity C1 are (Neyer 2020):

- to document the tools and their specific applications,
- to provide measured data for validation of the tools, and
- to adapt the selected ones for sunbelt boundaries.

The initial finding from the published literature about the solar cooling system design tools and models were presented in Asia-Pacific Solar Research Conference (APSRC) in 2021 (Aye et al. 2021). The software tools applied in solar cooling system research found in the literature and their websites were presented in APSRC 2022 (Aye et al. 2022). Based on these findings, a set of interviews/questionnaires were developed to obtain an insight into which tools and applications are being mostly used and implemented by the members of the Task 65. In order to gather sufficient data, the questionnaire developed was sent to all participants of Task 65. This first set of questionnaire is presented in a table format (Table 1) in view of that the configuration allows the formulation of direct questions, which facilitates the understanding and accelerates the analysis of the information. Expert meetings were used to explore further feedbacks and contents for Subtask C. With the help of an interactive tool (Mentimeter), closed and open questions on the use of specific tools in the different project phases are collected, discussed, and analysed. In this third

update, the findings from the interviews/questionnaires and interactive questionnaires (sample size of polling , n = 18) on solar cooling system design tools and models are presented.

Table 1 Solar cooling system component design tools (example entry)

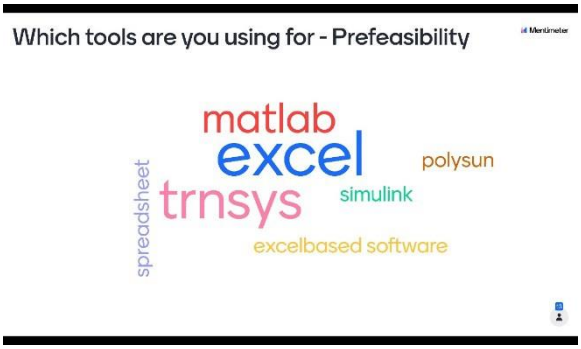
Component→	Solar collector				Cooling technology					Delivery			Storage	
Design stage or output ↓	Flat plate	Evacuated tube	Trough	PV PV/T	Absorption	Adsorption	Liquid desiccant	Solid desiccant	Vapour compression	Air	Liquid	Electricity	Heat	Battery
Prefeasibility														
Sizing														
Technical performance														
Financial performance														
Hourly simulation	TRNSYS	TRNSYS	TRNSYS	TRNSYS	TRNSYS	-	-	-	TRNSYS	TRNSYS	TRNSYS	TRNSYS	TRNSYS	TRNSYS
...														
...														

Results

The consolidated results of the interviews/questionnaires are presented in Table 2. We found the following software tools are currently being implemented in the applications and research of the participants: MATLAB, Meteonorm and Excel tool, TRNSYS, EES, Phyton. The results of the interactive questionnaires are shown as word clouds, where the same results in answers are clustered and shown in size of the word/headline compared with other answers. The results show the use of software tools in different phases of projects, starting from prefeasibility to detailed simulations and analyses of technical and economic performance (Figure 1). For prefeasibility, the experts mainly use calculations tools based on Excel or other spreadsheets (Figure 1a). However, even in prefeasibility, TRNSYS, MATLAB or Polysun are used as well (Figure 1a). The main tools applied in sizing are simulations tools like TRNSYS, Polysun or Excel spreadsheets (Figure 1b). For analysing economic performance, mainly Excel based tools are in use (Figure 1d). For more detailed hourly simulations TRNSYS and MATLAB have been applied (Figure 1e). The final report of the Activity C1 Design Tools and Models for IEA SHC Task 65 may be found in (Daborer-Prado et al. 2023). It should be noted that compared to previous IEA tasks the aim is not to evaluate or validate any model nor compare their results in specific cases. It is more an overview of software tools frequently used for solar cooling and heating systems. A very detailed description of various simulations tools used in solar cooling was presented in IEA SHC Task 38.

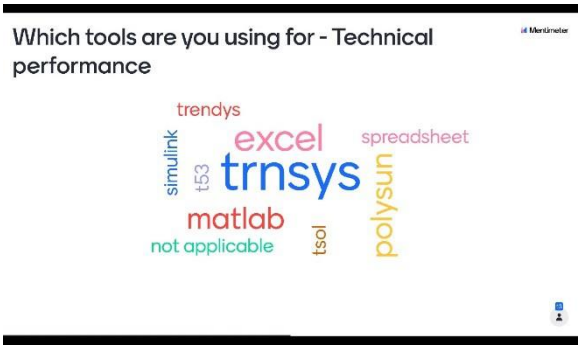
Table 2 Consolidated results of interviews/questionnaires

Component→	Solar collector				Cooling technology					Delivery			Storage	
Design stage or output ↓	Flat plate	Evacuated tube	Trough	PV PV/T	Absorption	Adsorption	Liquid desiccant	Solid desiccant	Vapour compression	Air	Liquid	Electricity	Heat (cold)	Battery
Prefeasibility	Meteonorm + Excel Tool Phyton	Meteonorm + Excel Tool Phyton		Meteonorm + Excel Tool	MATLAB EES Excel Tool	Phyton			MATLAB EES Excel Tool	x	x	x	MATLAB TRNSYS Excel Tool Phyton	
Sizing	Meteonorm + Excel Tool	Meteonorm + Excel Tool		Meteonorm + Excel Tool	MATLAB EES TRNSYS Excel Tool				MATLAB EES TRNSYS Excel Tool			x	MATLAB TRNSYS Excel Tool	
Technical performance	Meteonorm + Excel Tool	Meteonorm + Excel Tool		Meteonorm + Excel Tool	MATLAB EES TRNSYS Excel Tool				MATLAB EES TRNSYS Excel Tool				MATLAB TRNSYS Excel Tool	
Financial performance	Excel Tool	Excel Tool		Excel Tool	MATLAB EES TRNSYS Excel Tool				MATLAB EES TRNSYS Excel Tool				MATLAB TRNSYS Excel Tool	
Hourly simulation	MATLAB TRNSYS Meteonorm + Excel Tool	MATLAB TRNSYS Meteonorm + Excel Tool	MATLAB	Meteonorm + Excel Tool	MATLAB EES TRNSYS Excel Tool	-	-	ENERGYPLUS	MATLAB EES TRNSYS Excel Tool	-	-	-	MATLAB TRNSYS Excel Tool	-



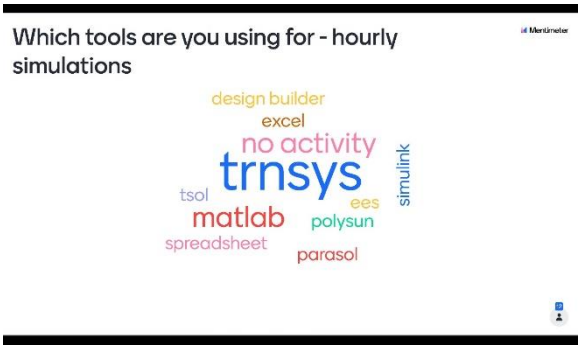
(a)

(b)



(c)

(d)



(e)

Figure 1 The results of the interactive questionnaires

Conclusions

Modelling and assessment of technical and economic behaviour of solar cooling plant is essential in all phases of design up to implementation and optimisation. Different tools are used, from sophisticated dynamic simulation models to simple spread sheet calculations. Companies and their experts often develop their own, for their specific components and systems. Generic models which are freely available can be found for almost all applications, especially simulation tools. The configuration and data sheets for the entire tools depend on the approach and are often difficult to find.

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