DS²BE

Doctoral Seminars on Sustainability Research in the Built Environment

Development of an Assessment Methodology for Resilient Cooling

A.Sengupta [a], H. Breesch [b], M. Steeman [c]

[a, b] Department of Civil Engineering, KU Leuven, Construction TC, Ghent and Aalst Technology Campuses, 9000 Gent, Belgium

[c] Department of Architecture and Urban Planning, Universiteit Gent, 9000 Gent, Belgium

KU LEUVEN

UNIVERSITEIT GENT

PROBLEM STATEMENT

Buildings worldwide and in Belgium are subjected to climate change and heatwaves causing a risk of overheating and increasing energy use for space cooling. *[1]*

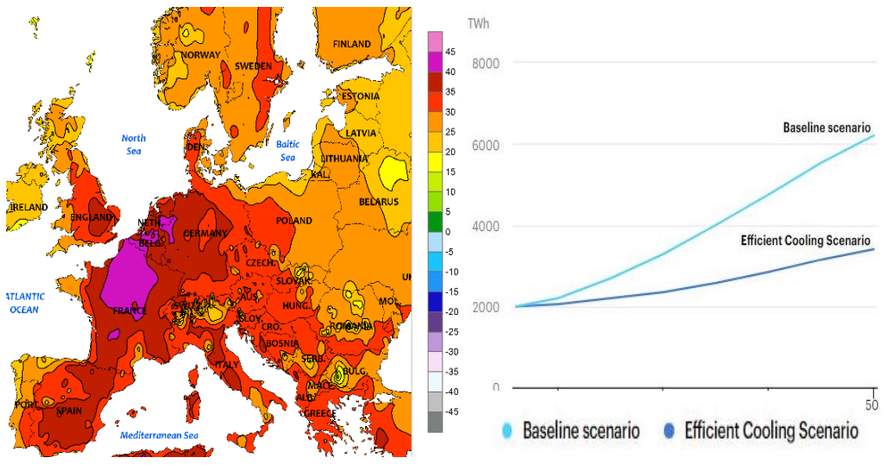

Fig.1. Maximum temperature on 25th July 2019 in Europe (left) [2] and Space cooling energy growth and saving potential, baseline and efficient cooling scenario 2016-2050 (right) [3].

The energy reduction and climate neutral goals of the European Union (EU) and Flemish Government

➡ Low energy cooling solutions are promising *[4]*.

However, performance of low energy cooling technologies in case of **heatwaves** and exceptional events like **sun shading or power failure, increase in occupancy**, etc. is not guaranteed.

(Building) resilience is a method to deal with these uncertainties and is stated as **"an ability of the building to withstand disruptions caused by extreme weather events, man-made disasters, power failure, change in use and atypical conditions; and to maintain capacity to adapt, learn and transform."**

Thermal Comfort	Parameters	Thermal Autonomy (TA)	
		Passive Survivability (PS)	
		Ventilation Autonomy (VA)	VA- Indoor environmental quality
			VA- CO2 Level
			VA- Air Ventilation Rate
		Future Climate Scenarios	
	Events	Power Disruption	
		High Occupancy	
		Sun Shading Failure	
		High Internal Loads	
Function	attribute	Risk Avoidance (RA)	
		Durability and Longevity (DL)	
		Redundant Systems (RS)	
		Response and Recovery (RR)	
		Control Strategies	
		Adaptive Criteria	
		Thermal Mass	
	LCA	Service Life of Cooling Technology	
	Design Phase	Retrofit	

Fig.2. Existing Resilience Indicators applied on Low Energy Cooling Technologies

However, at present the definition of Resilience and resilience assessment indicators (Fig.2) specific for low energy cooling technologies are lacking.

OBJECTIVES

The goal of this research project is to improve the resilience of low energy cooling technologies by developing a resilience assessment framework focusing on low energy cooling.

The objectives are:

- To test the existing building resilience definitions and performance indicators (Fig.2)
- To determine resilience definition and performance indicators specific for low energy cooling
- To translate the tested and refined definition and assessment indicators of resilience into guidelines for (1) resilience rating of low energy cooling technologies and (2) improvement of the resilience of the cooling system

BUILDING TYPOLOGIES

- **RESIDENTIAL**
- **SMALL NON RESIDENTIAL**

COOLING TECHNOLOGIES

Individual or combination of the following:

- **NIGHT COOLING**
- **INDIRECT EVAPORATIVE COOLING (IEC)**
- **RADIANT FLOOR COOLING**

CASE STUDY BUILDING

-Test lecture rooms at KU Leuven, Ghent Technology Campus (**Night Cooling + IEC**) *[6]*.

-A single family residential house **(Night Cooling)**

-A single family house **(IEC + Floor cooling)**

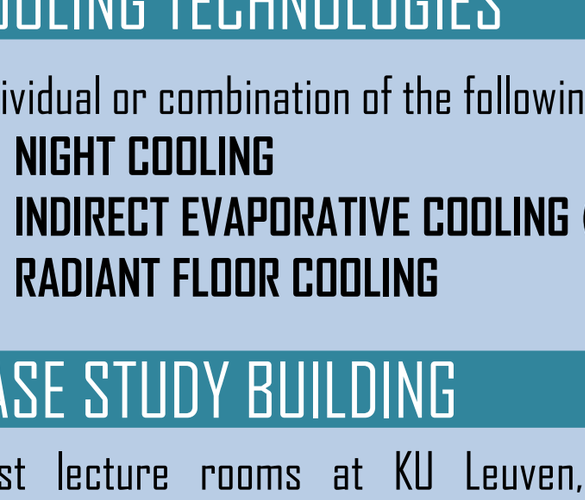

Fig. 3. Principle of Natural Night Ventilation in Case study 1 Building [5]

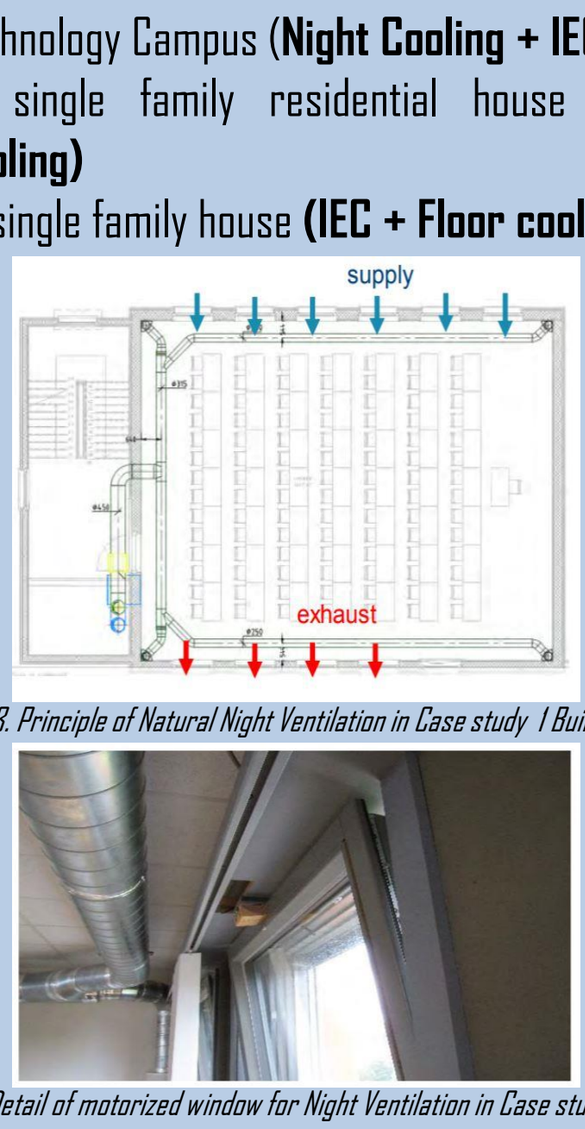

Fig. 4.Detail of motorized window for Night Ventilation in Case study 1 Building

METHODOLOGY

A step-wise methodology :

- Start with **collect** (WP1) and **test** (WP2) existing definition of Resilience from literature
- **Identify** the most influencing building and system parameters of the cooling performance in the **sensitivity analysis** (WP3) and identify the resilience indicators specific for low energy cooling technologies (WP2)
- **Test** the new definition and indicators (WP4)
- **Translate** the results into guidelines (WP5) for practical application into the field.

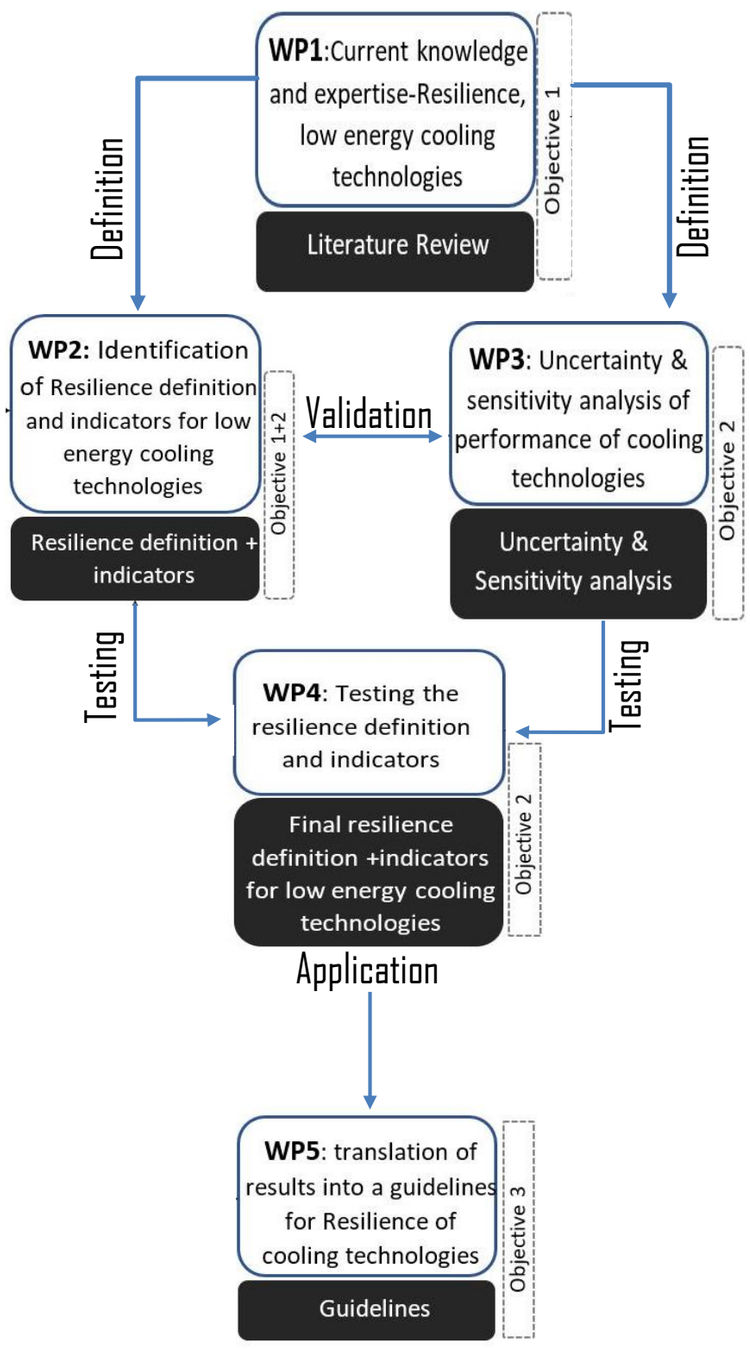

Fig.5. Work packages and Methodologies

REFERENCES

1. IEA/EBC, "Ventilative Cooling (State-of-the-art review) Annex 62," *IEA - EBC Program.*, vol. Annex 62, p. 213, 2015.
2. M. Hamdy, S. Carlucci, P. Hoes, and J. L. M. Hensen, "The impact of climate change on the overheating risk in dwellings d A Dutch case study," *Build. Environ.*, vol. 122, no. August 2003, pp. 307–323, 2017, doi: 10.1016/j.buildenv.2017.06.031
3. OECD/IEA, "The Future of Cooling Opportunities for energy-efficient air conditioning Together Secure Sustainable," p. 92, 2018.
4. European Commission, "Going climate-neutral by 2050," *Facilities*, 2018.
5. Agency, International Energy, and Communities Programme. *Ventilative Cooling Case Studies Energy in Buildings and Communities Programme*, 2018.
6. Breesch, H. "Passive Cooling in a Low-Energy Office Building" 79 (2005): 682–96. https://doi.org/10.1016/j.solener.2004.12.002.