COOLFACADE - Architectural integration of solar cooling strategies into the curtain-wall

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COOLFACADE

Architectural integration of solar cooling strategies into the curtain-wall

PhD Research Project | Alejandro Prieto

FIELD OF RESEARCH: Architecture | Façade Engineering | Renewable energy | Cooling
KEYWORDS: Decentralised Building systems | Integrated facades | Solar cooling

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Energy efficiency has increasing worldwide relevance in the current context. The necessity of lowering energy consumption from fossil fuels demands to take action on optimizing systems currently under operation, and at the same time on developing new technologies driven by renewable sources of energy.

As result of the application of energy saving measures and the development of new technologies, the thermal performance of buildings during winter period has been greatly improved. However, due to a number of reasons such as increasing standards of life, affordability of air-conditioning, temperature increase in the urban environment and the global climate change; the energy needs for cooling have increased drastically (Santamouris & Kolokotsa, 2013).

Solar cooling systems have been focus of attention these last years, for their potential to lower indoor temperatures using solar thermal energy. However, there is a lack of knowledge regarding the possibilities for their architectural integration in buildings.

This PhD project deals with the integration of solar cooling strategies into the building façade, as a way to support the use of low-exergy alternatives instead of the use of centralized AC in office buildings. Furthermore, the possibility of using the façade itself as a heat dissipation system is seen as an opportunity for the development of self-sustaining cooling façade modules to be applied either on new buildings or refurbishment projects, avoiding mechanical cooling equipment whatsoever in the line of new "nearly zero" energy standards.

RESEARCH QUESTION

To what extent could curtain-walls incorporate solar cooling systems in order to meet thermal requirements avoiding conventional centralised mechanical cooling?

MAIN HYPOTHESIS

To support a widespread integration of solar cooling technologies in façades, product design and development must consider two main aspects, related with the performance of cooling systems and facade integration respectively (Fig.3):

- **Cost effective cooling systems** depend on the successful merge between passive design strategies (passive optimisation) and the use of decentralised solar cooling technology.
- **Building services integration in facades** requires an holistic approach to façade design and construction, considering constructive and functional aspects for the development of solar cooling integrated facades.

RESEARCH STRATEGY

Following the main hypothesis, the research project deals with the integration of two families of aspects as input for the design of solar cooling facades: Those related with the design of integrated facades and those related with solar cooling system possibilities. Consequently, the body of the research is structured in two parallel lanes, dealing with each set of variables separately before integrating them in a latter stage.

The body of the research is also divided in three consecutive stages: A first part that considers the reviews and clarification of concepts; a second part that deals with each different input required to fulfil the objective; and finally a third part that incorporates them all into façade concepts for evaluation and definition of overall possibilities and constraints for architectural application (Fig.4)

DELIVERABLES

Besides publications and dissemination of partial results, there are two main expected deliverables from the research project: the conceptual design and evaluation of a solar cooling façade concept considering climate specific variations; and the development of a roadmap for solar cooling façade product development considering current possibilities and constraints along with future scenarios.

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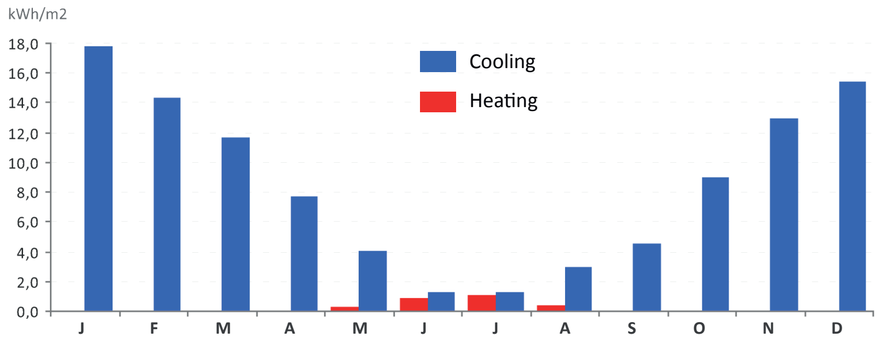

Fig.1: Cooling and heating montlhy demands of a typical office building in Santiago, Chile (Prieto, 2011).

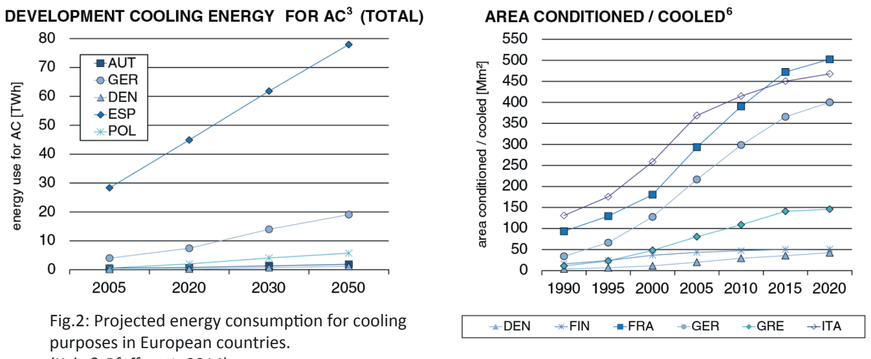

Fig.2: Projected energy consumption for cooling purposes in European countries. (Kalz & Pfafferott, 2014)

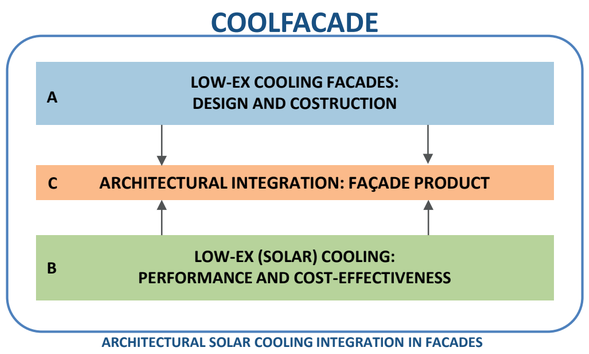

Fig.3: Basic scheme of the main hypothesis of the research project

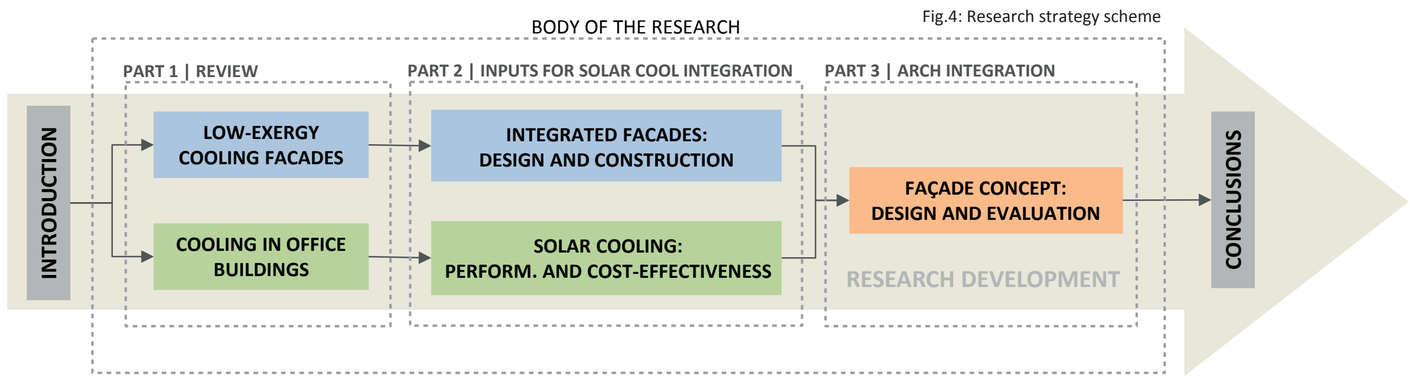

Fig.4: Research strategy scheme

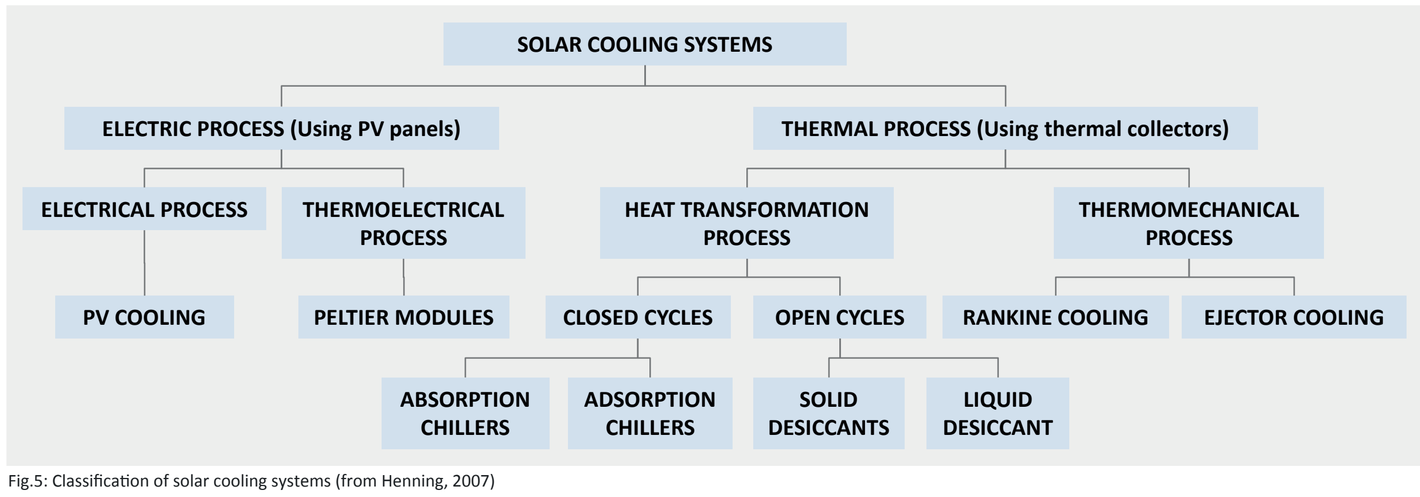

Fig.5: Classification of solar cooling systems (from Henning, 2007)

Fig.6: Examples of building services and solar collectors integrated in facades

PROJECT INFORMATION

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