Welcome everyone!

Time	Agenda
9:00-9:15	Welcome & introduction round
9:15-9:25	Research background
9:25-10:30	Interactive session and activities
10:30-10:45	Reflection
10:45-11:00	Closing

TU Delft BK Bouwkunde
Department of Architectural Engineering +Technology

A Co-Creation Workshop on Designing and Developing Solar Cooling Integrated Facades

Hamza Hamida, Thaleia Konstantinou, Ulrich Knaack and Alejandro Prieto

My PhD: Solar Cooling Integrated Façades

The Team

Hamza Hamida

PhD Researcher, TU Delft

Thaleia Konstantinou

Associate professor
Leader of the Building Design & Technology Section, TU Delft

Ulrich Knaack

Professor of Design of Construction, TU Delft

Alejandro Prieto

Associate professor, Diego Portales University

Who you are

- Name
- Background and field of experience
- Which team you belong to
  - Client Team
  - Design Team
  - Construction Team

Why are we here?

Think and plan together

Identify and map key decisions, information and roles

Reflect together

Why are we here?

TU Delft Department of Architectural Engineering +Technology
BK Bouwkunde

Identify key design decisions → Organize and prioritize the decisions → Determine the required information to process the decisions → Identify stakeholders involved in making decisions

Agenda

TU Delft Department of Architectural Engineering +Technology
BK Bouwkunde

Time	Agenda
9:15-9:25	Research background
9:25-10:30	Interactive Session and Activities
10:30-10:45	Reflection
10:45-11:00	Closing

Solar Cooling Technologies and Façades

TU Delft Department of Architectural Engineering +Technology
BK Bouwkunde

- Façade products integrating solar active cooling technologies
- Exposure to solar radiation
- Renewable source of energy

Thermally-Driven Processes

- **Producing hot water through Solar Thermal Collectors (STC)**

1. **Powering generators of sorption cooling systems**
2. **Thermal energy is converted to mechanical energy which used for producing cooling effects**

Electrically-Driven Processes

- **Producing electricity through Photovoltaic (PV) panels**

1. **Producing cooling effect through conventional systems**
2. **Thermoelectric processes having thermocouples (semiconducting thermoelements)**

Solar Cooling Technologies and Façades

TU Delft Department of Architectural Engineering +Technology
BK Bouwkunde

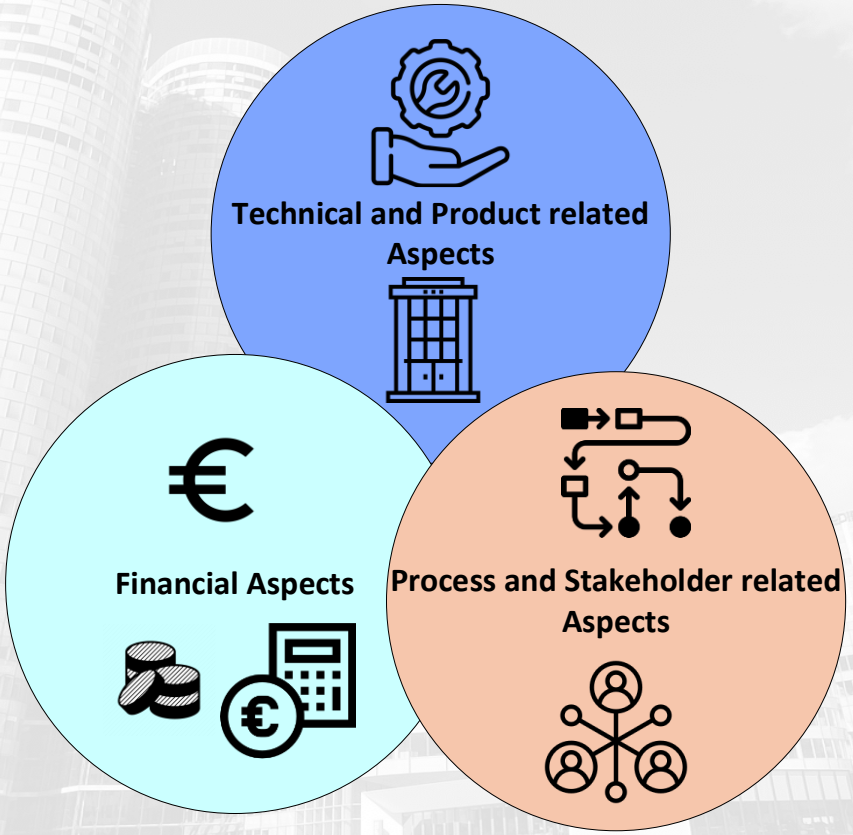
- A more practical definition that can be considered (Hamida et al., 2023)

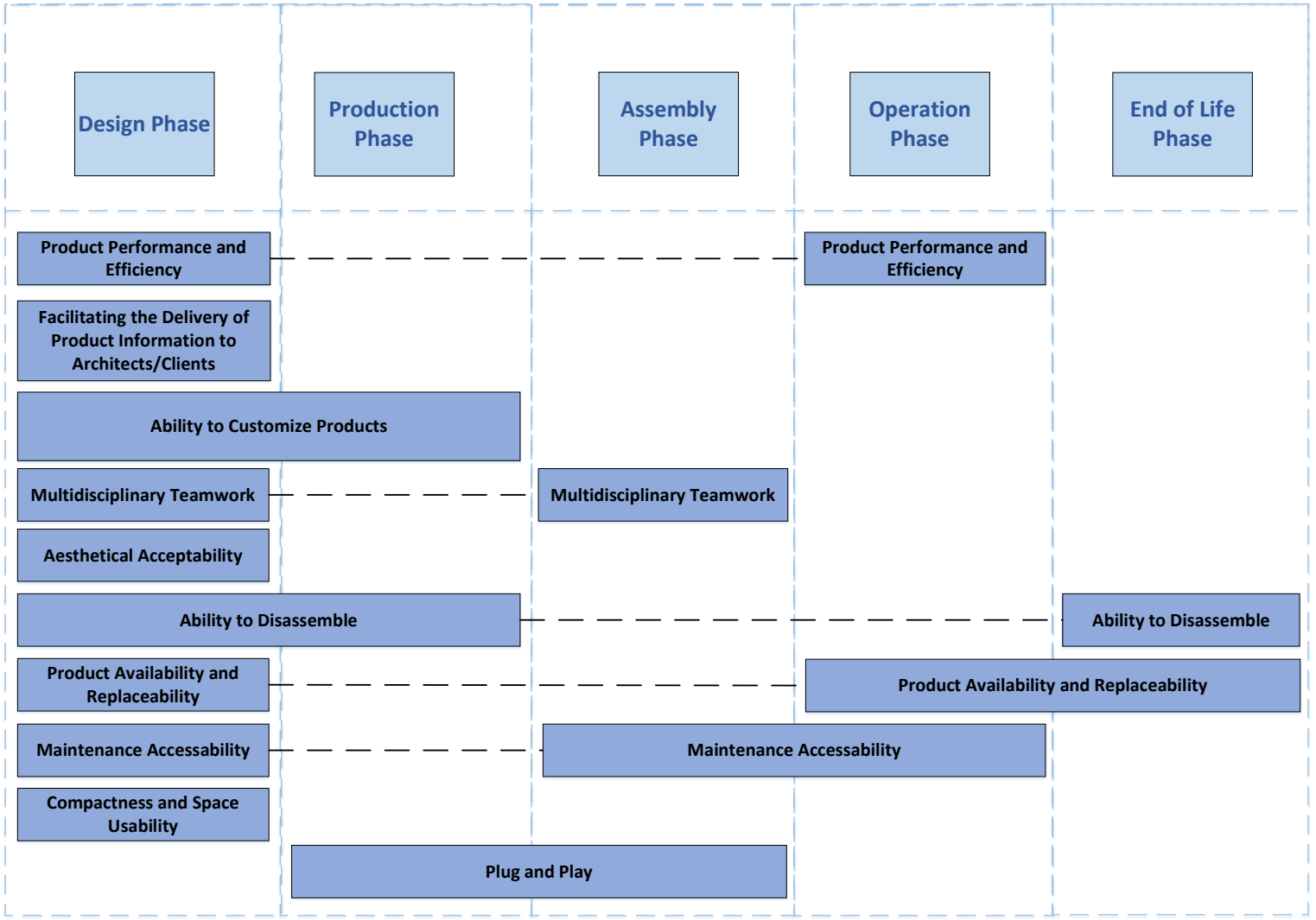
"Building envelop systems that include elements using and/or controlling solar radiation to deliver self-sufficient solar renewable electric and/or thermal energy needed to generate cooling effect in a particular indoor environment"

Hamida, H., Konstantinou, T., Prieto, A., & Knaack, U. (2023). Solar Cooling Integrated Façades: Towards investigating product applicability. In S. Roaf, & W. Finlayson (Eds.), *Measuring Net Zero: Carbon Accounting for Buildings and Communities* (pp. 58-70). Ecohouse Initative Ltd.

Why not commonly applied?

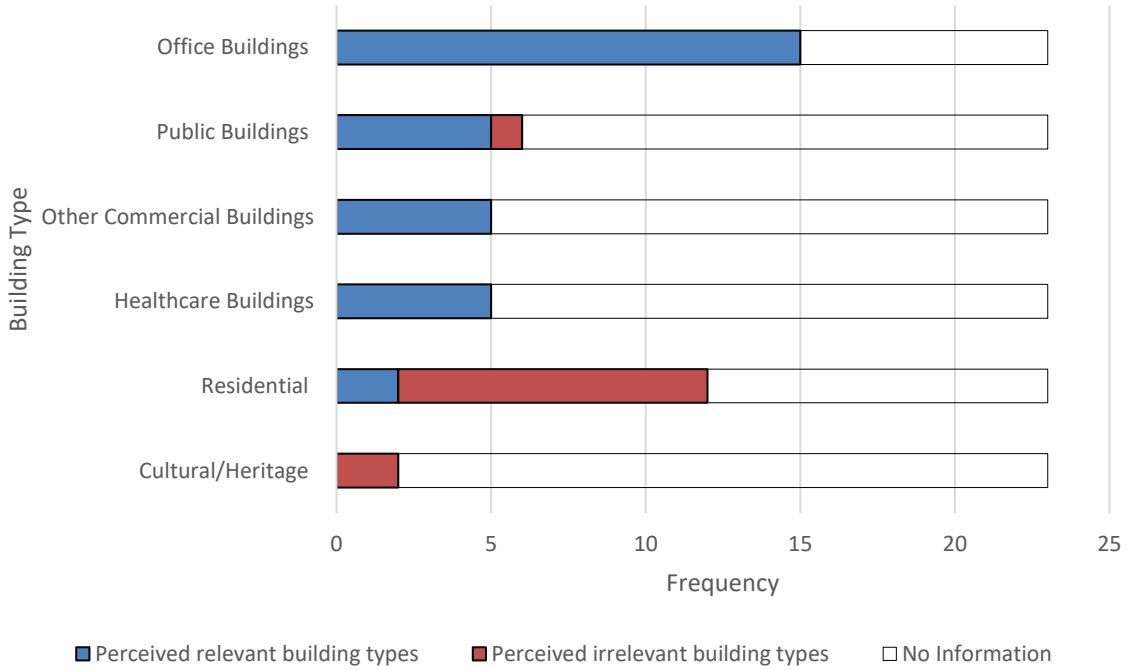
- Requirements to consider and integrate various aspects



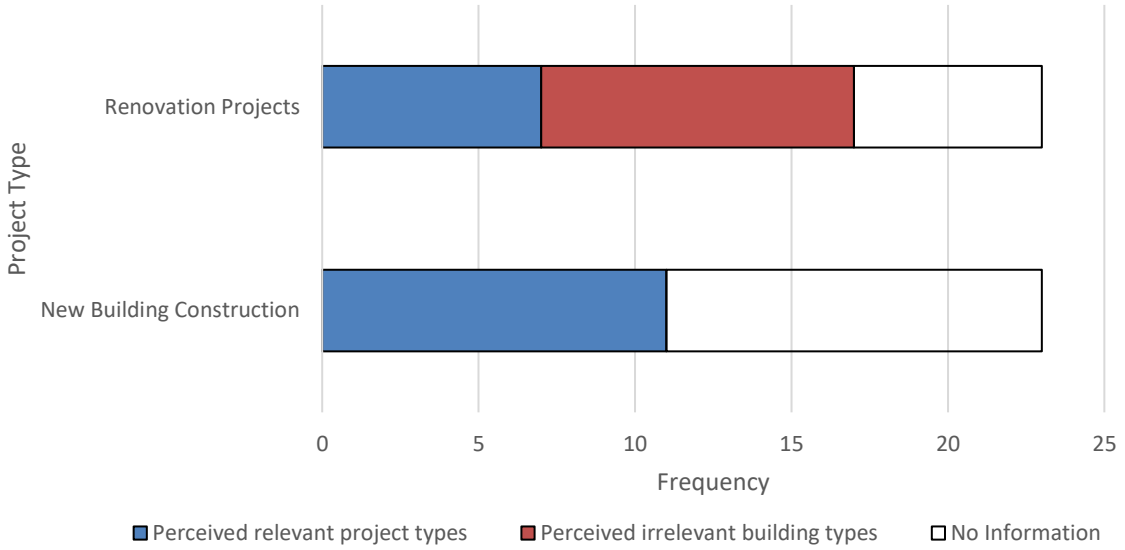


Mapping the enabling factors in the façade design and construction process

Hamida, H., Konstantinou, T., Prieto, A., & klein, T. (2023). Solar Cooling Integrated Façades: Key perceived enabling factors and prospects of future applications. *Journal of Building Engineering*, *76*, Article 107355. https://doi.org/10.1016/j.jobe.2023.107355



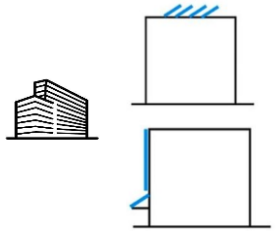
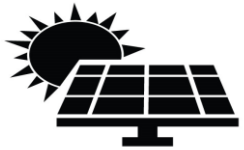
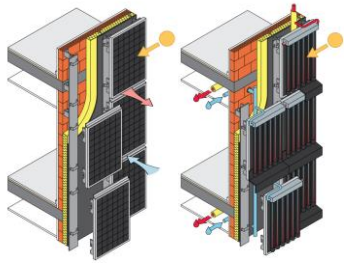
Perceptions of the future applications based on building type



Perceptions of the future applications based on project type

Hamida, H., Konstantinou, T., Prieto, A., & klein, T. (2023). Solar Cooling Integrated Façades: Key perceived enabling factors and prospects of future applications. *Journal of Building Engineering*, *76*, Article 107355. https://doi.org/10.1016/j.jobe.2023.107355

My Framework: Design and Development Stages

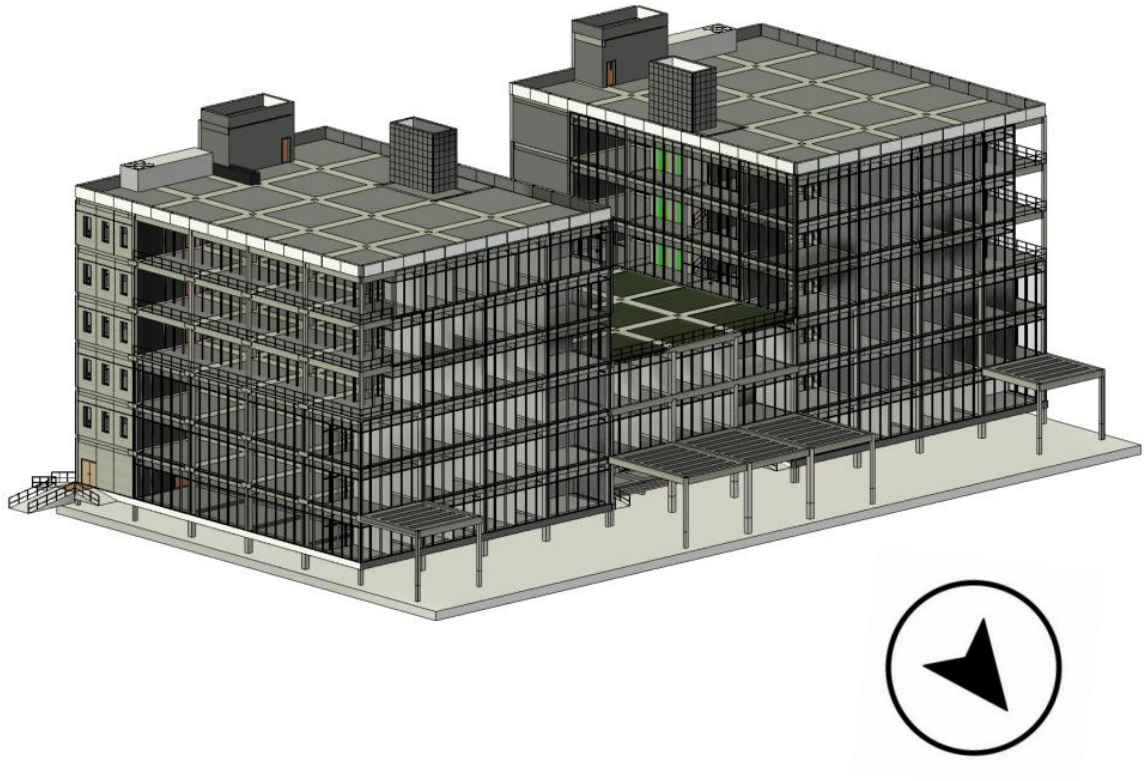
Stage 1 Conception and Strategic Definition	Stage 2 Preparation and Briefing	Stage 3 Façade Technological Selection	Stage 4 Façade Integration Design	Stage 5 Execution Design
				
Identify possibilities for building integration	Assess the feasibility of the generated possibilities	Select the relevant architectural façade technology	Present the detailed design of integrating the selected technology	Design for installing façade components

Activities

TU Delft Department of Architectural Engineering +Technology
BK Bouwkunde

Identify key design decisions → Organize and prioritize the decisions → Determine the required information to process the decisions → Identify stakeholders involved in making decisions

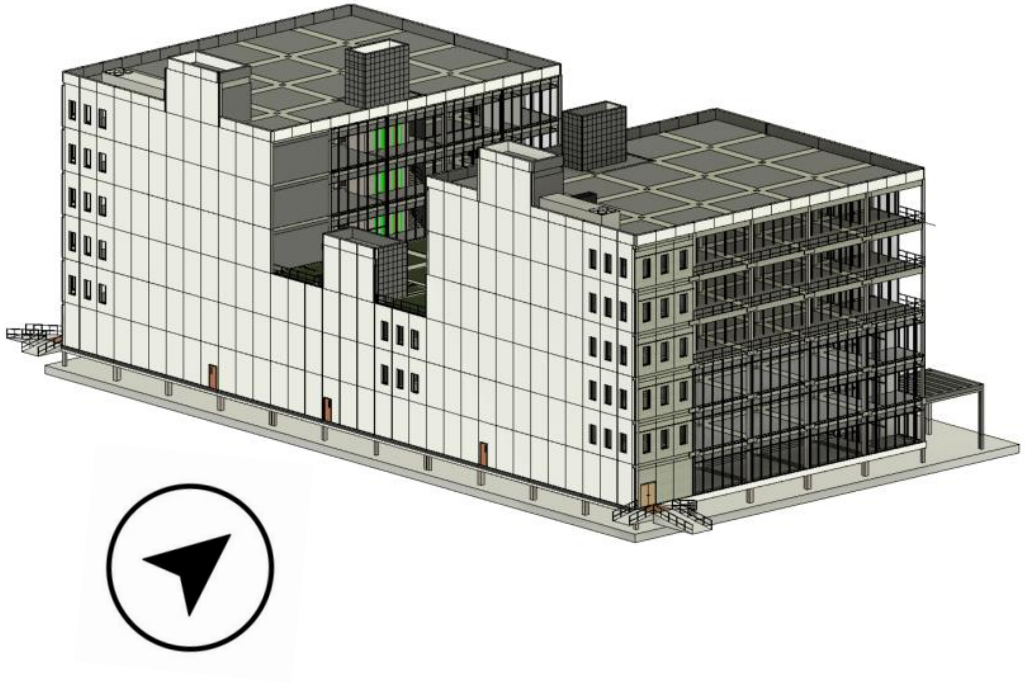
Activities



Overview of the selected building case

Item	Description	Values
Function	Office building (5 story building)	-
Project	New construction	
Location	Madrid, Spain	-
Spaces functions	Generic office areas, storerooms, toilets, eating/drinking areas, and light plant rooms	-
Ground floor area	Ground has its own same layout	2695.68 m^2
Window-to-Wall Ratio (WWR)	Proportion of exterior glazed walls	55%

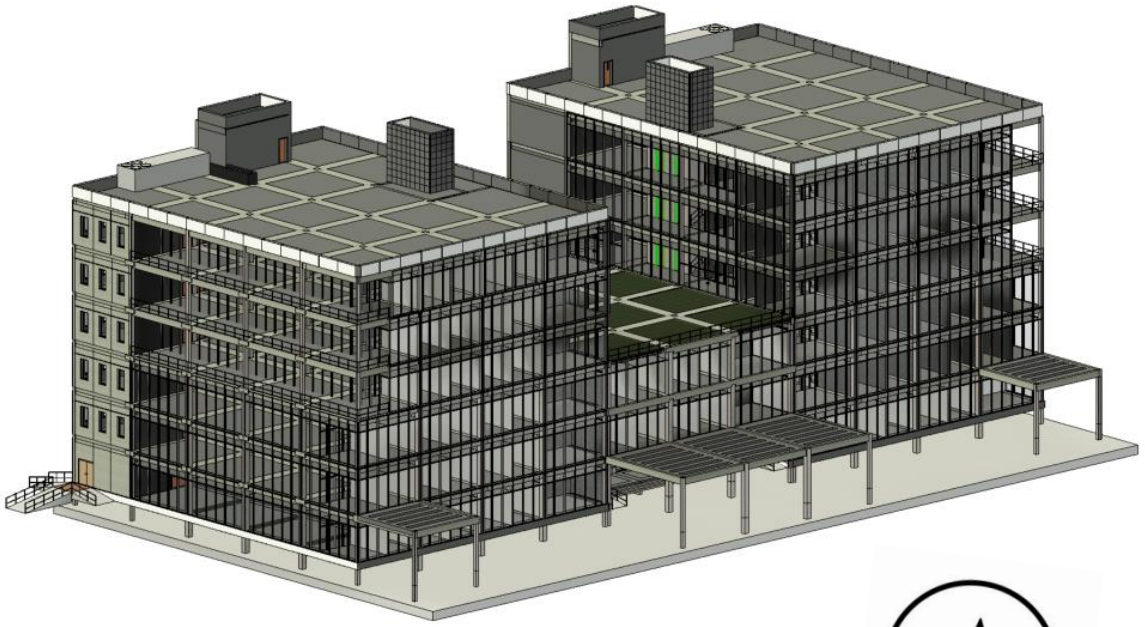
Activities



Overview of the selected building case

Item	Description	Values
Function	Office building (5 story building)	-
Project	New construction	
Location	Madrid, Spain	-
Spaces functions	Generic office areas, storerooms, toilets, eating/drinking areas, and light plant rooms	-
Ground floor area	Ground has its own same layout	2695.68 m^2
Window-to-Wall Ratio (WWR)	Proportion of exterior glazed walls	55%

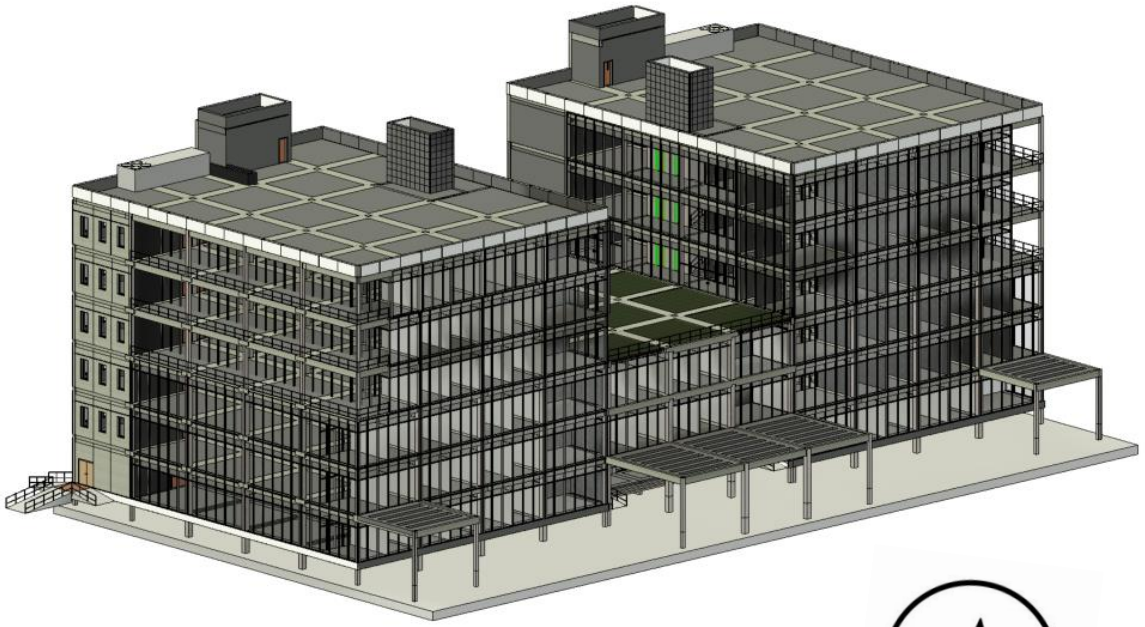
Activities



Construction characteristics of the thermal envelop elements according to local energy saving guidelines in Spain

Construction element	Considered materials and system to meet requirements	Values
Opaque façade	Ventilated Façade-Multi-layered opaque external walls	U-Value = 0.263 [W/m2K]
Glazing (Openings)	Doble-glazing low-emissive	U-Value = 1.35 [W/m2K]
Roofs (Top slab)	Cast concrete slab	U-value = 0.21 [W/m2K]
GF Slabs (floors in contact with ground)	Cast concrete slab	U-value = 0.30 [W/m2K]

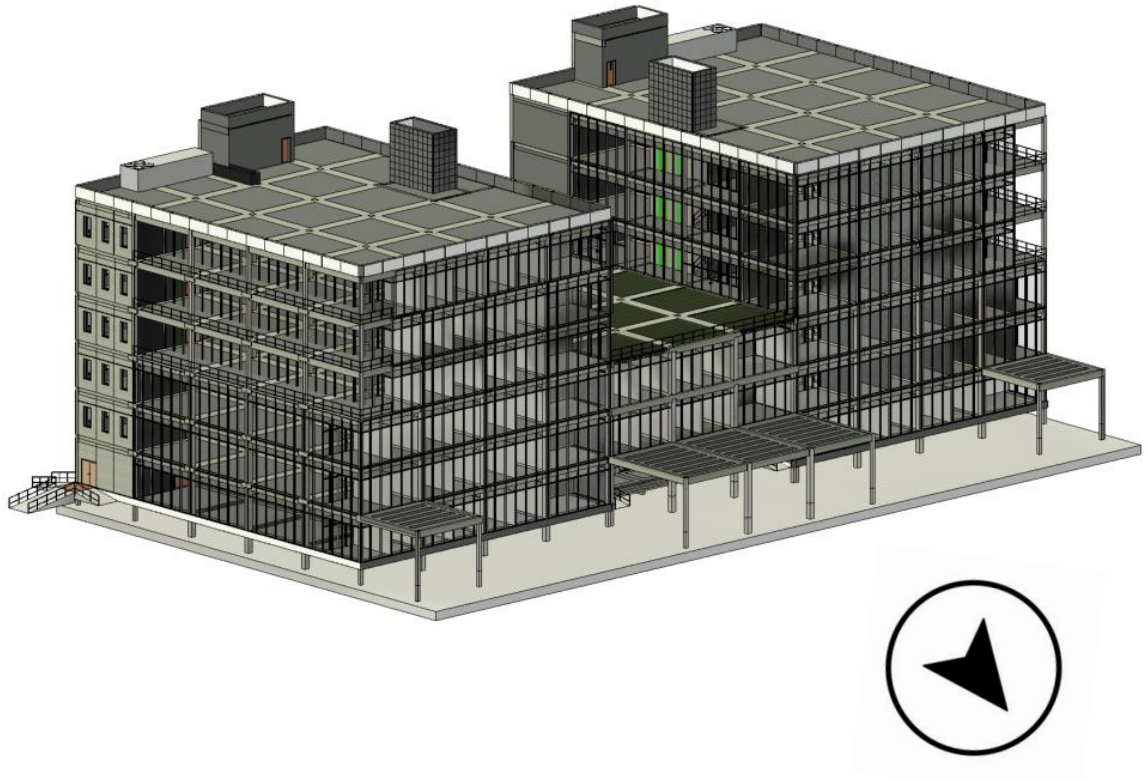
Activities



Energy performance of the building

Item	Values
Building annual energy use intensity	227.02 [kWh/m2/year]
Building annual cooling demand intensity	53.61 [kWh/m2/year]
Building average daily cooling demand in Summer Design Week	9805.58 [kWh/day]

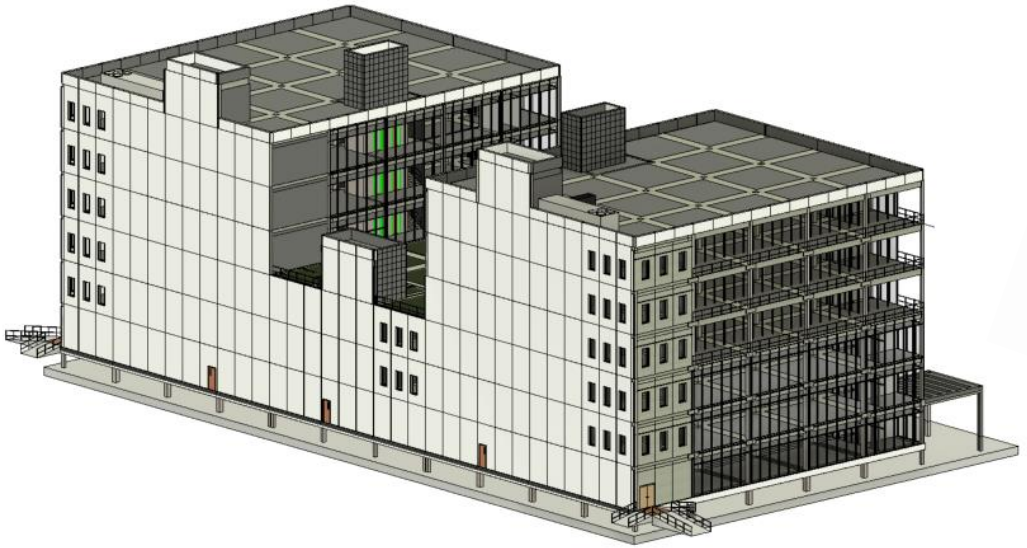
Activities



Contracting method and type of building ownership

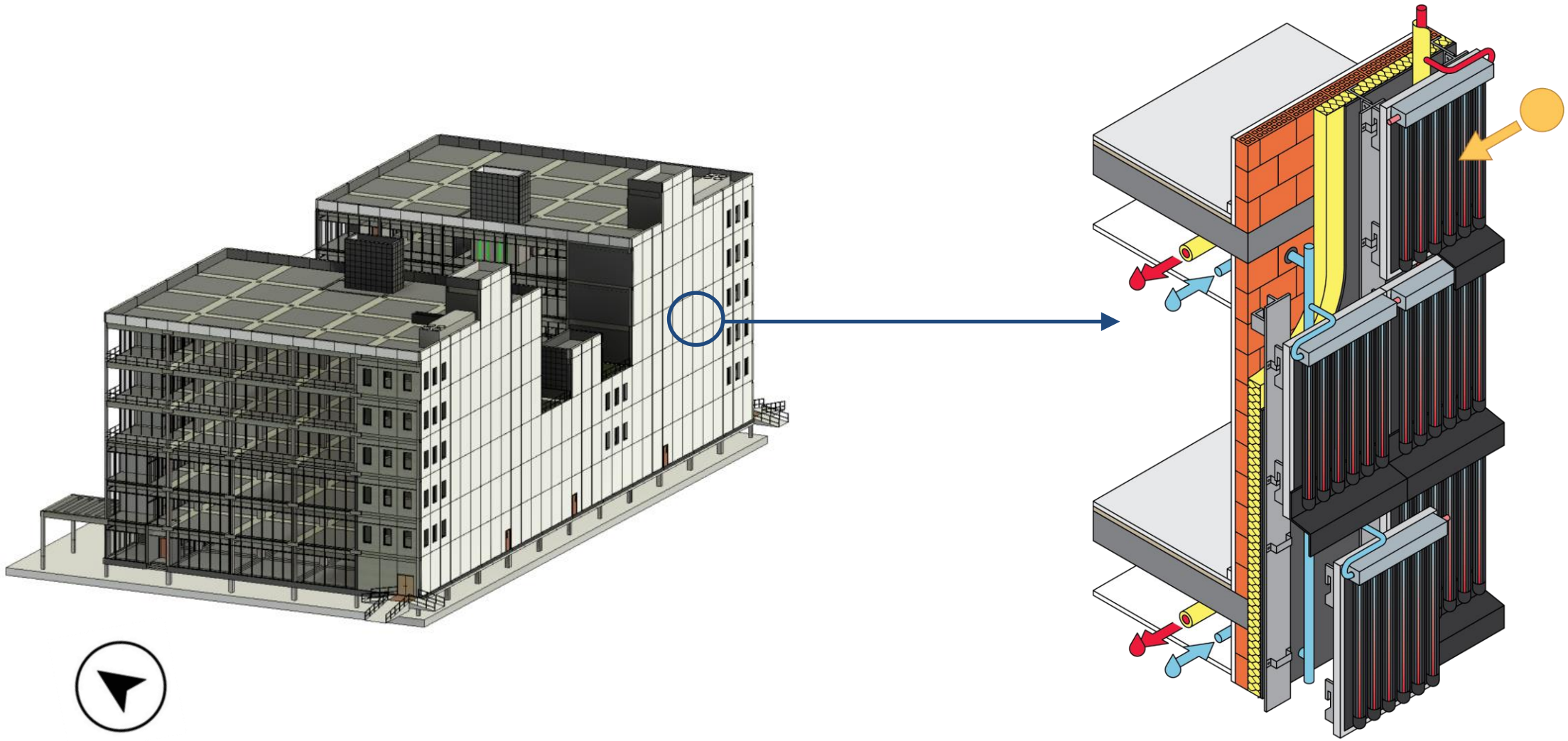
Item	Type
Project client	The client is a private owner investor
	The client has the freedom to determine other stakeholders involved in the project
Building ownership and use	Single company owning the whole building
	The owner is the building user

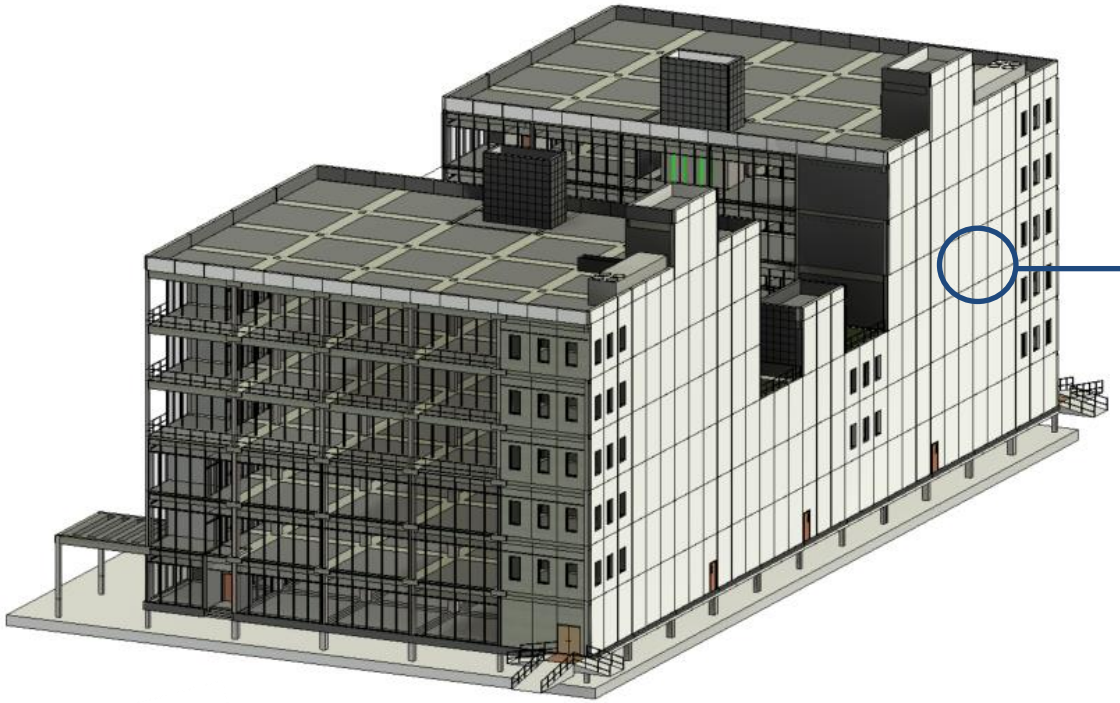
Activities

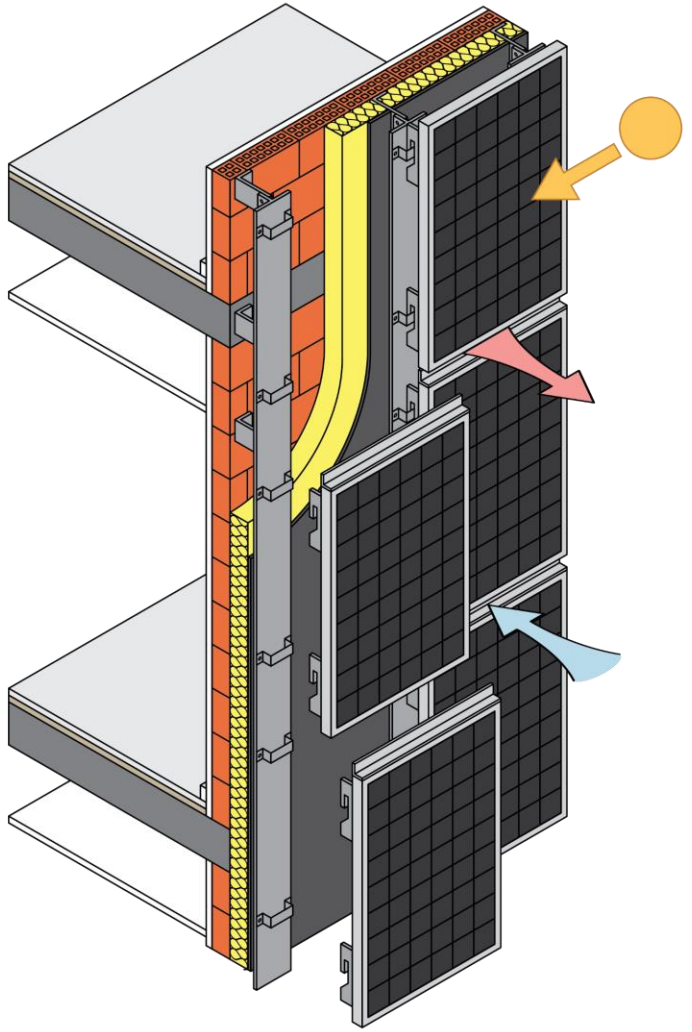


Options of technologies to be integrated

- **Thermally-Driven** → **Evacuated tubes solar thermal collectors and absorption chillers**
- **Electrically-Driven** → **Photovoltaic (PV) Panels and water-cooled vapor-compression chiller**

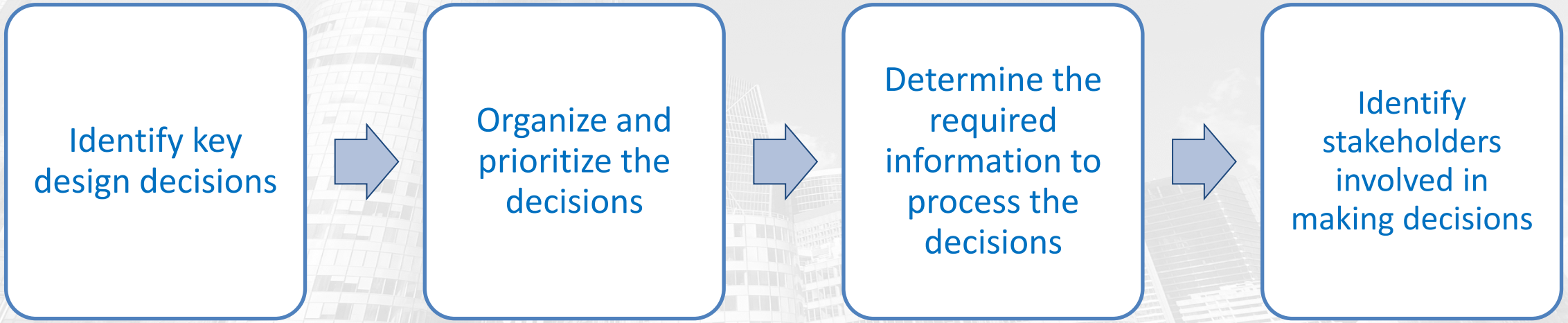






Activities

- Role of participants and moderation principles
  - Go to the canvas (MS Whiteboard)



Activities

- Role of participants and moderation principles
  - Go to the canvas (MS Whiteboard)

Reflection

TU Delft Department of Architectural Engineering +Technology
BK Bouwkunde

- Are there any key aspects that we have not covered?
- Were there any parts of my framework that were not addressed?
- Which parts did you find difficult to decide on, and why?
- To what extent do the integrated decisions, information and stakeholders support the design and development of solar cooling integrated façades? (Consider both drivers and concerns.)

Closing

TU Delft Department of Architectural Engineering +Technology
BK Bouwkunde

- Summary of key points and themes and reflecting on the thoughts
- Some perspectives regarding future developments.

Thank you