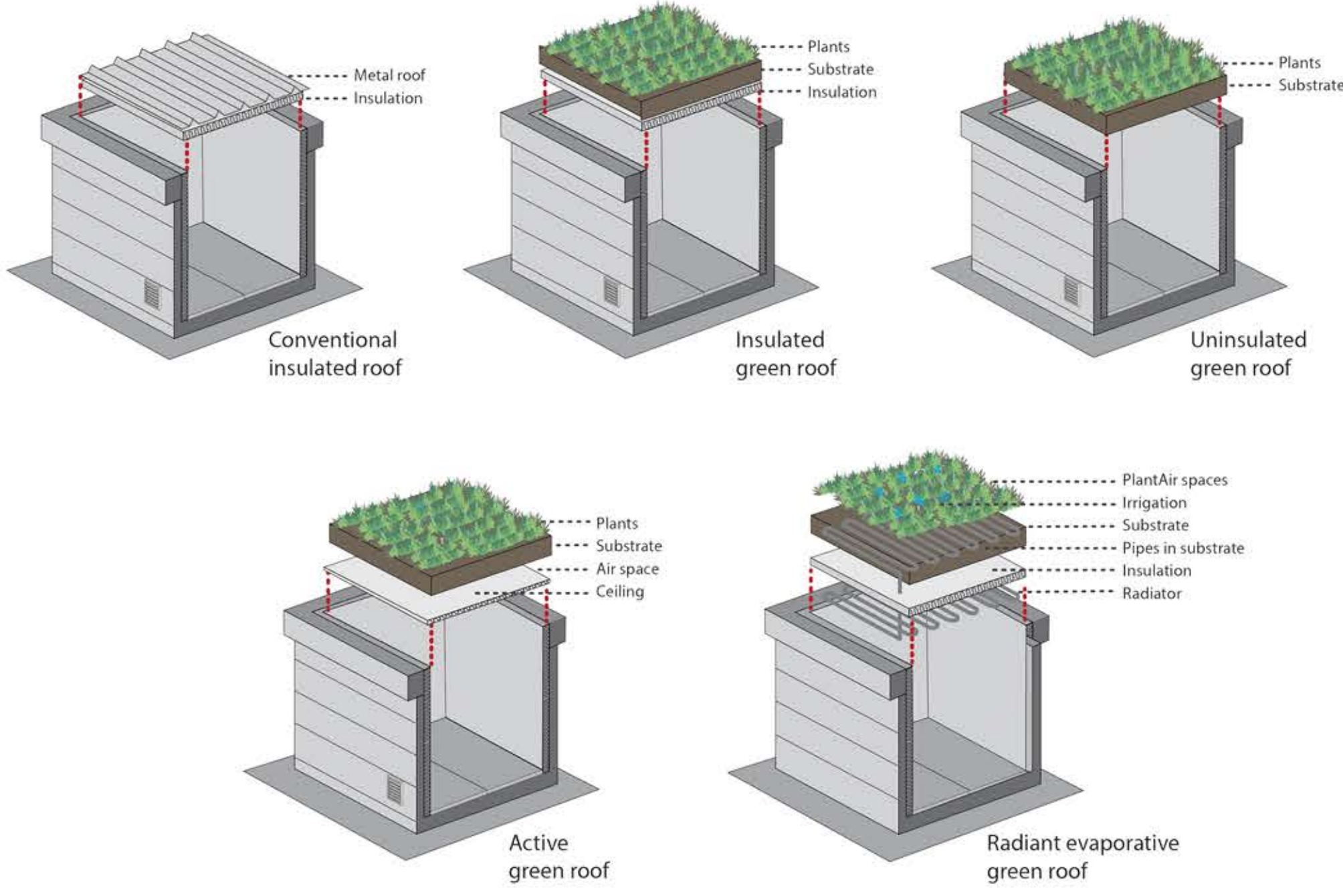


# Green Roofs for Cooling in Different Climates

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## 1. GREEN ROOF SYSTEMS



This poster describes the cooling potential of four different green roof configurations, two of them developed by the authors :

- A) An insulated green roof,
- B) An uninsulated green roof,
- C) A variable insulation green roof with a plenum and a sensor-operated fan,
- D) A radiant- evaporative cooled green roof with pipes embedded.

The four green roof configurations were evaluated using test cells in which the roof is the only change. The cells are at the Lyle Center for Regenerative Studies at Cal Poly Pomona University, 30 km east of Los Angeles, a hot and dry climate with an average high temperature of 31.5 °C in August and an average low of 5.3 °C in January.

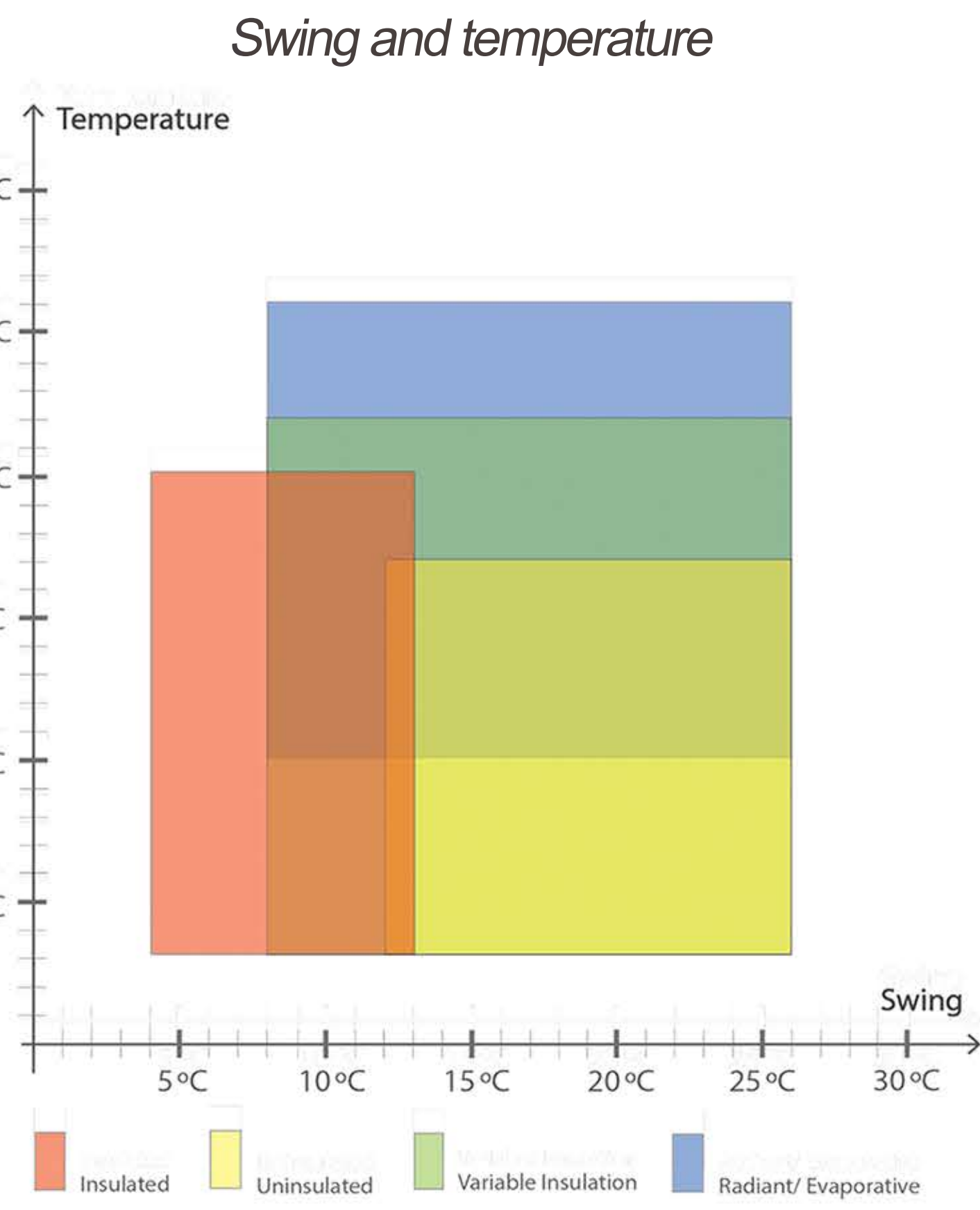


## 2. CLIMATIC APPLICABILITY

The effectiveness of the different types of green roofs varies by climate and is shown in two to select the most effective green roof for cooling.

The insulated green roof performs best with an outdoor swing between 4°C and 13°C, outdoor maximum temperatures between 18°C and 35°C and below 15 g/Kg of absolute humidity.

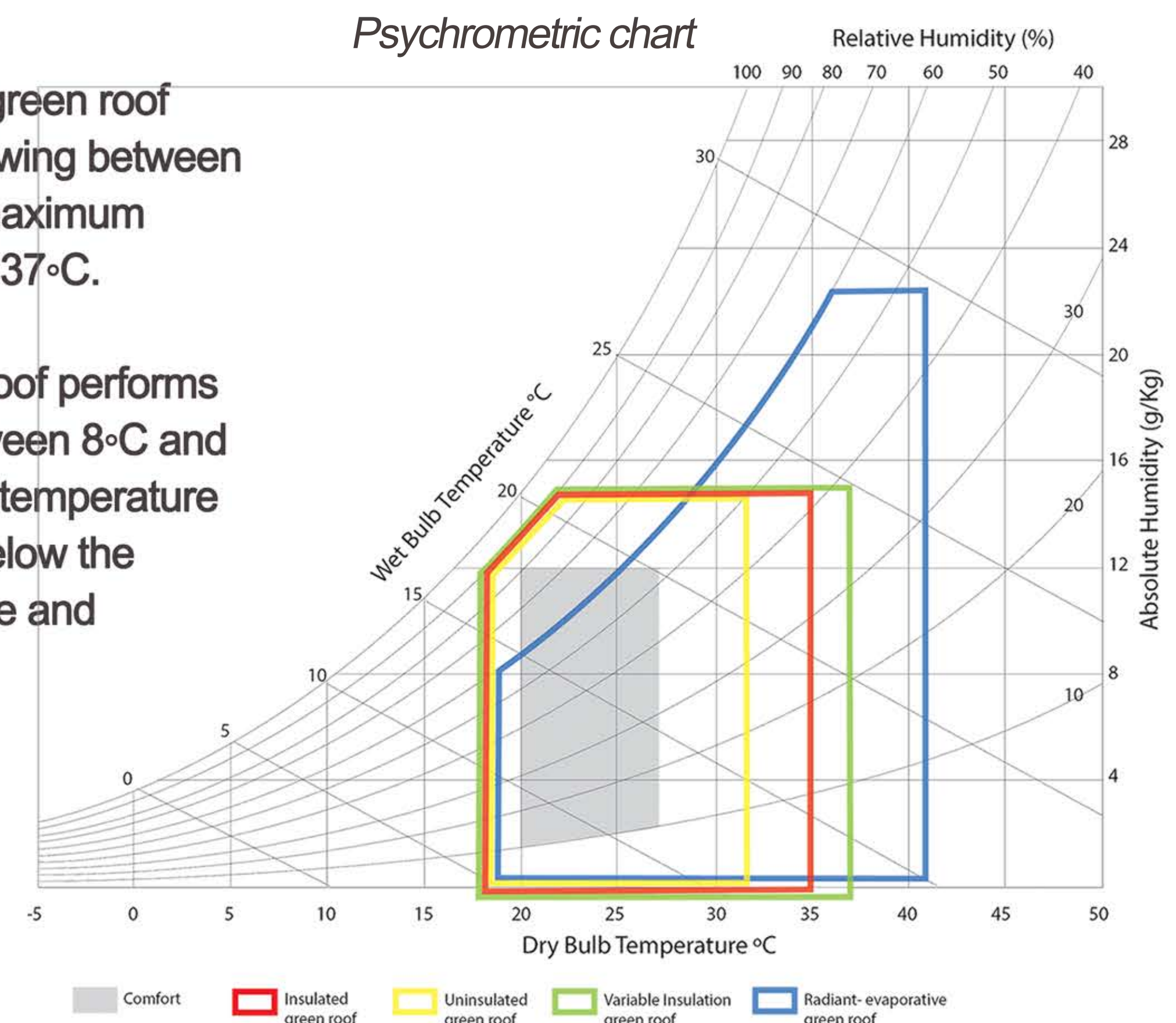
The uninsulated green roof performs best with an outdoor swing between 12°C and 26°C, outdoor maximum temperature below 32°C, (18°C to 32°C) and below 15 g/Kg of absolute humidity.



Psychrometric chart

The variable insulation (active) green roof performs best with an outdoor swing between 8°C and 26°C and an outdoor maximum temperature between 18°C and 37°C.

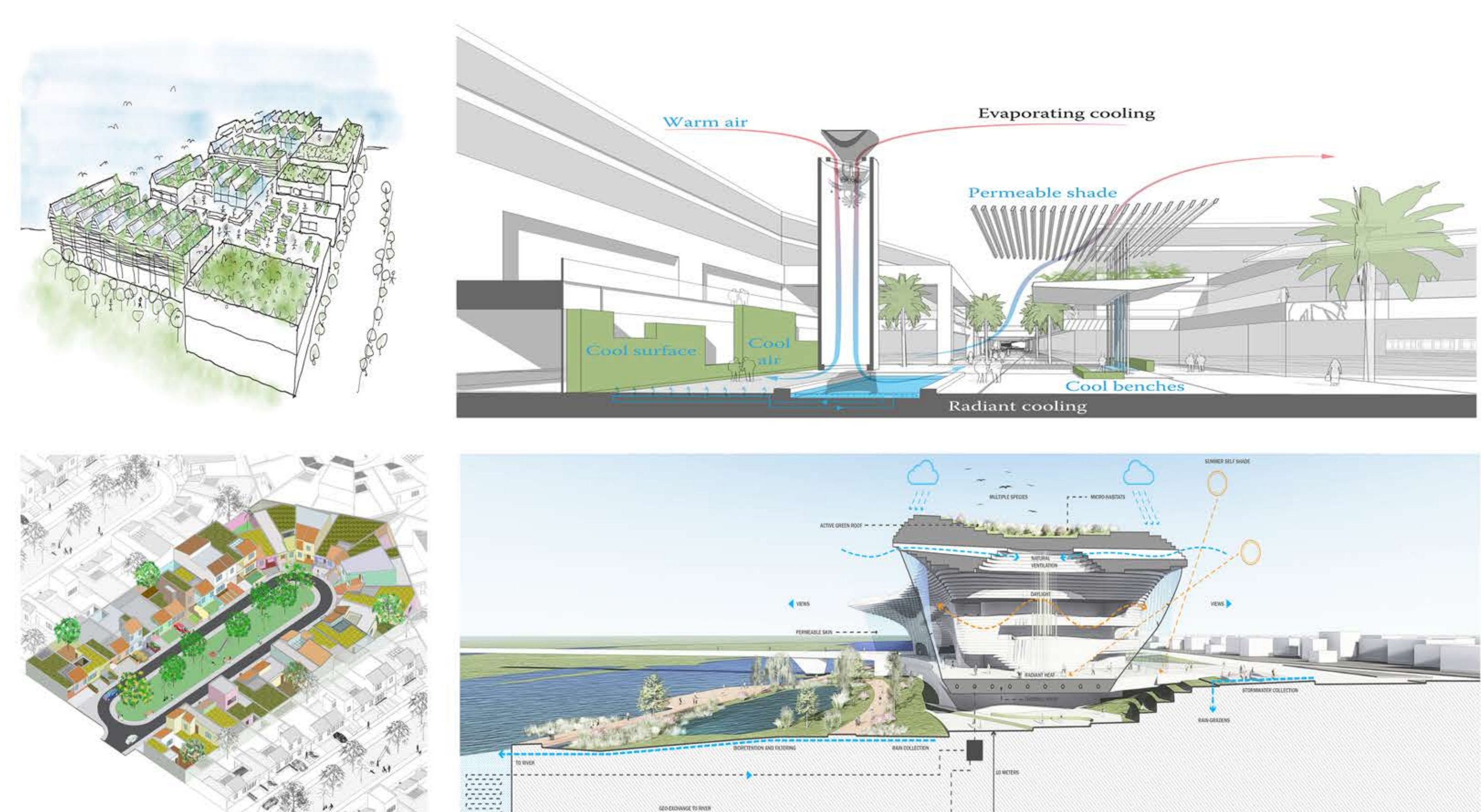
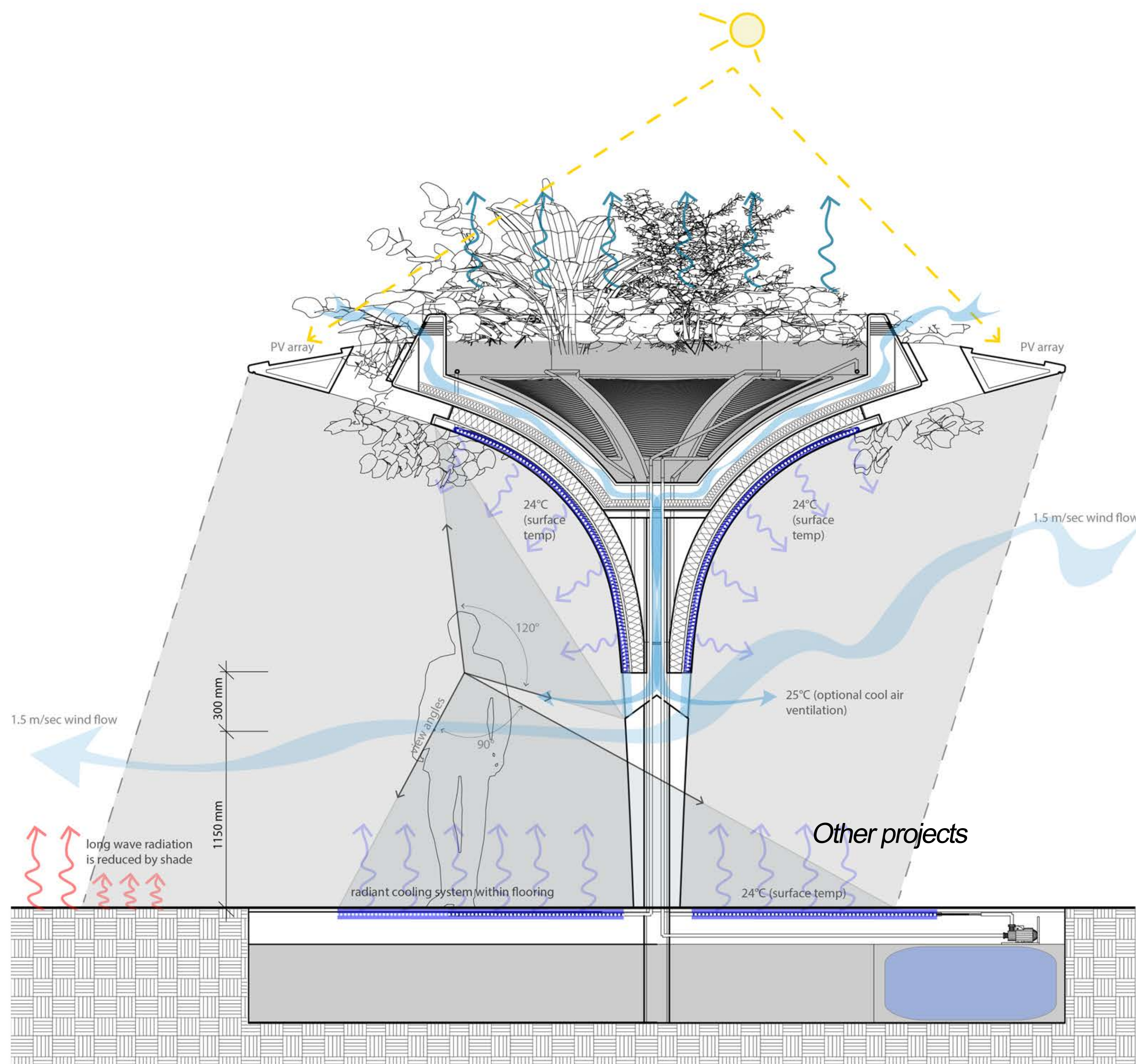
The radiant evaporative green roof performs best with an outdoor swing between 8°C and 26°C and an outdoor maximum temperature between 18°C and 41°C, and below the 60% relative humidity curved line and 23 g/ Kg of absolute humidity.



## 3. IMPLEMENTATION IN PROJECTS

The concepts tested in the cells can take multiple forms. An example is the Xylem, developed at CallisonRTKL, implementing several principles of the radiant/evaporative test cell, to improve outdoor thermal comfort while mitigating the heat island effect.

Different versions of the green roof have been incorporated in other design proposals. Examples are the Kaunas concert hall competition, an office competition in southern France, a residential project in Kuwait, an external canopy in Nanjing, a retrofit to a residential project in Maracaibo and exterior spaces in Miami.



## 4. CONCLUSION

These green roofs use heat flow paths to promote cooling and improve thermal comfort and are integral to the architectural design intent in form and construction.

In the future, buildings will be shaped by the natural forces and integrated with the environment, reinforcing the connection between passive cooling strategies and thermal comfort.

