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# MacKimmie Tower and Block Redevelopment

## Case Study: Facade Design and Performance

Christian Oberdorf | Transsolar KlimaEngineering, Munich (Germany)

Facade Tectonics Forum: Simulation vs. Reality, 06. May 2021

Image courtesey of WSP

# MacKimmie Tower and Block Redevelopment

## Tower Redevelopment



1968




2018-2020



2021

# MacKimmie Tower and Block Redevelopment



## CaGBC Zero Carbon Building Standard: Pilot Program



**MacKimmie Complex Redevelopment**  
Calgary, Alberta

The MacKimmie Complex Redevelopment is a multi-year, multi-phase project to address deferred maintenance and accommodate growth on the University of Calgary campus.

[Read the full project profile »](#)



## Zero Carbon Building Pilot Program

Featuring 16 of Canada's most innovative projects.

- GFA: 33'500 m<sup>2</sup> (Total Complex)
- GFA: 23'000 m<sup>2</sup> (Tower)

### Design:

- TEDI: 29 kWh/m<sup>2</sup>/yr (Max Allowed: 36 kWh/m<sup>2</sup>/yr)
- EUI: 75 kWh/m<sup>2</sup>/yr (Pre-Reno: 440 kWh/m<sup>2</sup>/yr)

# MacKimmie Tower and Block Redevelopment

## Tower Active Double Wall Facade



Image courtesy of DIALOG



Image courtesy of DIALOG



# MacKimmie Tower and Block Redevelopment

## Interior View: Rendering and Photo



Image courtesy of DIALOG

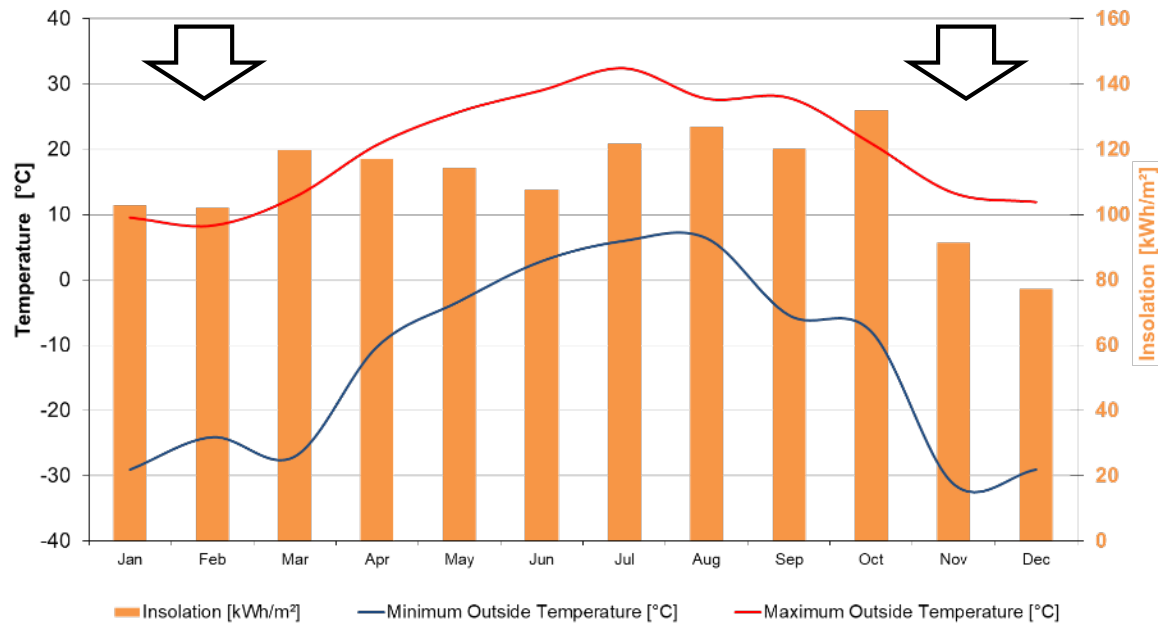


Image courtesy of DIALOG

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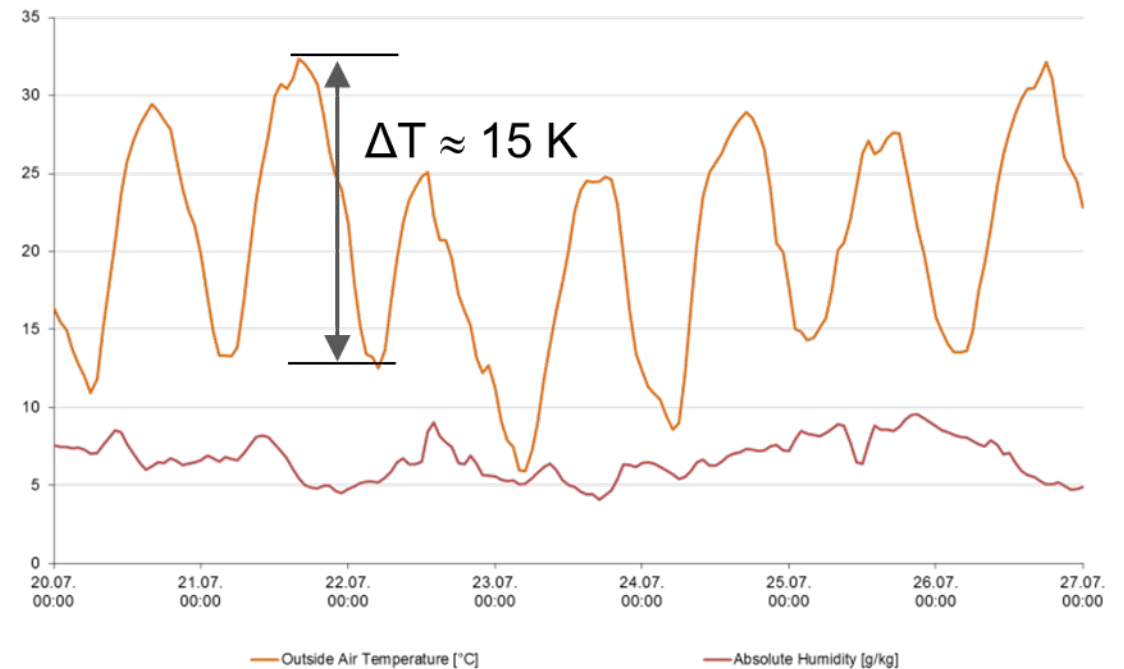
## Design Motivation: Calgary Climate Analysis

Outside Temperatures und Solar insolation on South Facade



→ High potential for **passive solar heating** during long and cold winter season

Typical summer diurnal temperature swing



→ High potential for **passive night cooling** / natural night flushing

# MacKimmie Tower and Block Redevelopment

## Design Motivation and Façade Functional Requirements

**Dynamic control of active Double Façade (DF) through operable vents** in order to:

1. Create “warm jacket” around the building
  2. Enable natural ventilation
- Maintain air temperature in DF cavity around 10 .... 20°C ( $T_{amb} + x$  °C in summer)
  - Limit pressure differences and
  - Control air velocity in DF cavity to enable natural ventilation

### **Special challenge:**

High level of dynamics of independent environmental condition  
(solar insolation and wind)

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## Tower Double Wall Façade Design

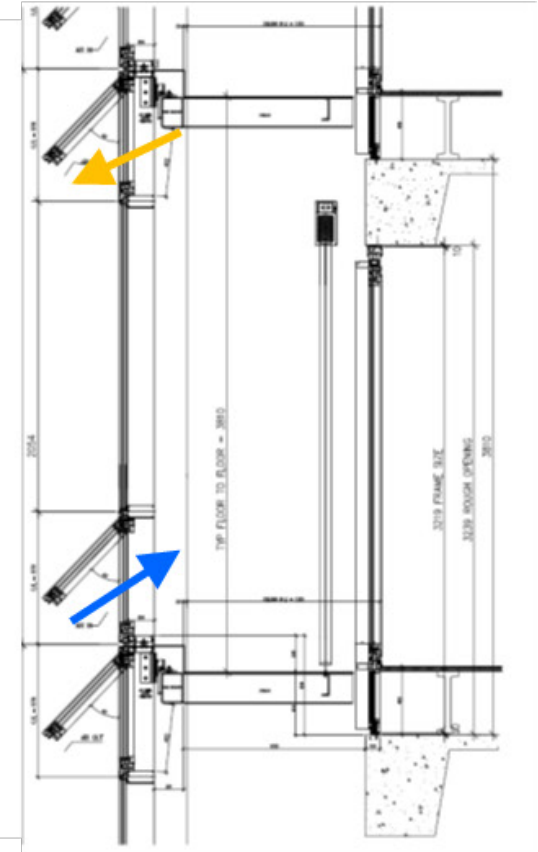
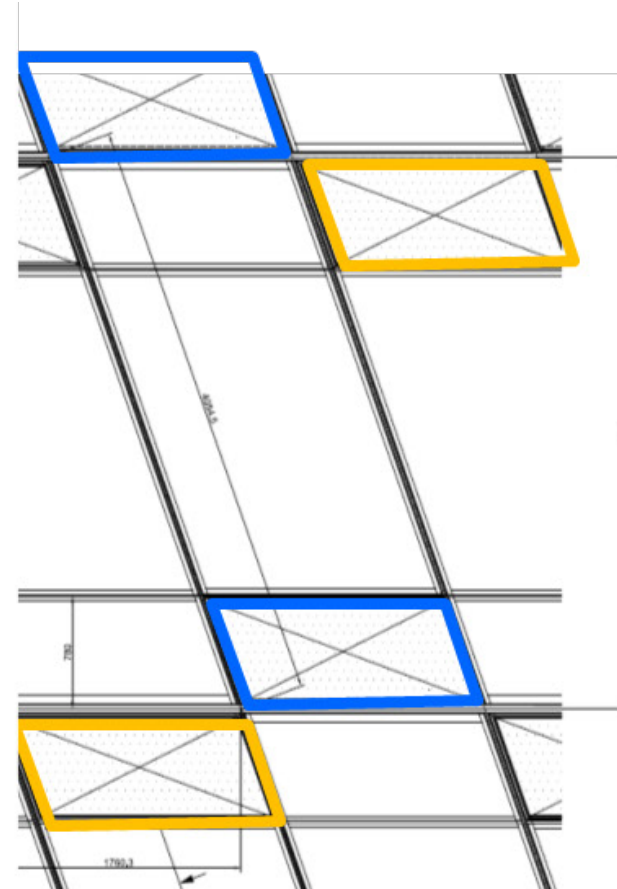
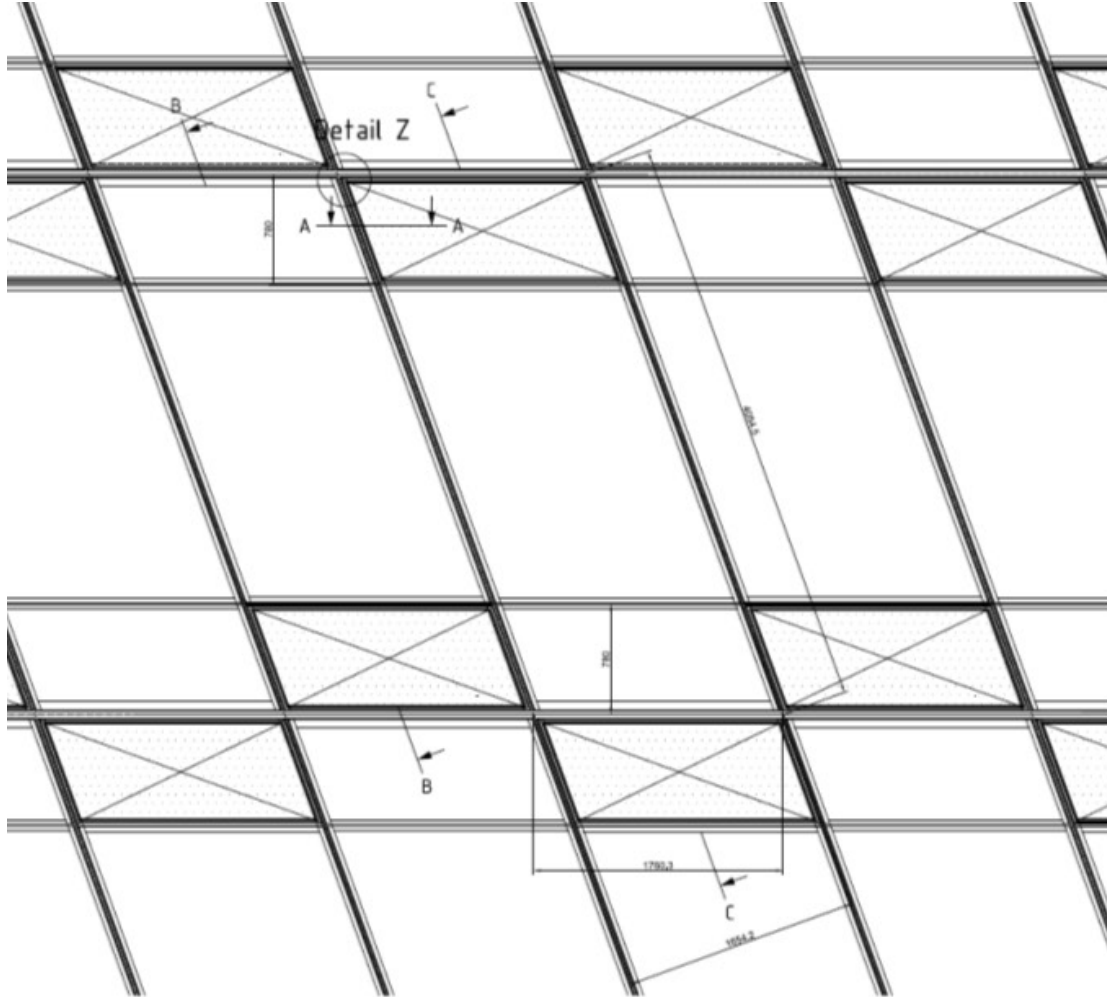


Image courtesy of DIALOG

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## Tower Double Wall Façade Design

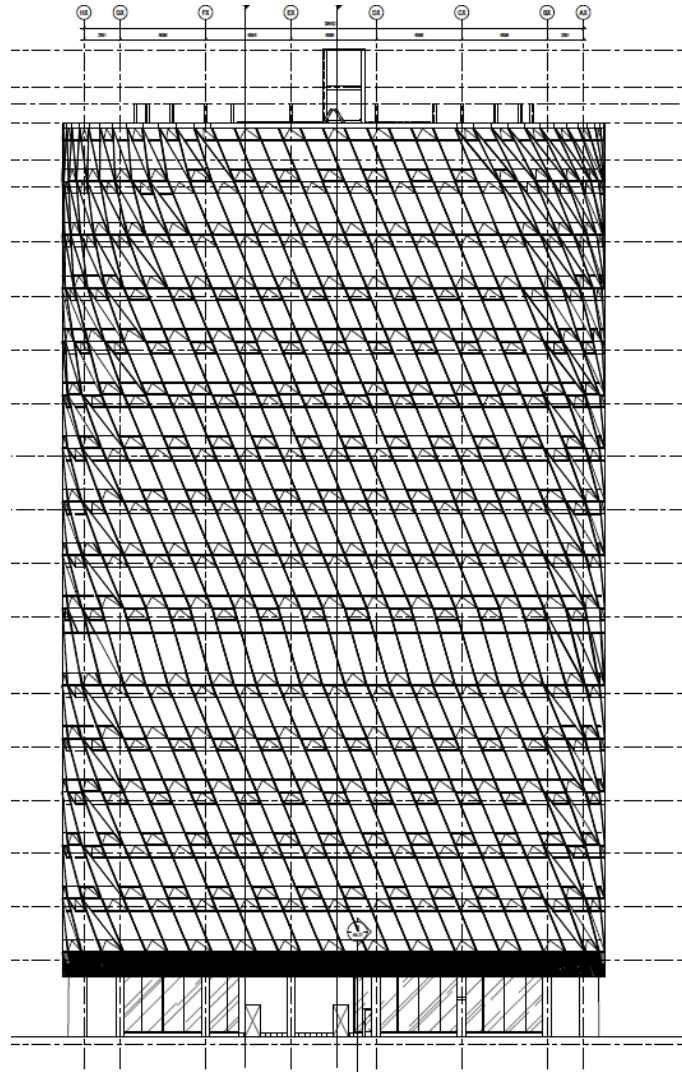
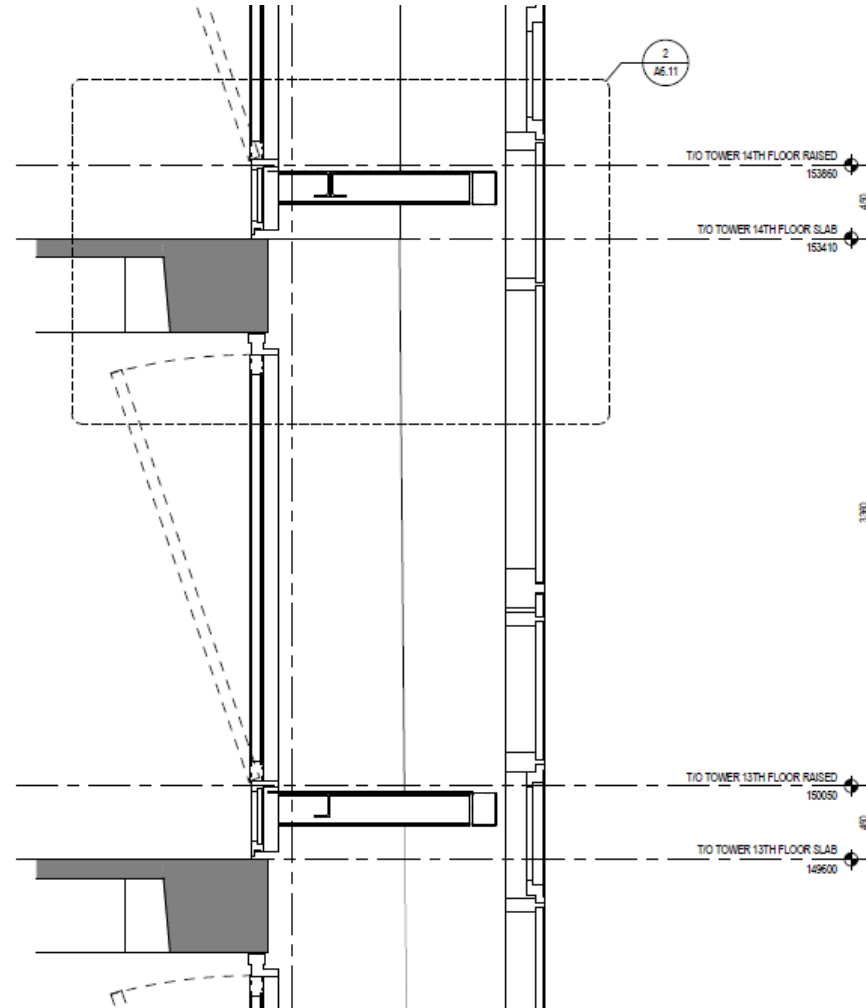
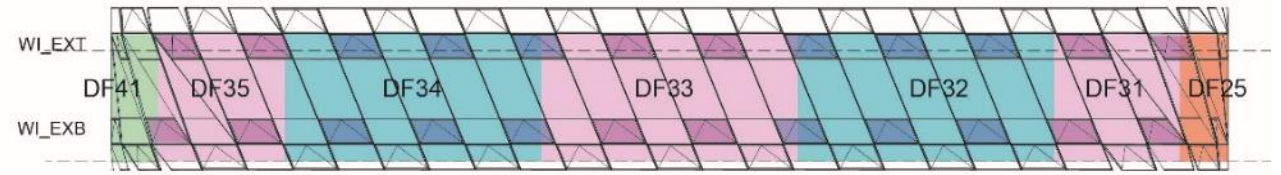
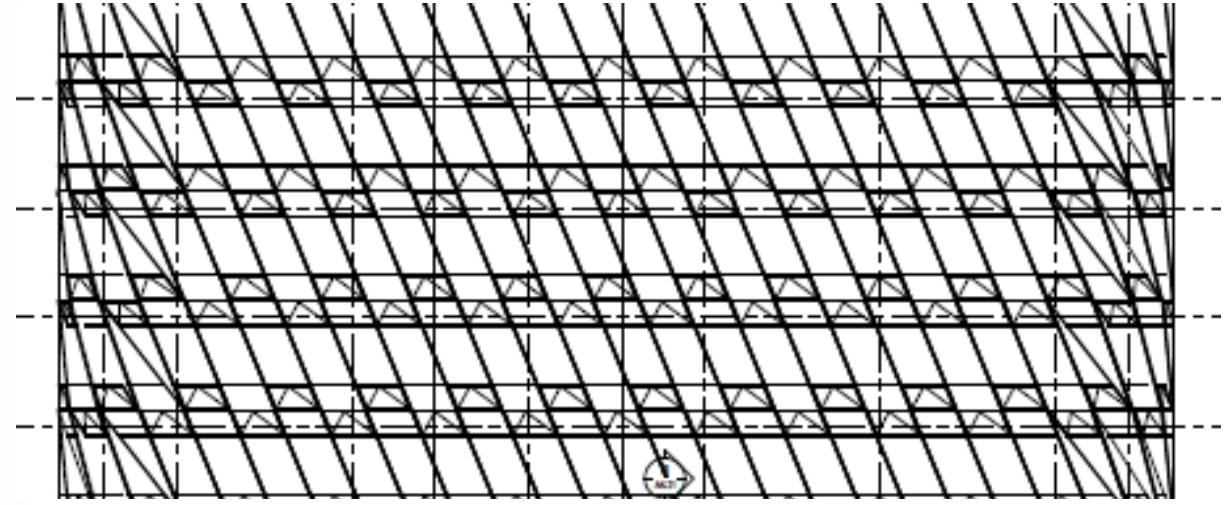
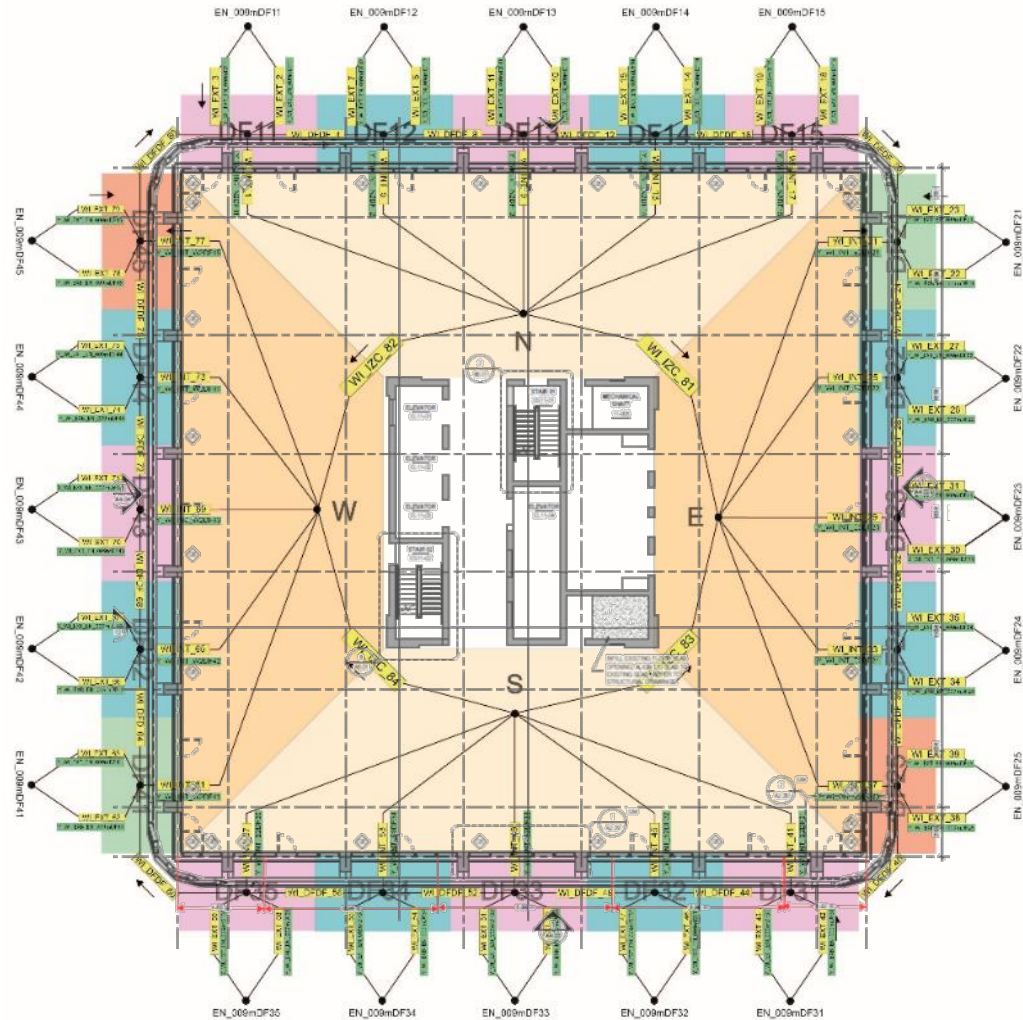


Image courtesy of DIALOG



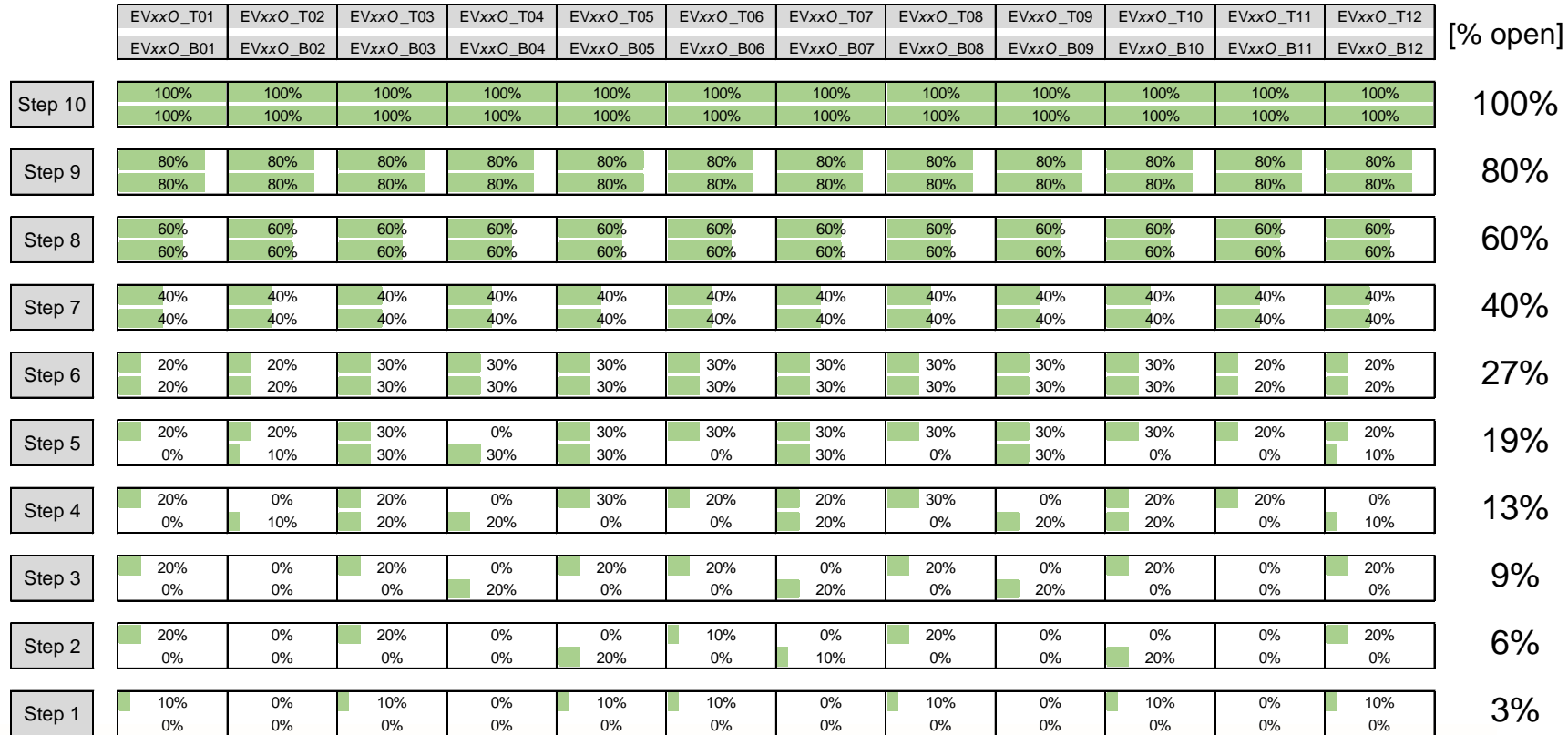
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## Dynamic Simulation Model Overlay: Combined Thermal and Airflow Simulation

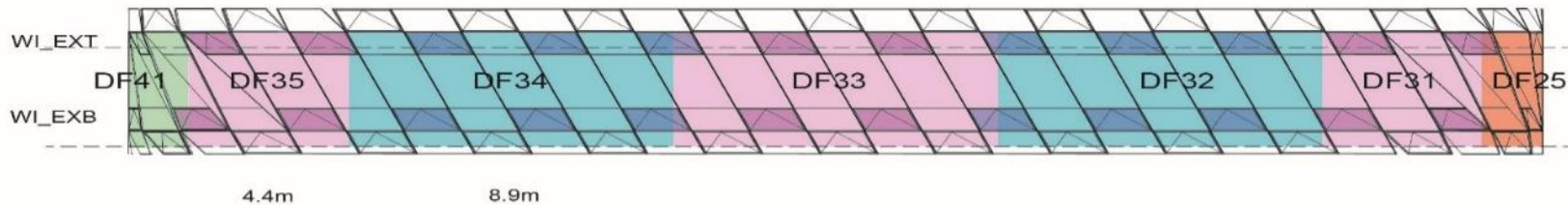


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## Transfer to Vent Control Sequence



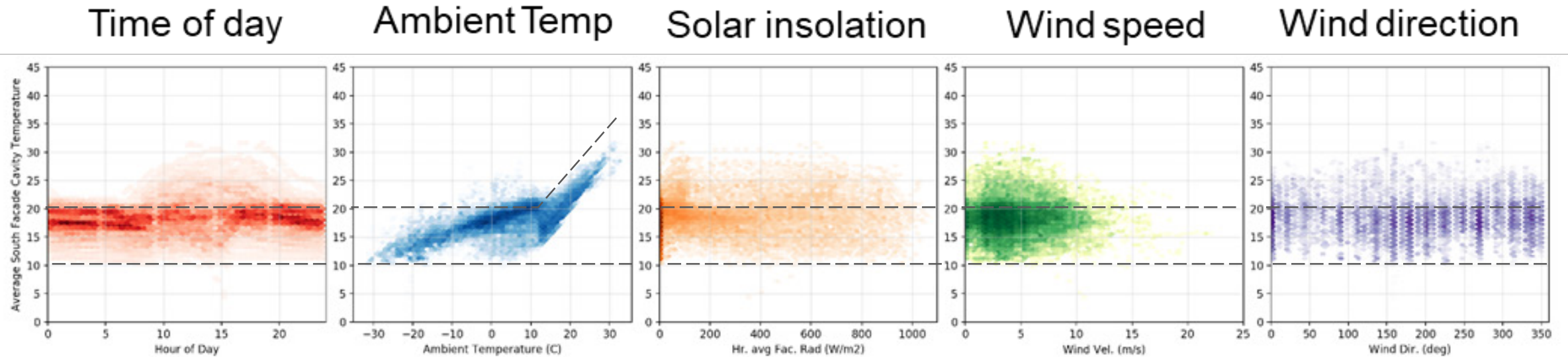
**Automatic vent operation algorithm** derived from simulation **model** and broken down in a (non-linear) **10-step control sequence.**



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## Dynamic Simulation Results: Façade Temperatures

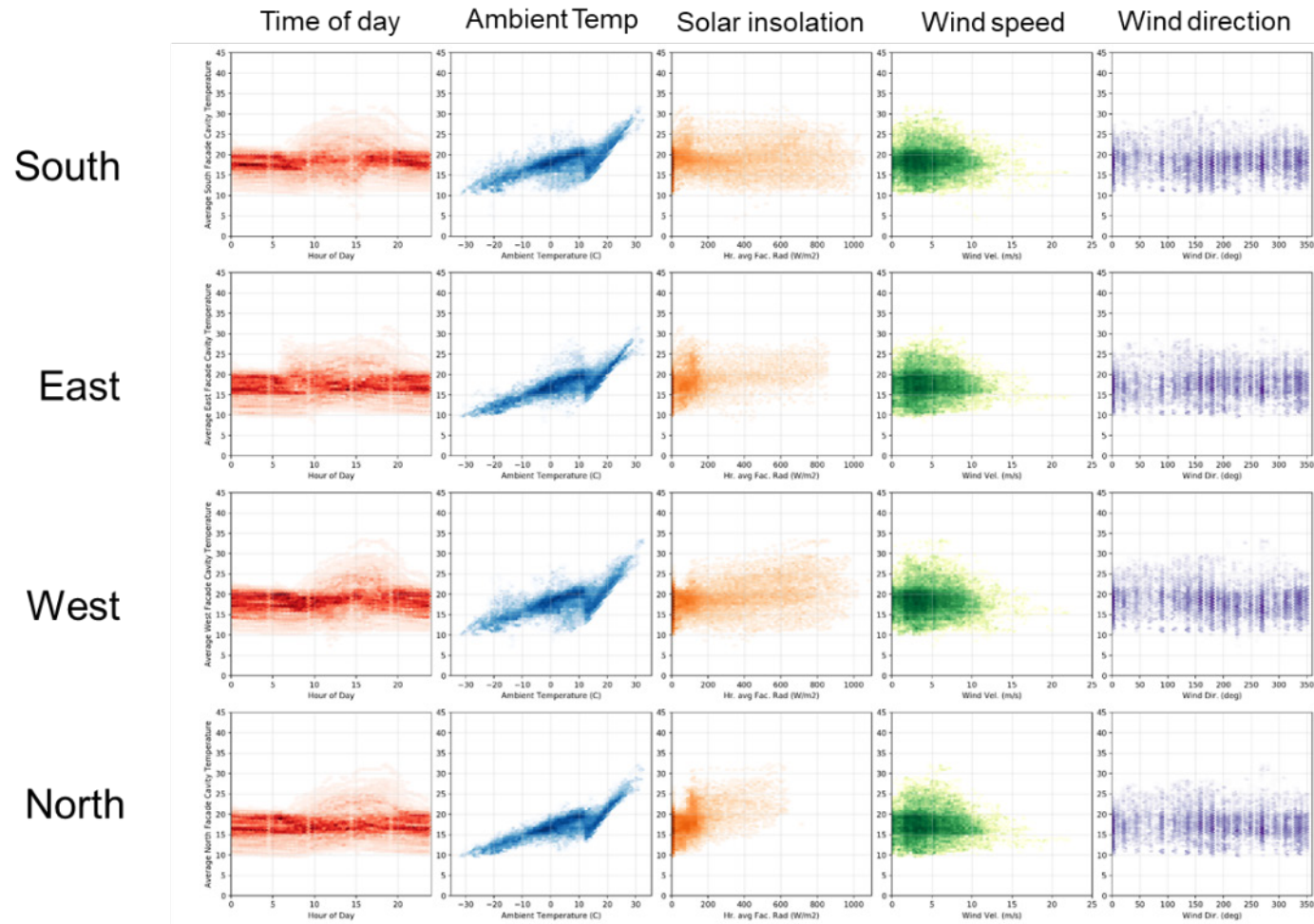
Resulting Double Façade air temperature as function of



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## Dynamic Simulation Results: Façade Temperatures

Resulting DF air temperature as function of

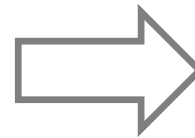
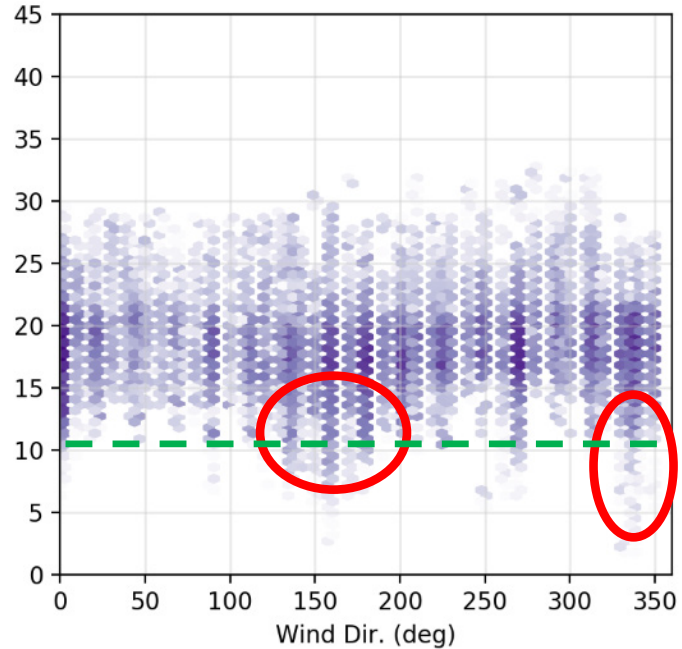


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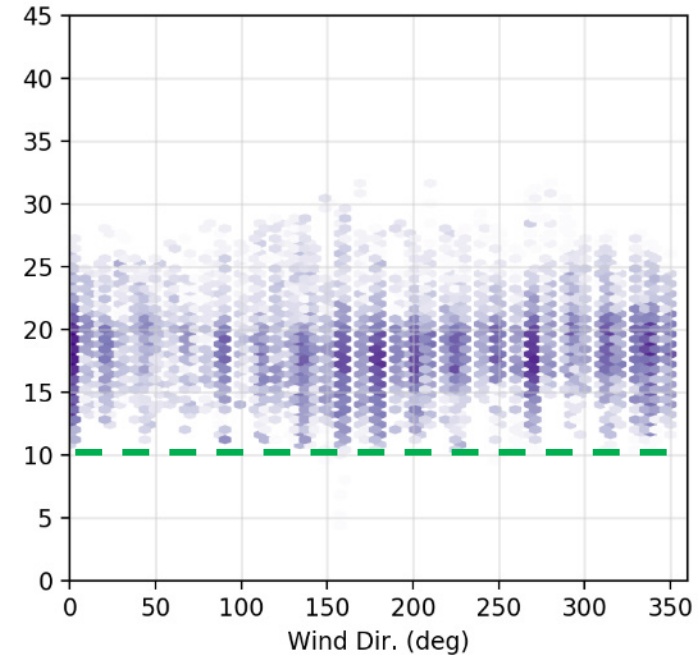
## Control Algorithm Tuning Based on Simulation Results

Resulting DF air temperature as function of wind direction

Initial Control

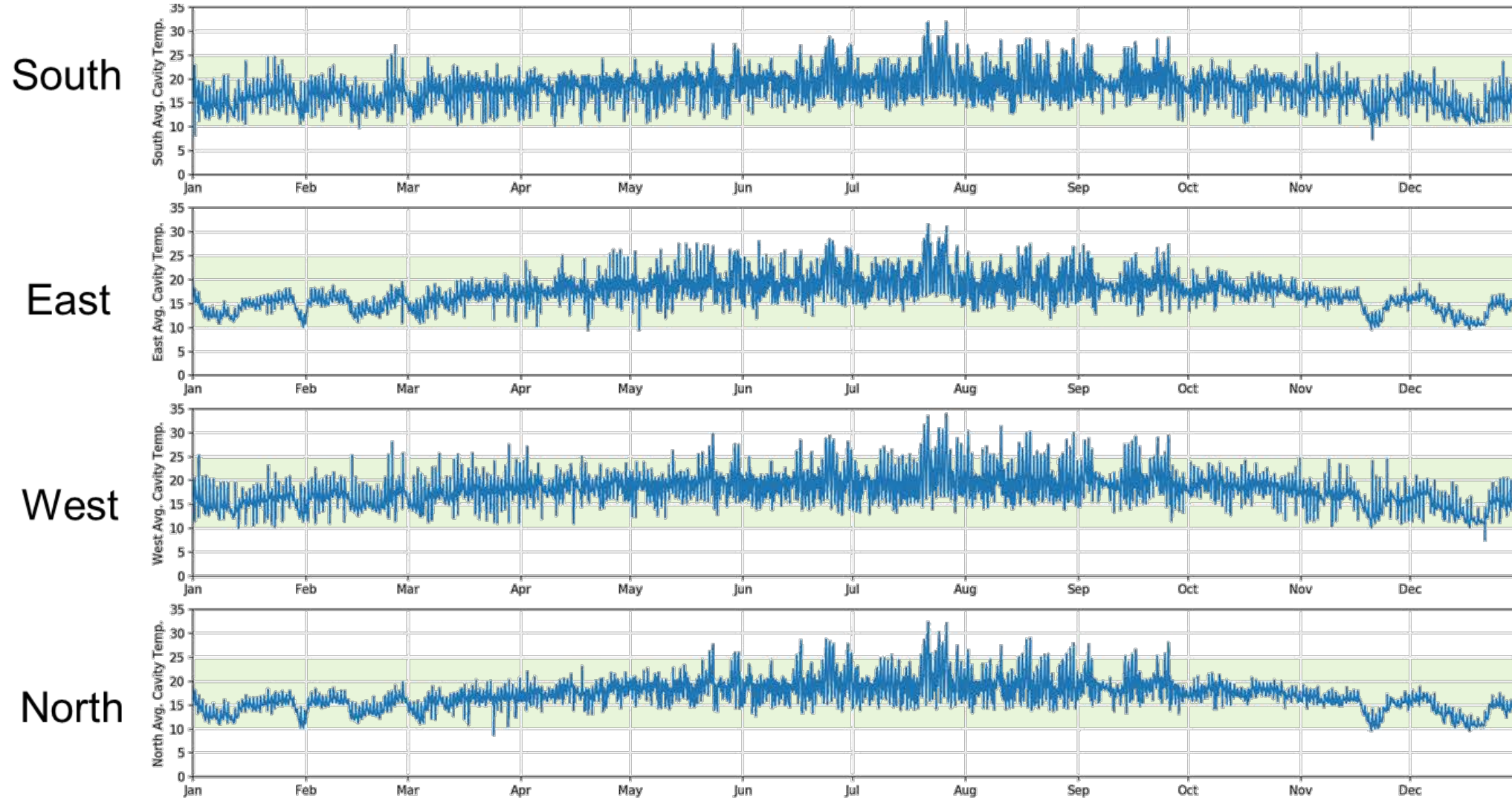


Corrected Control



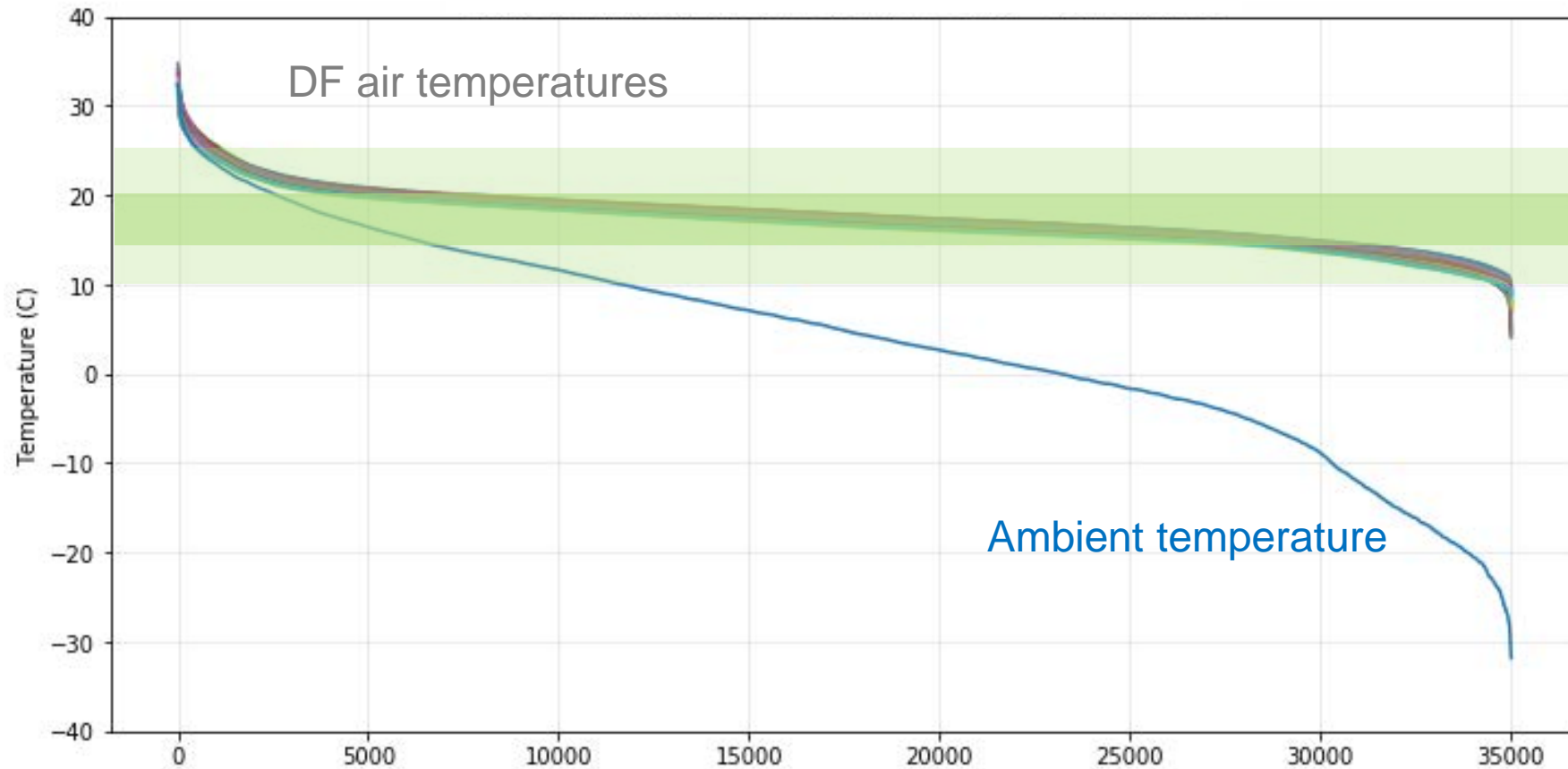
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## Simulation Test Results: DF Façade Temperatures per Orientation



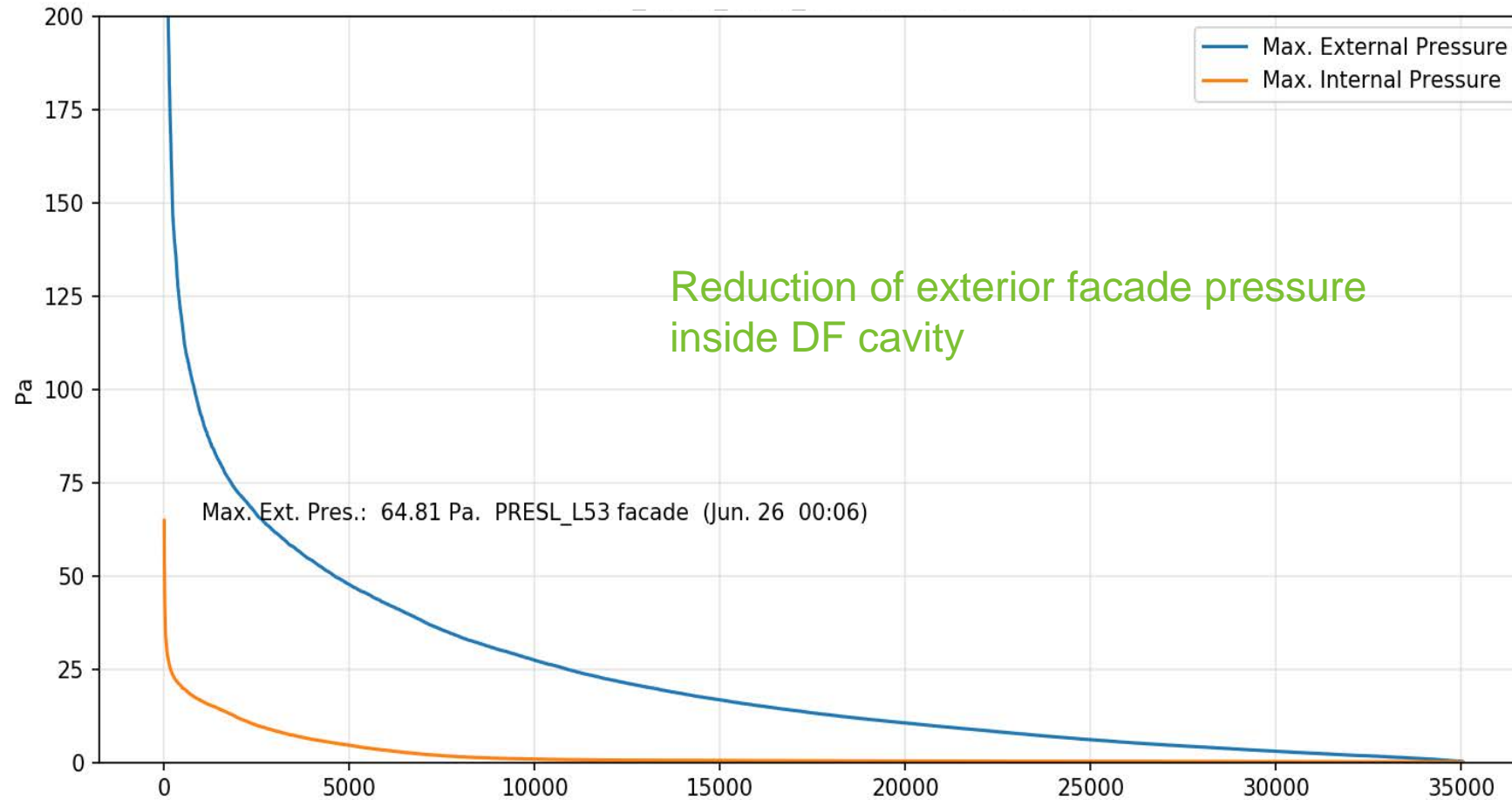
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## Simulation Test Results: DF Façade Temperatures



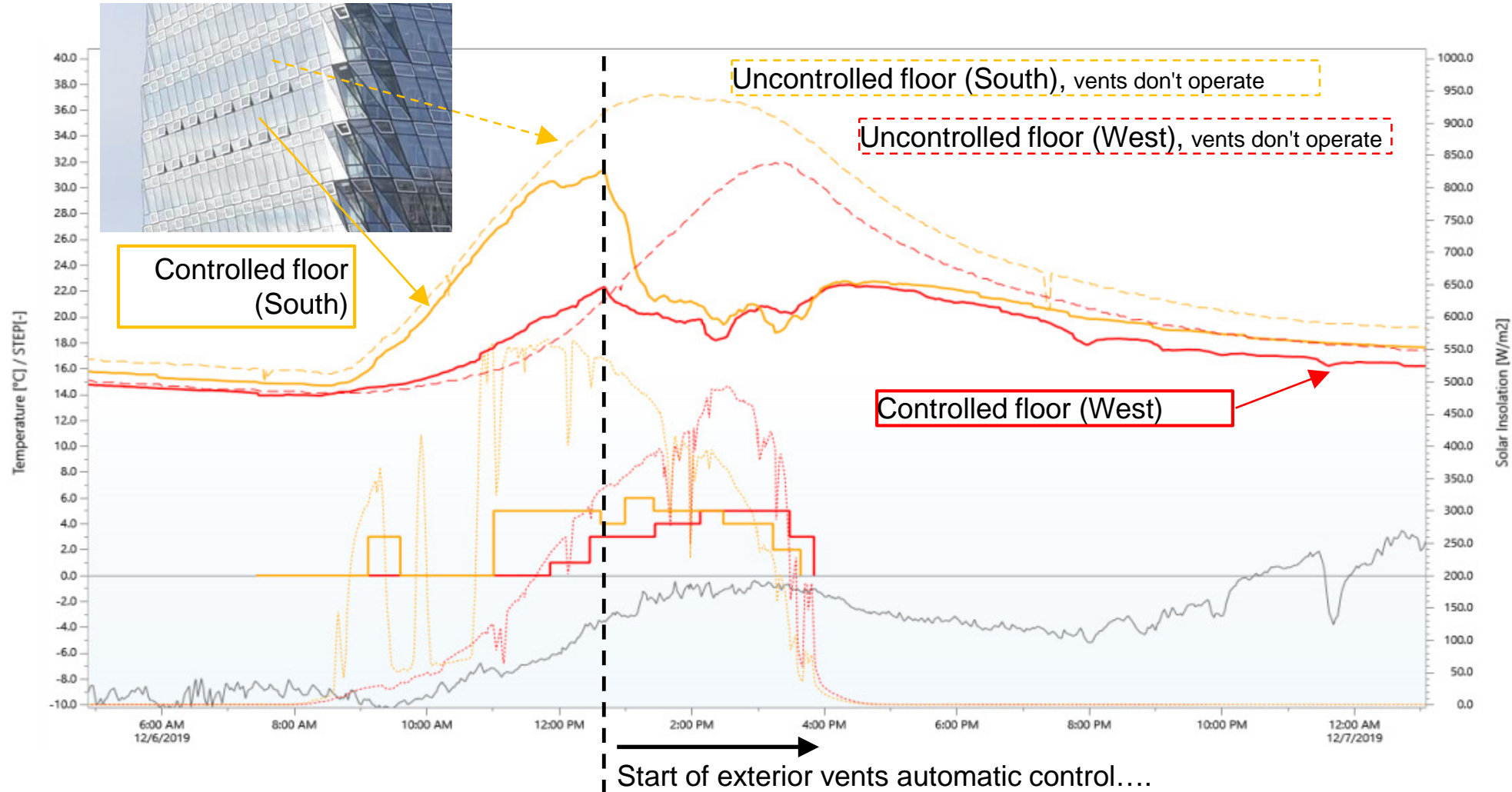
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## Simulation Test Results: DF Façade Pressure



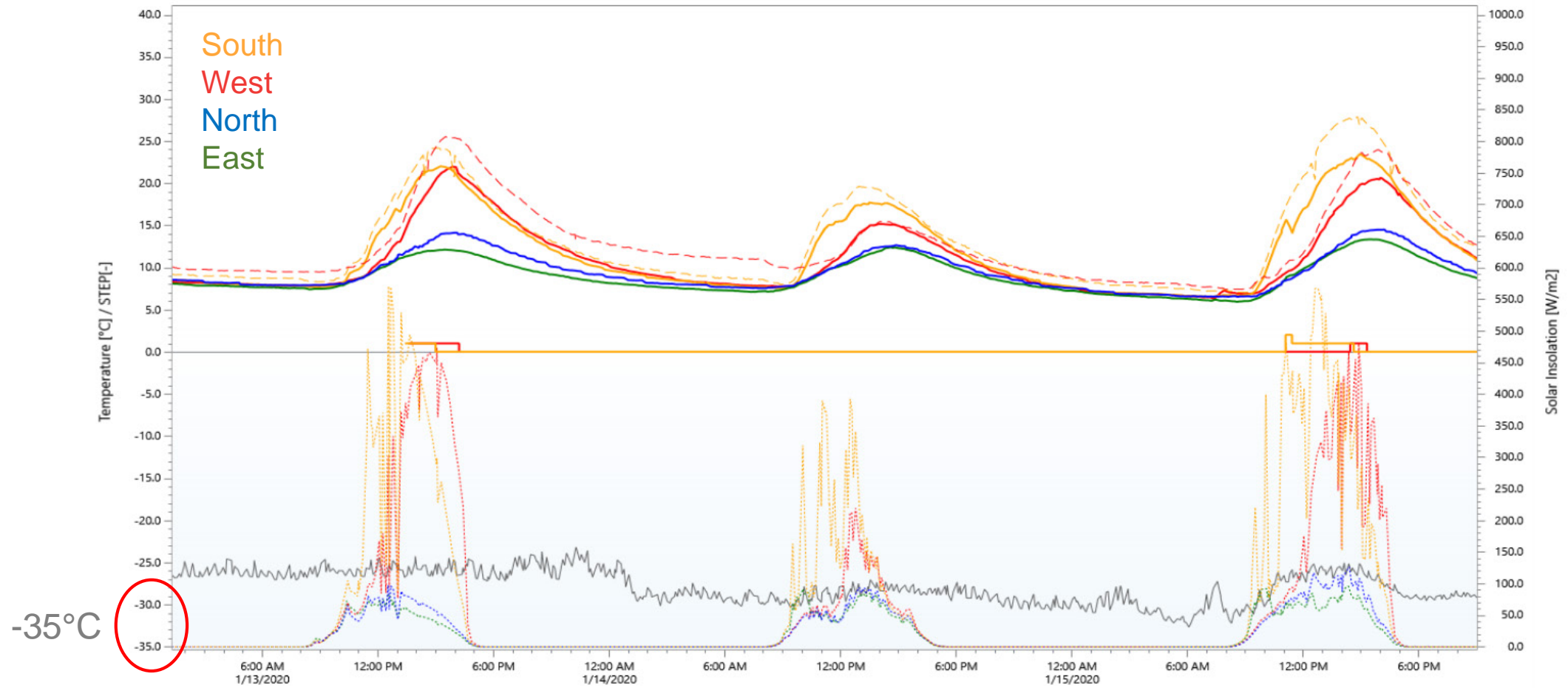
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## Double Façade: Initial Measurement Results



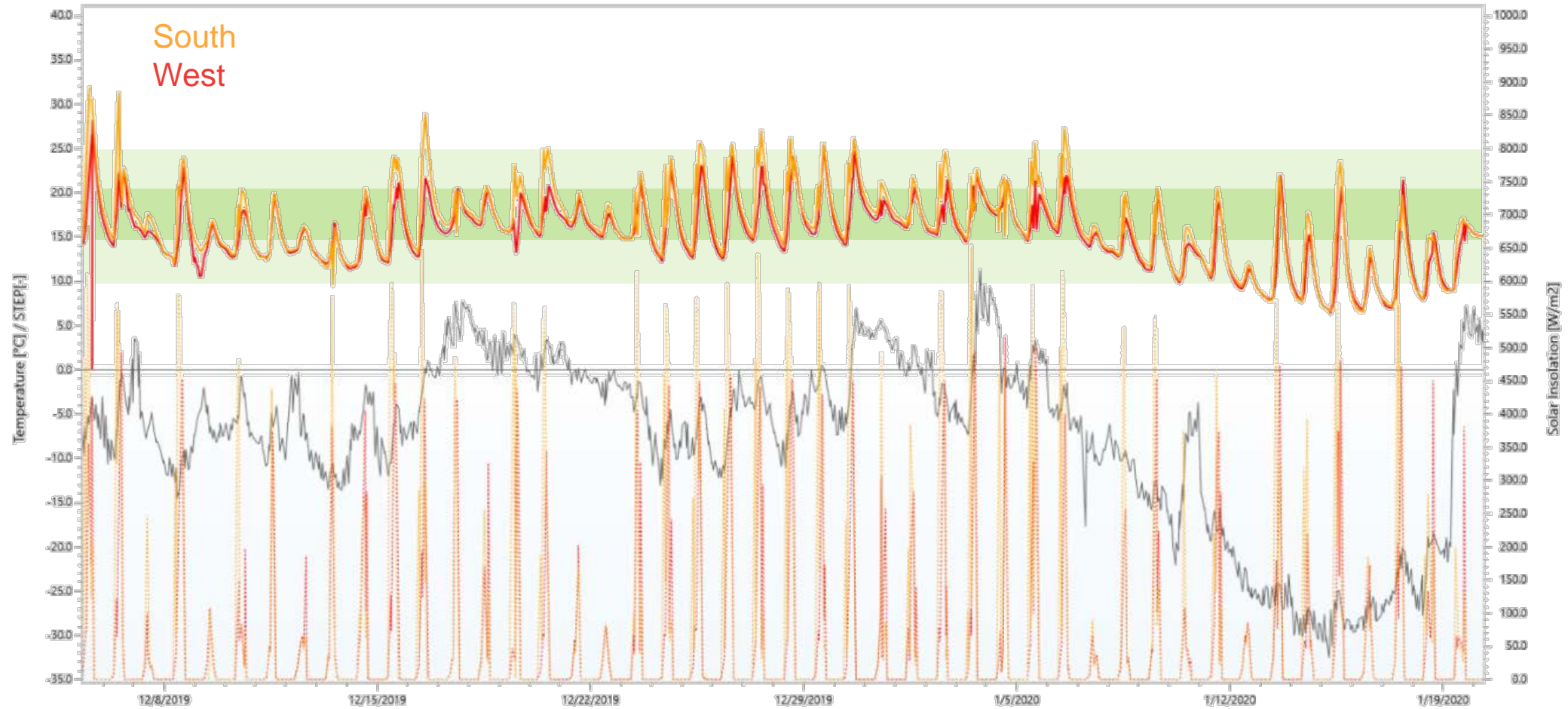
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## Double Façade: Initial Measurement Results - Deep Winter



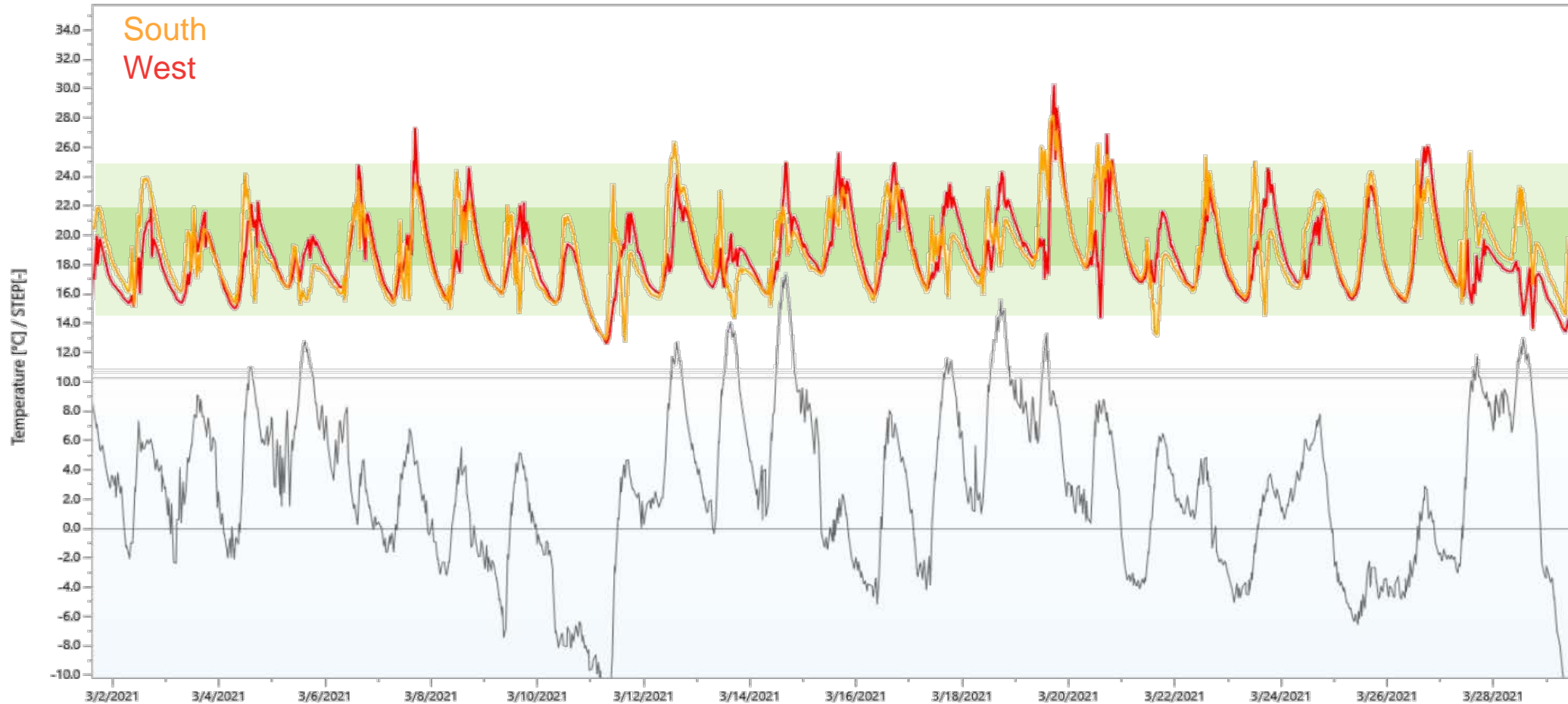
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## Double Façade: Initial Measurement Results - Typical Winter Period



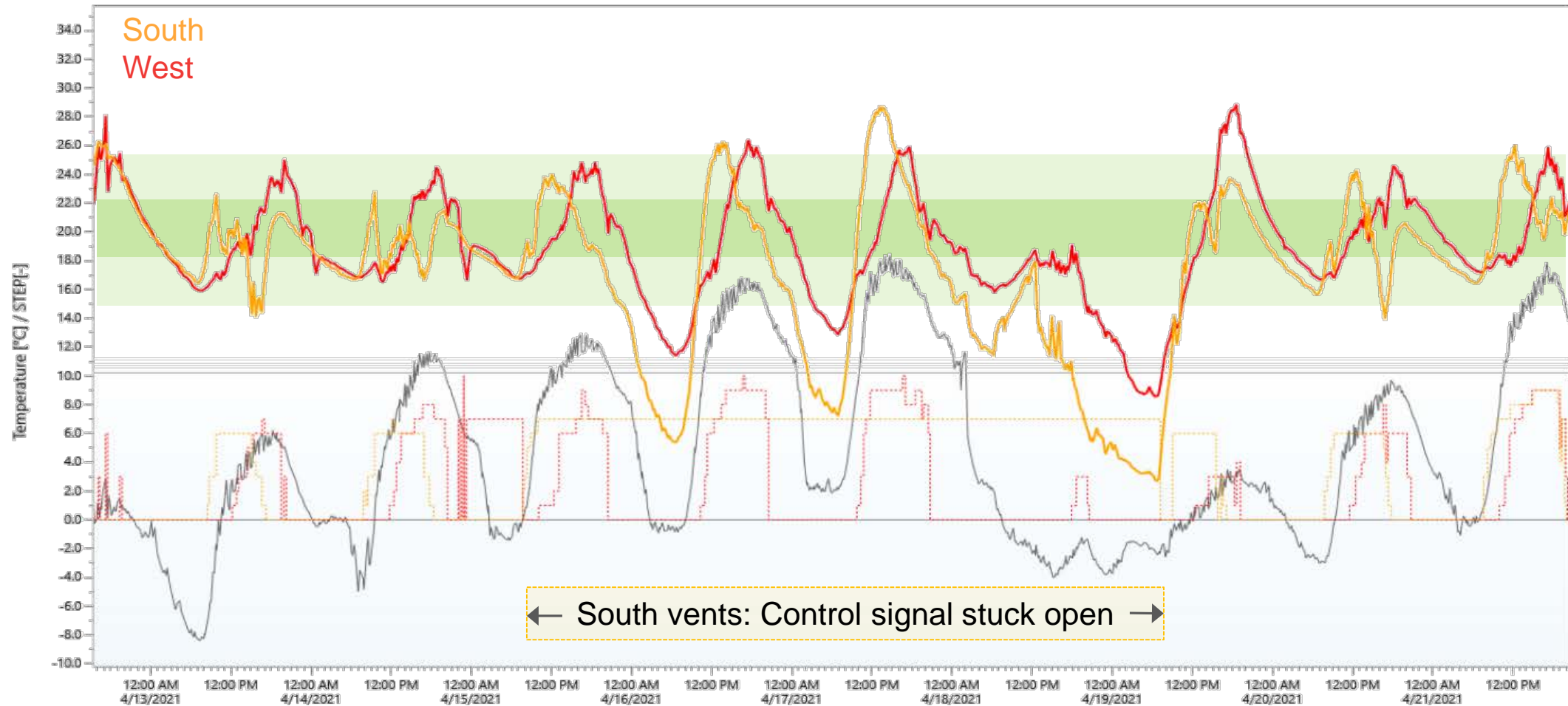
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## Double Façade: Initial Measurement Results - Typical Spring Period



# MacKimmie Tower and Block Redevelopment

## Double Façade: Initial Measurement Results - Typical Spring Period



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## Conclusion

- **Modelling and simulation** provide **powerful tool** to develop and optimize
  - **Façade design**
  - **Dynamic control sequence**
- **Successful implementation of control algorithm** derived directly from **dynamic model**
- **Simulation results** are verified by **measured performance**
- **Fine tuning** of control parameters during **commissioning / seasonal testing** and **monitoring**