

NVBV Kennisdag | 9 June 2022

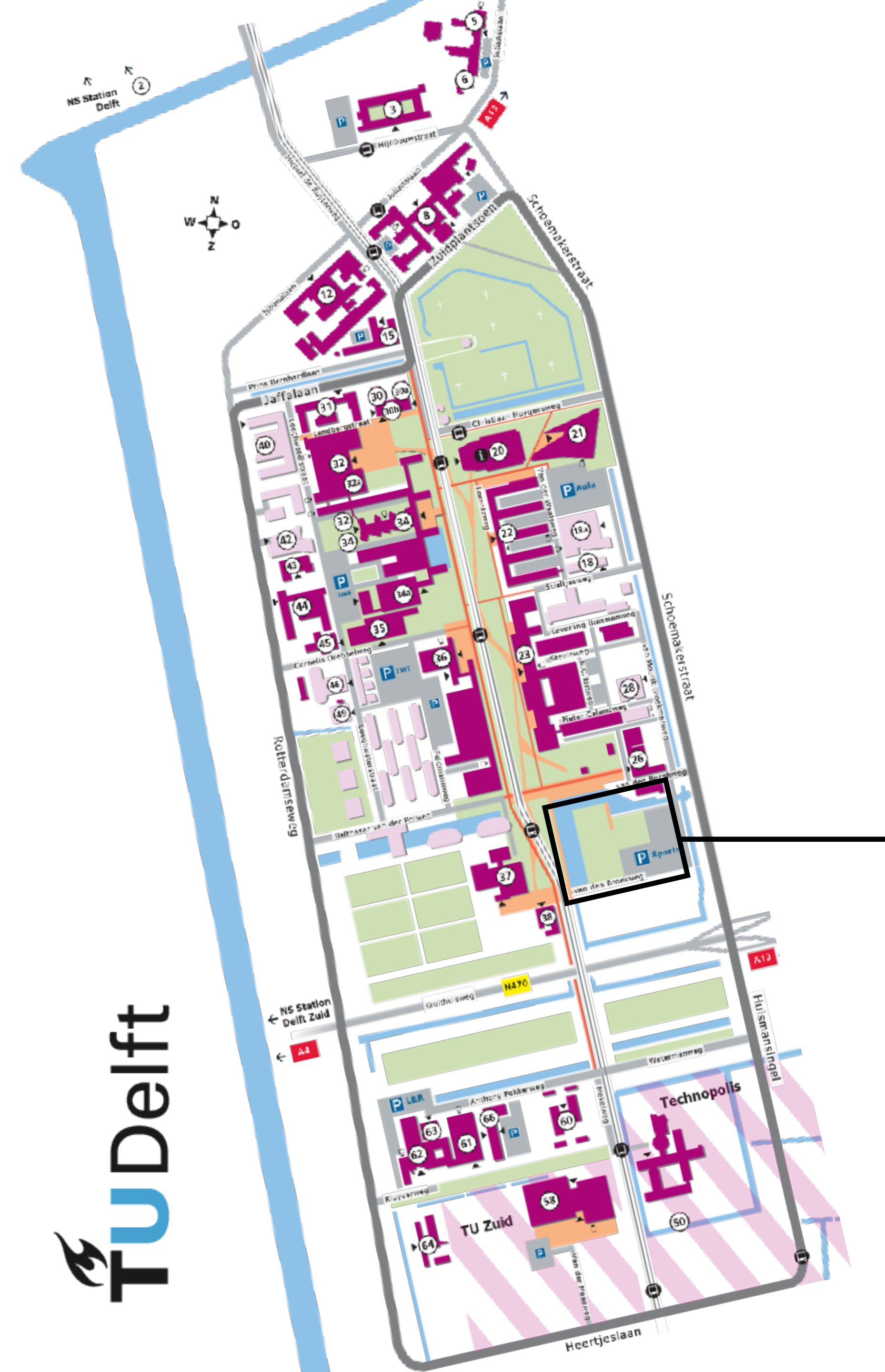
Converge : Windows to the Future

Dr Eleonora Brembilla | Assistant Professor in Building Physics
Faculty of Architecture and the Built Environment



- High transparency buildings
- Indoor environmental quality
- Sustainable development goals





**Windows to
the Future**

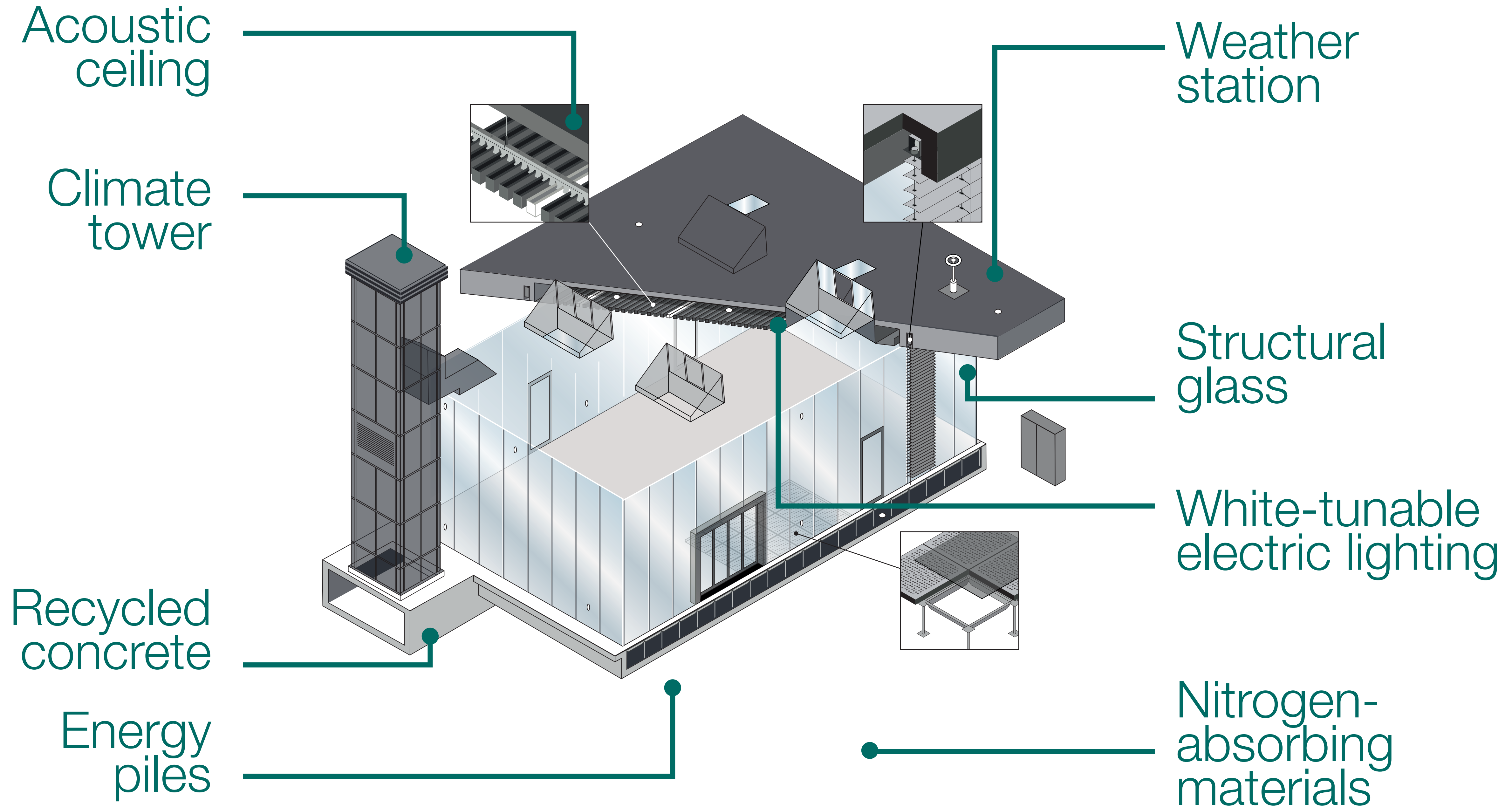
Converge

**THE
GREEN
VILLAGE**

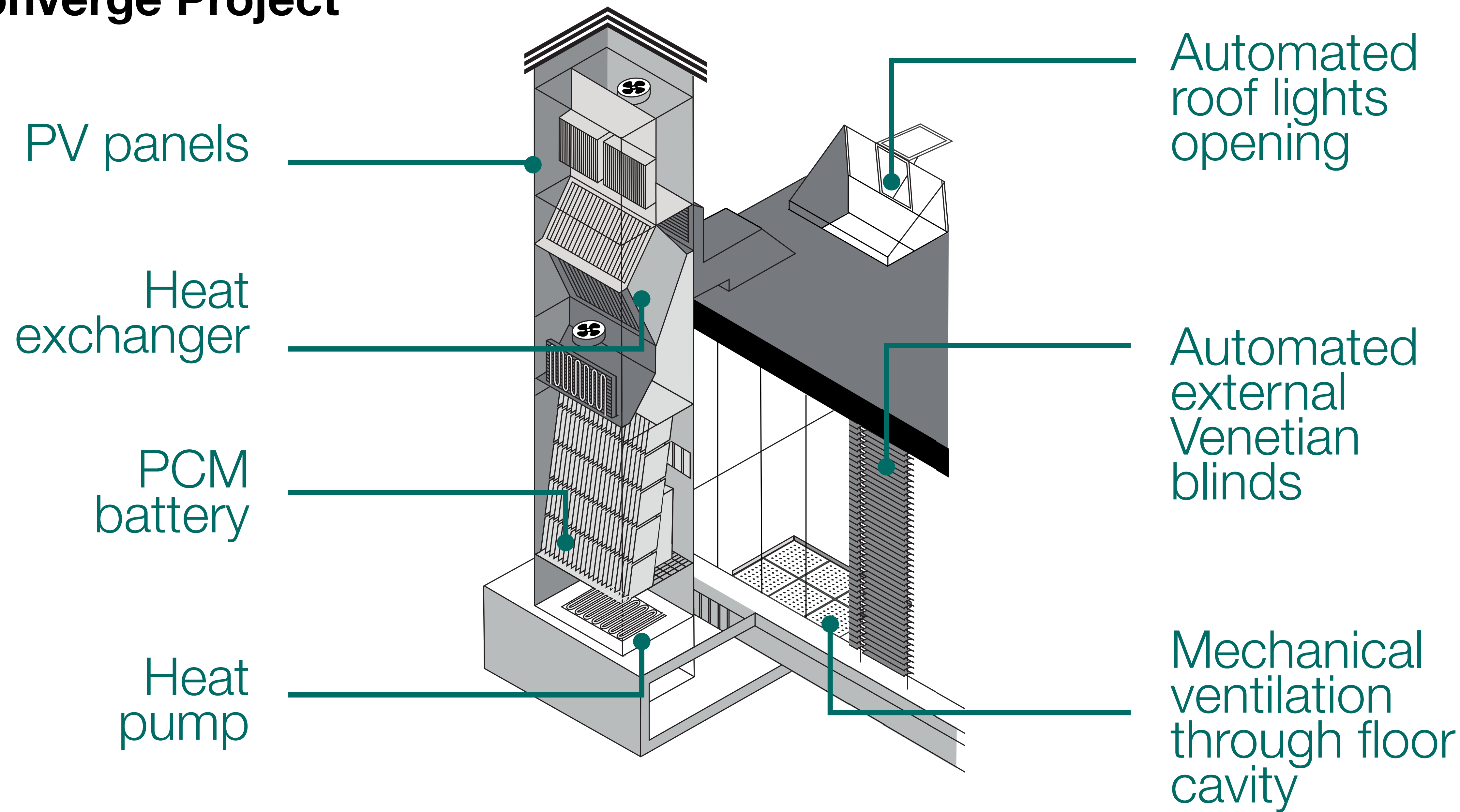





nono house



Converge Project





- 
- Ceiling multi sensor (temperature, RH, PIR, light levels)
 - ~40 temperature sensors (floor/glass/beams/ceiling)
 - Supply/return air (temperature, CO₂, RH)
 - Occupancy (entrance through door and movement)
 - Weather station on roof (wind, outdoor temperature, outdoor RH, global horizontal irradiance)
 - High accuracy illuminance sensors (4 outdoors, 1 indoors)

Converge Project

Can a fully transparent building reach nearly net zero energy consumption, while guaranteeing indoor comfort?

Conductor?

Heating systems

Cooling systems

Ventilation systems

Solar shadings



Sensor Data

Sensor Data

Simulation Models

Sensor Data

Simulation Models

Weather Forecast

**Rule-based
controls**



Settings optimisation at
commissioning stage

**Model-based
controls**

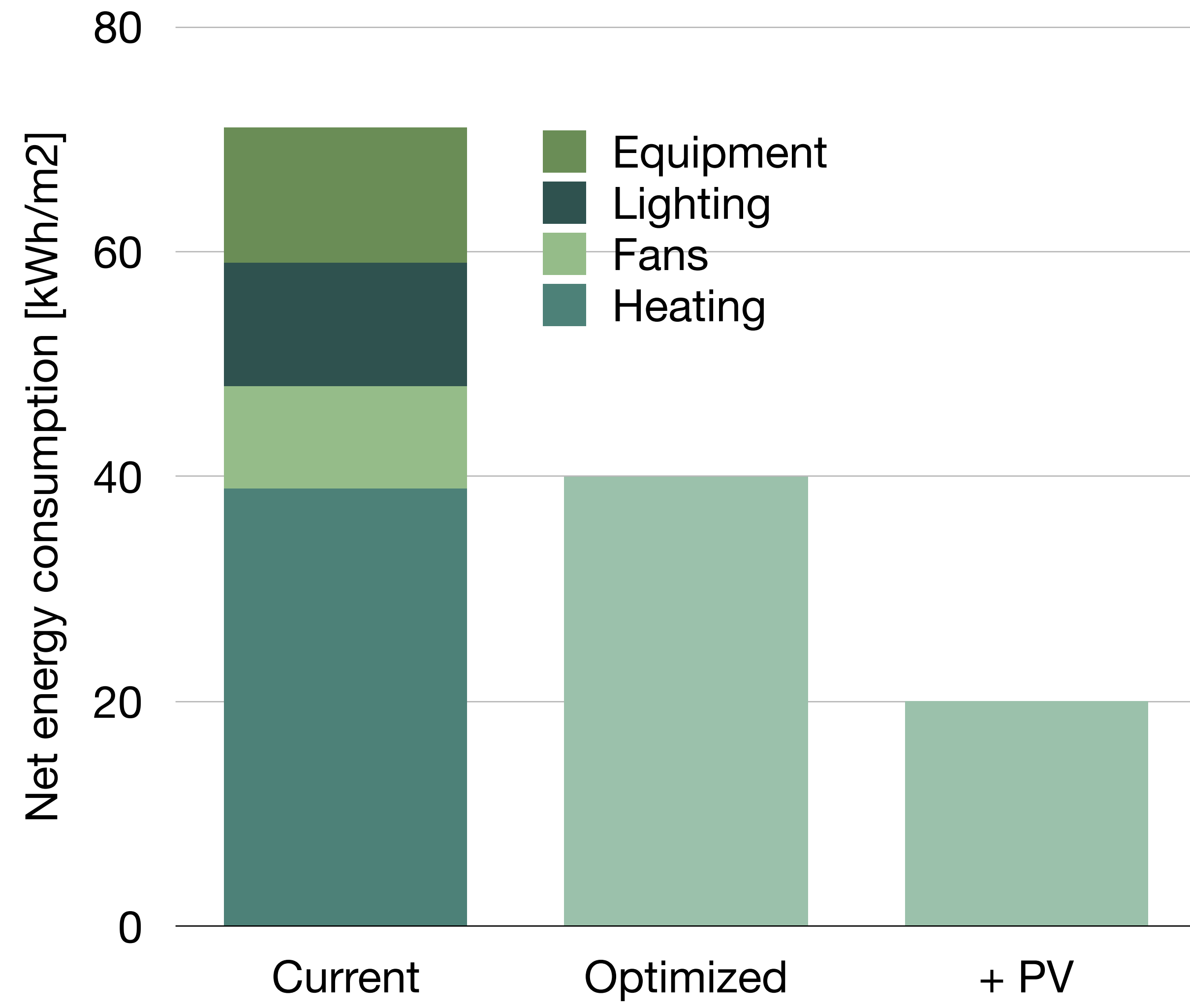


Systems optimisation at
current conditions

**Model-predictive
controls**



Systems optimisation for
near-future conditions











Occupancy and activity

- Small meetings
- Large events
- Exhibitions
- TV recordings

Weather conditions

- Warm/cold
- Sunny/overcast
- Stable/variable sky



Energy mode

- Exploit solar heat to reach the desired energy balance

Visual comfort mode

- Provide comfortable visual conditions for occupants

Challenge #1

- Representing complex environments
- Modelling occupants' indoor comfort in an atypical space
- Responding to conflicting demands and systems limitations

Illuminance sensors

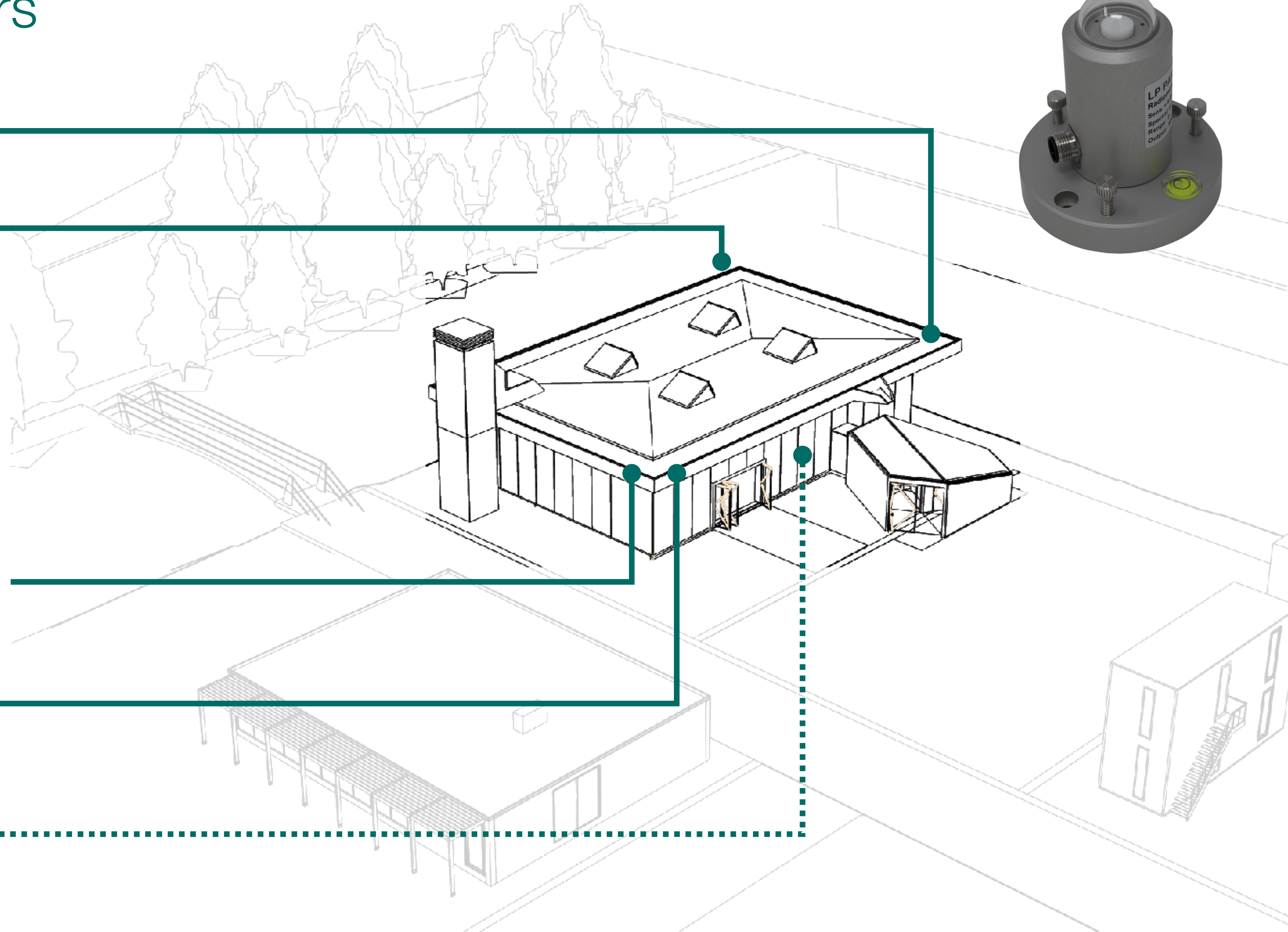
Sensor #1: 'UP'

Sensor #2: 'WEST'

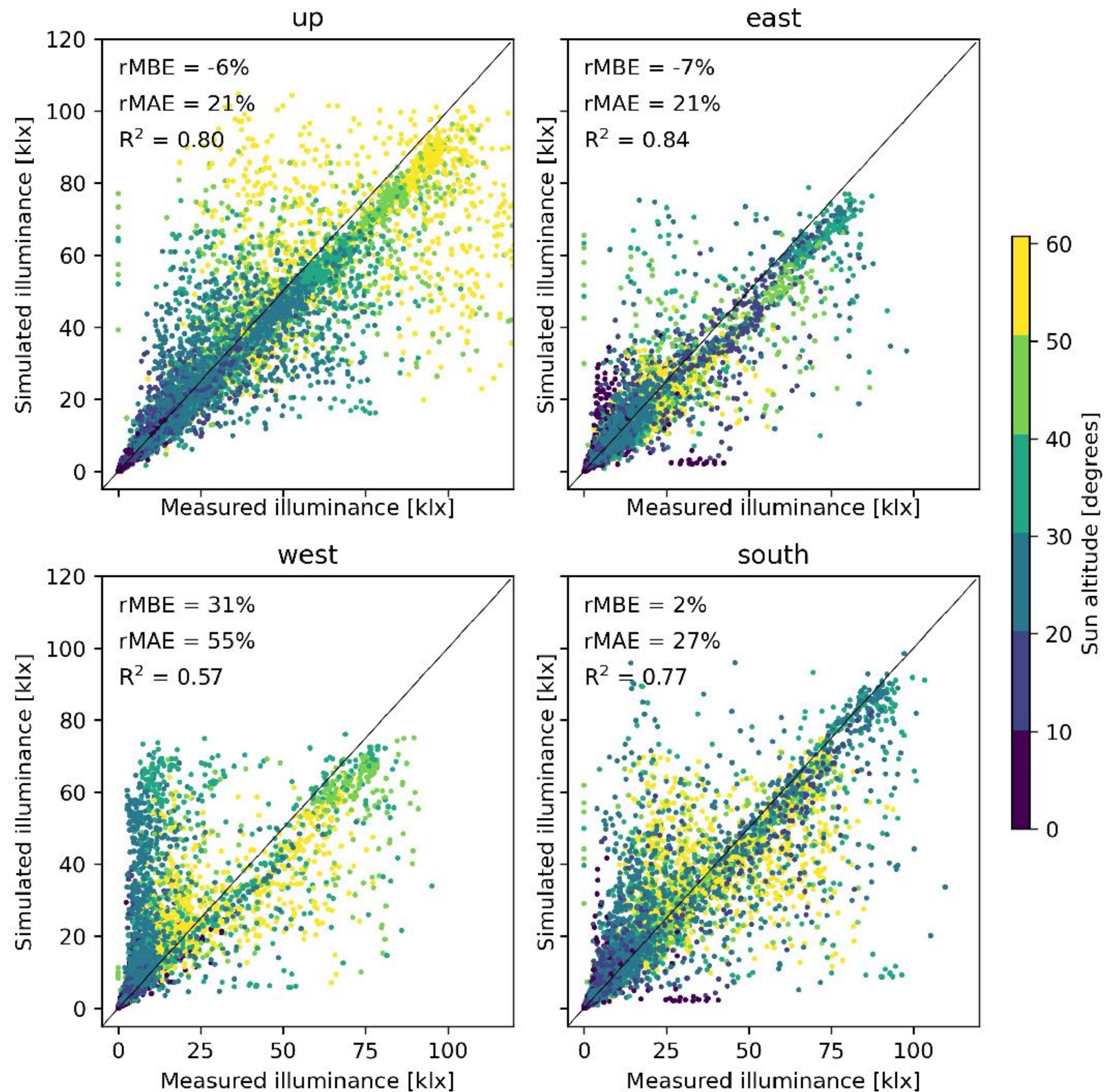
Sensor #3: 'SOUTH'

Sensor #4: 'EAST'

Sensor #5: 'IN'

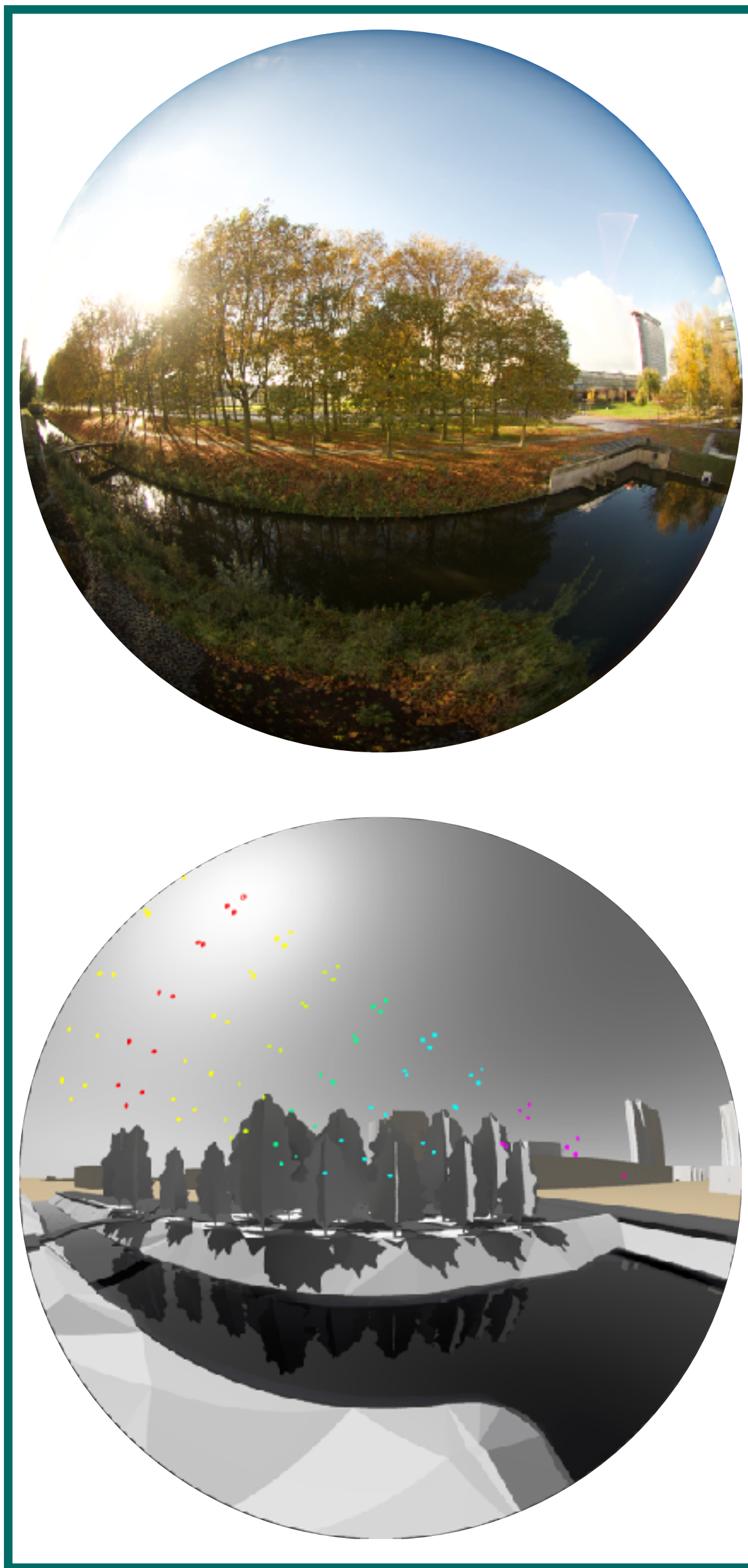


Measured vs simulated illuminance





illum. sensor #1: 'UP'



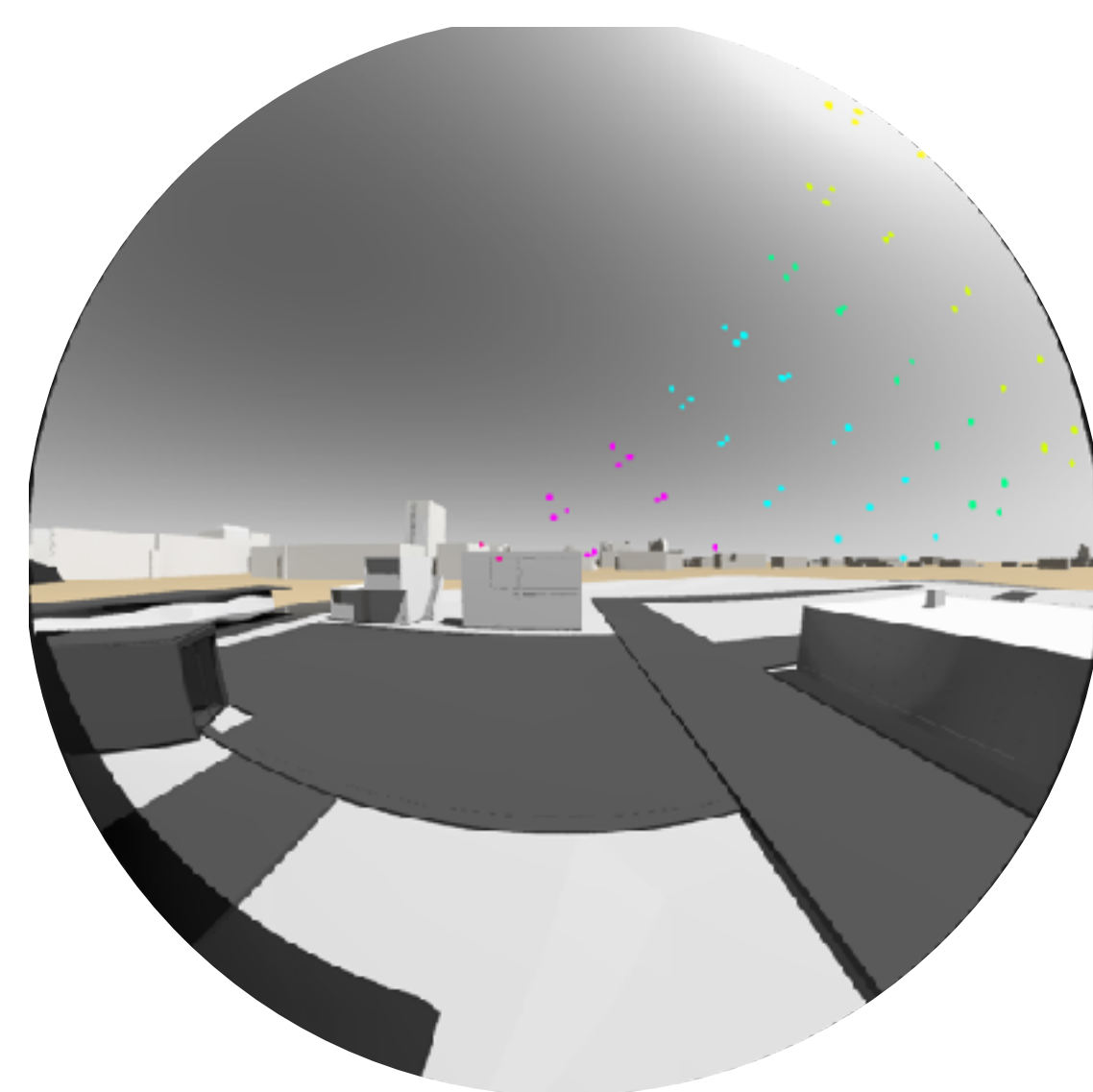
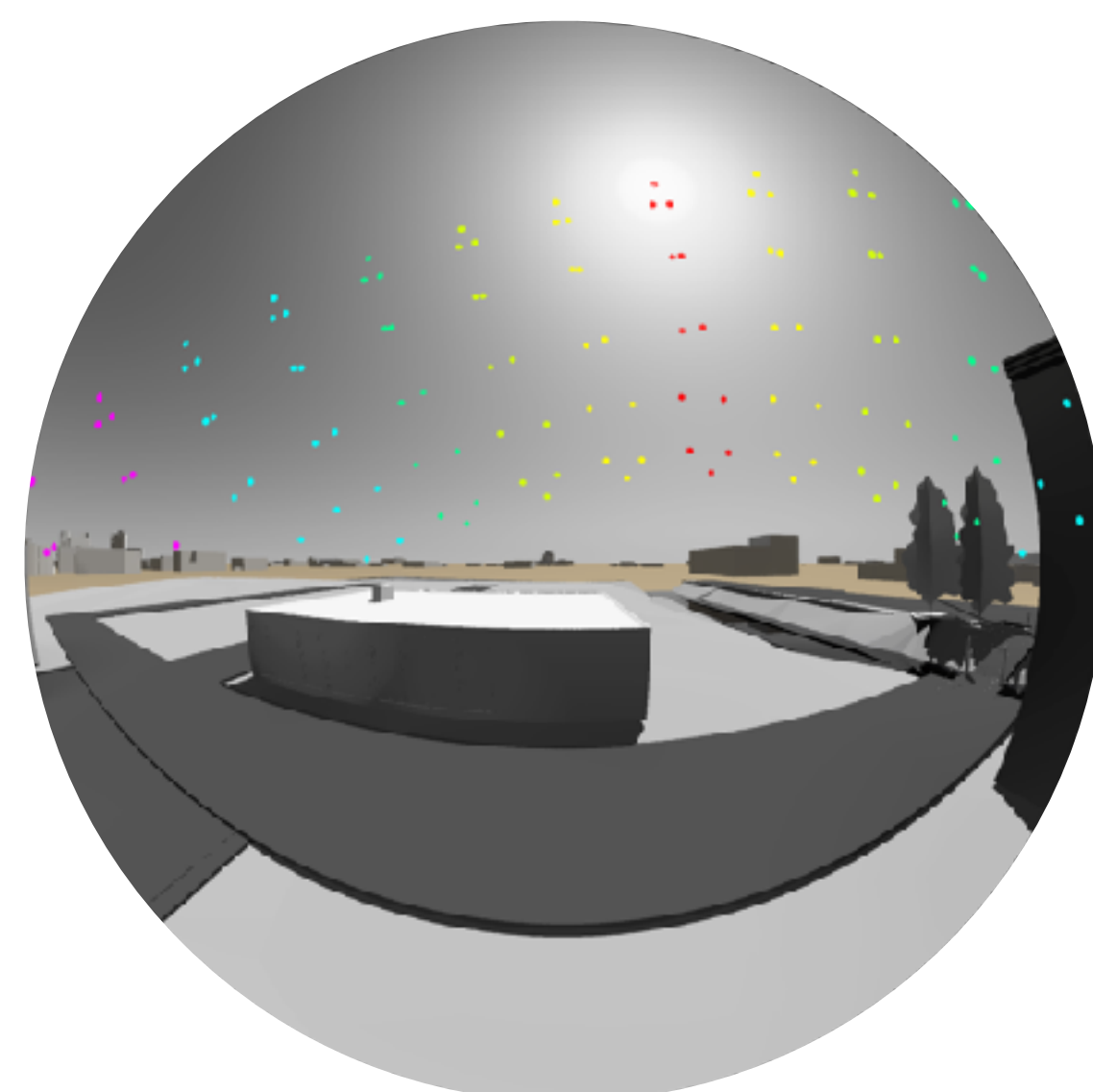
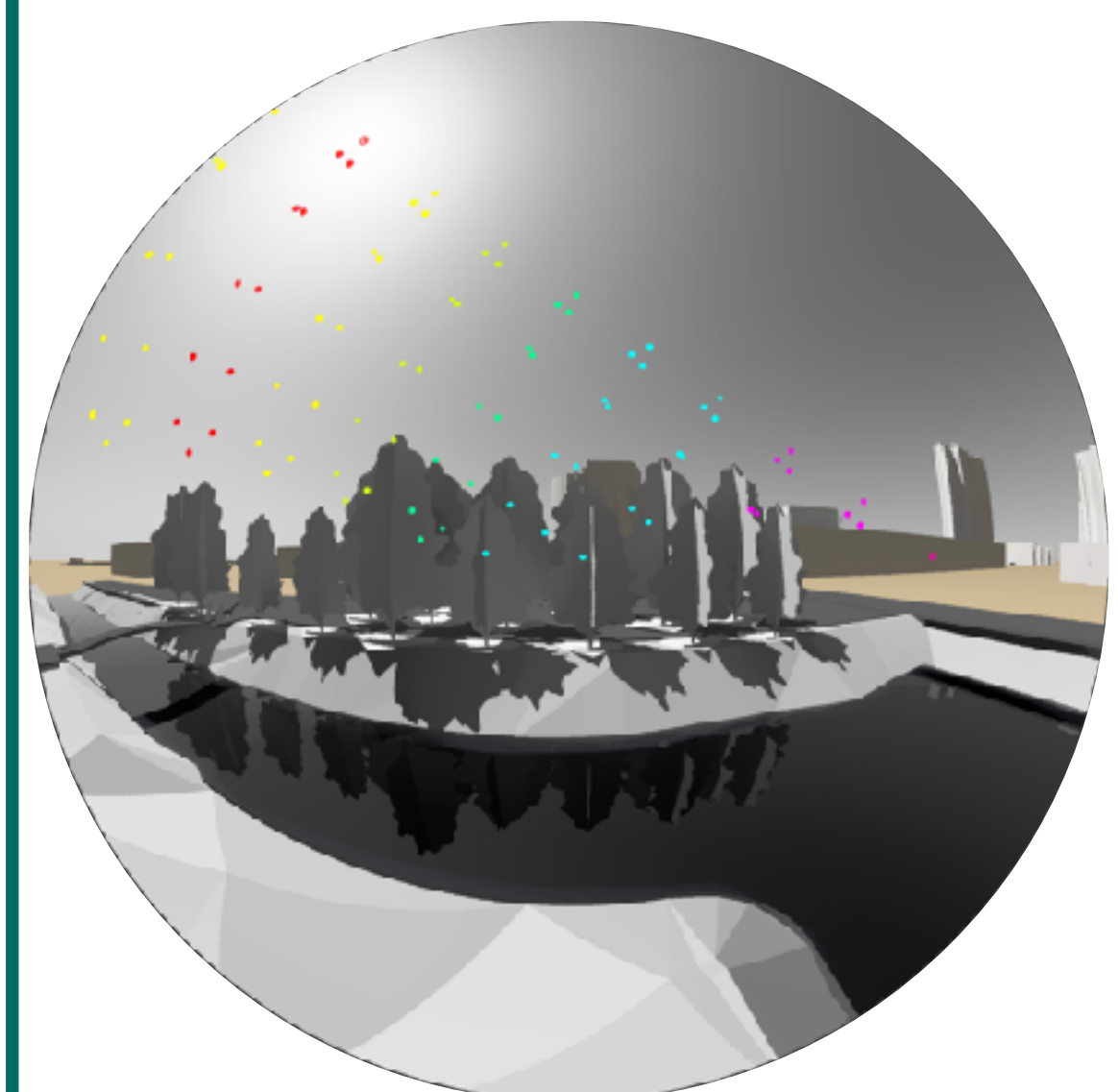
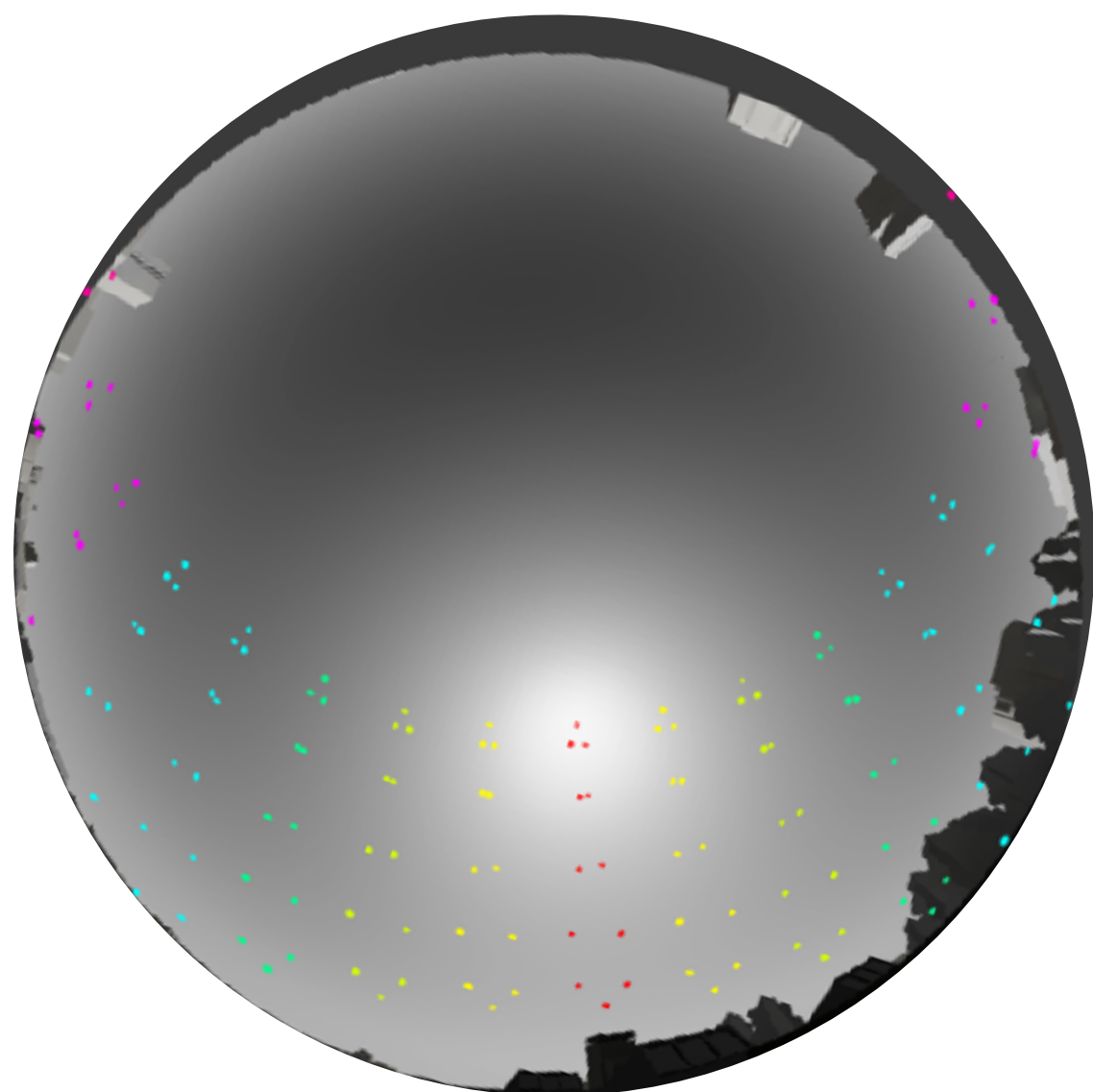
illum. sensor #2: 'WEST'

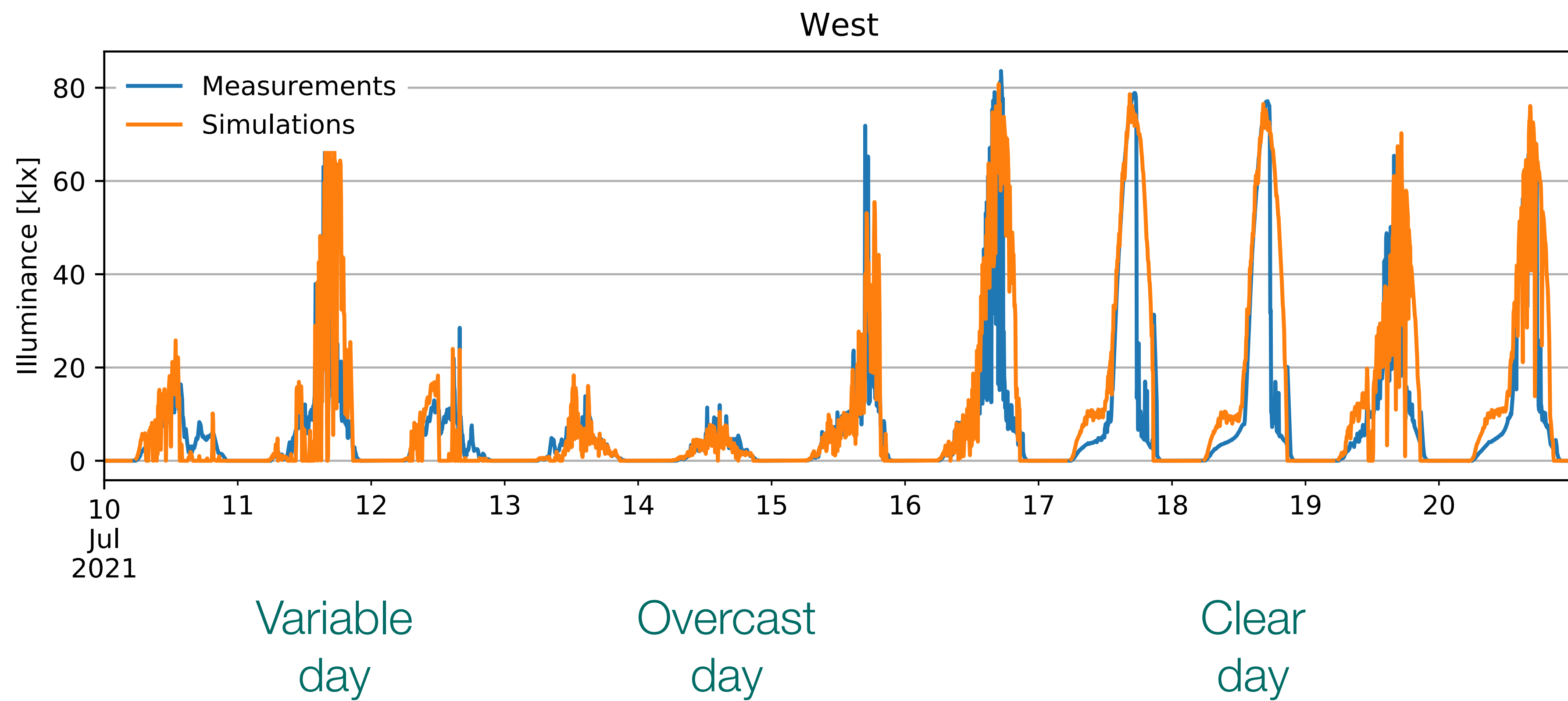
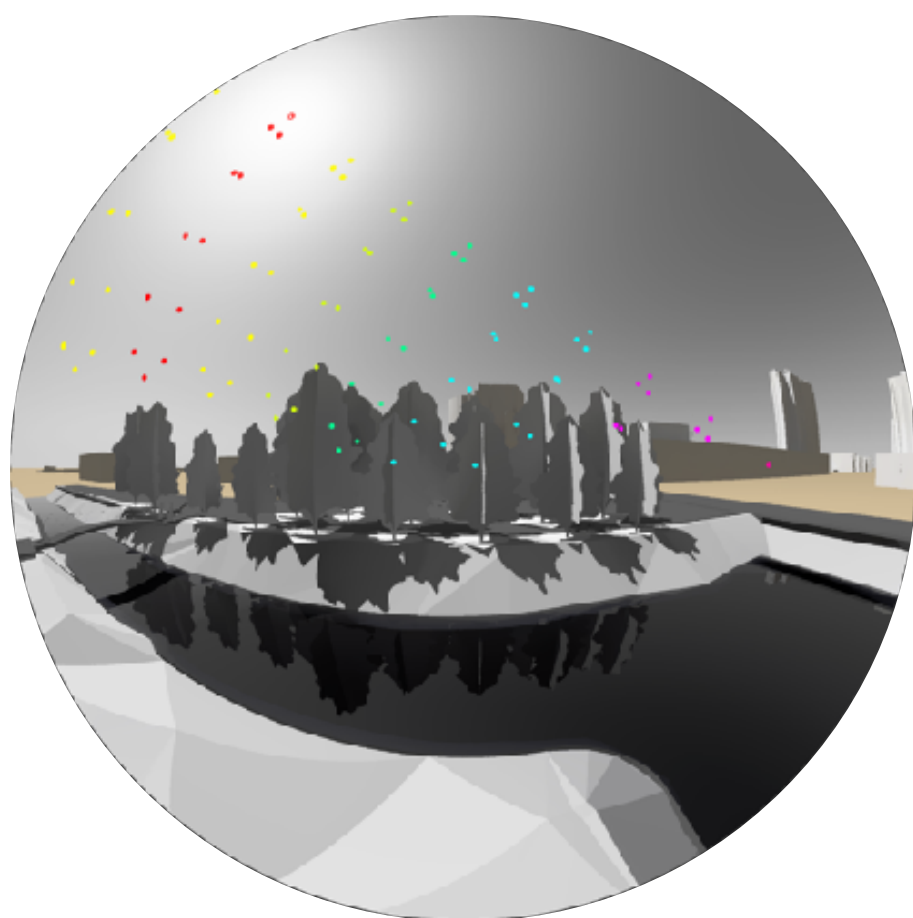


illum. sensor #3: 'SOUTH'



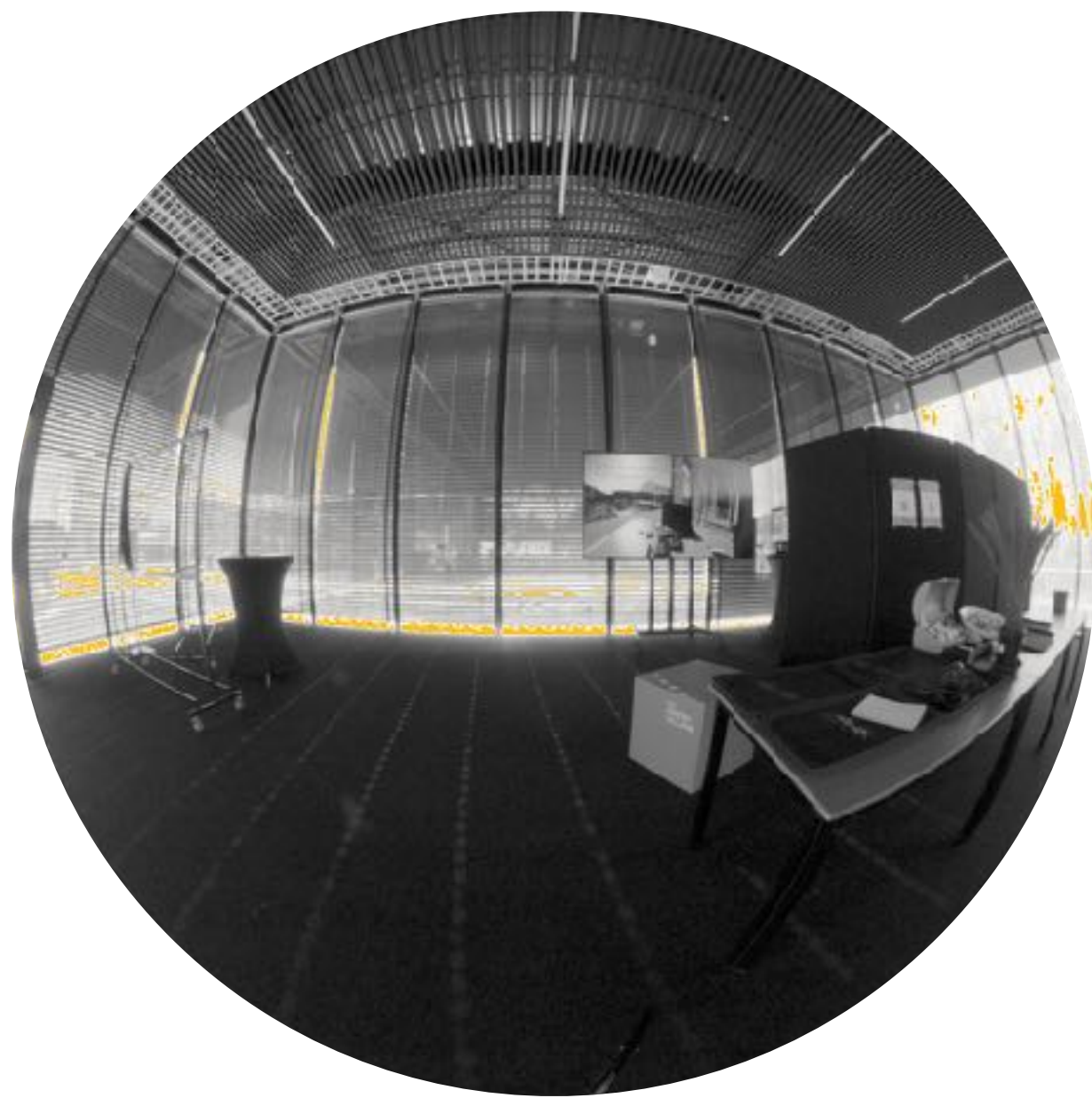
illum. sensor #4: 'EAST'





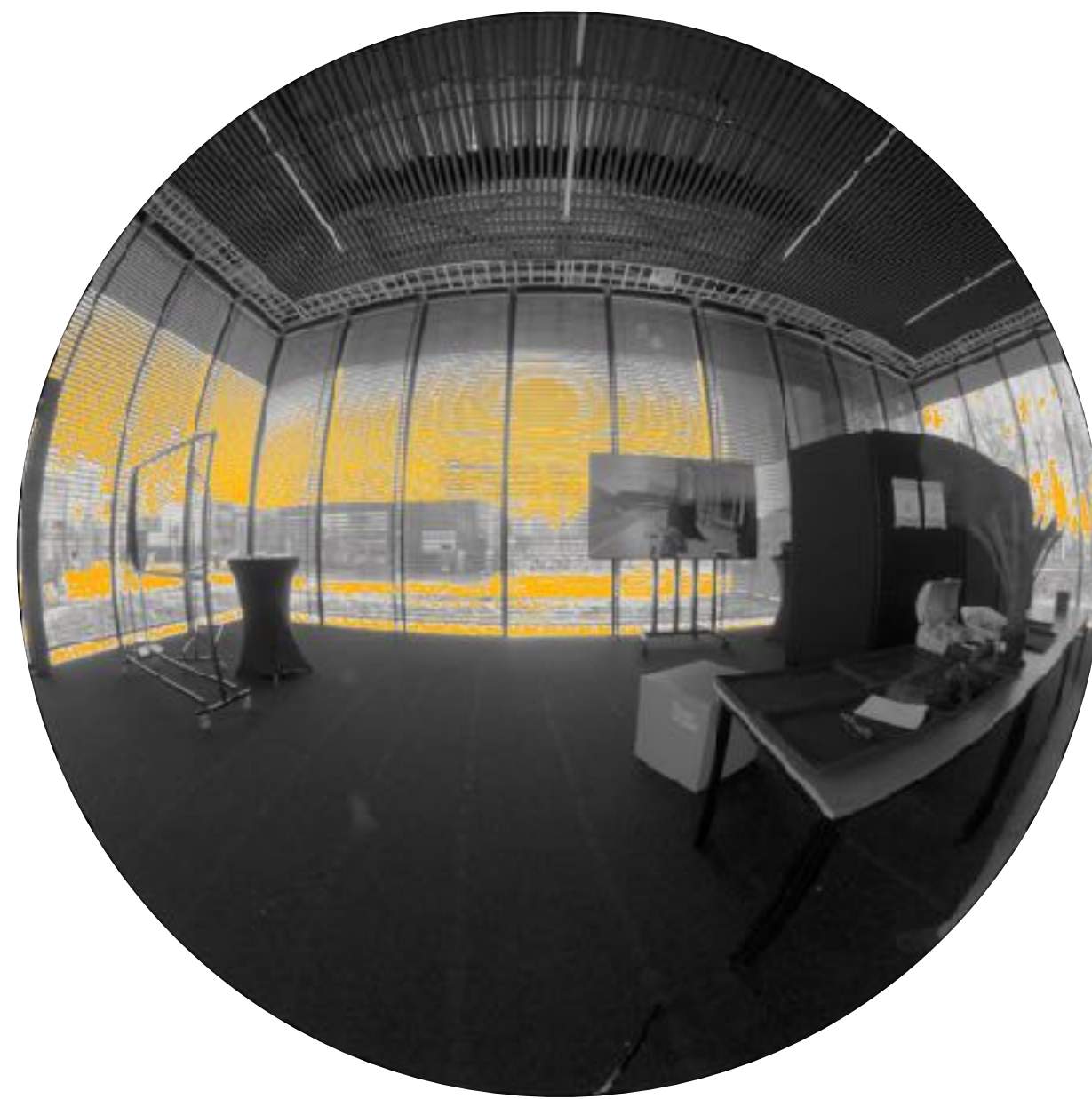
Challenge #2

- Representing complex environments
- Modelling occupants' indoor comfort in an atypical space
- Responding to conflicting demands and systems limitations



Daylight Glare
Probability (DGP)

DGP
0.24 (imperceptible)



DGP
0.29 (imperceptible)



DGP
0.38 (noticeable)

Unified Glare
Probability (UGP)

UGP
0.79 (noticeable)

UGP
0.87 (disturbing)

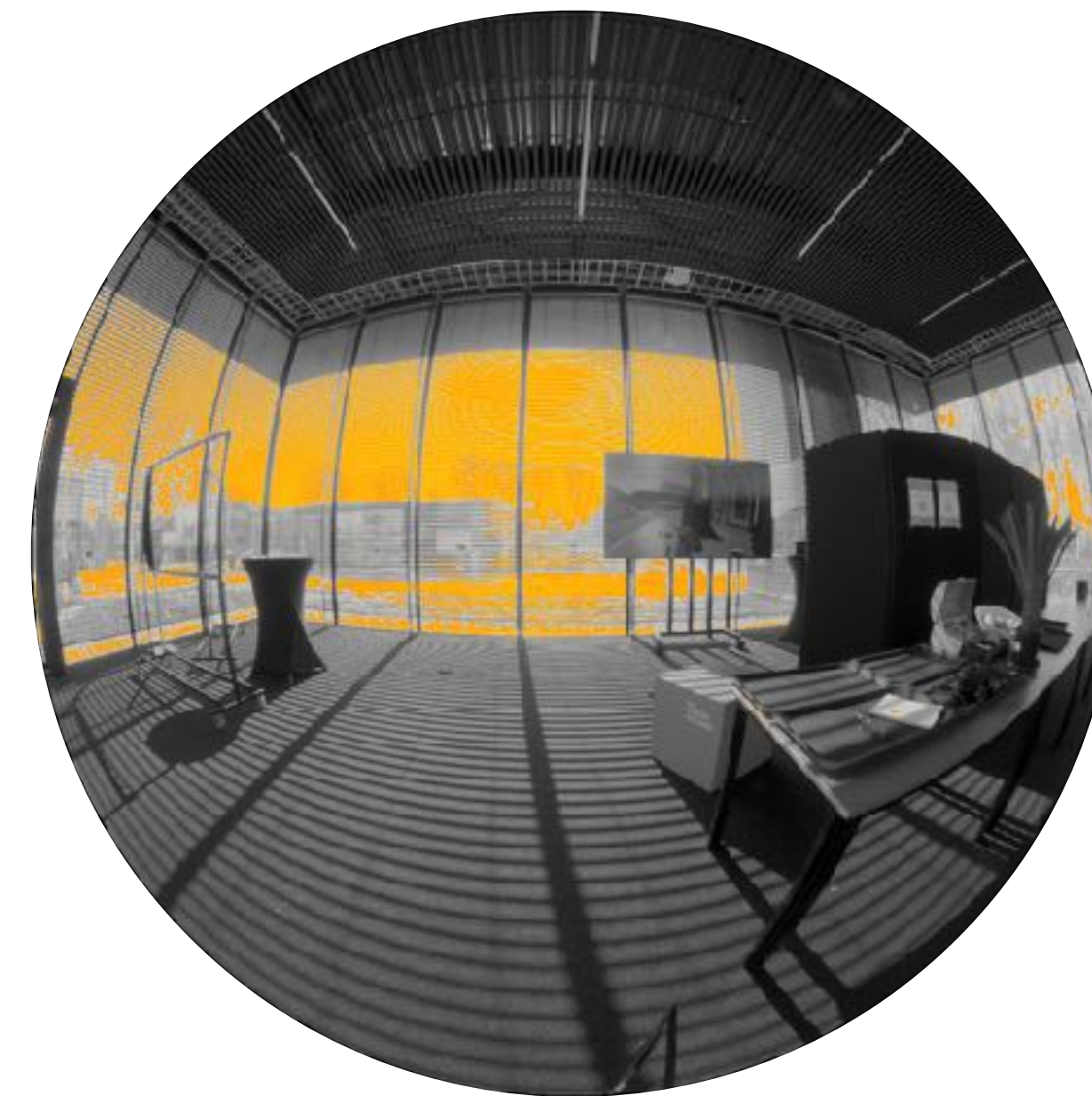
UGP
0.87 (intolerable)



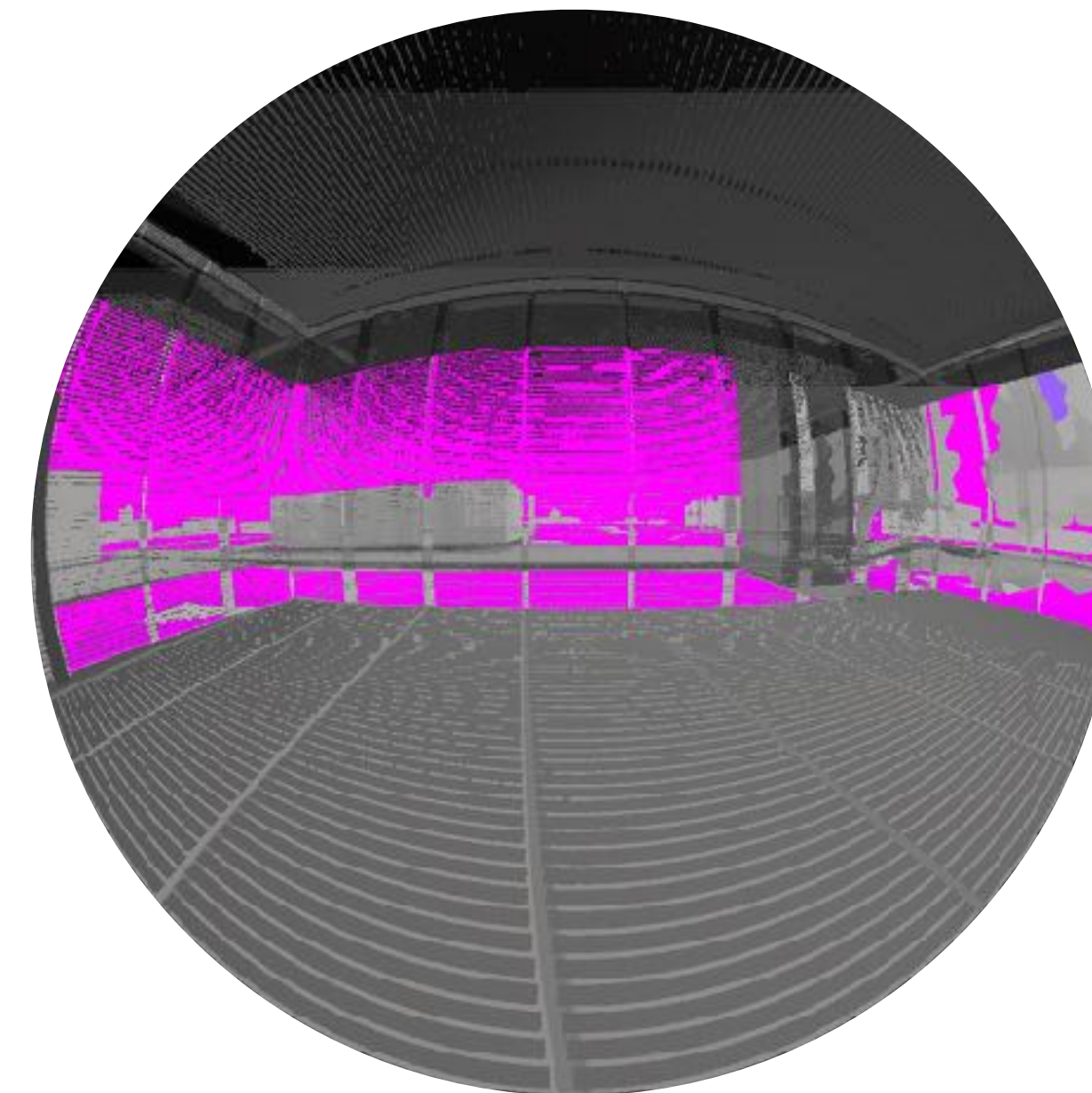
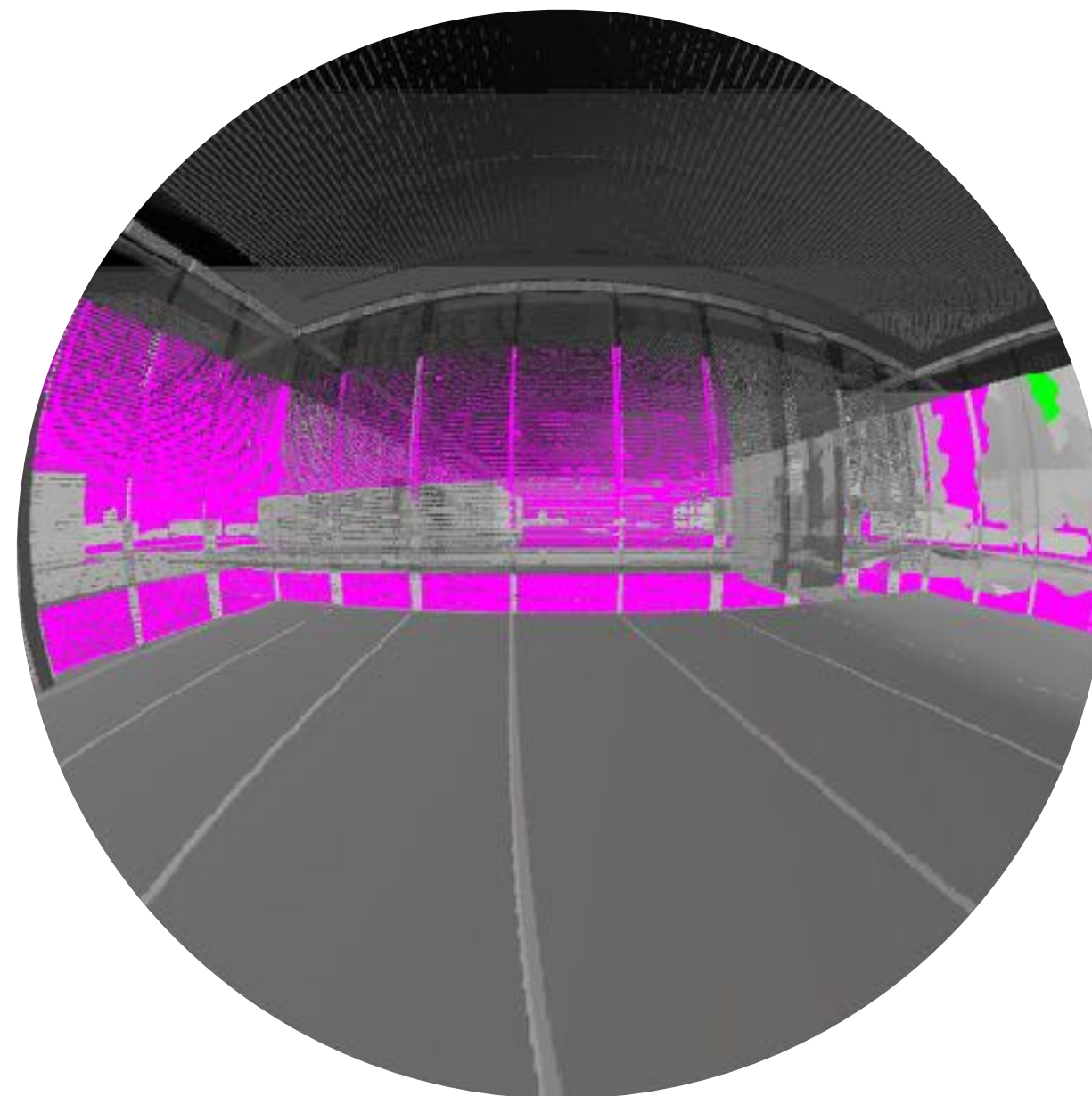
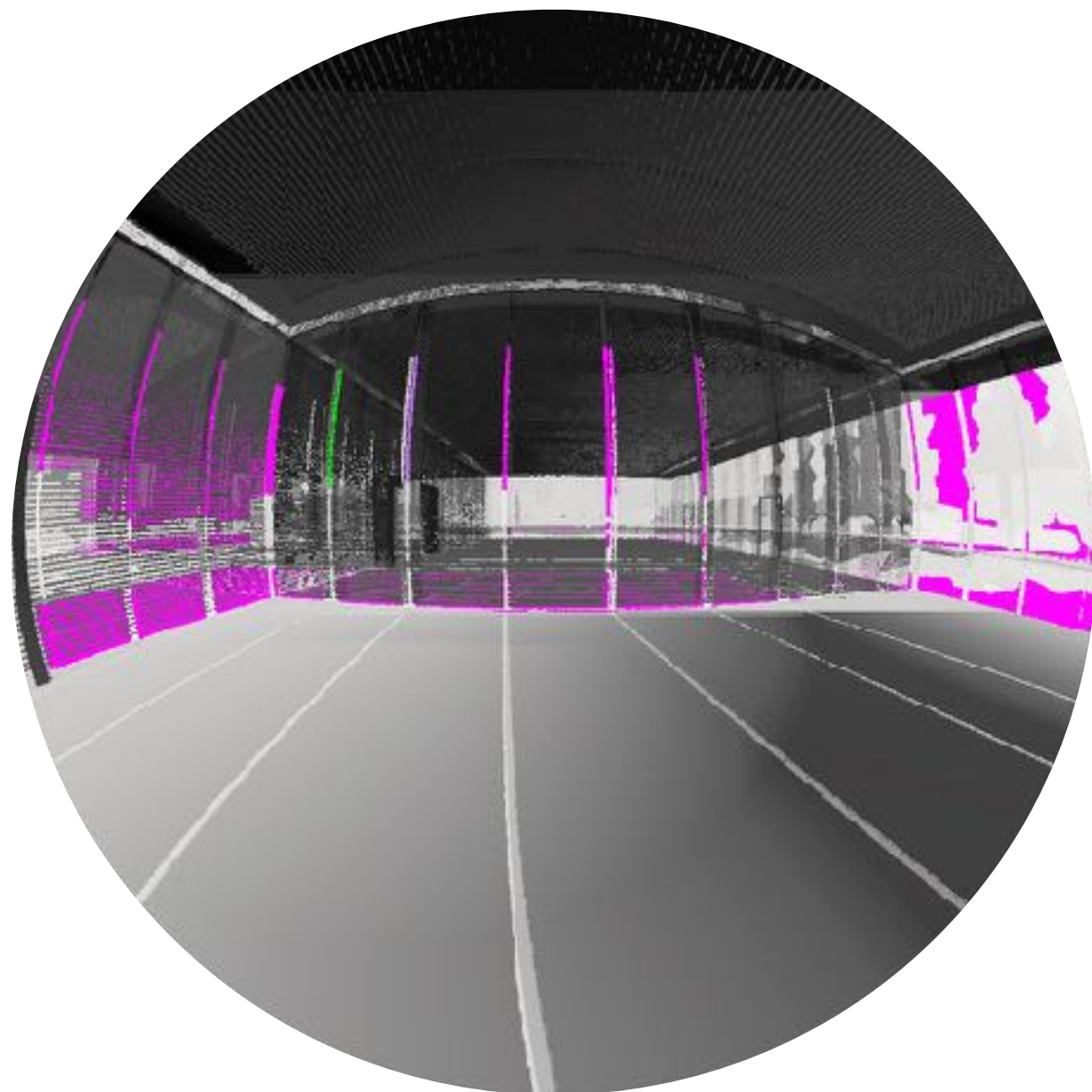
DGP=0.24 (imperceptible)
DGP=0.30 (imperceptible)



DGP=0.29 (imperceptible)
DGP=0.41 (disturbing)

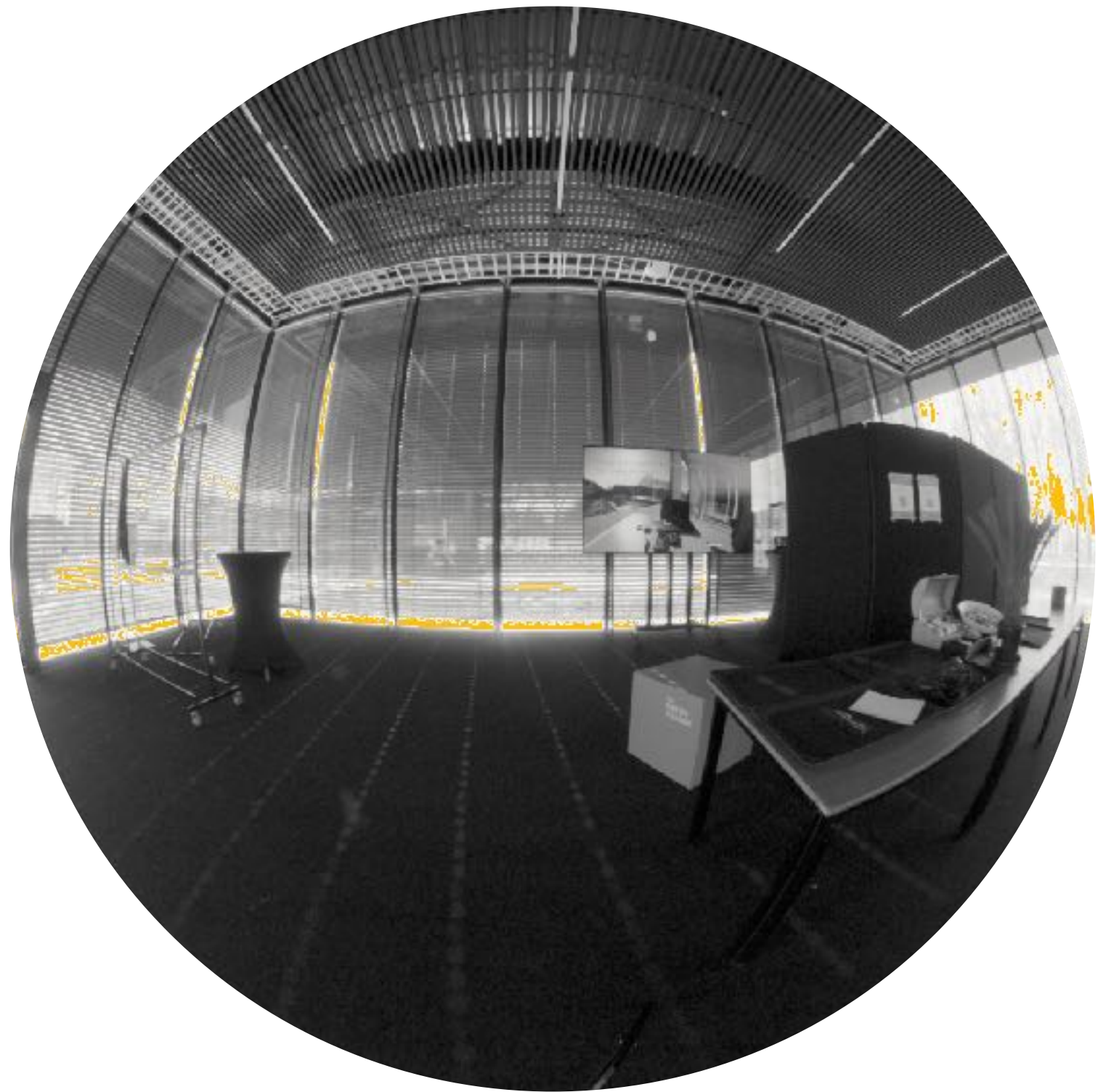


DGP=0.38 (noticeable)
DGP=0.55 (intolerable)



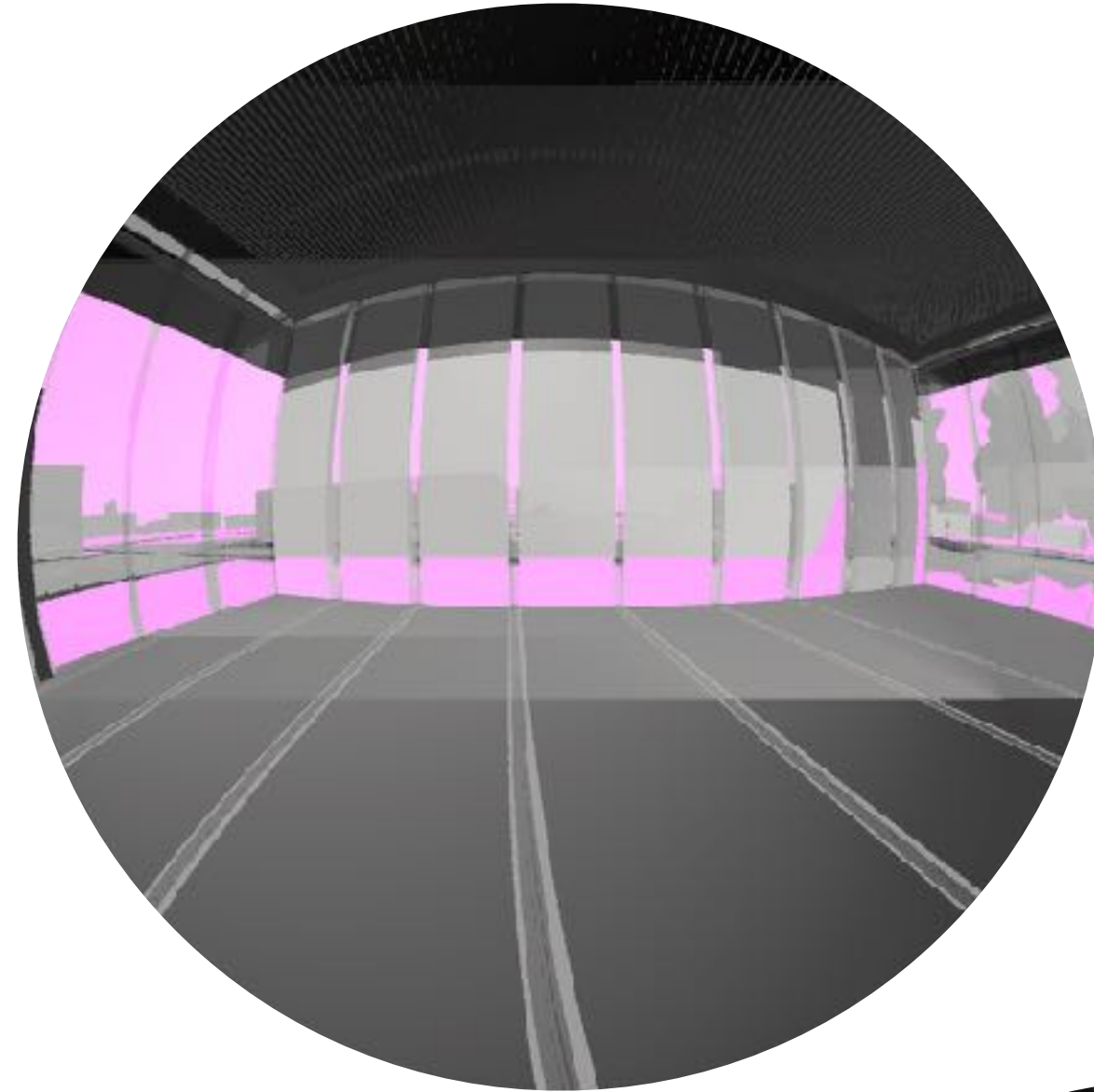
Challenge #2

- Representing complex environments
- Modelling occupants' indoor comfort in an atypical space
- Responding to conflicting demands and systems limitations

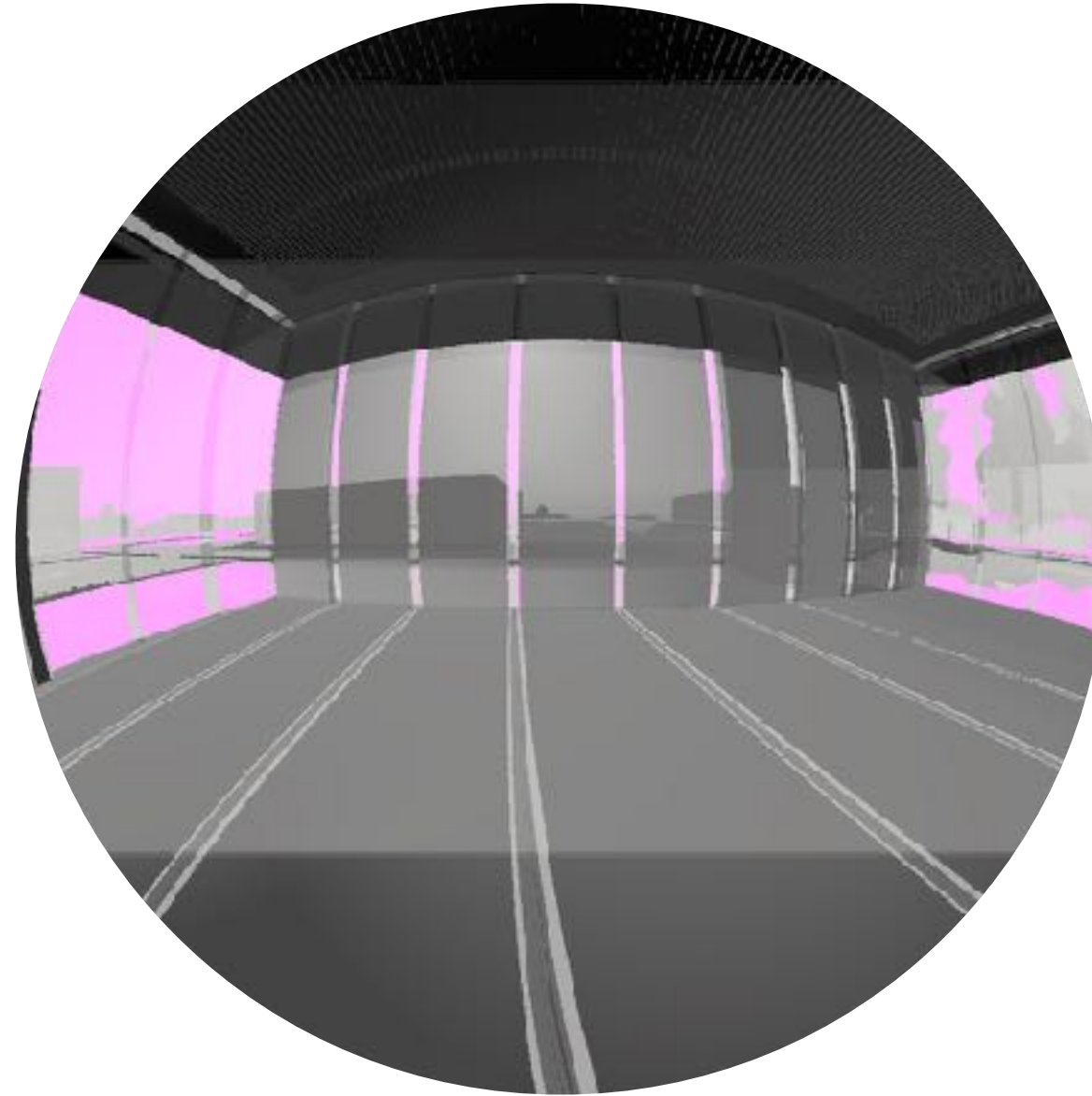


- Strict choice between comfort or energy mode
- Reduced view to the outside
- Specular reflections on the inner glass surface
- Glare in windy conditions
- Higher electric lighting consumption

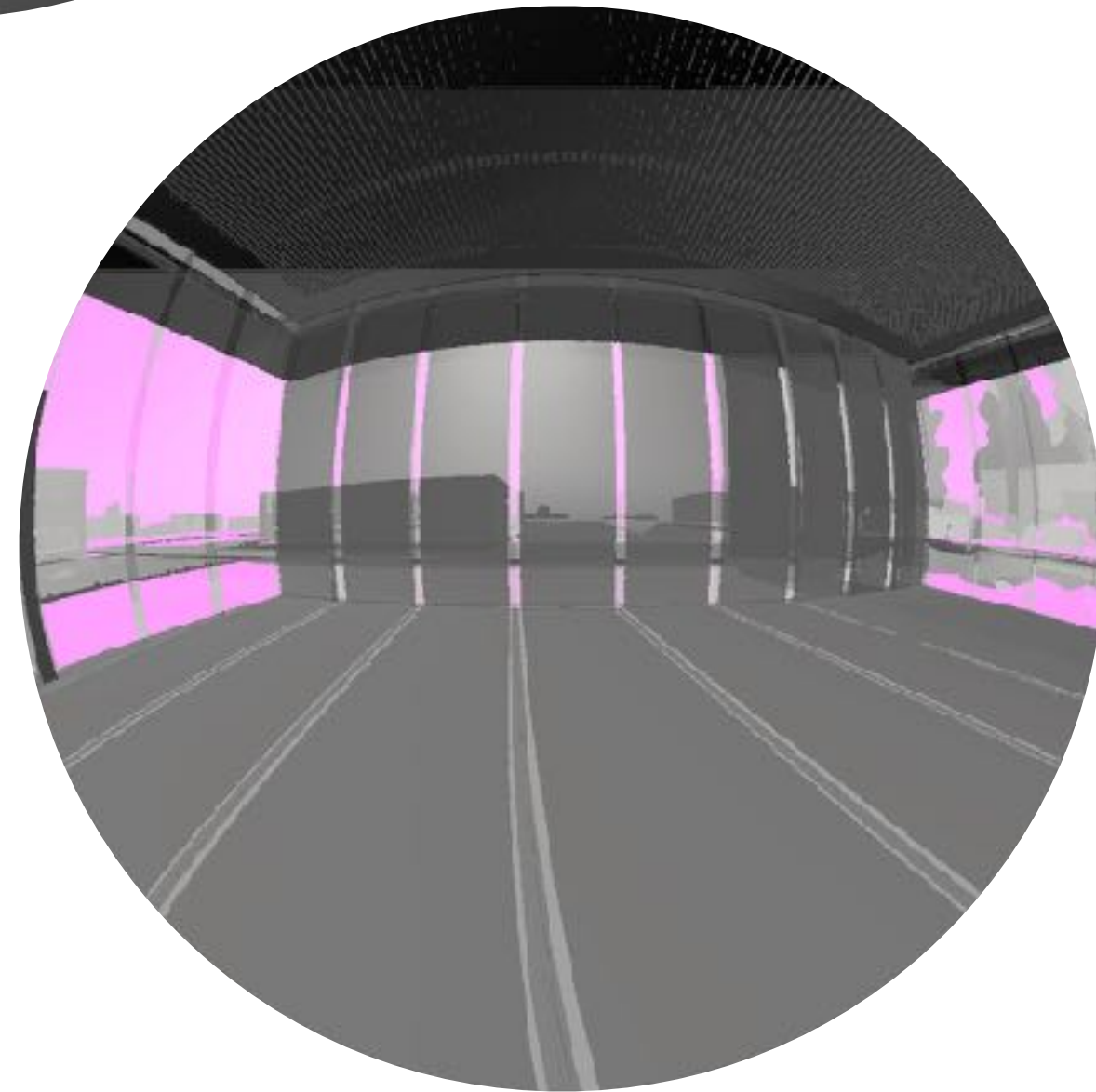
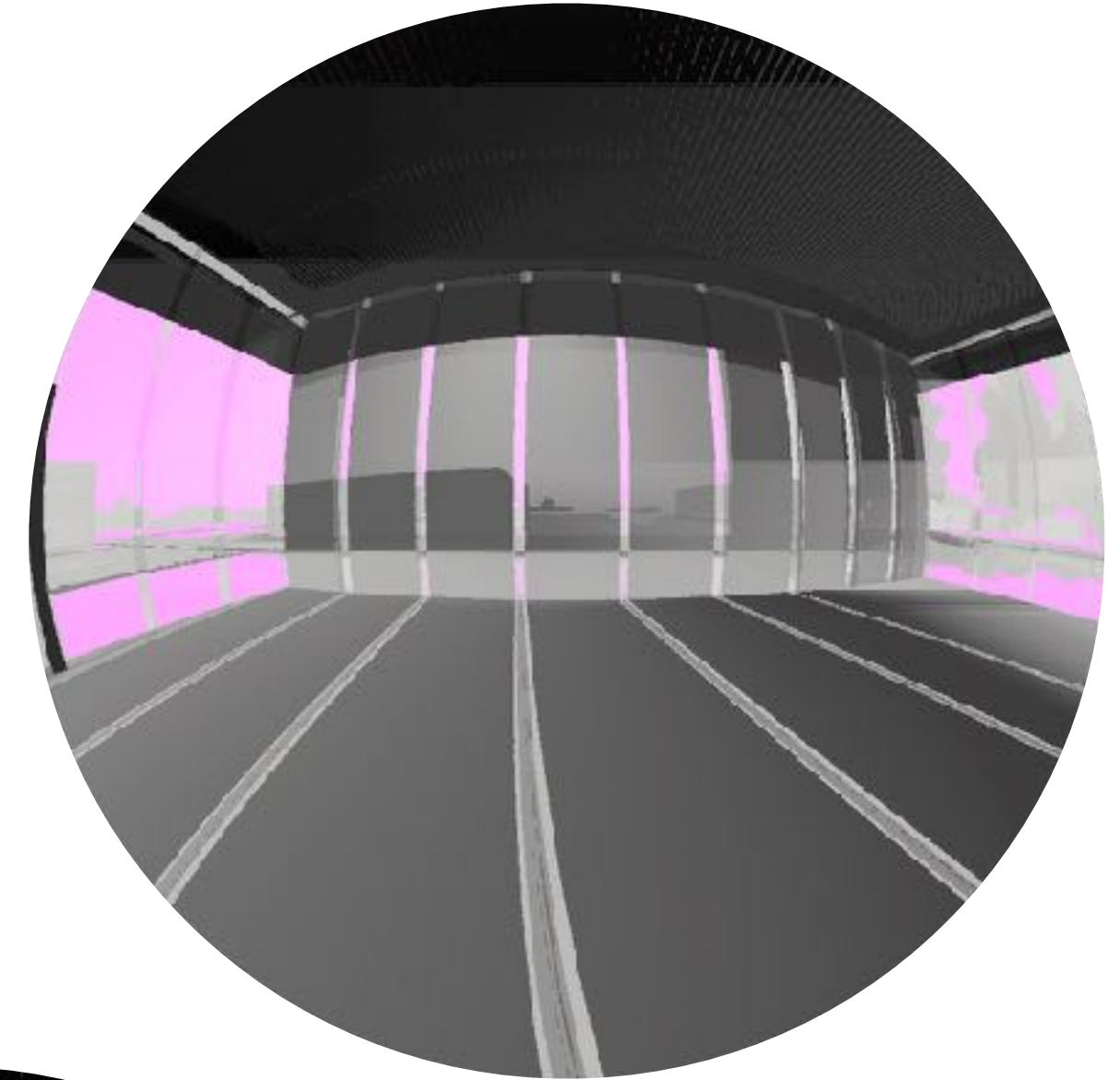
White OF 1%



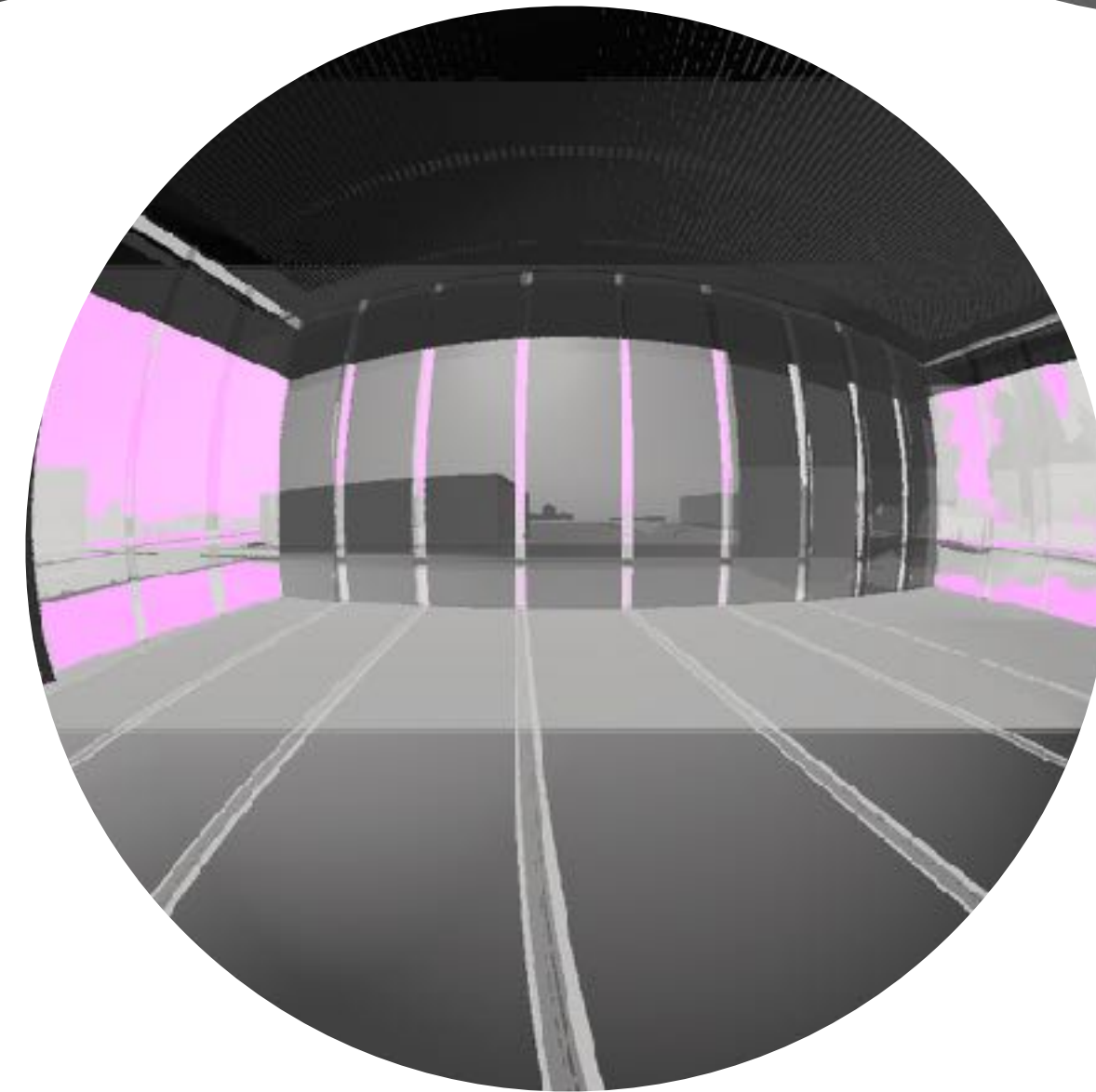
Pearl OF 3%



Pearl OF 1%



Black OF 3%



Black OF 1%

Windows to The Future Project



- Quantify the possible energy savings under Dutch climate conditions
- Investigate user perception and experience upon long-term contact with the product
- Explore the viability of the overall business case for the end users



Converge

Regina Bokel, TU Delft

Peter van den Engel, TU Delft

Eleonora Brembilla, TU Delft

Peter Luscuere, TU Delft

Wouter Beck, Hunter Douglas

Tim Jonathan, The Green Village

Luigi de Araujo Passos, TU Delft

Bert van Dorp, Orange Climate

Rob van Hasenbroek, Priva

Jan Knijnenburg, Priva



Windows to the Future

Martin Tenpierik, TU Delft

Thaleia Konstantinou, TU Delft

Zara Huijbregts, TU Delft

Juan Azcarate Aguerre, TU Delft

Eleonora Brembilla, TU Delft

Marco Ortiz, TU Delft

Philomena Bluyssen, TU Delft

Tillman Klein, TU Delft

Spyros Bousios, Brite Solar Technologies

Wout Hoogendoorn, Si-X

Tim Jonathan, The Green Village



Thank you!

Dr Eleonora Brembilla
e.brembilla@tudelft.nl

Assistant Professor in Building Physics

Faculty of Architecture and the Built
Environment

TU Delft

