Project acronym	B4B
Project full name	Brains for Building's Energy Systems
Grant No	MOOI32004
Project duration	4 year (Starting date May 1, 2021)

Use case Chesswise

Engineering of a new concept room ceiling sensor

Authors	Siebren de Vries
Workpackage(s)	1
Results	2
Due Date	24 April 2025
Deliverable Status	Final

living buildings mymesh powered by simac

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1. Starting point: a new ceiling sensor (1)

- Talking to customers, we recognised the definition of a new room sensor that combines the most wanted functions in one box, but foremost would be invisible (no bulb on the ceiling) and prevent additional sensors or boxes on the walls.
- This wall argument is based on costs. Adding cabling to the walls is not only expensive at the start, but becomes increasingly expensive when walls are moved around in a later stage of the building's life.
- The challenge is the accurate measurement of room temperature from the ceiling. Later on, a second challenge was defined with the accurate measurement of the occupancy in rooms. Occupancy is important for climate control: the amount of fresh air is directly related to the number of people occupying the space. More generally, active climate control is necessary when people are working in a room/space. Less so, when the room/space is empty.
- For the two functions, an InfraRed 64 pixel camera is used. The design of the product and its embedded software was done just before the start of B4B.

1. Starting point: Engineering/validating the new ceiling sensor (2)

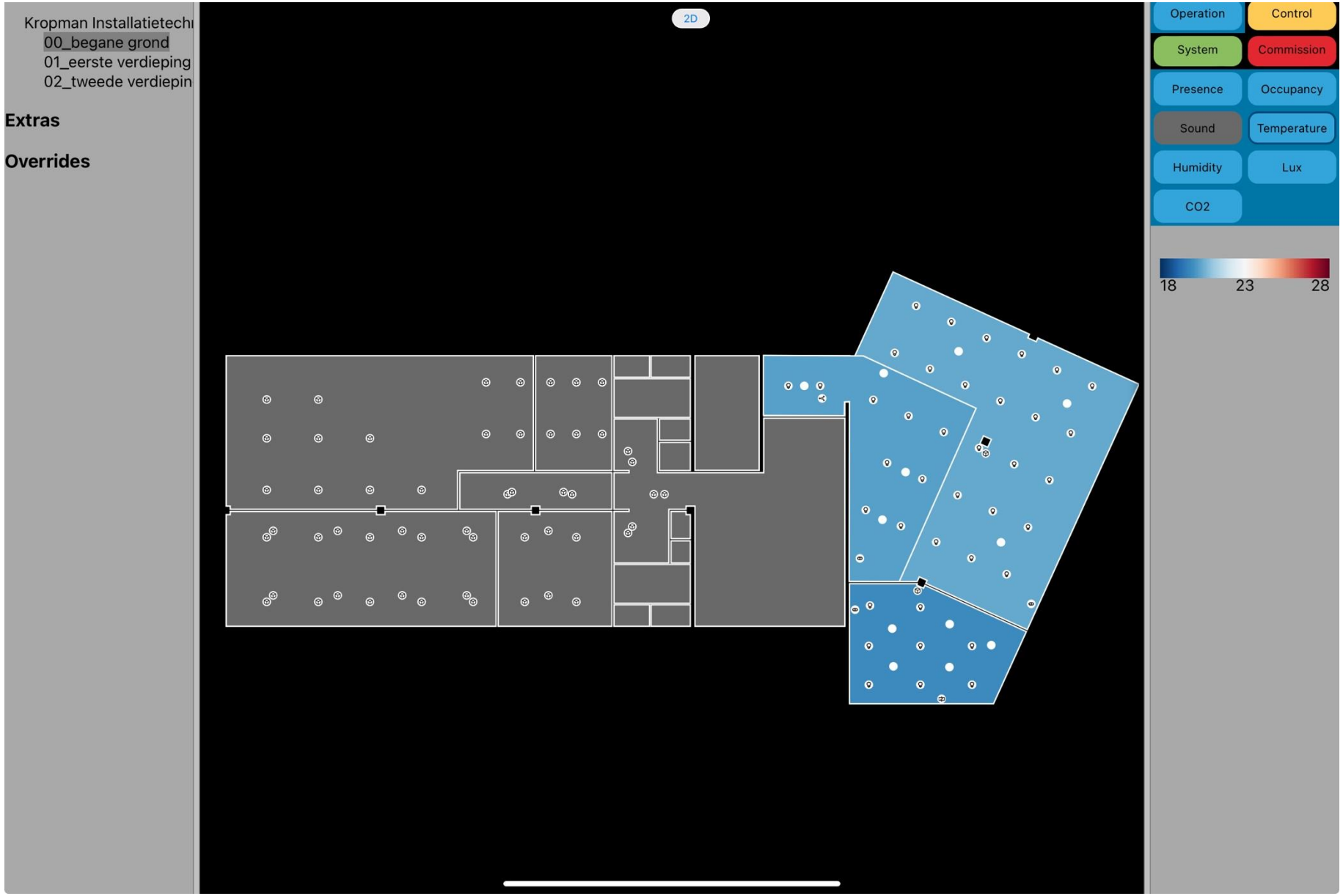
- Engineer and validate a building sensor mounted as part of the room ceiling. The sensor communicates in the Mymesh wireless network, and via a gateway, it makes all measured data available in the cloud for different users. This sensor provides data concerning the presence/absence of people, occupancy (number of people), room temperature, room humidity, lux light level and sound level.
- The sensor was tested for room temperature measurement within the TU/e climate room as part of another project. The sensor is designed as part of the local (lighting/climate) control loop within the distributed wireless network, allowing the real-time actual values and set points to be available in the network and the cloud.
- The outcome showed the necessity of calibrating the IR camera against a black body. Without this calibration, the measurement accurately follows the room temperature but with a fixed offset. After proper sensor calibration, the result is an accurate temperature sensor (within 0.2° of the test system within the measured range) that looks down from the ceiling. The 64 pixel thermopile brings a precise result and is far less influenced by air streams and change of location than classical wall thermostats.
- Combining multiple sensors in a space allows one to average or sum the measured entities. This function of adding/averaging is part of the Mymesh network functionality. The average temperature of 2, 4 or more sensors represents a very accurate room temperature reading.

2. Field testing in the Kropman living lab (1)

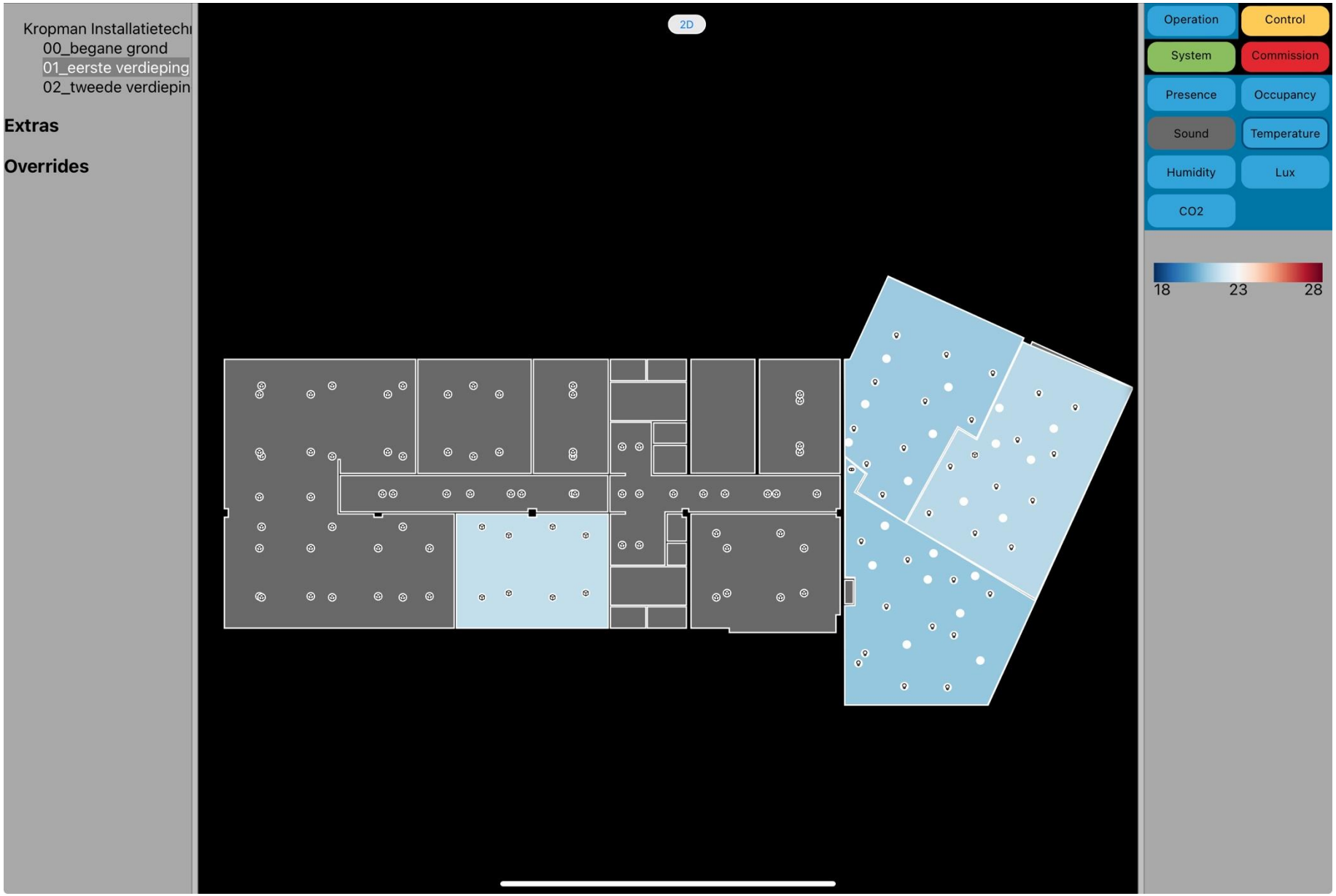
- As part of the B4B project, 32 sensors were installed (+ commissioned) in Kropman's living lab, including making real-time data available via the cloud server to third parties.
- All the sensor data is live and historically available via a REST API call. All measurements are stored in an Influx real-time data series database and are available for use by others. This creates the basis for constant live observation of the living lab and historical analysis.
- Within Mymesh, commissioning controls the averaging or summing of measured values. If two or more sensors are combined in a room, the Mymesh network configures itself to calculate the room values. So, playing with virtual rooms in a larger space allows one to move from observing a single sensor towards a larger group of sensors.
- In the first instance, the sensors were grouped into distinct rooms, whereby the measurement result was presented at the room level. This did not fit nicely with the first conceptual ideas around the AI learning systems. Next experiments were conducted with smaller virtual rooms coupled to individual sensors. This generated too much frustration for the daily users of the spaces and thus was commissioned back to room operation with some separate control zones. These smaller virtual rooms (entities) also bring smaller sections in the lighting control, generating annoying effects depending on people working behind their desks and walking around.

2. Field testing in the Kropman living lab (2)

- Occupancy measurements were not precise enough. The errors were caused by double counting between sensors, not counting when the person was in between sensors (larger distance between sensors), wrong counting of hot objects (like PC's), etc.
- Next, the occupancy results were improved with a new software version. Also, three CO_2 sensors were installed and made part of the available data stream. Sound is installed but not yet activated. Sound-level logging can be commissioned to make it available for future experiments.
- The expected correlation between occupancy and CO_2 can be shown, as well as the seasonal effect on the room temperature (see slides *9 and 10*). This is important because the occupancy signal is available earlier than the CO_2 high level. And thus proper ventilation can be started earlier, preventing higher concentrations of CO_2.
- The next two slides (7 and 8) show the actual temperature over the spaces on the first and second floors. This data is observed in real-time using the Mymesh tool. Of course, all these actual measurements are available in Influx as historical data.



Viewing temperature on the ground floor in 3 separate spaces



Viewing temperature on the first floor in 4 separate spaces

A view on Influx database with historical data stored.
Query over 6 month's or 26 weeks.

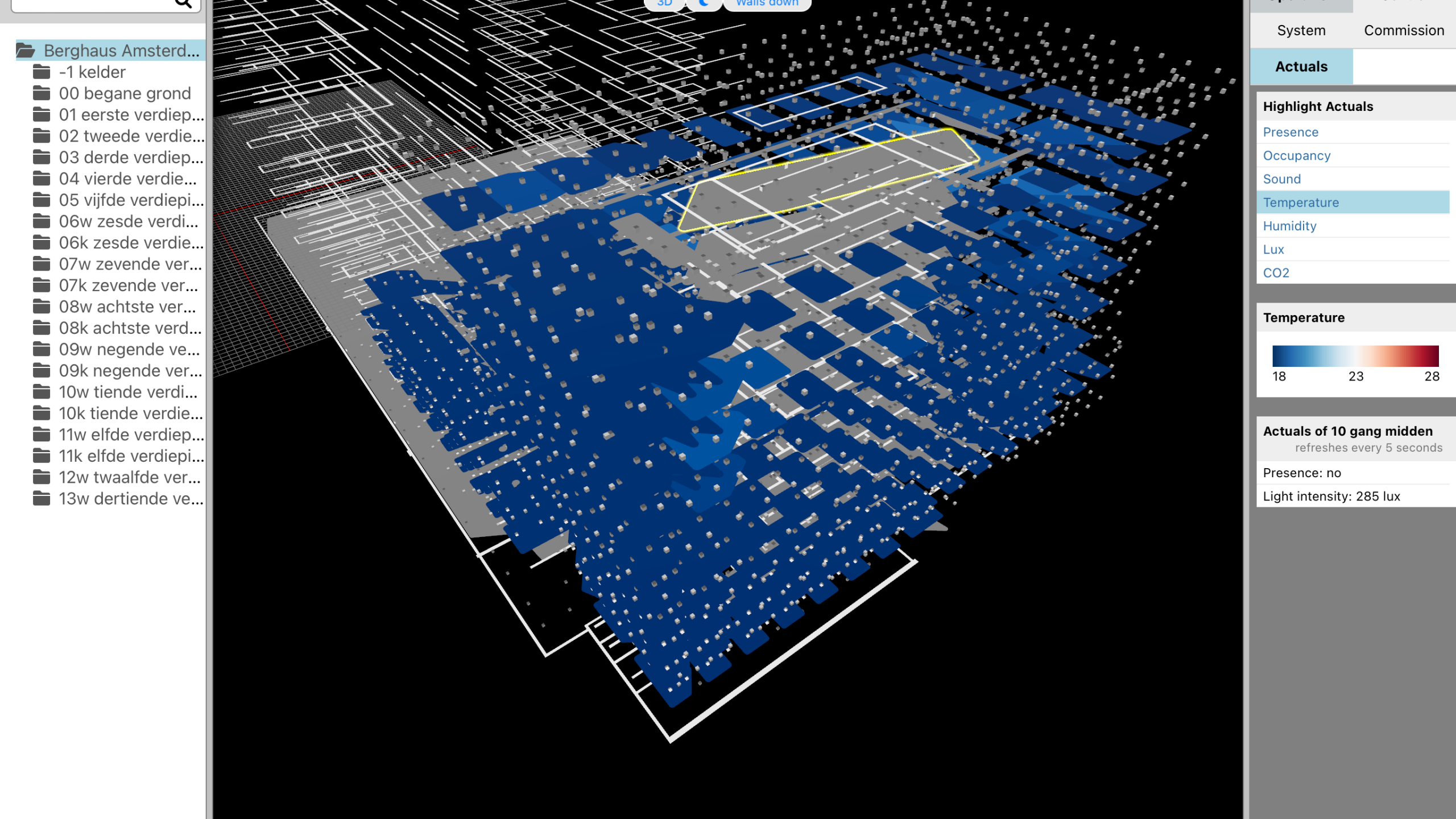
Upper right window is the presence detection used for light control. Clearly see all days of the week and the weeks, because the weekends there is only absence.
Left middle window is the occupancy, which shows the irregularity of the amount of visitors in this space.

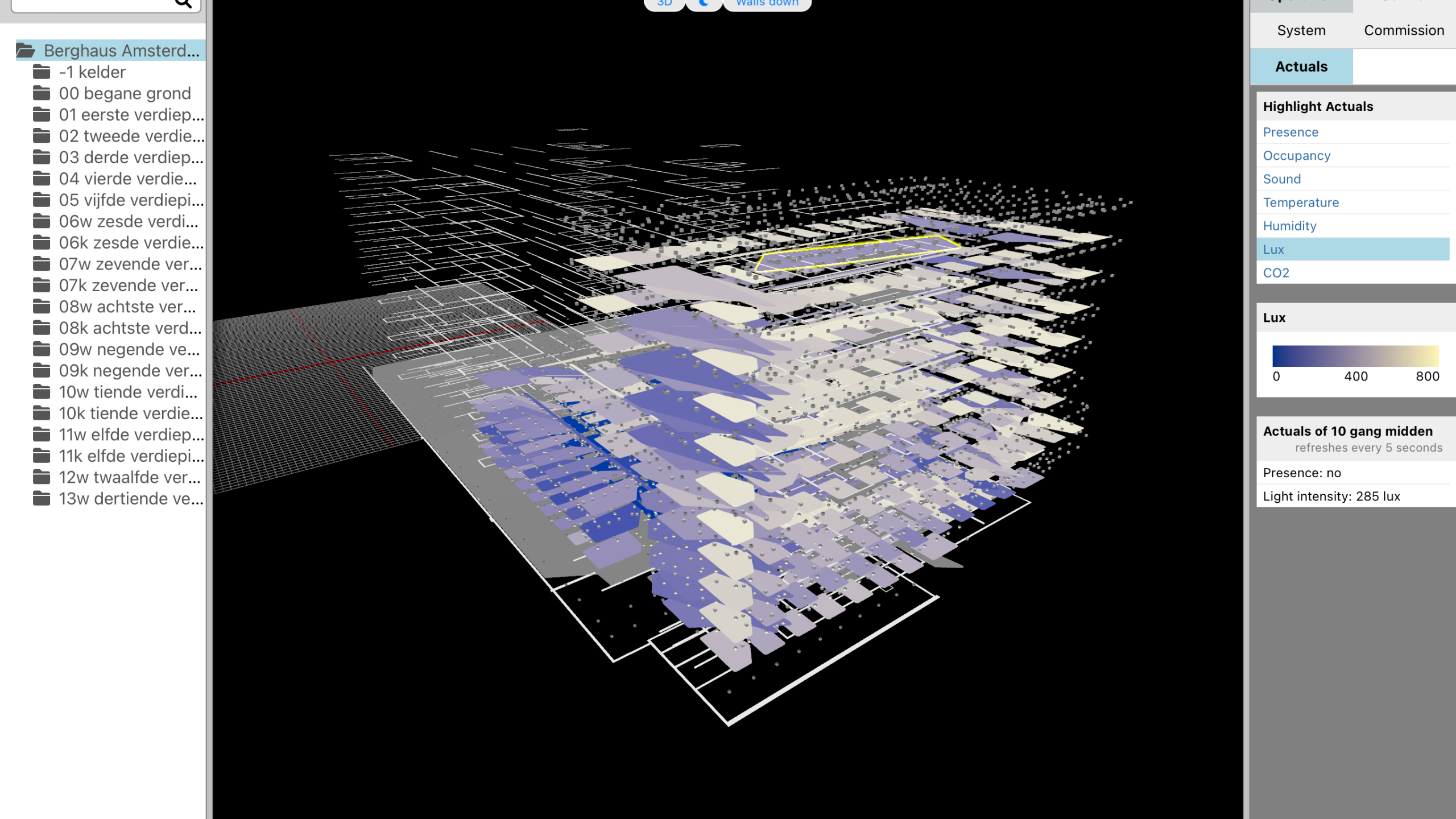
Left under the temperature over the same time window. Clear shift towards summer plus the daily swing.

When looking for the relationship between occupancy and the CO2 measurements, we observe a very clear correlation. It is obvious that the occupancy is detected earlier than the rising CO2 level.

3. Business results

- Discovering the necessity for factory calibration of the temperature measurement. The result is now a very accurate space/room temperature measurement.
- Determined proof for the ventilation based on occupancy instead of CO_2.
- A series of new projects acquired using the above results
- Improved the user interface towards an operational building. Looking at all temperatures in the whole building gives great insight into the installation.
- The next slides show an example of the larger building, completely based on this sensor. We show temperature and light level over a 13 story building in one go. A big help is finding errors in the installation.
- The next slide is a week of historical data from the office in Veldhoven. Gives great insight into the temperature behaviour of the building.
- Outside B4B scope, we added beaconing to the same product and use this for a location-based control App, allowing users to look and change the set-points of their space.
- Also based on the gathered data we no present ESG reporting, even live in the control App.
- The last two slides are two more projects. In this presentation, we used Kropman/Breda, Berghaus Plaza/Amsterdam, Simac TechniekHuijs/Veldhoven, Staalkade/Amsterdam,


Berghaus Amsterd...
-1 kelder
00 begane grond
01 eerste verdiep...
02 tweede verdie...
03 derde verdiep...
04 vierde verdie...
05 vijfde verdiepi...
06w zesde verdi...
06k zesde verdie...
07w zevende ver...
07k zevende ver...
08w achtste ver...
08k achtste verd...
09w negende ve...
09k negende ver...
10w tiende verdi...
10k tiende verdie...
11w elfde verdiep...
11k elfde verdiepi...
12w twaalfde ver...
13w dertiende ve...
3D
Walls down
System
Commission
Actuals
Highlight Actuals
Presence
Occupancy
Sound
Temperature
Humidity
Lux
CO2
Temperature
18
23
28
Actuals of 10 gang midden
refreshes every 5 seconds
Presence: no
Light intensity: 285 lux


Berghaus Amsterd...
-1 kelder
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07w zevende ver...
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08k achtste verd...
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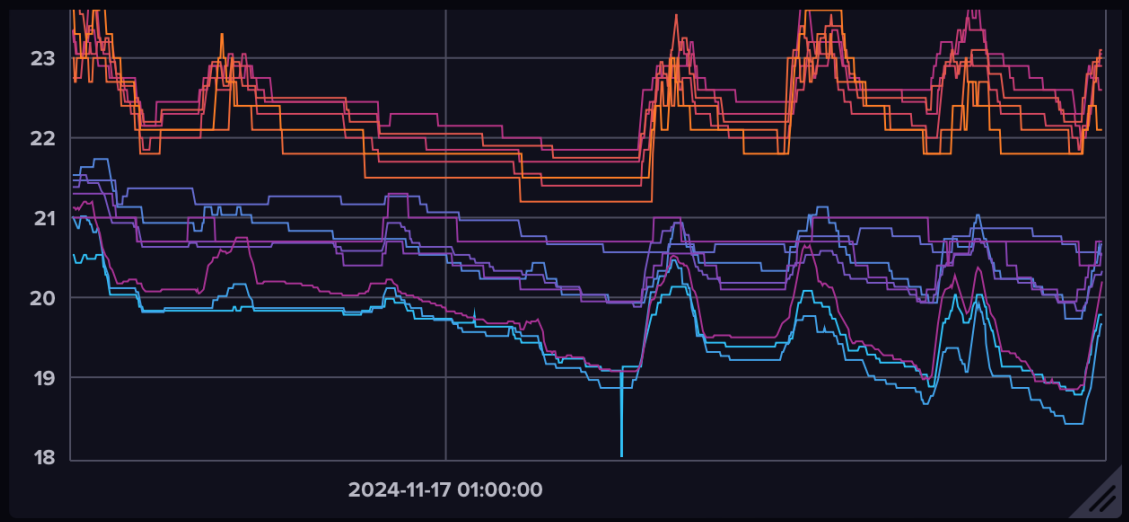
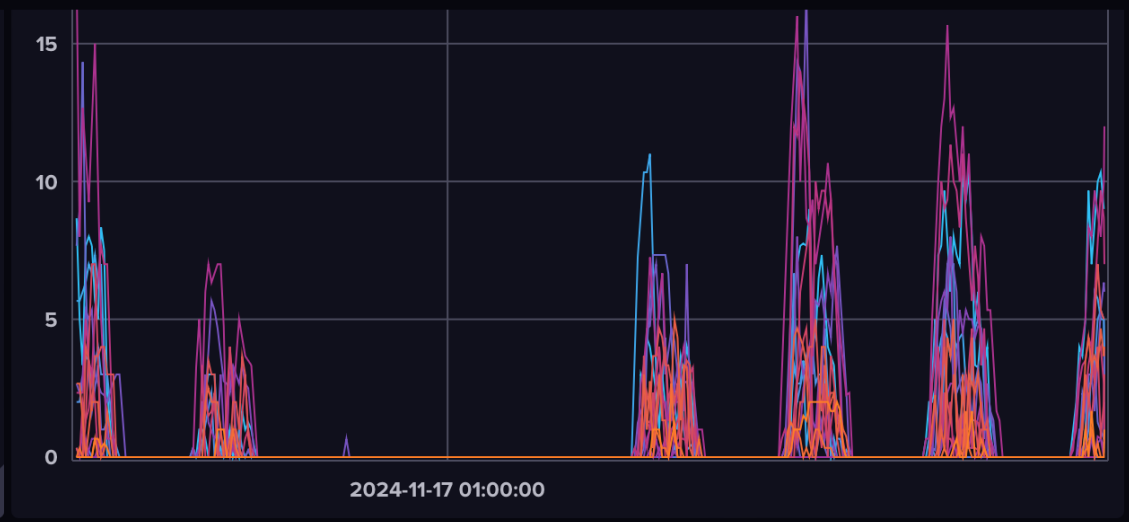
12w twaalfde ver...
13w dertiende ve...
3D
Walls down
System
Commission
Actuals
Highlight Actuals
Presence
Occupancy
Sound
Temperature
Humidity
Lux
CO2
Lux
0
400
800
Actuals of 10 gang midden
refreshes every 5 seconds
Presence: no
Light intensity: 285 lux

HVAC Panel TechniekHuys

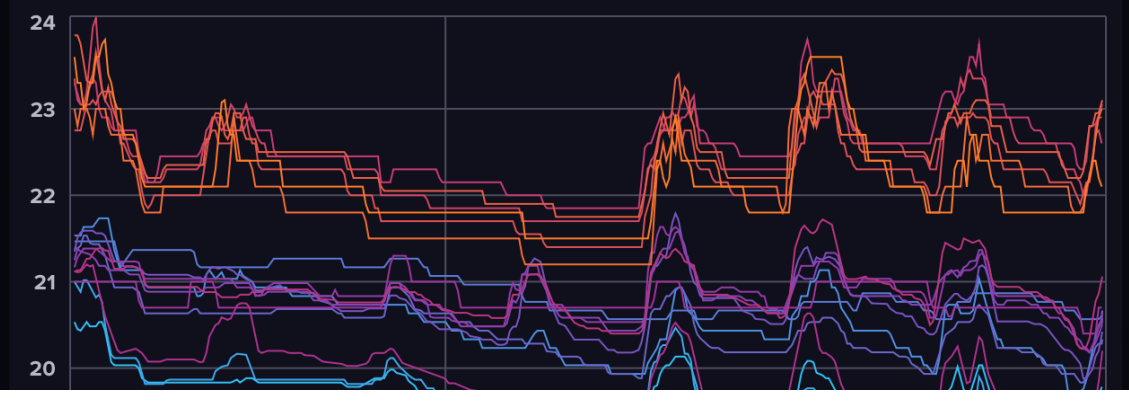
ADD CELL | ADD NOTE | Show Variables | Enable Annotations | ··· | SET AUTO REFRESH | Local | Past 7d

EntityId_e8005 1 | Floor_e8005 3

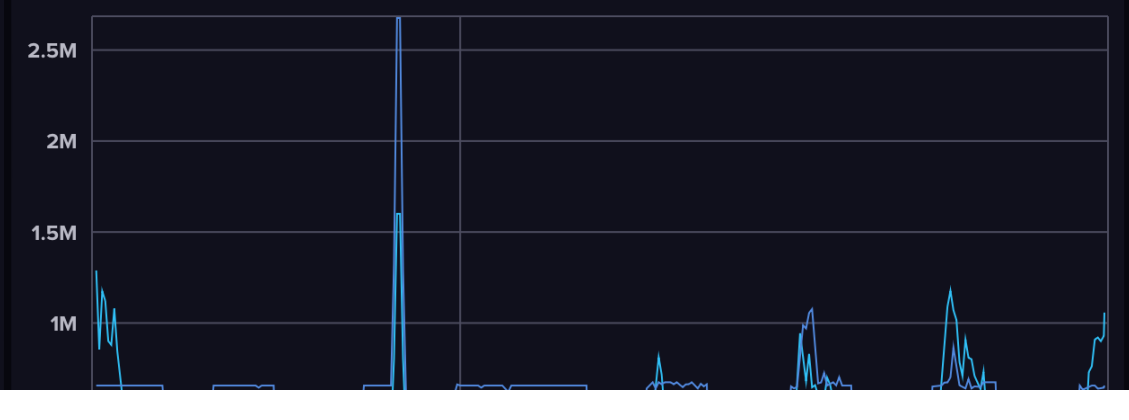


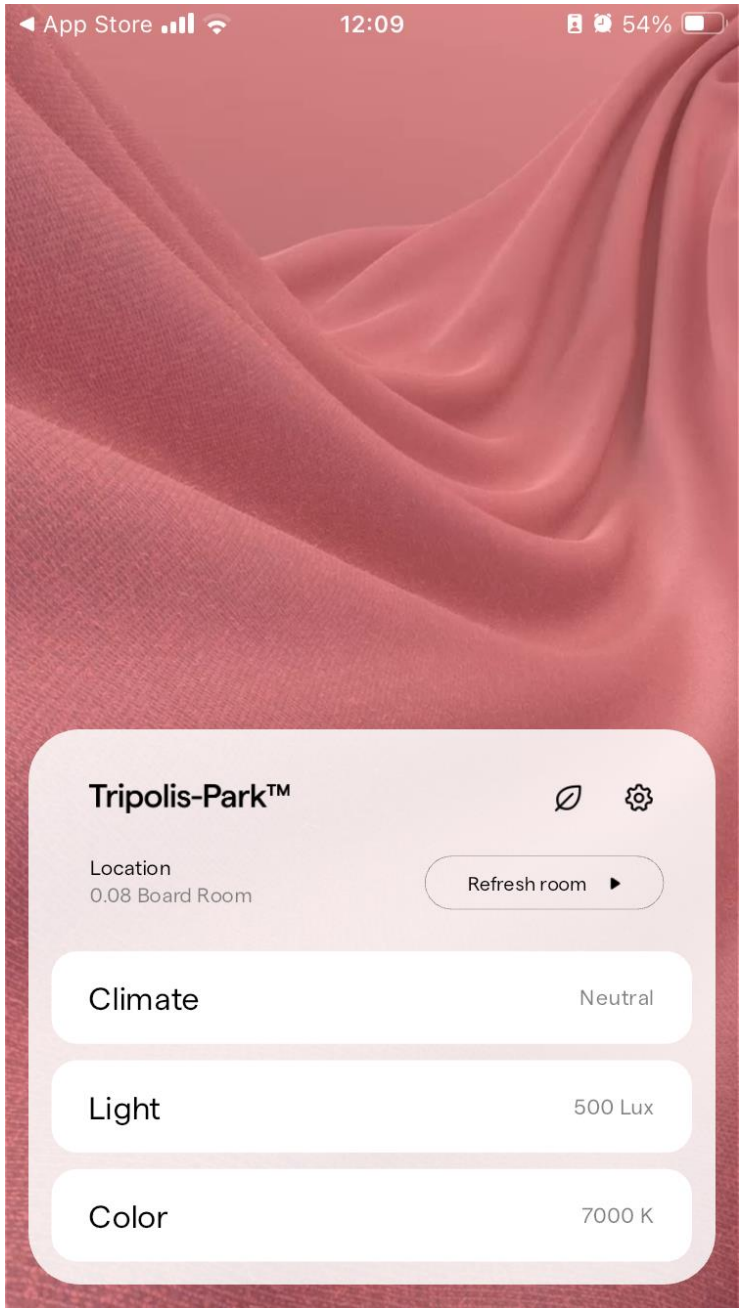


Temperature by floor — window period: 10000ms



Airflow by floor — window period: 10000ms




App Store
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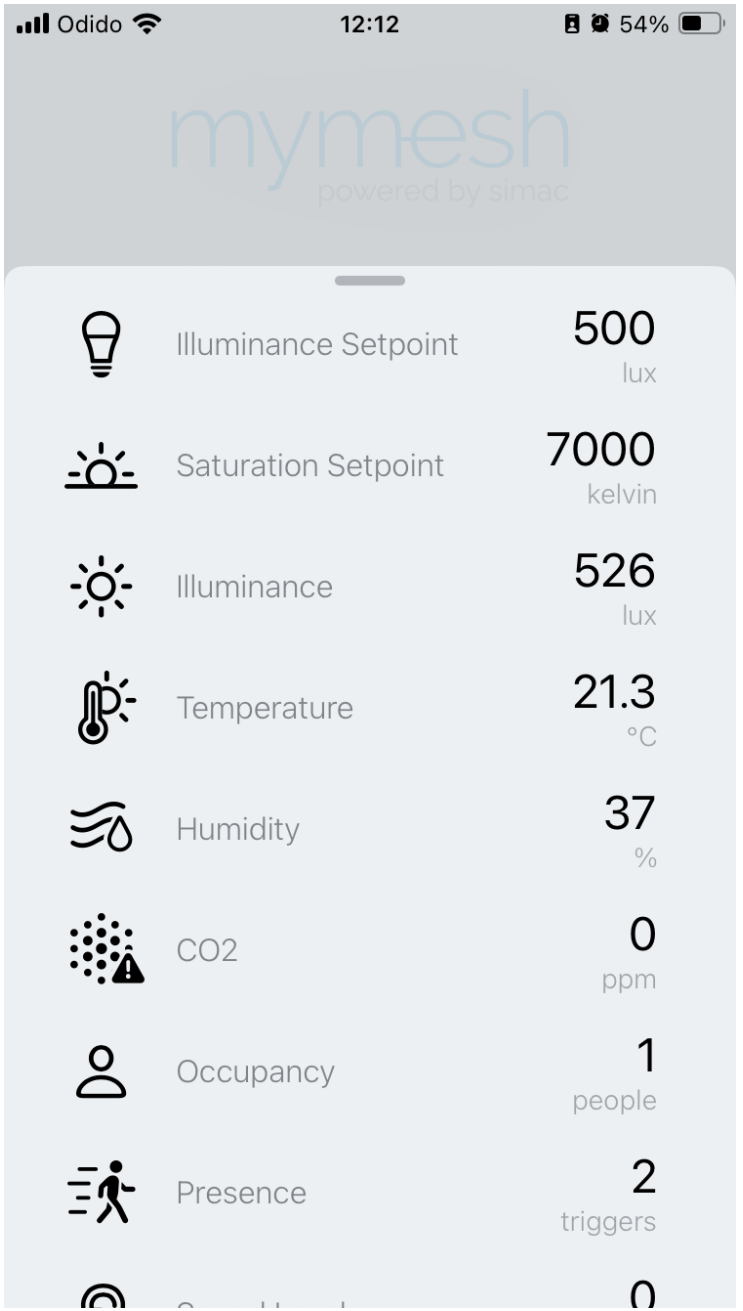
54%
Tripolis-Park™
Location
0.08 Board Room
Refresh room
Climate
Neutral
Light
500 Lux
Color
7000 K


Odido
12:12
54%
mymesh
powered by simac
Illuminance Setpoint
500
lux
Saturation Setpoint
7000
kelvin
Illuminance
526
lux
Temperature
21.3
°C
Humidity
37
%
CO2
0
ppm
Occupancy
1
people
Presence
2
triggers

Capacity	Occupancy	Occupancy rate
4.200	1.297	31%

Energy consumption