Getting Climate Control Under Control Program: Case Study

Ny Carlsberg Glyptotek

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Resume

The report concerns the Glyptotek's participation in the project "Getting Climate Control Under Control" and describes the journey from getting started to a mix of preliminary conclusions, lessons learned and wishes for the future.

Introduction

The Ny Carlsberg Glyptotek commonly known as Glyptoteket, is an art museum in central Copenhagen, Denmark and founded by the brewer Carl Jacobsen (1842–1914), the son of the founder of the Carlsberg Breweries.

Glyptoteket's collection contains over 10,000 works of art and archaeological objects, primarily from Ancient Egypt, the worlds of Ancient Greece and Rome, Etruscan Culture, as well as Danish and French art of the 19th century. Works of art and objects are in traditional materials, such as oil on canvas and wood, works on paper, sculpture in stone, metal, terracotta and plaster. Archaeological objects are in wood, painted wood, clay, terracotta, stone, bronze, textiles, glass, and comes also as human remains.

The Building and its Climate

The Glyptotek is a complex of three buildings: the Dahlerup building from 1897, the Kampmann building from 1906, and the Henning Larsen building from 1996. In short, building materials are bricks, mortar, steel and glass. The Glyptotek was originally intended to be a daylight museum, only open during daylight hours. Artificial lighting was later added, but daylight still plays a key role in the architecture of the museum. Daylight reaches almost all galleries except in the Larsen building, which is an envelope building in the courtyard of the Kampmann building.

In general, the Dahlerup and Kampmann buildings are without systems for climate control but have local systems with heating by pipes or cooling by fans and either local humidifiers or dehumidifiers. The Larsen building is the only exhibition area with a CTS-controlled HVAC system, dating from 1996 and is set to maintain a temperature between 19-21 degrees and a RH of 50% plus minus 5%. For long periods of the year the system cannot cope with the task. Summer and Autumn, the relative humidity is between 60 and 70% and in Winter and Spring it drops to between 30 and 40%. There are frequent fluctuations, sometimes of more than 10% within 24 hours. This system is therefore outdated. When this program started the plans were to replace it with a new system in Spring 2024, but plans changed and only components of the system have been changed.

Since 2020 the galleries 26 and 31, both in the Dahlerup building, have been reused for the exhibition of the permanent French painting collection like they were before the build of the

Larsen building. This step back is caused by the lack of exhibition areas for temporary exhibitions. Artworks in these galleries are threatened by daylight from skylights, which also results in great heat impact from solar energy, as well as high UV and lux values. The galleries are thus equipped with blackout curtains, UV filters, the temperature controlled by heating by pipes and cooling by fans, and the humidity controlled with humidifiers and dehumidifiers: humidifiers in Winter and Spring, and dehumidifiers in Summer and Autumn. Measurements show relative humidity between 38-64 % and temperature between 18-24 degrees.

Why participate in "Getting Climate Control Under Control"?

First, sustainability and green transition are part of the Glyptotek's strategic focus. We continuously seek developing strategies and plans to ensure that green transition becomes an integrated part of the Glyptotek's daily operations and existence as a museum.

The Glyptotek is facing a large indoor climate and renovation project, named" the Future Glyptotek" (FG) aiming at ensuring an optimal balance between energy efficiency, audience experience and preservation of works of art. The start of the project is currently set for 2027. Joining the program has been relevant for the process of planning and design, for the strategies to be implemented in the FG project but also in general for the technical department and the conservator, bringing new and crucial knowledge about climate control and sustainable solutions.

Selection of Team members.

The project team consisted of members from the museum and advisors from FG project.

Christina Collet Hvolgaard, Registrar for outgoing loans

Karl Adrian, Technical department, Operation Manager

Rebecca Hast, Conservator

Henrik Ryberg, FG advisor

Brian Hurup-Felby, FG advisor

Christian Dahl Melchiorsen, Head of Building and Security, owner of the project at NCG

Getting started – challenges and solutions.

First, we focused on what could be done immediately, namely the wording of the loan agreements, requirements regarding climate, transport and couriers.

Next, challenges occurred when looking at the museum's energy consumption and the monitoring of art works. Initially we wished to focus on the upper galleries in the Dahlerup building and the

Larsen building assuming the HVAC system and the local climate control systems, ventilation and humidifiers/dehumidifiers must be heavy in the use of energy. The challenge was how to measure the actual energy consumption and use of electricity for different locations of the building. It is simply not possible to split up the electricity bill and investigate separate locations.

Also, how to make a meaningful selection of art works to test when the current climate conditions for relative humidity are between 30-70% with fluctuations (and most likely have been for the last 125 years).

An on-site visit by coach and energy advisor Jakob Nørby resulted in the following work strategi for the participation in the program:

- Focusing on learning and the process part of the program rather than actual technical adjustments.

- Regarding the Dahlerup building: Due to the upcoming indoor climate renovation, the technical adjustment of setpoints in the building will not be relevant. However, there will continue to be a focus on gaining knowledge and learning about the condition and registration of objects with a view to bringing it into the upcoming indoor climate renovation. A comprehensive indoor climate measurement program has already been established in connection with the upcoming indoor climate renovation of the building

- Regarding the Larsen building: The ventilation systems are expected to be replaced within a shorter time frame (tenders have been obtained). The building is expected to be used as a storage facility for works under renovation of the Dahlerup building. Inputs to the action plan: IoT sensors are set up in relevant places in the building to look at the possibilities of adjusting some technical parameters, and thereby gain some insights that can be taken further into the project for replacing the ventilation systems.

Action concerning the loan activity:

In 2023 we revised our loan agreement (for outgoing loans) to follow the Bizot recommendations for humidity and environment in the exhibition galleries. The relevant paragraph for climate sensitive loans has the following wording:

Environmental conditions

Control of relative humidity and temperature is required in the exhibition gallery, storage and packing areas, where loans from the Ny Carlsberg Glyptotek are located. Fluctuations must be minimized.

a. *Temperature levels must be maintained at a range of 59-77 Fahrenheit/15-25 Celsius*

b. *Humidity levels must be maintained at a setpoint in the range of 45 – 55% RH with an allowable drift of +/- 5% yielding a total annual range of 40% minimum – 60% maximum. Fluctuations must be minimized.*

Crated artworks must be acclimatized in a stipulated environment for 24 hours before opening.

It has always been very common with questions and request regarding environmental and other loan conditions for the specific art works. Both for incoming and outgoing loans. We always seek to be reasonable and try to find a suitable solution – but always with priority for the condition of the art works. We have not experienced any change in questions and request regarding loan agreements.

For requirements regarding transport of the art works, we try to be more open to share and combine transport with loans from/to other museums. We see that the transport agent has more focus on combined transports – we get many of requests to accept other crates onboard. And our impression is that most museums are more willing to consider accepting shared transports.

These small changes have however no significant impact on our loan administration.

Our registrar has participated in Artichecks Virtual Courier Tool workshop. At present, the Glyptotek uses virtual couriers as an alternative for the physical presence of couriers when possible.

Also, we tend to be more critical in relation to the necessity of sending courier or not – and possibly assess with arrival and installation, whether it can be dispensed with courier for the de-installation. Or possibly sharing courier with fellow institutions in DK.

Action concerning climate control:

We received 15 IoT sensors in October 2023 (2 full, 5 medium and 8 mini), which were set up at relevant places in the Larsen building. Sensors were also set up in the Dahlerup and Kampmann building and the datalogging started October 10, 2023. In the beginning, we had challenges with incorrect measurements and getting connection between IoT sensors and main receiver. Our choices of location of IoT sensors are mainly guided by exhibition and storage of climate-sensitive works such as painting and paper, but also to get an overview of the climate in some of the sculpture galleries. The Iot-sensors are sending data to the technical department, the conservator, and the exhibition coordinator.

Inspired by Caitlyn, SMK and Skagens Museum we wanted to test series of controlled shut down of the HVAC in the Larsen building. Extra IoT sensors were purchased, which were placed at selected locations in the Larsen building, i.e. in an exhibition, in a storage room and one in the area outside the Larsen building, called Trappegaden, a buffer zone for the climate in the Larsen building.

The first attempt at controlled lockdown was carried out on a Monday in April from 9 am to 2.45 pm. The measurements clearly showed where and when the cleaning is working in the area due to

floor washing. The first test gave an indication of the system's moisture sensitivity, while the temperature appeared more stable.

It was then decided to carry out 3 sets of controlled lockdowns on 3 consecutive days but at night: 25.4. at 02-07; d. 26.4., 00-07; 27.04., 00-09. See appendix for selected locations, measurements with and without shutdown. The temperature generally showed small fluctuations, whereas larger fluctuations occurred for the humidity, but again with a large difference from floor to floor, and from floor to floor. The fluctuations in humidity were a bit surprising and indicate some technical issues with air change. One possible explanation is that the shut-off devices for fresh air intake remain open during shutdown. This will need to be investigated further.

It must be questioned or assumed that there will be greater energy consumption when the system is restarted. Here, it would have been a huge gain for the project and in general to be able to read the energy consumption separately for the Larsen building. For the time being we are not able to conclude whether kW hours are saved during a controlled shutdown or not.

About the “Mock-up” in the Dahlerup building

In matter of getting the right machinery for improved climate control in the Future Glyptotek it was decided to establish a mock-up in one of the most challenged galleries of the museum, when it comes to climate, in the Dahlerup building.

Henrik Ryberg, FG advisor, writes October 2024: “The project-team behind the Future Glyptotek will be testing a Mock-up for improved climate control in Room 31/32 as part of a large project to upgrade the Glyptotek. The testing program has been discussed with Jakob Nørby and sparring input was given back to the technical consultants from Artelia.

Input regarding stress testing, potential use of AI-driven control technologies, and a suggestion to test a risk-based approach to climate control for objects and guests were among the inspirations given. Also, a reference was made to the HERIe2, that Joel was involved in developing Permanence calculations, TWPIs, and conservation physics – Ki Port (kifutures.org).

Although the Future Glyptotek has not been the main scope for the climate control sessions, it has been good to get an independent peer review of the testing program and to discuss the overall approach for control strategies, discussion of shut-downs, pressure distribution inside/outside, seasonal variations for the controls, humidification and dehumidification, start-up-procedures etc. “

It has taken some time to get all the parts for the mock-up but now it’s up and running. Results so far have not been shared, at least not to the conservator.

Latest changes

HVAC components for humidifying and dehumidifying in the Larsen building have been replaced November 2024. The set points have been changed to 50% + - 10% relative humidity; 21 + - 2 degrees Celsius in temperature.

We plan to do a second round of controlled shutdown in January 2025 in the Larsen building. This part of the museum is as earlier mentioned an envelope building with a buffer zone. We should be able to obtain a controlled shutdown while keeping a stable climate without any fluctuation. But again, it depends on the solving of the problem with the fresh air in-take.

Future project on the wish list

In relation to the preservation of our works of art, climate zones and limit values in relation to the large climate project (FG) and what realistic requirements the museum will make in relation to

climate control, we have received the opportunity for expert help from Jesper Stub from the Viking Museum and Cecil Krarup Andersen from the Department of Conservation. The idea is to examine a selection of approx. 10 French paintings with a special focus on mapping their history, e.g. treatment, loans, and storage. We met for the first time on 28.11.2023 to concrete the project, the scope, and time consumption.

The project will be focusing on monitoring and documenting the condition of selected works of French paintings to qualify and document damage to the works and the cause (climate, handling, vibrations, light, biological, chemical, etc.) in relation to damage to the works in a historical perspective. Potentially this could contribute to new research in the field for the benefit of painting collections at partner museums.

Additional to contributing to a long-term and sustainable conservation strategy and collection care for the French painting collection it could be qualifying the climate strategy of the “Future Glyptotek. Unfortunately, a decision on and the start of this project is still pending.

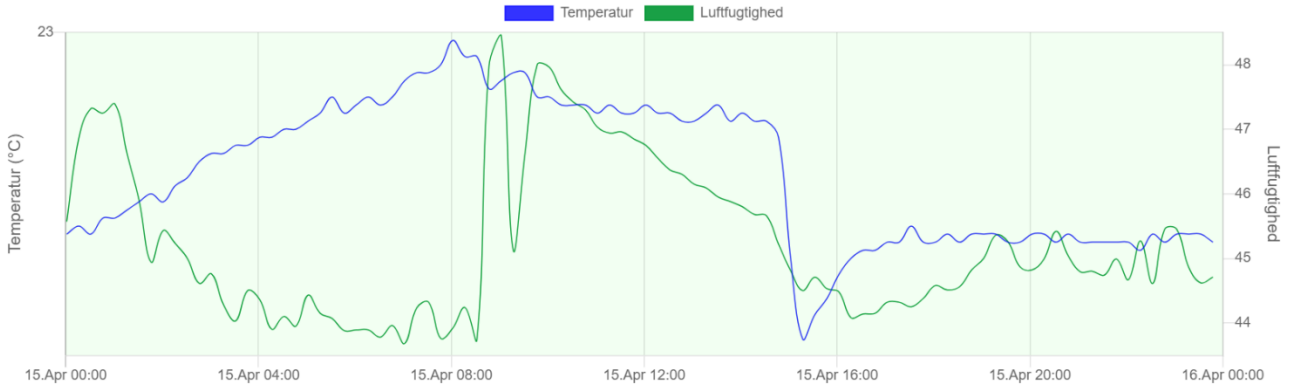
Conclusion, lessons learned, wishes

- The project has been inspiring and has challenged the existing learning and assumptions about climate
- New professional contacts for future transition work to a green museum are of high value
- The importance of getting to know your building, to work with your building and save energy at the same time
- Importance and need for stronger cross-disciplinary cooperation and communication throughout the institution
- The need for a staff member dedicated to sustainability and energy efficiency
- The wish and need for a project focusing on long-term and sustainable conservation strategy for paintings
- It is important to include the international sparring that has taken place in the upcoming FG project

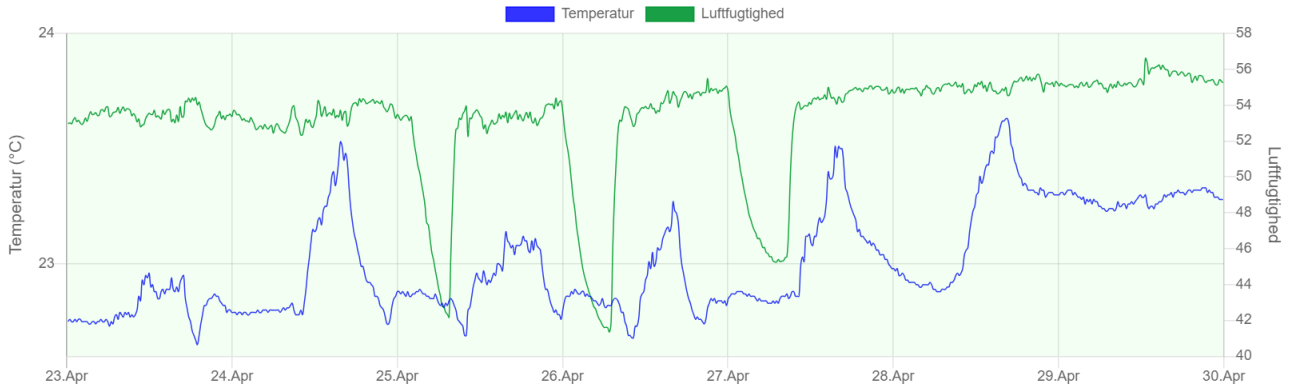
APPENDIX

Unit 1, Gallery 56, ground floor:

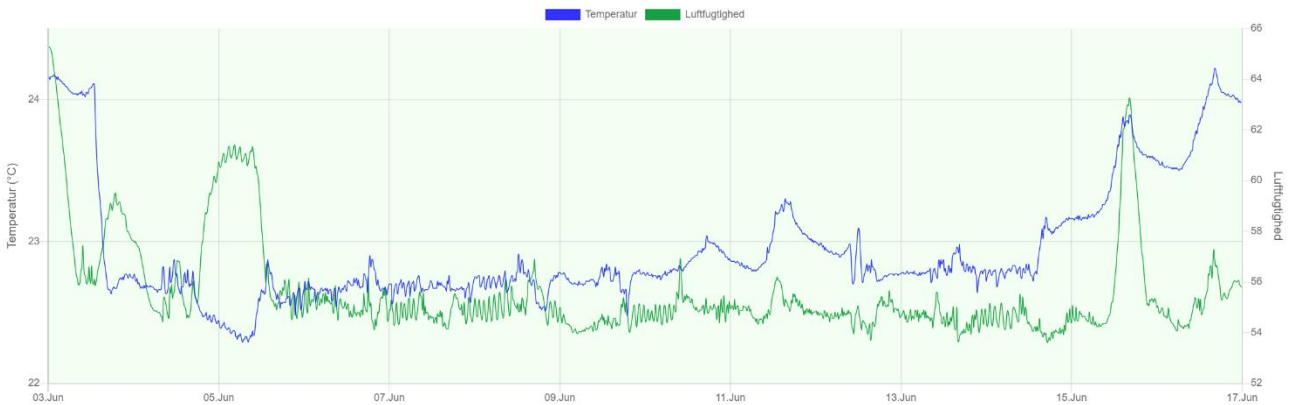
Shutdown, 15th April 2024, 9-14.45 o'clock



Shutdown, 25-27April 2024:

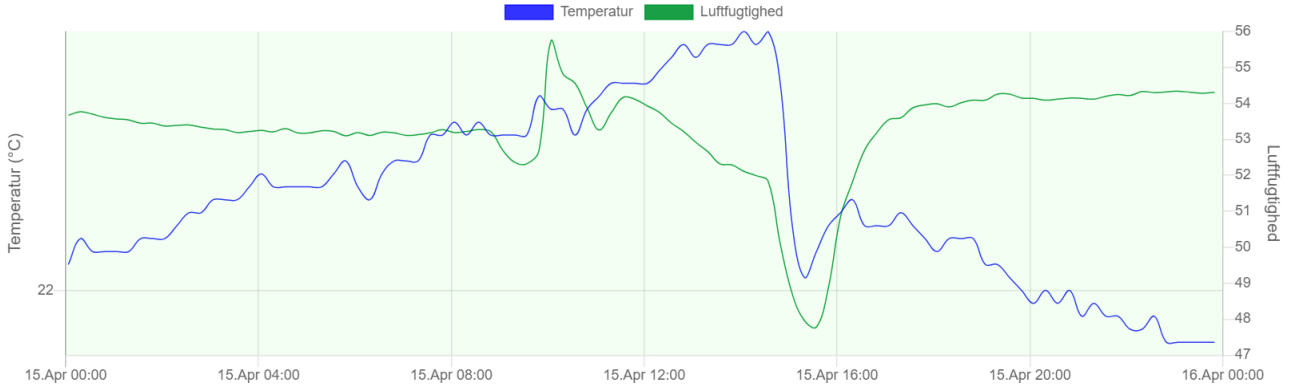


Compared with measurements without shutdowns, June 2024:

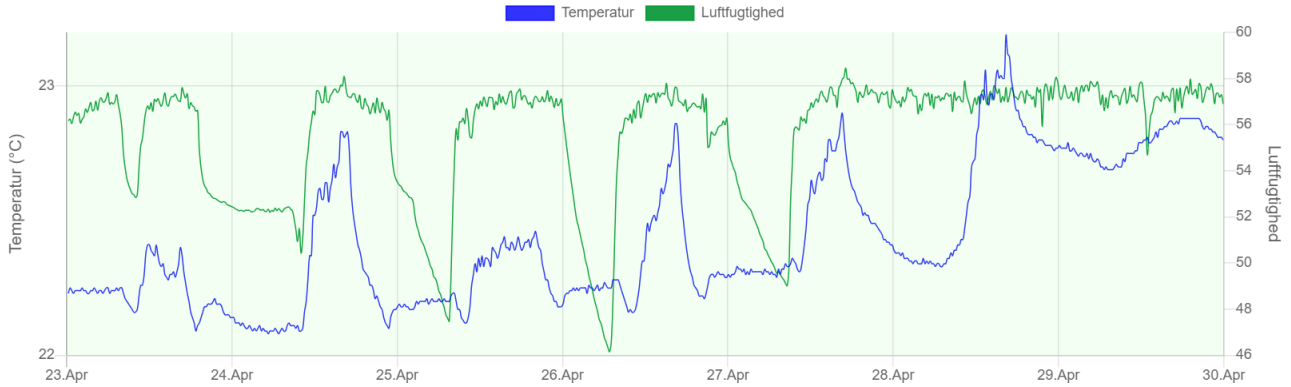


Unit 1, Gallery 62, 1. floor:

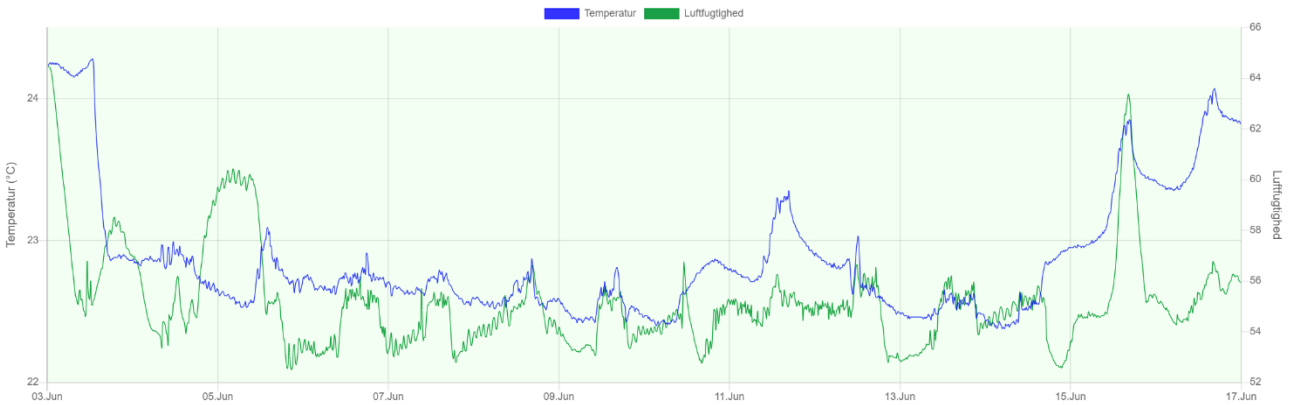
Shutdown, 15th April 2024, 9-14.45 o'clock



Shutdown, 25-27 April 2024:

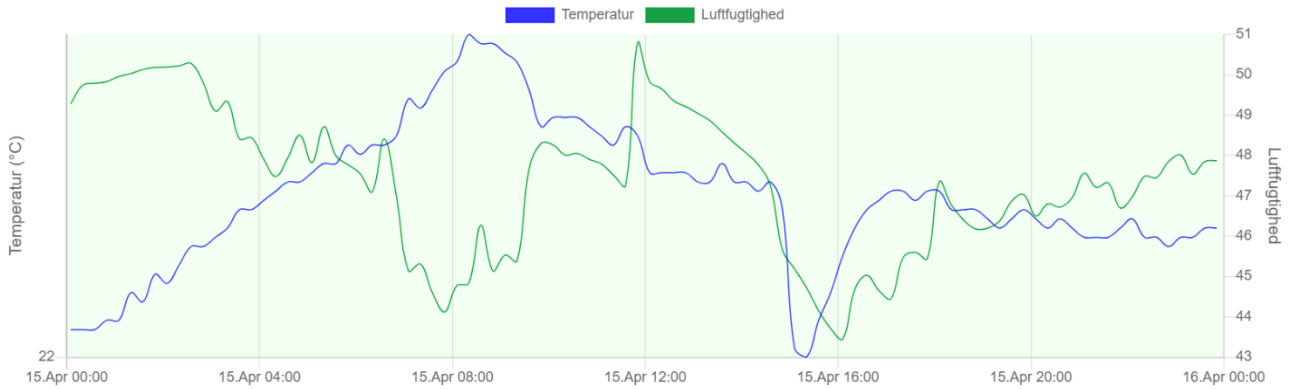


Compared with measurements without shutdowns, June 2024:

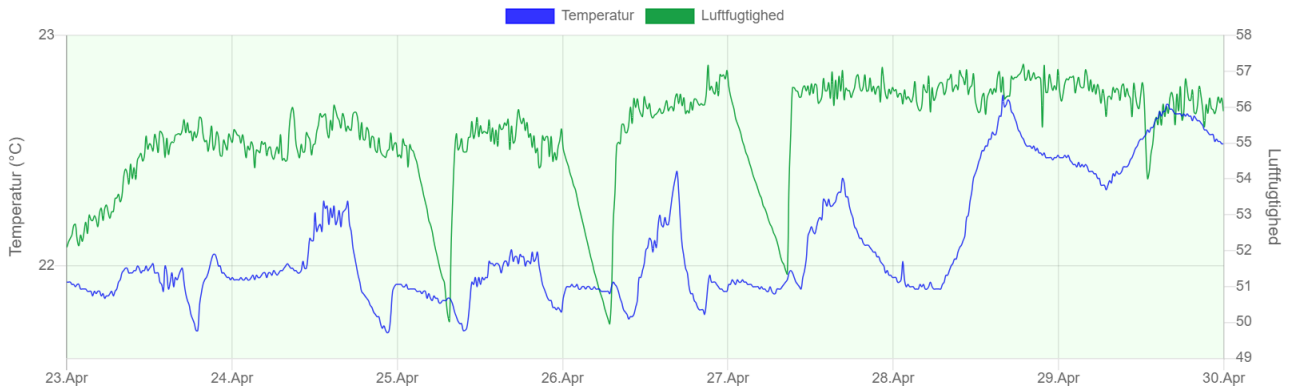


Unit 1, Gallery 64, 2. floor:

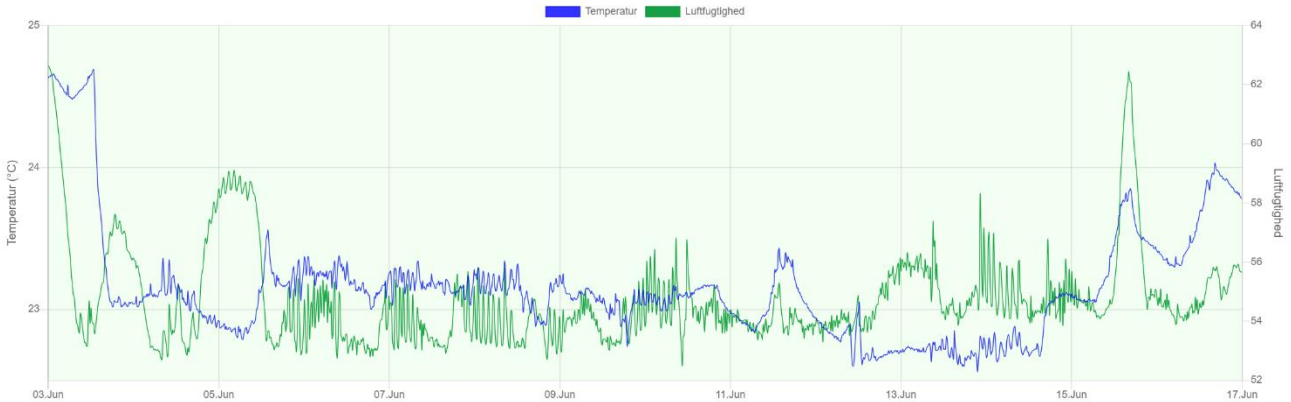
Shutdown, 15th April 2024, 9-14.45 o'clock



Shutdown, 25-27 April 2024:

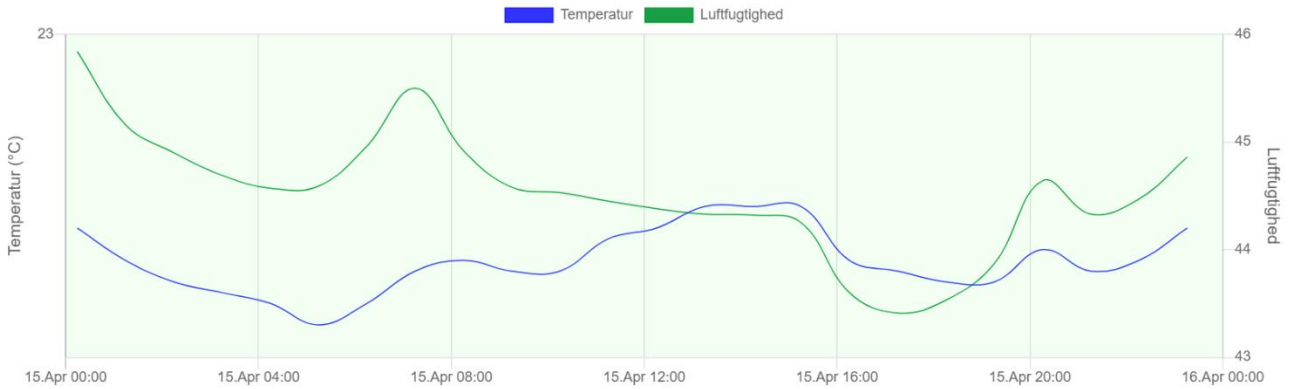


Compared with measurements without shutdowns, June 2024:

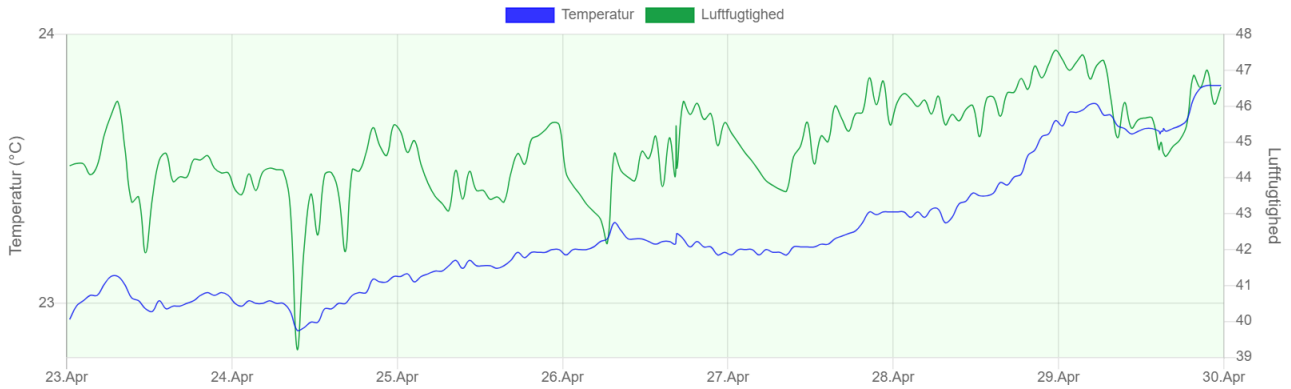


Unit 3, ÆM1, storage, ground floor:

Shutdown, 15th April 2024, 9-14.45 o'clock



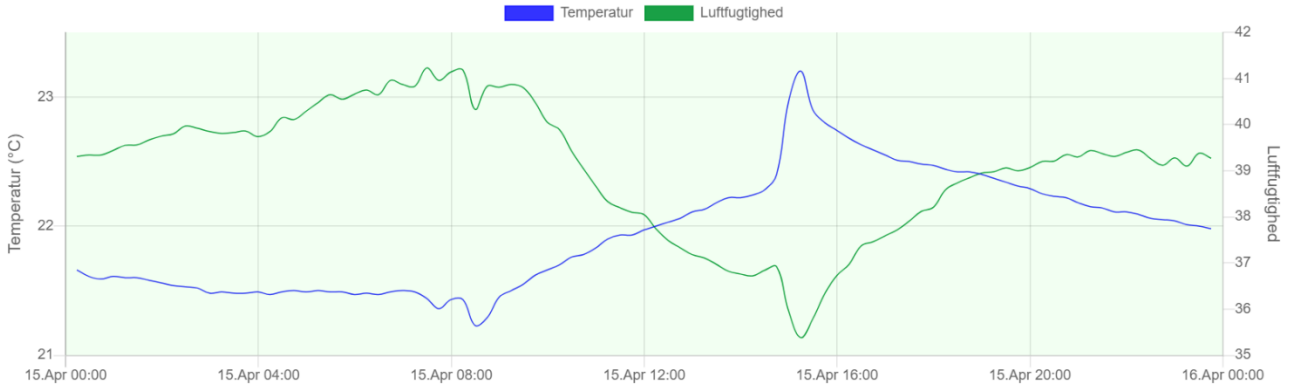
Shutdown, 25-27April 2024:



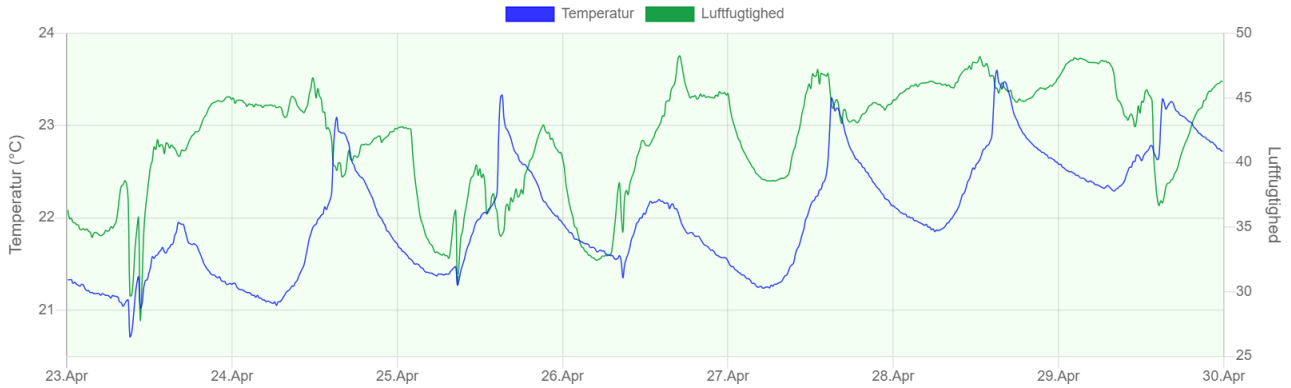
Compared with measurements without shutdowns, June 2024:

“Trappegade”, bufferzone, ground floor:

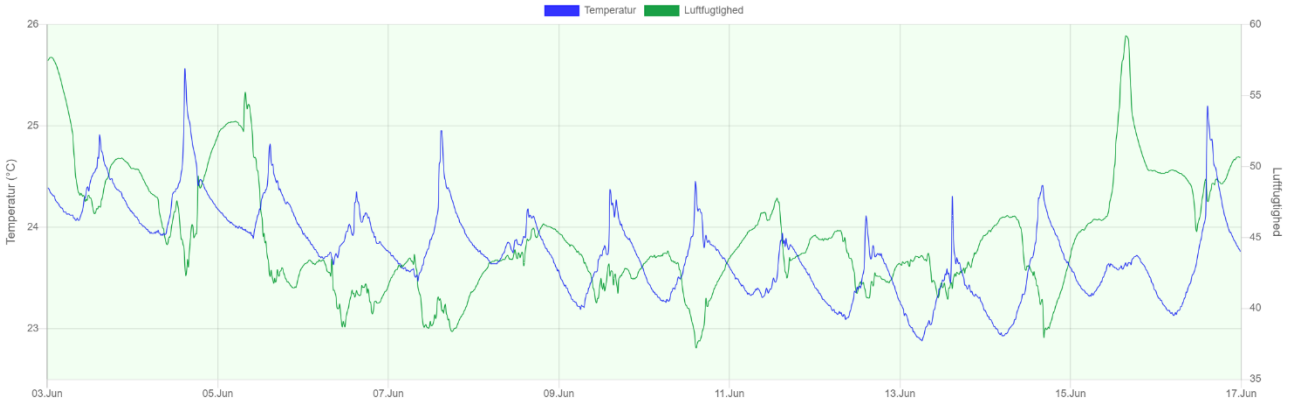
Shutdown, 15th April 2024, 9-14.45 o’clock



Shutdown, 25-27April 2024:



Compared with measurements without shutdowns, June 2024:



There is no climate control in the bufferzone, only secondary heating from adjacent heat sources.