Getting Climate Control Under Control

SECOND INTERNATIONAL CLIMATE CONTROL CONFERENCE

LOUISIANA Museum of Modern Art - Denmark

Anette Hansen
Director of Facilities and Security

Bo Heinrich Kristensen
BMS Technician / Building & Safety Department

Ulrik Staal Strange Dinesen
Head of Conservators and Exhibition Producers

700.000 visitors a year
42.000 m2
Modern art, sculpture park
350 employes

LOUISIANA

GOAL FOR THIS PRESENTATION

All systems can be revised

Starting the dialogue about climate control, not only between colleagues in the museum world, but also between different industries leads to new understandings and optimizations options.

LOUISIANA

GOAL FOR JOINING THE PROJECT

Broaden the climate systems to RH 50% ± 10 % (before 50% ± 2%).

Reduced air speed (20%).

Observation on object / watercolor and crayon on paper.

/

Parallel project to the KI project: Installed new damper on two locations

Implemented an AI solution

LOUISIANA

ENERGY OPTIMIZATION

Before the project started

All the low-hanging fruit

LOUISIANA

ENERGY OPTIMIZATION

Hardware

Circulation pumps

- 74 out of our 77 pumps were cost-effective to replace
- Payback period between 0.6 and 7.7 years

Old pump

New pump

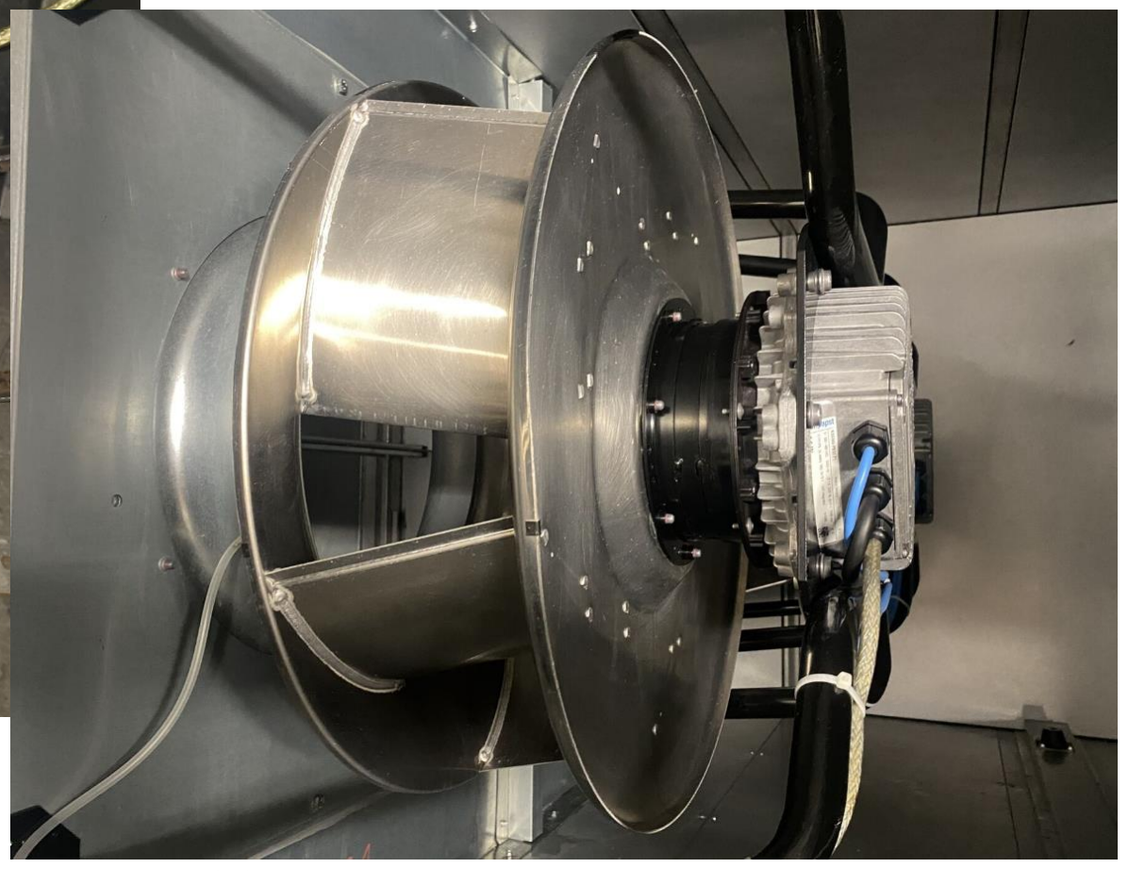
ENERGY OPTIMIZATION

Hardware

Fans

- All 44 fans were cost-effective to replace
- The average payback period was 2.6 years.

Old belt-driven fans

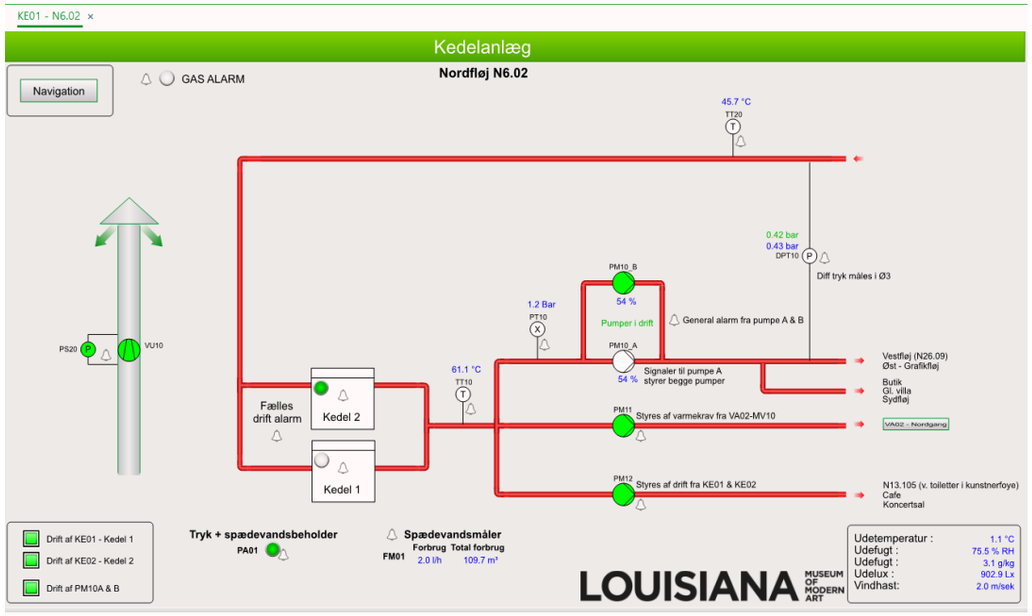


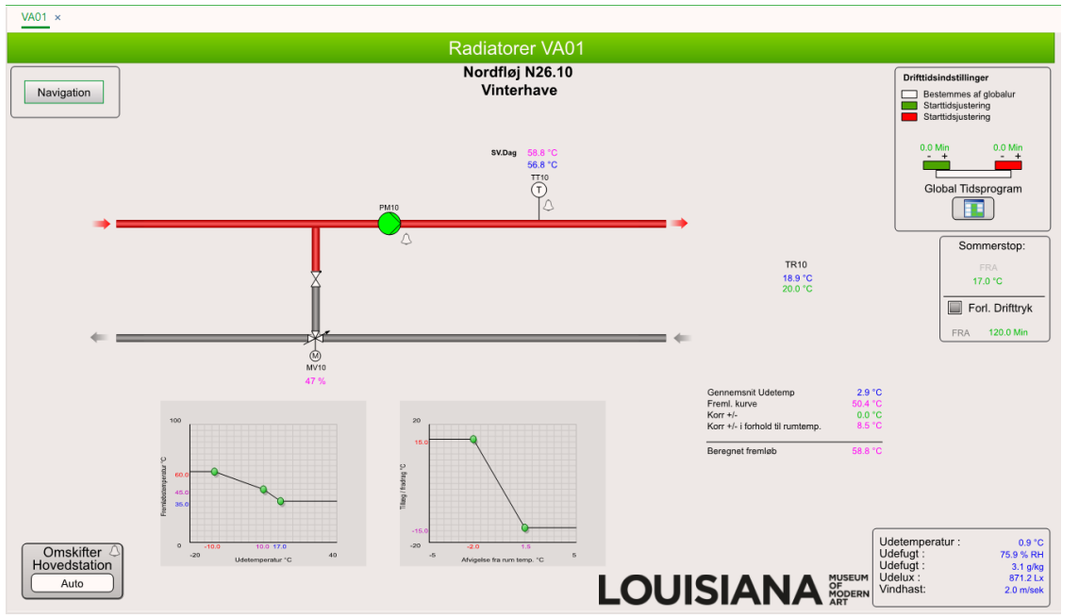
Energy-efficient EC fans

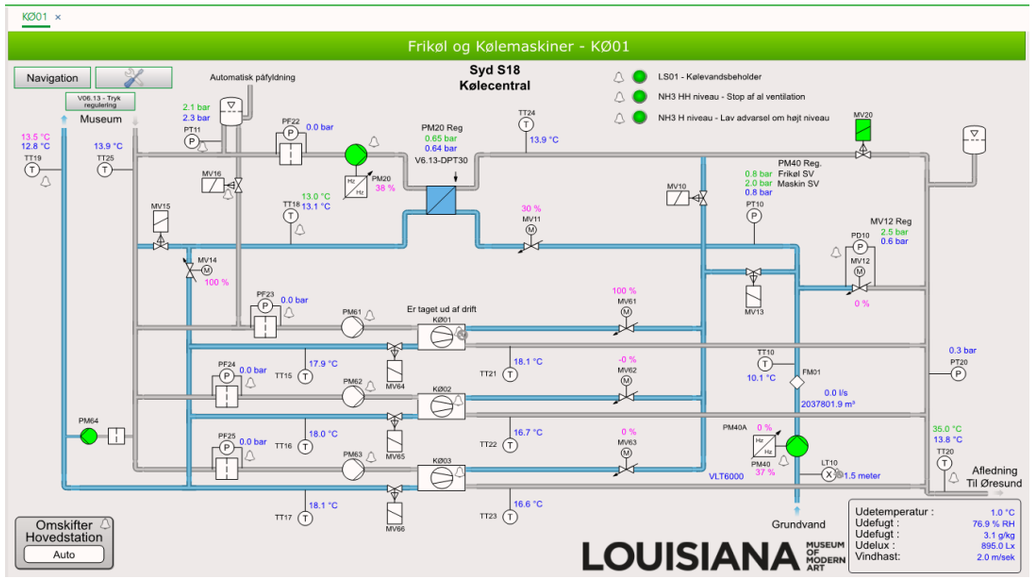
ENERGY OPTIMIZATION

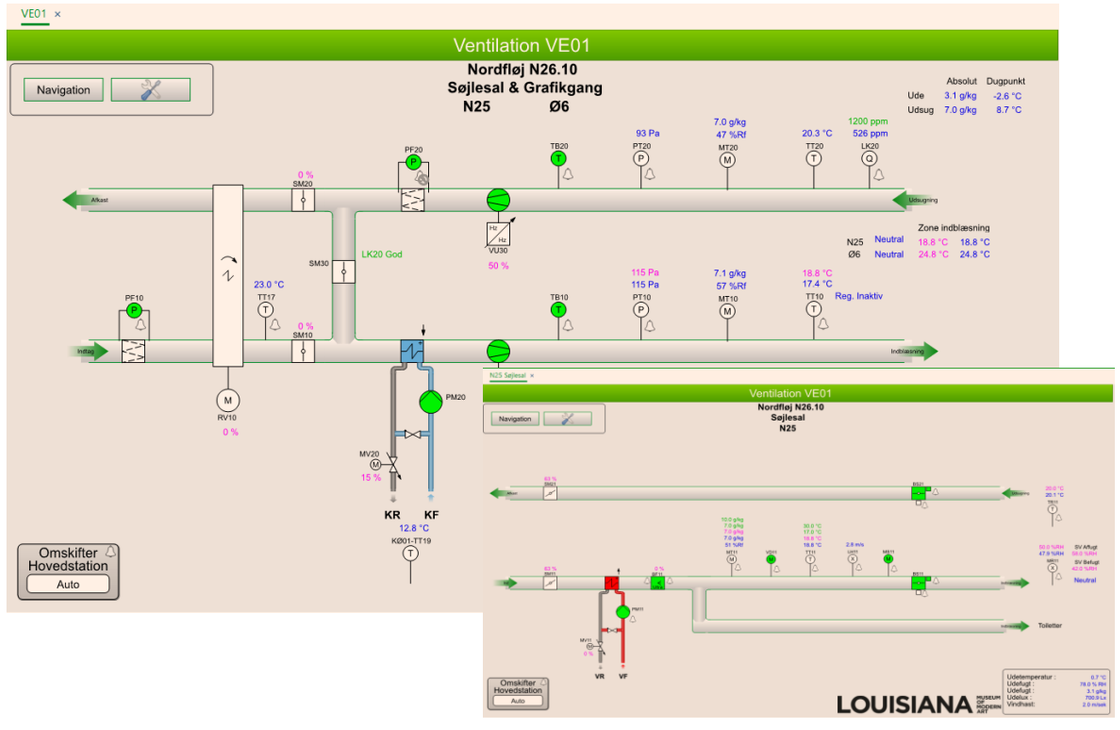
Insights, Decisions, and Programming

System coherence...







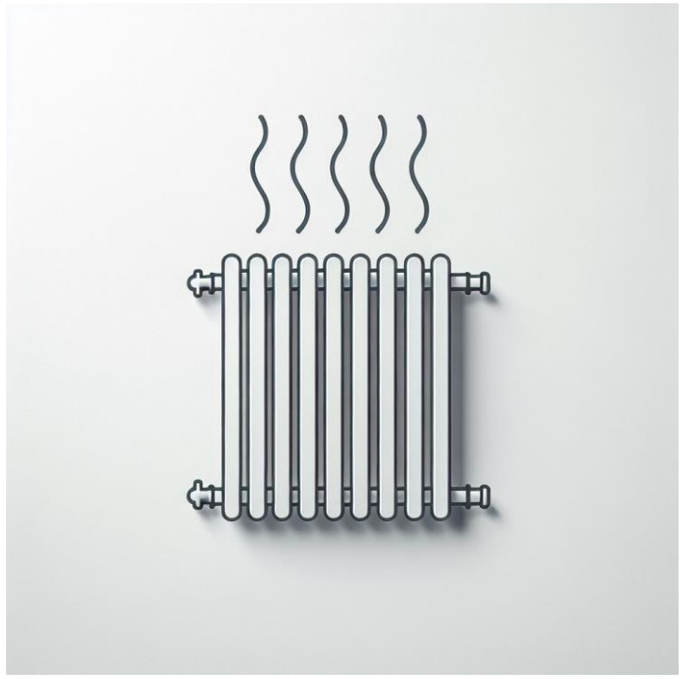


ENERGY OPTIMIZATION

Insights, Decisions, and Programming

System coherence...

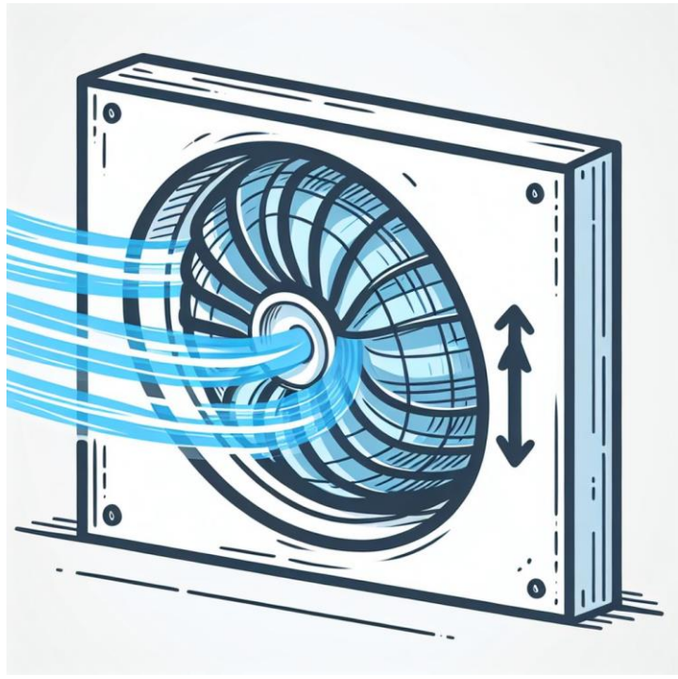
Heating



Heats up to 20°C

Dead band/neutral zone between 20°C and 22°C

Cooling



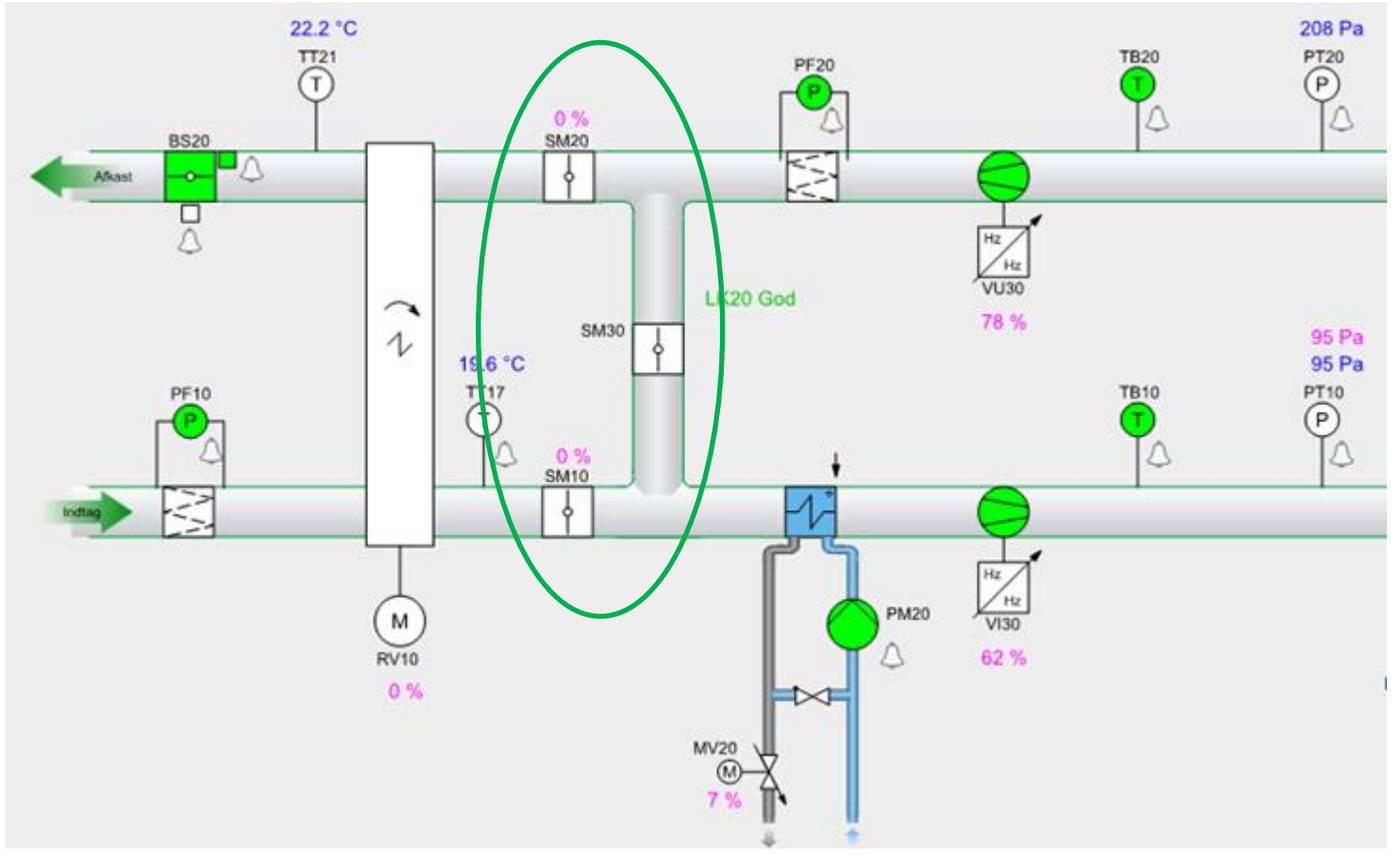
Cools down to 22°C

ENERGY OPTIMIZATION

Insights, Decisions, and Programming

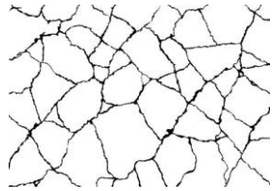
Using Outdoor Humidity to Control Indoor Humidity

OUTSIDE



ROOM

DRY



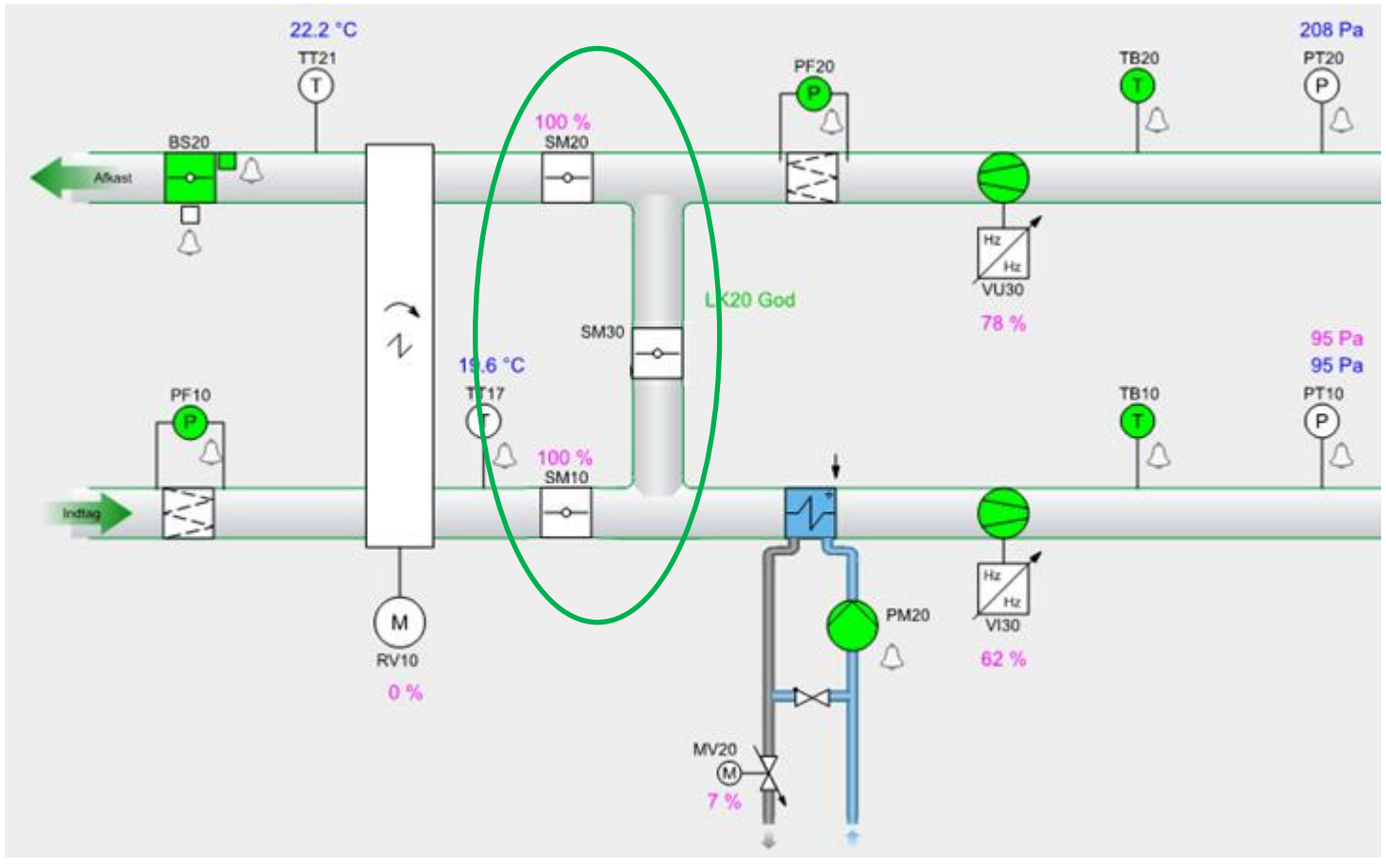
LOUISIANA

ENERGY OPTIMIZATION

Insights, Decisions, and Programming

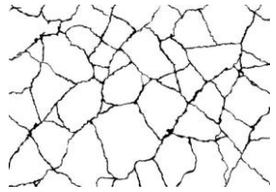
Using Outdoor Humidity to Control Indoor Humidity

OUTSIDE



ROOM

DRY



Moist air from outside is used to humidify the room

LOUISIANA

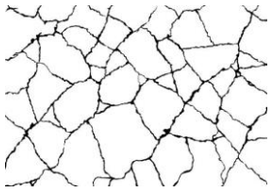
ENERGY OPTIMIZATION

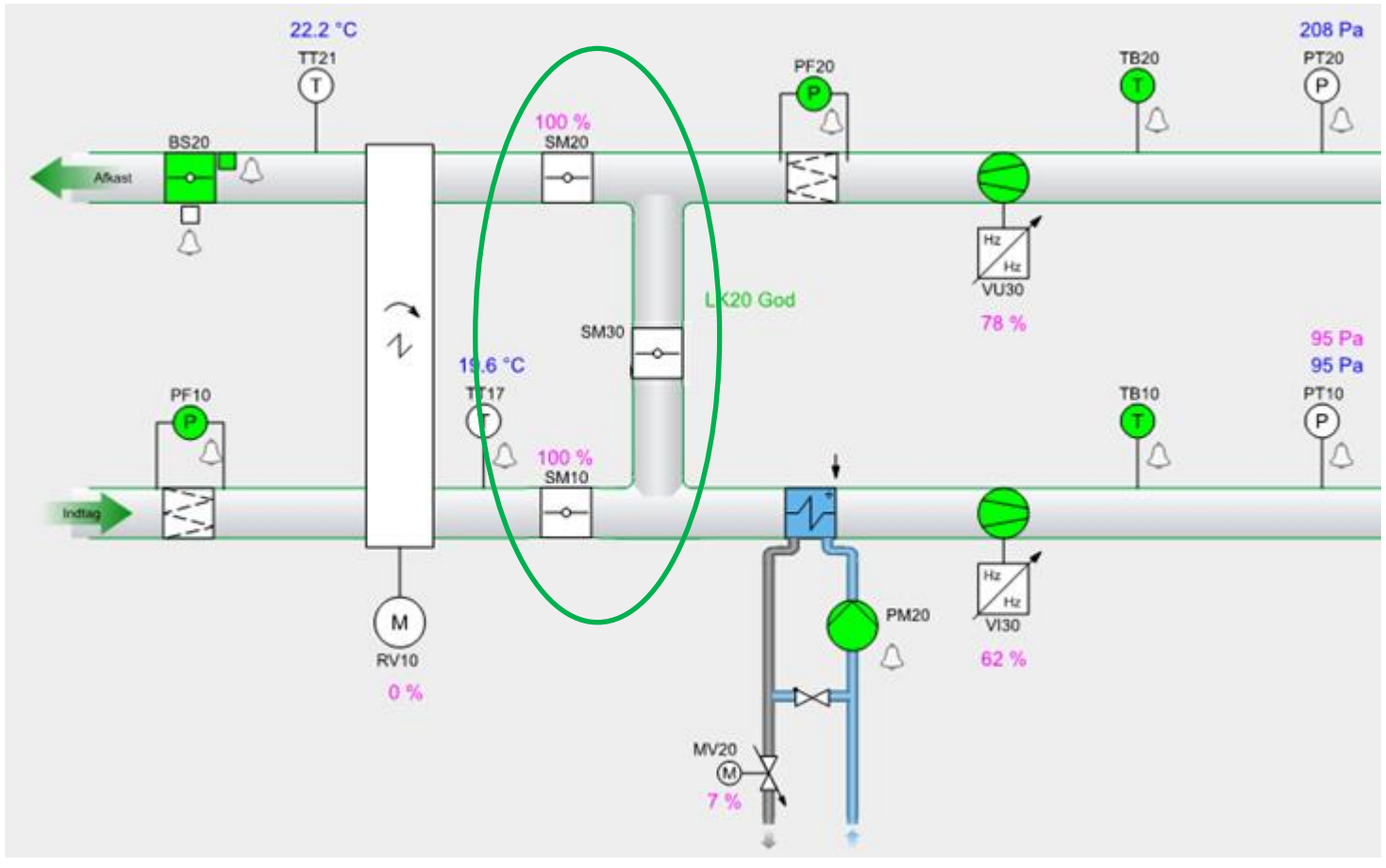
Insights, Decisions, and Programming

Using Outdoor Humidity to Control Indoor Humidity

OUTSIDE

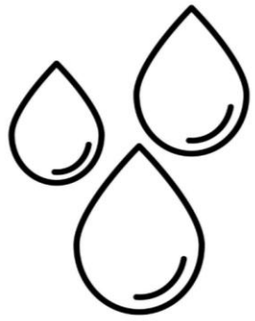
DRY





ROOM

Too humid

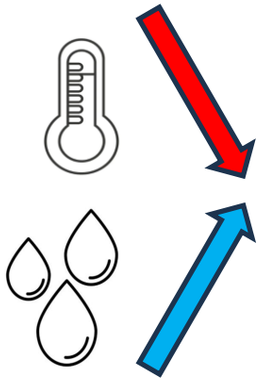


Dry air from outside is used to dehumidify the room

ENERGY OPTIMIZATION

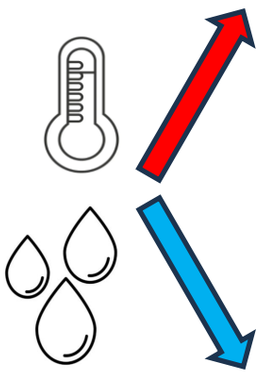
Insights, Decisions, and Programming

Temperature Control Helps with Humidity



Humidity demand in the room

- Lower the room temperature setpoint
- A 1°C temperature drop increases the humidity in the room by 2-3%.



Dehumidification demand in the room

- Raise the room temperature setpoint
- A 1°C temperature increase lowers the humidity in the room by 2-3%.

ENERGY OPTIMIZATION

When the project started

What now?

LOUISIANA

ENERGY OPTIMIZATION

Setpoints

Before:

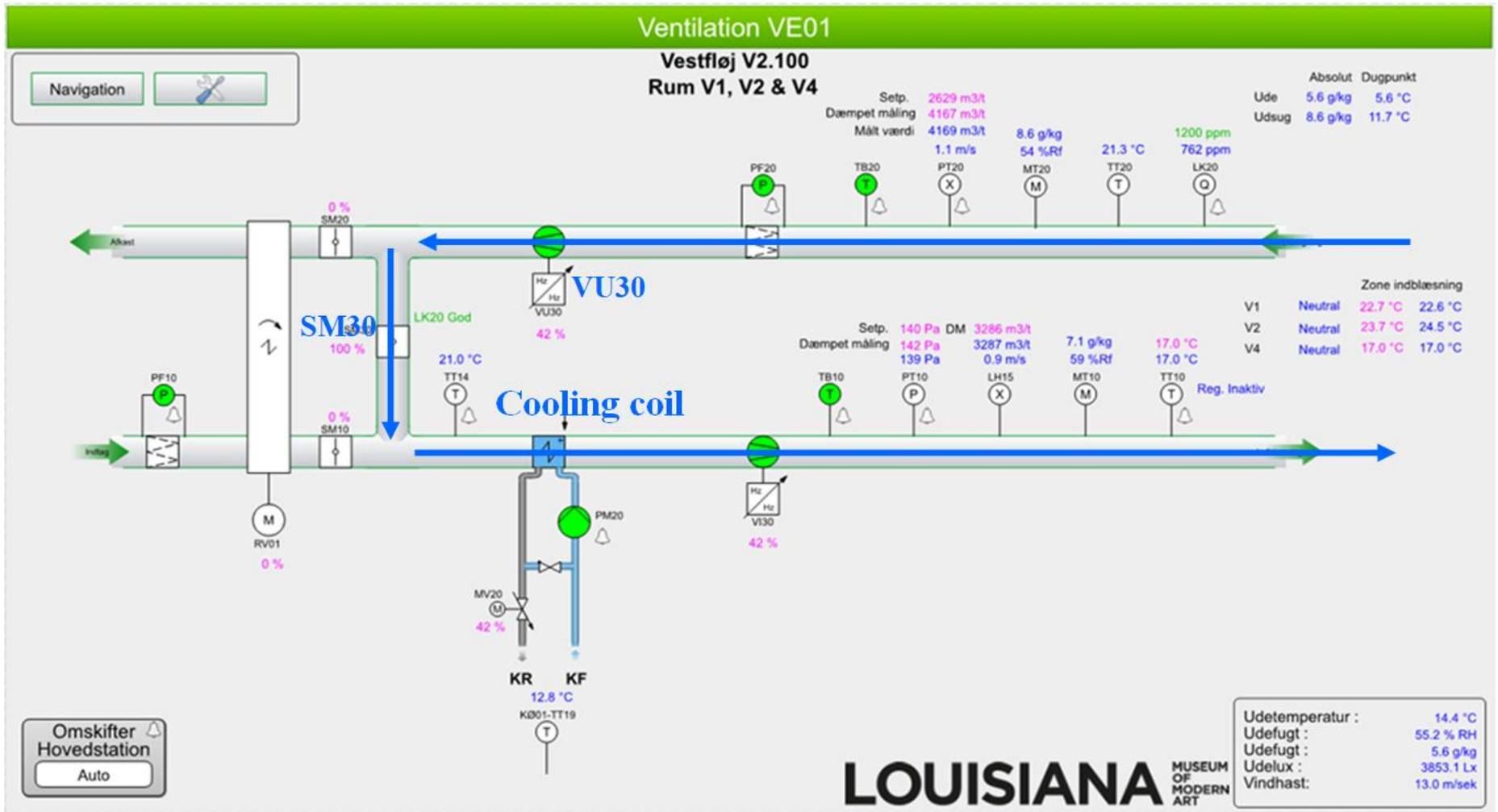
RH: 50% +/- 2%
Temp.: 20 +1°C (Temperature setpoint controlled by humidity requirements)

After:

RH: 50% +/- 8% (Bizot group +/-10%)
Temp.: 20 +1°C (Temperature setpoint controlled by humidity requirements)

ENERGY OPTIMIZATION

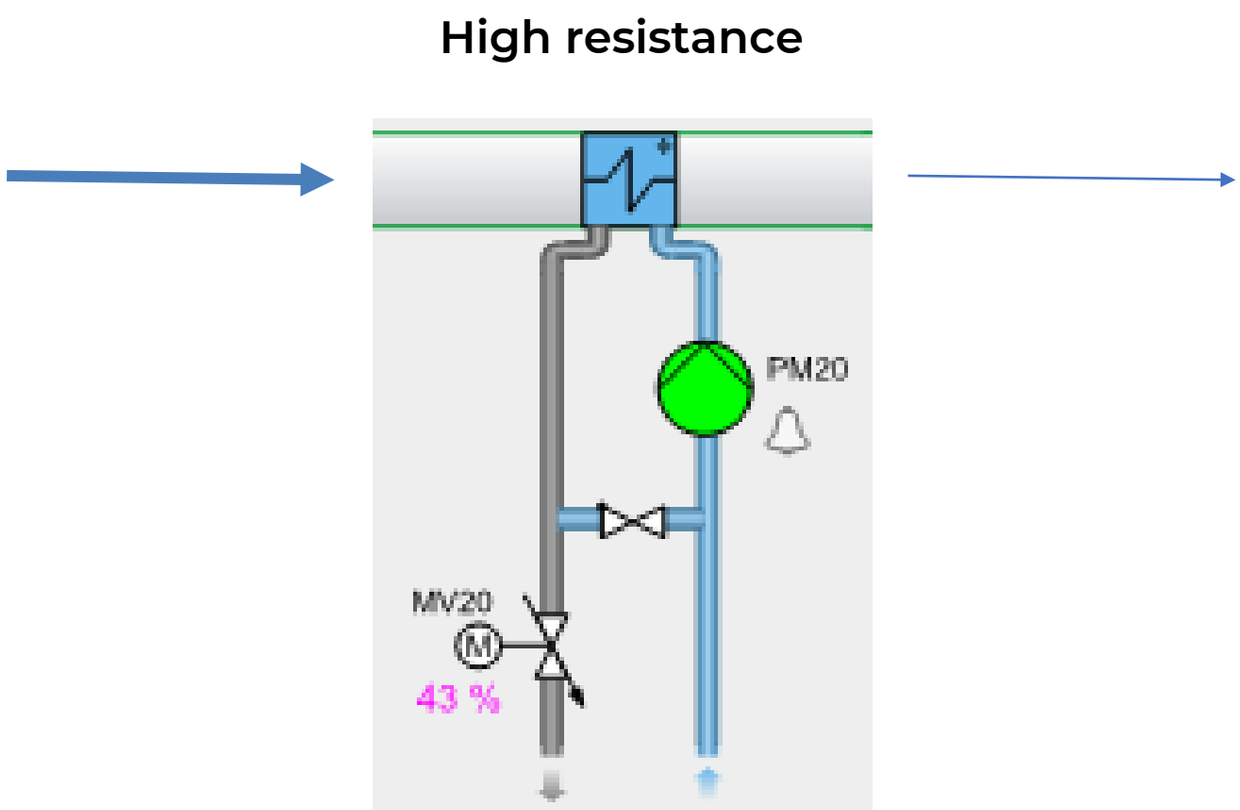
New Bypass Damper



Original Setup

ENERGY OPTIMAZITION

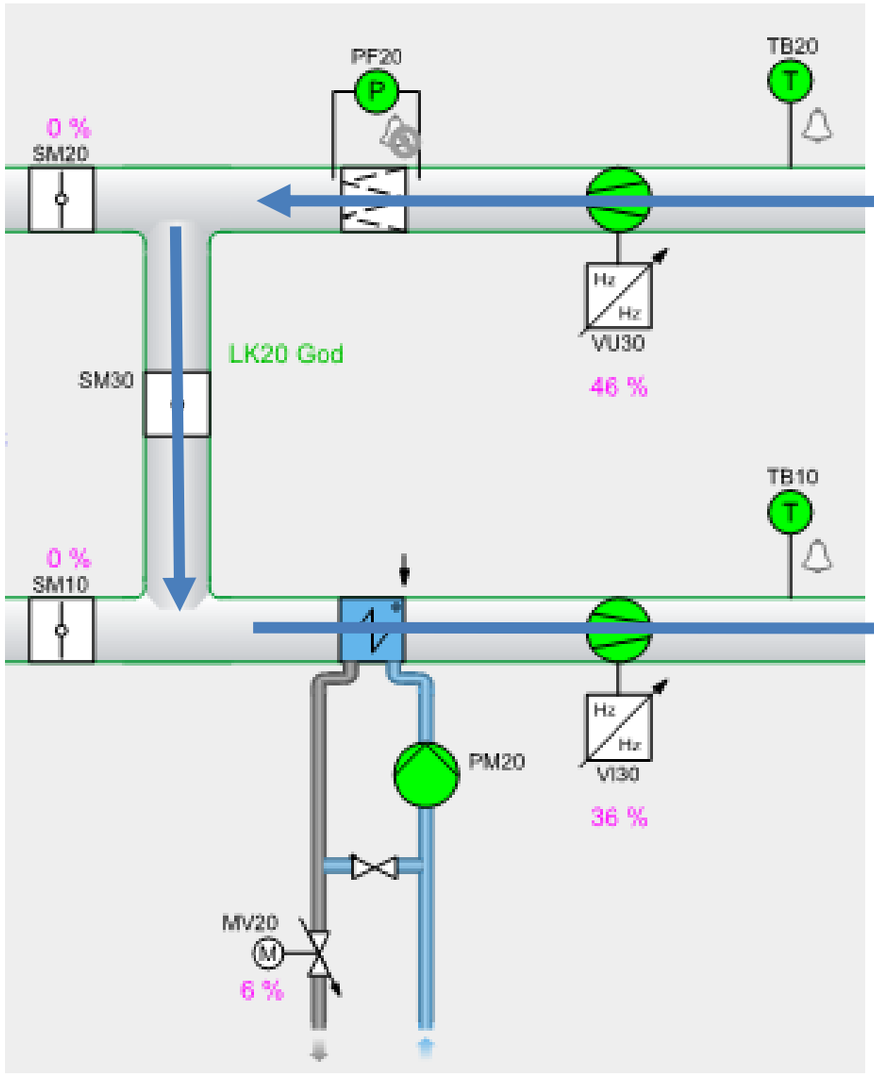
New Bypass Damper

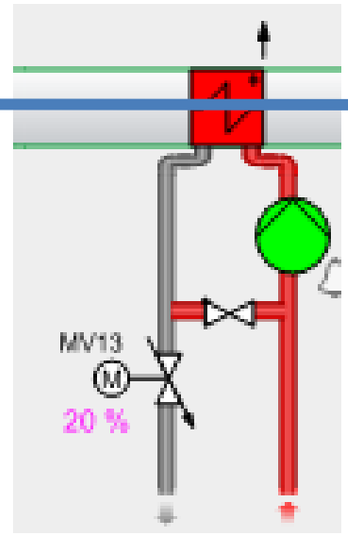


LOUISIANA

ENERGY OPTIMAZITION

New Bypass Damper



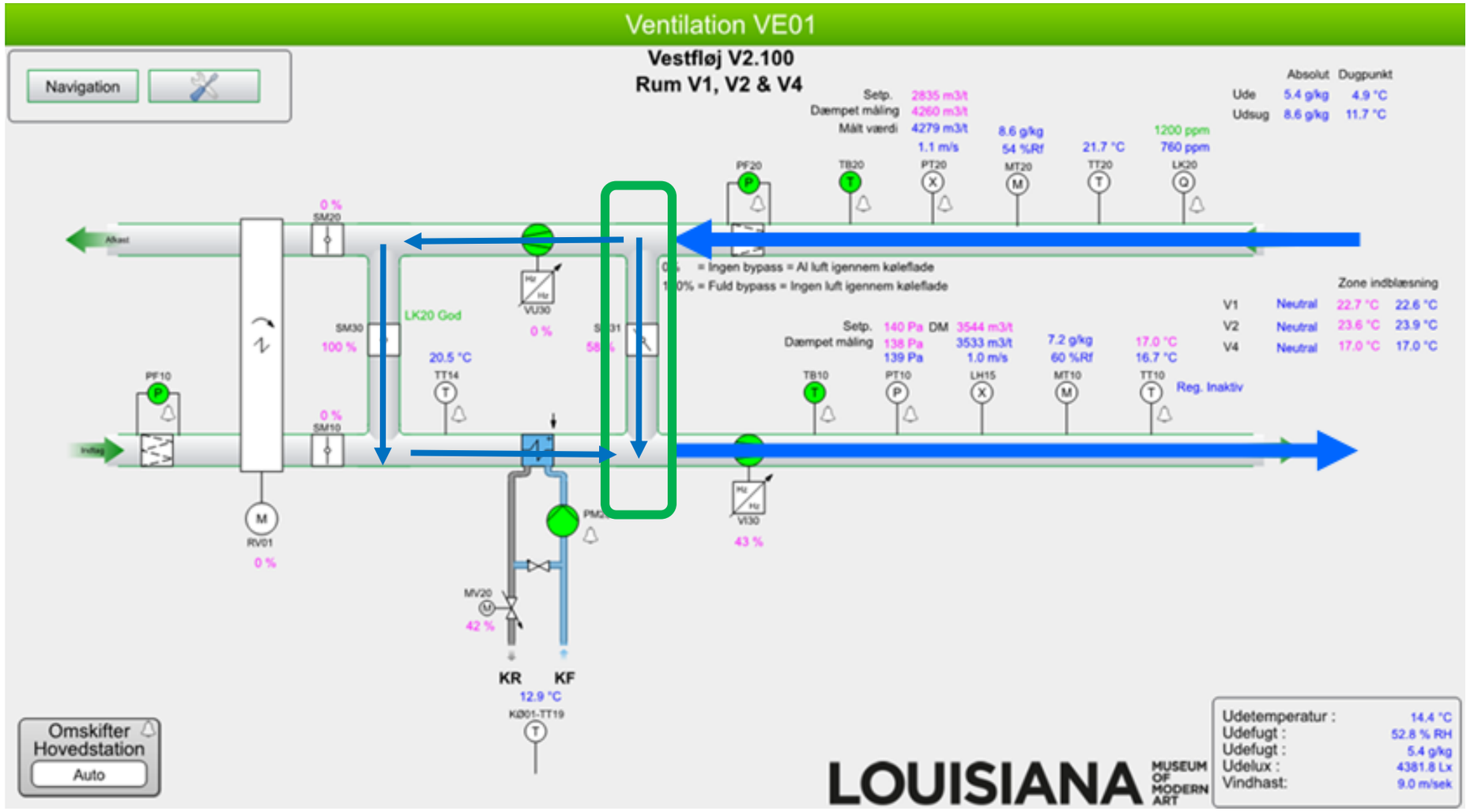


Galleries

LOUISIANA

ENERGY OPTIMAZITION

New Bypass Damper

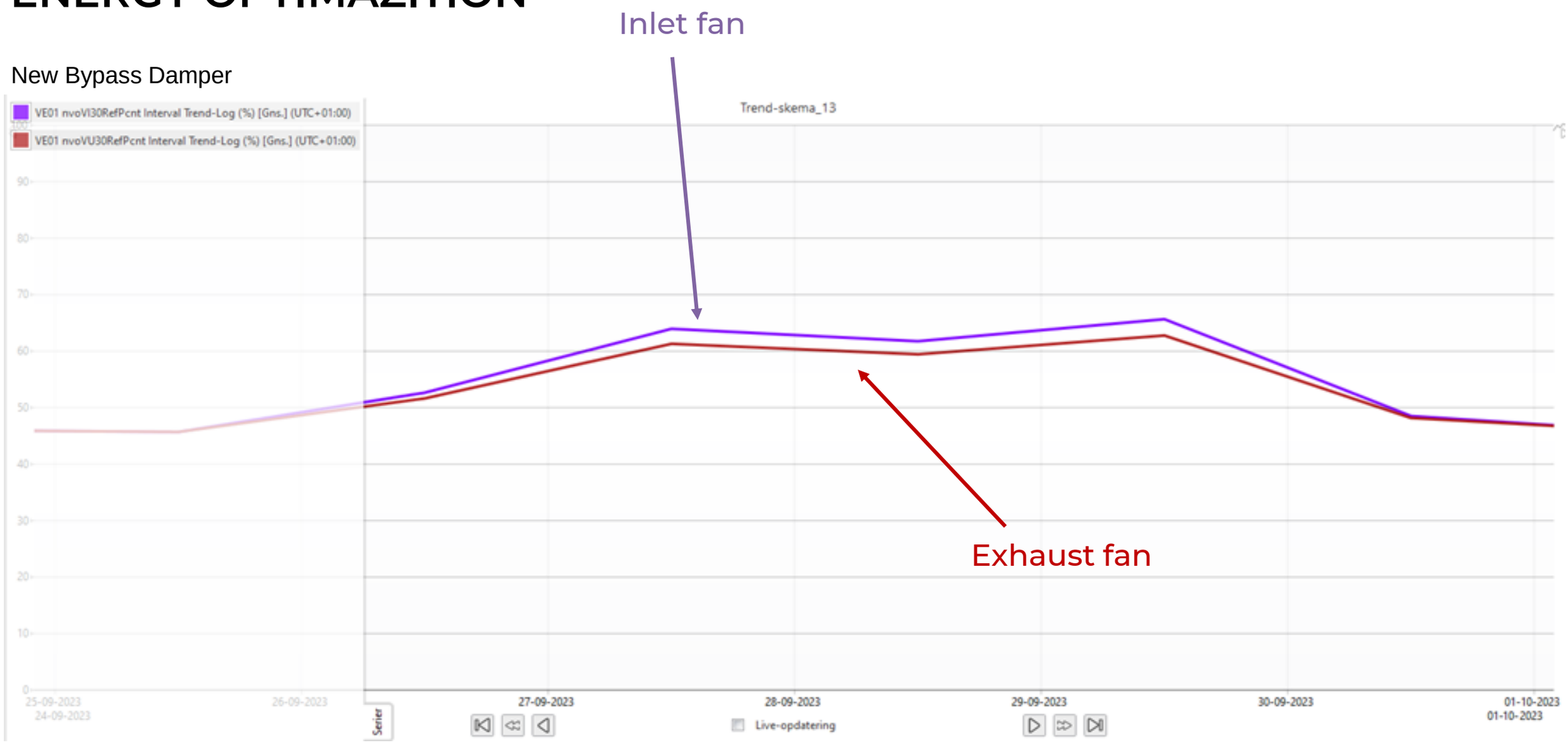


After the modification

LOUISIANA

ENERGY OPTIMAZITION

New Bypass Damper

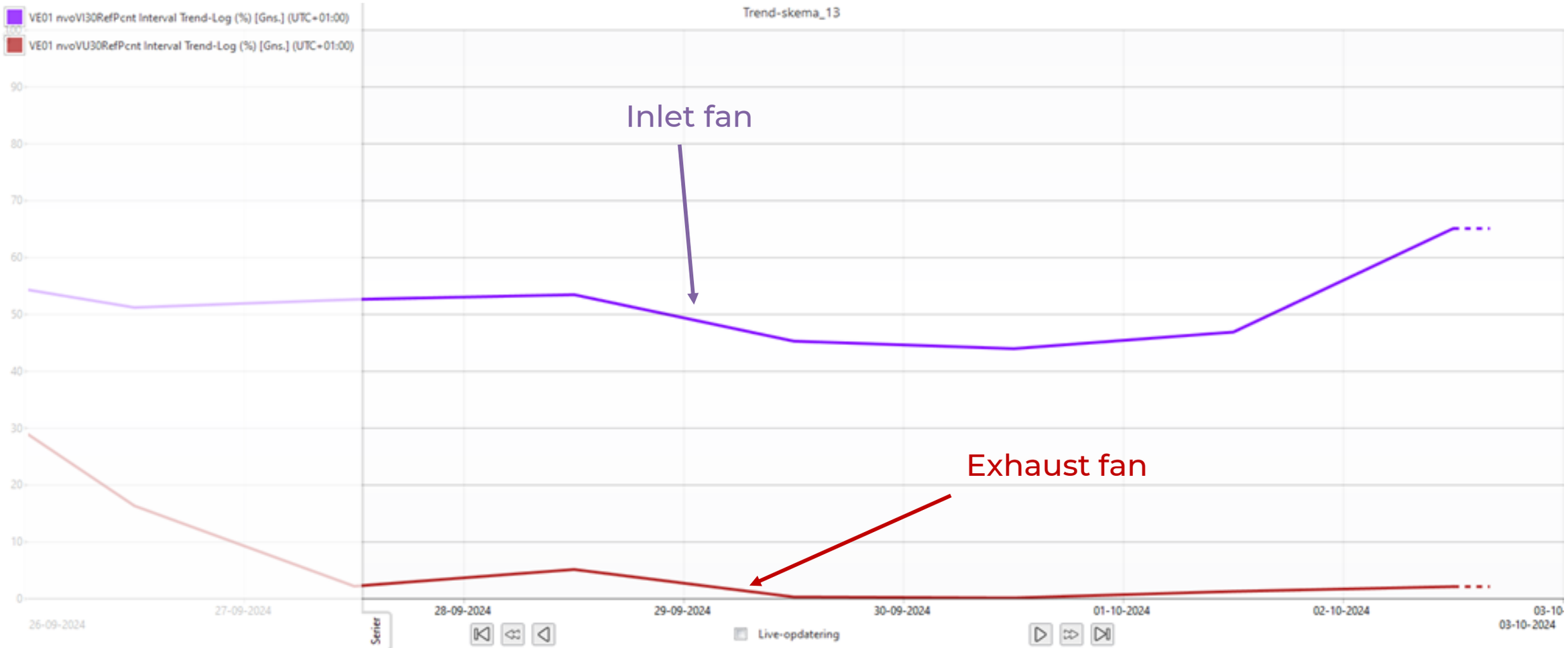


Before new damper

LOUISIANA

ENERGY OPTIMAZITION

New Bypass Damper



With new damper

LOUISIANA

ENERGY OPTIMAZITION

What now?

- Change of air
  - How many times per hour?
    - Why is it the number of times that matters?
- What matters is
  - Humidity
  - Temperature
  - Air quality

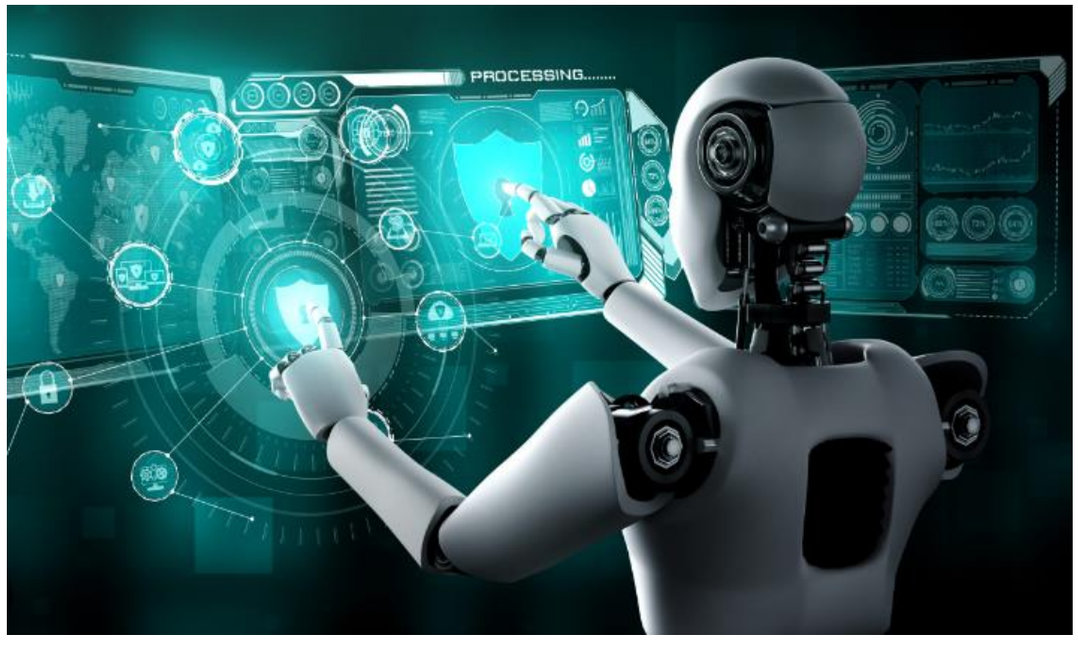
LOUISIANA

Change of air

- How far down can we go?
  - 10% ?
  - 20% ?
  - Will it work when we need to humidify?
  - Will it work when we need to dehumidify?

ENERGY OPTIMAZITION WITH AI

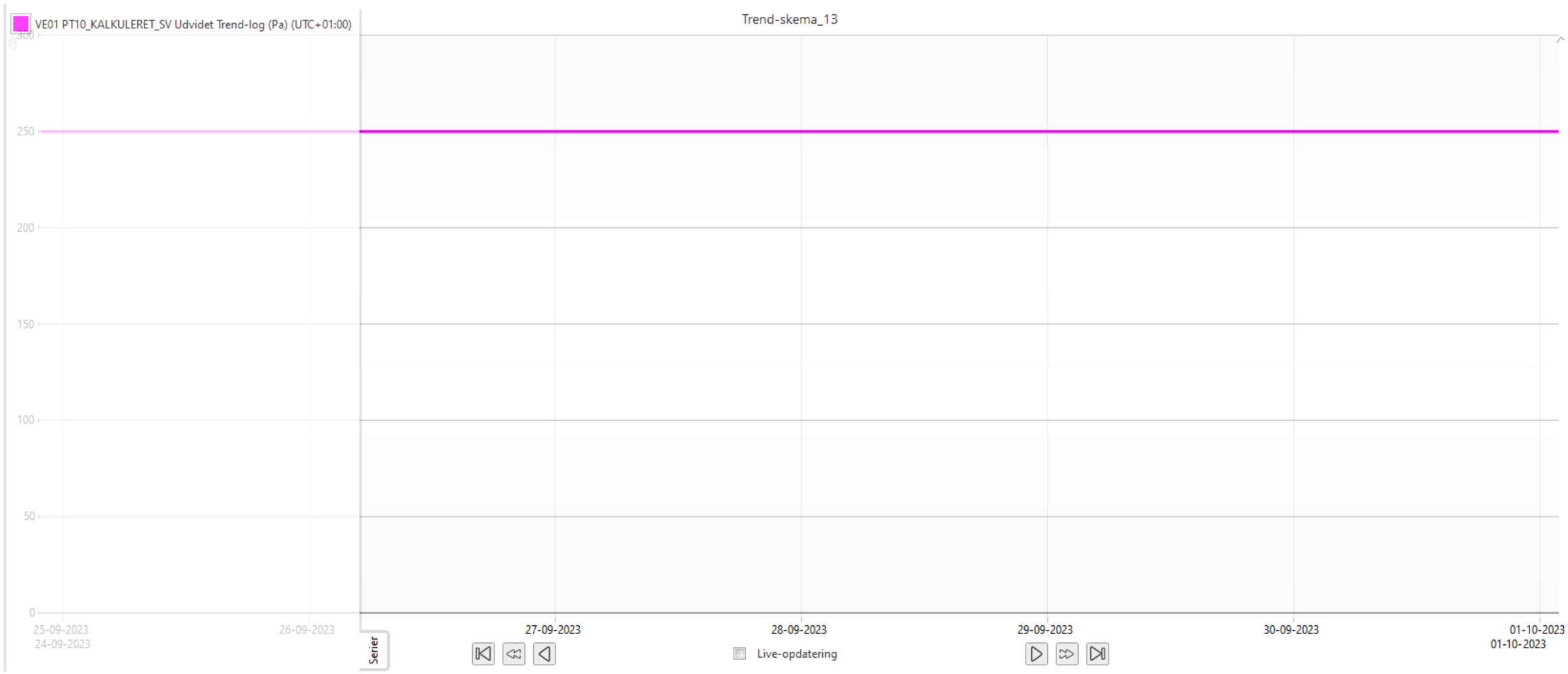
- AI automatically adjusts the supply air pressure based on experience, fan efficiency and data from:
  - Indoor temperature and humidity
  - Setpoints for indoor temperature and humidity
  - Air speed
  - Air quality
  - Supply pressure
  - Setpoint for supply pressure
  - Supply and exhaust motor speed
  - Humidifier control signal
  - Heating and cooling valve control signal
  - Visitors
  - Outdoor temperature and humidity
  - Electricity prices (in the long term)



LOUISIANA

ENERGY OPTIMAZITION WITH AI

Setpoint before AI:



LOUISIANA

ENERGY OPTIMAZITION WITH AI

LOUISIANA

ENERGY OPTIMAZITION WITH AI

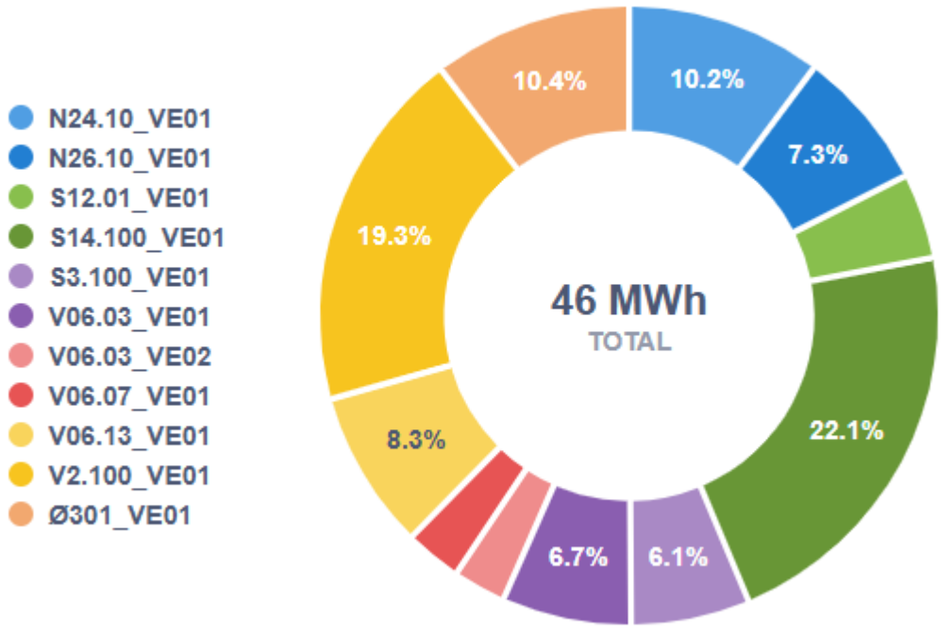
Date Filter
October 1, 2023 - November 25, 2023 ×

BEFORE AI

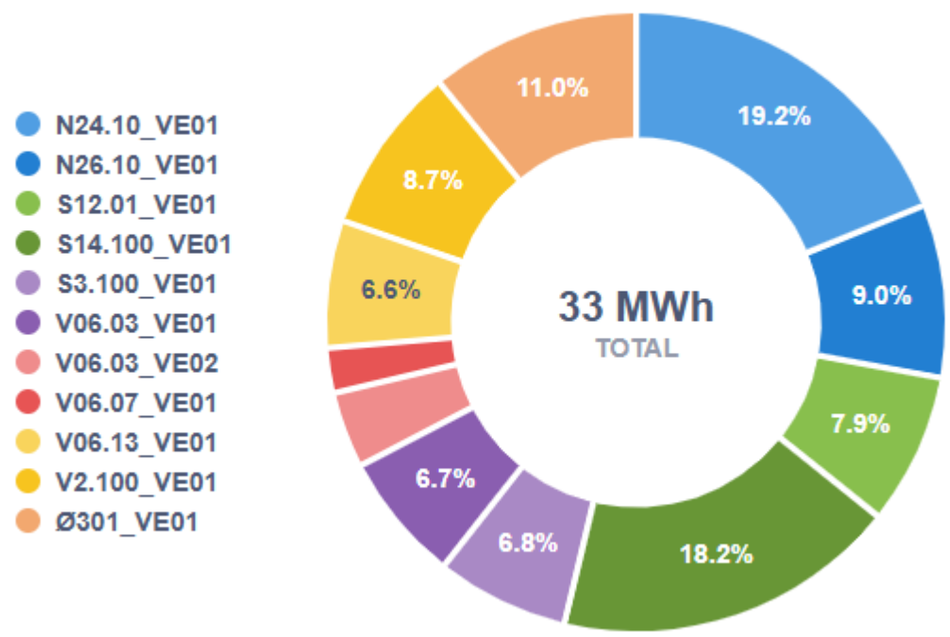
Date Filter
October 1, 2024 - November 25, 2024 ×

EcoVent by 4i4
https://4i4.dk

Electricity Consumption Breakdown



Electricity Consumption Breakdown



Savings in the first 2 months = 28%

Only on electricity for the fan motors

Not included: Saved energy for heating, cooling

LOUISIANA

LOANS

From Garry Thompson to Bizot

Out going loans

In going loans.
If lender requires the "old" standards, we now respond referring to the Bizot-guidelines.

Recommendations

Challenge the climate control system, no matter the state and efficiency.

Louisiana recommends that other museums take part in the Bizot-guidelines and open the climate range to RH 40-60 % when possible

If any questions, please don't hesitate to contact

Bo Heinrich Kristensen
BMS Technician / Building & Safety Department
bhk@louisiana.dk

Anette Hansen
Director / Facilities & Security
ah@louisiana.dk

Ulrik Staal Strange Dinesen
Head of Conservators and Exhibition Producers
usd@louisiana.dk

LOUISIANA