



# Energy Efficient Cooling Infrastructure for CERN Accelerators

Presenters:

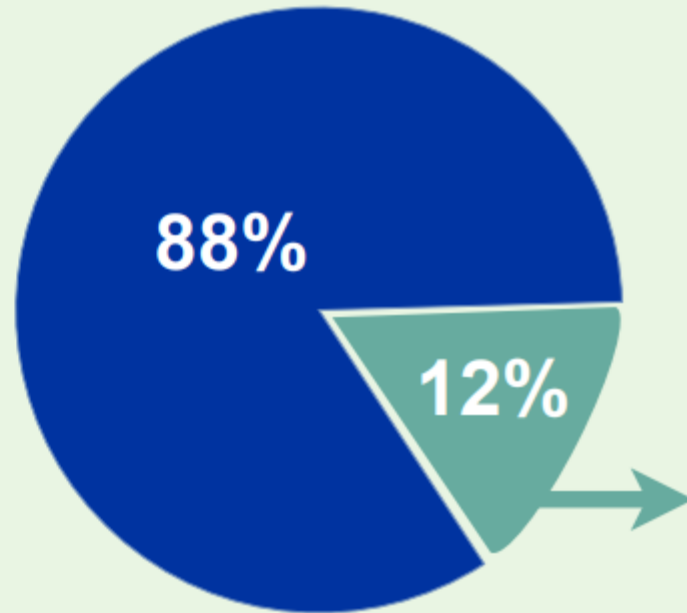
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# Motivation

*Following global sustainability concerns, “pursuing actions and technologies aiming at **energy savings and reuse**” is listed as one of the main objectives for 2021-2025 at the European Organization for Nuclear Research (CERN). This objective extends to the Cooling and Ventilation group.*

# Cooling and Ventilation

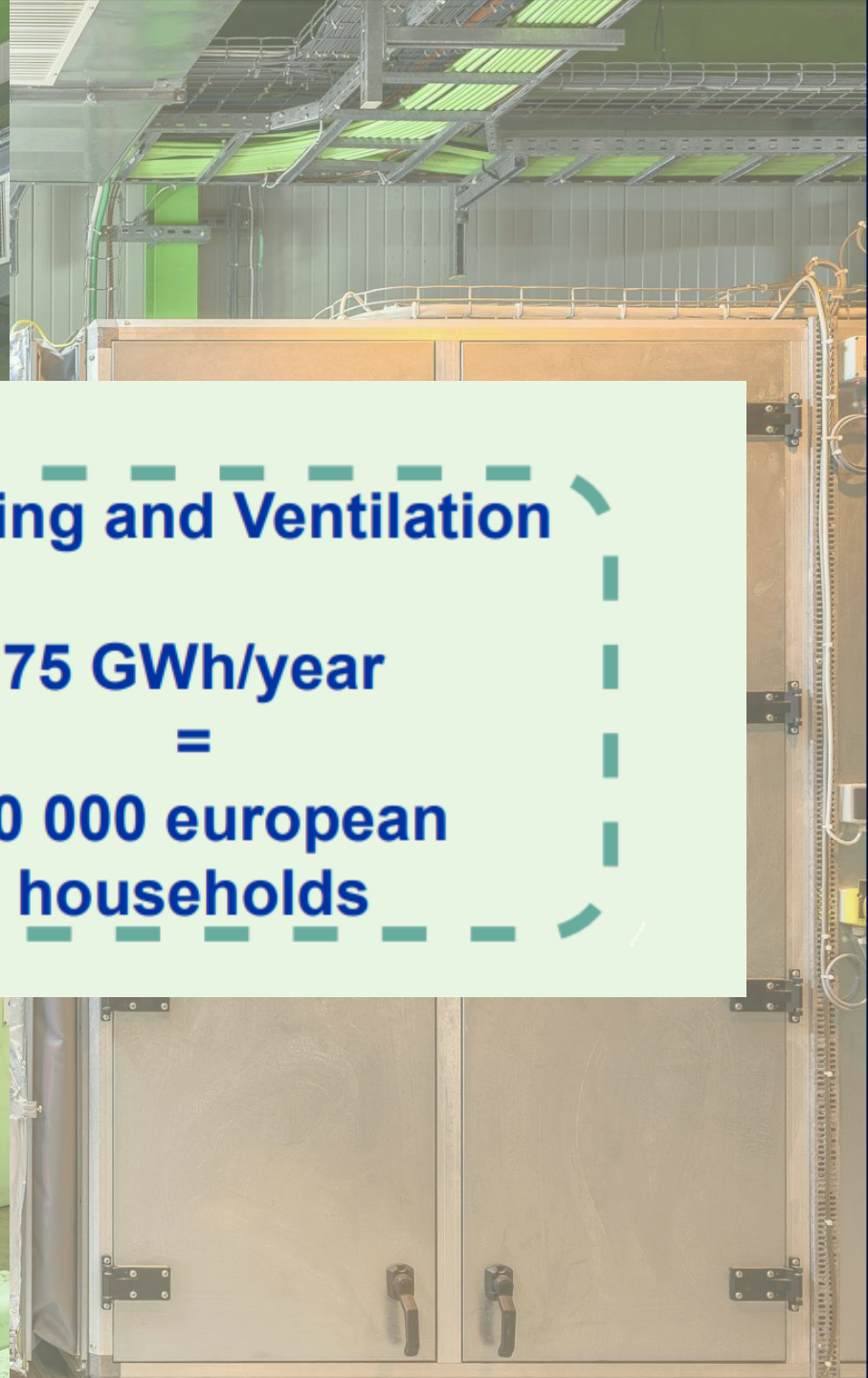
**Large Hadron Collider (LHC)**  
Electricity  
Consumption



**Cooling and Ventilation**

**75 GWh/year**  
=

**20 000 european  
households**



# Optimization of controls

# Control system

Controls based  
on performance  
AND electricity  
consumption

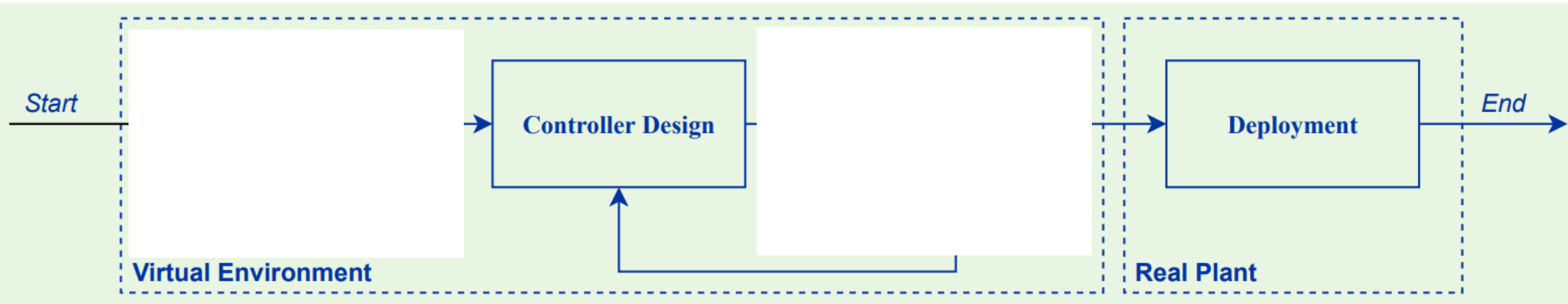


System being controlled

# Energy Optimization Algorithms

Controls Optimization with help of Digital Twin and other simple approaches

# Controls Optimization with Digital Twin (DT)



## Key Outcomes

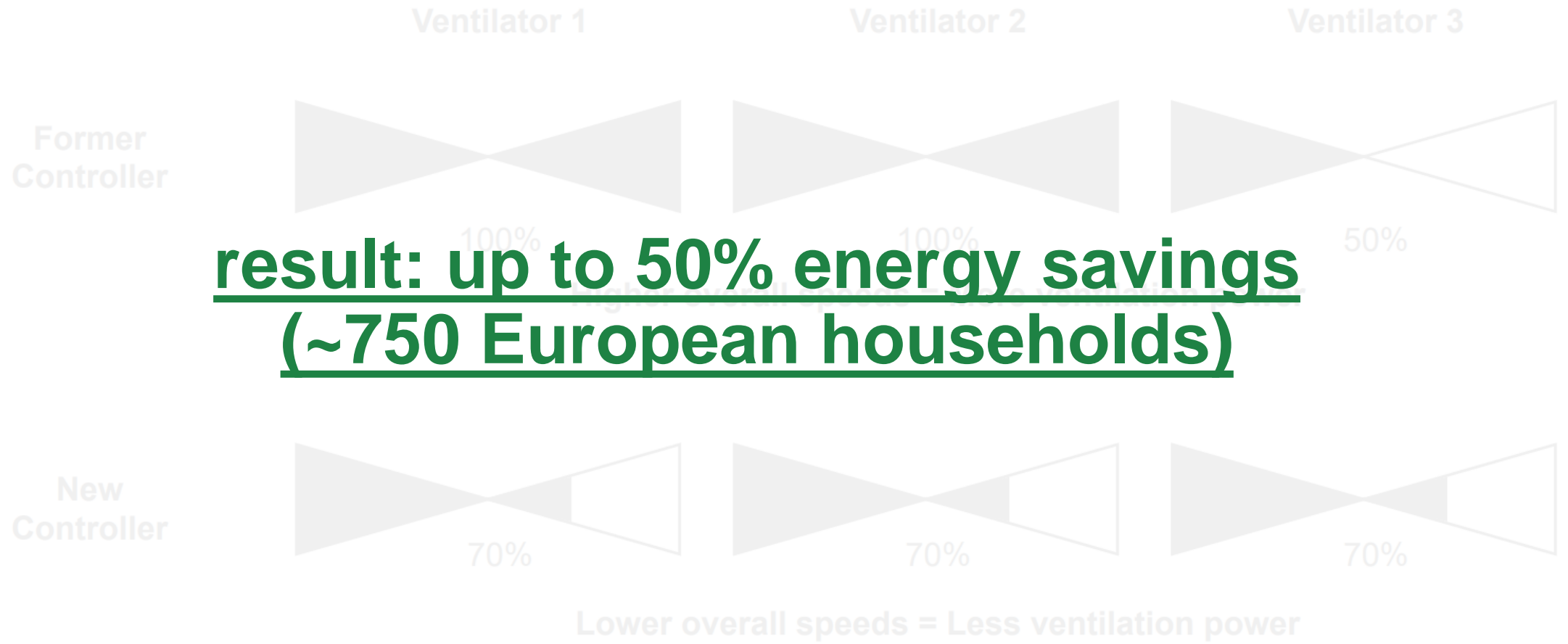
- ✓ reliable study
- 🌱 € testing finer regulation strategies
- 💡 extended knowledge about plants

## Key use-cases of DT:

- Validation of new plant **design**
- Virtual **commissioning**
- Design of control algorithms for **energy savings**

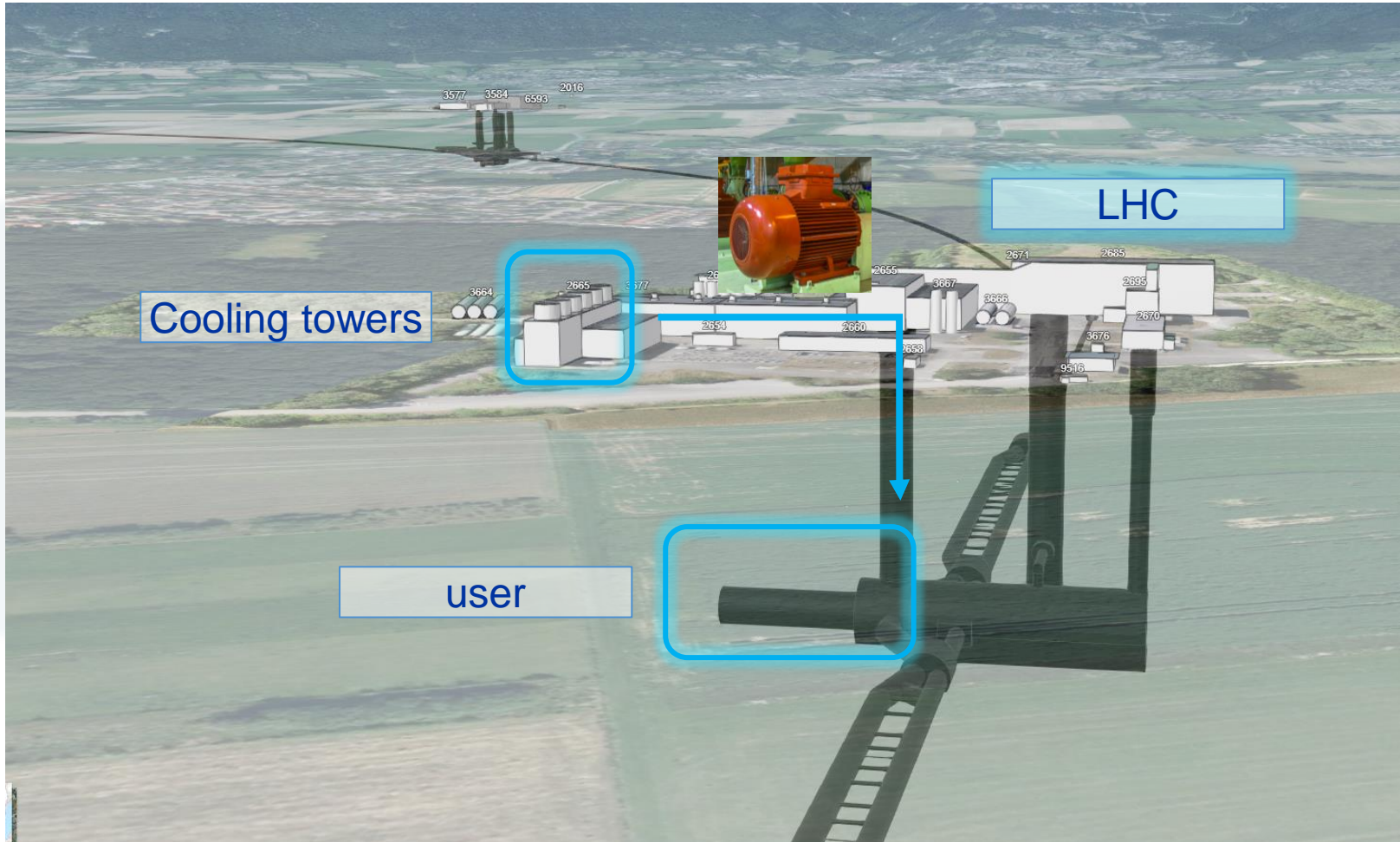
# Cooling towers

## Simplified view on change in controller' logic





# Water Distribution



# HVAC – ongoing project data driven model with neural networks



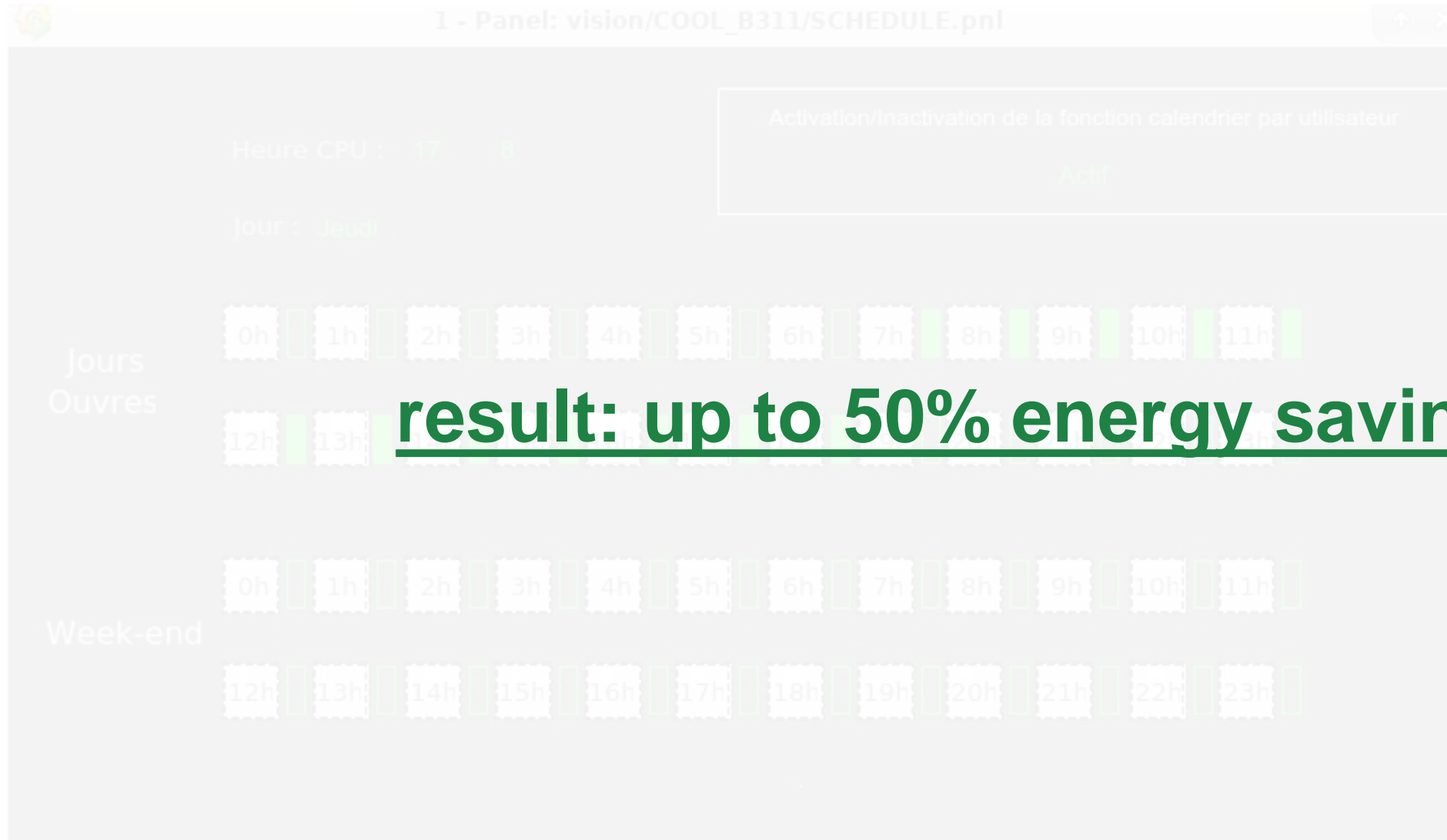
## Advantages of data-driven model

- **Reduced Development Time and Cost**
- **Flexibility**
- **Efficiency** (reduced computational load)

## Disadvantages

- **Lack of Insight into Internal Processes**
- **Dependency on Quality of Data**
- **Limited Accuracy in Novel Situations**

# Scheduling



# Takeaways

- problem: CV systems are energy intensive
- One solution: optimization of controls
  1. Controls Optimization with Digital twin
    - a. Simulation software
    - b. **Data-driven model**
  2. Simple Approach
    - a. Scheduling
- future work

