



DATA DRIVEN METHODS FOR ENHANCING ENERGY EFFICIENCY

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TALLINN UNIVERSITY OF TECHNOLOGY 2023

8,846
students

876 International students
from **85** different countries
80 study programmes
5 joint programmes
23 international programmes

2,050
employees

67 nationalities
44.92 average age
146 professors

1,249
publications

73 PhD degrees awarded
49% international PhD students

82,507
alumni

3.7% international alumni

ENERGY INFORMATICS

HOW ENERGY PERFORMANCE CAN BE IMPROVED?

- **ENERGY INFORMATICS: ENERGY + INFORMATION**
- Energy informatics is a research field covering the use of information and communication technology to address energy utilisation and management challenges.

Energy + **Information** < Energy

ENERGY INFORMATICS

HOW ENERGY PERFORMANCE CAN BE IMPROVED?

FUSION OF ENERGY AND IT

Energy (application areas):

- ✓ Buildings
- ✓ Cities
- ✓ Industries
- ✓ Grid
- ✓ Transportation
- ✓ Factories
- ✓ Agriculture
- ✓ ...

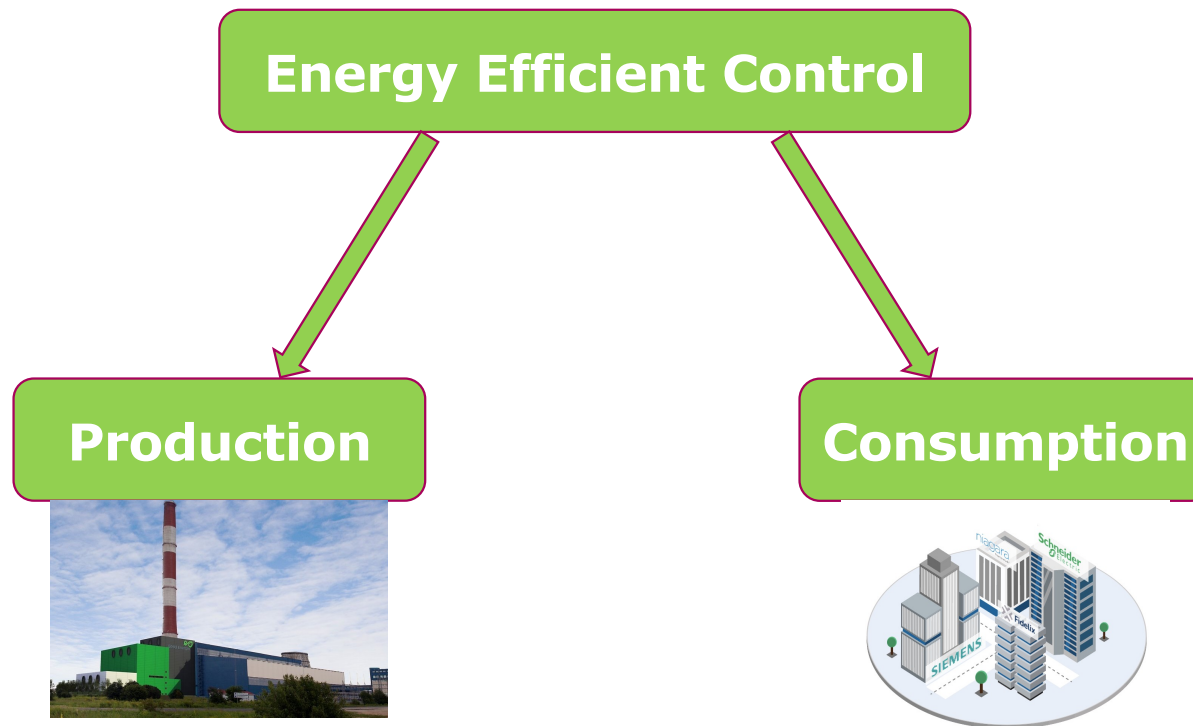
Energy efficiency,
Cost savings,
Sustainability,
Energy management

IT (enabling technologies):

- ✓ Internet of Things
- ✓ Digitalisation
- ✓ Machine learning
- ✓ Artificial Intelligence
- ✓ Blockchain
- ✓ Cloud computing
- ✓ Big data
- ✓ Data analysis
- ✓ ...

DATA!

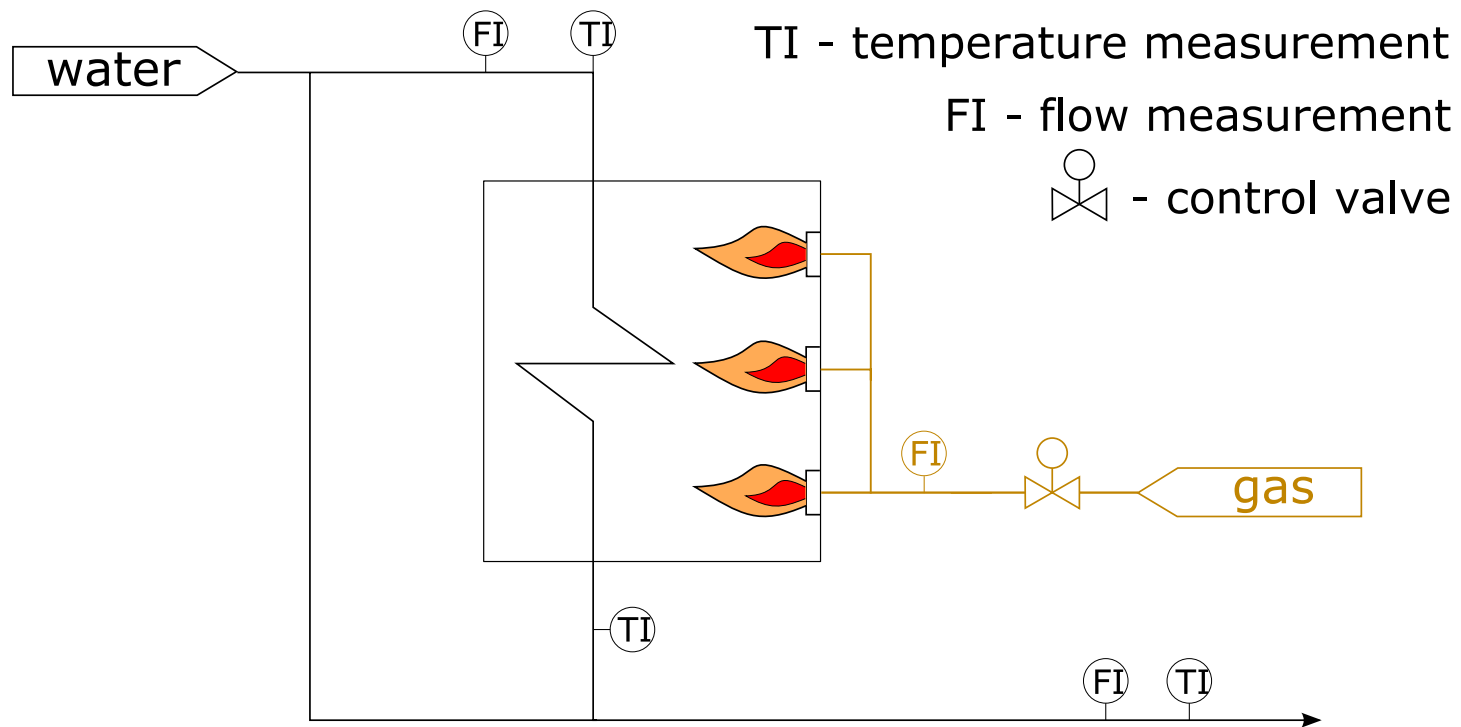
ENERGY EFFICIENCY: TWO SIDES OF THE COIN



PRACTICAL EXAMPLES

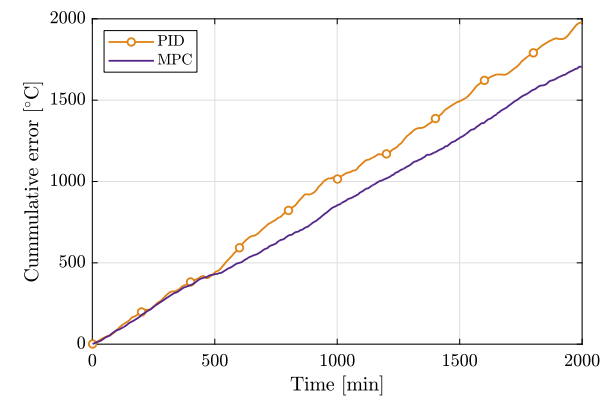
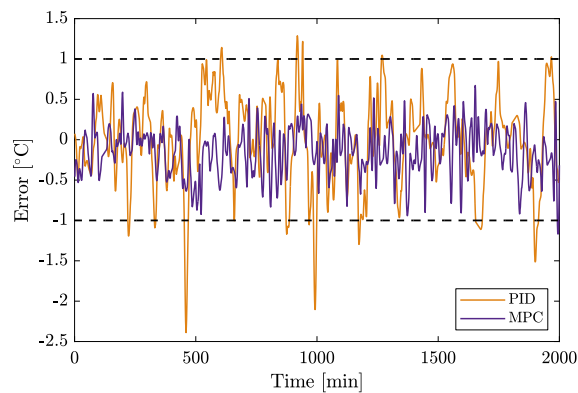
- Model based control of a district heating plant
- Short-term forecast of electric energy consumption
- Data-driven analysis and fault detection of Heating, ventilation, and air conditioning (HVAC) systems.
- Intelligent control of HVAC systems.

PROBLEM STATEMENT/ DISTRICT HEATING PLANT



REACTIVE CONTROL VS. PROACTIVE CONTROL

- Classical reactive control reacts to the situation and adjusts production.
- Intelligent proactive control predicts the demand and produces exact amount of energy.



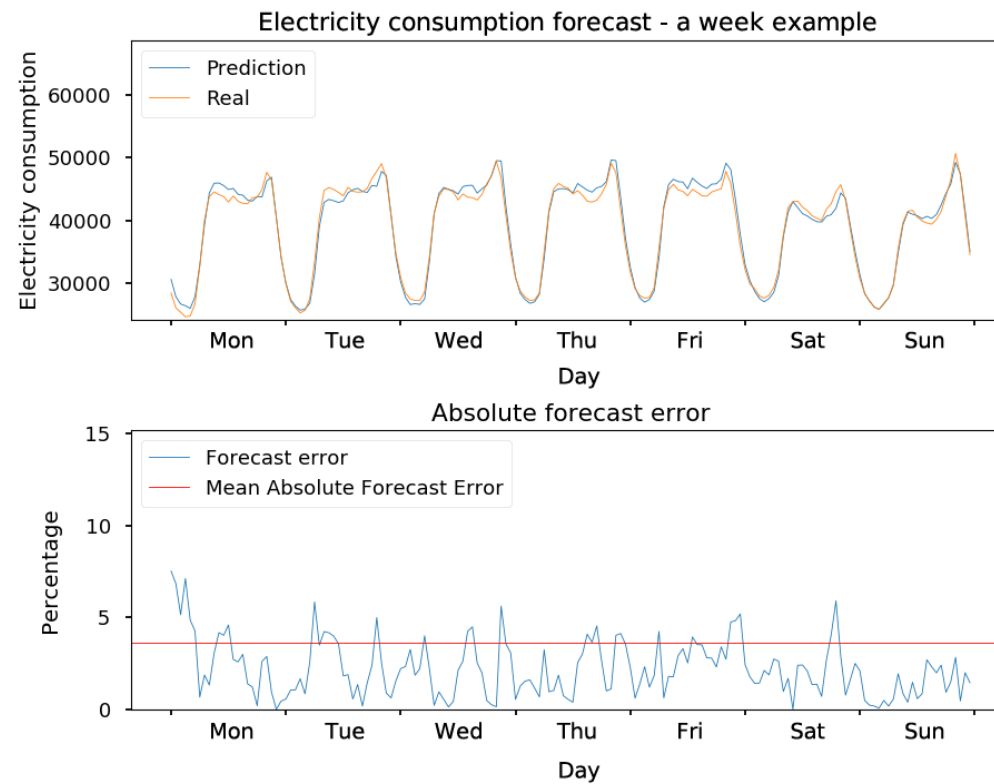
SHORT-TERM FORECAST OF ELECTRIC ENERGY CONSUMPTION

- **Problem:** electricity is non-storable in large amounts
- Electricity producers need to know how much electricity they need to generate tomorrow per hour
- Deadline for **order submission** for electricity suppliers

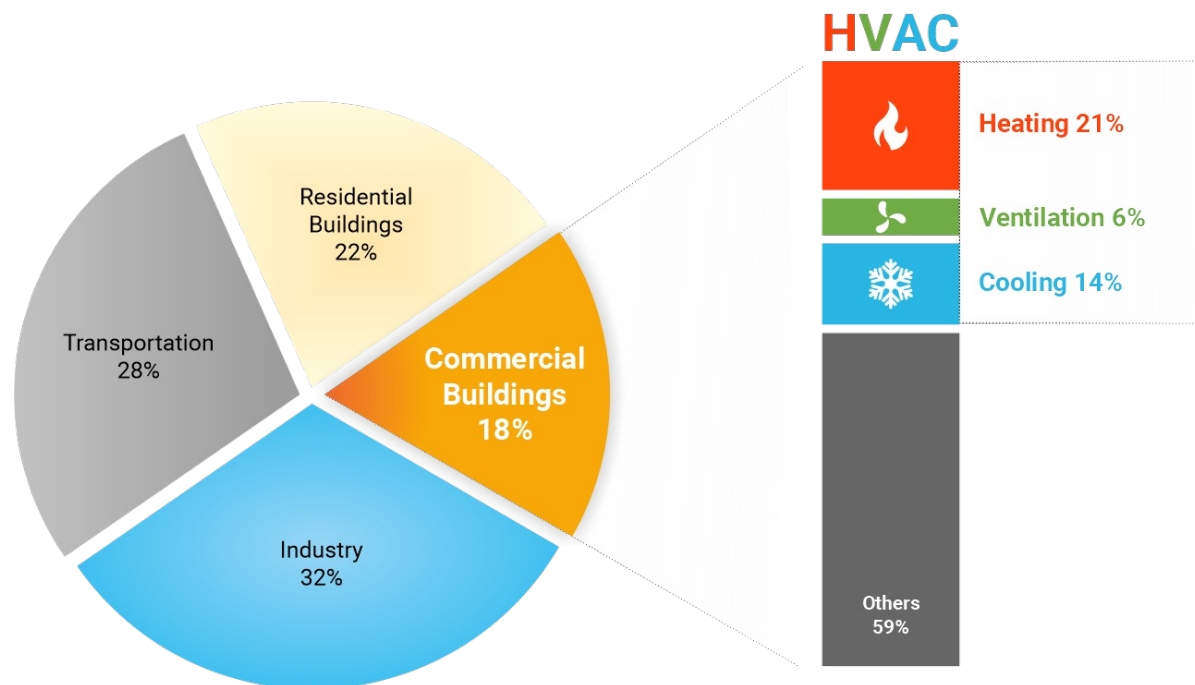
AVAILABLE DATASETS

- Electricity consumption for 2016-2019 years
- Weather historical data and forecasts:
 - Temperature
 - Humidity
 - Pressure
- Electricity consumption in Estonia
- Day length
- Electricity production of the solar panels (Alexela)
- Holidays and pre-holidays database
- Generated data: time, day, week, month

PREDICTION OF THE ELECTRICITY CONSUMPTION



ENERGY CONSUMPTION BY SECTOR

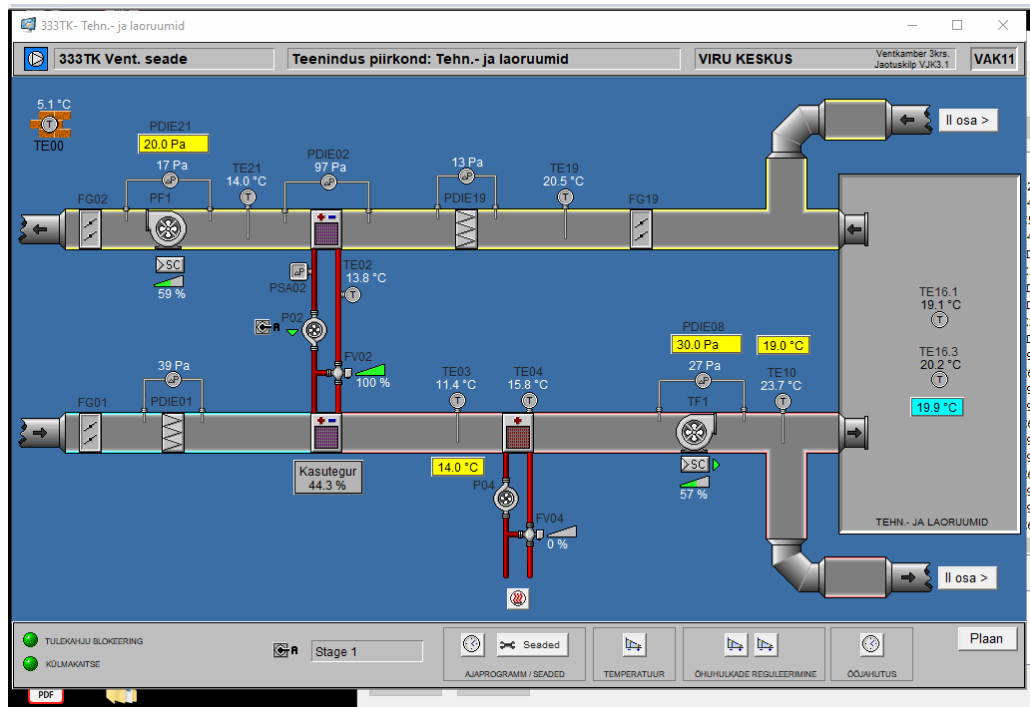


Cooperation with R8 Technologies OÜ started in 2019.

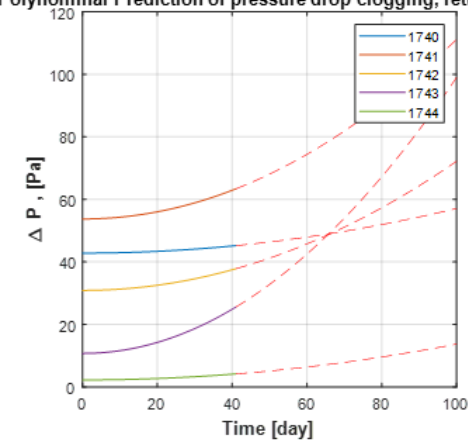
DATA-DRIVEN ANALYSIS AND FAULT DETECTION OF HEATING, VENTILATION, AND AIR CONDITIONING (HVAC) SYSTEMS.

Data from Building Information System

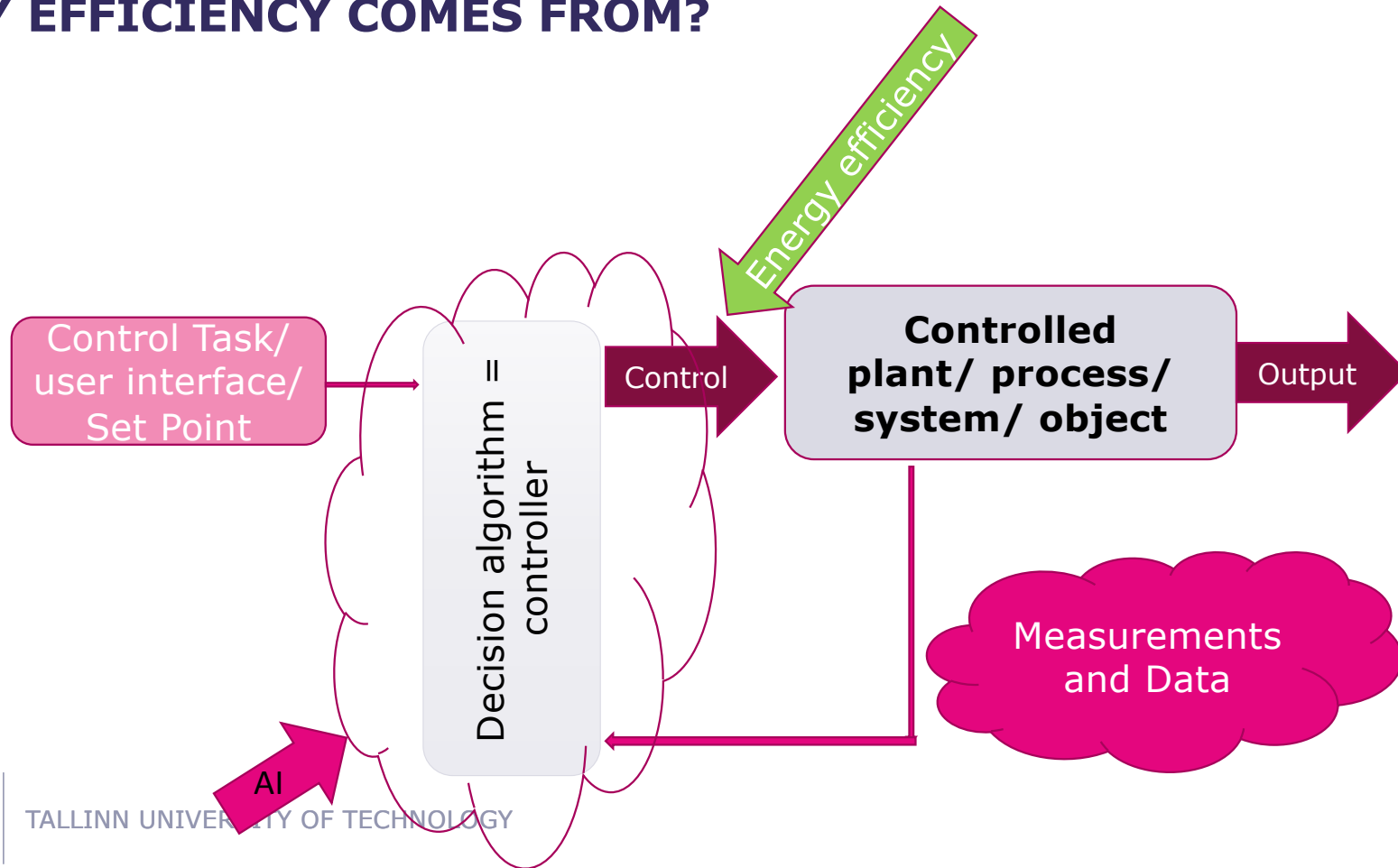
Prediction of filter clogging



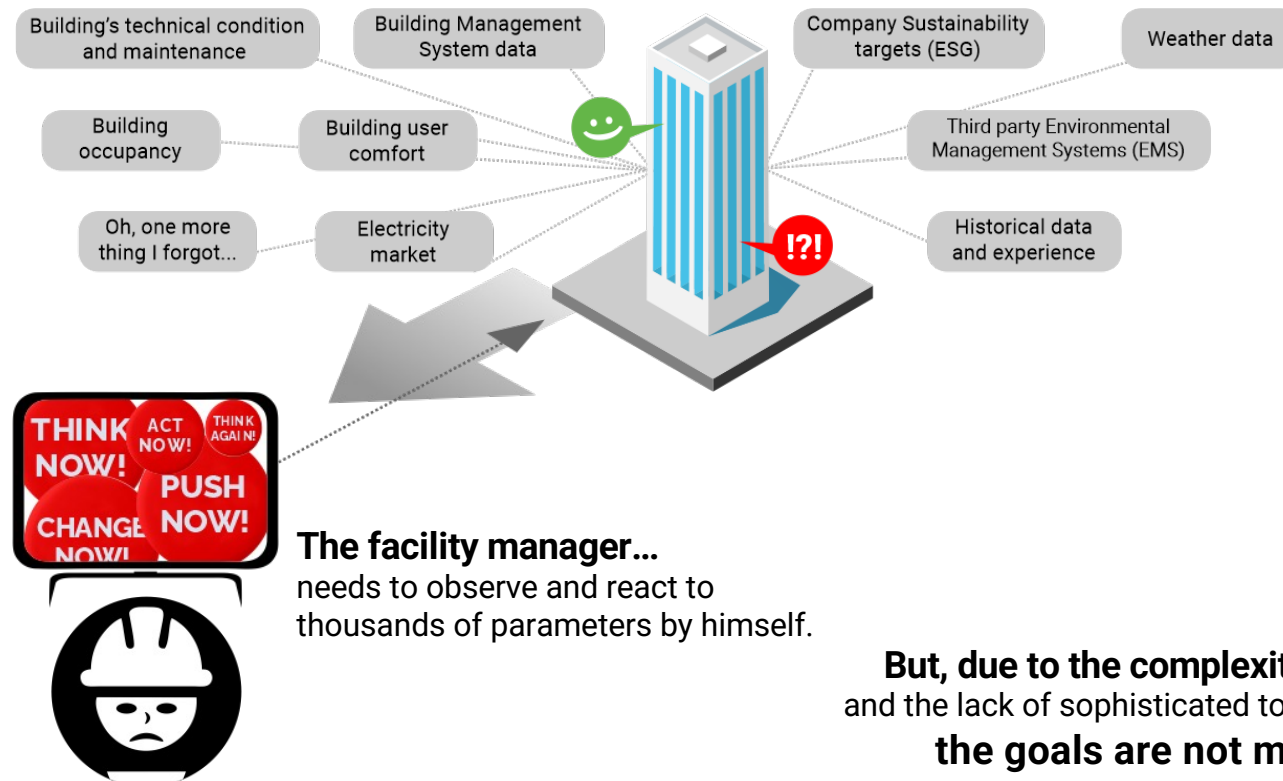
Polynomial Prediction of pressure drop clogging, return filter



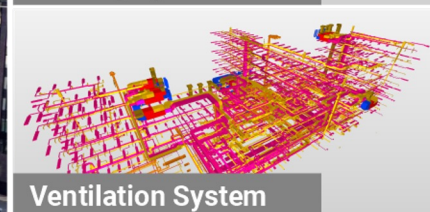
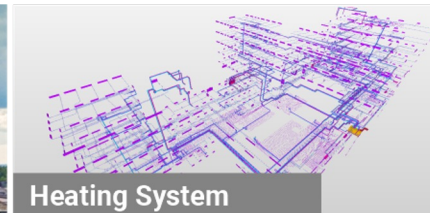
WHAT MEANS AUTOMATION AND WHERE ENERGY EFFICIENCY COMES FROM?



HOW CRE PROPERTIES ARE OPERATED TODAY?



SHOWCASE



 **constructed**
2018

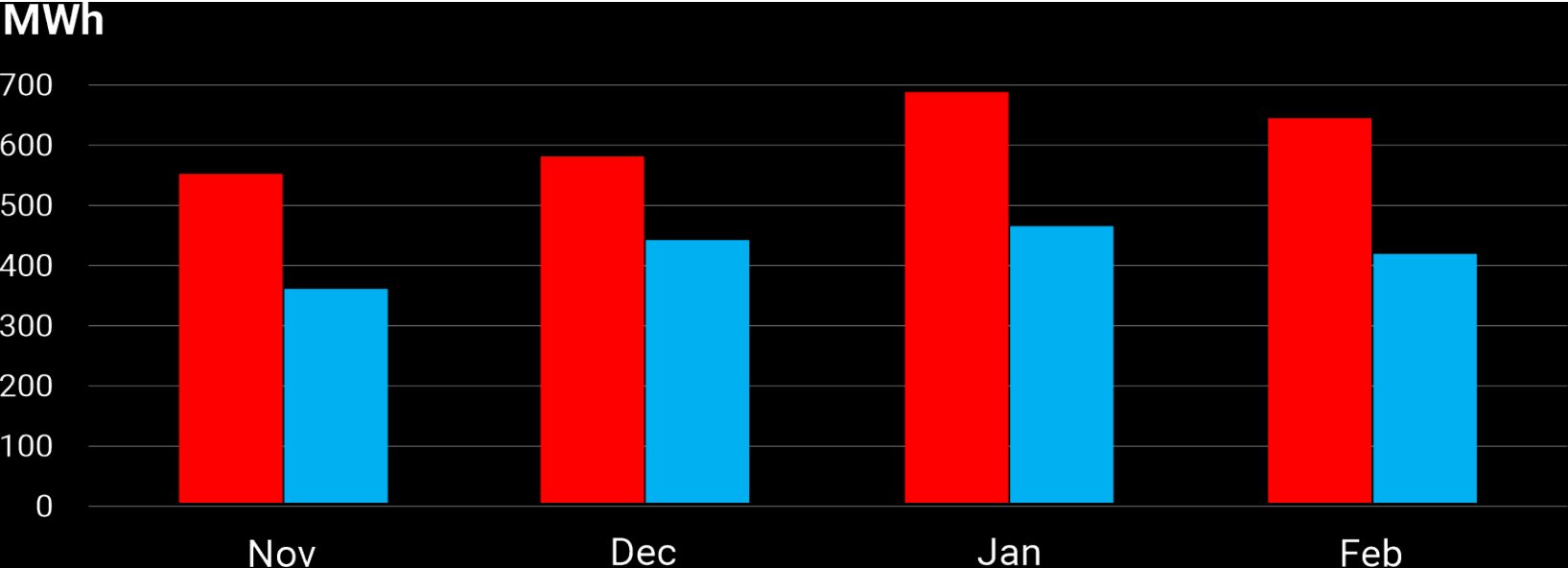
 **25 304 m²**
office building

 **48 813**
datapoints

 **2 898 controllable**
HVAC components

SHOWCASE: COURT HOUSE, TALLINN

Energy consumption: 31.5% savings on total costs



680 000
setpoint changes



900+ faults and
anomalies detected

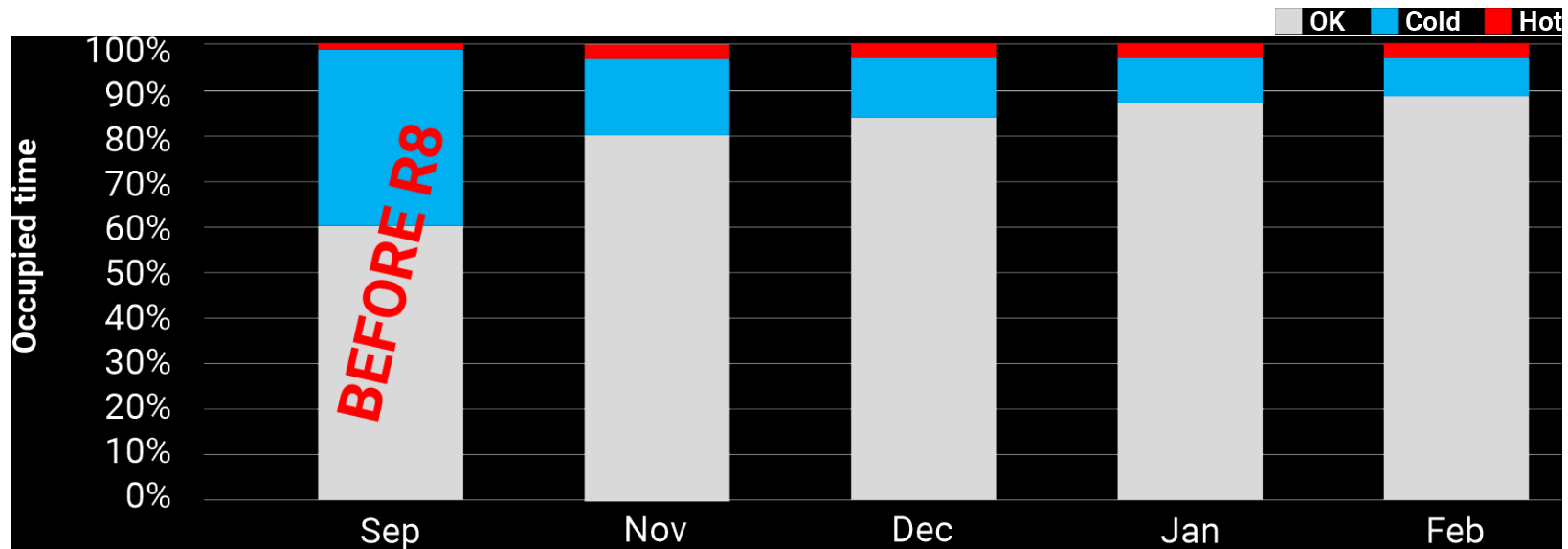


225 000+
kg CO₂ savings



SHOWCASE: COURT HOUSE, TALLINN

Thermal comfort increase from 60% to 90%



680 000
setpoint changes



900+ faults and
anomalies detected



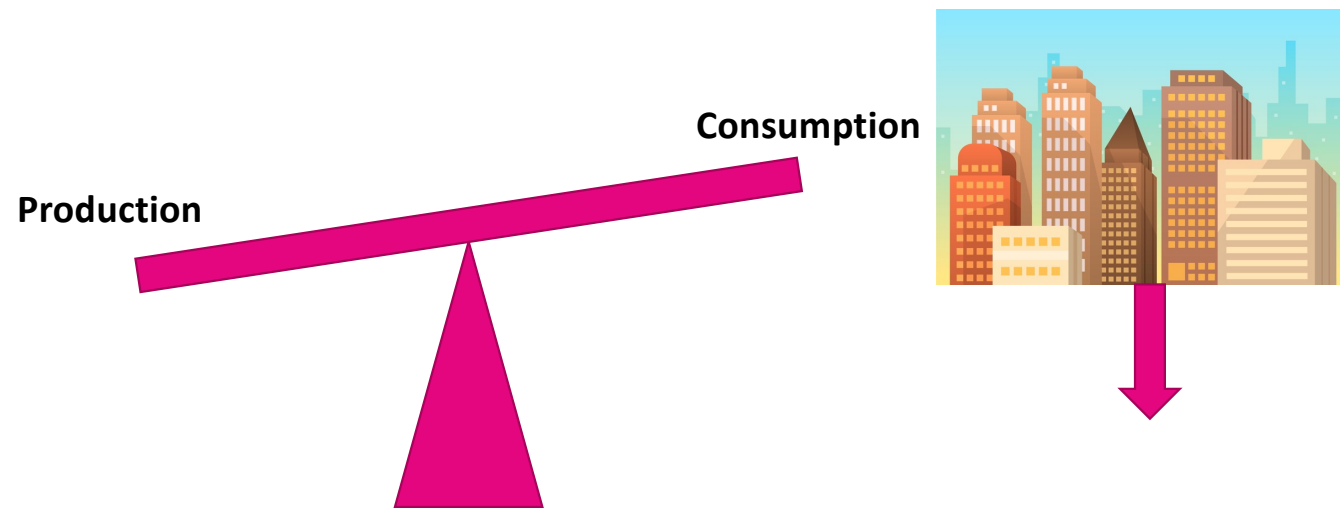
225 000+
kg CO₂ savings

**TAL
TECH**

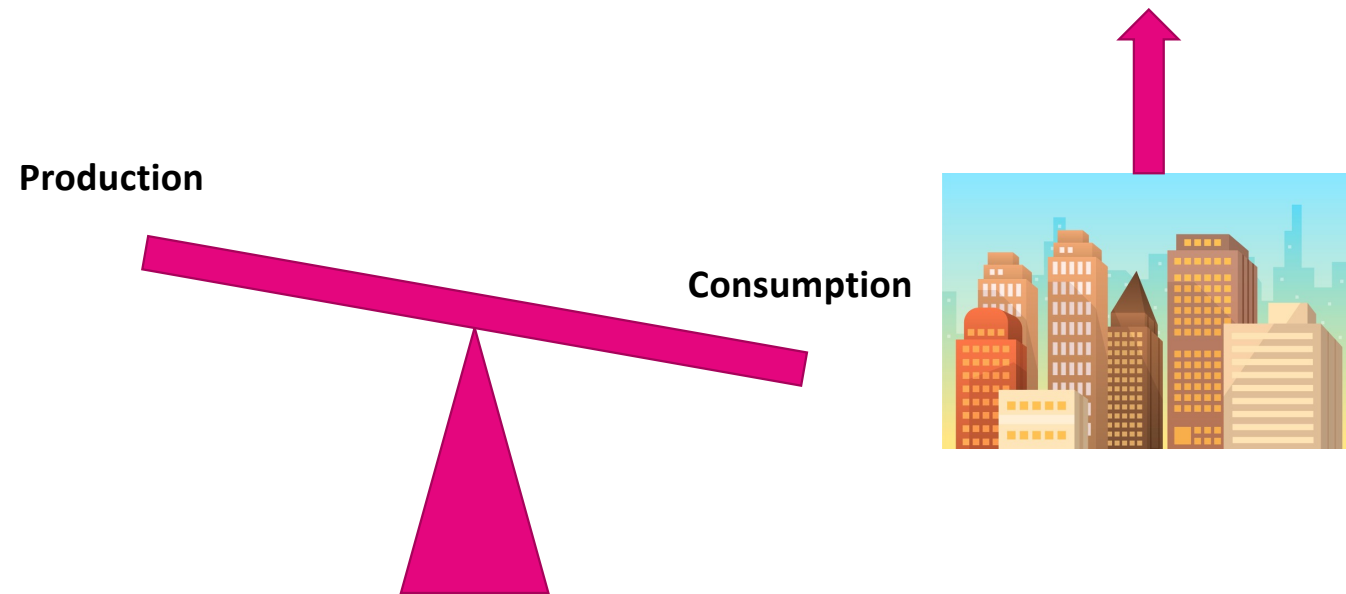
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R8
tech
Your invisible power

AI-DRIVEN DEMAND RESPONSE/ VIRTUAL POWER PLANT

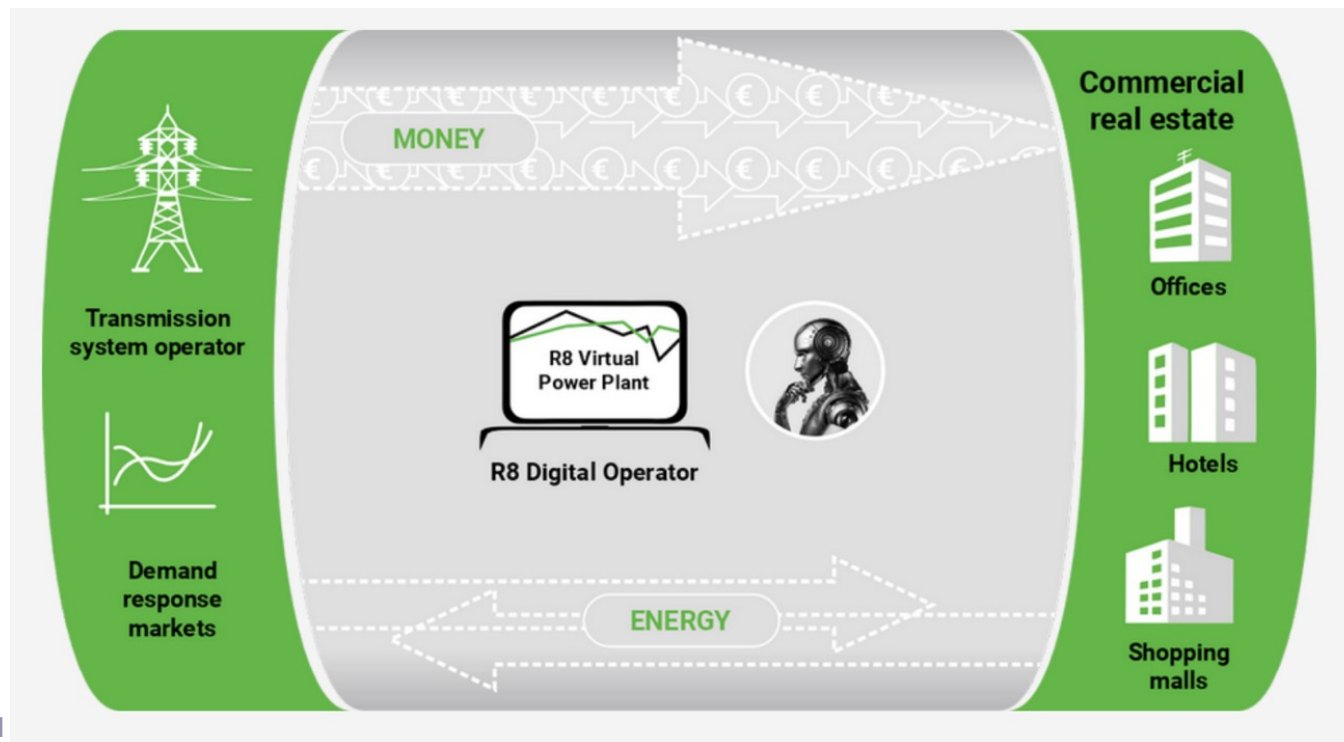


AI-DRIVEN DEMAND RESPONSE/ VIRTUAL POWER PLANT



AI-DRIVEN DEMAND RESPONSE/ VIRTUAL POWER PLANT

Sell your unused energy to the grid



THANK YOU!

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