Intelligent data-driven methods for energy-efficient control of commercial buildings

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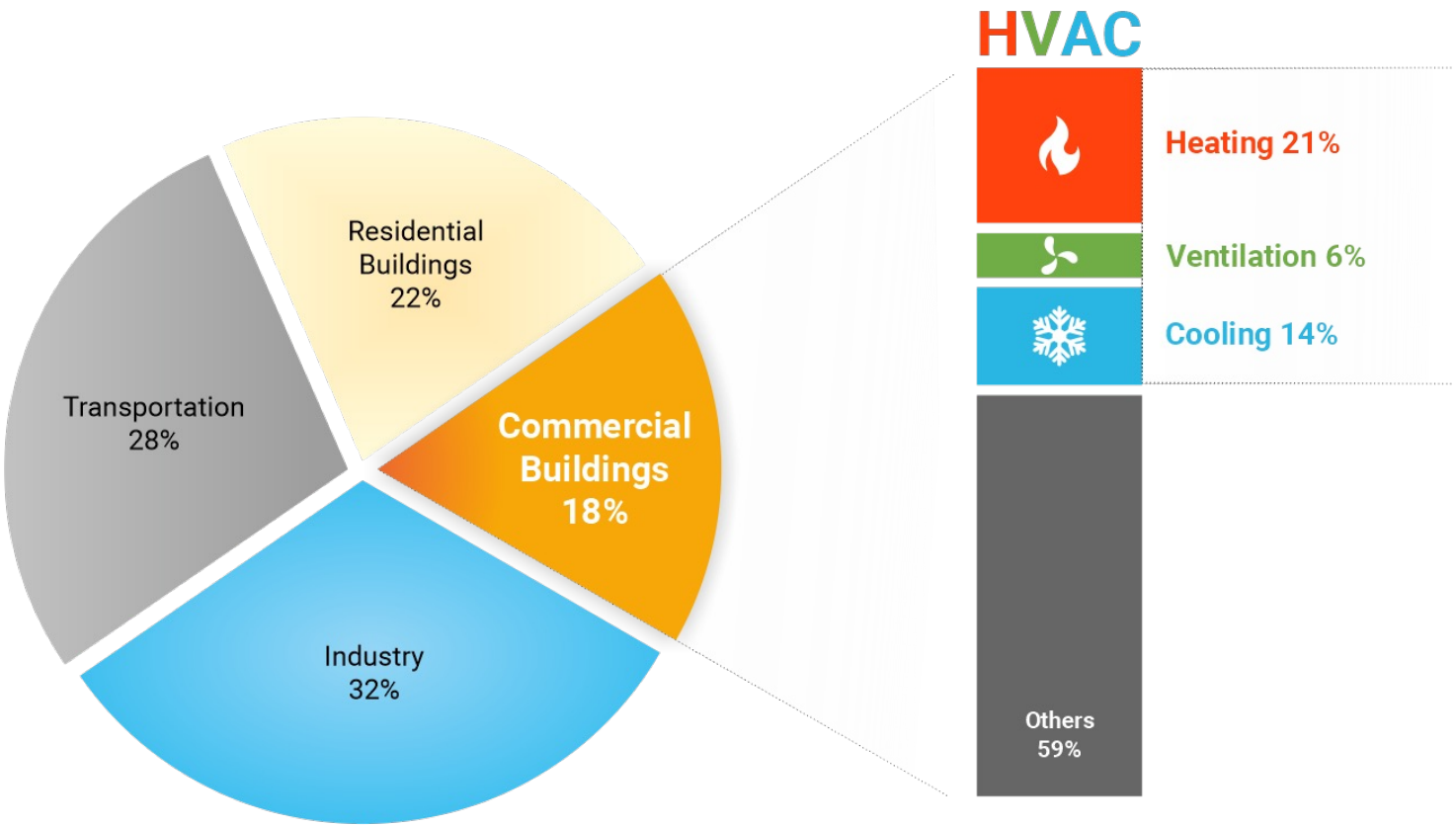
November 25-26, 2025 | Porto, Portugal

Energy Consumption by sector in EU



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

This equation is attributed to: Jørgensen, B. N. (2018). Energy Informatics. *Energy Informatics*, 1(7). https://doi.org/10.1186/s42162-018-0014-6

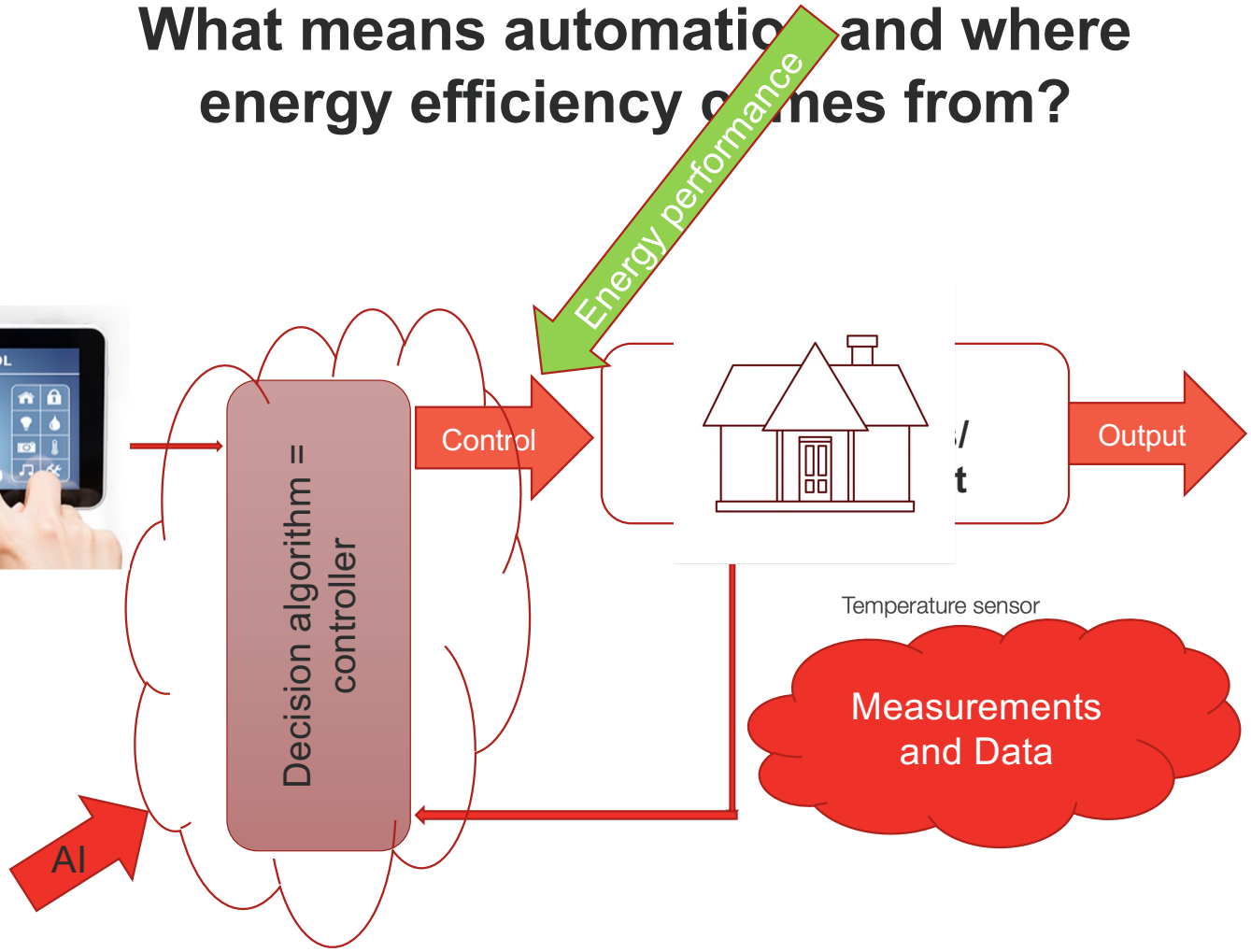
Consumption side

Importance of efficient HVAC systems for sustainable buildings

Key Performance Indicators

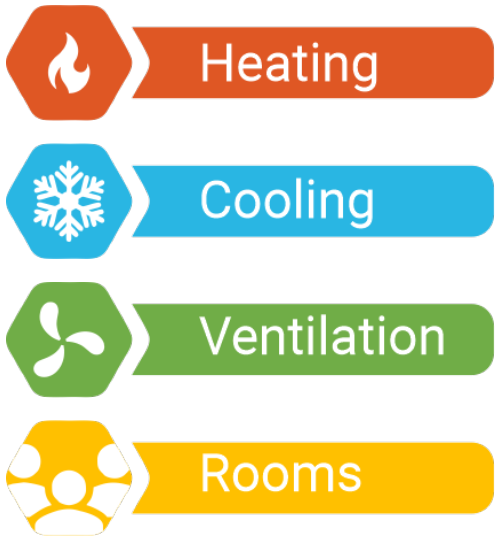
- Comfortable Indoor Climate
- Energy Efficiency
- Technical Condition

What means automatio and where energy efficiency c mes from?

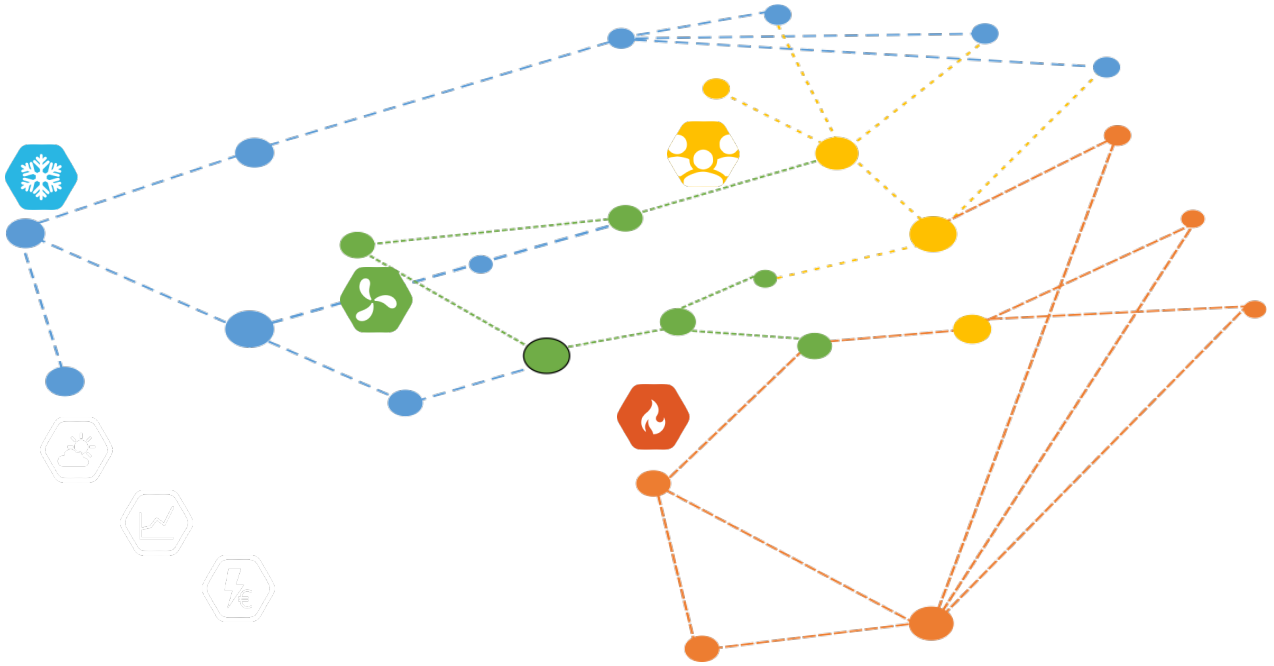


SMART CONTROL optimizes HVAC equipment by interconnecting them

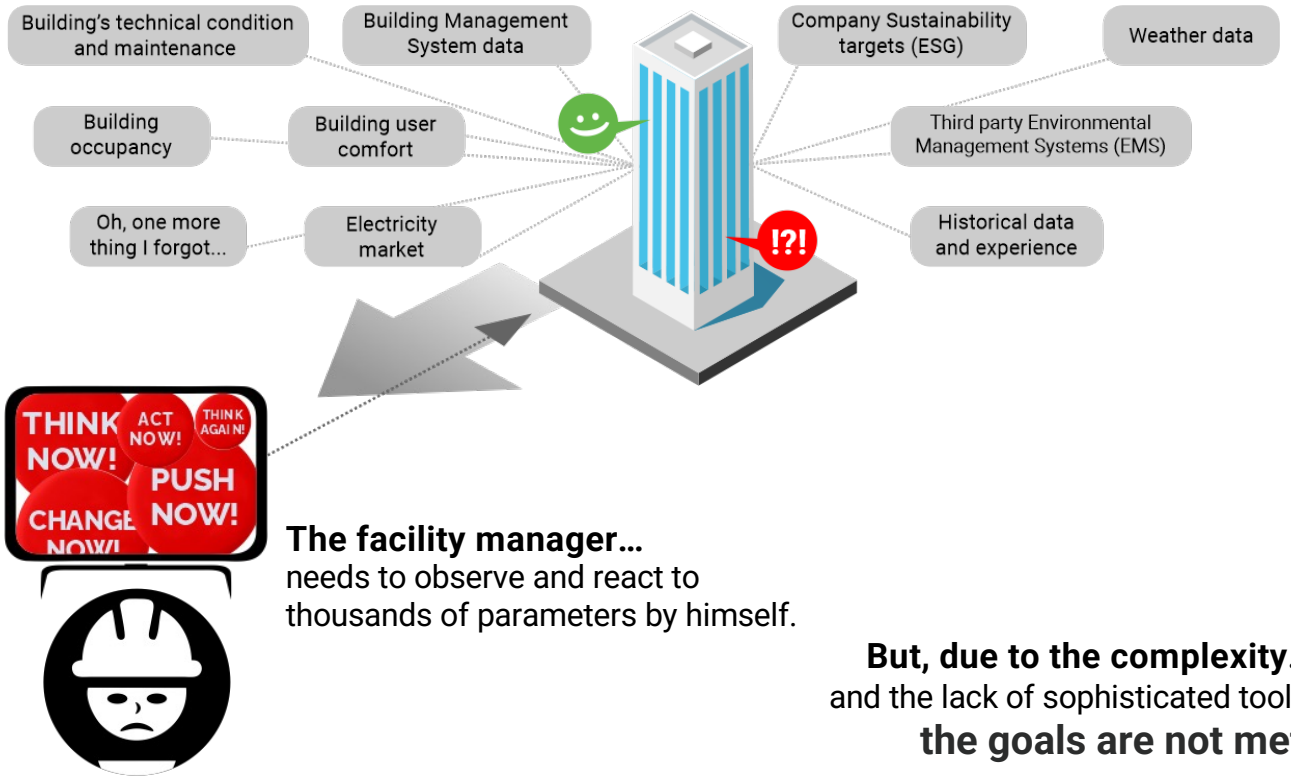
Traditional: building technical systems are sub-isolated and "managed" independently:



Smart Control synchronizes all sub-components by micro adjustments:



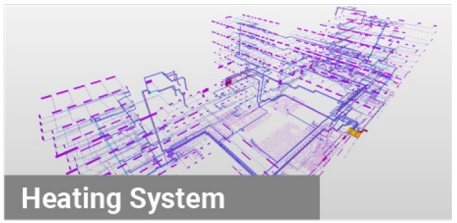
How real estate is operated today?

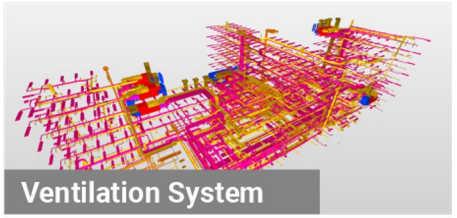


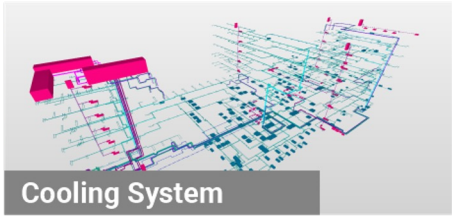
The facility manager…
needs to observe and react to thousands of parameters by himself.

But, due to the complexity…
and the lack of sophisticated tools,
the goals are not met.

Showcase







constructed
2018

25 304 m²
office building

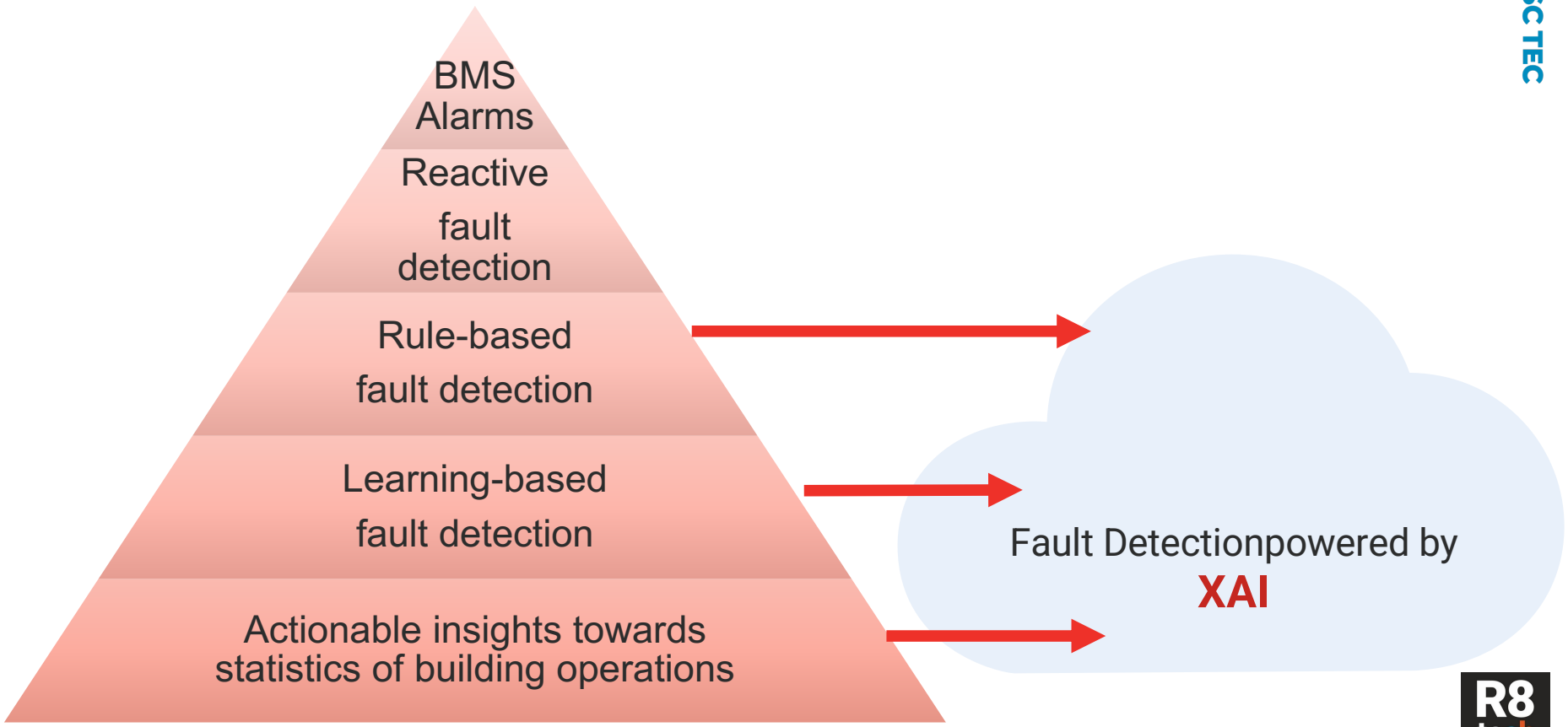
48 813
datapoints

2 898 controllable
HVAC components

What could it look like if a human could do it?

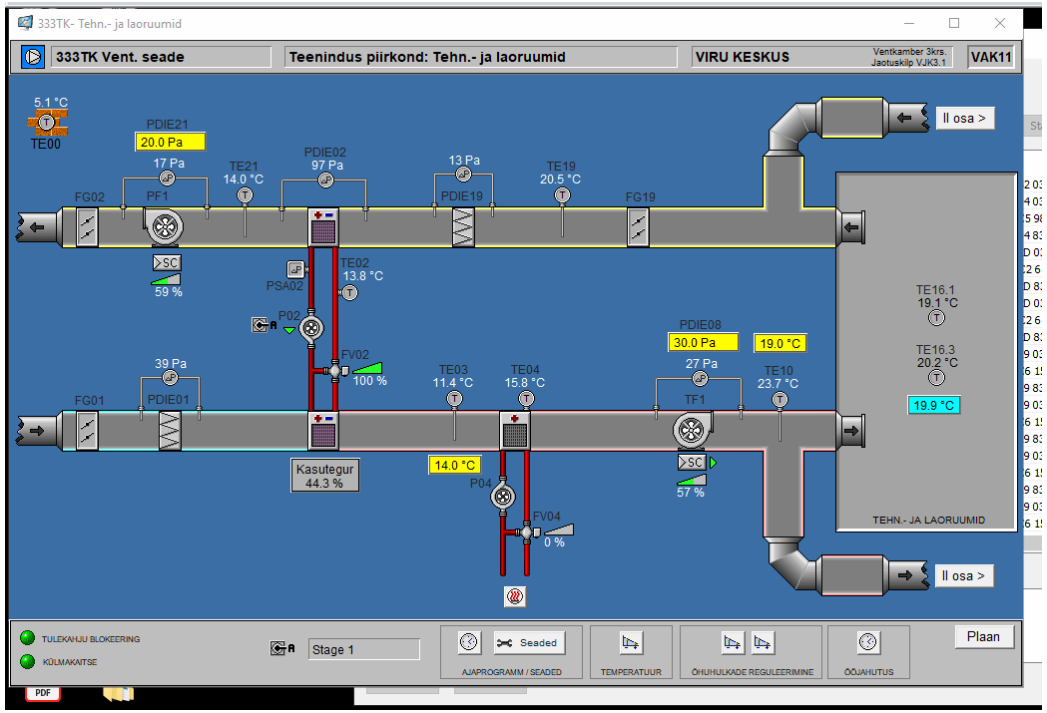
Takemoto, Y. (Director), & Gatoh, S. (Writer). (2006, June 11). *Iteza no Hi* [射手座の日] (Season 1, Episode 11) [TV series episode]. In T. Ishihara (Executive Producer), The Melancholy of Haruhi Suzumiya. Kyoto Animation.

Commonly used Fault detection and diagnosis (FDD) methods for HVAC equipment

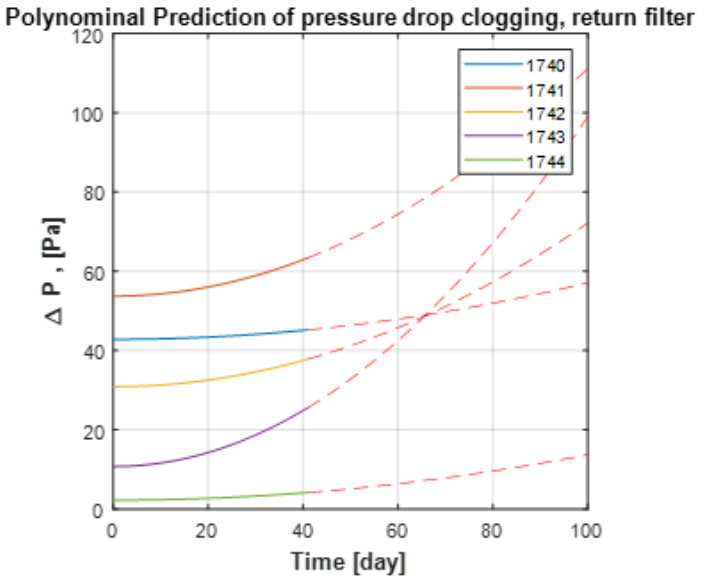


Data-driven analysis and fault detection of Heating, ventilation, and air conditioning (HVAC) systems.

Data from Building Management System

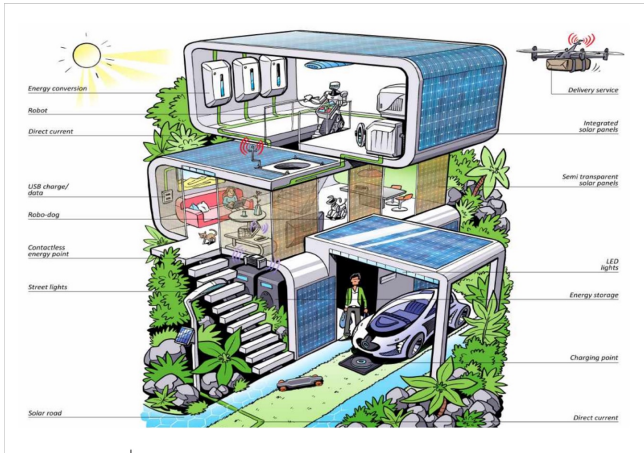


Prediction of filter clugging

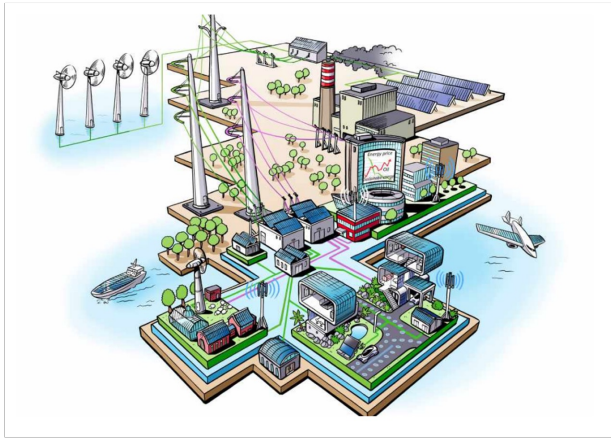


Future smart homes and smart cities

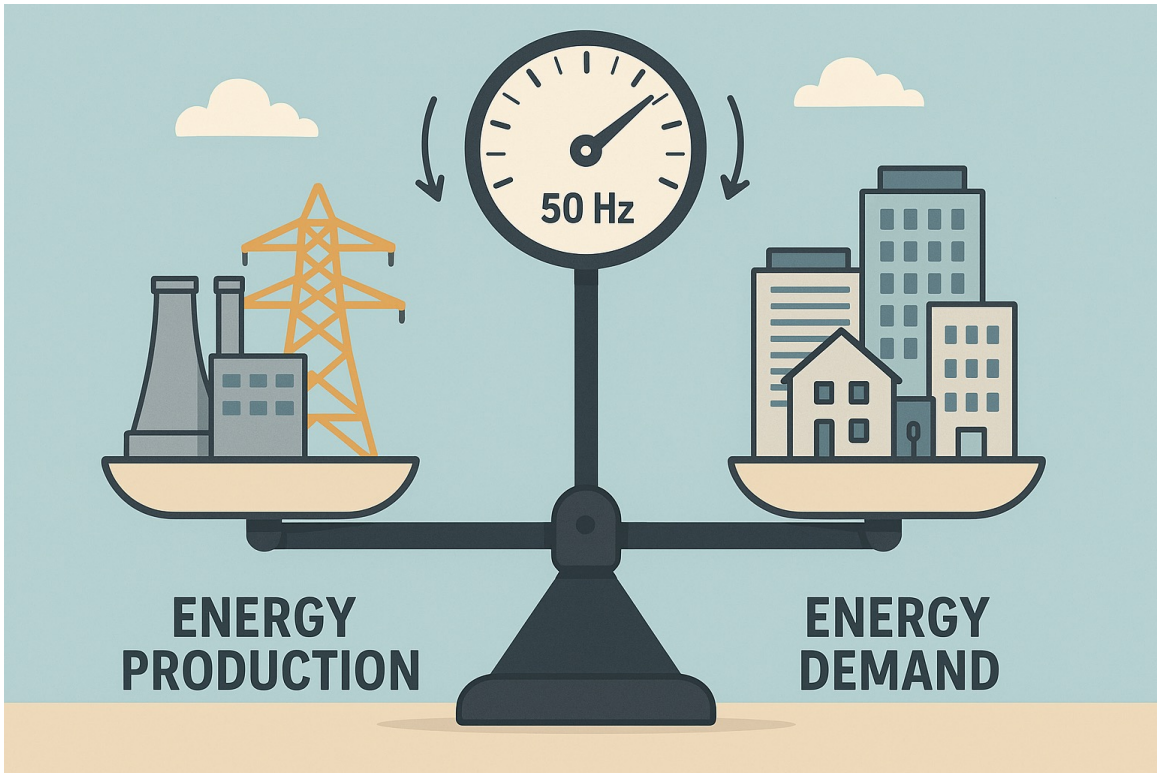
Future smart homes will be capable to satisfy their own energy needs.
They will be equipped with IoT devices to bring both user comfort and energy efficiency.



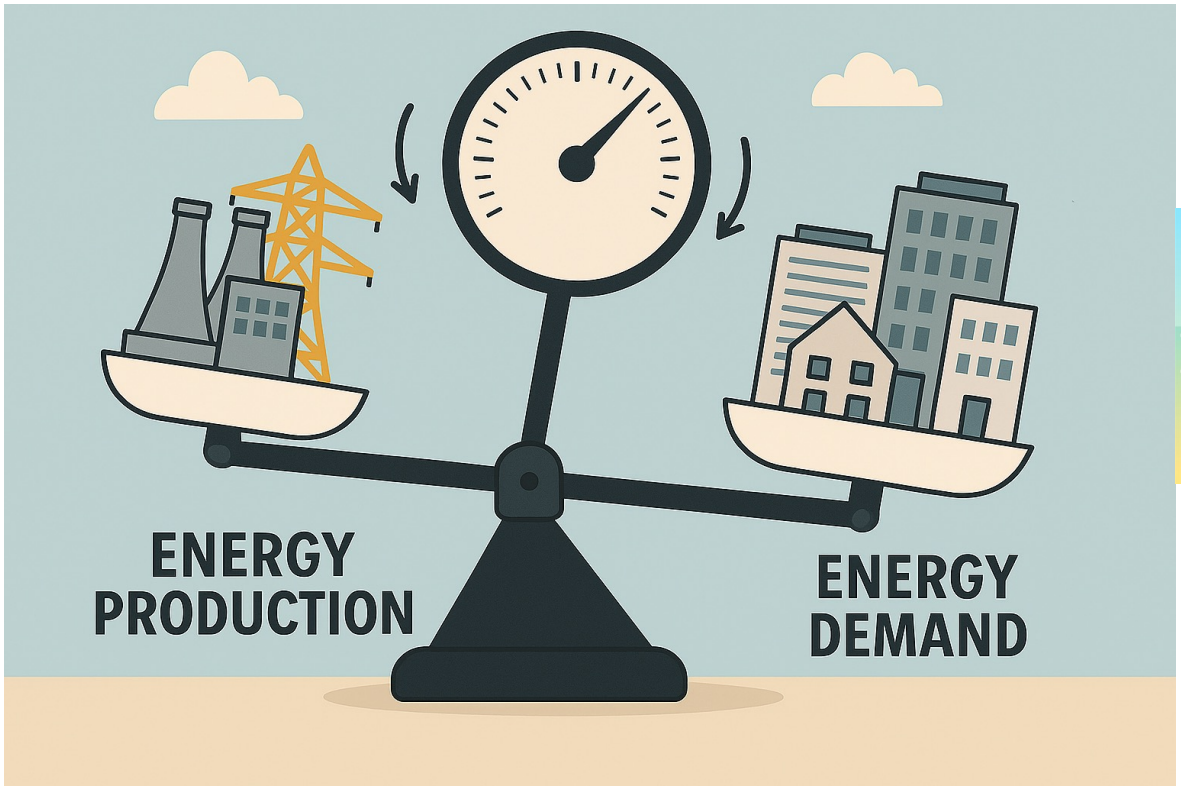
Future smart cities will be armed by smart technologies such as smart grids, autonomous transportation etc.
They will enable the city and their citizens to be connected in a smart and rational city environment.

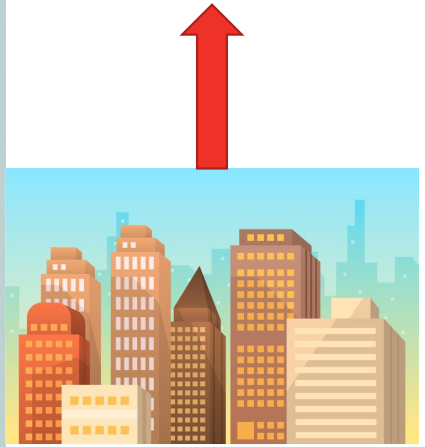


Ai-driven Demand Response



Ai-driven Demand Response





Decrease aggregated energy consumption

=

Increased production

Benefits of AI-driven solution

- Works 24/7
- Analyzes huge amounts of data (“Big Data”)
- Can model and predict buildings’ dynamics
- Optimizes consumption based on day-ahead forecasts
- Considers the energy price
- Buildings can learn from each other
- Cloud solution without additional hardware
- Synchronizes all sub-components
- Can make a lot of micro-adjustments

- **As a result…**
- Comfortable indoor climate with a 15% to 30% lower energy consumption

Challenges related to AI-driven control

- Explainability: Black box and grey box models
- Complexity
- Computational costs
- Data quality, availability and amount
- Trustworthiness
- Safety
- Reliability
- Stability

Thank you!

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