The Mystery of Energy Data Science

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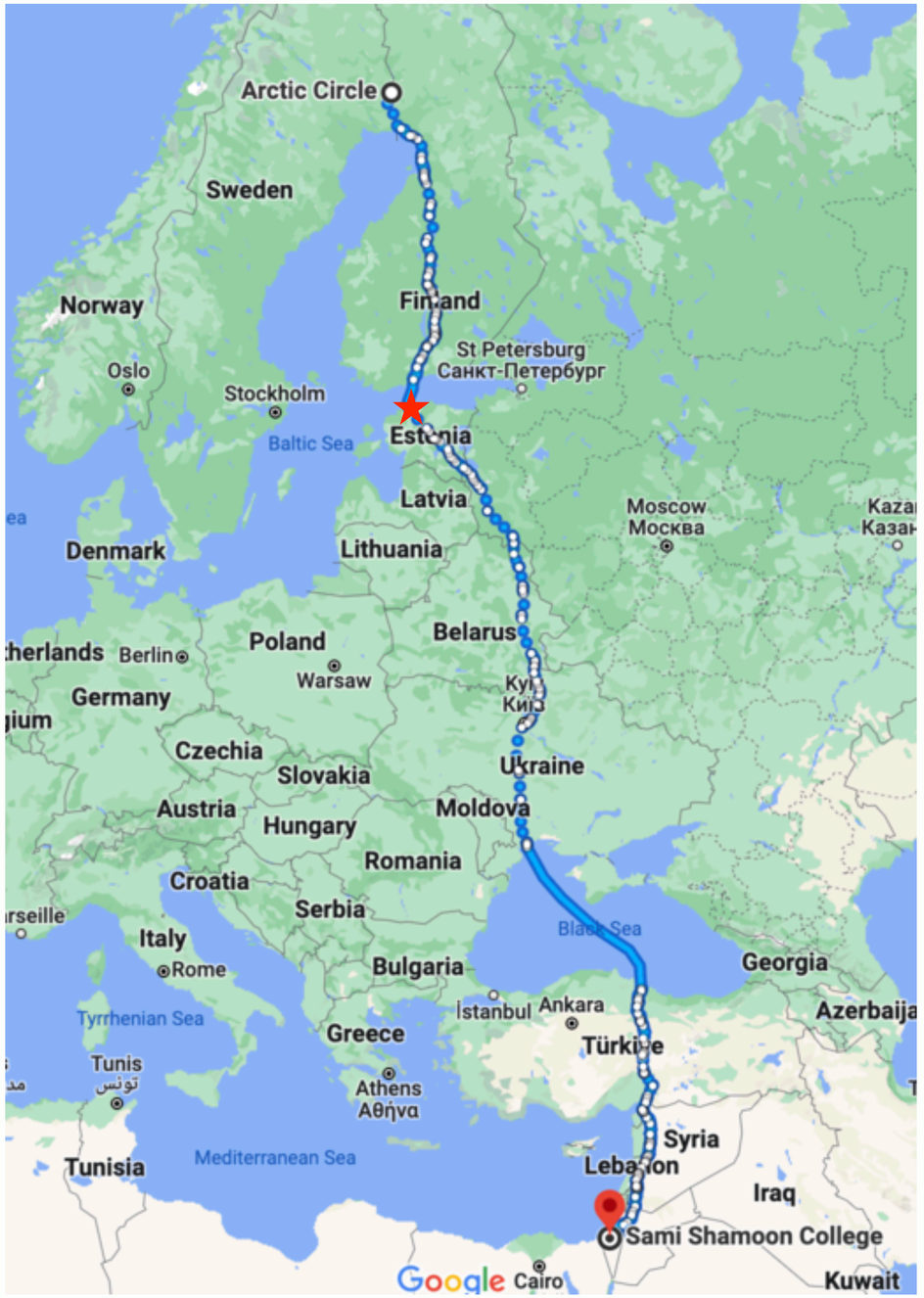
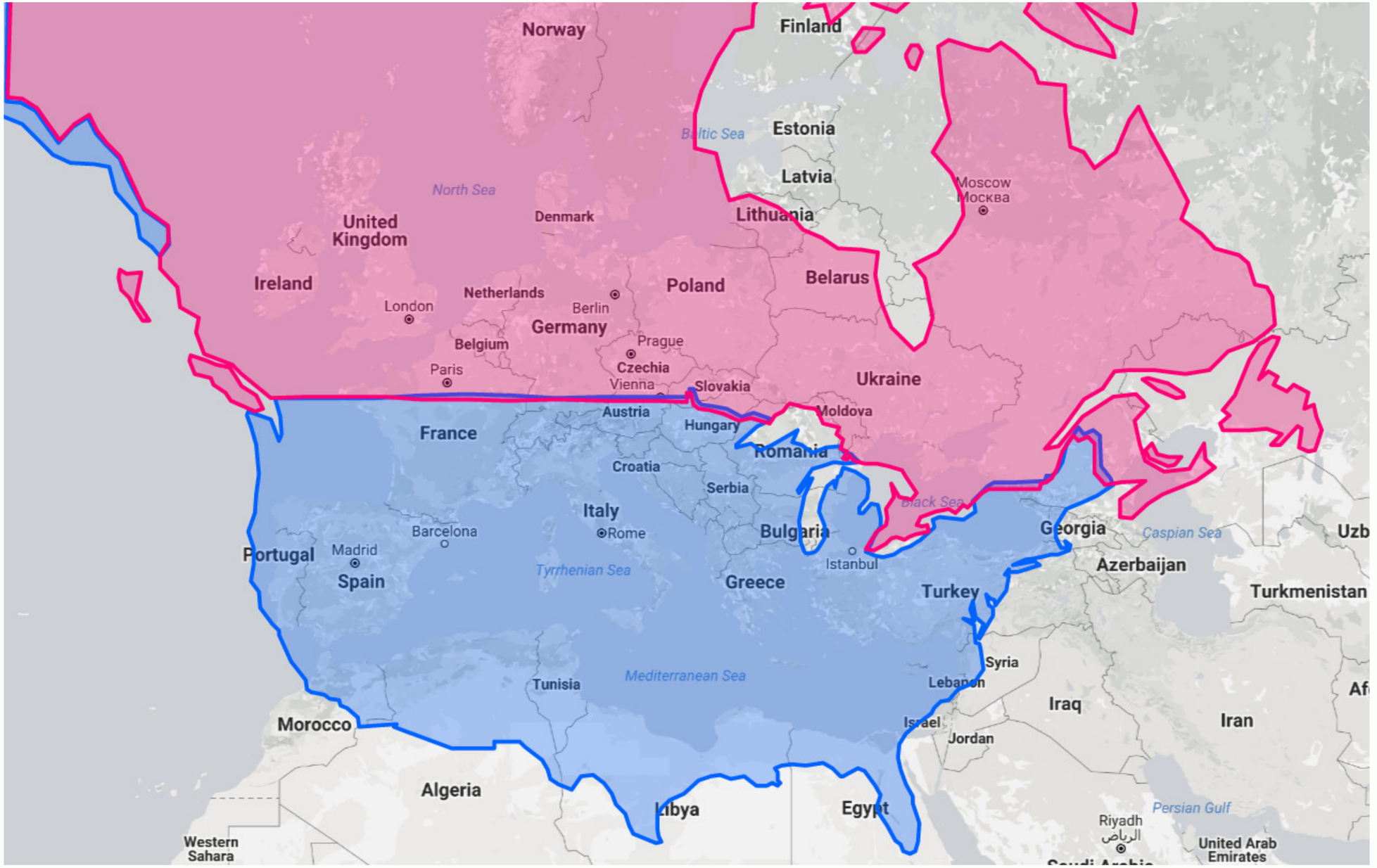
Shamoon College of Engineering, Beer Sheva, 27.03.2025

ESTONIA

- ✓ Area 45,227 km2
- ✓ Population ~1.3 mln
- ✓ Capital: Tallinn
- ✓ Currency: Euro
- ✓ Over 52% is covered with forest
- ✓ Highest point is 318m above the sea level
- ✓ 10 unicorns (eg Skype, Playtech, Wise, Bolt, etc.)





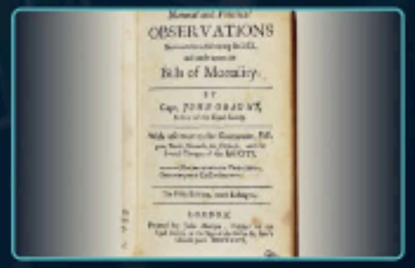
[Accessed February 27, 2025], https://www.reddit.com/r/MapPorn/comments/63m1fn/the_united_states_and_canada_at_the_same/

HISTORY OF DATA

19,000 BC

The Ishango bone holds the first evidence of data collection and storage.

1600s



John Graunt introduces the concept of data analysis in 1663.

1800s

Herman Hollerith designs a machine that helped complete the US census in 1890.

1900s

Fritz Pfleumer invents the magnetic tape which later inspired the invention of floppy disks and hard disk drives.

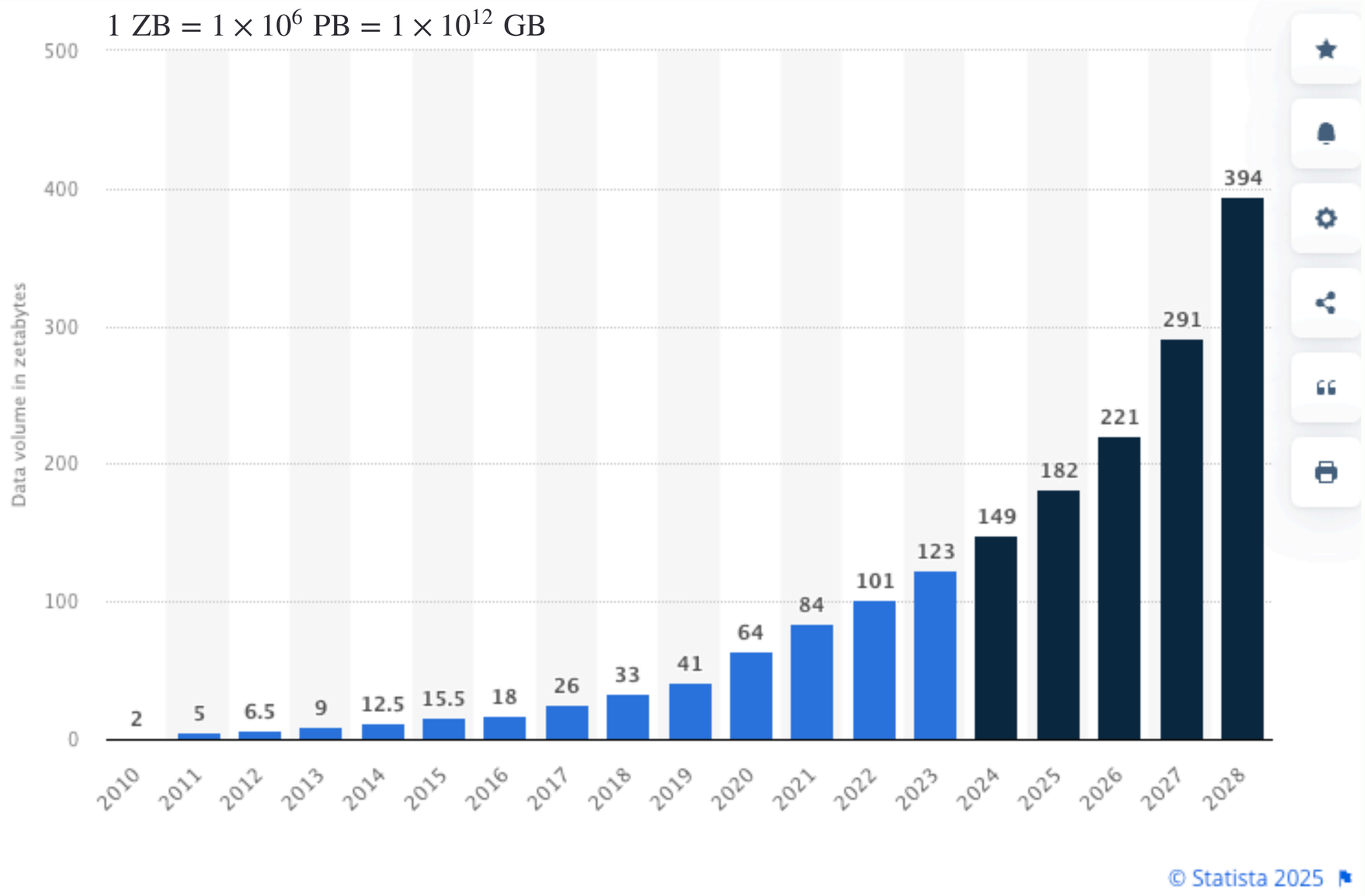
1990s

Sir Tim Berners Lee invents the World Wide Web.

[Accessed February 27, 2025], https://365datascience.com/trending/history-of-data/

WORLD DATA IN NUMBERS

$$1\ \text{ZB} = 1 \times 10^{6}\ \text{PB} = 1 \times 10^{12}\ \text{GB}$$

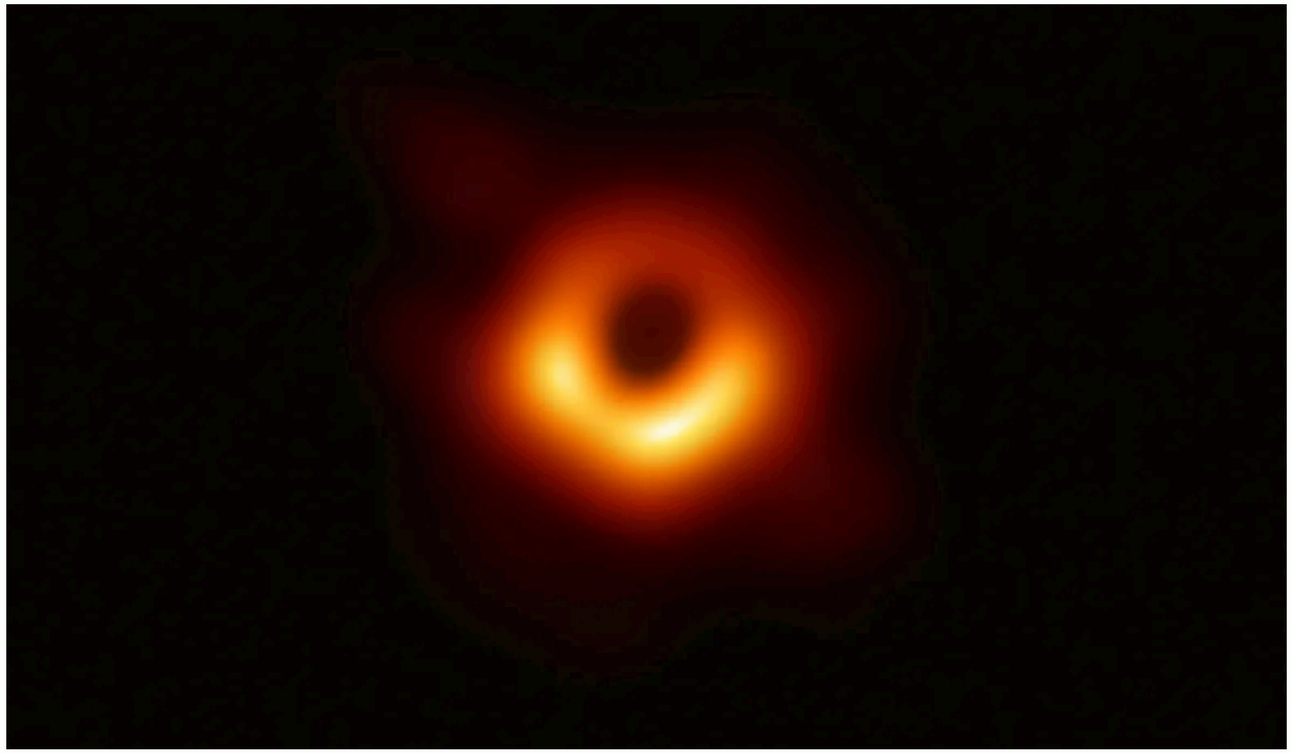


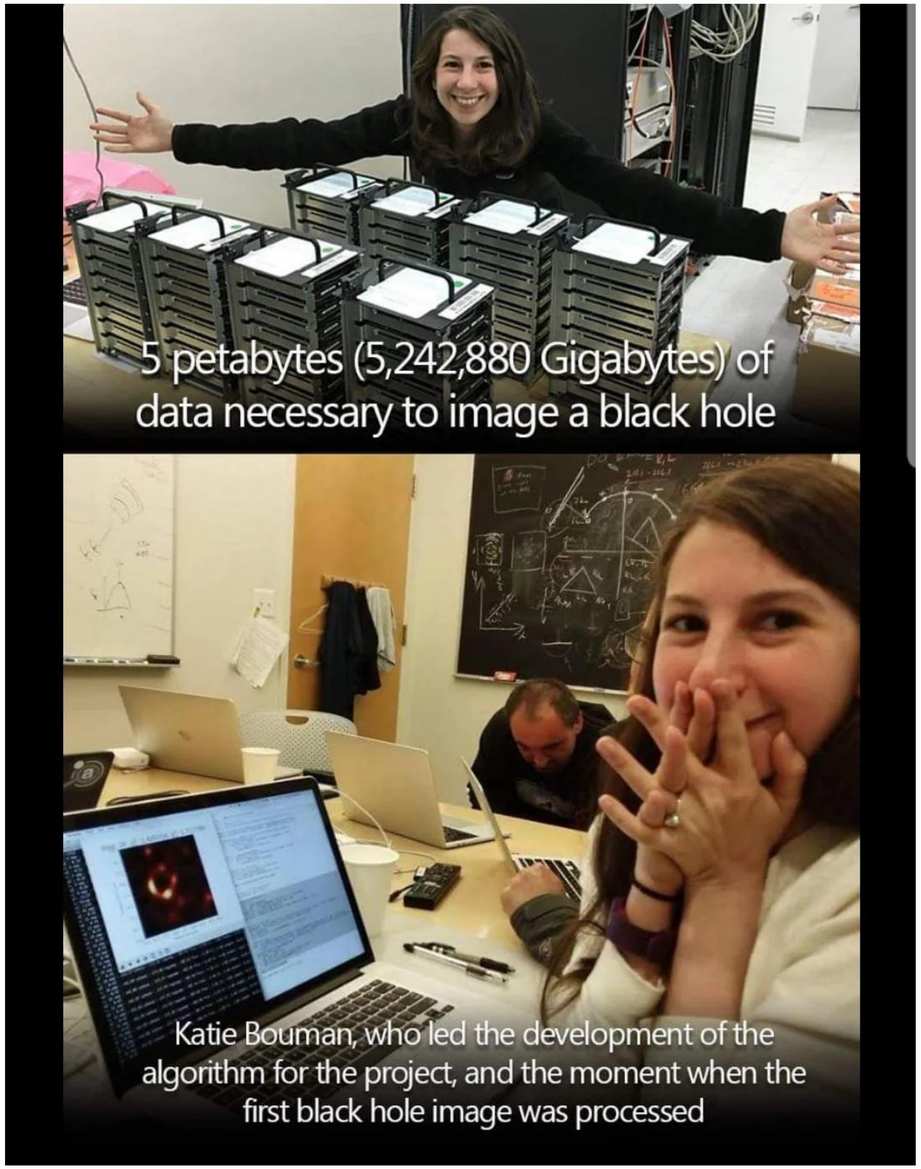
[Accessed February 27, 2025], https://www.statista.com/statistics/871513/worldwide-data-created/

WORLD DATA IN NUMBERS (2)

Home > Extreme

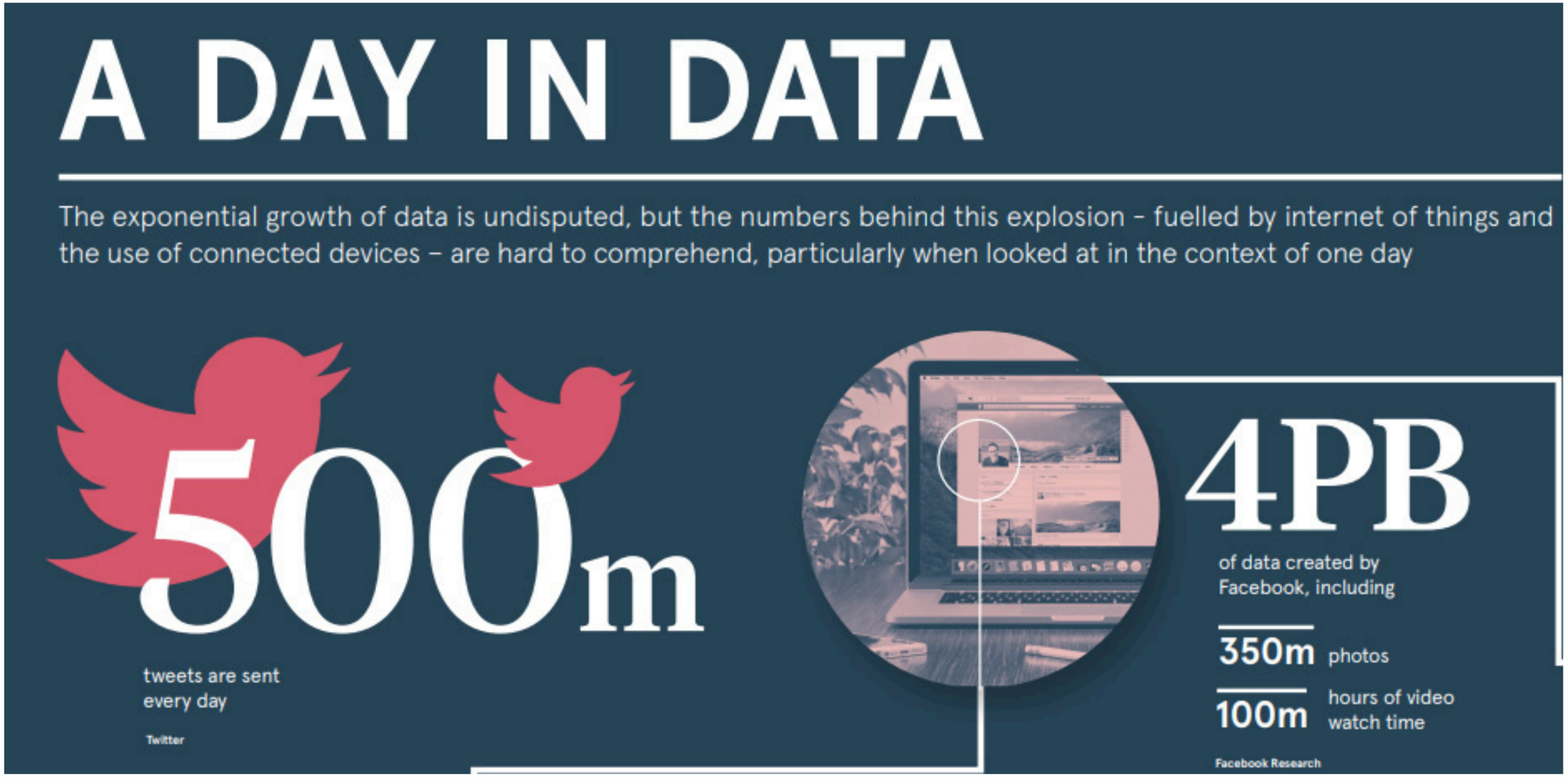
It Took Half a Ton of Hard Drives to Store the Black Hole Image Data





[Accessed February 27, 2025], https://www.extremetech.com/extreme/289423-it-took-half-a-ton-of-hard-drives-to-store-eht-black-hole-image-data
https://science.nasa.gov/resource/first-image-of-a-black-hole/

WORLD DATA IN NUMBERS (3)



[Accessed August 19, 2024], https://www.visualcapitalist.com/wp-content/uploads/2019/04/data-generated-each-day-wide.html

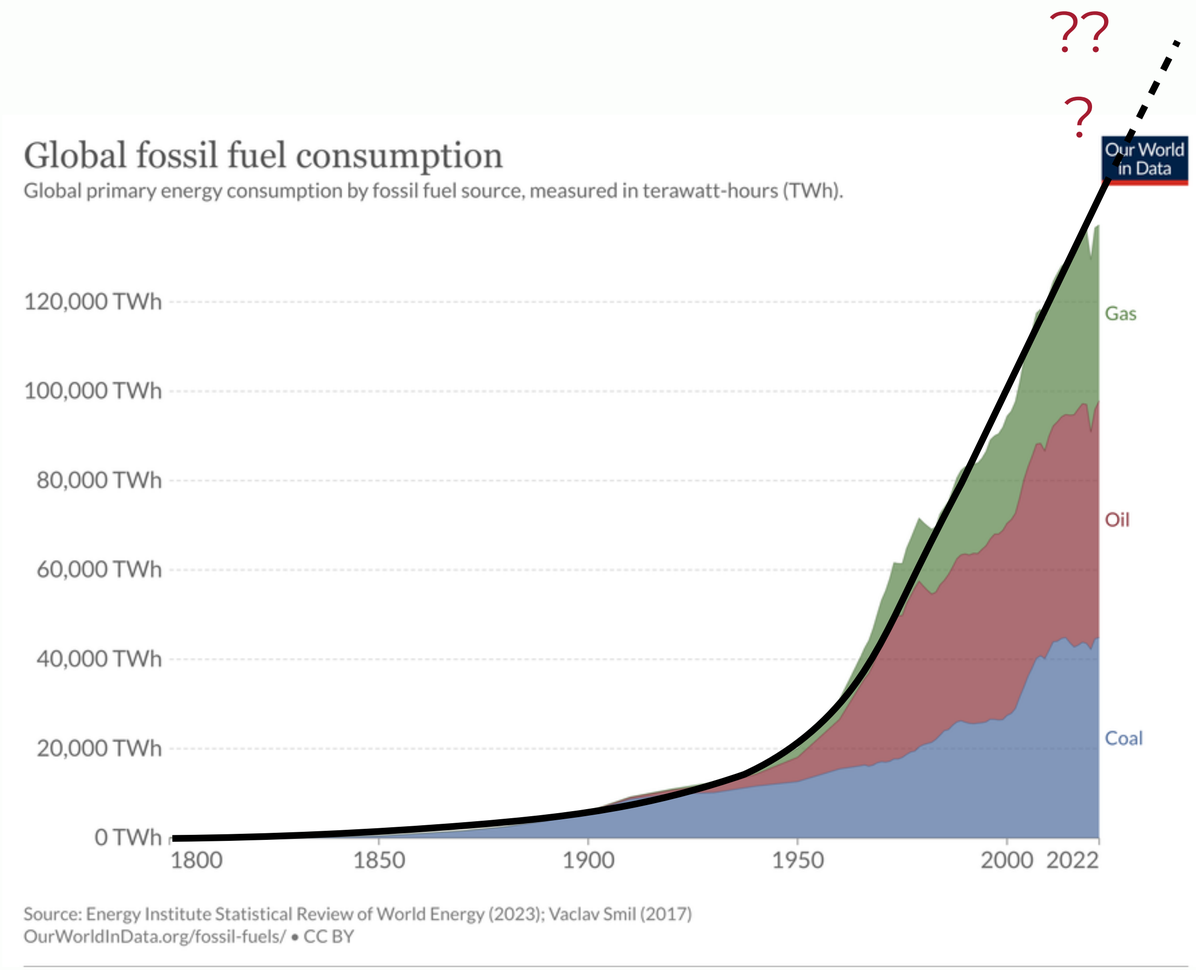
[Accessed February 27, 2025], https://dryield.com/using-predictive-data-analytics-in-manufacturing/

ENERGY & SCIENCE

Humans learn to use more energy ...

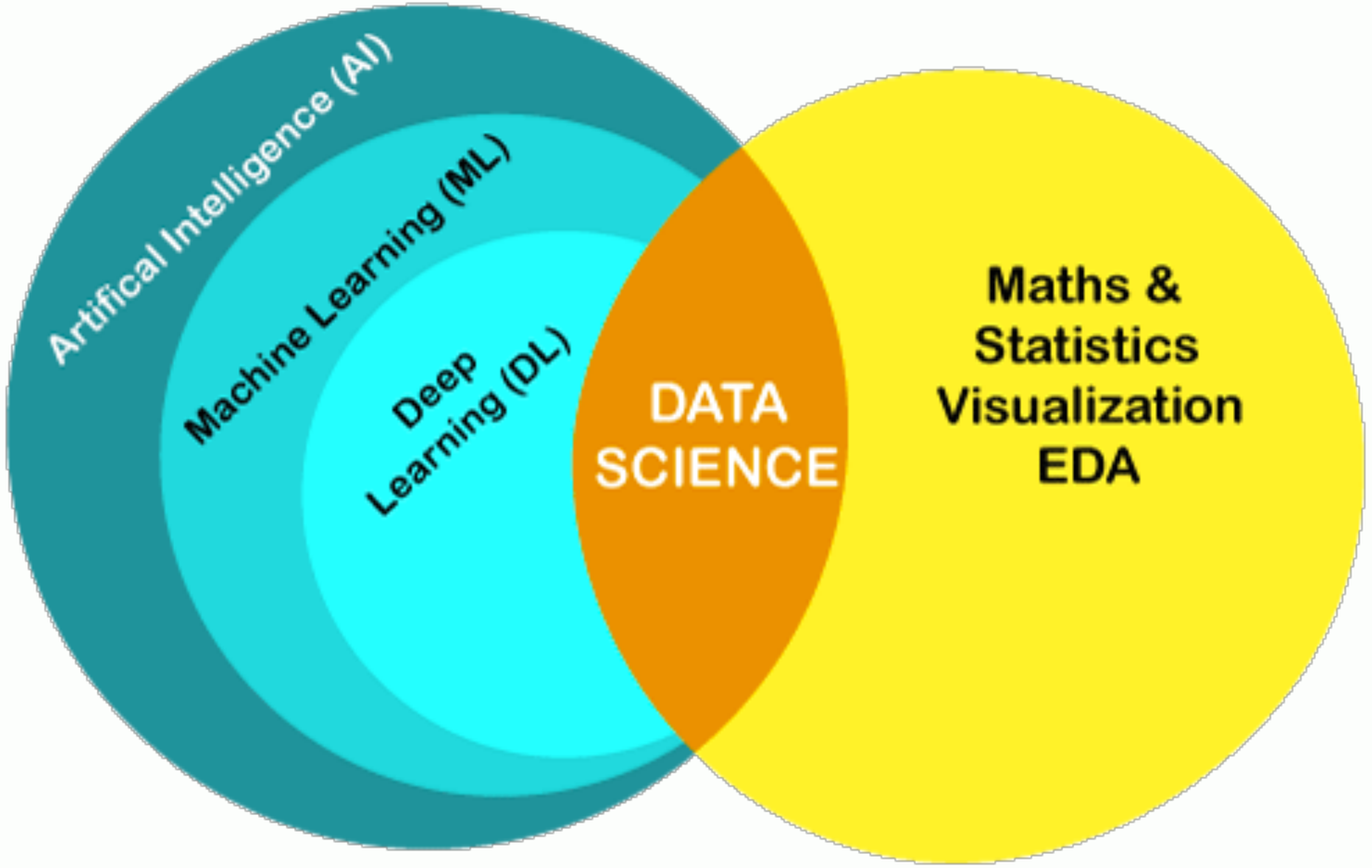
ENERGY LANDSCAPE: HOW LONG?

Such a growth is not *sustainable* and cannot last forever ...



https://ourworldindata.org/energy-mix

[Accessed February 27, 2025], https://www.linkedin.com/pulse/exploring-interdependency-data-governance-management-science-garg-6i85e/



[Accessed August 20, 2024], https://www.javatpoint.com/data-science-vs-machine-learning

WHAT IS A DATA SCIENCE?

Data science **combines** math and statistics, specialised programming, advanced analytics, artificial intelligence (AI), and machine learning with specific subject matter expertise to **uncover** actionable insights hidden in an organisation’s data.

These insights can be used to guide decision making and strategic planning.

by IBM

https://www.ibm.com/topics/data-science
https://hbr.org/2012/10/data-scientist-the-sexiest-job-of-the-21st-century
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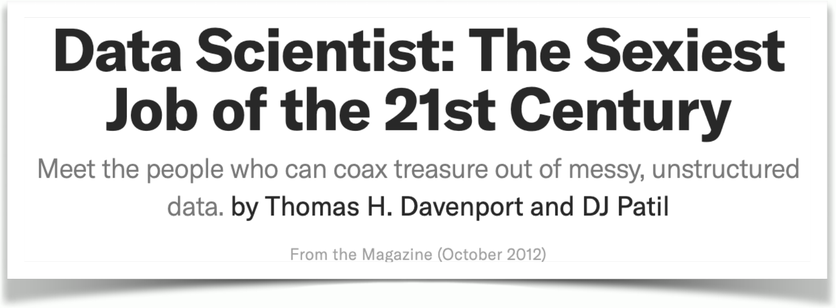

Data Scientist: The Sexiest Job of the 21st Century

Meet the people who can coax treasure out of messy, unstructured data. by Thomas H. Davenport and DJ Patil

From the Magazine (October 2012)

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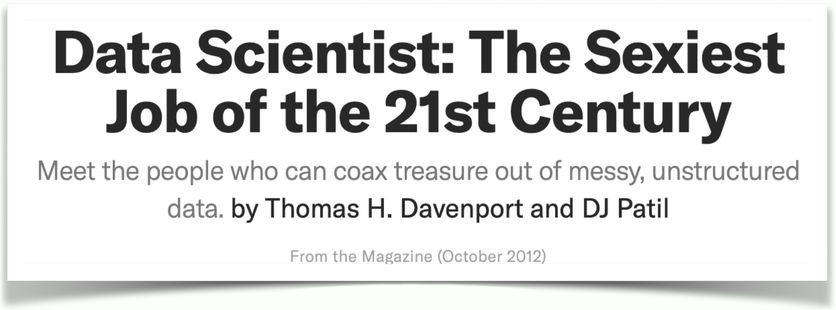

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July 15, 2022

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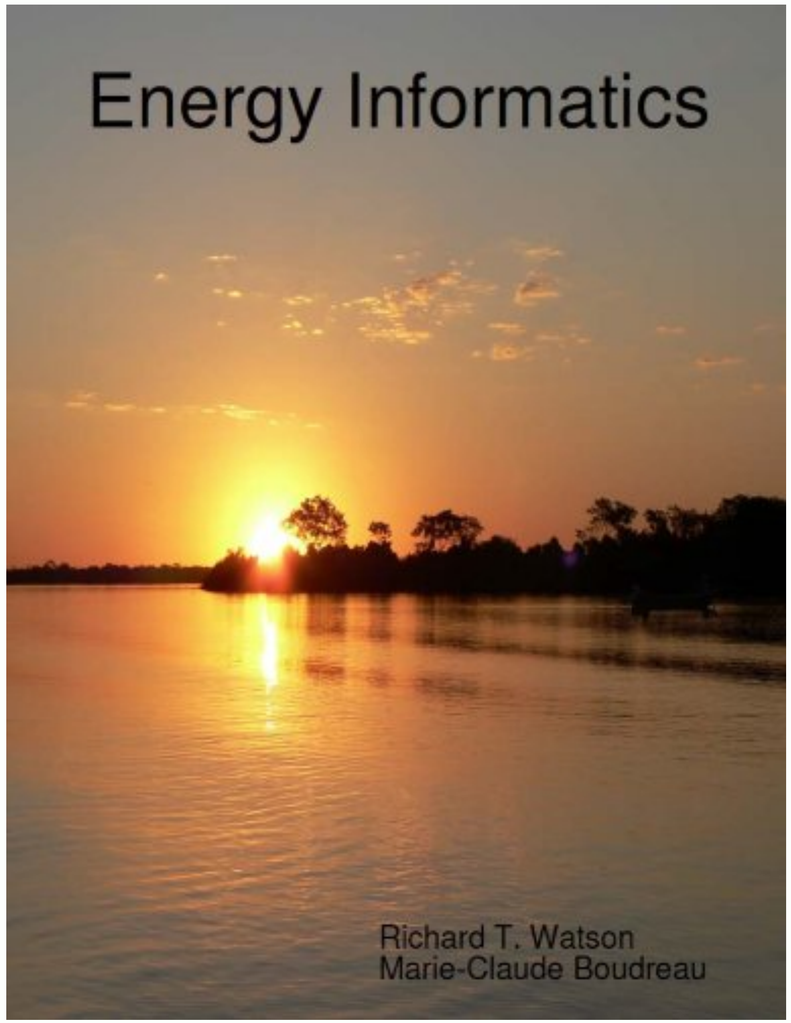
Adopted from https://nearlearn.com/blog/machine-learning-data-science-life-cycle-whats-the-difference/

ENERGY INFORMATICS



“Energy Informatics”
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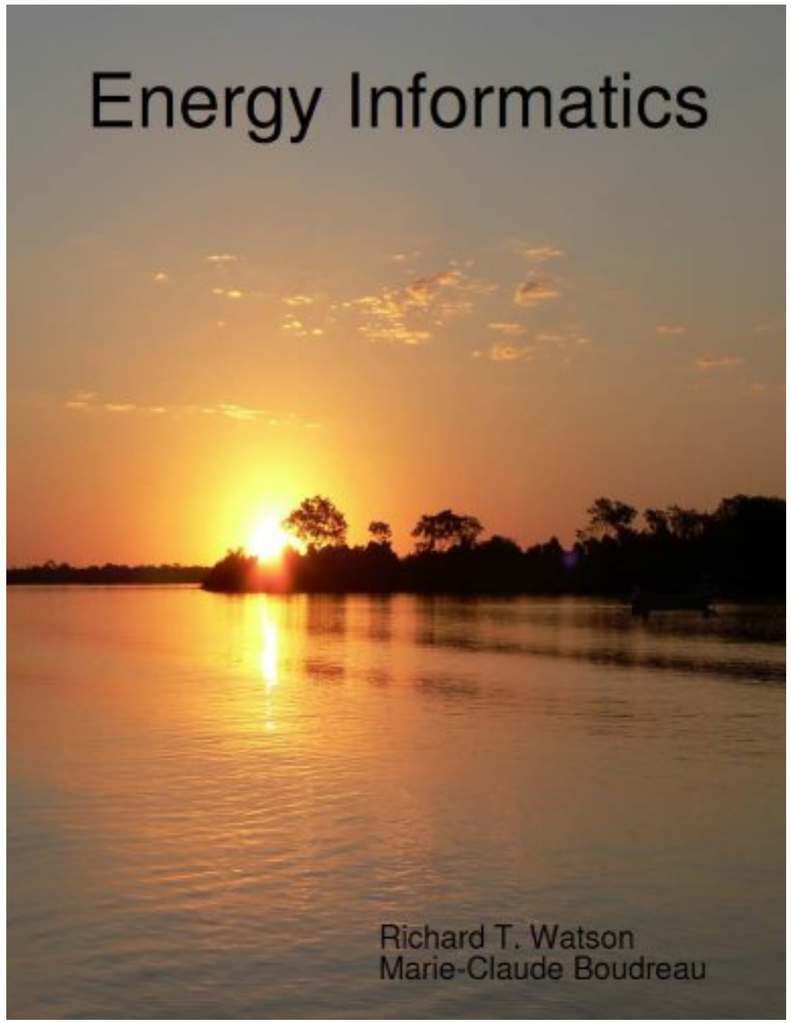
“According to Darwin, fire (a form of energy) and language (an information system) are the two most important human inventions.”

ENERGY INFORMATICS



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Fundamental principle:

Energy + Information < Energy

FUSION OF ENERGY AND IT

APPLICATION	GOAL	TECHNOLOGY

Energy (application areas):

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

- Energy efficiency
- Predictive maintenance
- Renewable energy integration
- Consumer engagement

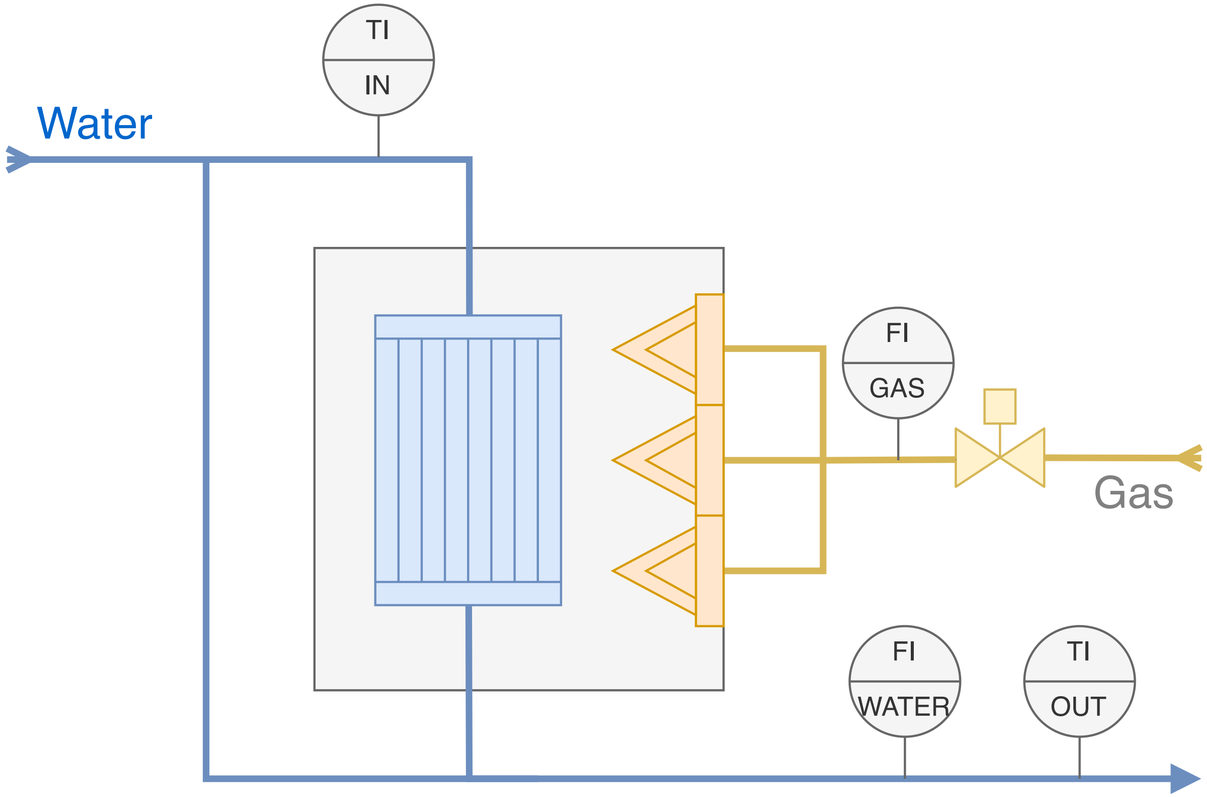
IT (enabling technologies):

- ✓ Internet of Things
- ✓ Digitalisation
- ✓ Machine learning
- ✓ Artificial Intelligence
- ✓ Big data
- ✓ Data analysis

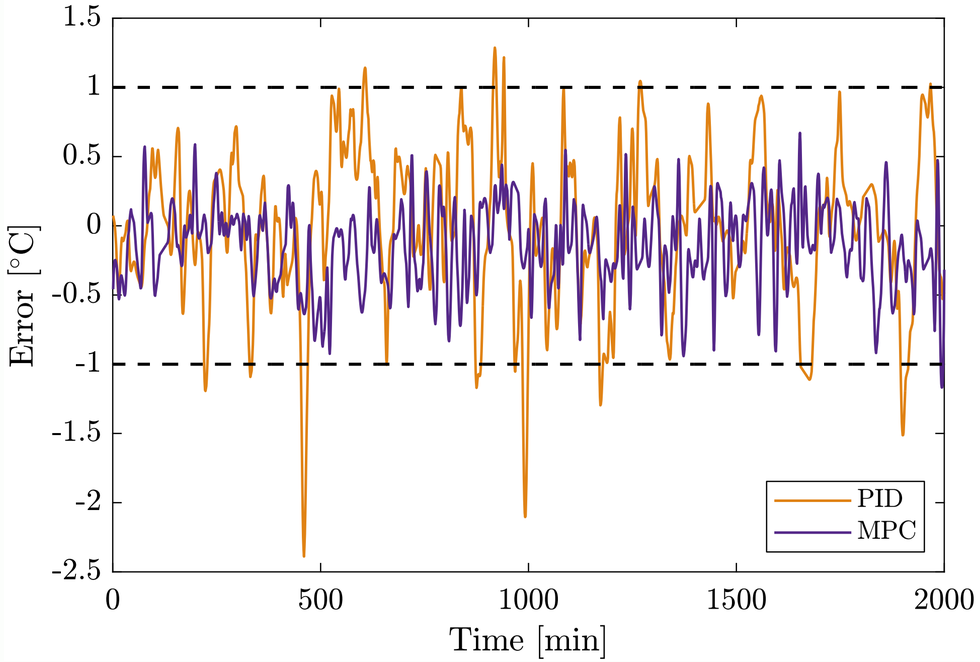
DATA!

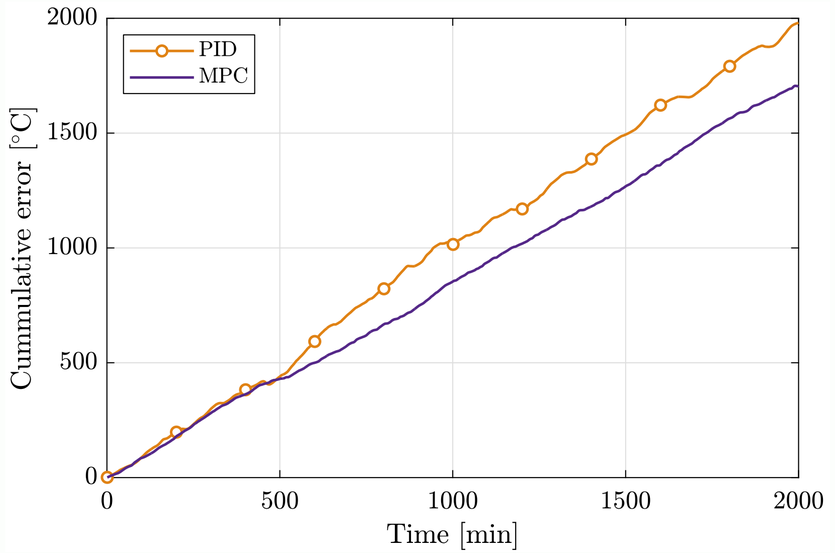
Practice-oriented Research

DISTRICT HEATING PLANT



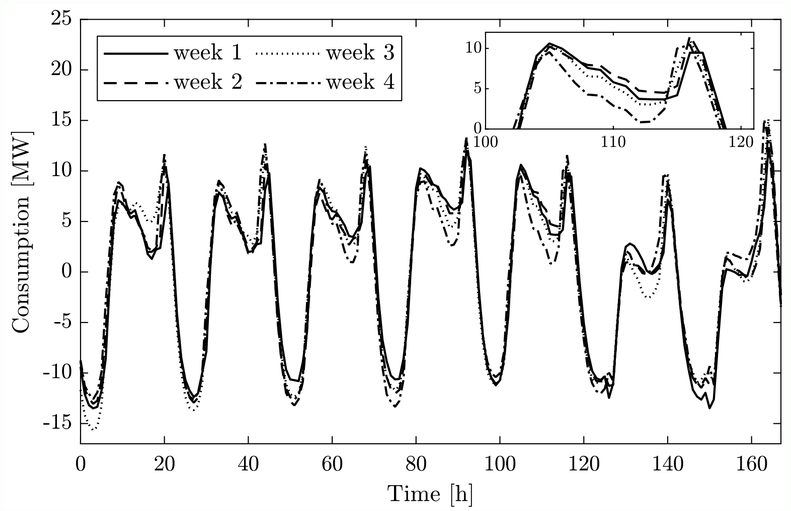
Reactive vs proactive

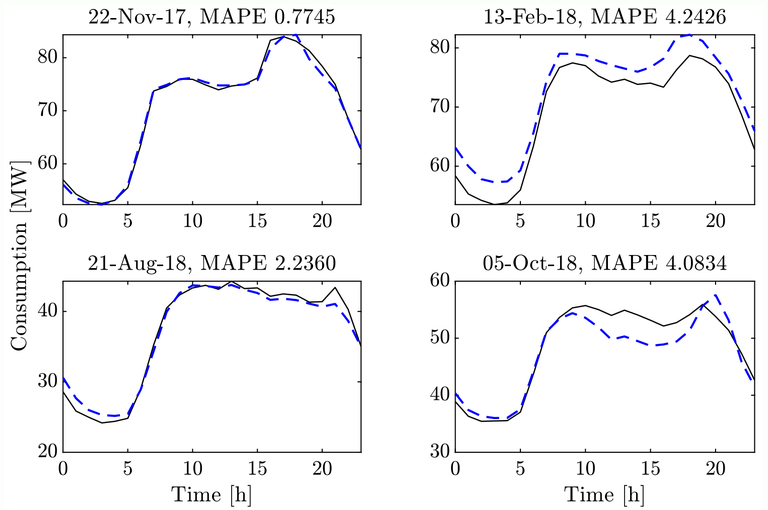


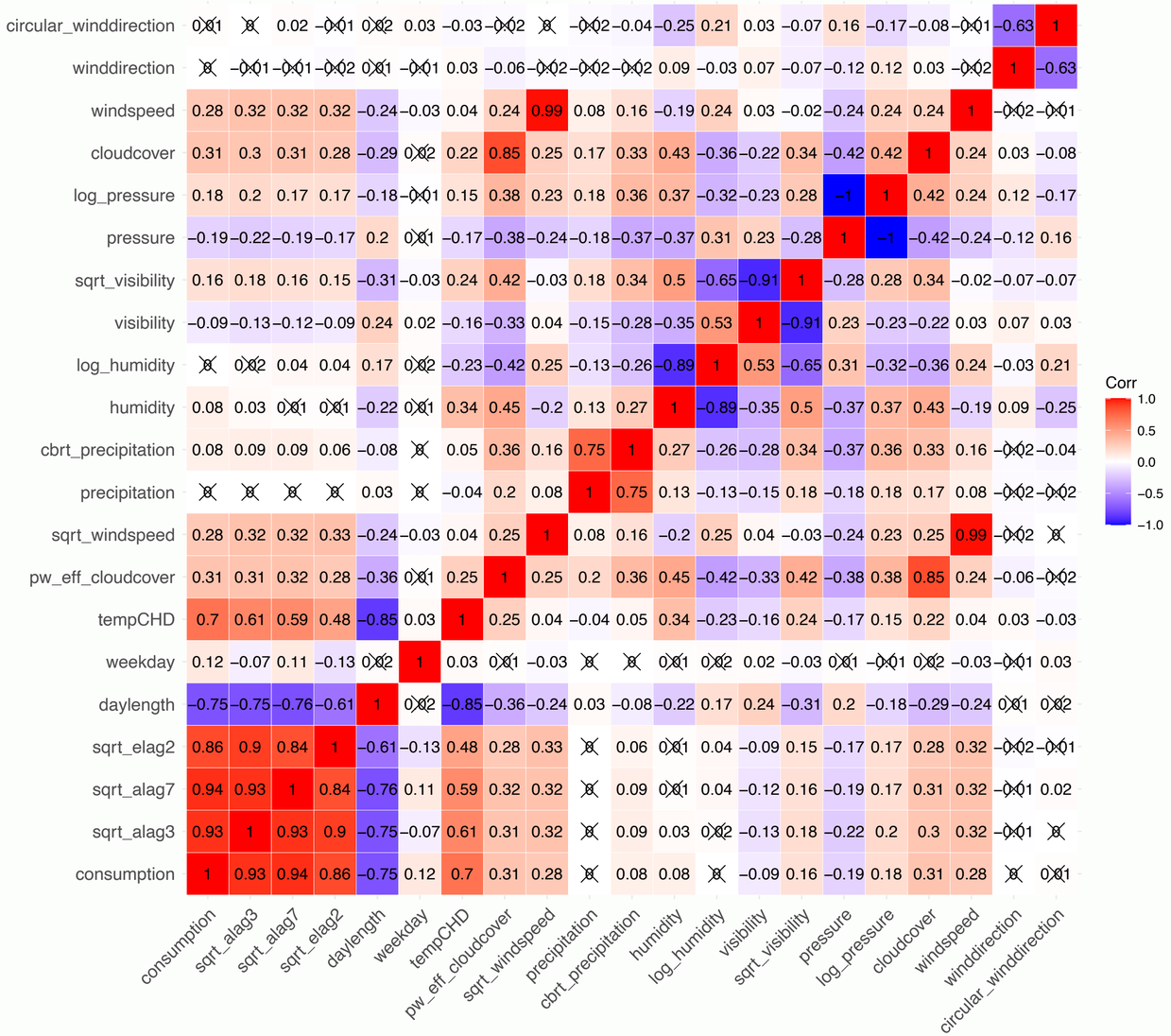


Vansovits, V.; Petlenkov, E.; Tepljakov, A.; Vassiljeva, K.; Belikov, J. Bridging the Gap in Technology Transfer for Advanced Process Control with Industrial Applications. *Sensors* 2022, *22*, 4149.

FORECASTING ELECTRICITY DEMAND

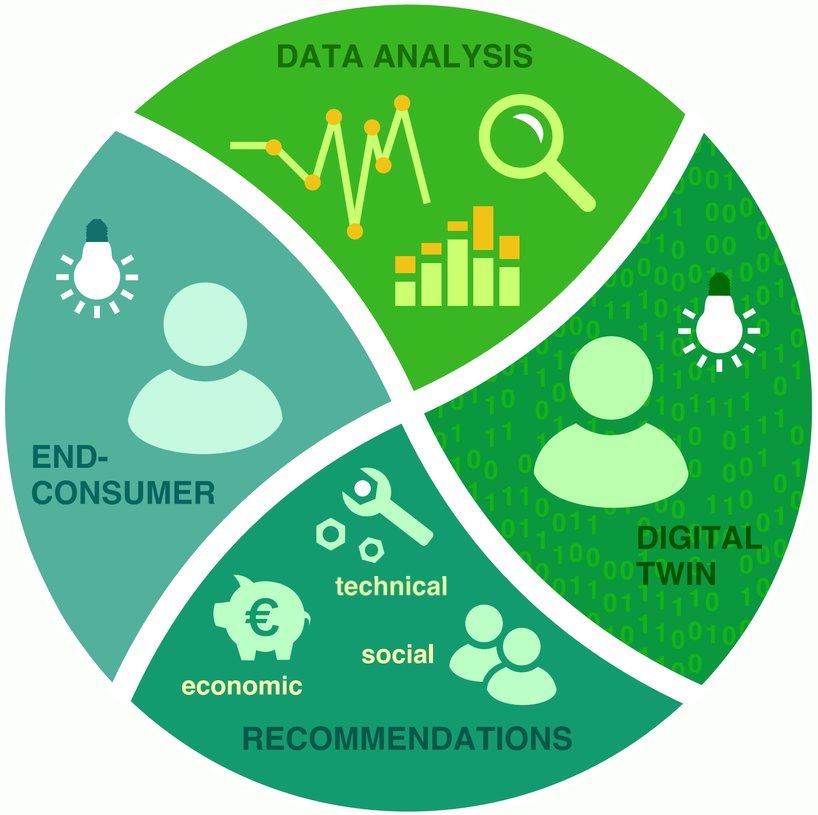


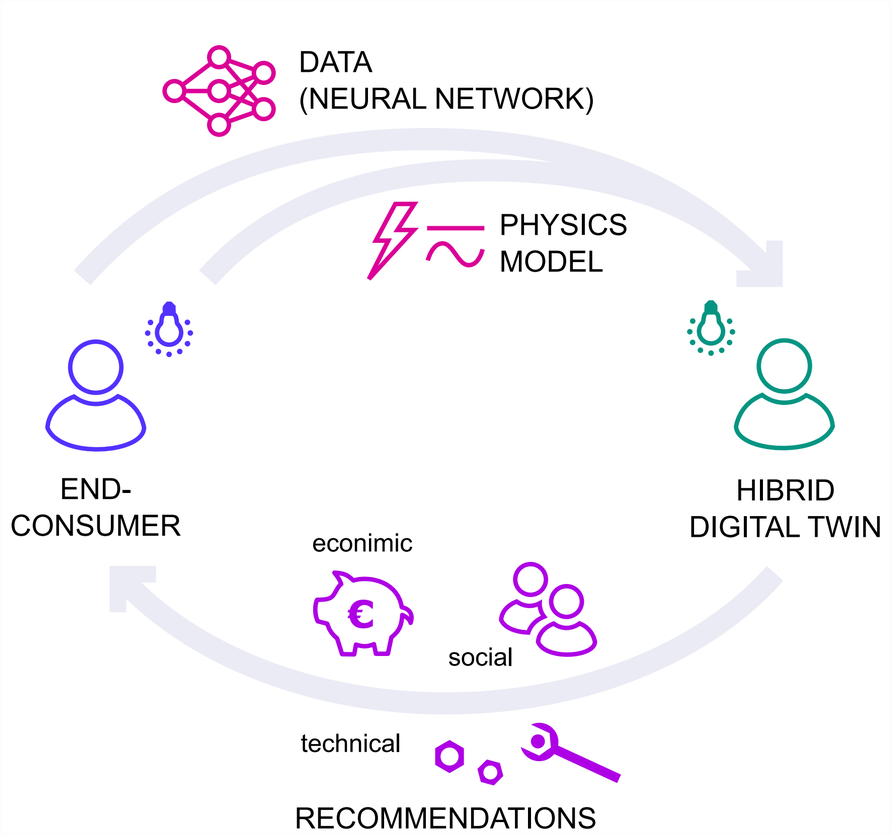




M. Sinimaa, M. Spichakova, J. Belikov, and E. Petlenkov. Feature engineering of weather data for short-term energy consumption forecast. *IEEE Madrid PowerTech*, June 28th - July 2nd, 2021, Madrid, Spain.

DT & INTELLIGENT ENERGY SERVICES



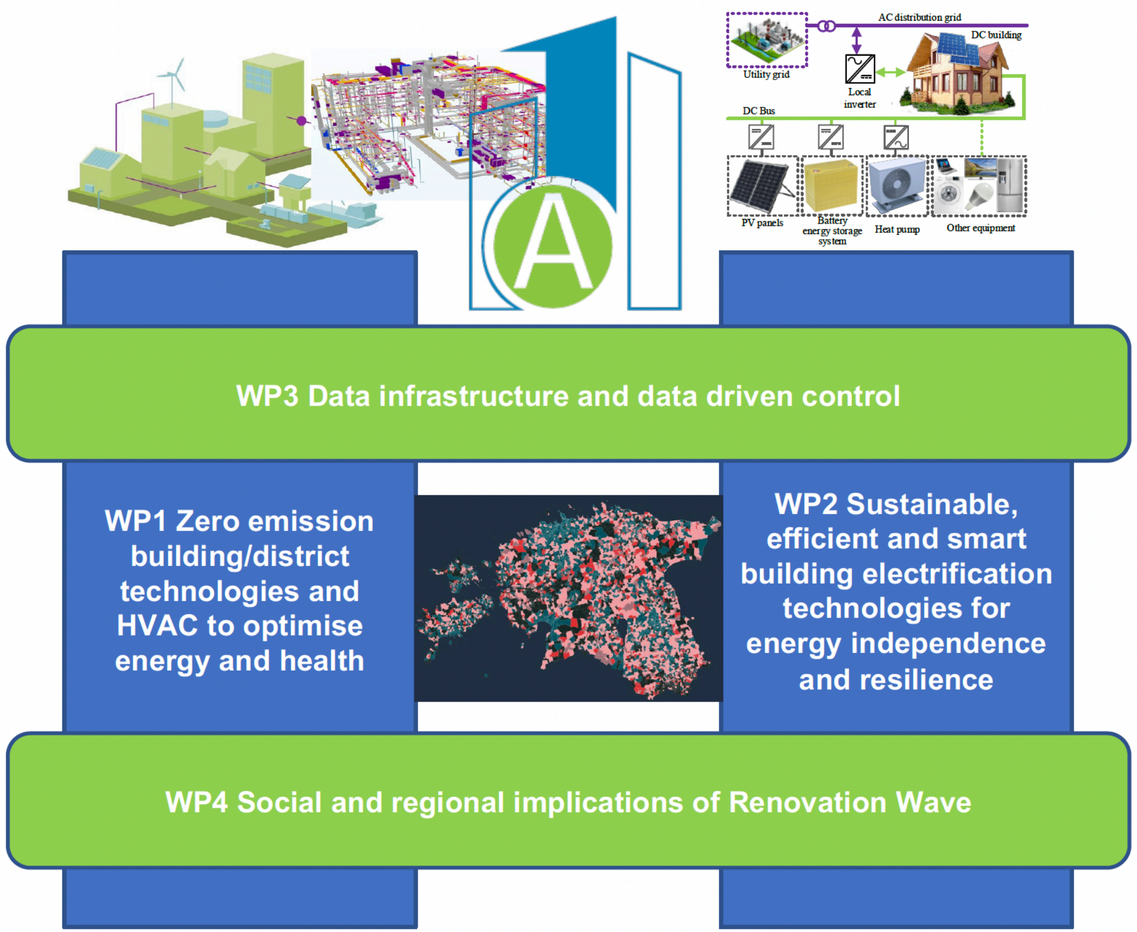


A. E. Onile, J. Belikov, Y. Levron, and E. Petlenkov
Energy efficient behavior modelling for demand side recommender system in solar microgrid applications using multi-agent reinforcement learning model.
Sustainable Cities and Society, 90, 104392. DOI: 10.1016/j.scs.2023.104392.

SMART & COGNITIVE BUILDINGS

- Human-centric AI
- Demand side management
- Optimal control
- Demand/supply forecast
- Mixture of enabling technologies: AI, ML, data science, IoT, smart materials and electronics, etc.

ENER



Data infrastructure, and data driven monitoring and control

- Development of data infrastructure
- Data driven modelling and control
- Intelligent energy services
- Trustworthy and reliable AI
- Occupant in the loop control

Centre of Excellence in Energy Efficiency

https://ener.ee/juhtimissusteemide-andmeteaduse-uurimisruhm/

Forbes

FORBES > SMALL BUSINESS

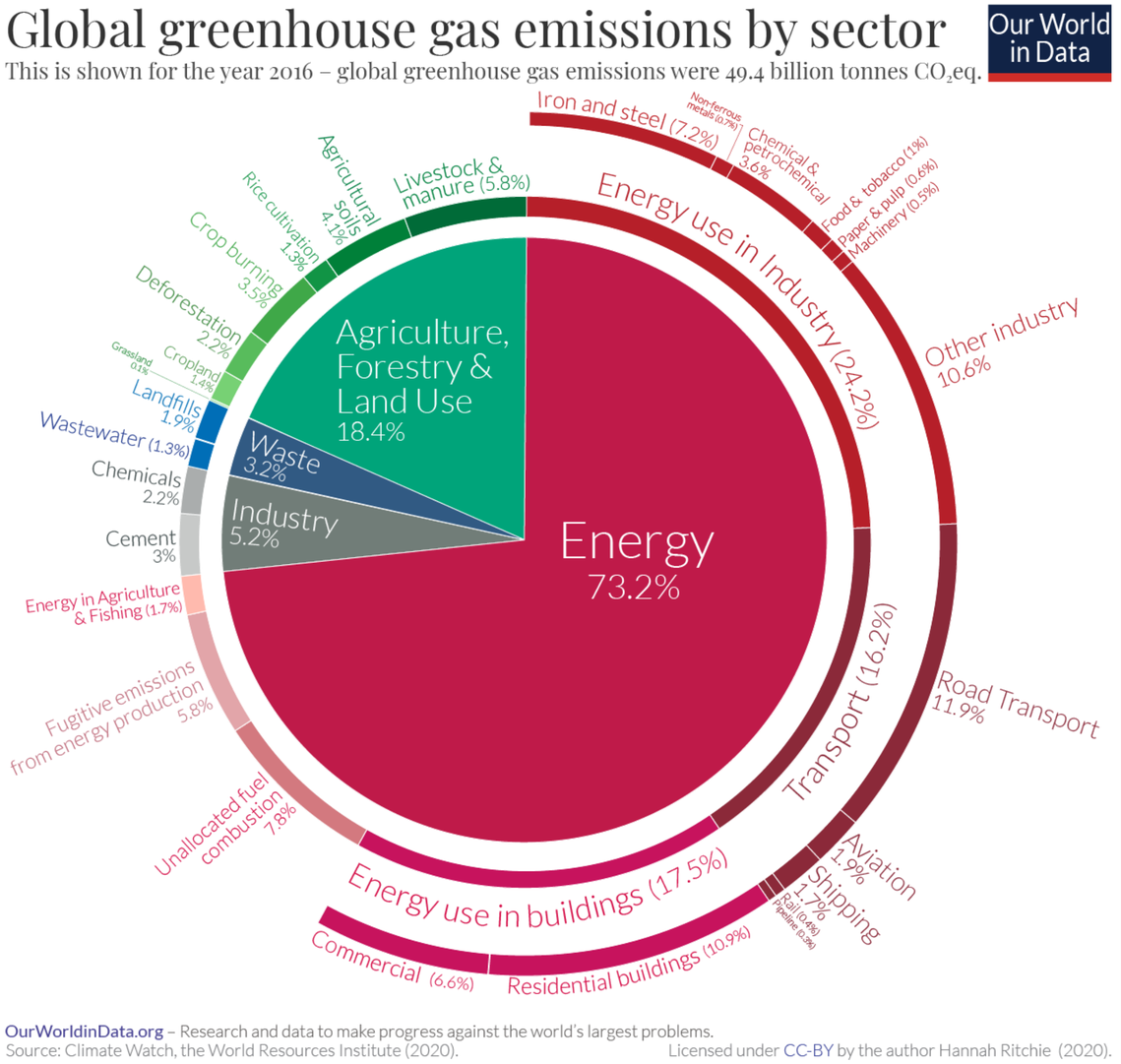
Confronting Commercial Real Estate's Biggest Challenges With Technology

Jeri Frank Former Forbes Councils Member
Forbes Business Council COUNCIL POST | Membership (Fee-Based)

Aug 4, 2022, 09:00am EDT

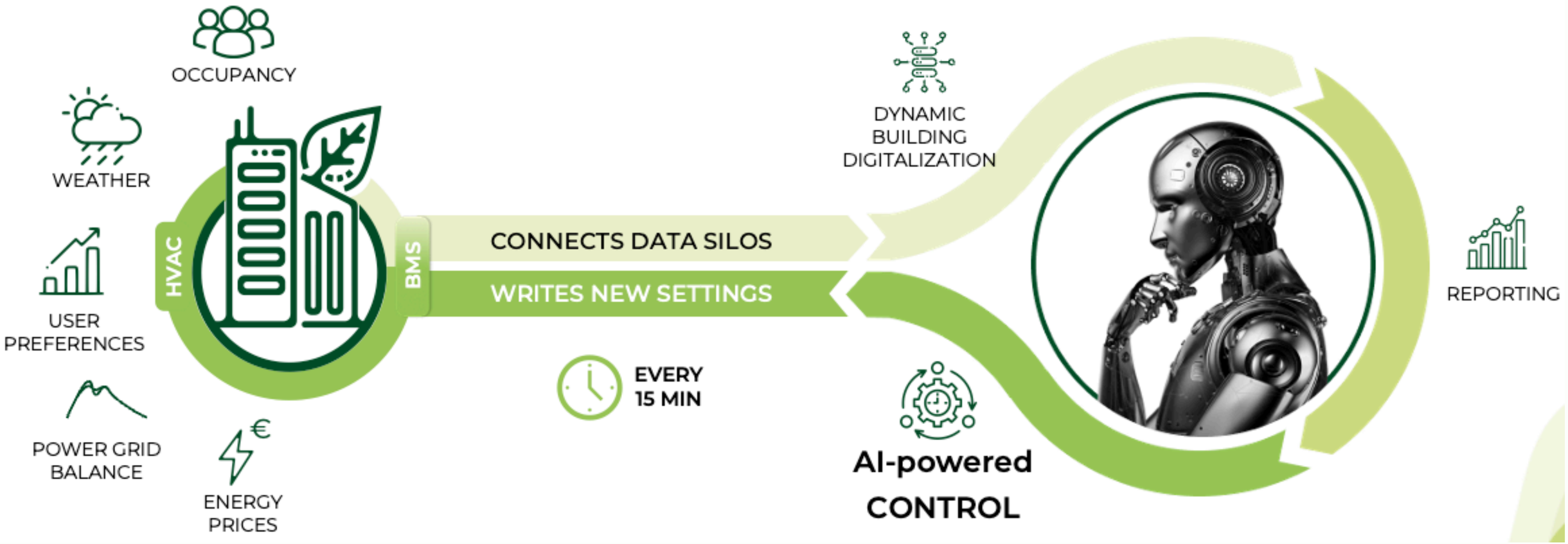
Climate Change And The Impact On Technology

First, let's talk about climate technology and how it is affecting the real estate industry. Nearly half of all greenhouse gas emissions are generated from real estate. Approximately 27% of annual CO2 emissions come from building operations and another 20% come from building materials, construction and other construction-related causes. Concrete, steel and aluminum for new construction are particularly large contributors to carbon emissions. Existing buildings are contributing to the climate crisis due to a lack of energy efficiency. Even though upgrades are available, many real estate developers and owners are slow to embrace sustainable solutions.

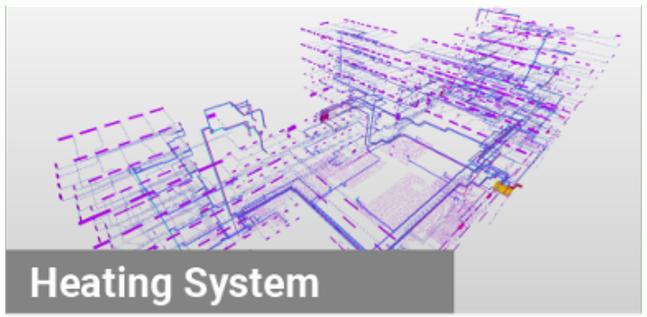


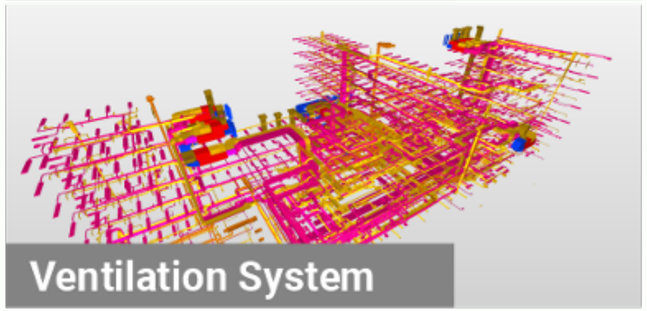
[Accessed February 27, 2025], https://www.forbes.com/sites/forbesbusinesscouncil/2022/08/04/confronting-commercial-real-estates-biggest-challenges-with-technology
https://ourworldindata.org/ghg-emissions-by-sector

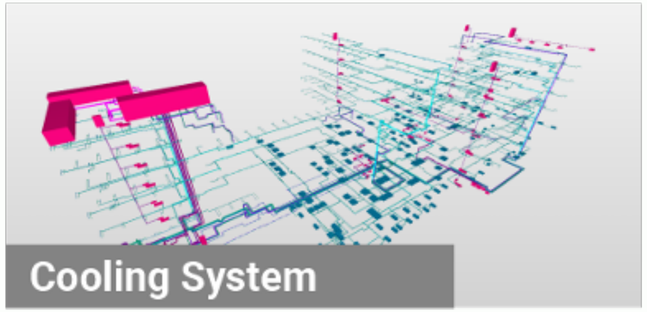
DIGITAL OPERATOR



SMART BUILDINGS







constructed 2018

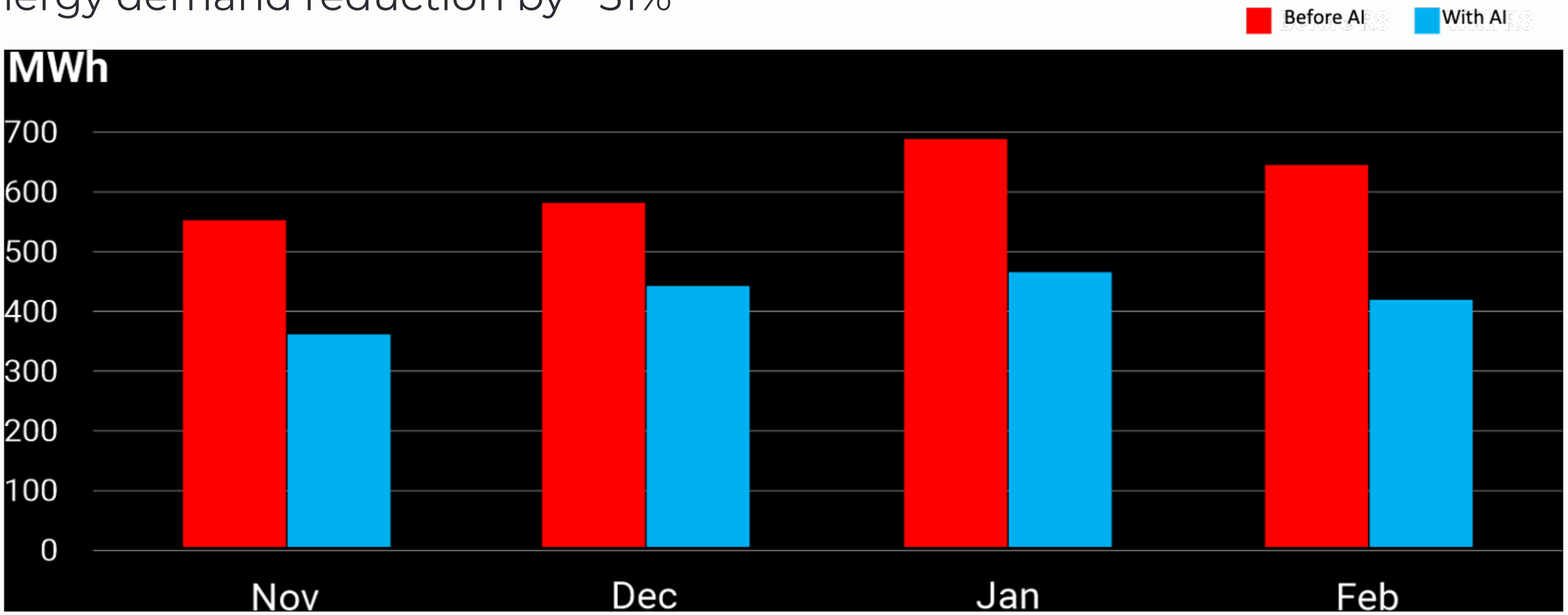
25 304 m² office building

48 813 datapoints

2 898 controllable HVAC components

SHOWCASE

Energy demand reduction by ~31%



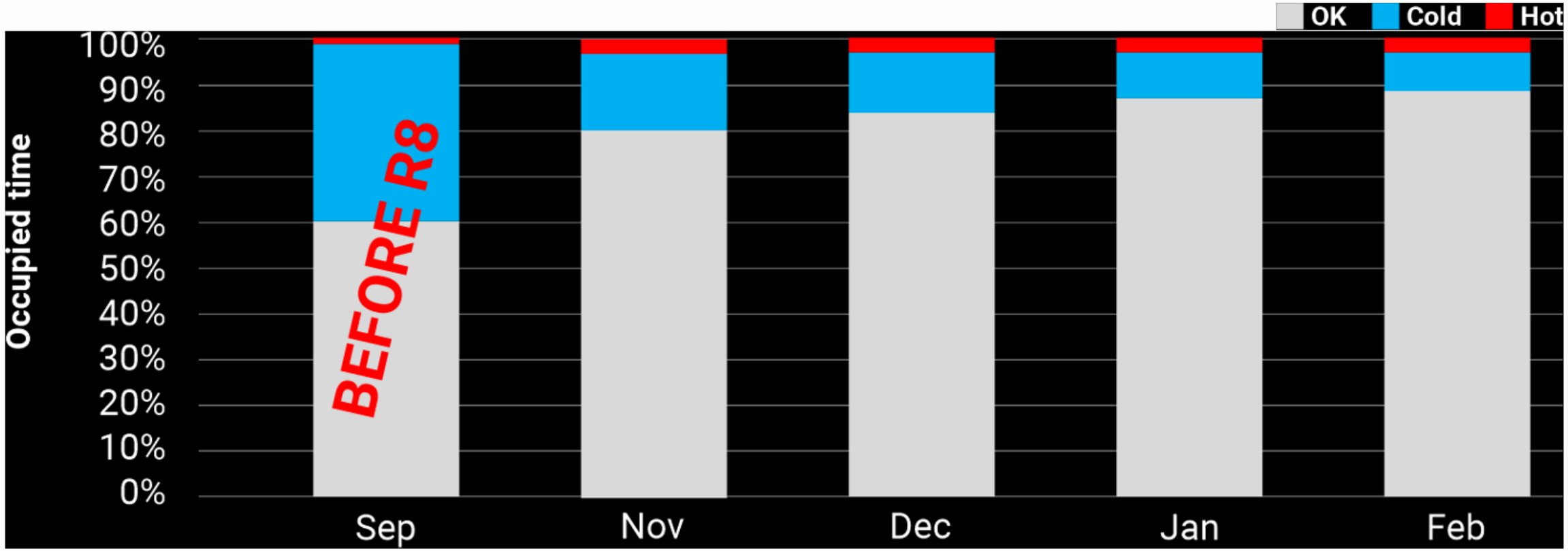
680 000
setpoint changes

900+ faults and anomalies detected

225 000+
kg CO_2 savings

SHOWCASE (2)

Thermal comfort increase from 60% to 90%



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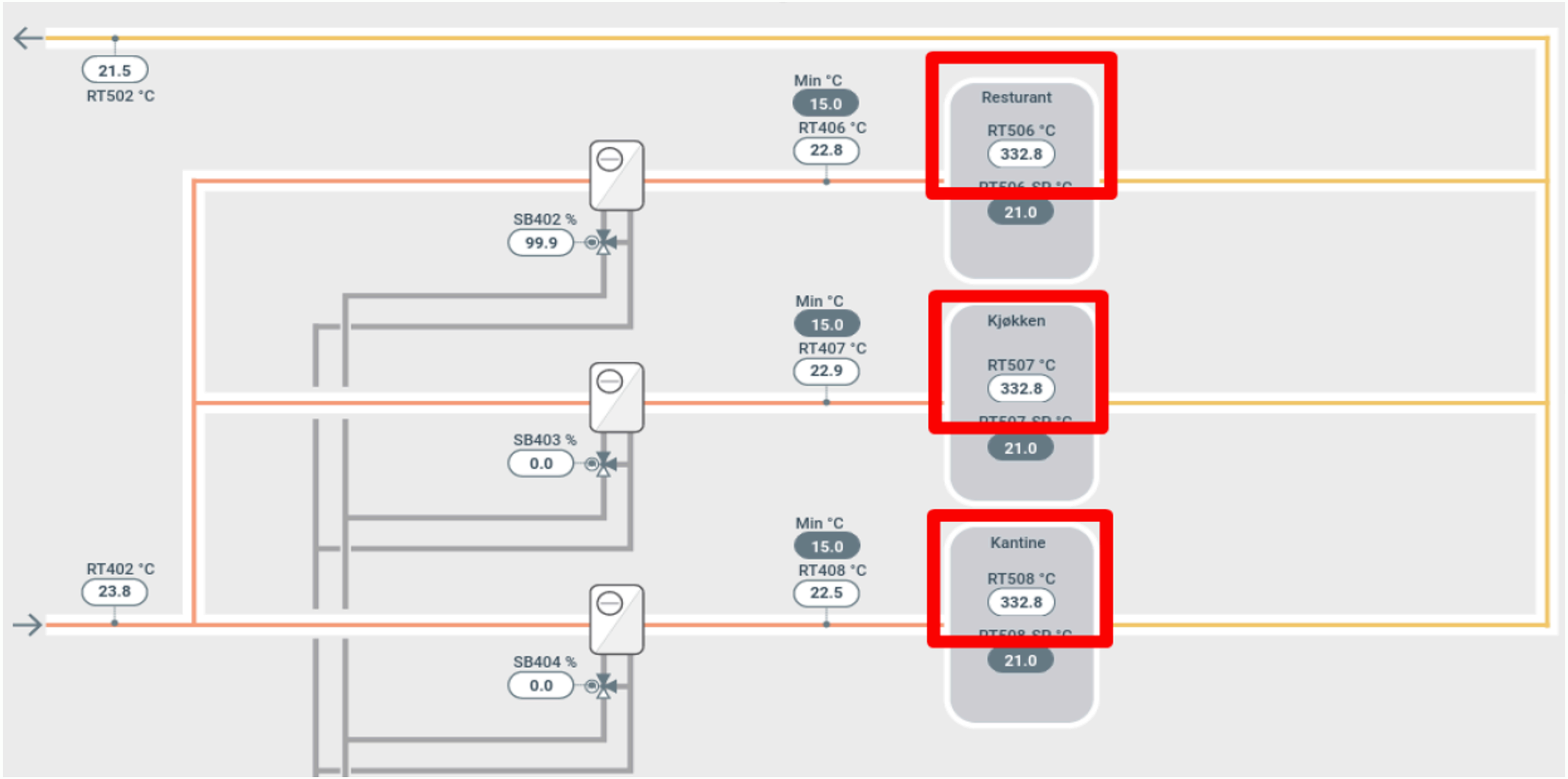
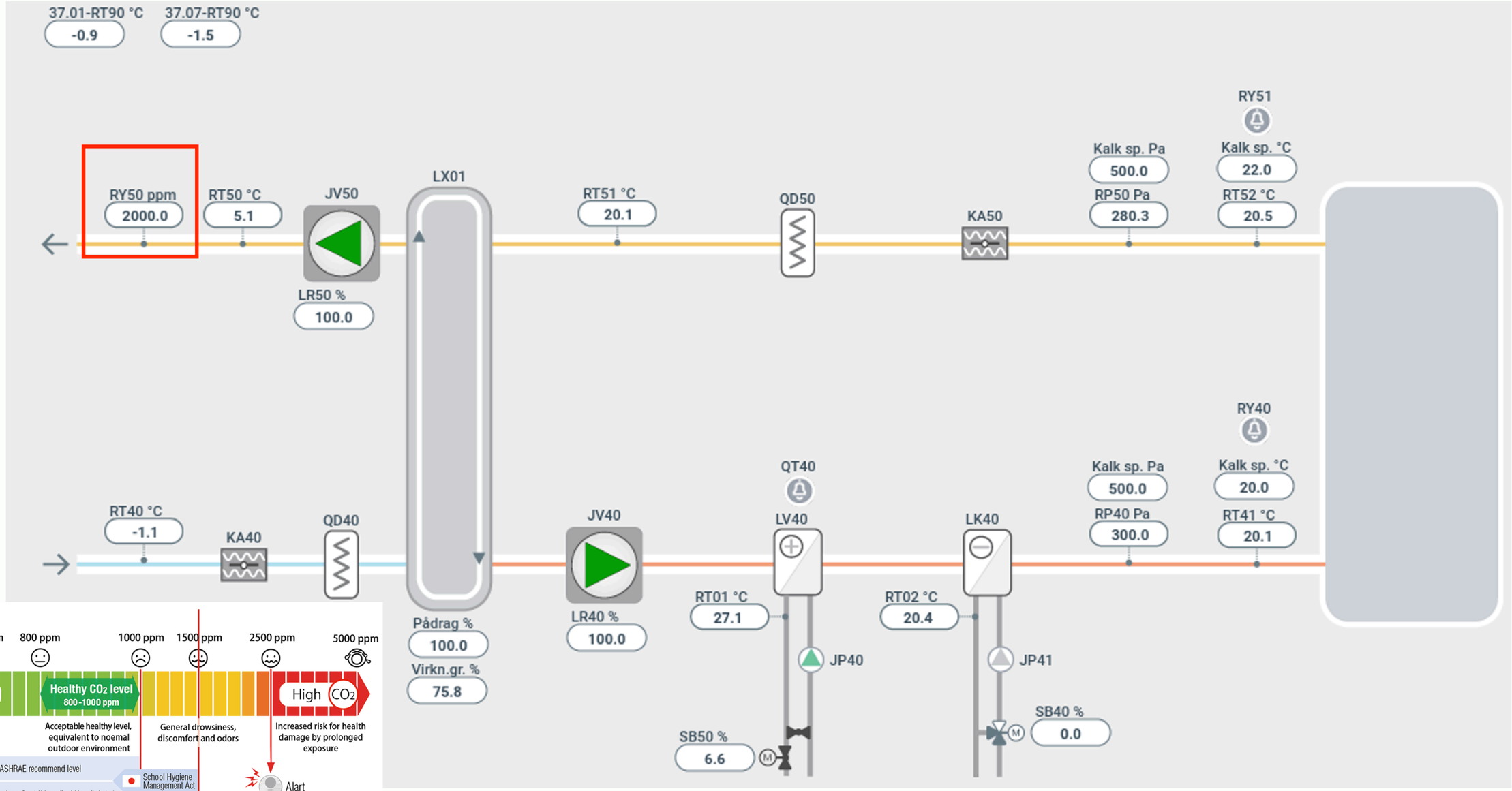
SHOWCASE (3): ROOM TEMPERATURE SENSORS ARE STATIC



SHOWCASE (3): VENTILATION UNIT WORKS AT 100%; BROKEN CO2 SENSOR



Thank you for your attention!