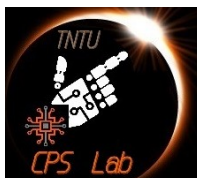




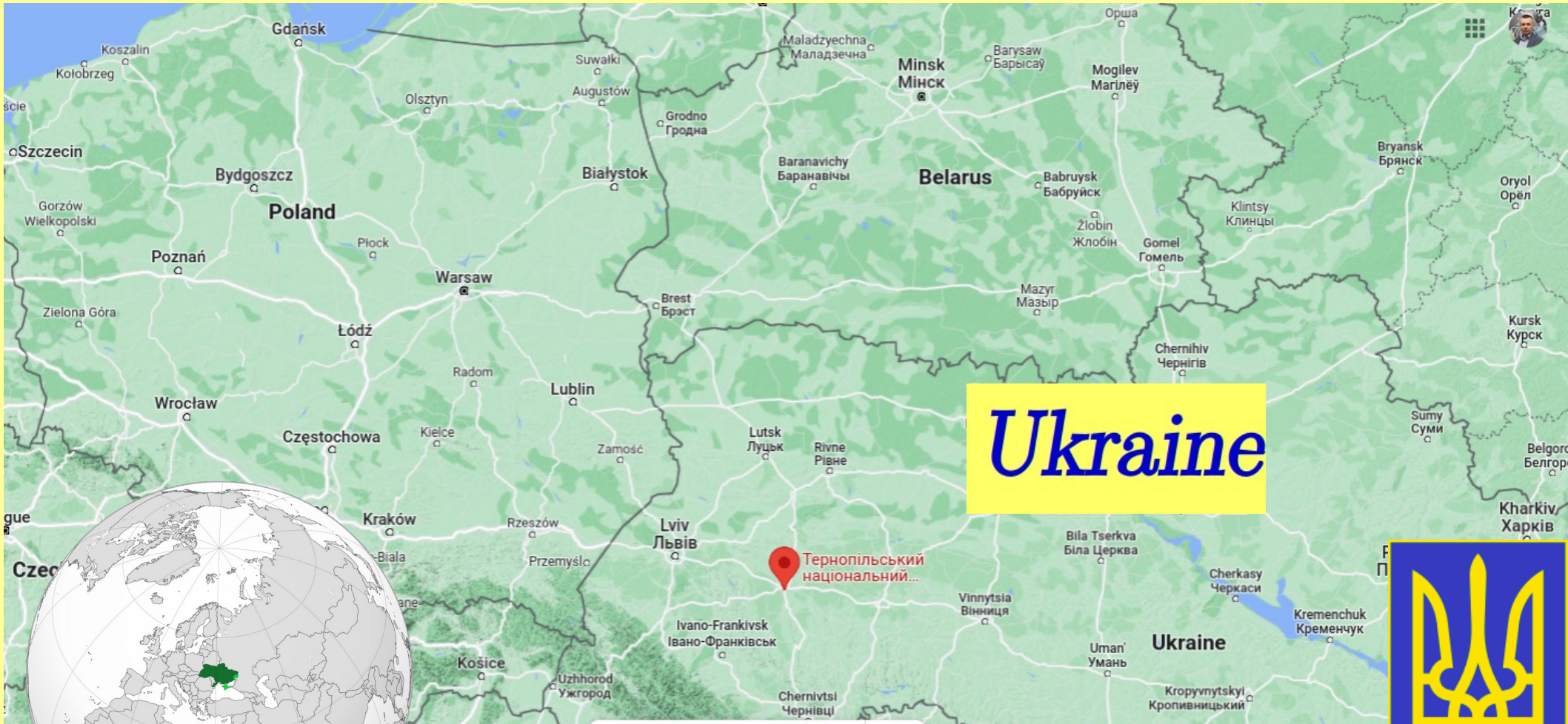
THOMAS
@ **MORE** International Days 2025

Constructing Smart House of tomorrow



Dr. Yuriy SKORENKYY,
Physics Department
Ternopil Ivan Puluj National Technical University
Ternopil, Ukraine





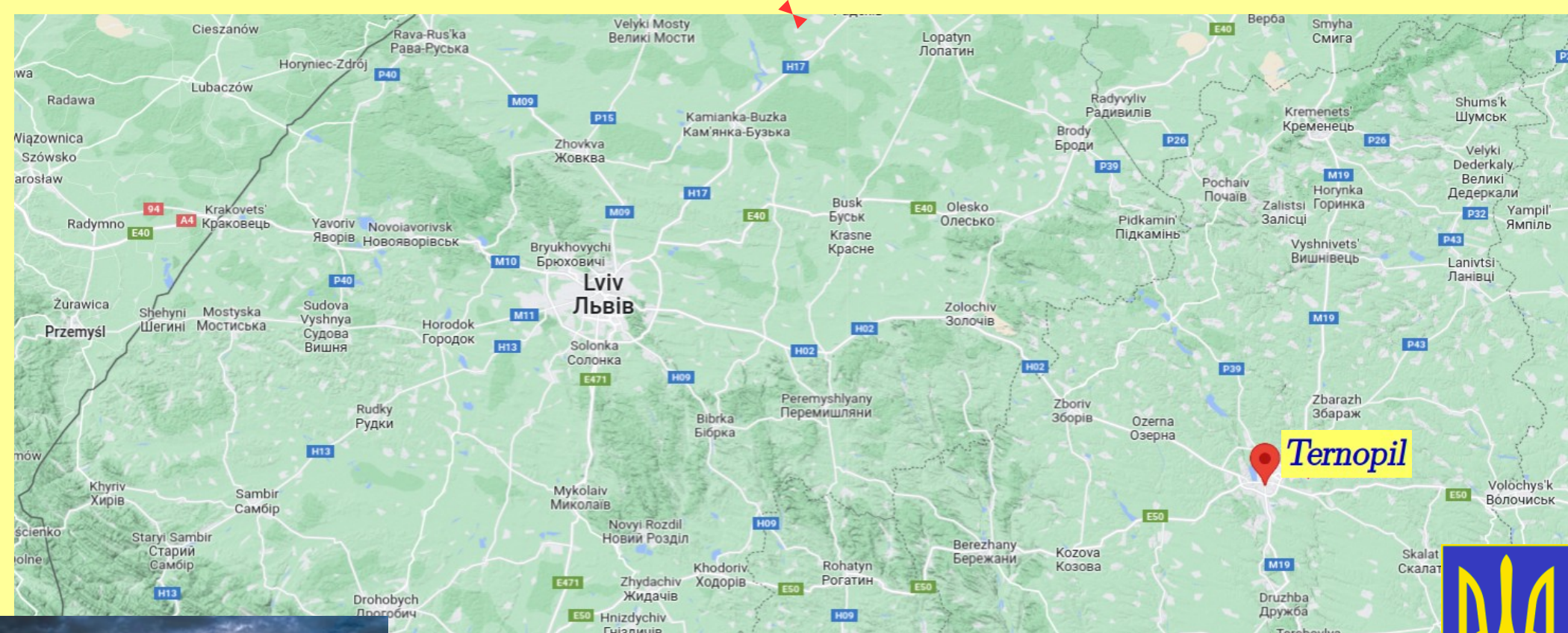
Ukraine:

Population 36.7 mln (2023)

Time zone UTC+2

Area 603 628 km²

Summer UTC+3



Ternopil



Population 225 thousand inhabitants (2022)

Area 72 km²

The first written reference in 1524

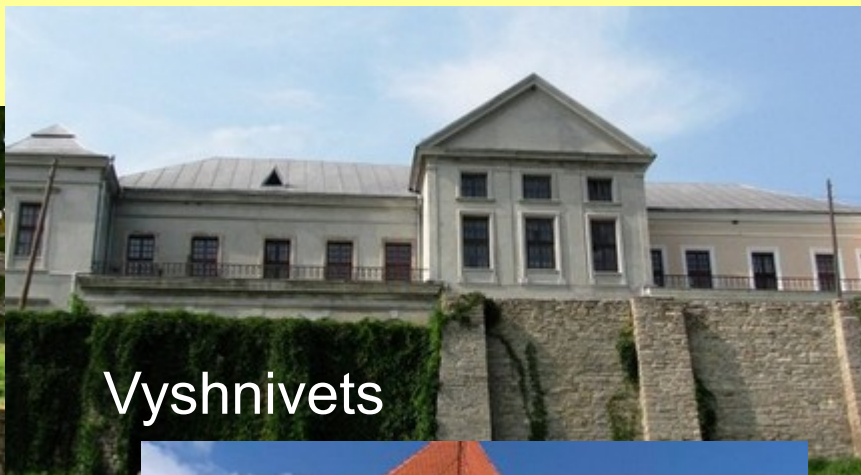
City was founded in 1540 by Polish nobleman Jan Amor Tarnowski



Old castles near Ternopil



Zbarazh



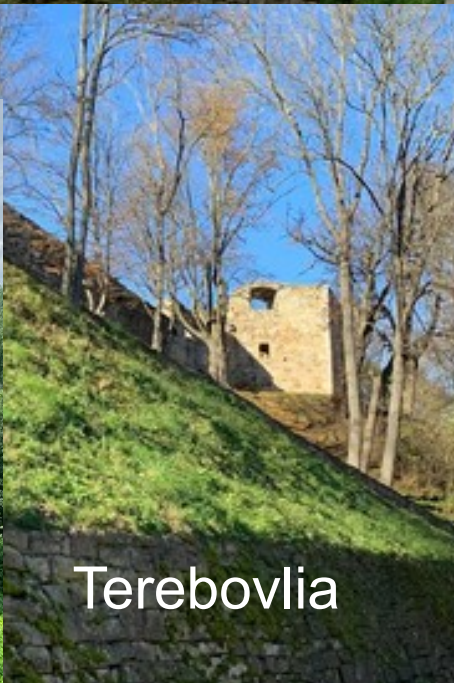
Vyshnivets



Kryvche



Yazlovets



Terebovlia



Skalat



Zolotyy Potik



Kremenets



Ternopil



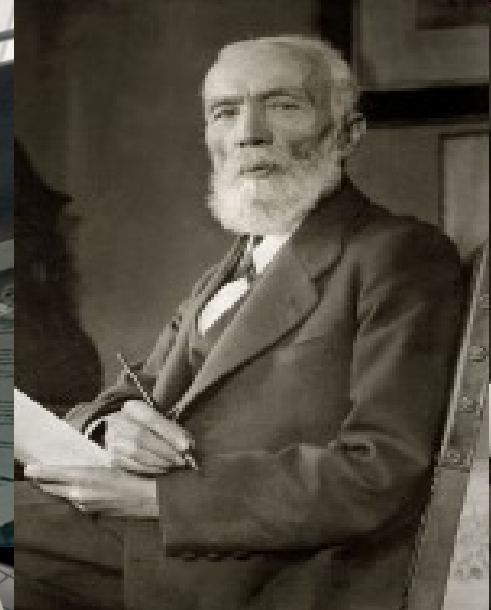
Ternopil Ivan Puluj National Technical University



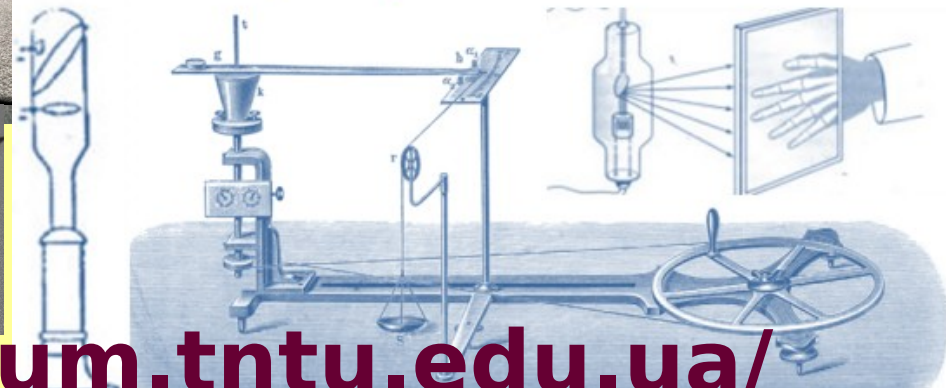
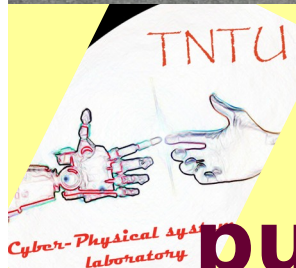
4 Faculties:

**of Engineering of Machines, Structures and Technologies,
of Applied Information Technologies and Electrical Engineering,
of Computer Information Systems and Software Engineering,
of Economics and Management**

tntu.edu.ua



Ivan Puluj
(1845-1918)



puluj-museum.tntu.edu.ua/

Why Construction?



<https://mhinfographics.com/2024/06/22/visualizing-the-destruction-in-ukraine-a-years-long-project-following-satellite-clues/>

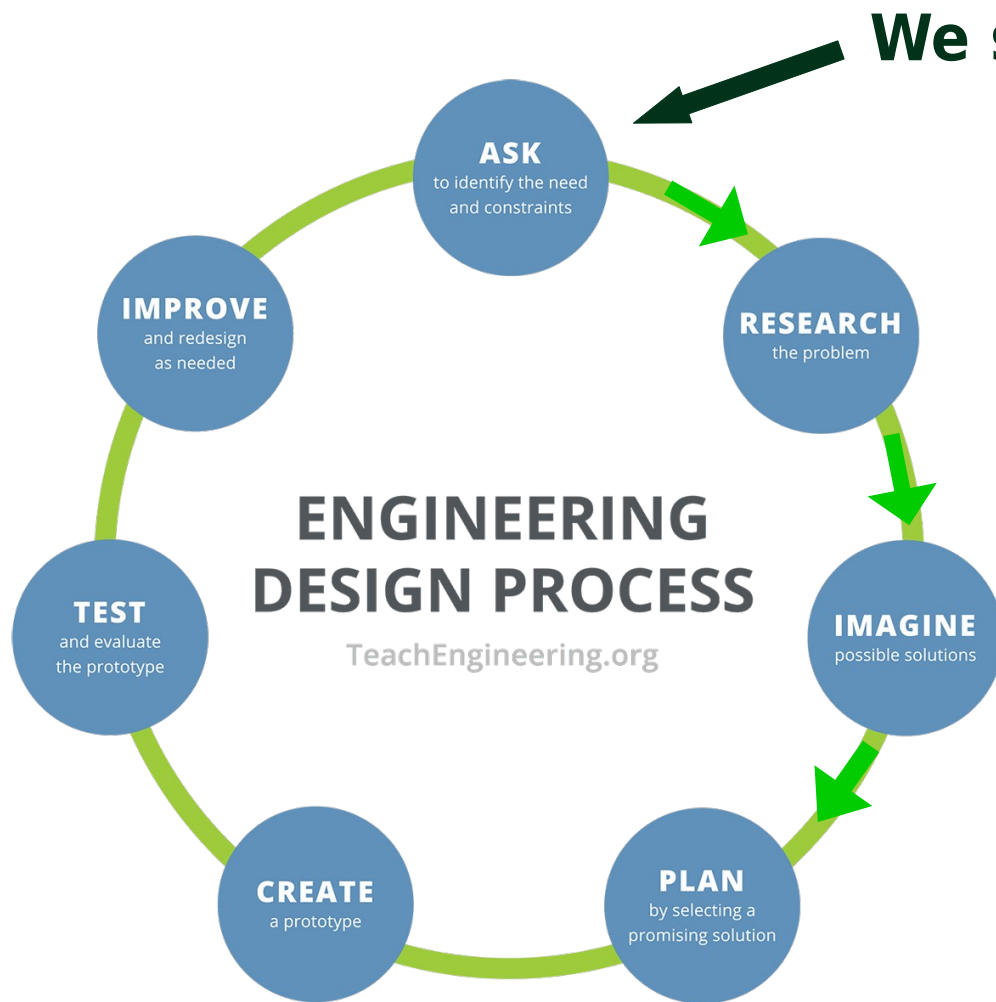
<https://www.rferl.org/a/ukraine-destroyed-cities-russia-war/32454453.html>



<https://www.rferl.org/a/ukraine-destroyed-cities-russia-war/32454453.html>

**We want to live
in a smart house.**

How do we envision it?



monday.com/blog/project-management/design-process/

We start here



<https://www.nngroup.com/articles/design-thinking/>

Characteristic features of smart building :

- a residence that uses internet-connected devices to enable the remote monitoring and management of appliances and systems, such as lighting and heating¹;
- provide insights into energy use that can help you become more energy efficient and mindful of ecological factors²;
- efficient and intelligent home³;
- a residence equipped with devices that automate tasks normally handled by humans⁴;
- a house which is equipped with connected devices that can be programmed and controlled remotely via a smartphone or computer⁵,
- comfortable and intuitive⁶.

EMPATHIZE

UNDERSTAND

DEFINE

[1] www.techtarget.com/iotagenda/definition/smart-home-or-building,

[2] <https://www.constellation.com/energy-101/what-is-a-smart-home.html>,

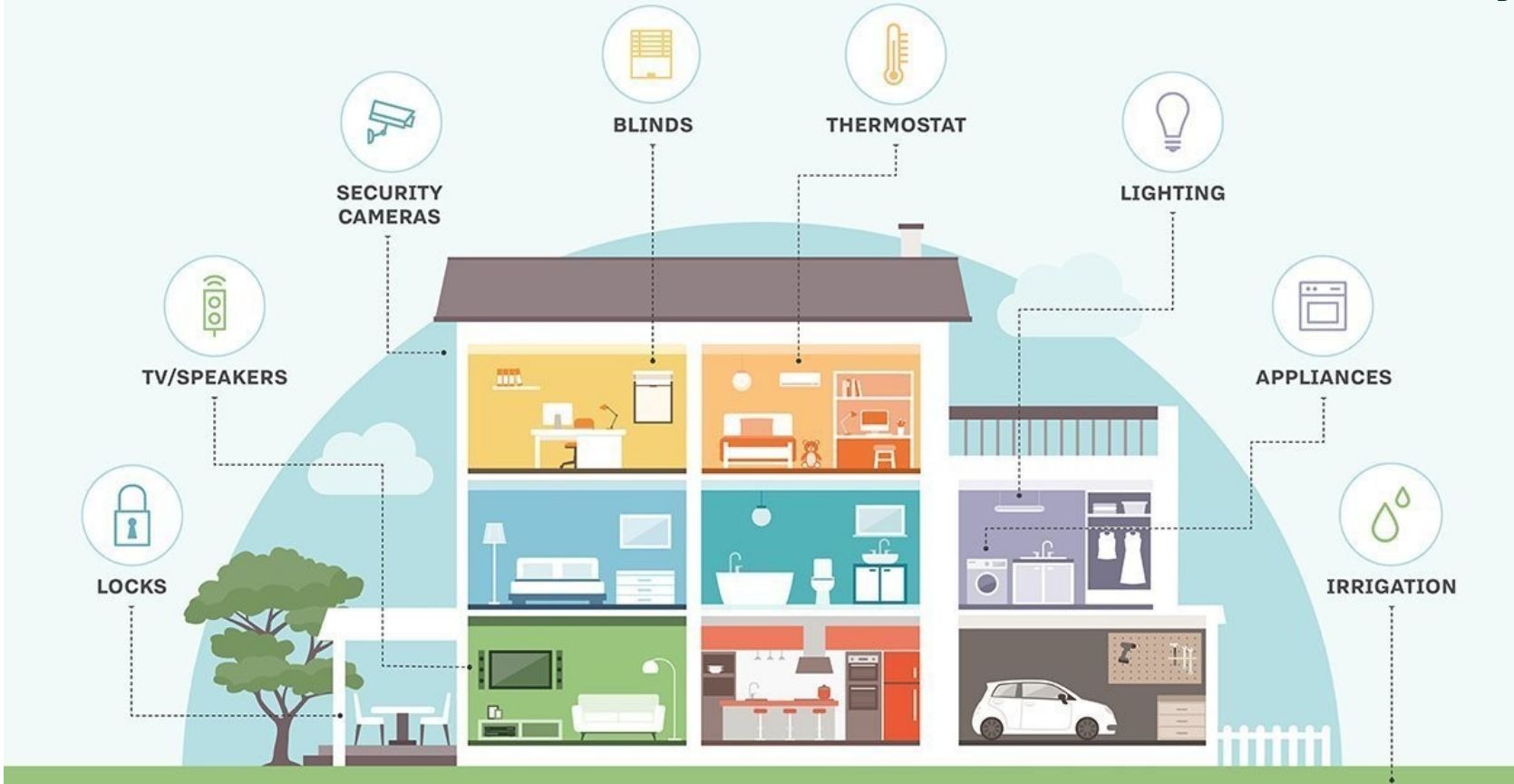
[3] <https://www.eescorporation.com/smart-home-devices-checklist>,

[4] <https://www.vationventures.com/glossary/smart-home-definition-explanation-and-use-cases>,

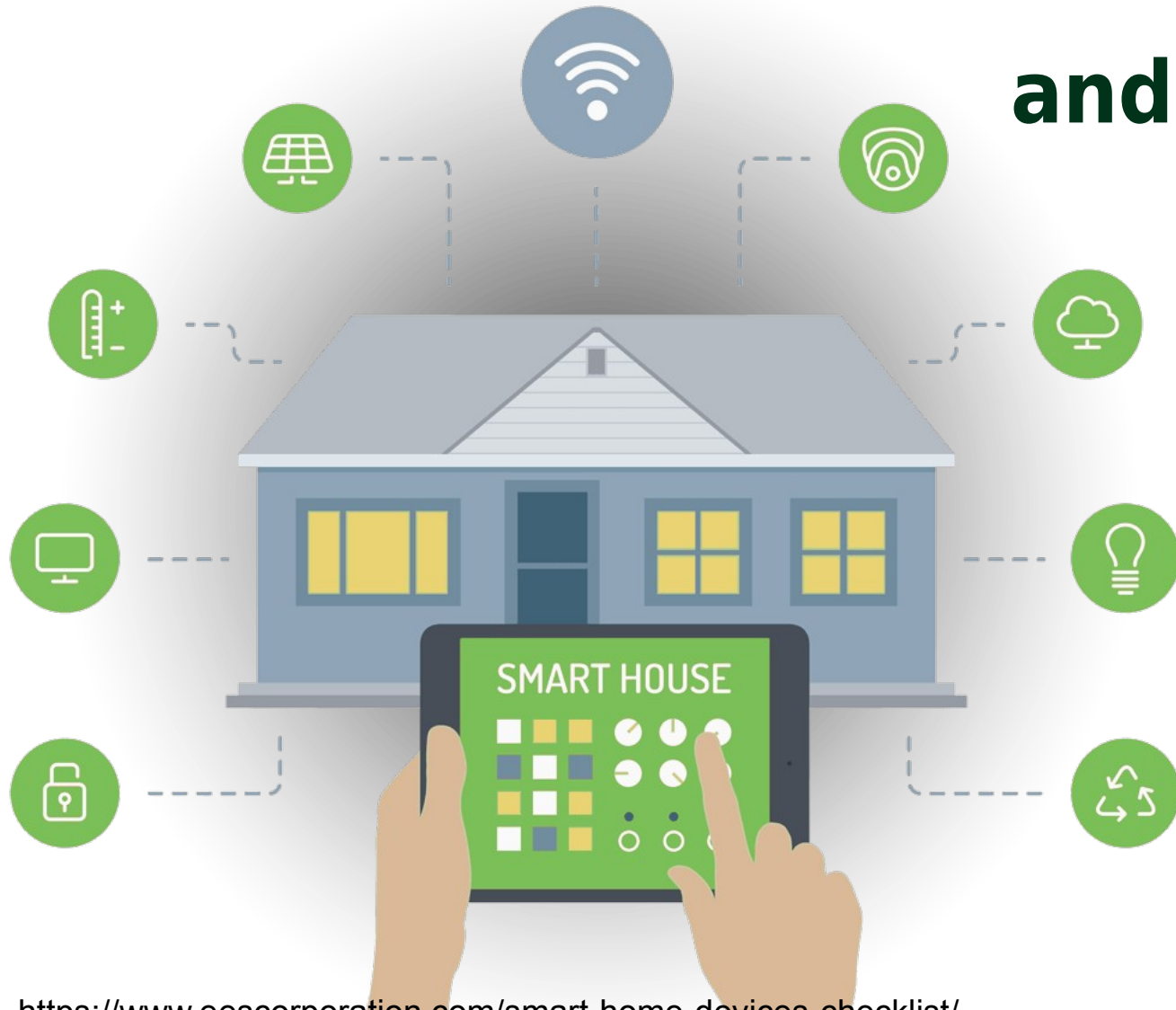
[5] <https://smarthomeenergy.co.uk/what-smart-home/>,

[6] personal opinion.

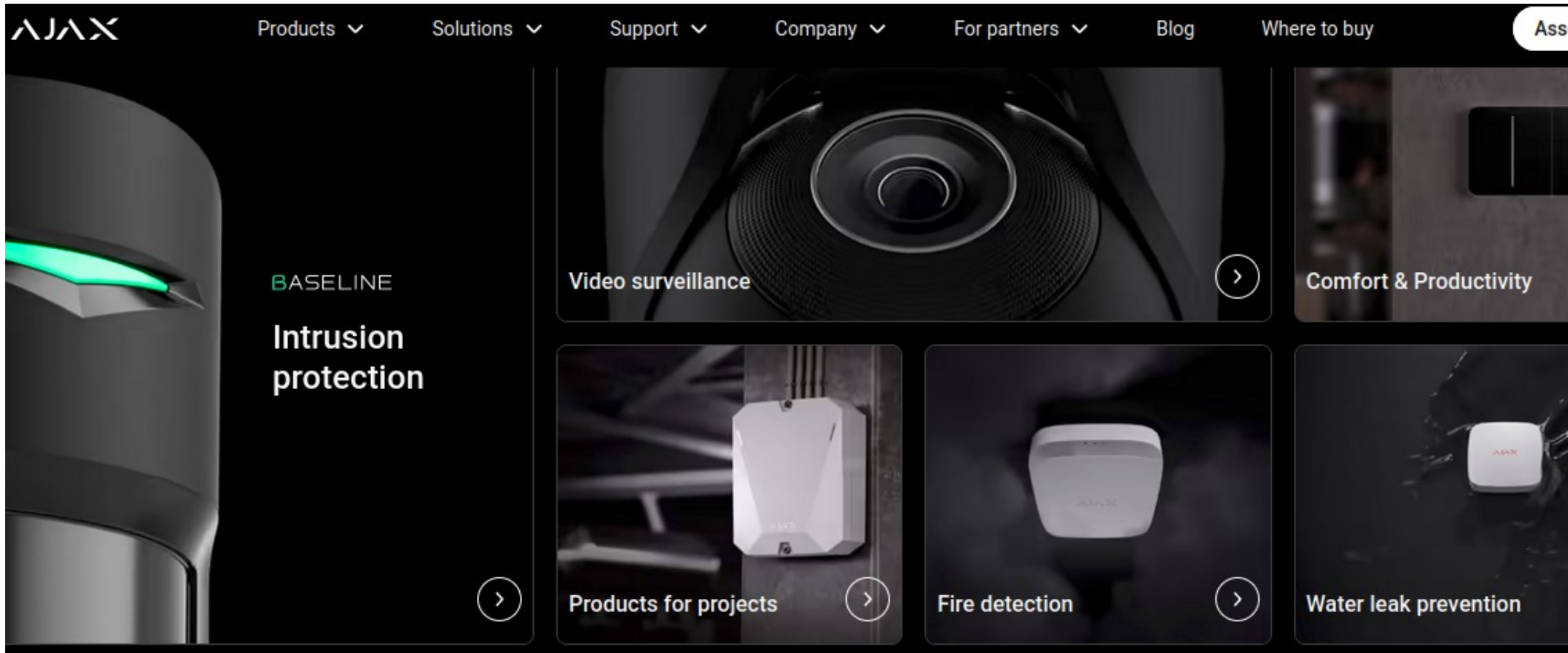
HOME SMART HOME - comfort, safety and efficiency.



and control!



Intrusion protection - Wireless security devices



<https://ajax.systems/solutions-by-facility-type/apartments/>

What about industry?

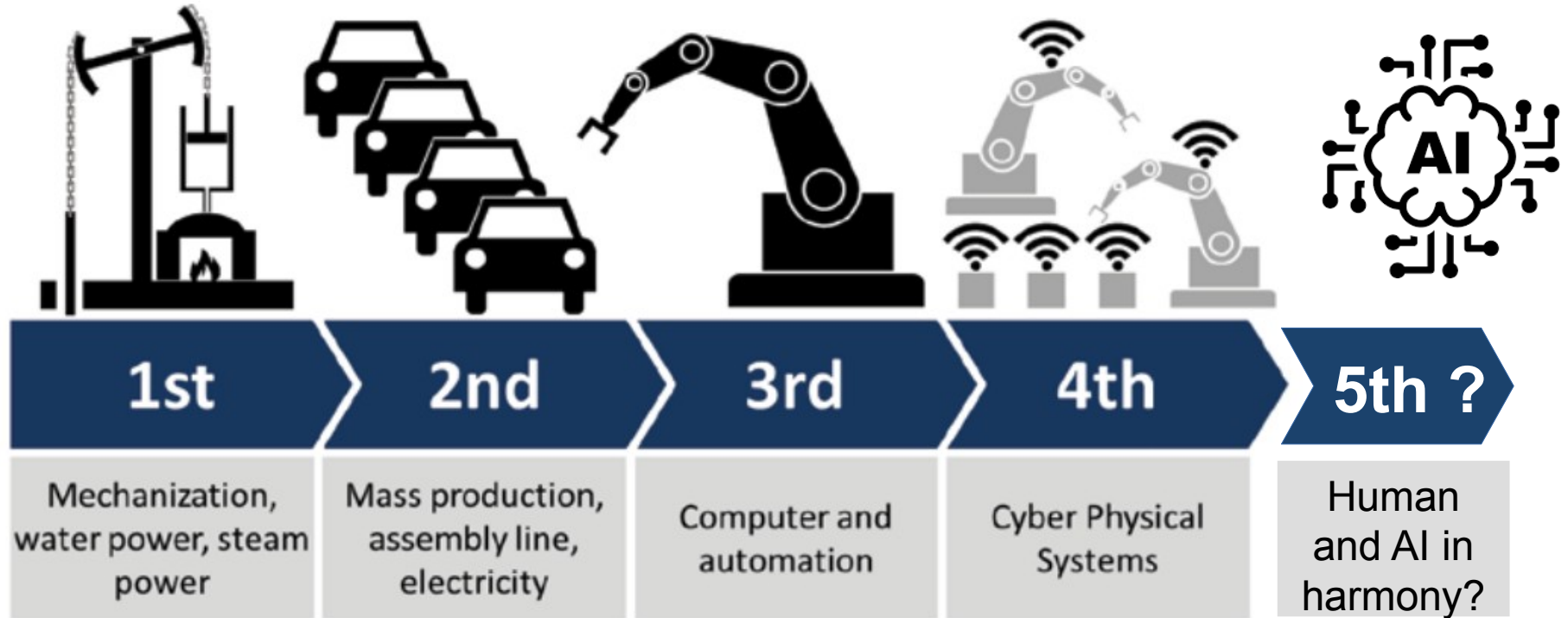
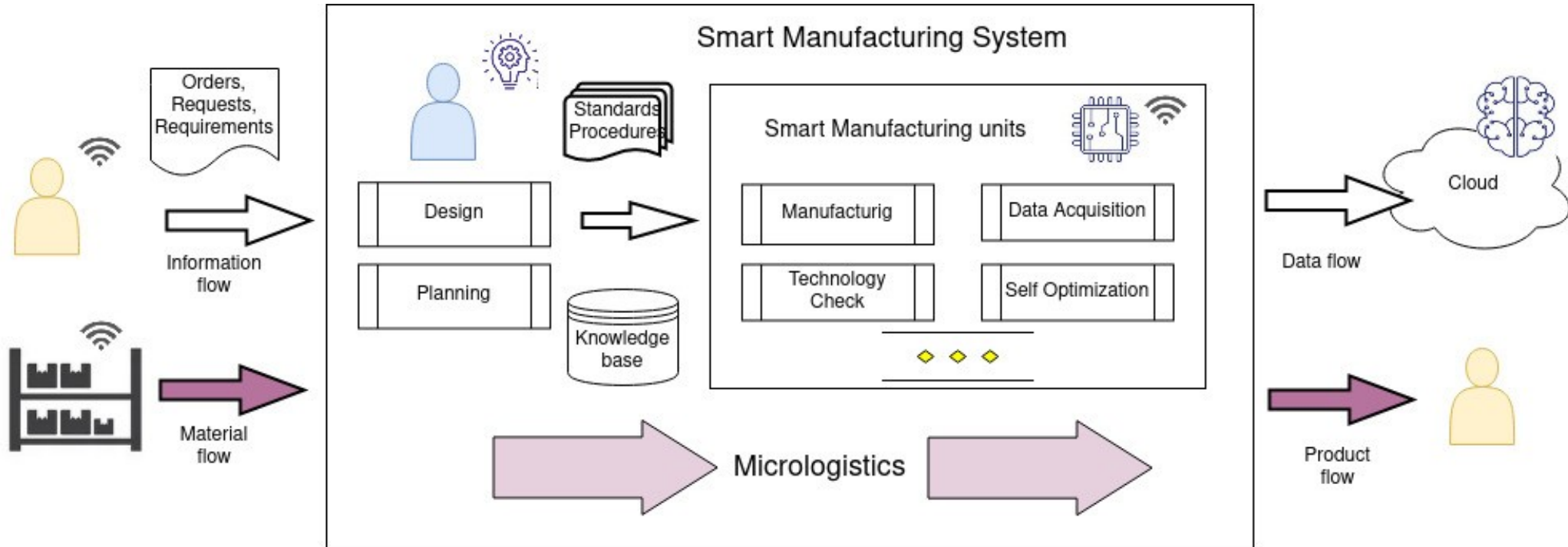


Figure 2.3 Four Industrial Revolutions. (Source: https://commons.wikimedia.org/wiki/Category:Industry_4.0#/media/File:Industry_4.0.png)

More control!



Why do we care?



SUSTAINABLE DEVELOPMENT GOALS

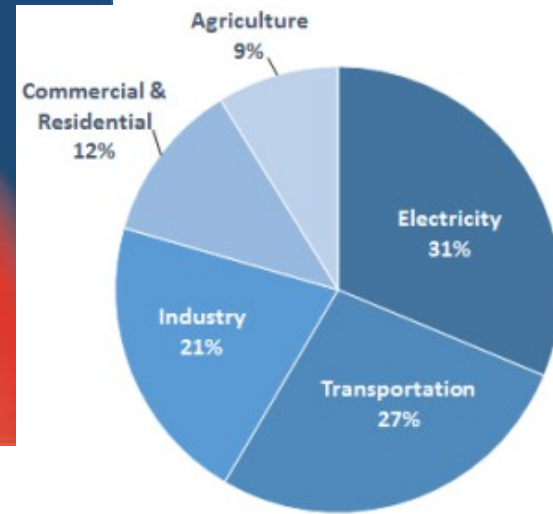
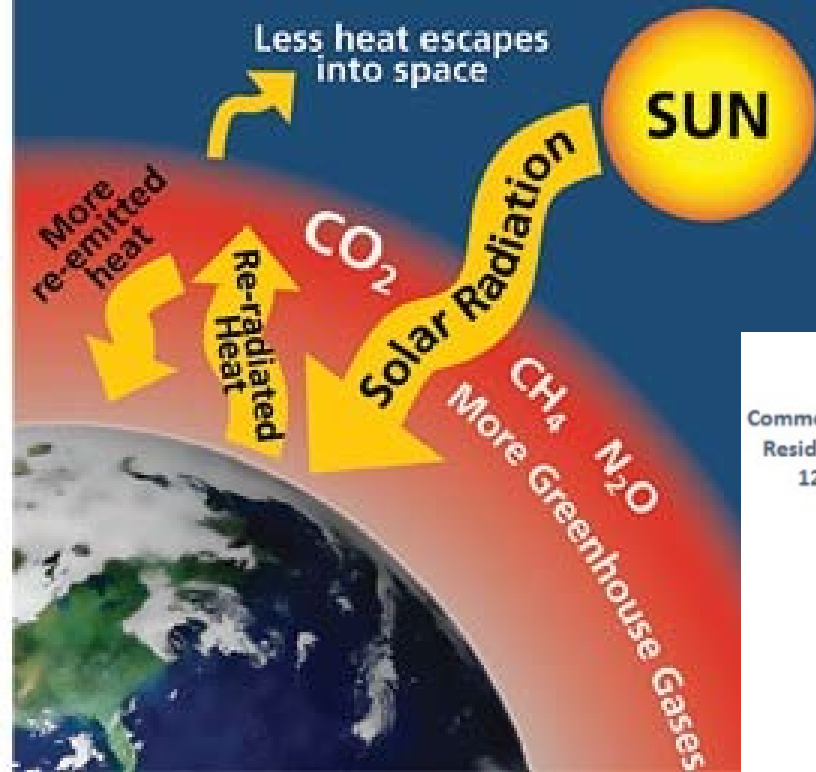
17 GOALS TO TRANSFORM OUR WORLD



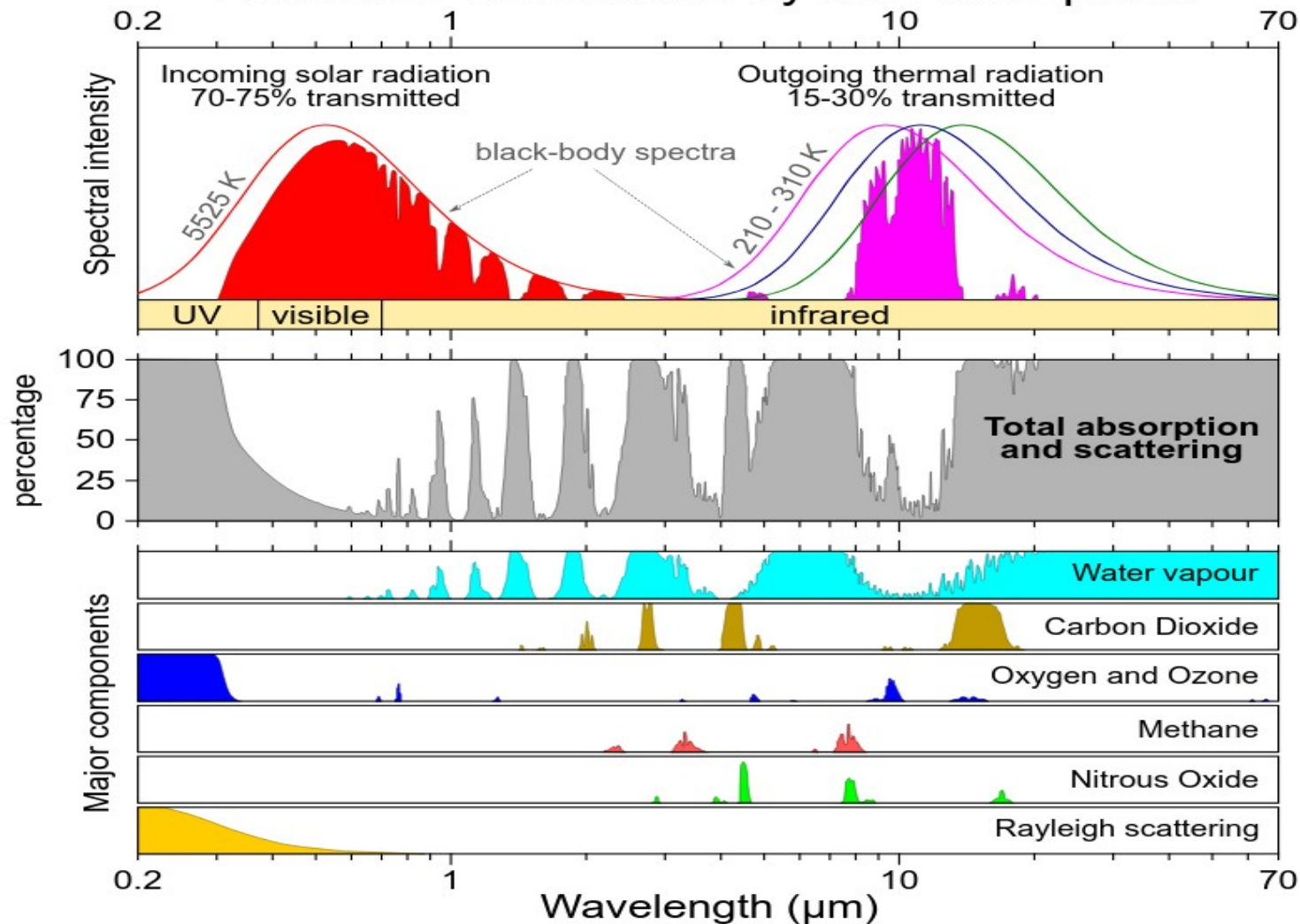
Natural Greenhouse Effect



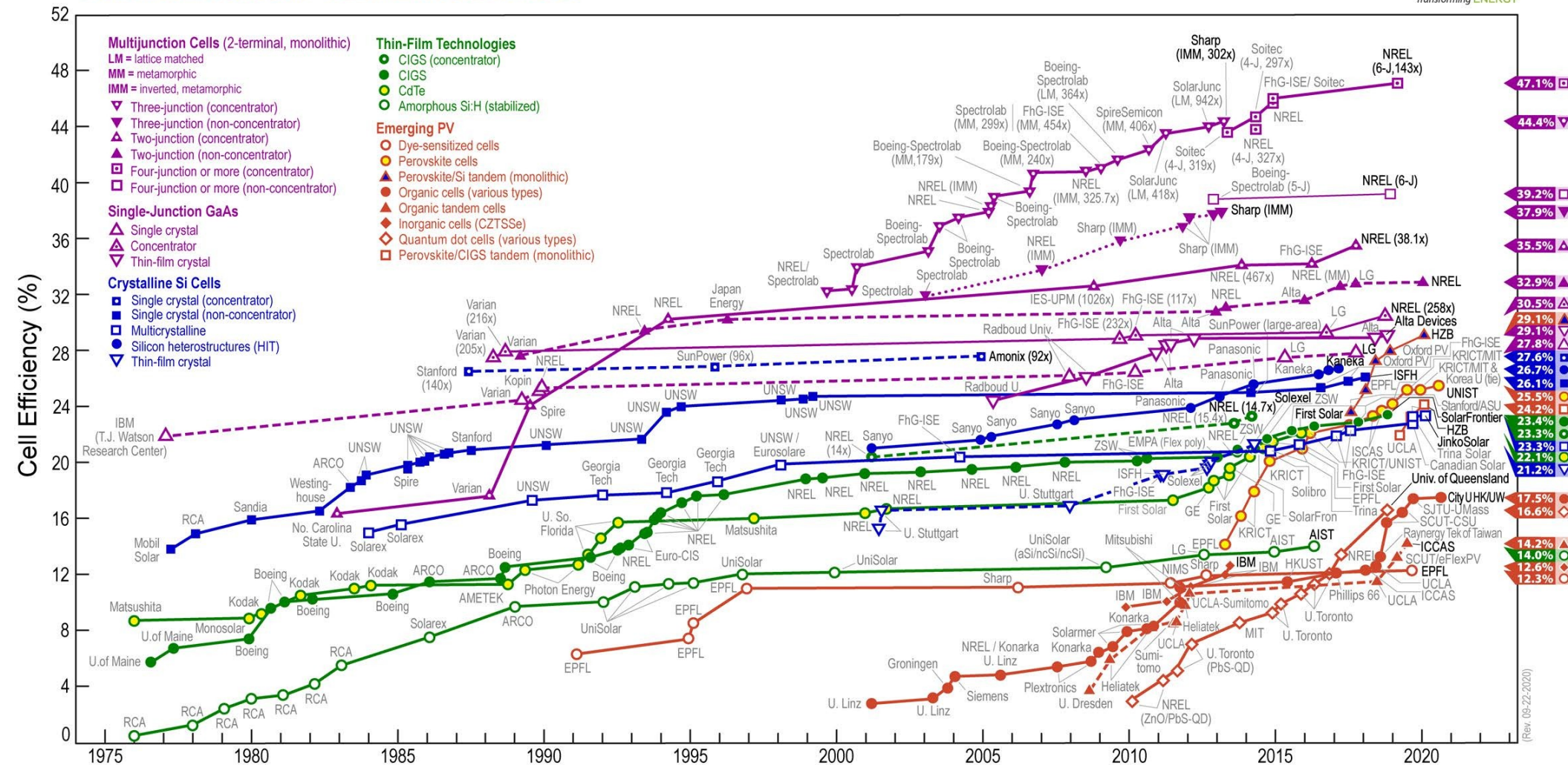
Human Enhanced Greenhouse Effect

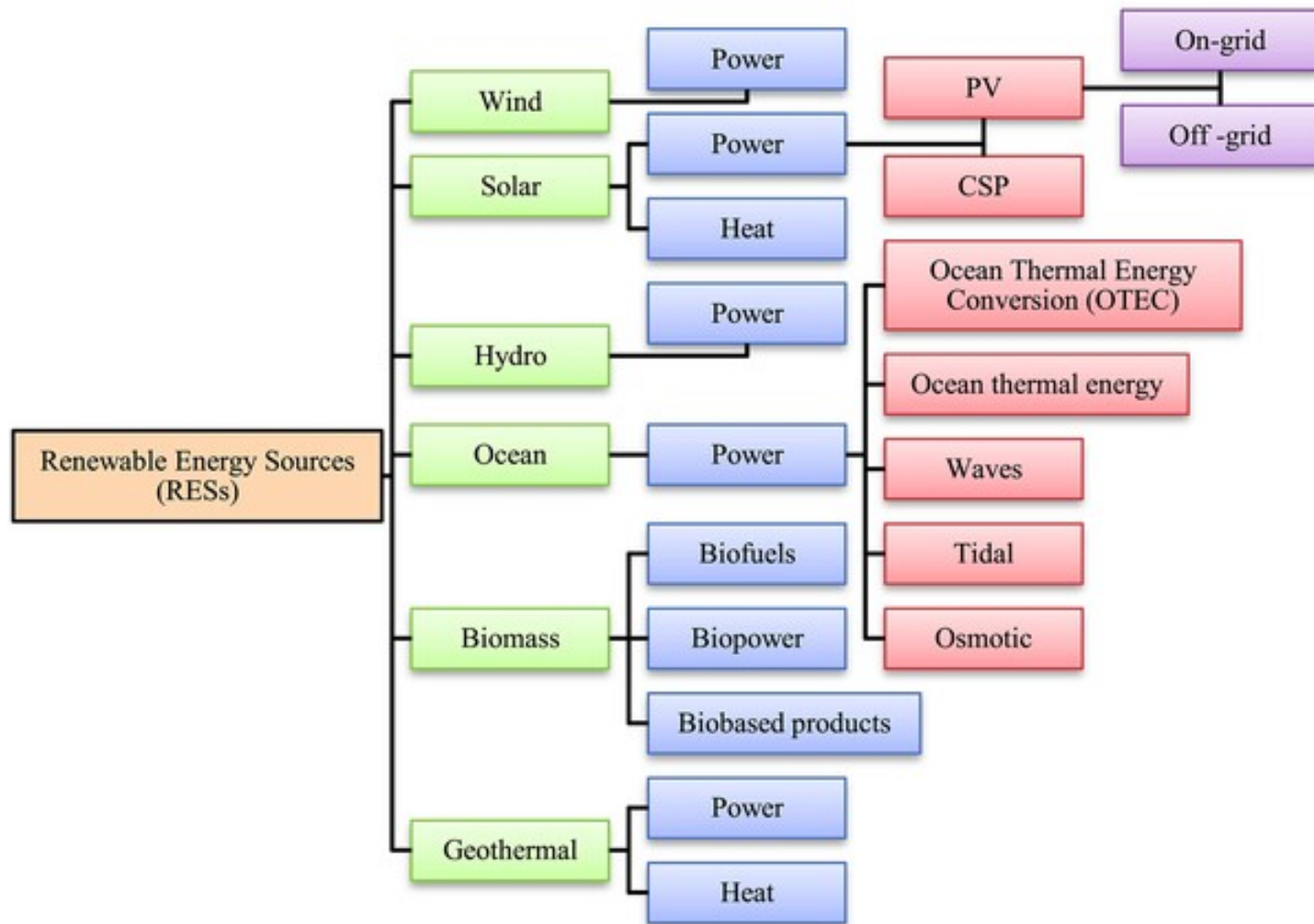


Radiation Transmitted by the Atmosphere



Best Research-Cell Efficiencies





Nuclear is still the best!

https://www.researchgate.net/figure/Different-types-of-renewable-energy-sources-within-main-utilizations-28_fig4_364315857

So we decided, we need:

- Smart Lighting Solutions;
- Smart Thermostat;
- Smart Plugs;
- Smart Home Air Quality;
- Smart Home Air Quality;
- Smart Locks;
- Smart Home Network;
- A Virtual Assistant.

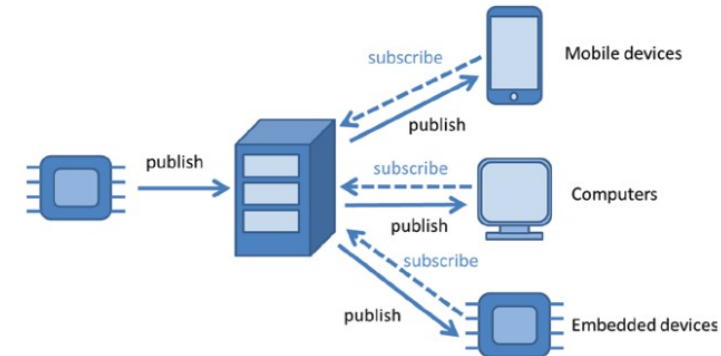
This is our smart house:



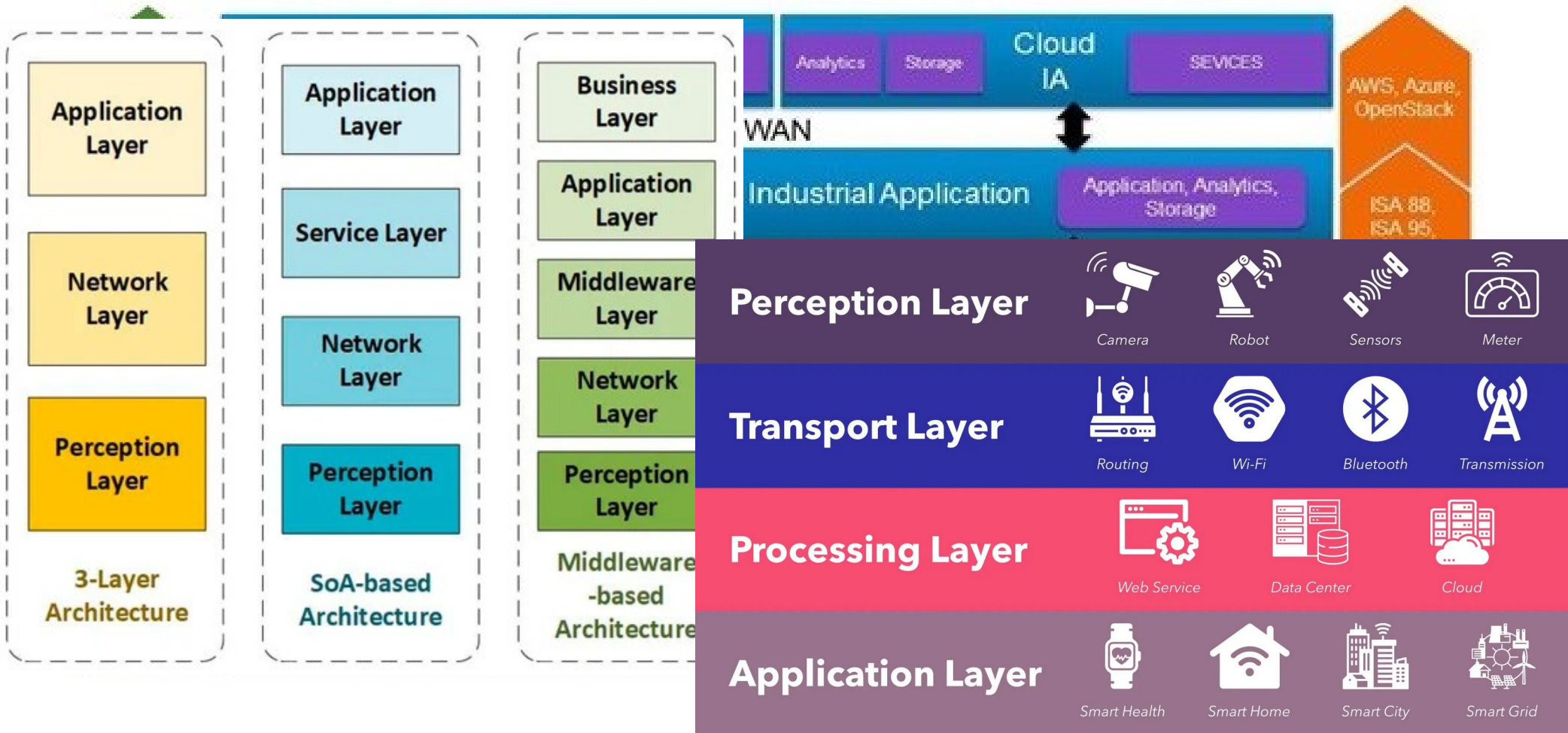
	Flood Sensor		Water Valve
	Door Locks		Security panel
	Solar Panels		Robot Cleaner
	Garage Door		Shades
	Wifi		Multimedias
	lights		Thermometer
	Weather		Video
	Activity Sensor		Camera

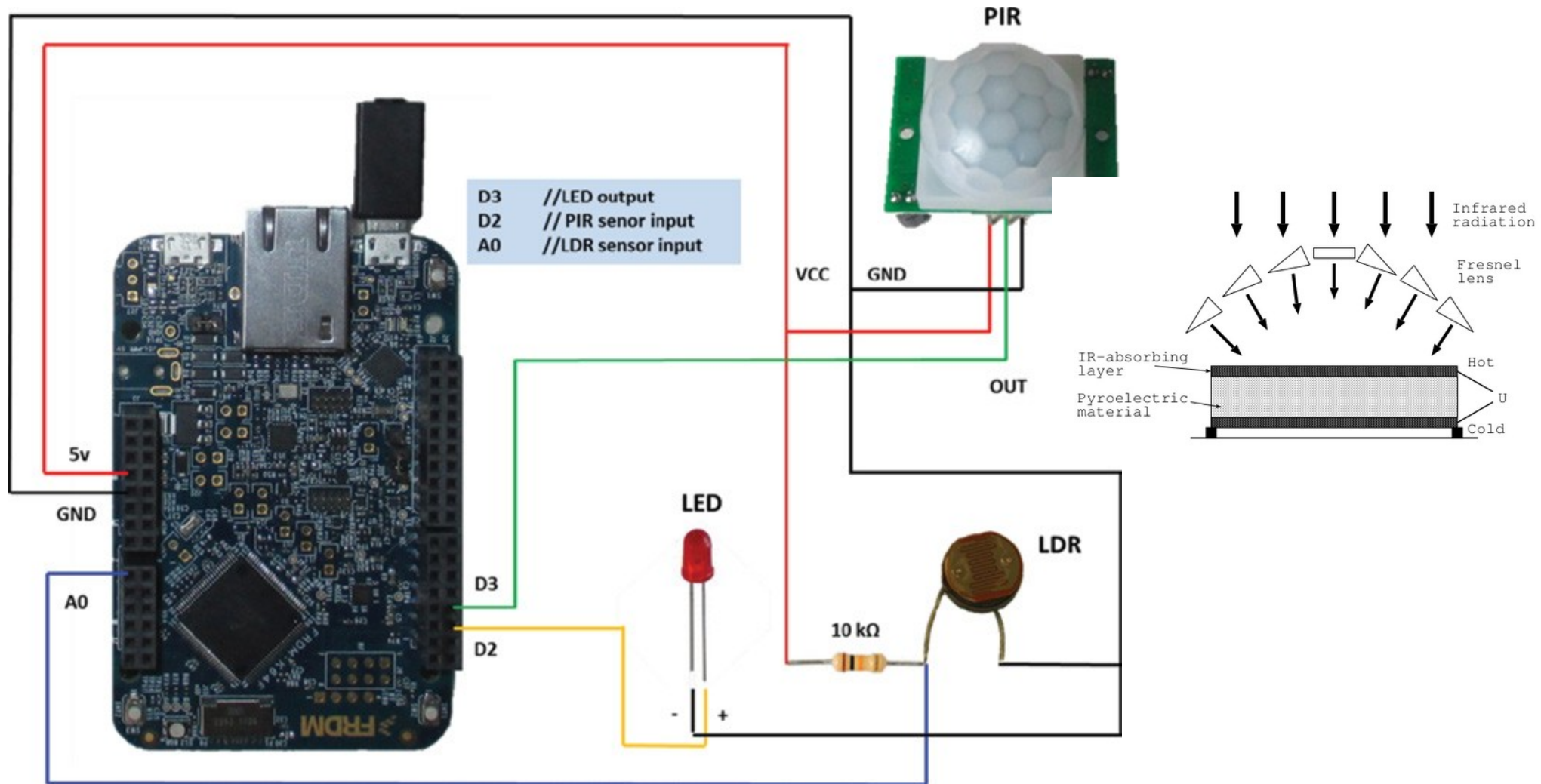
How do we get there?

Sensors (data sources), IoT (Internet of Things), embedded systems



IoT Architecture



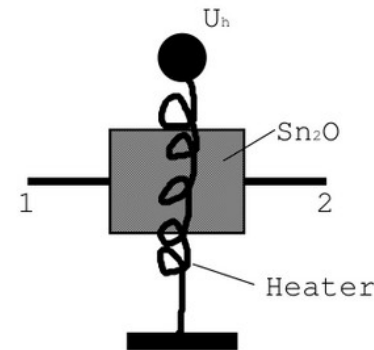
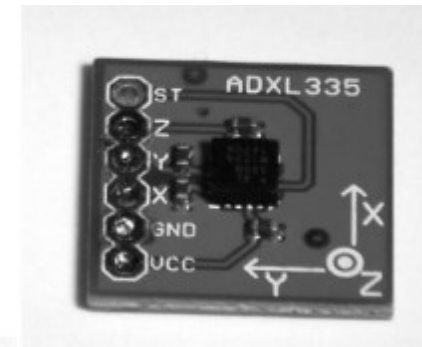
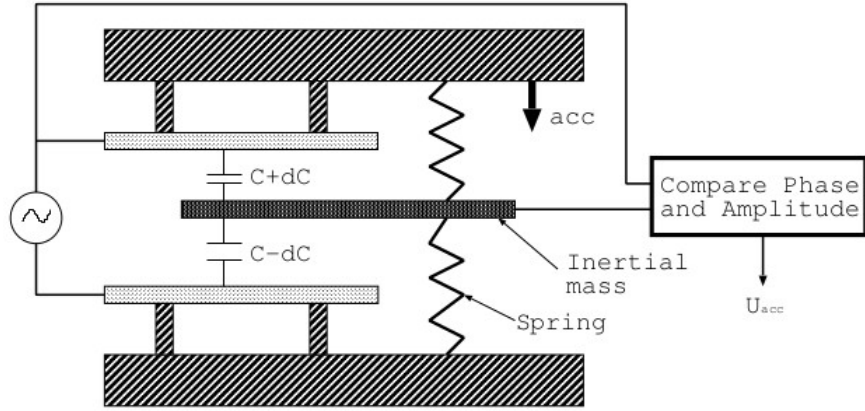


Hall effect

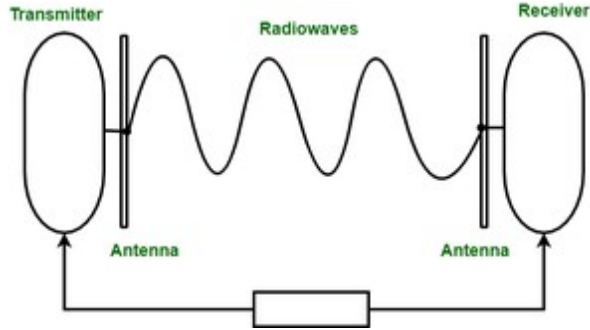
Magnetic field

current

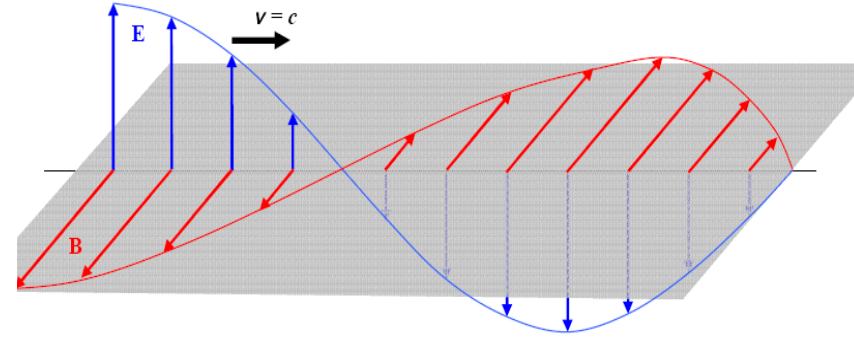
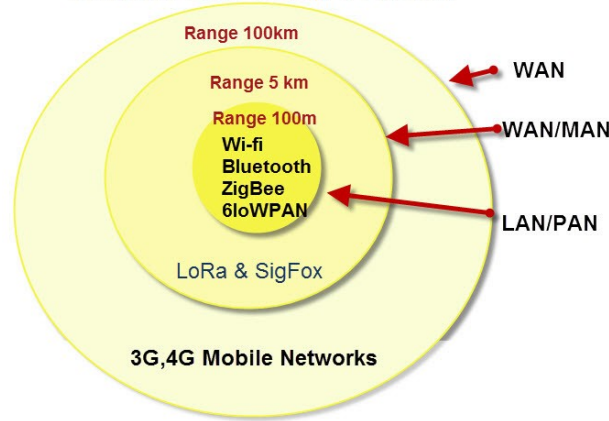
transverse voltage



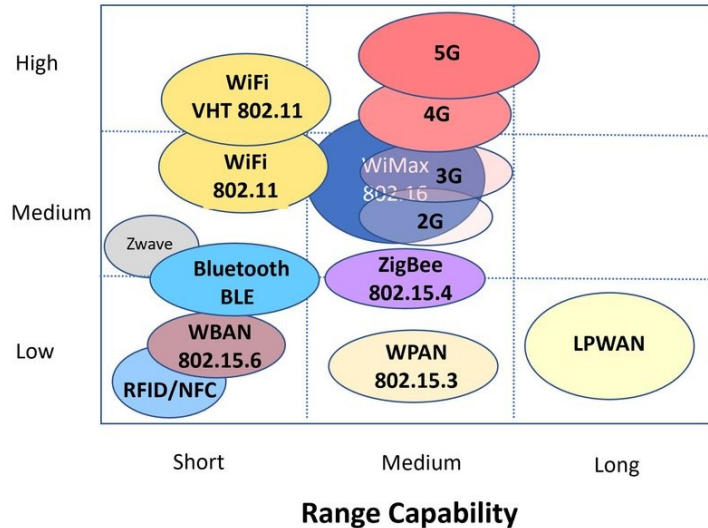
communication



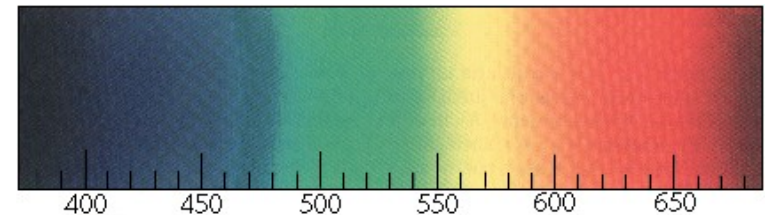
Wireless Networking Overview



Comparison of Wireless Technologies



<i>Kind of Light</i>	<i>Frequency</i>	<i>Wavelength</i>
Radio Waves	< 300 MHz	> 1 m
Microwaves	300 - 750 000 MHz	.4 mm - 1 m
Infrared	750 GHz - 430 THz	700 nm- .4 mm
Visible	430 - 750 THz	400 - 700 nm
Ultraviolet	750 - 6 000 THz	5 - 400 nm
X rays	6 000 - 50 000 000 THz	.006 - 5 nm
Gamma Rays	> 50 000 000 THz	< .006 nm



**What's about
intelligence?**

Intelligent systems are
technologically
advanced machines
that perceive and
respond to the world
around them.

M I N D

A QUARTERLY REVIEW

OF

PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND
INTELLIGENCE

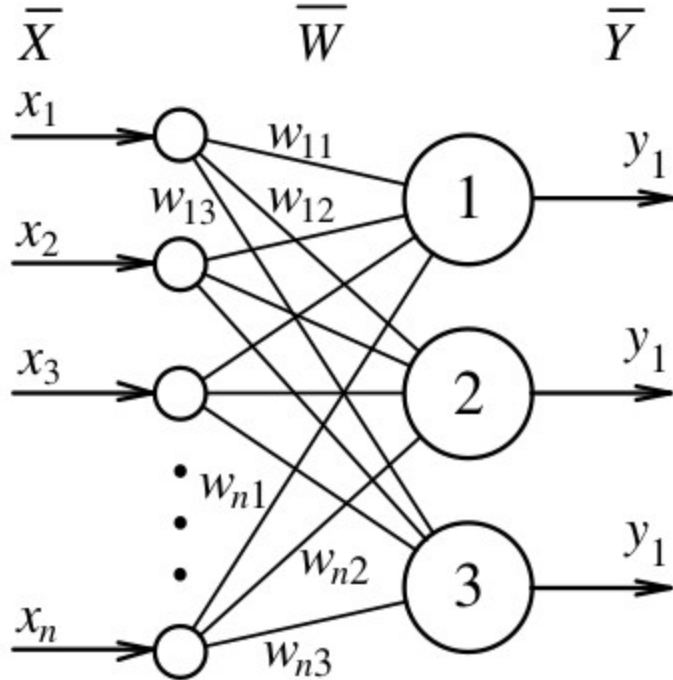
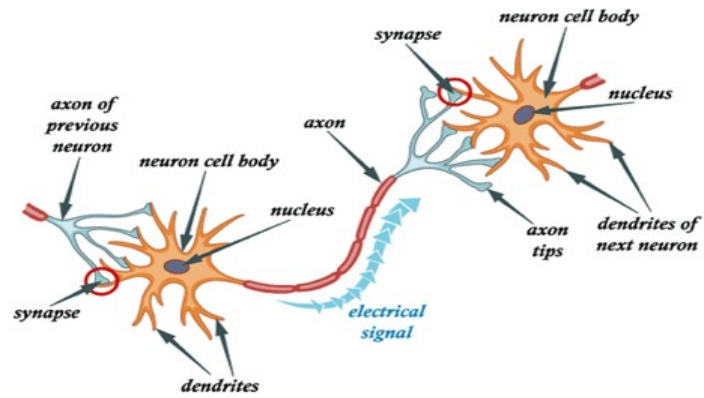
By A. M. TURING

1. *The Imitation Game.*

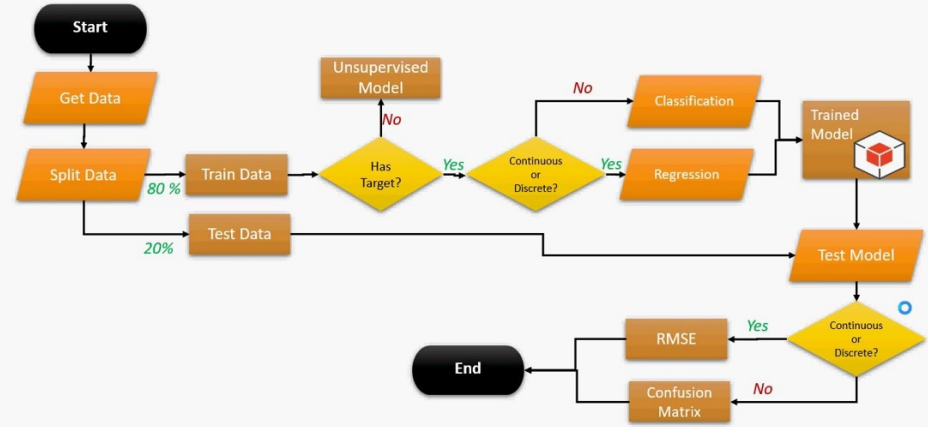
I PROPOSE to consider the question, 'Can machines think?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, 'Can machines think?' is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

The new form of the problem can be described in terms of a game which we call the 'imitation game'. It is played with three people, a man (A), a woman (B), and an interrogator (C) who may be of either sex. The interrogator stays in a room apart from the other two. The object of the game for the interrogator is to determine which of the other two is the man and which is the woman. He knows them by labels X and Y, and at the end of the game he says either 'X is A and Y is B' or 'X is B and Y is A'. The interrogator is allowed to put questions to A and B thus:

C: Will X please tell me the length of his or her hair?
Now suppose X is actually A, then A must answer. It is A's



Machine Learning – Model Flowchart



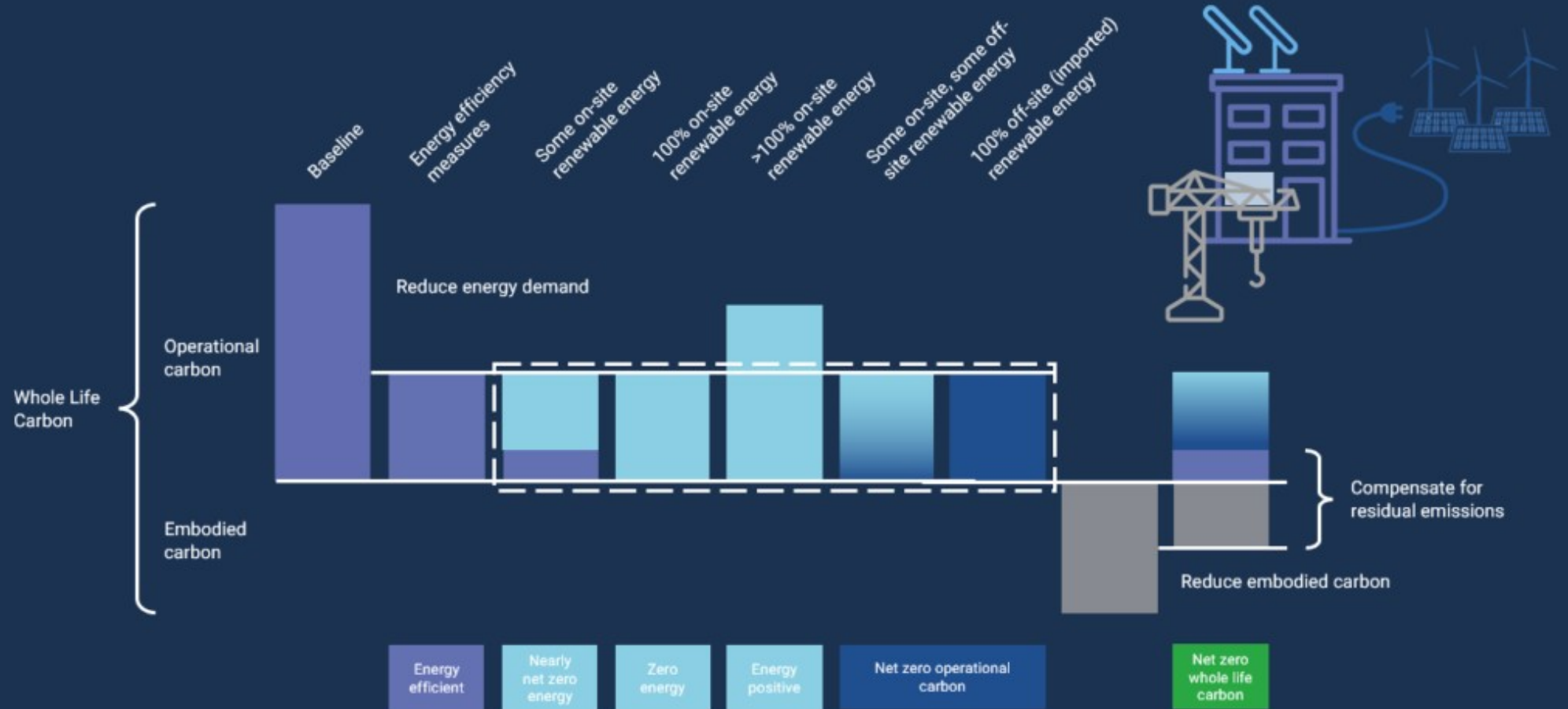
<https://www.youtube.com/watch?v=1wVgtlNZIT4> and more

$$\left\{ \begin{array}{l} y = f(s) \\ s = \sum_{i=1}^n x_i \cdot w_i + T \end{array} \right.$$



**What are the
constraints?**

Definitions: Net Zero Carbon Buildings



Total Energy Use Intensity (EUI) -
Energy use measured at the meter should be equal to or less than:

- 35 kWh/m²/yr for residential

For non-domestic buildings EUI equal or less than:

- 65 kWh/m²/yr for schools
- 70 kWh/m²/yr (Net Lettable Area) or 55 kWh/m²/yr (Gross Internal Area) for commercial offices

Building fabric is very important therefore
space heating demand should be less than
15 kWh/m²/yr for all building types.

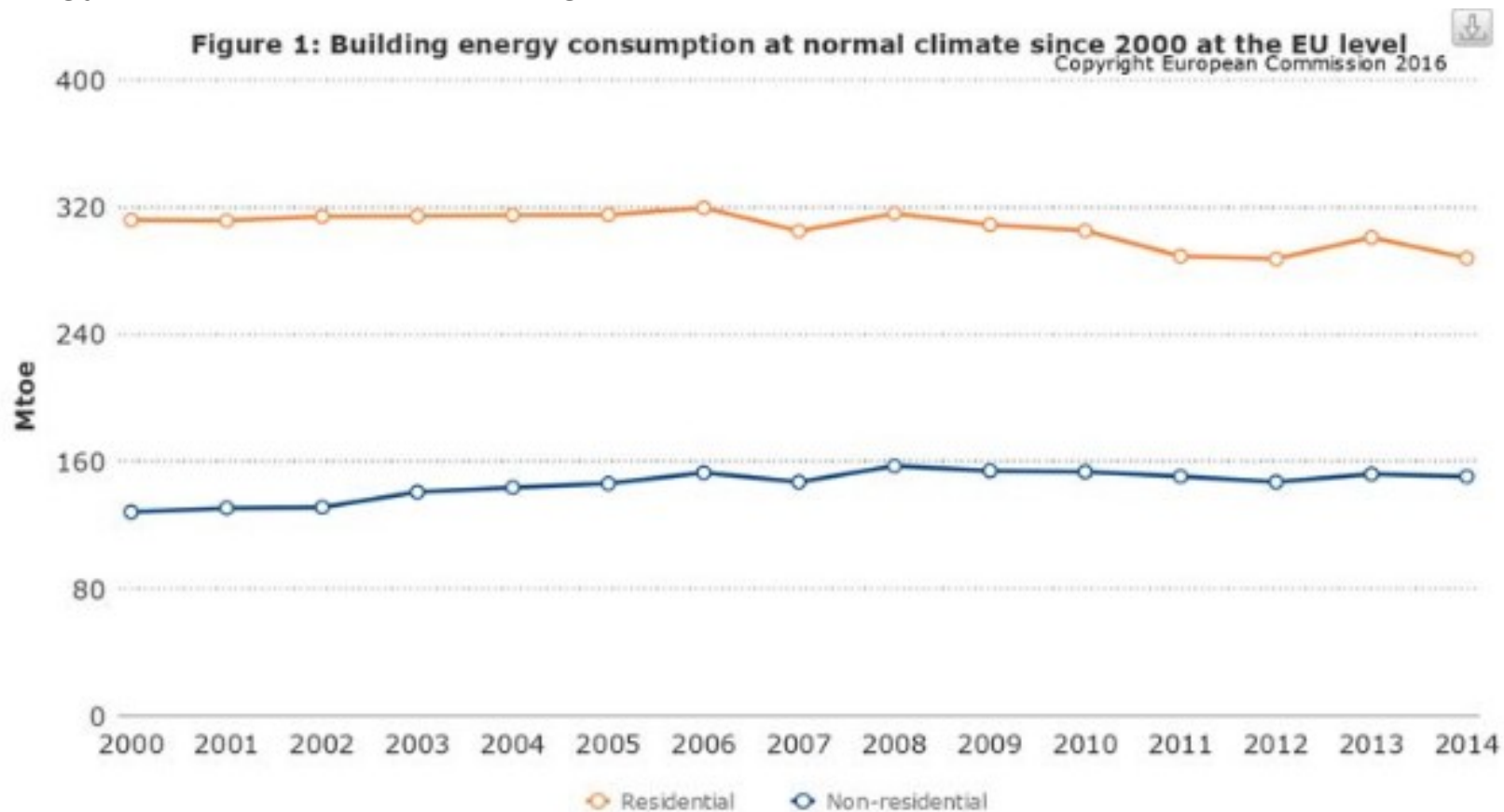
<https://ukgbc.org/resources/net-zero-carbon-one-pager-for-new-buildings/>



... manufacturing lumber is the least energy intensive, at 33kg net carbon emissions per production ton, compared to 220kg for recycled steel, 265kg for concrete, and 694kg for virgin steel...

<https://www.thinkwood.com/sustainable-architecture-design/net-zero-carbon-buildings>

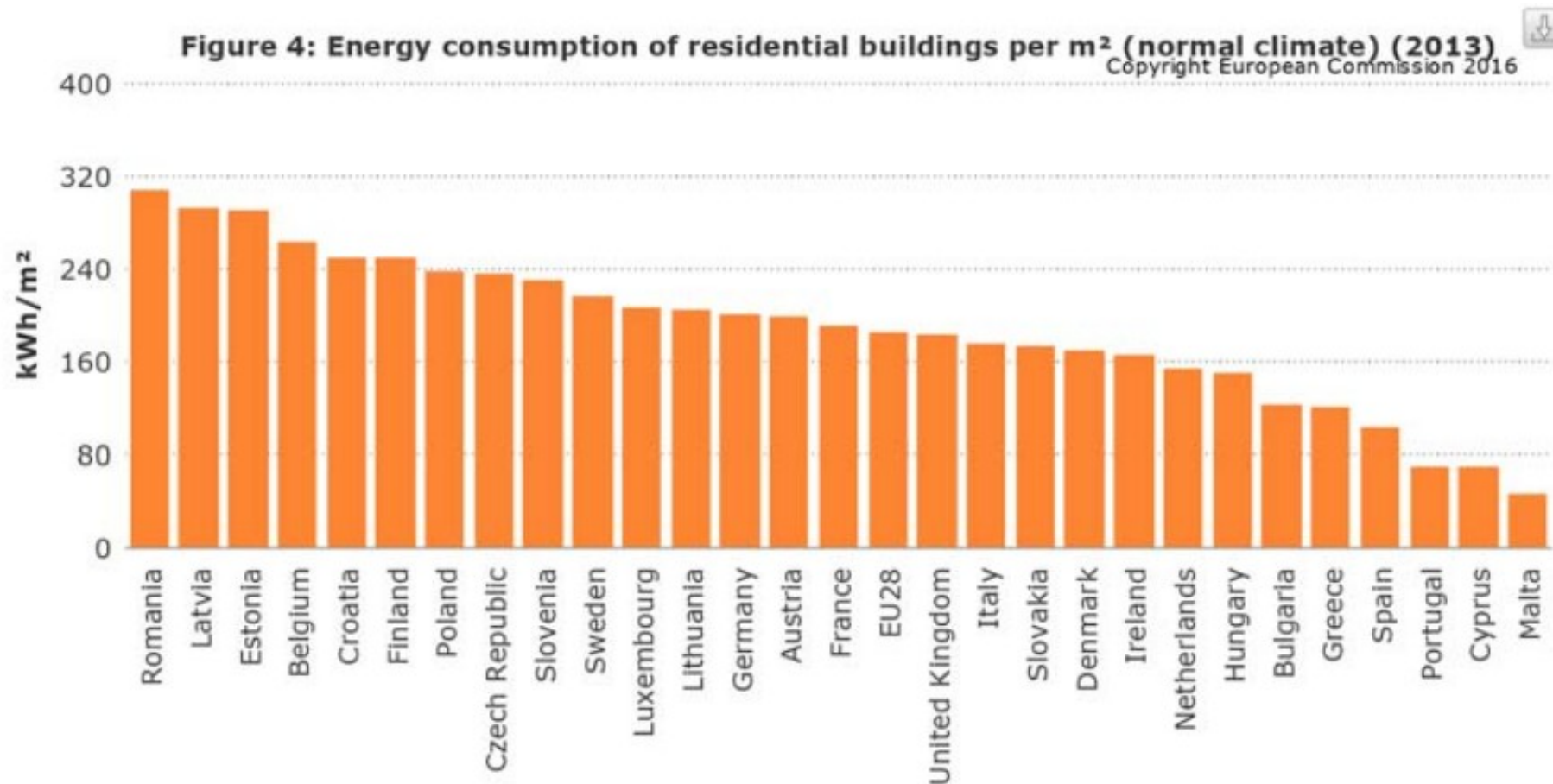
Energy consumption in buildings



https://energy.ec.europa.eu/system/files/2016-11/energyuse_0.pdf

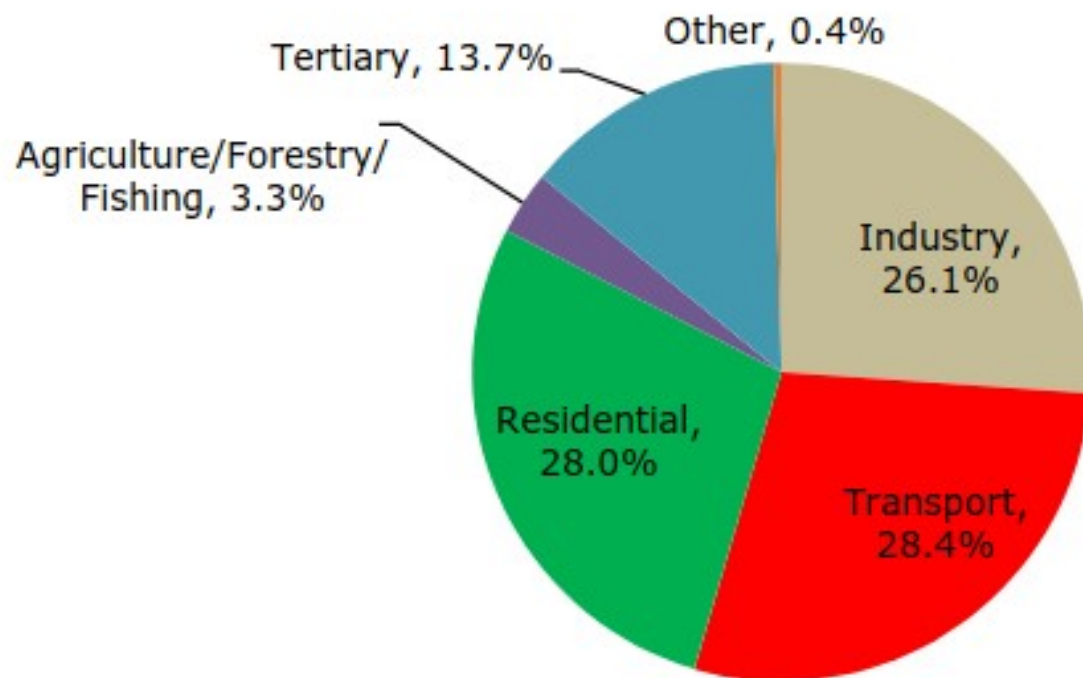
https://climateactionaccelerator.org/solution-areas/energy_consumption_of_buildings/

Energy consumption in buildings



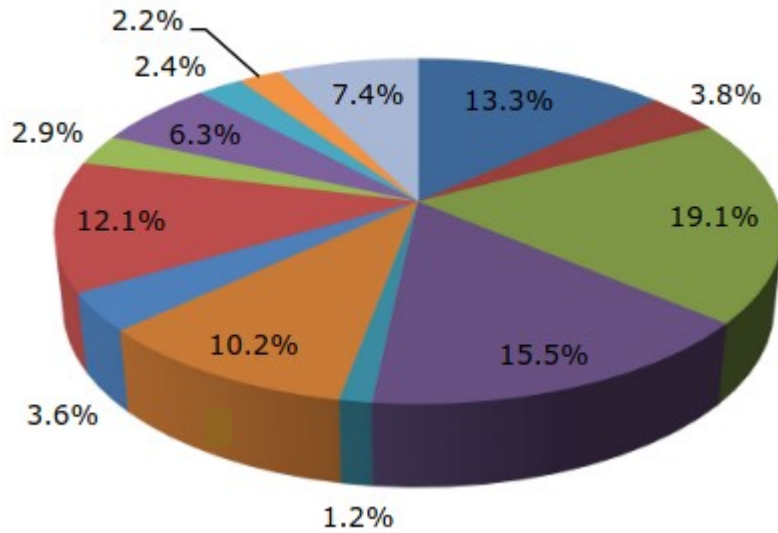
https://energy.ec.europa.eu/system/files/2016-11/energyuse_0.pdf

Figure 7: Final energy consumption breakdown into sectors in the EU-27, 2020



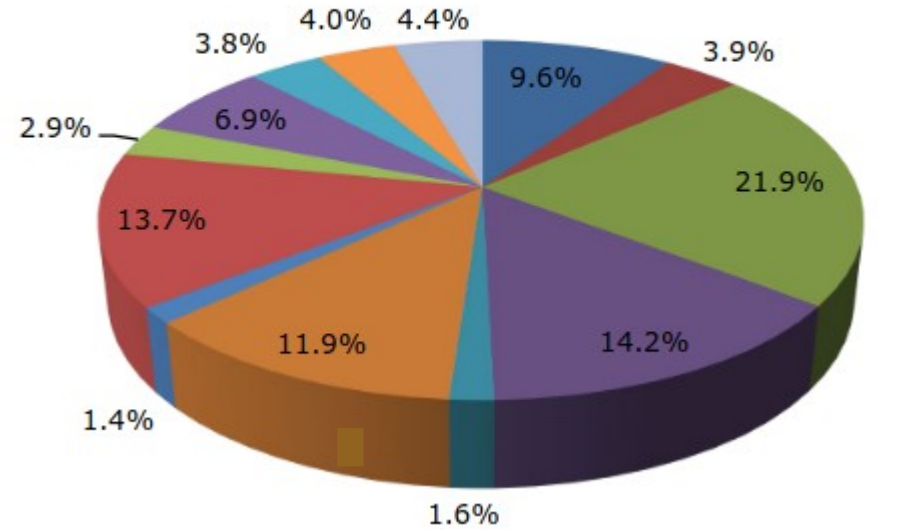
Source: Eurostat

2000



- Paper, Pulp and Print
- Transport Equipment
- Machinery
- Wood and Wood Products
- Construction
- Non-specified (Industry)

2020



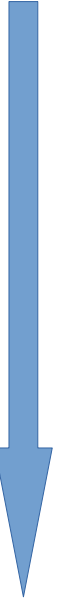
- Iron and Steel
- Non-Ferrous Metals
- Chemical and Petrochemical
- Non-Metallic Minerals
- Mining and Quarrying
- Food, beverages and Tobacco
- Textile and Leather

How to overcome obstacles?

DEFINE

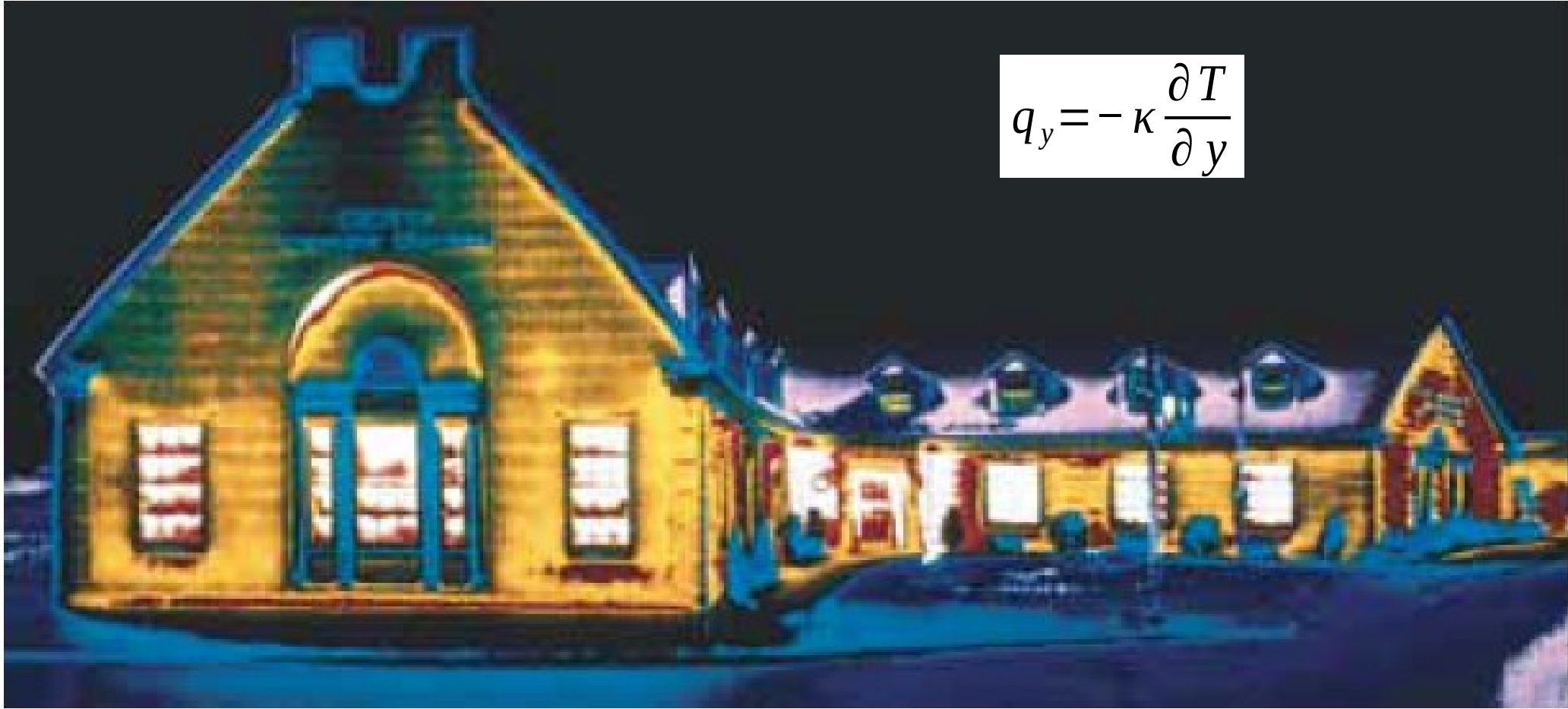
EXPLORE

IDEATE



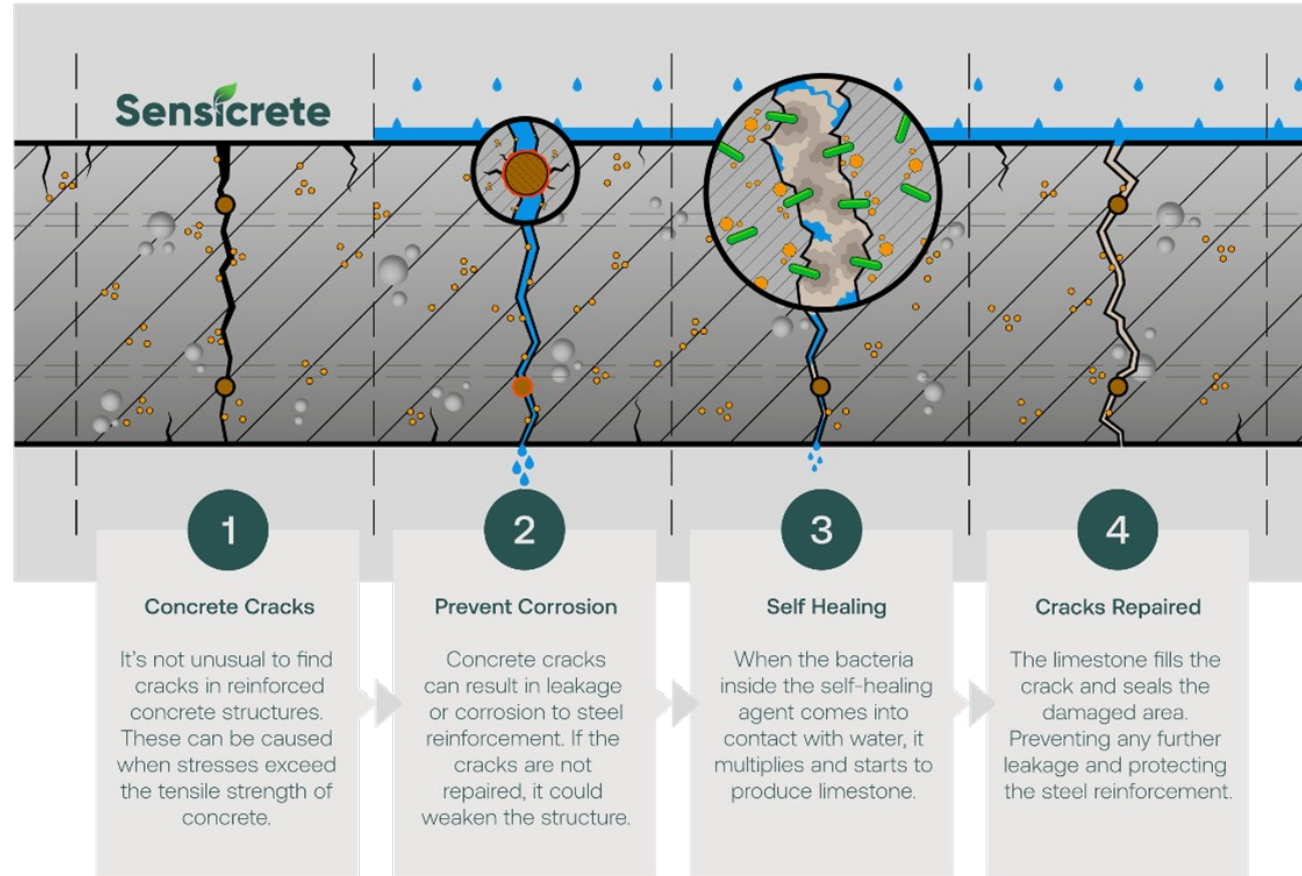
New materials?

$$q_y = -\kappa \frac{\partial T}{\partial y}$$



What do we heat?

Self-healing concrete ?



<https://www.rics.org/news-insights/building-a-sustainable-future-the-incredible-potential-of-self-healing-concrete>

<https://pmc.ncbi.nlm.nih.gov/articles/PMC9106089/>

Compressed Earth Blocks (CEB) ?



<https://uku.eu/en/clay-products/ceb-compressed-earth-block/>

Richlite (recycled and renewable forest products combined with a thermosetting resin under extremely high heat and pressure) ?



<https://www.richlite.com/>

Light-Generating Concrete?



<https://theconstructor.org/building/smart-materials/light-emitting-cement/210471/>

Translucent Wood?



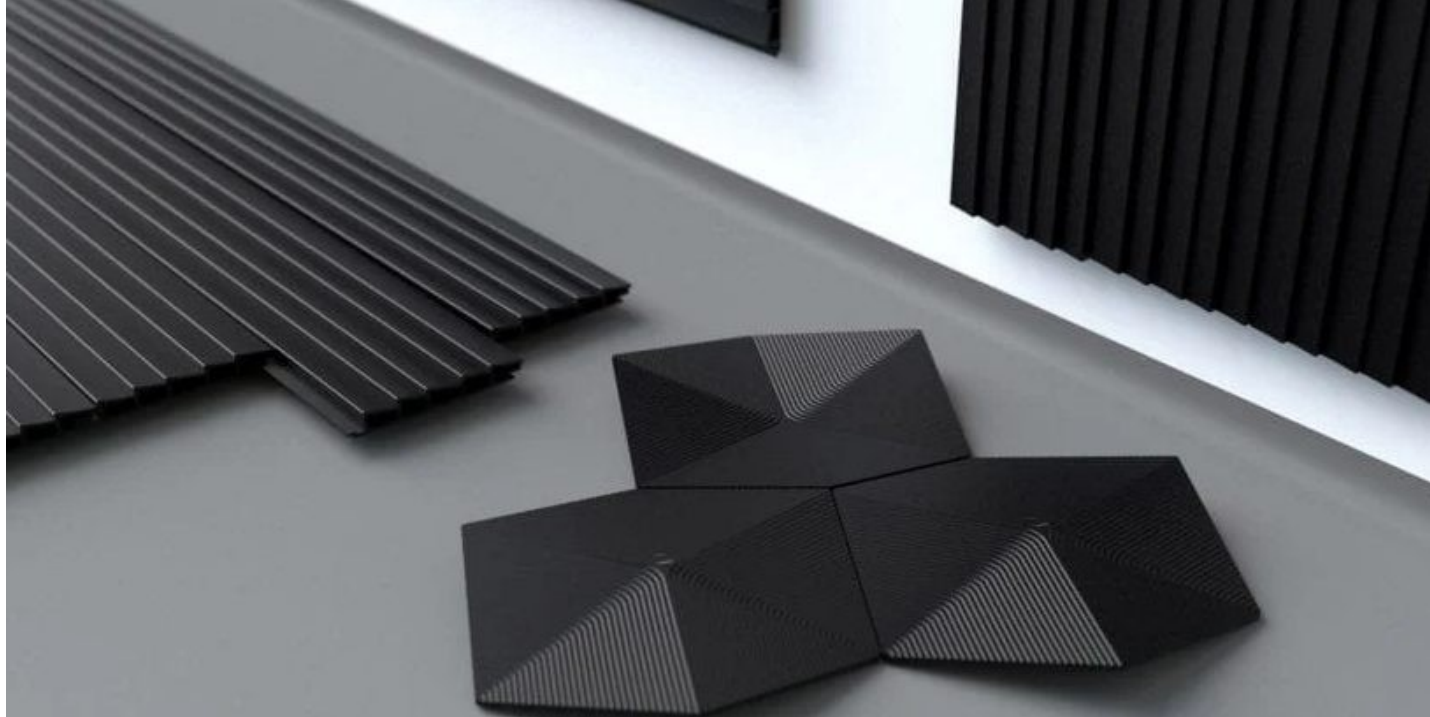
<https://www.newscientist.com/article/2265874-wood-can-easily-be-turned-transparent-to-make-energy-saving-windows/#ixzz7P7Av0sSb>

Power-generating glass?



<https://architecturecompetitions.com/5-innovative-materials-in-architecture-construction>

HexChar (non-toxic bioplastic made of biochar from forest and agricultural waste capturing carbon) ?



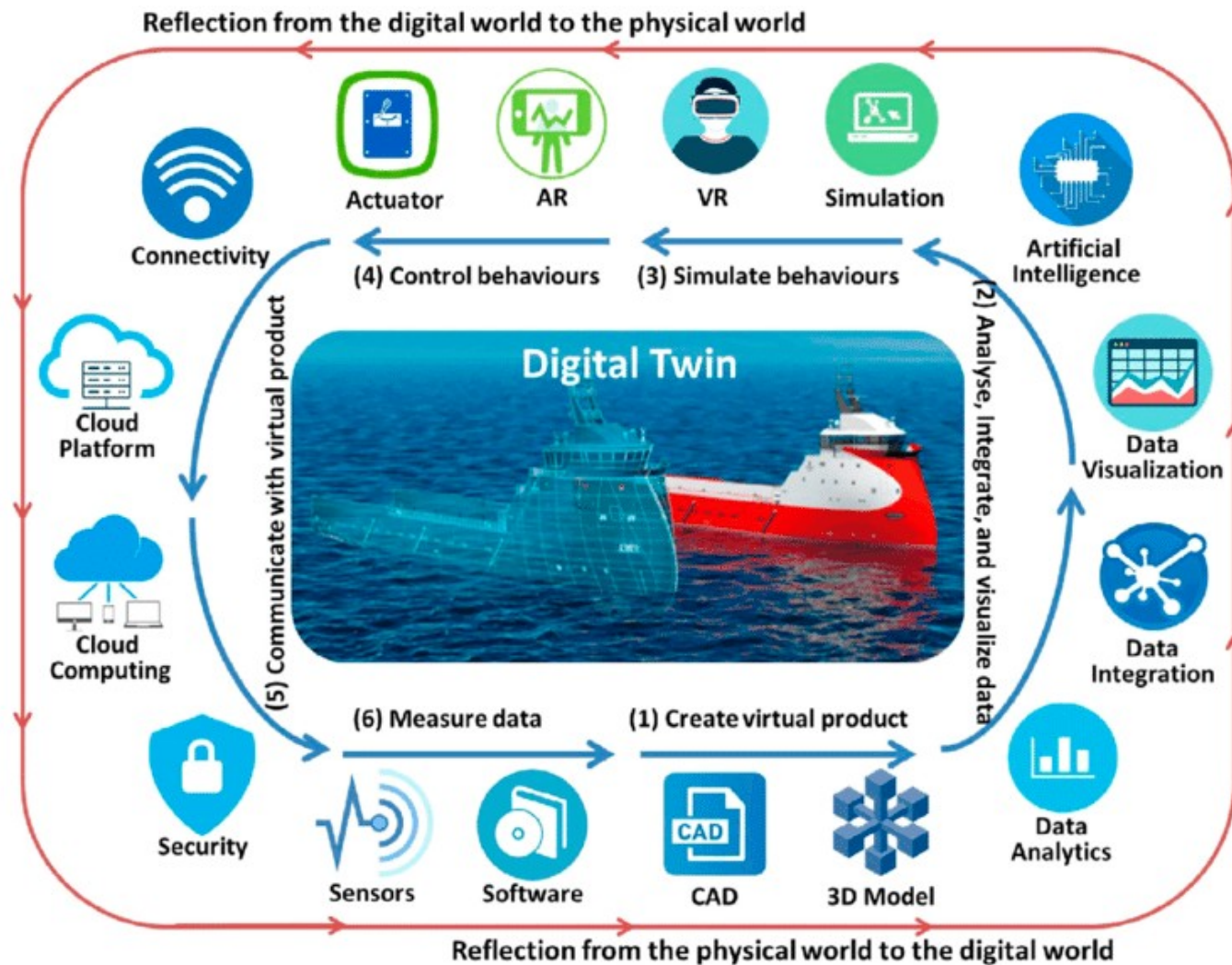
New technologies?

Emerging Construction Technology Trends

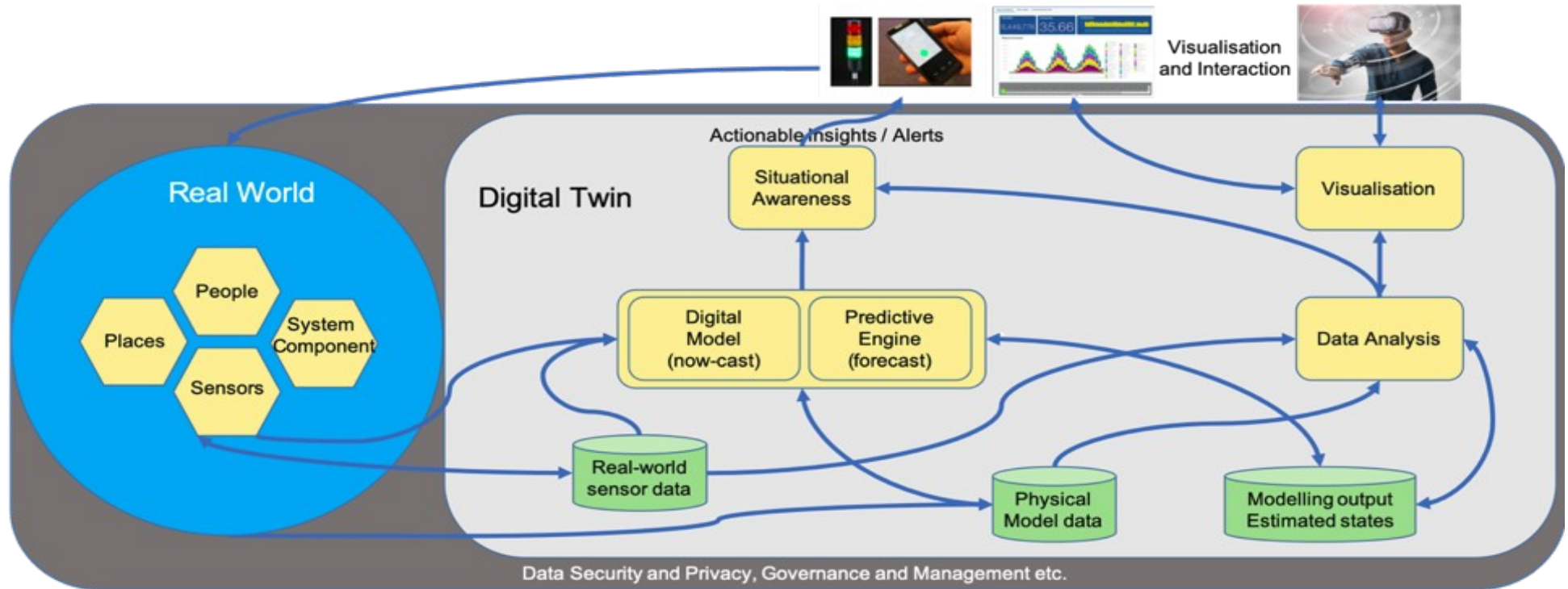
- Project Management Software;
- Virtual and Augmented Reality;
- Generative AI;
- Drones;
- Construction Robotics and Automation;
- Digital Twin;
- 3D Laser Scanner;
- 4D Simulation;
- Building Information Modelling;
- 3D Printing;
- Data Analytics in Construction Technology.

<https://www.intellectsoft.net/blog/emerging-construction-technology-trends/>

Digital Twins?



Digital twin reference architecture



<https://developer.ibm.com/articles/what-are-digital-twins/>

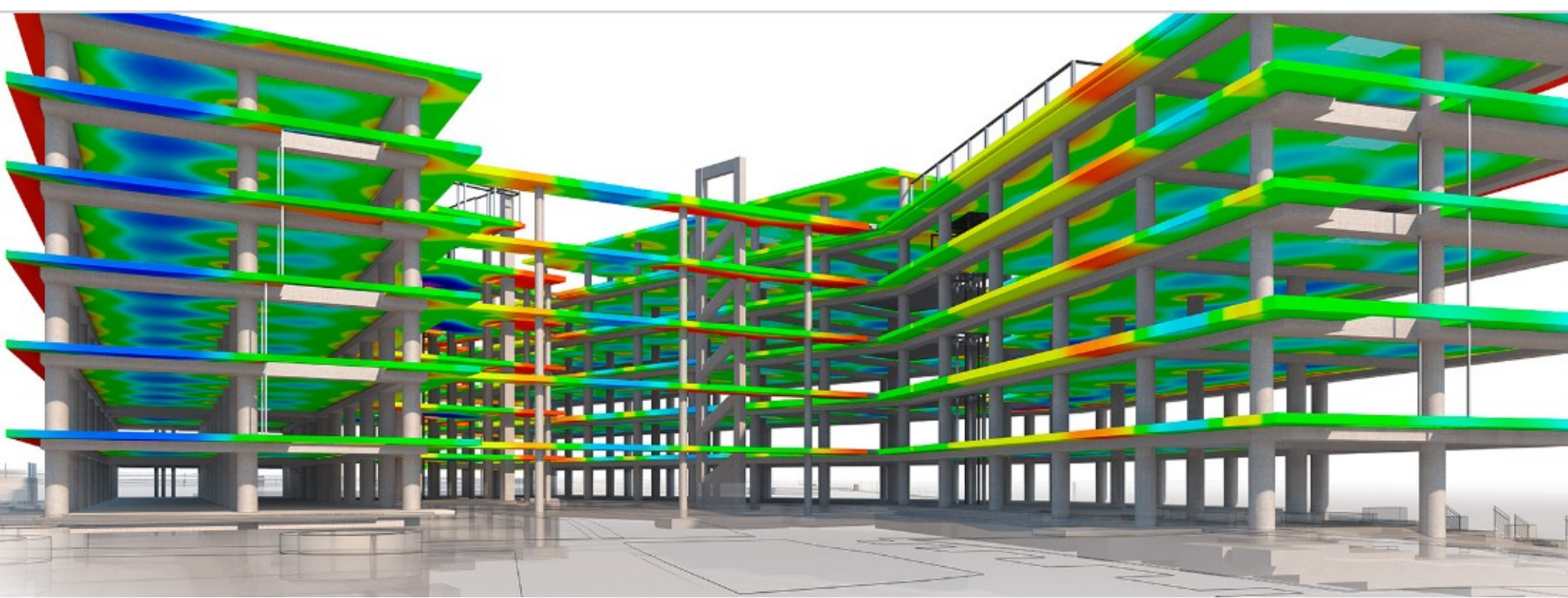
Building information modeling?

Building Information Modeling (BIM) is a collaborative way for multidisciplinary information storing, sharing, exchanging, and managing throughout the entire building project lifecycle including planning, design, construction, operation, maintenance, and demolition phase.

[2017, Encyclopedia of Sustainable Technologies](#)

Building information modeling (BIM) is described in various ways: as a technology and a methodology, as product modeling and process support, as three-dimensional (3D) and n-dimensional (nD) technology, as object-based representation and shared knowledge resource, but above all as a promise of higher performance.

[2020, Advances in Construction and Demolition](#)

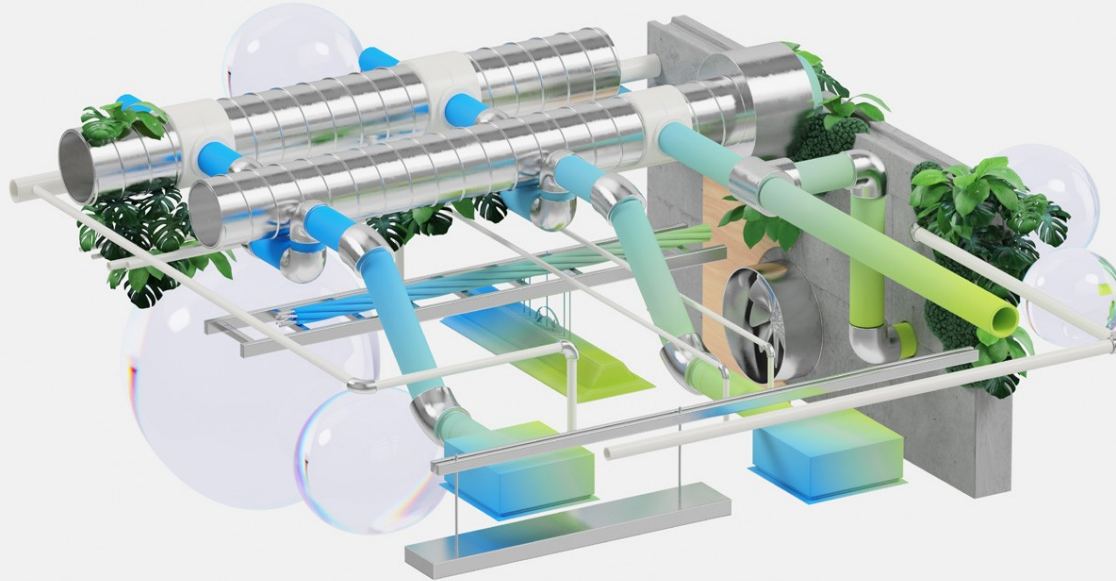


Seamless Collaboration
Optimized designs

Design Automation
Integrated Analysis

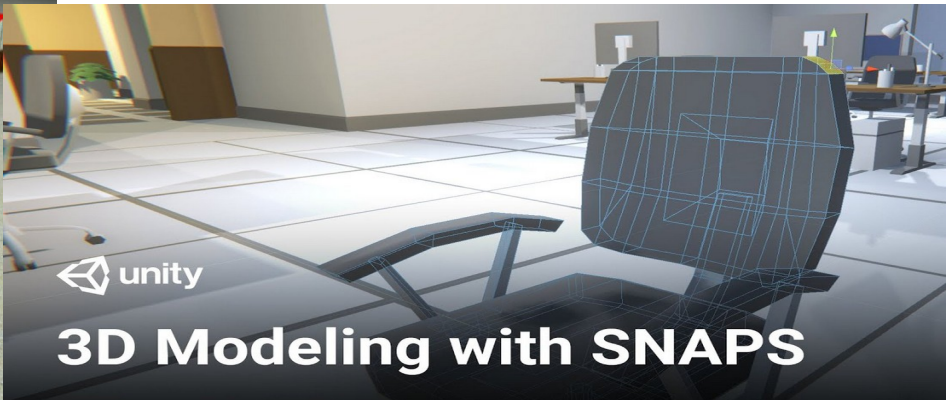
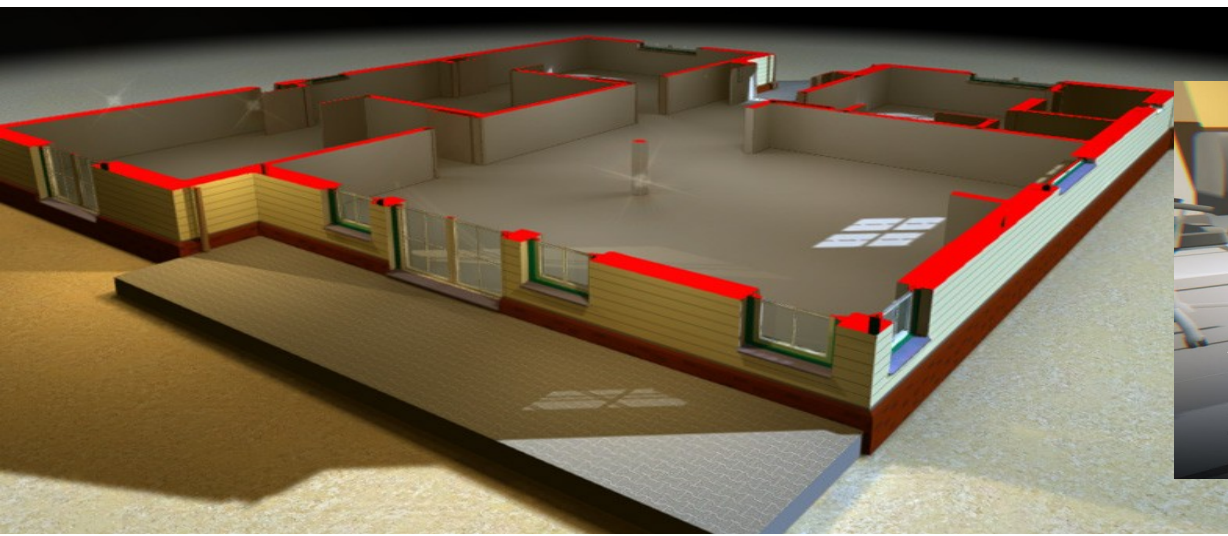
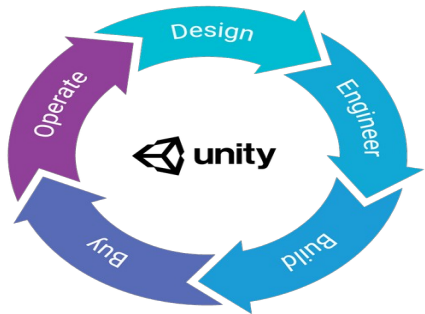
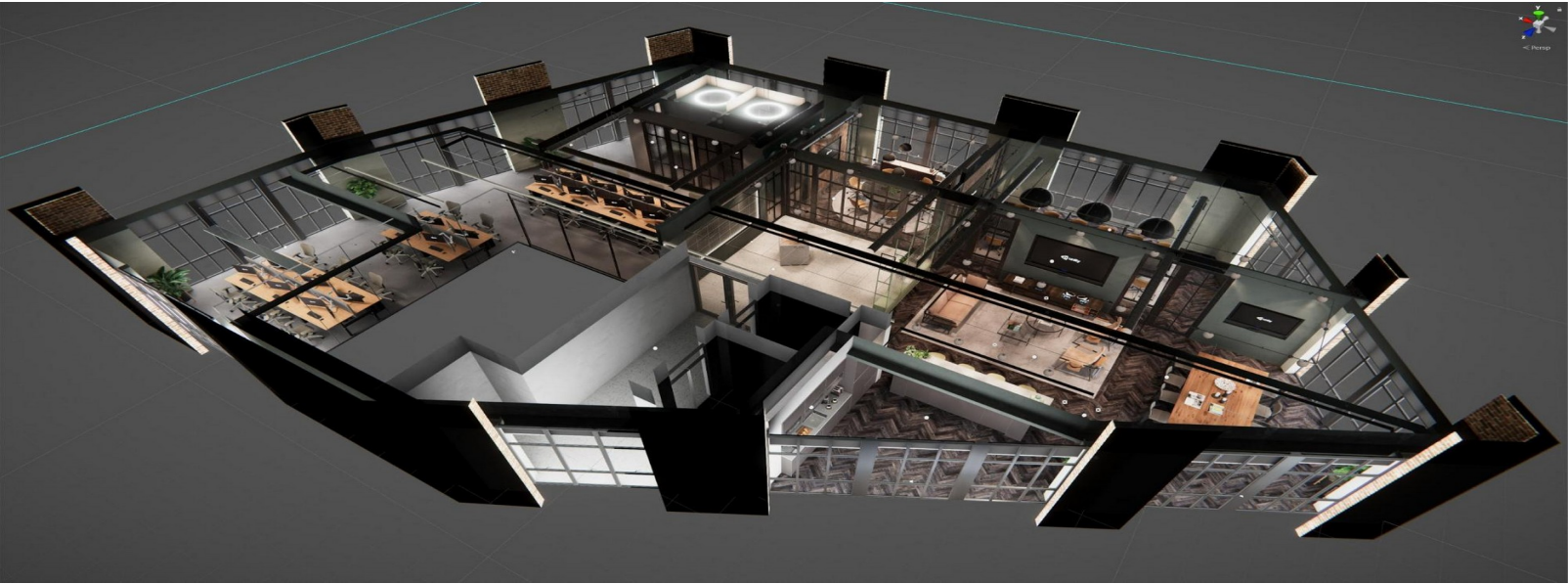
<https://www.autodesk.com/solutions/aec/bim/structural-engineering>

Energy-Efficient Buildings for a Sustainable Future



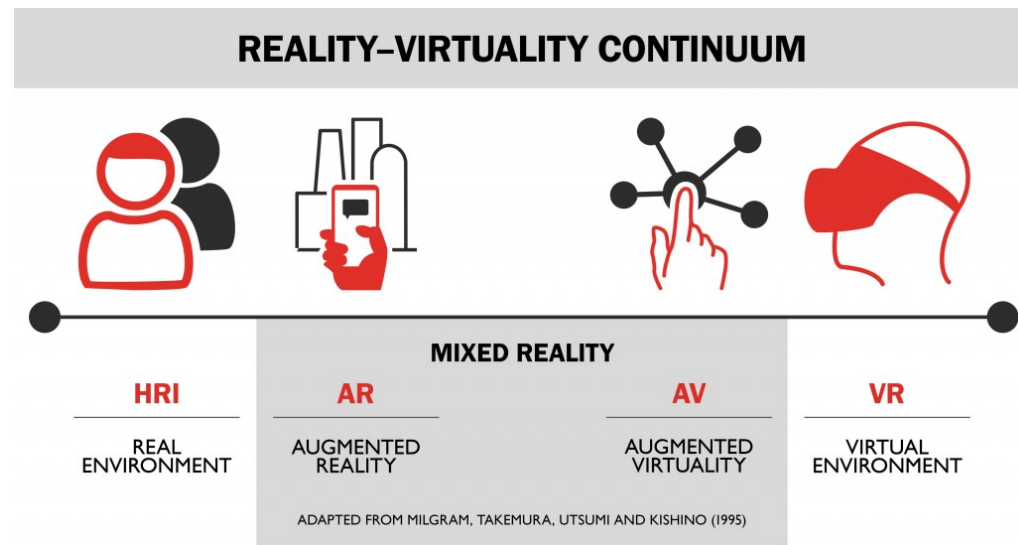
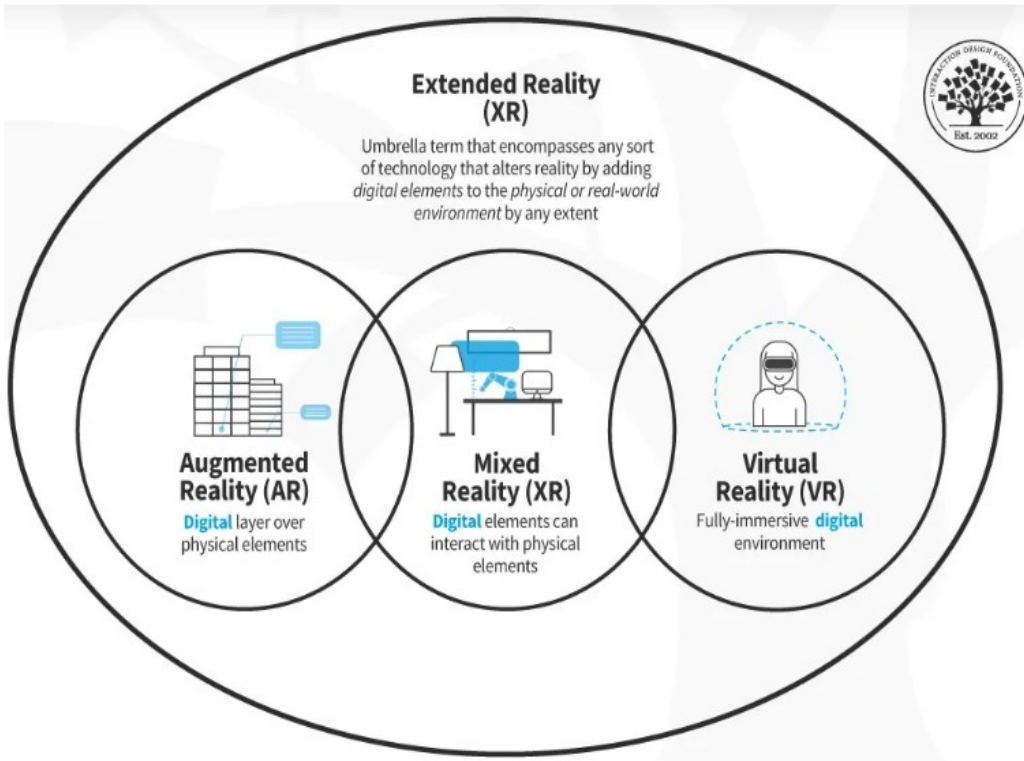
A WHITEPAPER BY  **MagiCAD**

<https://www.magicad.com/whitepapers/energy-efficient-buildings-sustainable-future/>



<https://blogs.unity3d.com/ru/2019/03/12/look-closer-thats-the-power-of-real-time-3d-for-aec/>

VR / AR ?



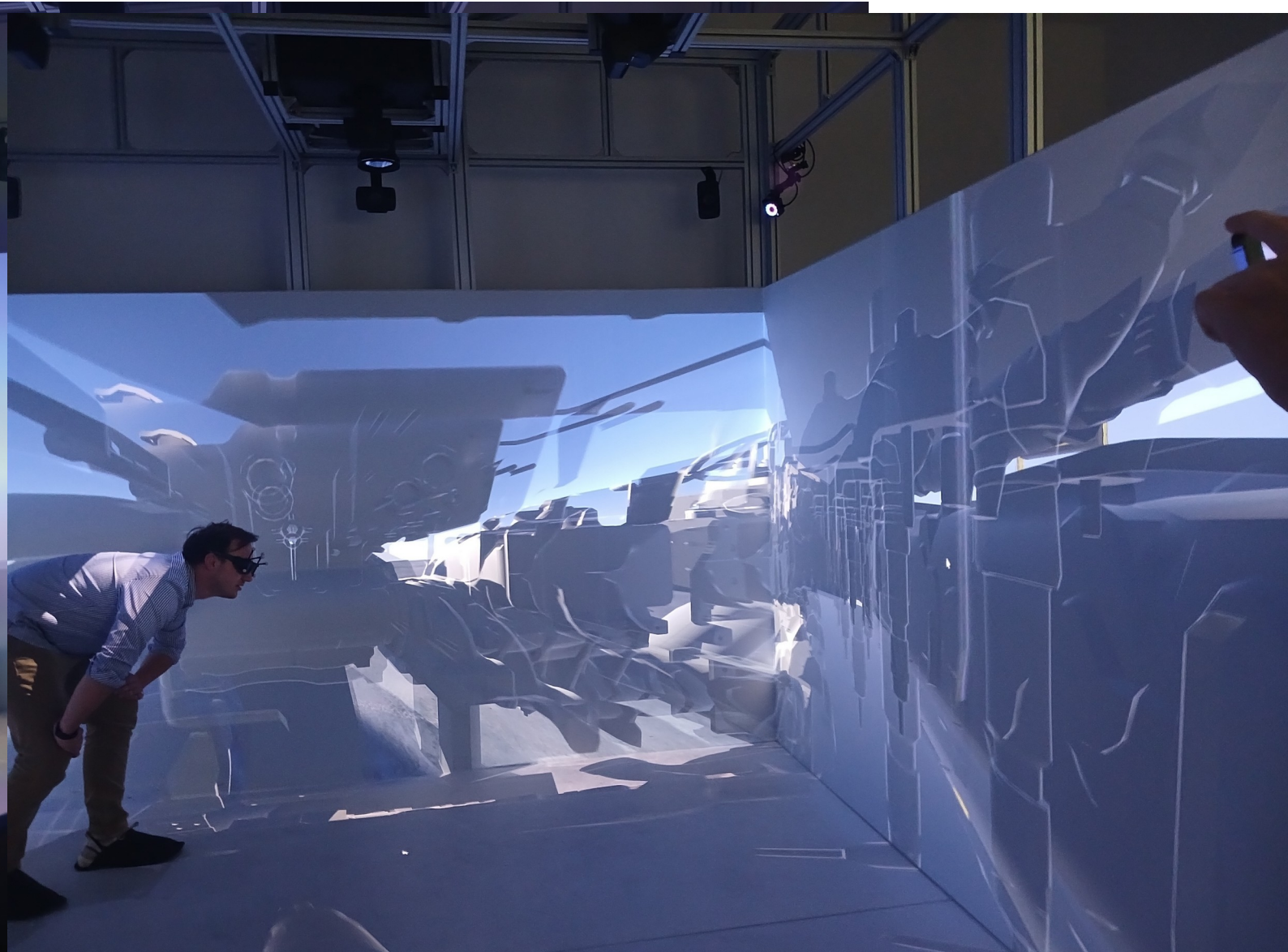


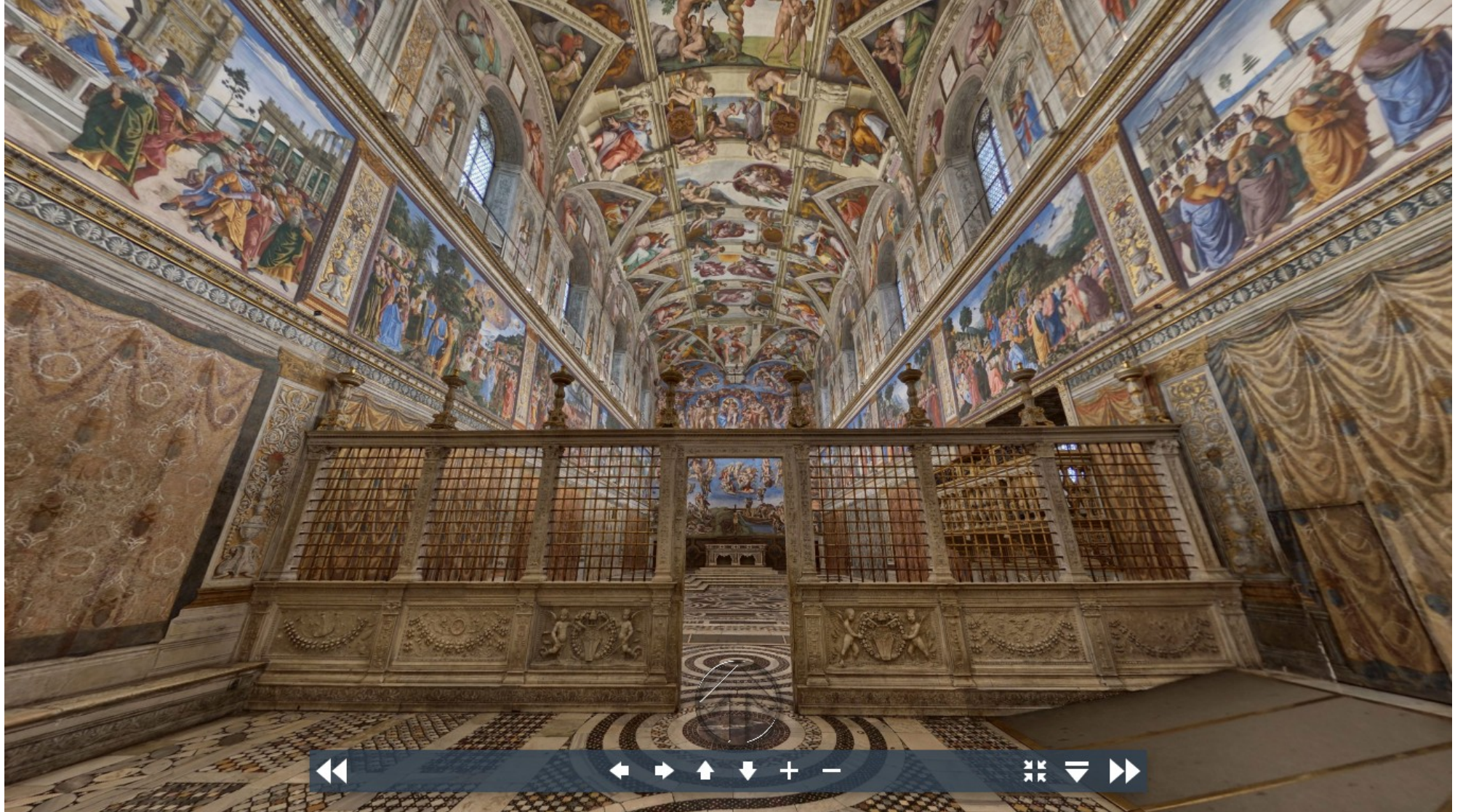
MADE
Competence Center I4.0

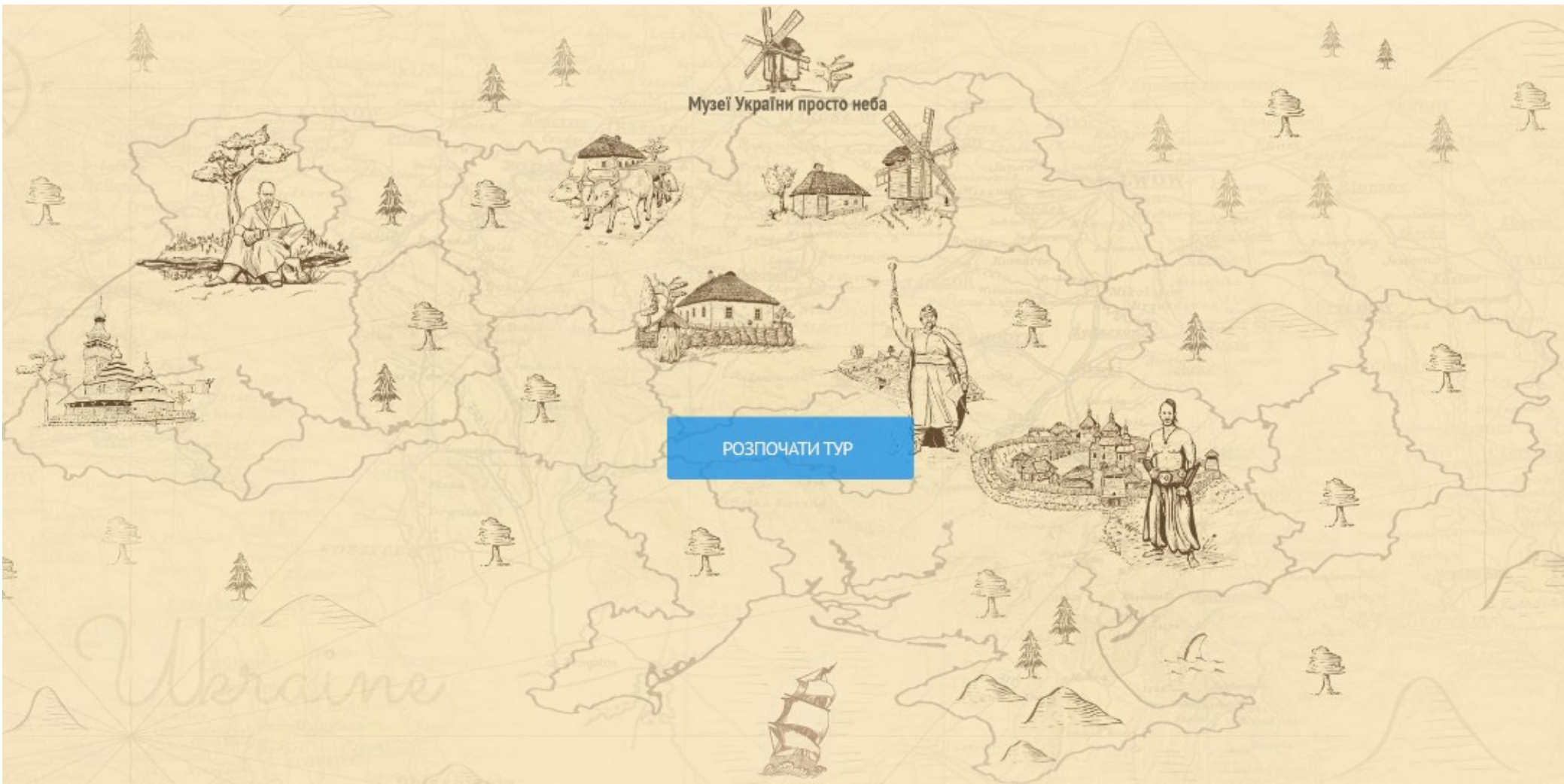
www.made-cc.eu



www.made-cc.eu

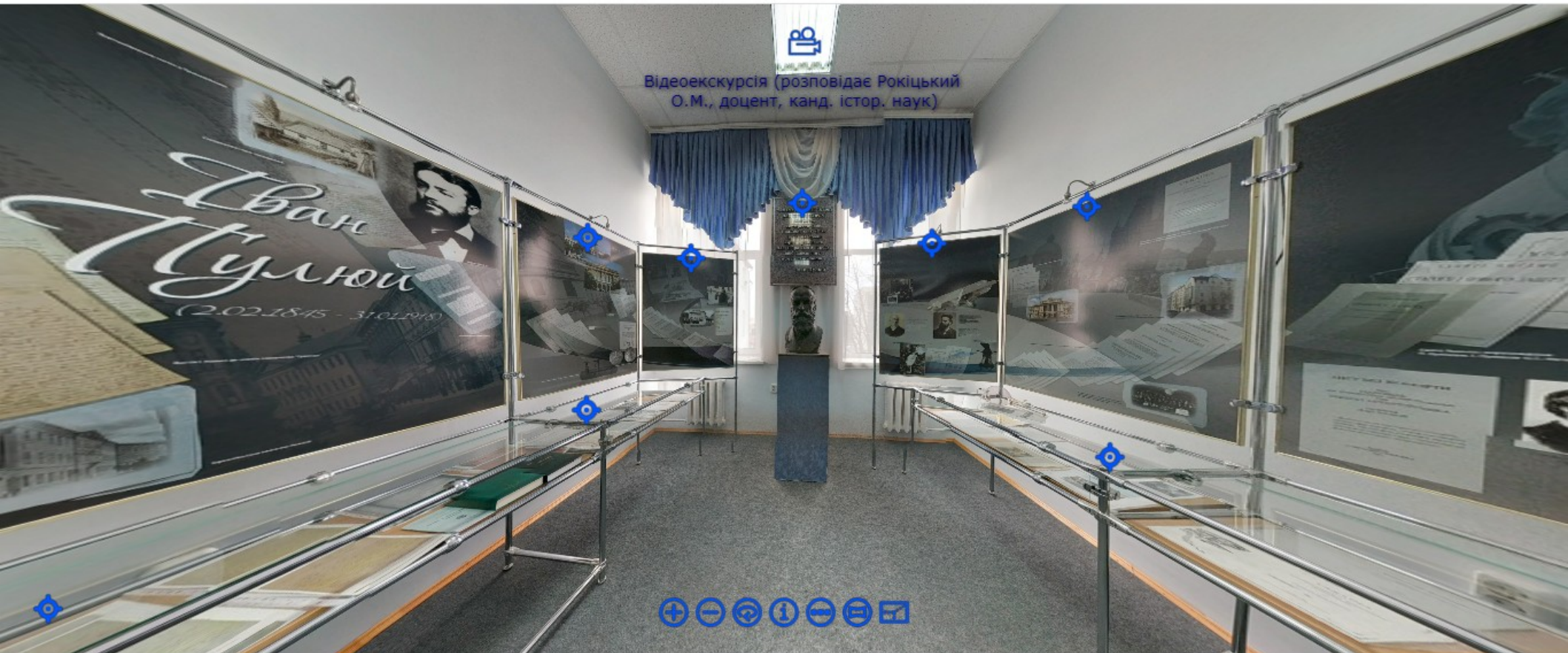


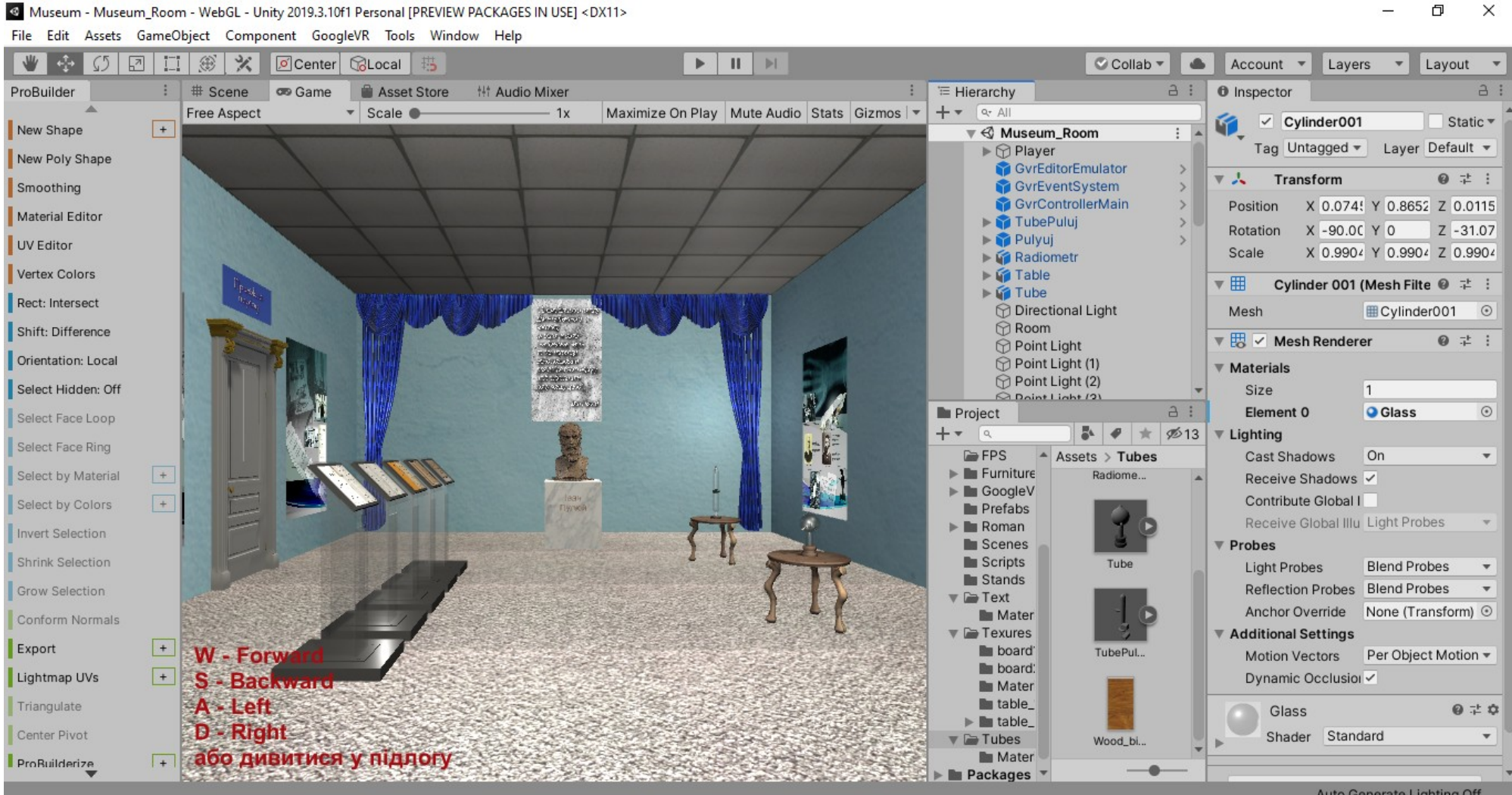




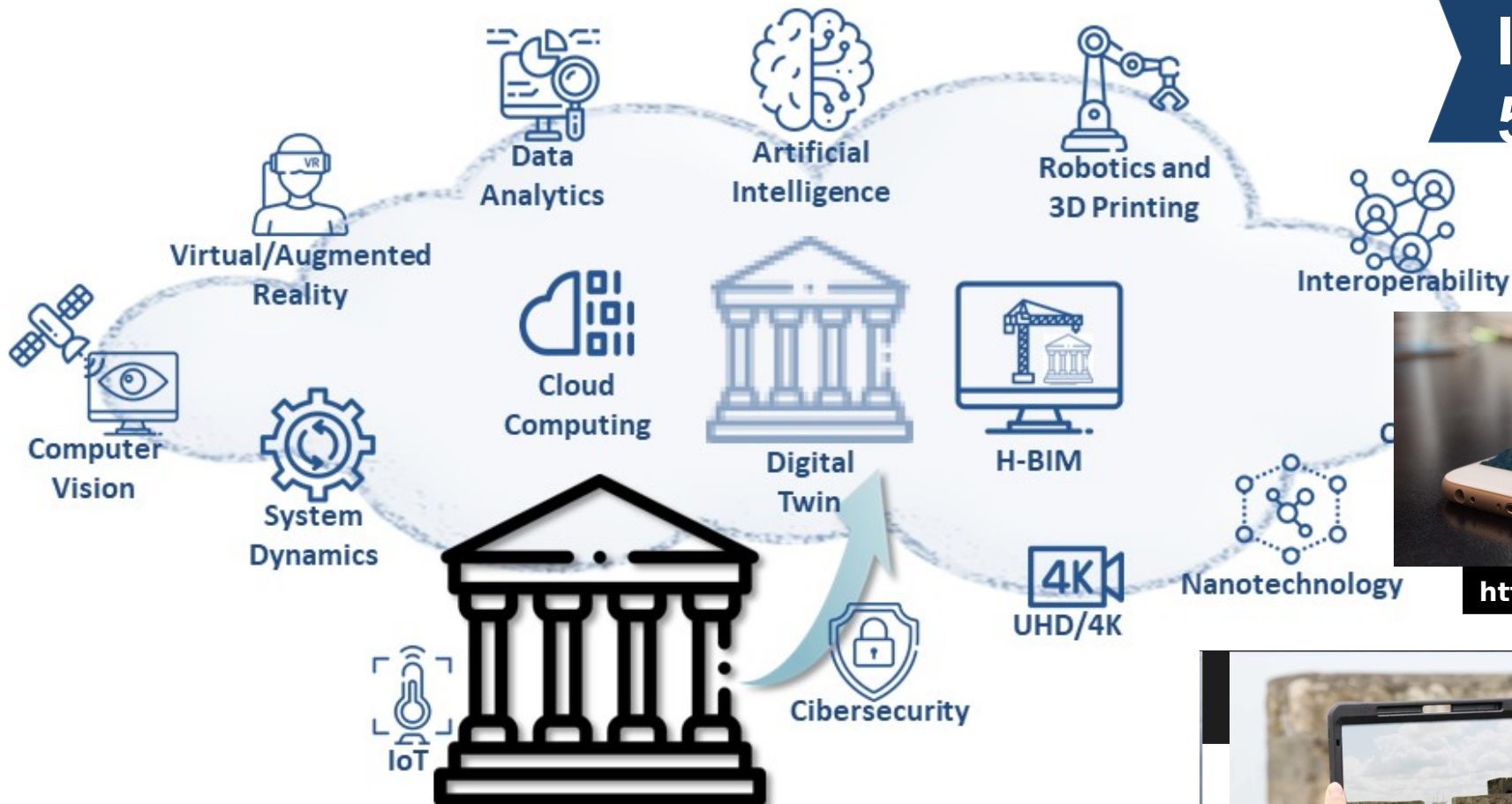
<https://museums.authenticukraine.com.ua/ua/>

<https://pulu-j-museum.tntu.edu.ua/>

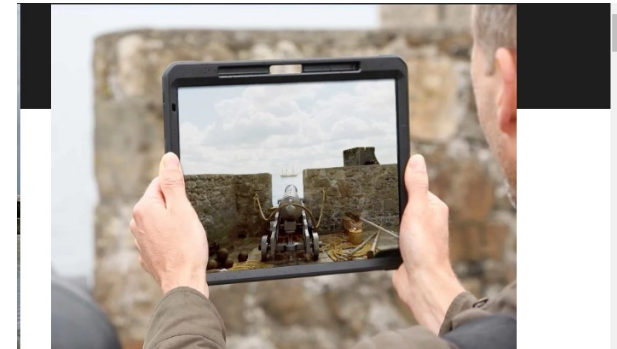




Industry 5.0



<https://curve.gr/en/>



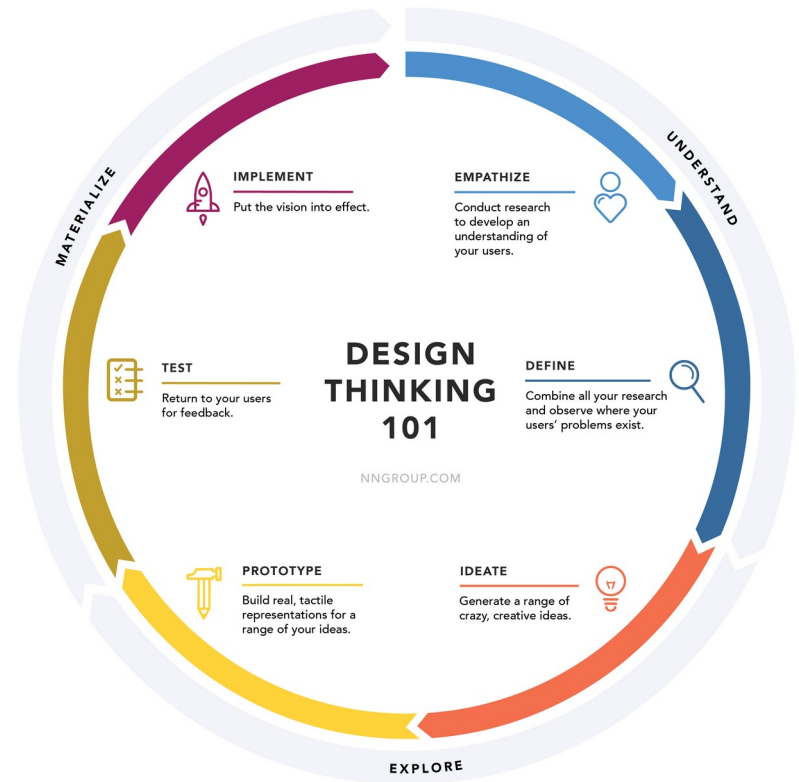
<https://blog.cartif.es/en/digitizing-cultural-heritage-what-are-we-talking-about/>

<https://curio.zubr.co/case-study/carrickfergus-castle/>

Time to wrap up.

So, what do we use in design of smart building of tomorrow?

- new ideology,
- new materials,
- new enabler technologies,
- new requirements...



and be
aware of real
nature of our
world...

