

#AIAEC2021

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# Harvest the power of the building digital twin with artificial intelligence

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Artificial Intelligence in Architecture, Engineering and Construction

**AI in AEC CONFERENCE 2021**

March 24-25, 2021 **Virtual Conference** ●●

# Foundation TECNALIA Research & Innovation

We are a leading research and technological centre in Europe.

*Our mission unites us:*  
we transform technology into GDP.

*And our vision sets us apart:*  
to be agents of the transformation of the industry.

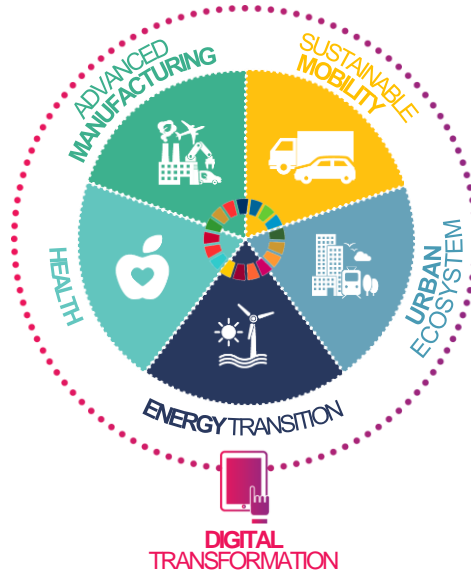


1.446 staff members



255 PhD

## SCOPES OF ACTION



## IMPACT SERVICES



Laboratory Services

R&D and Innovation Projects

Development of Investment Opportunities

> 7.800 CLIENT COMPANIES  
(2011 - 2020)

75%  
SMEs

25%  
Large companies

## Why now?

1943

- Walter Pitts and Warren McCulloch create a computer model based on the neural networks of the human brain

1956

- John McCarthy coins the term “Artificial Intelligence” at a conference in Dartmouth

1960

- Henry J. Kelley propose the first continuous back propagation model

1979

- Kunihiko Fukushima uses the first convolutional neural networks

1997

- Computer program Deep Blue beats world chess champion Garry Kasparov



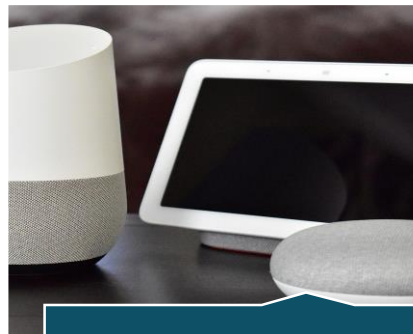
## Heterogeneous data sources



PLC



Wireless sensors

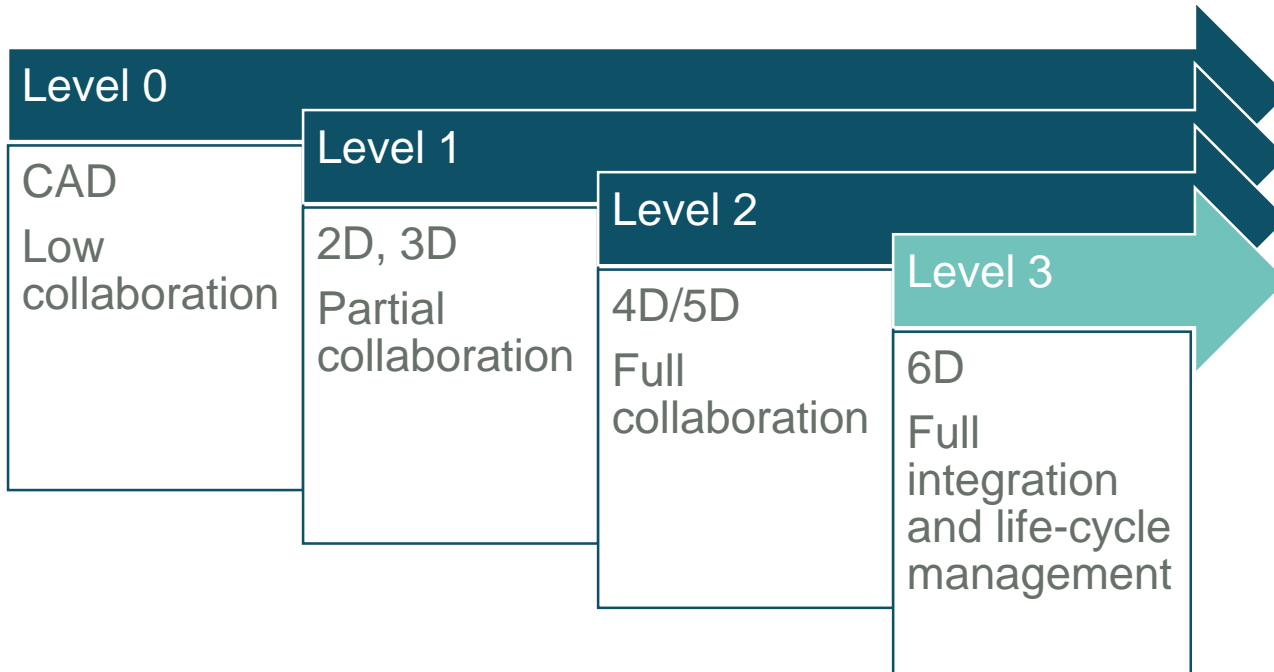


Smart home



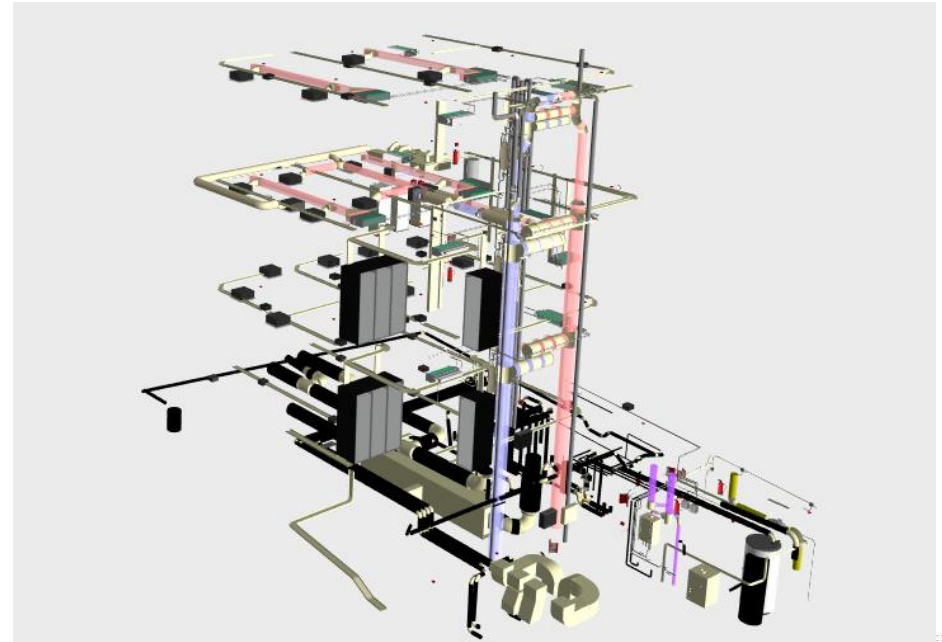
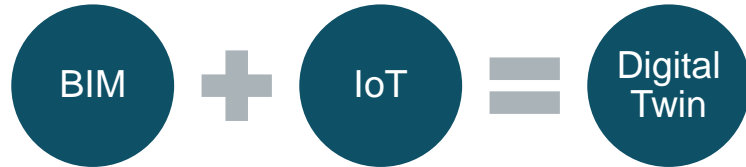
User inputs

# Moving to BIM maturity level 3



## Building digital twin

The technical bases of the construction industry are ready to move to the next level of digitalisation



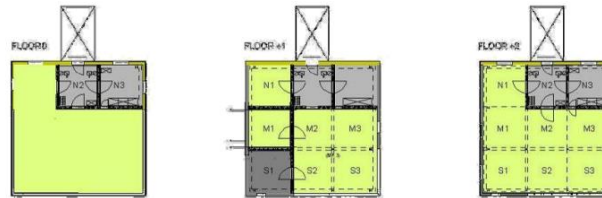
Source: Tecnalía

# From experimental platform for building technologies ...

KUBIK is a building with **configurable architecture**:

- ❑ Configurable exterior elements (facades, Windows, roof, shading system)
- ❑ Configurable internal partitions
- ❑ Accessibility and aging laboratory

More than 800 sensors that record the internal and external test conditions.



Configuration (2010)

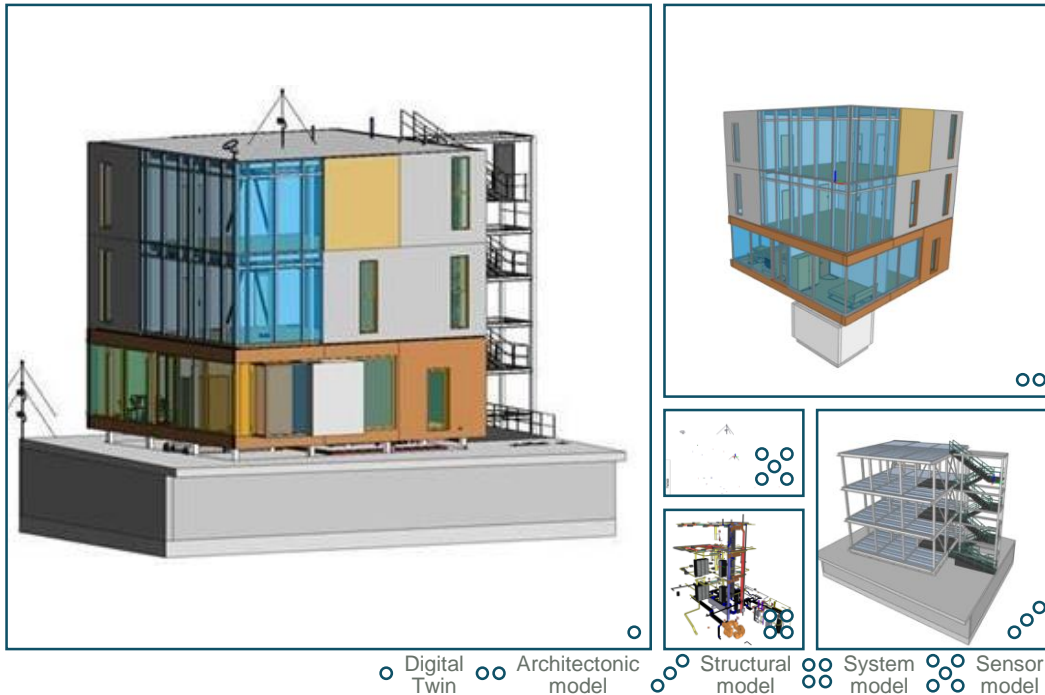


■ Individual test cells  
■ Test facade

■ Highly glazed open space (77m<sup>2</sup>)  
■ Highly glazed open space (44m<sup>2</sup>)  
■ Highly glazed open space (44m<sup>2</sup>)

Configuration (2011)

## ... to KUBIK 4.0 Digital Twin



**KUBIK 4.0** has an infrastructure of:

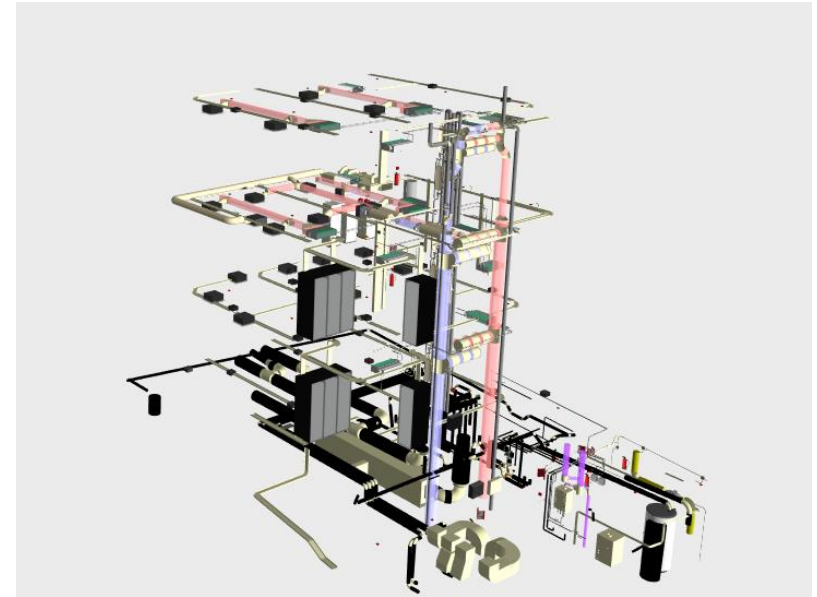
- ❖ Simulation of both a **tertiary and residential** environments
- ❖ Singular and experimental **thermal systems**
  - ❖ Heat pump coupled to PCM thermal storage battery.
  - ❖ Solar thermal installation
  - ❖ Absorption equipment
- ❖ **IoT node** for data interconnection where the different technologies on the market coexist to monitor and control the facilities (Modbus, Backnet, KNX, Dali, Z-wave, EnOcean, LORA, ...).
- ❖ It has a complete **monitoring and control** system of the installation that allows up to 10 structural or digital experiments to be carried out in parallel.
- ❖ **Installation Virtualization Environment.** BIM-MEP model of the installation connected in real time with the building's infrastructure. Allowing a complete monitoring of the installation.

# Respond to the needs of the physical world

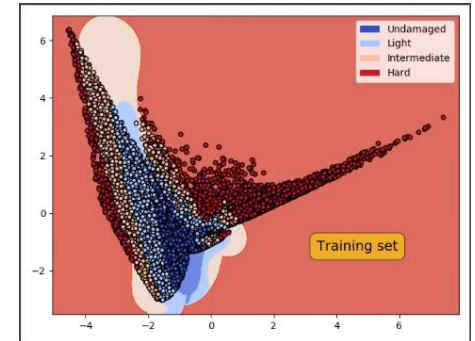
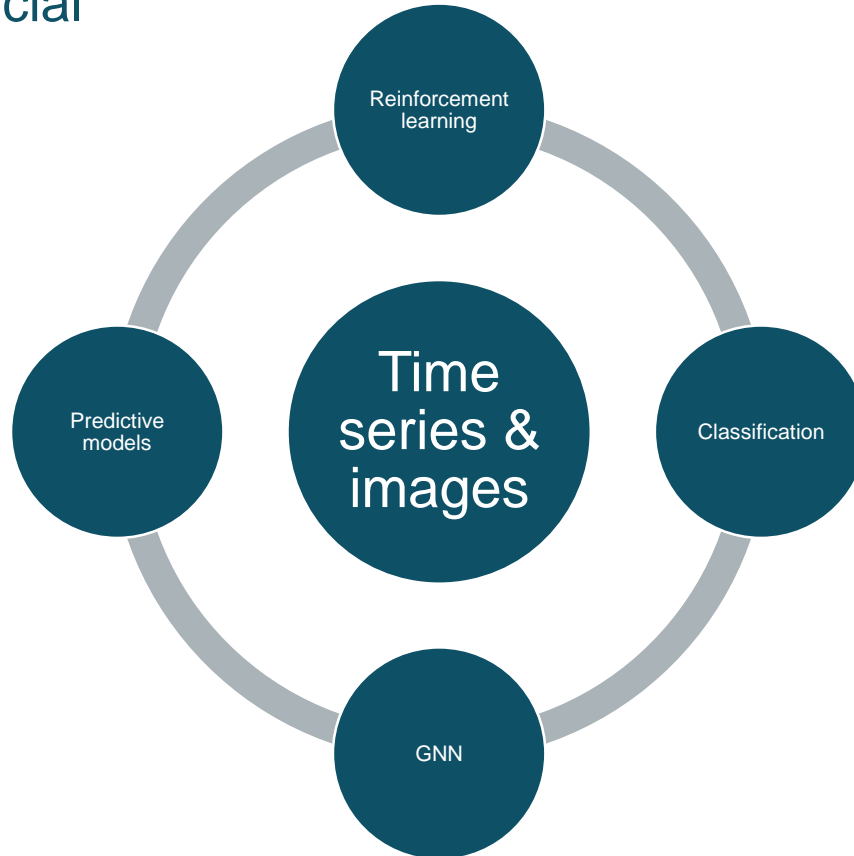
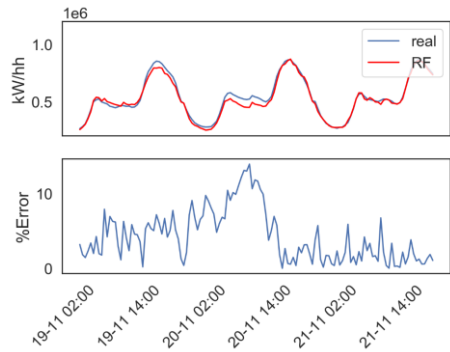


## Like never before we can ...

- ❑ Exploit the big quantity of data harvested during the building life cycle (design, technical characteristics, data, ...)
- ❑ Maintain the knowledge gained when the actors change
- ❑ Know in real time the state of all the components of the building and predicting their future behaviour
- ❑ Consider all the scales of the building, from the high-level processes' conceptualisation to the performance of each individual equipment
- ❑ Test new configurations and generate scenarios
- ❑ Visualize and plan during the building life cycle



# Where does artificial intelligence fit?



# Digital twin for the building life cycle



Design



Construction



Operation & Maintenance



Decommissioning

## Hybrid ecosystem



Use



User



Physical infrastructure



Technical infrastructure



# Diversity of use



# Aging population

Antón, M.Á.; Ordieres-Meré, J.; Saralegui, U.; Sun, S. Non-Invasive Ambient Intelligence in Real Life: Dealing with Noisy Patterns to Help Older People. *Sensors* 2019, 19, 3113.

<https://doi.org/10.3390/s19143113>

## GESTOR GIRO

Cambio de idioma: Castellano

Hola Amaia

MONITORIZACIÓN

CONFIGURACIÓN DEL SISTEMA

HISTÓRICO

INFORMES

MONITORIZACIÓN

Habitacion 2 - CO2

TIPO SENSOR

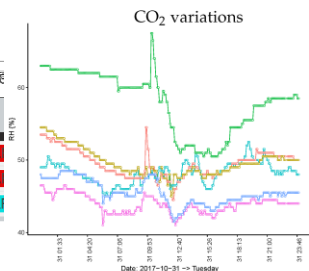
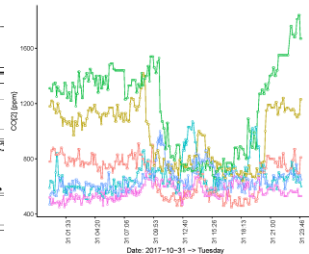
VALOR 1360 ppm

ESTADO Nivel alto

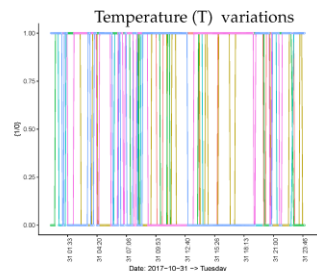
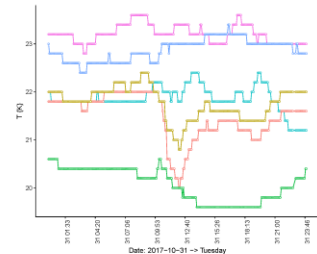
FECHA: 2017-07-17 09:23:02

**ALERTAS ACTIVAS**

Habitacion 2 - CO2	lunes 17 de julio de 2017 2:12:44	ALTA
Habitacion 3 - Humedad	martes 4 de julio de 2017 11:55:53	ALTA
Habitacion 3 - Temperatura	martes 4 de julio de 2017 11:16:03	ALTA

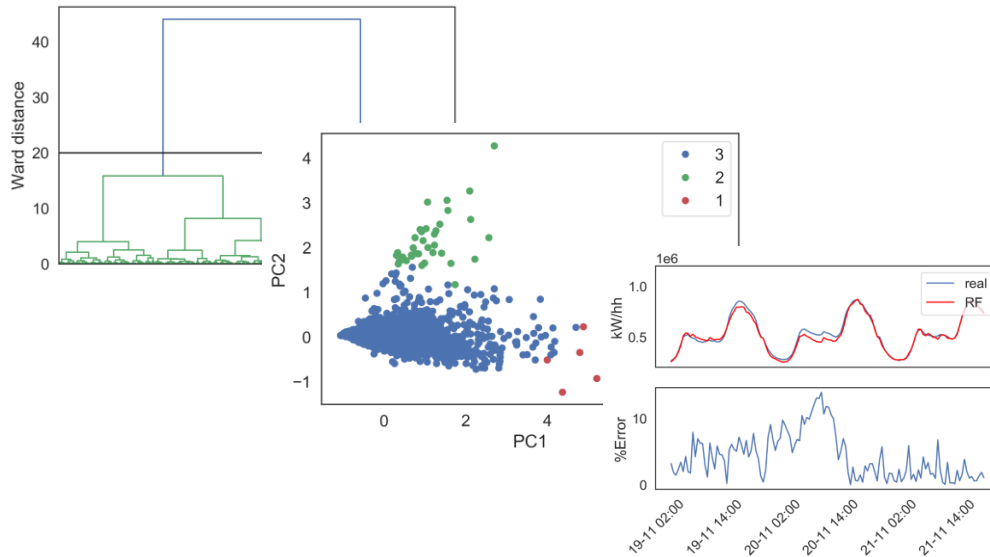


Relative humidity (RH) variations



Presence sensor variations

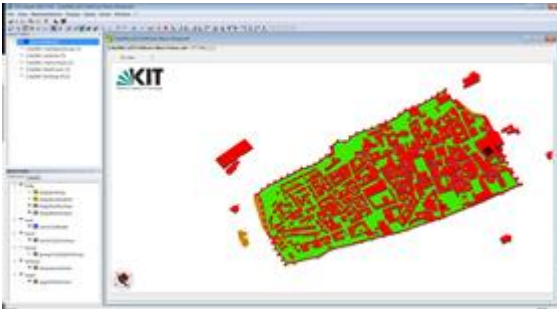
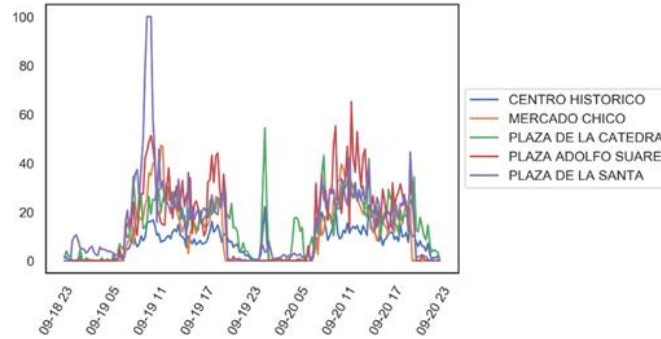
# Energy behaviour



**Noyé S**, Saralegui U, Rey R, Anton MA, Romero A. Energy demand prediction for the implementation of an energy tariff emulator to trigger demand response in buildings. E3S Web Conf. 2019;111:05025.

<https://doi.org/10.1051/e3sconf/201911105025>\_Clima19

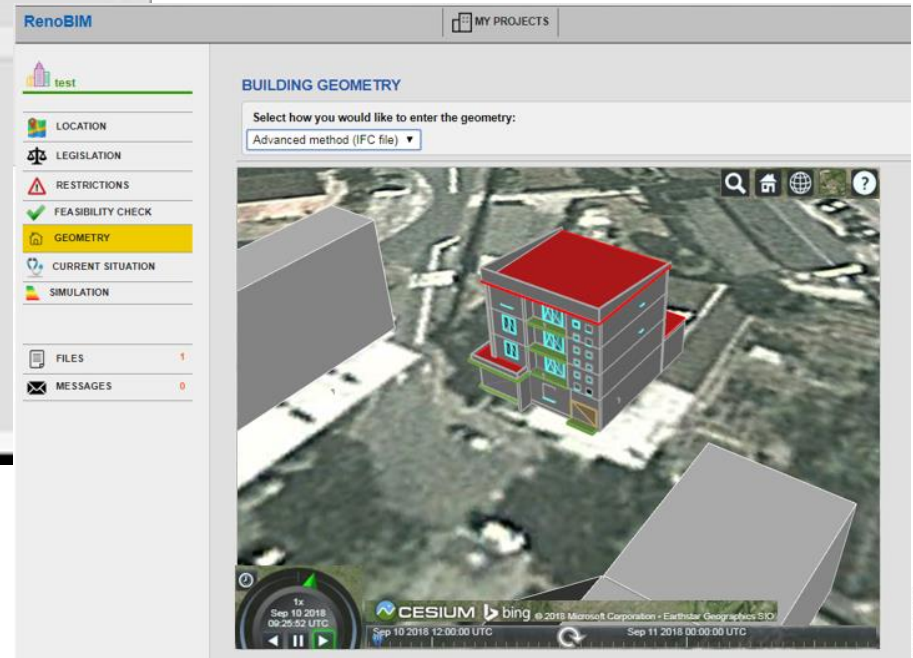
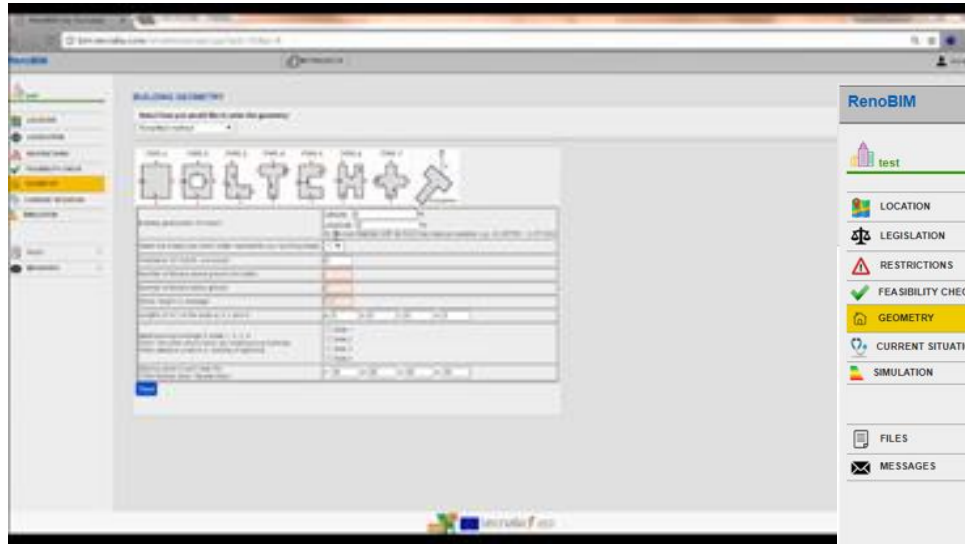
# Management of historical heritage

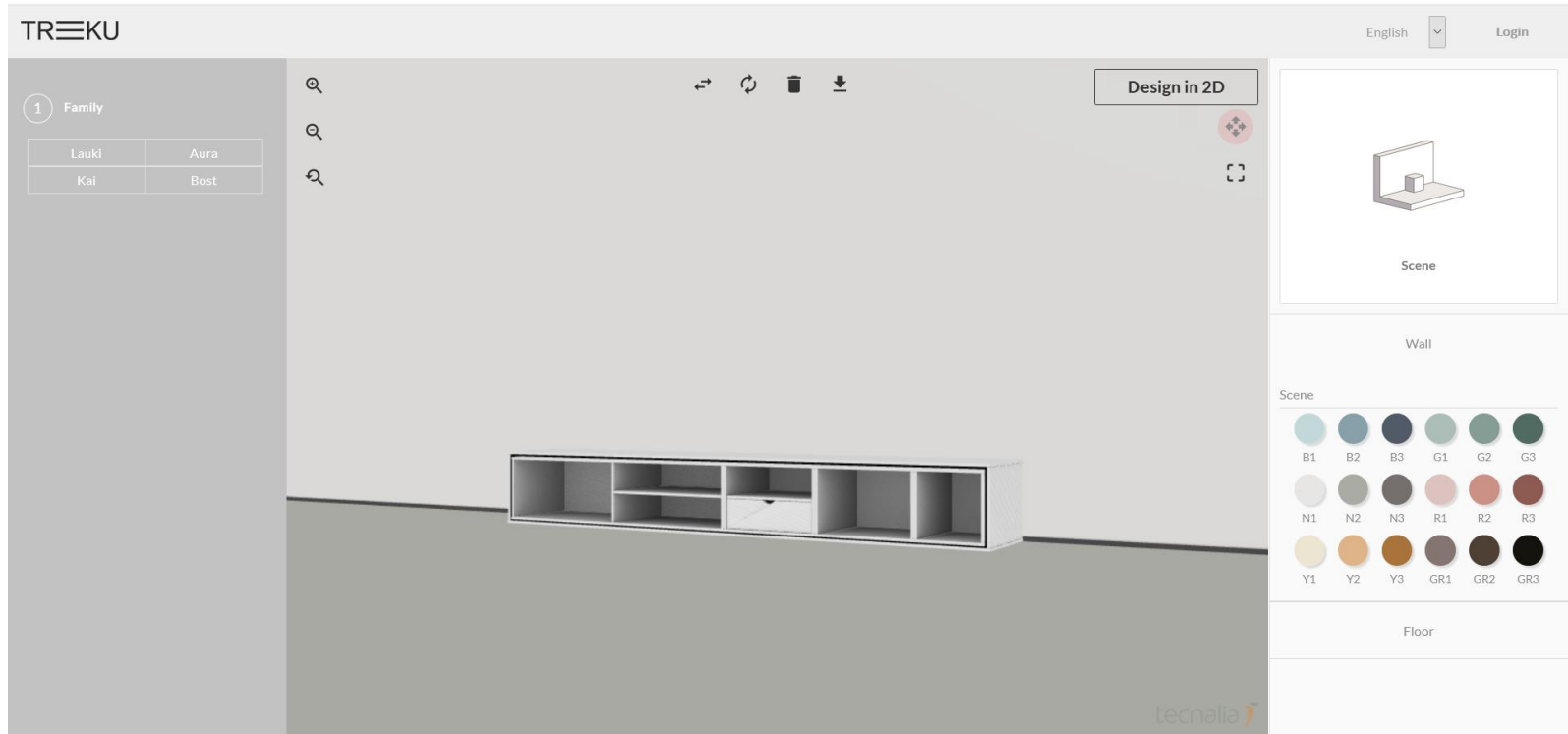
Zubiaga, M.; Izkara, J.L.; Gandini, A.; Alonso, I.; Saralegui, U. Towards Smarter Management of Overtourism in Historic Centres Through Visitor-Flow Monitoring. *Sustainability* **2019**, *11*, 7254.

<https://doi.org/10.3390/su11247254>

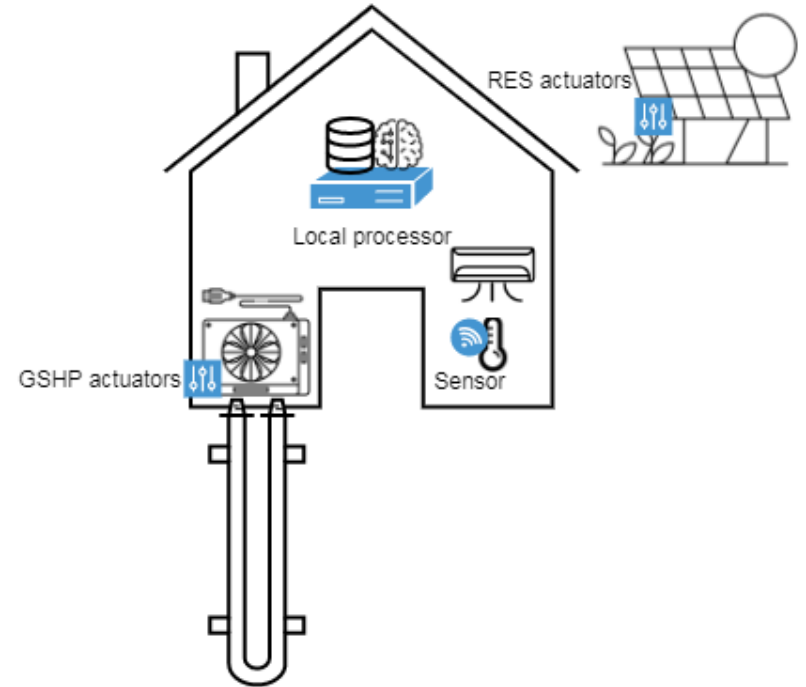
# From parametric design ...



# ... to generative design



# Control of a multi-renewable system with GSHP



# Energy management



GESTOR DEL EDIFICIO

MONITORIZACION CONFIGURACION DEL SISTEMA INFORMES HISTORICO

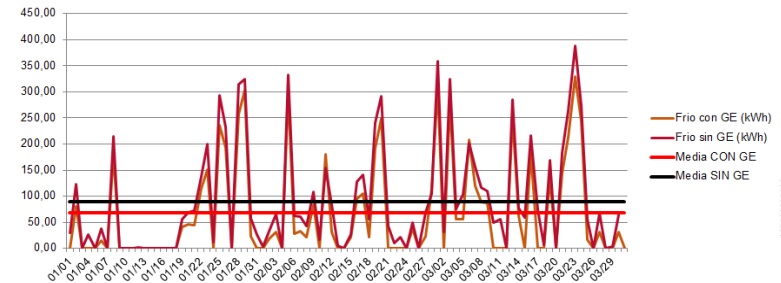
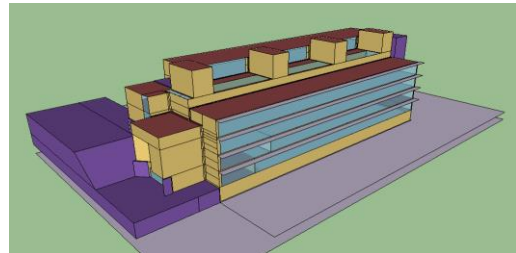
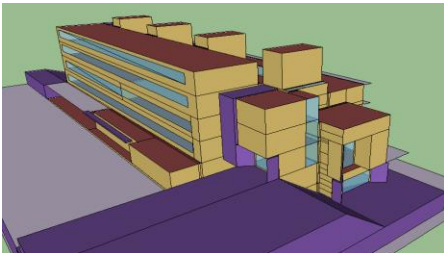
ILUMINACION CLIMATIZACION AFANADOS CONTROL INSTALACIONES GENERACION TERMICA

Seleccione la vista: Trabajo

ALERTAS ACTIVAS

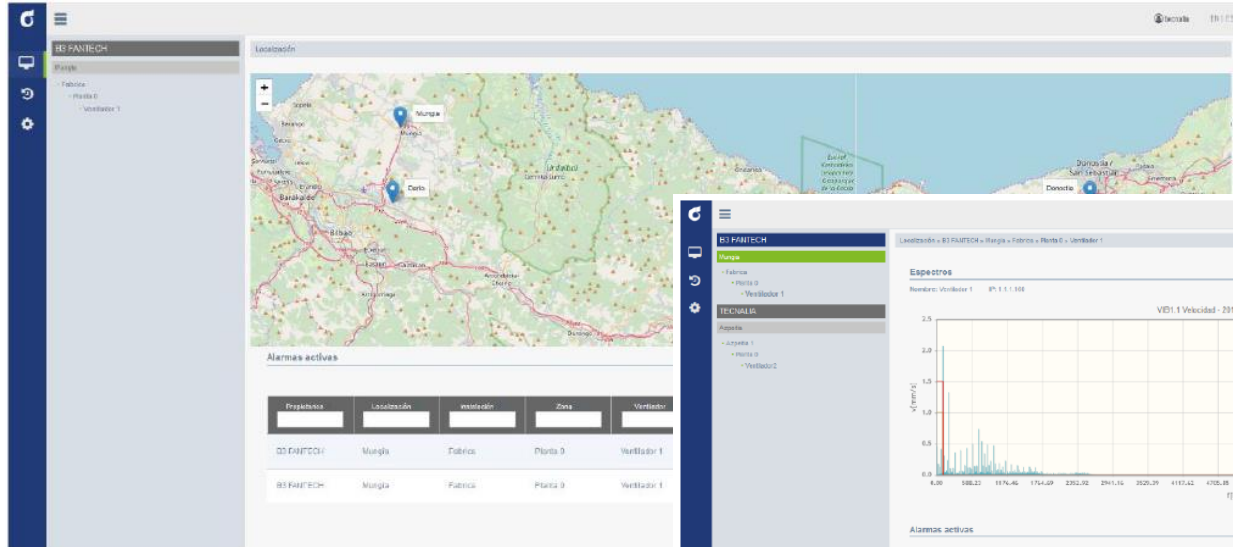
FECHA	ESTADO	TIPO	VALOR	CATEGORIAS	LOCALIZACION	BORRAR ALERTA
Tue Oct 15 16:23:53 CEST 2013	ALARMAS	SWITCH	up	ILLUMINATION	Planta 8	Borrar
Tue Oct 15 16:19:23 CEST 2013	ALARMAS	BLIND	up	ILLUMINATION	Planta 1	Borrar

by TECNIALIA



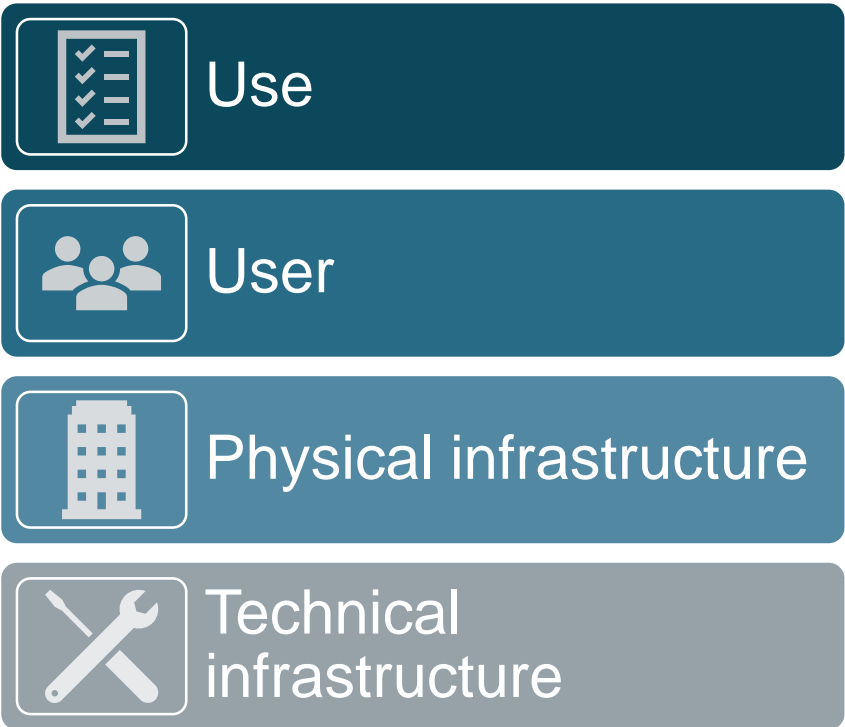
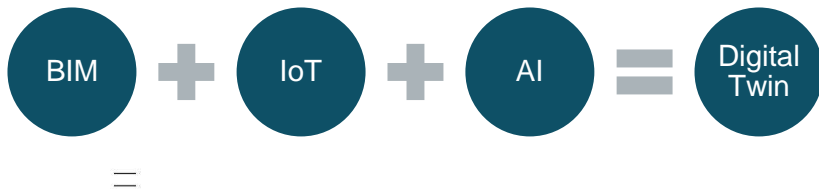
# Maintenance

From reactive to predictive, preventive and corrective maintenance



## Harvest the power of the building digital twin with artificial intelligence

- The construction industry is ready for digital twins
- AI is key to achieve DT's potential
- The digitalisation will only be successful if use, user, physical infrastructure and technical infrastructure are considered together



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Thank you for your  
attention

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PROGRAMA DE APOYO A LA REALIZACIÓN DE PROYECTOS DE INVESTIGACIÓN INDUSTRIAL Y DESARROLLO EXPERIMENTAL DE CARÁCTER ESTRATÉGICO EN LA CAPV - Programa ETORGAI  
ACTUACIÓN COFINANCIADA: Proyecto nº ER-2014/00017 - GIRO  
ACTUACIÓN COFINANCIADA POR EL GOBIERNO VASCO Y LA UNION EUROPEA A TRAVÉS DEL FONDO EUROPEO DE DESARROLLO REGIONAL 2007-2013 (FEDER)

The HOLISDER project has received funding from the European Union's H2020 research and innovation programme under grant agreement No 768614

The EPC RECAST project has received funding from the European Union's H2020 research and innovation programme under grant agreement No 893118

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The BIM4REN project has received funding from the European Union's H2020 research and innovation programme under Grant Agreement No. 824395.

PROGRAMA DE AYUDAS DE APOYO A LA I+D EMPRESARIAL - HAZITEK  
ACTUACIÓN COFINANCIADA: Proyecto nº ZL-2020/00523 - DMIX  
ACTUACIÓN COFINANCIADA POR EL GOBIERNO VASCO Y LA UNION EUROPEA A TRAVÉS DEL FONDO EUROPEO DE DESARROLLO REGIONAL 2014-2020 (FEDER)

The GEO4CIVHIC Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 792355